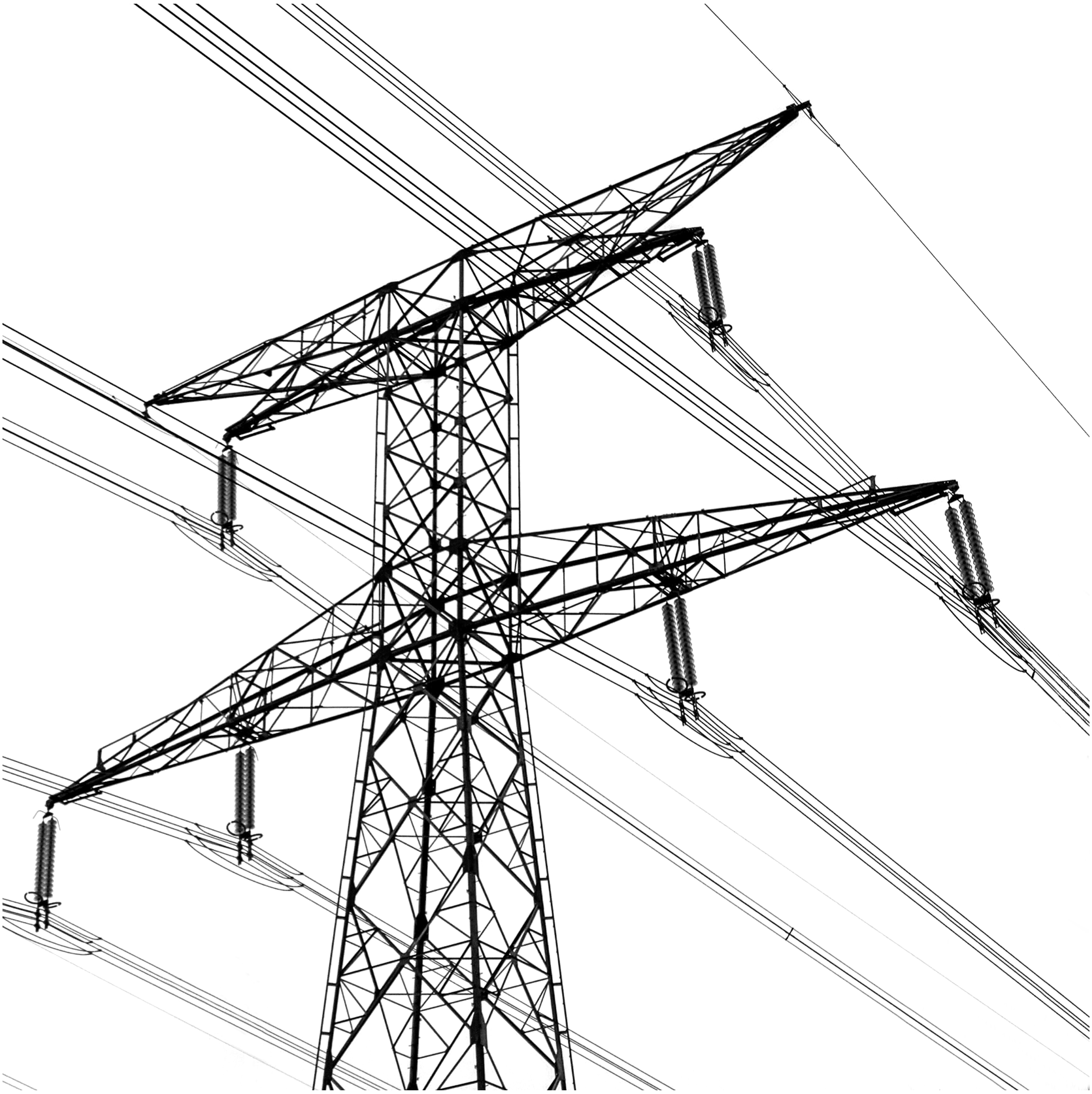

The Energy Sector and Energy Policy of the Czech Republic

Tomáš Vlček et al.

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Abstract

This book addresses various aspects of the energy sector of the Czech Republic. There is hardly a more turbulent or more sensitive sector of the Czech economy than the energy sector. As a result, its future is carefully monitored not only by the political and economic elite of the country, but also by the general public.

The book *The Energy Sector and Energy Policy of the Czech Republic* is divided into eight chapters. The first describes the key actors and legislative framework of the energy sector of the Czech Republic, including an analysis of the Government, the Ministry of Industry and Trade, the Ministry of the Environment, and other legislative and regulatory bodies and political parties. The second chapter introduces the rich and complicated history of the development of the Czech national energy sector. The following chapters familiarize the reader with coal, oil, natural gas, nuclear, renewables industries, and electricity and heat.

The intended readership consists of scholars and researchers, as well as experts in the relevant fields of study, but the book will also serve as a guide for those outside academia who work with the topic daily, such as in public administration. Finally, the general reader can make great use of this book to gain a thorough yet accessible impression of the Czech energy sector.

Introduction

In 2013, a monograph of the same name was published, building on the success of its 2012 Czech edition. Understood and meant primarily as a textbook for students of energy policy and the energy security of the Czech Republic, the book quickly found an audience among the scholars, journalists, researchers and practitioners of energy policy in the Czech Republic. The book covered all Czech energy sectors, their history, legislation, and actors and thus gave readers a comprehensive and nuanced picture of the situation.

However, within the Czech economy, there is no sector more sensitive or more turbulent than energy. Thus, some years after the publication of the first edition, the data and information it contained slowly became dated and it lost its original reliability and competence. For this reason, a group of outstanding graduates and lecturers of the International Relations and Energy Security program at the Faculty of Social Studies of Masaryk University decided the monograph needed to be updated.

Dear reader, the outcome of our joint effort you hold in your hands.

The monograph has become an edited book but retains its original structure. Starting from a detailed historical excursion through the development of the Czech energy sector, we put forward basic information regarding individual energy commodities, electricity and heat, while we have devoted a part of the book also to foreign policy issues. The book thus contains chapters on historical developments, actors and legislative background, and the individual commodity sectors–coal, oil, natural gas, nuclear energy, renewables, and the electricity industry. Since the energy industry is a complex topic, the book is supplemented by a number of tables showing and illustrating the relevant subjects of discussion.

The ambition of this publication is not to be a complete guide to the subject at hand, and the authors had to, for lack of space, leave out a number of issues. Accordingly, the book is not primarily intended for the direct use of experts in the field, who, as part of their tightly delimited fields, have likely available more detailed and expert works to consult. The target group is a broader public audience, predominantly including the academic, and it strives to give a more comprehensive picture of the sector, to lay out the problems and provide knowledge for further studies or contemplation. It is precisely this broader public that might feel a keen lack of sources of information that would allow them to lead a decent debate addressing energy issues. For this reason, we hope this publication will meet the stated purpose, and that it will be useful to the readers in their efforts to become acquainted with the very interesting story of the Czech energy sector.

Brno, August 2019
Tomáš Vlček

Chapter 1: Actors in, and the Legislative Framework of, the Czech Energy Sector[1]

Tomáš Vlček, Filip Černoch, Veronika Zapletalová

The energy sector of any state, including the Czech Republic, presents an active arena comprising the clash of interests and priorities of a diverse spectrum of actors–starting with offices of state and continuing through to private companies. Providing a concise characterization of at a minimum those actors that represent the state–their competence, influence, interests and activities–is therefore a logical part of this book. In the second part of this chapter this information will be supplemented by an assessment of the legal framework of Czech energy, including the introduction and evaluation of basic conceptual documents and reports.

Given the broad subject matter, we will narrow the entire issue down to the period from 2006, when the Government of Mirek Topolánek commenced, through to the end of 2018.

1.1 State Institutions

On the following pages, the chief governmental bodies and relevant regulatory institutions responsible for the management of the energy sector are introduced.

1.1.1 The Ministry of Industry and Trade

In terms of formal competence, this is the central government body that oversees the production, transport, and trade of energy and the preparation of energy related strategic documents, primarily of the State Energy Concept, the Integrated Raw Materials Policy, and the Use of Mineral Resources. It is also the central governmental body for commodity exchange, except for issues under the purview of the Ministry for Agriculture, and also supervises inspections in the energy sector. This ministry is also responsible for legislative coordination and for the implementation of European law within the department. (Ministry of Industry and Trade, 2019)

Because of the authority entailed by the position, the Minister of Industry and Trade has a unique opportunity to give Czech energy policy a specific shape. Unsurprisingly, the functioning of the Ministry of Industry and Trade is significantly influenced by particular person who currently serves as minister.

Following the elections to the Chamber of Deputies of June 2–3, 2006, this job was given to the liberally-oriented electrical engineer and lawyer Martin Říman (ODS). His appointment did not give rise to any notable political dispute, but during his term of office he did arouse opposition, predominately from the coalition Green Party and the opposition Social Democrats (ČSSD). They were, above all, dissatisfied with his role in preparing the National Allocation Plan[2] for 2008–2012, in which he arranged for the Czech Republic to receive an average 101.9 million tonnes of emission allowances per year, a 25% increase on 2005. This opened hime to the charge that he was allowing an increase in the emissions burden on the environment, although he never betrayed the actual wording of the election campaign program of his party because the platform never mentioned emission limits (see European Commission, 2006).

1 This chapter makes substantial reference to the text *The Czech Energy Policy as the Matter of Political Parties' Decision-Making: Aggregation and Articulation of Interests in terms of Their Intensity and Consistency* (Černoch, Zapletalová, Vlček, 2010, p. 255-284).

2 The key element of the EU ETS emission allowances trading system is that it decides how allowances will be allocated in the Czech Republic and to what companies.

He also received a great deal of criticism for supporting the breach of territorial limits on brown coal mining in North Bohemia and consenting to the construction of two additional blocks at the Temelín nuclear power plant. For these actions, Martin Říman won the (anti)award 'Gobbler of the Year' in 2006. But it is also true that his actions were substantially based in the 2004 State Energy Concept (see Anketa Ropák & Zelená perla, n.d.).

Following the appointment of Jan Fischer's Government on May 8, 2009, Říman was replaced as Minister of Industry and Trade by a non-partisan, Vladimír Tošovský, nominated by the Czech Social Democratic Party (ČSSD), also an electrical engineer, with broad working and professional experience in the field. During his year in office, he pursued a more conservative energy policy based on domestic resources. The energy concept he proposed accepted that mining limits would be breached, uranium mining extended, coal mining in Beskydy would continue, and greater exploitation of nuclear energy would take place (see Kubátová, 2009).

Under the new Government headed by Petr Nečas, the post of Minister of Industry and Trade was assumed on June 13, 2010 by the economist Martin Kocourek[3] (ODS); therefore, after a long time a politician without expertise and a professional background in the energy sector had the job. Nor did he hide his inclination towards more robust exploitation of nuclear fuel and coal, and he remained in the post long enough to see through a new draft State Energy Concept that called for expanding Czech nuclear power by 15 units with 1,000 MW capacity each. Both experts and the general public strongly opposed the notion for the unrealistic calculations it relied upon and the infeasibility of construction (see Lukáč, 2011). Kocourek lost his position in a financial scandal, in which he practically confessed he had swindled his wife out of part of their joint property during divorce proceedings. (see Ekonom, 2011)

Despite reservations on the part of the public[4], on November 16, 2011, the vacant ministry was filled by Martin Kuba (ODS). He announced the preparation of a new, more balanced revision of the State Energy Concept, took a long-term stance on the need nuclear power, including support for completion of the Temelín nuclear power plant, and did not hide his disdain for providing further support for renewables.

During the rather turbulent 2013–2018 period, seven ministers rotated through the position, only one of whom had enough time to really have an impact on energy sector of the country. Jan Mládek (ČSSD) served from January 29, 2014 – February 28, 2017 and cultivated a conservative approach to energy. Under his supervision, a 2015 State Energy Policy Update was prepared that strongly emphasised nuclear energy and the coal industry. (Ministry of Industry and Trade, 2015) Mládek initiated a debate on opening a new uranium mine at Brzkov, insisted that the government take over the collapsing OKD hard coal company, and further sensitised the topic of territorial ecological limits that restricted production in the North Bohemian and Sokolov brown coal basins by partially rescinding them. (Baroch, 2014), (Černoch, Lehotský, Ocelík, Osička, & Vencourová, 2019)

If we look at the group of ministers that held this position in succession, there is apparent a major similarity in their preferences and ideas on how the Czech energy sector should look in the future. In their eyes, it should be based on local resources, coal mining, and uninterrupted support for the nuclear power industry. They also held in common a restrained attitude towards renewables and reliance on savings and energy efficiency. Scepticism about energy-environmental proposals coming from the European Union was prominent, with individual ministers accepting them only to the minimum possible extent.

Aside from specific ministers, the Ministry of Industry and Trade can in any case be marked as one of the main creators of the Czech energy sector, at least at the level of public administration. Its authority and influence rank highly in the country, while playing a much lesser role in international forums and at EU level, sharing power, for example, with the Ministry of Foreign Affairs.

1.1.2 The Ministry of the Environment

The other important body in the energy field is the Ministry of the Environment. This is the central body of the government administration for protection of the environment in general, for operation of the National Geological Survey, protection of the mineral environment, including mineral resources and groundwater, geological work, and environmental mining supervision. It is also responsible for environmental impact assessments on industrial

3 We should not however understate his activity in the Supervisory Board of ČEZ, a.s. in 2006–2010.

4 Aside from the lacking education in the field, the new minister was reproached also for his previous alleged connection with the company PSM, based on the principle of a pyramid scheme, as well as for his disputable working activity in the South-Moravian Region, where he came into contact with one of "the ODS godfathers", Pavel Dlouhý (see Kopecký, Šťastný, 2011).

activities and their consequences, including cross-boundary, and stands behind the National Environmental Policy. As part of the safeguarding and oversight activity of the Government, the Ministry of the Environment coordinates activities of an environmental character performed by all ministries and other central administrative authorities. (Ministry of Environment, 2019)

Like the Ministry of Industry and Trade, the Ministry of the Environment is strongly affected by the person at the top. Following the 2006 elections, the post of Minister of the Environment was assumed by a non-partisan, Petr Jan Kalaš. After some five months, on January 9, 2007, he was replaced by the then-president of the Green Party, Martin Bursík. With his arrival, the Ministry of the Environment experienced a phase in which it played a very active and important role within the Czech energy sector.

As a representative of the new party in the Parliament, the Green Party, Bursík's aspiration to be Minister of the Environment was logical. In relation to electoral success (6.29%, 6 MPs in the Chamber of Deputies), this position then provided the Green Party with negotiating power above its weight. Such a position helped the Green Party find a way to implement basically all the crucial energy points of its election campaign program, specifically environmental tax reform, an Act on Promotion of Renewable Energy Sources, postponement of a decision on the construction of new nuclear power plants, and departure from the policy of breaching environmental territorial limits on brown coal mining[5] (see Strana zelených, 2006, p. 14–18).

Passing the above-mentioned propositions would have most likely been impossible if the result of 2006 elections had not been an impasse and if the coalition government had not been so dependent on just six Green Party MPs. While the policy statements of the Green Party and of the other governing party, the Christian and Democratic Union – Czechoslovak People's Party (KDU-ČSL) were fairly similar (mainly as concerns territorial environmental limits on brown coal mining, exploitation of renewables, and energy savings) and a consensus could be expected even without the impasse after the 2006 elections, the consensus between the Green Party and the leading government party, the Civic Democratic Party (ODS) on postponing the decision on construction of new nuclear power plants and no longer breaching the territorial environmental limits on brown coal mining should be to a great extent perceived as the outcome of the indecisive election and the need to cooperate (see KDU-ČSL, 2006, p. 40). Proof lay in the fact that when the coalition started to collapse, the political power of the Green Party dropped significantly. The first serious sign of this was in February 2009, when the Chamber of Deputies rejected a draft amendment to the Environmental Assessment Act proposed by Bursík because of a lack of votes from the coalition ODS and KDU-ČSL parties (see ČT24, 2009).

With the appointment of the Jan Fischer Government on May 8, 2009, another rotation of the post of Minister of Industry and Trade occurred, making way for the non-partisan Ladislav Miko, nominated by the Green Party.[6] This educated biologist and environmentalist with long working experience in the Czech Environmental Inspectorate, was on leave of absence from the position he had in the Directorate–General for the Environment during his mandate at the Ministry. He returned to that position (see Aktualne.cz, 2009) not long after, on November 30, 2009, when the position of Minister of the Environment was assumed by the non-partisan (he suspended his membership in the Green Party for the function) Jan Dusík, also nominated by the Green Party. On March 19, 2010, he resigned from the post over a dispute about the reconstruction plan for the Prunéřov power plant, and on April 15, the Ministry of the Environment was taken over by Rut Bízková, who had some experience in the energy field–somewhat surprisingly, however, as spokeswoman for ČEZ coal power plants and as Counsellor to the Deputy Minister of Industry for energy, metallurgy, and civil engineering.

As in the Ministry of Industry and Trade, during the Nečas Government, two ministers rotated through the Ministry of the Environment as well. The first of them, Pavel Drobil, left at the end of 2010 (having been in the position, then, for about six months) over suspicions that he influenced investment tenders commissioned by the State Environmental Fund of the Czech Republic (see Aktualne.cz, 2010) He was replaced by the political scientist and lawyer Tomáš Chalupa, who devoted the initial year of his mandate to the dispute that then raged over Šumava National Park and the problematic Green Savings Program.

5 Among all parties succeeding at the 2006 elections, the Green Party had the best developed approach concerning the Czech energy sector.

6 Ladislav Miko accordingly stayed as Chairman of the Directorate for Nature within the Directorate-General for the Environment under the European Commission. He got two months leave to perform the function of minister and, given the unanticipated delay in the early elections, was forced to resign from that function.

After the six month reign of Tomáš Podivínský (Nonpartisan, July 2013 – January 2014) Richard Brabec (ANO) took over the position in January 2014, and he is still in office. The former CEO of fertilizer producer Lovochemie, a company owned by Prime Minister Andrej Babiš, and a man reservedly aspiring for the Ministry of Industry and Trade, was not welcomed to office by the environmental organization with optimism. (Novotný, 2017) As a minister, he has never come up with truly ambitious plans or actions, and his ministry has been accused more than once of being very responsive to the interests of his boss's business empire. (see Pšenička, 2017; Pšenička, 2017b) But he was also able to further or defend some significant pieces of environmental legislation. (see Bartoníček, 2017) In the energy sector, for example, his ministry supervised an ambitious program of subsidizing the exchange of obsolete solid fuel boilers with new and less polluting ones in homes, financed from European funds. (see Skoupá, 2017) His work so far has thus been accepted with mixed feelings among both industrial and environmental stakeholders.

As already stated, the Ministry of the Environment is a key actor in the Czech energy sector, mainly as a result of having the authority to interfere in the approval processes of various energy projects as well as having an effect on the final version of legal acts relevant to the energy sector. It is also to some extent expected to be a counterpart to the Ministry of Industry and Trade. One pursues the goal of a well-functioning industry and energy sector, the other of ensuring that this affects the environment as little as possible.

This role was compromised to some extent in recent years when ministers like Miko, Bursík, and Dusík, educated or experienced in the field and more or less dedicated to the effort to protect the environment, were replaced by Bízková, Drobil, and Chalupa (all ODS). The party never hid its reservations about the "anti-business" sentiment of the Ministry and openly called for "de-greening" the institution. "We want to proceed with a non-dogmatic, non-ideological approach", said Prime Minister Nečas (ODS) when launching Chalupa (see Dolejší, Frouzová, 2011). With Brabec, the situation seems to be slowly and modestly getting back to normal.

1.1.3 Monitoring Bodies and Other Institutions

The State Energy Inspection (SEI) performs monitoring functions at the prompting of the Ministry of Industry and Trade, the Energy Regulatory Office or at its own initiative. Its responsibilities include the supervising compliance with the Energy Act and the Act on Prices, regulating conditions for access to the network for cross-border exchanges in electricity and the Act on the Promotion of Electricity Production from Renewable Energy Sources. It also has the power to impose fines. (see Státní energetická inspekce, 2019)

The Energy Regulatory Office (ERÚ) is a body with a significant level of authority that stems substantially from the European Union. The ERÚ sets the rules for business activity in the energy sectors as well as the rules of trading. The Office establishes the business conditions of the electricity market operator, decides disputes over access to the network, and performs a number of other functions. (see Energy Regulatory Authority, 2019)

The fairly stable relationship between these two institutions and their distribution ended with an amendment to the Energy Act of August 18, 2011 (Act No. 211/2011 Coll.), which emerged primarily in reaction to the Third Liberalization Package of the EU. This gives significantly expands the scope of authority of the Energy Regulatory Office: "One of the new major competences will be inspection of the electricity and gas markets in order to decide whether competition exists in these markets and the imposition of measures (in matters not within the scope of the Office for the Protection of Competition). The ERÚ will have a number of oversight powers, including the right to enter business premises, inspect business records, seal premises, etc. Finally, the ERÚ will monitor compliance with the provisions of the Energy Act on Protection of Consumer Interests in Business Activities in the Electricity and Gas Sectors" (see Pravda, 2011, p. 39).

The revision of the ERÚ's position is also interesting from the perspective of significant changes that occurred within its management. The then-Chairman of this "small Energy Ministry", Josef Fiřt, was replaced on August 1, 2011, by Alena Vitásková. Her appointment provoked diverse reactions, mainly over her previous employment as Chairwoman of Transgas and her stake in Vemex, partly owned by Gazprom (see Léko, 2011a). The main objection was that the management of the principal energy regulatory body should not have such close ties with specific (regulated) companies.

During her time in the job, Vitásková strongly criticized state support for renewable sources and used political, diplomatic, and legal measures to limit this support. Heavily politicizing the ERÚ, she even campaigned (unsuccessfully) in her last year in the position to be elected to the Senate of the Czech Republic. Her confrontational managerial style and her unwillingness to resign from the office contributed to the changes in the structure of the institution. In 2017, the ERÚ began to be managed by a collective body comprised of five directors, instead of a single chairperson. (see Černoch, 2017; Klimeš, 2016; Lukáč, 2017; Dolejší, 2016)

The final important regulator of the Czech Energy market is the Czech Electricity and Gas Market Operator (OTE). It evaluates and counts the consumption and supply imbalances of each market participant, organizes the short-term electricity and gas market and energy balancing market, prepares market reports and consumption forecasts. It administers the National Register of Greenhouse Gas Emissions as well as the trading portal of electricity from the combined generation of electricity and heat. Unlike the other mentioned institutions, it is a joint stock company, with a share of at least 67% to be owned by the state under law. (see OTE, 2019)

1.2 The Legislative Framework of the Energy and Raw Materials Policy of the Czech Republic

The founding strategic document and the flagship of legislative development in the first half of the 90s was the Energy Policy of the Czech Republic, adopted at the beginning of 1992. It was largely declaratory in character, primarily aimed at completing the processes of privatisation and restructuring within the energy sector, changing the legal framework so as to involve new provisions, and promoting the formation of a regulatory body for the energy sectors. The long-term aim of this document was to form an active price and tax policy, support competition in the field of energy production, and harmonize Czech legal norms with those of the EU (see Stehlík, 2000, p. 152–156).

This whole framework then underwent changes in terms of basic legal acts. First, electricity, gas, and heat supply legislation needed replacement as it had been set up for the conditions of central planning and the presence of state companies. It was therefore incompatible at many points with the market-driven context of the newly emerging joint stock enterprises and other energy market entities (see Neužil, 1995, p. 1).

Work on these acts had been taking place since 1992, but it was later decided to bring them together into a single document, which was, moreover, supplemented by an amendment to the Act on the State Energy Inspection. This body monitors compliance with energy laws, and exercises the right to impose fines and define[7] their scope (see Neužil, 1995, p. 2). The resulting Act on Business Conditions and on the Execution of State Administration in the Power Industries and on the State Energy Inspection, usually called the "Energy Act", was adopted on November 2, 1994, and entered into effect on the first of January of the following year. In this way, it became the third multifaceted legal act in the history of Czechoslovak, and later Czech, energy legislation.[8]

This "basic code" of Czech energy law has for twenty years now delimited the terms of business activity within the energy sectors, and thereby in the sectors of electricity, gas and heat production and distribution, in the public interest. It also defined the state's role in relation to business entities and set the relationship between energy suppliers and energy users. It was gradually supplemented by Act No.18/1997 Coll. on the Peaceful Utilization of Nuclear Energy and Ionizing Radiation, Regulating the Requisites of Nuclear Power Plant Operation and the Treatment of Fuel and Waste (the so-called "Atomic Act") and Act No. 309/1991 Coll. on the Protection of Air from Polluting Substances with an Impact on the Desulphurisation of Coal Power Plants. A bit later, in 1999, Act No. 189/1999 Coll. on Emergency Oil Reserves and on Emergency Oil Management came into law (see Neužil, 1995).

Also noteworthy is the preparation of the new energy policy in the second half of the 1990s, which came to an unsuccessful conclusion. The first renewed attempt to arrive at a new version of the policy was made by Minister of Industry and Trade Vladimir Dlouhý in a proposal which emphasised an entire line of environmentally-friendly measures and focused on the creation of an independent energy monitoring office. The document did not however even come under consideration by the Government.[9] His work was continued by Karel Kühnl, who in a new document counted on a fairly gradual wind-down to coal mining, the development of the nuclear power industry, including completion of the Temelín nuclear power plant and modernization of the Dukovany nuclear power plant, as well as pressure to liberalize the energy market. Due to early elections in 1998, deputies were unable to

7 Even though a portion of that authority was transferred to the Energy Regulatory Office in 2011, in line with the adopted amendment to the Energy Act.

8 It followed Act No. 438 from 1919 On State Support During the Commencement of Systematic Electrification and the previously mentioned Act No. 79/1957 on the Production, Distribution and Consumption of Electricity (for more details, see Neužil, 1995).

9 For more details on the proposal (see Šálek, 2004).

approve the document. The incoming Minister, Miroslav Grégr, in the end authorized the preparation of an entirely new draft highlighting his own priorities.

1.2.1 2000 State Energy Concept

The 1990s were years of major change in the energy policies of the Czech Republic and those of the EU, toward whose membership the country was heading. At the internal state level, there was a shift from a centrally regulated energy trade to a significantly more market-like milieu accompanied by the gradual withdrawal of state intervention in the form of such things as subsidized electricity prices. But environmental taxes had not yet been implemented, the energy legislation regulating the monopoly and final electricity consumption had not been completed, and the unfinished privatization of energy companies represented a major weakness. The lack of success was then addressed by the policy of energy savings and more intensive exploitation of renewables.[10] In line with events at the EU level, the Czech Republic was compelled to respond to legislation associated with strong liberalization efforts in the field of natural gas and electricity.

All these and many other changes demanded the preparation of a new conceptual document to regulate the long-term future of the Czech Republic, resulting in the 2000 State Energy Policy of the Czech Republic (SEP 2000). This is perceived to have been the first truly detailed strategic and conceptual document of its kind, adopted with clearly defined objectives and proposing the means to reach them. It also made a strong contribution to closing the energy chapter as part of the EU Accession Negotiations.

The first issue the SEP 2000 framework resolved was rectifying the price and tariff structure of energy commodities and associated services, mainly by removing cross-subsidies and charging less to households at the expense of industry users. This solution was intended to bring progressively rising prices set by the market by the year 2002.

The document also addressed the very sensitive matter of the final privatization of state shares in the key energy companies, specifically in ČEZ, Transgas, ČEPRO, MERO, and Unipetrol. With the exception of the latter, the state was, according to the Policy, supposed to maintain a degree of influence in each, and the intent was strictly to transform Transgas, ČEPRO, and MERO into joint stock companies under full state ownership. The privatization issue was also connected to the need for an independent regulatory body that would supervise the Czech energy sector in the future.

The document responded to the EU requests noted above by calling for regulations to be enacted that would pave the way for an internal electricity and gas market, distinguished by the ability of users to choose the supplier for these energy commodities. SEP 2000 also proposed some environmentally-friendly measures for the exploitation of renewables, promoted saving measures, and emphasized the combined generation of electricity and heat, with a portion of the document being devoted to support for domestic mining and a very optimistic future for the nuclear energy sector.

At approximately the same time as the State Energy Policy was being prepared, a start was made on the new Energy Act, as well, motivated primarily by an effort to adapt the Czech legal framework to bring it into line with European requirements, therefore, mainly in accordance with the Directive concerning common rules for the internal market in electricity (96/92/EC) and gas (98/30/EC). The resulting Act No. 458/2000 Coll. on Business Conditions and Public Administration in the Energy Sectors and on Amendments to Other Laws (once again called the “Energy Act”) predominantly regulated access of third parties to the network, introduced the term of public administration, defined an authorization principle for constructing new energy capacity, set an obligation to keep separate accounting across specific activities, and introduced gradual liberalization of the electricity and gas markets. A noteworthy part of the law was an obligation to regularly evaluate current energy policy every two years (see Šindler, 2006, p. 10–13). That was meant to prevent recurrence of the situation at the start of the 1990s, when the political will to create a conceptual document of this sort did not exist and energy entities were therefore forced to anticipate what the state had in mind for the future.

The Act also set up the Energy Regulatory Office for the electricity, gas, and heating sectors, the body responsible for regulating the energy field. It also gave rise to the Czech Operator of the Electricity Market. The act was naturally amended repeatedly, with the most notable changes in 2003 under Act No. 278/2003 Coll. (regulating the schedule of electricity market opening) and Act No. 670/2004 Coll. in 2004 (see Šindler, 2006, p. 16).

10 The summary is based on the document *Energy Policy of the Czech Republic* (see Vláda České republiky, 2000, p. 3).

Persistent market liberalization as well as accompanying protections for customers were then repeated in the revision of the Energy Act from 2011.

Together with the Energy Act, Act No. 406/2000 Coll. on Energy Management was passed as well. This document primarily aimed at reaching maximum efficiency in the production, transmission, distribution, and consumption of energy, including rules for making the means of achieving those aims. The act includes obligations that apply to construction companies and building owners, the labelling of appliances according to their energy efficiency, and guidelines for preparation of the State Energy Concept and Territorial Energy Policy, among other things.

Admission to the European Union was the pretext for the adoption of Act No. 180/2005 Coll. on the Promotion of Electricity Production from Renewable Energy Sources.

In line with the provisions of the Energy Act, at the end of 2001 an evaluation was made as to whether the requirements of 2000 SEP had been met, and the conclusion was that the majority of short- and long-term goals had been accomplished. The unions and the entrepreneurial sphere, however, were asking for a comprehensive revision of the policy in order to make the state's long-term goals clearer, so that they would have a clear basis for their business decisions. A decision on preparation of the updated State Energy Policy was classified as a priority by the new government. This decision making was additionally burdened by persistent problems stemming from the incomplete transformation of energy management, its environmentally still inadequate character, and admission to the EU (see Ekonom, 2003, p. 39).

1.2.2 Strategic Documents in the New Millennium

The 2000 State Energy Policy was followed by several foundational papers, mainly the 2004 State Energy Concept, the Paces report and the Updated State Energy Concept from February 2010 (SEK 2010).

The 2004 Energy Concept (SEK 2004) sharply revised the priorities that had priorly been emphasised, despite the fact that they were already largely accomplished. Instead of the previously emphasized restructuring and privatization, attention was turned to specific measures for the further long-term functioning of the sector. SEK 2004 was, moreover, to a certain degree a necessary reaction to Czech obligations at the EU level (usually with reference to the promise to produce a specific percentage of electricity from renewables) and the fact that 2005 was drawing closer, the year in which another evaluation of the 1991 coal mining limits was to take place.

Already by 2003, the body responsible for preparing the Concept was the Ministry of Industry and Trade, headed at that time by Milan Urban (ČSSD). His Deputy, Martin Pecina (ČSSD), previously General Director of the public company Hutní projekt Frýdek-Místek, also played a crucial role. The Ministry's draft worked with six different developmental scenarios that varied in terms of energy mix. The ministry itself opted for the one labeled Green, finding it the best, and basically the only appropriate option. It emphasised maximal Czech independence from fuel imports, to be achieved by using domestic sources and relying on the sustained self-sufficiency of the Czech Republic in the field of electricity production. The specific tools for reaching these objectives involved a broader use of nuclear energy and the construction of new coal power plants (connected to the possibility of mining beyond the territorial limits). SEK 2004 projected a smaller increase in natural gas employment, especially since it needed to be imported, as well as a rather limited role for renewable sources of energy (see Ministry of Industry and Trade, 2004).

The Ministry of the Environment, headed by Libor Ambrozek (KDU-ČSL), developed strong reservations about the Concept. Its office even prepared its own alternative version highlighting energy savings (for example, in the form of thermal insulation for homes), more active use of renewables, and a higher level of natural gas use. The key issues responsible for the clash between the Ministries were the breaching of territorial limits on mining and continuing construction of power plants. Following the repeated postponement of discussion over the final version of the document, accompanied by public protests organized by environmental organizations and representatives of mining-affected municipalities, the two parties came to a compromise. It basically followed the trend set by the Ministry of Industry and Trade, but dropped specific requirements referring to the breach of mining limits and requested only their re-evaluation in the future.[11] As far as nuclear energy is concerned, SEK 2004 continued to count on the construction of additional (not three, but two) blocks.

11 "The extracts on the breaching of territorial mining limits were left out of the Concept, replaced by the formulation of their rational evaluation in the future," said Ministry of the Environment spokeswoman Karolína Šůlová. (see Hospodářské noviny, 2004)

All the main participants in the debate, Libor Ambrozek, Martin Pecina, and Milan Urban, had basically followed the policy advocated by their parties, which however did not see the issue as a high priority. The entire preparation of the concept instead differed in focus the ministries (where the Ministry of Industry and Trade was generally inclined to a rather centralized character for the energy sector with massive sources and priority laid on electricity production, the Ministry of the Environment was rather interested in energy savings, renewables and landscape preservation) and the chief representatives (L. Ambrozek, as an environmentalist and a long term opponent of the nuclear energy, and M. Urban and M. Pecina as proponents of "the traditional" Czech energy sector, underlining the state role and use of local sources) had.

Some of the factual matters as well as debates over the preparation of the concept are addressed in other parts of this book, but here we may basically argue that it is precisely this concept that had brought the Czech energy policymaking process to a close at the strategic and legislative levels. The elementary legal framework treating this segment of the economy was created, one which stood shoulder to shoulder with its western counterparts. The energy sector ceased to be seen as a field that could survive by being left to free market forces, using state intervention only when necessary, and it became a more predictable, more stable system of updated concept documents (policies, concepts) that showed the direction of the energy sector over longer time horizons.

Accordingly, since that time, we have been able to point unambiguously to two issues that will impact the Czech energy industry in the future. These are, first, the still unsettled debate over the (non)breaching of coal mining limits and, second, the local development of the nuclear industry.

This routine of cyclically preparing concept documents (energy policies) was broken in 2008 with the appearance of a less typical document, the Report of the Independent Expert Commission for Establishing the Energy Demands of the Czech Republic (the Pačes Commission). This paper came in the aftermath of disagreement within the then-governing coalition, which had split over a nuclear sector matter and the continued use of coal beyond the territorial limits. According to the official explanation, this report was supposed to be some sort "an expert guideline" for the future Czech direction of the Czech energy sector.

The report emerged as a result of testy coalition negotiations between the Civic Democratic Party (ODS), the Christian Democratic Union – Czechoslovak People's Party (KDU–ČSL), and the Green Party in the second Government headed by the Prime Minister Topolánek (from January 9, 2007). The parties taking part in the negotiation process had the following preferences: ODS, represented in energy matters by Minister of Industry and Trade Martin Říman, perceived nuclear energy to be an indispensable source and its development, therefore, as the natural order of things, while support were overall rather turned to a substantial exploitation of coal as an important energy source.[12] Both were absolutely at odds with the interests of the Green Party, a future coalition partner. KDU-CSL, as the third government party-to-be, took a fairly moderate, even ambiguous stance, rather close to the ODS point of view.[13]

The resulting agreement formulated in the Government Decree for that reason unavoidably had to embody a compromise between these interests, but it was accordingly a substantial success for the Green Party. Not only did the Party force through a foundational part of its environmentally-relevant energy objectives such as insistence on reduced greenhouse gas emissions, it also sustained its priorities in the nuclear sector and coal mining limits: "The territorial limits on brown coal mining will remain. The Government will neither plan nor support the building of new nuclear blocks and, after consultation with the opposition, based on a consensus of all three political parties sitting in the Government, set up an Independent Expert Commission to assess the energy requirements of the Czech Republic in the long term" (see Vláda České republiky, 2007).

ODS placed quite strong hopes in this commission, trusting that its findings, provided they were neutral at least as concerned the nuclear sector, might serve it as a tool to make headway with the Green Party, which could then change its position and thereby lead to compromise. The Pačes Commission was set up in January 2008, but the parties did not nominate representatives to it until April of that year. ČSSD, moreover, announced that it would not participate in the Commission's work at all. "There is no reason when our representatives would only assist there in disputes between the Green Party and ODS, which the Commission will surely not be able to avoid", declared shadow Minister of the Environment, Petr Petržílek of CSSD (see Břešťan, 2007).

12 Although these topics do not show up in the 2006 election campaign program. The energy sector was mentioned only in relation to the need for a higher degree of energy efficiency within the economy (see ODS, 2006).

13 Neither does his election program in any specific manner deal with the energy issue. Although Libor Ambrozek, an opponent on these issues, was still an active member of KDU-ČSL, the party generally took a pragmatic stance (see KDU-ČSL, 2006).

The gradually released findings of the report aroused strong emotions. After releasing an initial incomplete version, the Green Party blamed the Commission for its unprofessional and improper conduct (Party Deputy-Head Dana Kuchtová). Martin Bursík even labeled the entire commission biased since it included former Minister of Industry and Trade Vladimír Dlouhy[14], whose previously written pro-nuclear pieces were not supposed to be considered by the commission in a detailed manner (see Pavlovič, 2008). A highly negative reaction also came from Martin Říman, who called it all "a trick" and an effort to sweep under the carpet those parts of the report that were inconvenient for the Green Party (see Petržílek, 2009).

Given the fragile governmental coalition and apparent readiness of the Green Party to leave it if any fundamentally pro-nuclear or pro-coal propositions were passed, the conclusions of the Pačes commission essentially stayed on paper, with no direct or specific guidelines for their execution.

In terms of its contents, the Pačes report was a decent document that mapped the situation and needs of the Czech energy sector. In terms of the traditionally sensitive points of the Czech energy sector, the report concludes that nuclear energy has and should have its place in the Czech energy mix, although the text is not particularly optimistic with regard to nuclear. But it also does not call for mining limits to be breached. (see Úřad vlády ČR, & Nezávislá energetická komise, 2008)

The Energy Act establishes the regular updating of the State Energy Concept, which is why the Ministry of Industry and Trade had started preparing its revision already during the commencement of the Paces commission, resulting in the 2010 State Energy Concept, which at least in its initial phase did not raise any great public or political attention.

Already by the start of 2009, the Ministry of the Environment, led by Green Party president Martin Bursík, had commented on the practically completed draft, now however not insisting on complete elimination of the formula concerning the need to extend nuclear energy in the Czech Republic, but narrowing his demands only to ensuring their maximum safety. "We are not fundamentally against it, if our remarks are noted. We are not fundamentally against nuclear energy," said spokesman Jakub Kašpar (see Šrámek, 2009). In terms of the Green Party's agenda, it represented a dramatic shift, albeit the Green Party and ODS continued to have absolutely varying stances on coal. It was precisely this issue, together with the continuation of uranium mining, that SEK 2010 addressed.

Aside from the by now traditional clash between the Ministry of Industry and Trade and the Ministry of the Environment, the debate over SEK 2010 was also joined by ČSSD.

It first started with Milan Urban's unhesitating request for the Government to involve the Social Democrats more in the document´s preparation, then with a particular criticism coming from shadow Minister of the Environment, Petr Petržílek. He described this piece of work as amateurish, poorly addressing issues of the environment, energy efficiency, energy savings and the treatment of raw material and said it did not reflect the conclusions of the Paces commission, the Integrated Raw Materials Policy of the Czech Republic, nor the country's EU obligations (see Petržílek, 2009).

The preparation of the State Energy Concept was, naturally, also significantly influenced by the change in Government that happened when Topolánek's cabinet was replaced by the caretaker government led by Jan Fischer. Represented by Minister of Industry and Trade and former leader of ČEPS Vladimir Tošovský, this Government worked on the final form of the concept, which emphasized maximum use of domestic raw materials, including nuclear and coal, enhancement of energy efficiency and a pro-export orientation for the electricity sector in the future. In terms of political viability, it was Tošovský who was in an advantageous position at the point when his concept received support in the Government from ODS (which, according to its statements, nevertheless stood against breaching of the territorial limits, although it had no issue in principle with coal itself) as well as CSSD (which was rather inclined to continue breaching the limit but on condition it be decided in a referendum), while the Green Party–following the departure of Minister of the Environment Dusík (of the Green Party) and his replacement by Rut Bízková (ODS, formerly employed at the Ministry of Industry and Trade) had few options to influence the concept's final approval.

14 The Commission consisted of: Chairman – Václav Pačes, President of the Czech Academy of Science; ODS – Vladimír Dlouhý (former Minister of Industry and Trade, Counselor of Goldman Sachs Bank), František Hrdlička (Dean of the Czech Technical University in Prague); KDU-ČSL – Aleš Doležal (member of the Association of Energy Managers), Josef Bubeník (Chairman of the Czech Energy Agency); KSČM – Petr Otčenášek (independent counselor in the energy department), Miroslav Kubín (member of the Association of Energy Managers); Green Party – Vladimír Vlk (energy auditor), Edvard Sequens (counselor in the energy field, Calla Association); ČSSD – refused to nominate its representatives in the Commission.

1.2.3 State Energy Policy Update of 2015

After multiple failures to update SEK 2004 because no minister ever stayed in office long enough to finish the concept, a new strategic energy document was approved by the Government and published in 2015, labeled the State Energy Policy Update of 2015 (SEPU 2015).

In this paper, six scenarios were developed and offered for evaluation, with the “Balanced” scenario chosen as the basis for modelling the future energy mix. Under this scenario, the long-term preference of the country for nuclear energy resonated strongly, with an expected increase of this technology in electricity generation from 32.5% in 2015 to 46%–58% by 2040. (Ministry of Industry and Trade, 2015) Surprisingly, SEPU 2015 did not offer answer the question of how the new sources should be financed, the problem which led the 2009 ČEZ nuclear tender to fail. Nor was the problem resolved in the National Action Plan for the Development of Nuclear Energy in the Czech Republic, adopted that same year. Even though the Action plan listed three options–investment through ČEZ, the existing owner and operator of the nuclear power plants, investment via a private investor consortium, and direct construction by the state by means of the newly established state-owned enterprise, and even though it expressed a preference for the first option, it did not suggest any way to persuade ČEZ to opt for this seemingly unprofitable venture. (see Ministry of Industry and Trade, Ministry of Finance, 2015; Tramba, 2015)

Nuclear sources were to be supplemented by renewables (a planned increase of 10.7% to 18–21% in 2015), natural gas (2.7% to 5–15%), and black and brown coal (54% to 11–21%). A significant decline in coal consumption was to result from the anticipated process of tightening domestic and EU environmental regulations and mining companies coming up against environmental mining limits in North Bohemia. In this regard it should be noted that the SEPU 2015 vision of a slow phase-out of coal was published around the same time the partial recission of the limits was announced, allowing companies to continue mining at the Bílina mine until approximately 2050. (see Adámková, 2015)

Surprisingly, SEPU 2015 also broke a basic rule of Czech energy planning–the huge emphasis laid on a strong export position for the country in electricity. From 2015, the country was to focus on producing just enough electricity to meet domestic demand, maybe with some limited overproduction, but the years of massive electricity exports seemed to be over. (Technický týdeník, 2015)

1.2.4 Conclusion

The legal delimitation of the energy sector requires one further note. The strategic concept (policy) is, under an ideal scenario, supposed to set the basic state limits and priorities that would be embodied in every newly prepared law and in the overall position of the governmental apparatus in regulating the sector. As far as the previously described documents are concerned, adoption of this idea has lagged behind to some extent, even if the State Energy Concept *does* indicate the Government’s stance on certain issues (usually when referring to limits on coal mining); however, their real concord with the energy sector is generally rather poor. Usually, one cannot sense that either of the governing parties in the coalition had anything to do with the wording, let alone their hypothetical compliance with the opposition and potential to outlive more than one Government in unaltered form. Instead of setting the direction for decades ahead, which would provide coordination for the public and commercial spheres and serve as a reliable guideline for investors in their efforts to rationally allocate their assets, these sorts of documents embody the current distribution of opinions and powers in the Government.

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Chapter 2: The History of the Czech Energy Sector[1]

Filip Černoch

Two basic trends are evident in the development of the Czech energy sector after 1989. First, there was the need to replace the system of a fully controlled and centrally run energy sector,[2] typical for the countries of former Eastern bloc, with a system that reflected the geopolitical, political and economic interests of a newly emerging state. This meant the need to privatize and liberalize the sector, to reduce its energy inefficiency, to restructure an environmentally unsatisfactory coal sector, and to reduce disproportionally high energy spending in households.

The second fundamental factor was the EU accession process, successfully completed in 2004. As part of that process, the Czech Republic had been adapting to the energy legal framework and the provisions of the *acquis communautaire,* which had primarily left a mark on acts addressing environmental issues, market liberalization, and control of the monopolistic behaviour of energy companies.

In this chapter, we will consider this course of development as well as try to capture some of the basic problems encountered by the Czech energy sector at present, issues that will likely remain relevant in the immediate future.

2.1 The Three Periods of Development from 1989 to Today

The post-revolutionary development of the Czech energy sector and energy policy may in principle be divided into three basic phases. The first, which lasted roughly until the mid-1990s, led to the restructuring of the centrally run energy system and its division into a number of smaller entities, often remaining in state hands. The second phase involved privatization of the key energy companies, with the greatest success coming mainly in the gas sector. In response to EU demands, in this phase came the initial steps of market liberalization with the goal of customers being able to choose an electricity or natural gas supplier. The third phase, starting roughly in 2005 and lasting until today, involves a stable situation in which privatization has been brought to an end and the focus is primarily on completing the liberalization of the energy market, further harmonizing with EU requirements, and maintaining the energy sector in decent shape for the future.

In parallel with these key processes, naturally, continuous modification of the entire line of further fundamental energy-related issues had been taking place – for example, the energy efficiency of the sector had been significantly improved. At that time the energy demand of the Czech economy was two to three times higher than in the rest of the EU. After many delays as a result of insufficient political will[3] and limited means, a trend towards energy production with cleaner, more modern and environmentally less damaging tools was set in motion. Once the position of the Russian Federation as practically the exclusive supplier of energy materials to the Czech Republic was weakened, one could also perceive a particular advance in Czech geopolitical security by, for

1 The chapter in some places makes direct reference to the chapter Energy Policy, published in the book Public Policy in the Czech Republic in the Years 1989-2009 (see Černoch, 2010, p. 141-167).

2 The energy industry and energy sector are for purposes of this text understood to refer primarily to the electric power industry, gas and heat supply sectors, to a relevant extent also coal industry and mining, as well as, peripherally, the processing of uranium ore. The Czech Republic has a very limited volume of domestic oil and natural gas, which is why these sectors will be addressed only if they have influenced or are currently influencing the Czech energy industry as a whole.

3 Former Minister of Industry and Trade in the period 1998–2002, Miroslav Grégr, may serve as a typical illustration here, emphasizing the use of nuclear fuel and domestic coal with an attitude verging on the disdainful towards investment into cost-saving technologies or renewable sources.

example, building the IKL pipeline. The solution of problems associated with the restructuring of the coal sector then acquired a social dimension, since the former had led to a reduction of mining, the shutting down of mines and the dismissal of miners and workers in related professions.[4] Two blocks of the second Czech nuclear power plant (Temelín NPP) were built, and further projects are in preparation.

2.2 The Restructuring Phase

At the beginning of the 1990s the energy sector of the Czech Republic faced a major task–to transform the centralized, office-directed, energy inefficient, polluting and geopolitically dependent energy sector to the standards common in Western Europe. The first step in this endeavour was to restructure the production and transmission divisions of energy companies. The change affected approximately fifty state companies active in the field of fuel and energy systems, which were transformed into joint stock enterprises.

Already in 1990, electricity distribution was separated from production, with eight regional energy distribution companies, or REAS, formed from ČEZ[5], though the state kept a majority stake in them as well as in the parent company.[6] ČEZ from that point controlled only large power plants, some heating plants, and the 400 kV and 220 kV transmission systems.[7] Over time, the heating supply companies that had been separated from ČEZ were privatised (with majority shares in the hands of municipalities), as well as research institutes, construction-assembling organizations and some smaller power plants.

Privatisation and restructuring in the coal sector was accompanied by notable social involvement by the state, since the programmed reduction of coal use and its replacement with natural gas understandably led to a reduction of mining and subsequent redundancies. As part of modifying the entire sector to attain acceptable environmental standards, by 1998 the coal power plants had been desulphurised (and in some cases shut down) (see Píha, 1998, p. 236–237).

The monopoly importer, transporter, and distributor of natural gas and other pipelined gases, ČPP[8], was restructured as of January 1, 1994, leading to the separation of eight distribution companies with significant shares in the hands of cities, municipalities, and the state. The transition system, a spinal pipeline network, underground gas tanks, and dispatch remained under state ownership in the form of a re-established company, ČPP Transgas. (see Energetika, 1999)

Direct state financial expenditures in the energy sector were gradually terminated. State subsidies were concluded and the operation of energy companies was financed from that point on only out of their own assets and bank loans. The latter, of course, caused pressure for increasing electricity prices, which until that time had been kept at an artificially very low level. It had been set by the Ministry of Finance and did not correspond either to production or transmission expenses, not to mention the corresponding profits.[9] Moreover, the subsidies for solid fuels were cancelled in 1994, liquid fuels in 1997 and thermal energy in 1998. (see Neužil, 1995)

In this initial transformation phase, the privatization difficulties typical of many transformations of post-soviet economies in the region emerged, with the sale of state property to private entities lacking transparency in a number of cases.

'Demonopolisation' of the entire sector was also delayed. Based on a Government Decree of Spring 1992, ČEZ was, for example, meant to be 'demonopolised' no later than during the second privatization wave (see the succeeding chapters), but that did not happen. Therefore, ČEPS, running the spinal network of the transmission

4 To complete the picture, between 1990 and 2000, mining experienced a decline of 35%, or 50.4 million tonnes per year in the case of brown coal, while in case of bituminous coal this reduction was from 23.3 million to 14.9 million tonnes per year. On the other hand, labour productivity had risen from 325 to 630 extracted tonnes per person per year for bituminous coal (in the same period), and for brown coal from 1,930 to 3,256 tonnes per person (also in the same period). (see Energetika, 2003)

5 Czech Power Works, previously Czechoslovakian Power Works.

6 Pražská energetická, a. s., Středočeská energetická, a. s., Jihočeská energetická, a. s., Západočeská energetická, a. s., Východočeská energetická, a. s., Jihomoravská energetická, a. s., Severomoravská energetická, a. s.

7 The transmission system and central dispatch were separated by 1999 and joined to ČEPS, while remaining under ČEZ ownership (see Píha, 1998, p. 236-237).

8 Czech Gas Company.

9 Criticism also came from representatives of the World Bank, which made a loan to the Czech Republic conditional on ending this situation. The complete liberalisation of prices occurred at the beginning of the 2000s.

system, remained in ownership of ČEZ even after its accounting independence in 1999. It was indeed the electric power sector that witnessed the emergence of an oligopolistic structure with a dominant company at its head, where a financially more efficient giant, i.e. ČEZ, decides prices and smaller producers are forced to adapt (see Invicta Bohemica, p. 18).

2.3 The Privatisation Phase

As previously noted, the most visible feature of the second phase of the post-revolutionary development of the Czech energy sector was the privatization of state shares in the dominant energy companies. This delicate process, the realisation of which in the electric power sector and petrochemicals proceeded without much transparency and in a tense atmosphere, was additionally burdened by EU liberalisation demands in the second half of the 1990s. The entire period is for this reason characterised by the noteworthy clash of two opposing processes, in which the gas sector was undergoing successful privatization but delayed liberalization, and by contrast, the electric power sector was experiencing unmanaged privatization but rapid liberalization (see Výlupek, 2003).

The Government aimed to complete privatization in basically a single stroke at the end of 2001. The state at that time still held a 67% share in ČEZ as well as in individual REAS (it had a majority share in five of them, while in PRE, JCE, and JME it held a minority share) and a 97% share in Transgas, where in addition to the majority share in six regional distributors, it had a majority share in PRP and JCP. The entire Unipetrol holding, including Chemopetrol Litvínov, Kaučuk Kralupy and Synthesie, was to be sold as well (see Invicta Bohemica, p. 18).

The political sensitivity of the sector led to a situation in which the Government, aside from the criterion of price, had set an entire line of limitations for applicants, thereby expressing concerns regarding the strategic, security, and social impact of privatization. The future owners had to agree to a ban on the resale of purchased assets for some period of time, not to restructure the companies without Government consent, and to abide by conditions on the production maintenance of some power plants or requiring the consumption of brown coal. Such a proviso, naturally, had its own impact on the price of the offered shares and the number of interested parties (see Invicta Bohemica, p. 18–19).

2.3.1 Unipetrol

The privatization of Unipetrol was complicated by the Government binding the new owner of this heterogeneous holding not to sell any of its parts over the first ten years. Of the three interested parties that finally decided to enter the competition, the Austrian-Hungarian coalition OMV-MOL-TVK was rejected for formal reasons, leaving only the offers from the company Agrofert of Czech entrepreneur Andrej Babiš, supported by the American company Conoco, and the British Rotch Energy, disadvantaged by its lack of experience in the petrochemicals field. Although the offers worked in favour of the latter, which was willing to pay 453 million EUR for the holding, in comparison to Agrofert's 361 million EUR, it was the Czech company that was finally chosen. A questinable clarification was that Agrofert was the greatest taxpayer in the Czech Republic, whereas Rotch Energy was a mere speculator and not a strategic partner (see Invicta Bohemica, p. 19).

The problems related to Unipetrol's privatization, however, persisted. On September 30, 2003, Agrofert announced that due to changes in circumstances which had an impact on its ability to meet the privatization requirements, it would not buy the share in Unipetrol and asked to negotiate a lower price and change its strategic partner to the Polish firm PKN Orlen. Vladimír Špidla's government for that reason decided to cancel the agreement and start a new privatization round.

The new round launched at the end of 2003 attracted the abovementioned PKN Orlen, again in cooperation with Agrofert, as well as Conoco, then the Hungarian firm MOL and British-Dutch Shell. The first applicant, although in collaboration with the already once problematic Agrofert,[10] then obtained the state share for 14.7 billion CZK.[11]

10 The Partnership of PKN Orlen and Agrofert eventualy terminated with a number of court proceedings exactly concerning ownership issues related to Unipetrol.

11 Already at the end of 2005, Unipetrol's privatization, however, erupted into a scandal with international reach, related to the suspicion of corruption both on the Polish and Czech sides. Locally the key moment was TV Nova's news report which videoed the meeting of the Head of the Prime Minister's Office (then Jiří Paroubek's office), Zdeněk Doležal with the Polish lobbyist Jacek Spyra, where Doležal allegedly asked for a five million bribe for privatization in PKN Orlen's favour. (see iHned, 2009)

2.3.2 ČEZ

The privatization of ČEZ was no less complicated. The Government was ideally anticipating CZK 300 billion from the sale[12], a great sum of money, at least in view of the conditions attachend, such as a fifteen-year obligated take-off of brown coal from dedicated domestic mines and the requirement to keep a minimum share of electricity production from nuclear sources.[13] Given the nature of the target company, practically every leading electric power company in Europe joined the contest. The unambiguous favourite was the French monopolist and the strongest electric power company in Europe, Electricite de France (EdF), with vast experience in the nuclear industry.

The German companies RWE and E.ON proved to have quite strong potential as well, but the weak point of the first of these was its agreement with the German government to terminate the nuclear program, while E.ON was unofficially handicapped by a previous decision to stop importing Czech electricity to Germany. British International Power (then-owner of the Opatovice power plant) and British Energy allegedly also had modest chances. The American companies AES, NRG and Energy Corp. made marginally interesting offers, and the chances were not high for the German-French EnBW, Italy's Enel, Spain's Union Fenosa, or Belgium's Electrabel (see Zajíček, 2001b, p. 8).

In preparing the list of companies eligible to even enter the tender, though, a very surprising turn of events took place. Only EdF, Electrabel, the consortium of Enel and Iberdrola, and the consortium of International Power and NRG were eligible to submit offers.

The privatization process progressed in similarly ambiguous fashion as well during the actual submission of the envelopes containing the offers. EdF eliminated itself in a very unclear manner, as its representative stayed too long in the canteen of the National Property Fund and missed the deadline by a couple of minutes, and its offer encompassed a significant number of conditions in the case of the potential purchase. British International Power was also eliminated for not meeting the formal requirements and, moreover, was abandoned by its American partner NRG due to the complicated situation on the domestic market. The subsequent support of E.ON and British Energy proved to be insufficient substitution, and they were not individually called to submit their offers. Enel submitted an offer independently as well, while the final participant, Electrabel, withdrew on its own initiative on the pretext of a non-transparent tender. Given the set of restrictions noted above on the potential owner of the company, it was no surprise that the only unproblematic offer (EdF) proposed, in the Government's terms, the very low price of 135 billion CZK, prompting the Ministry of Industry and Trade to invalidate the entire tender.

"After the first unsuccessful round of privatization in the electricity sector, another attempt came as soon as December 2001. Although it was clear that the conditions accompanying this sale were rigorous and restricted the investor for a number of years, not only did the Government not compromise on them, but it insisted on a minimum price of 200 billion CZK for ČEZ, including the transmission system and six transmission companies" (see Geussová, 2002, p. 18). The Government thus invited only two companies into the new round: Enel and EdF. These actors were willing to accept minimum price only on condition that the terms be measurable relaxed, something the Government rejected, and so the privatization process once again came to an unsuccessful end (see Geussová, 2002, p. 18).

It seems very hard to judge the entire privatization process at least moderately optimistically. During its realization, the Government sought to attain several goals at once, starting from sustained operations of nuclear power plants and (indirectly) the domestic coal sector, to employment in the energy sector and socially beneficial activities, to protection of "the national silver" from unwanted foreign buyers, through to insistence on the maximum price. All of that, moreover, spiced with the tender's lack of transparency, the selective choosing of which companies could enter the tender and a lack of understanding of the true value of the energy property. This led to the collapse of the entire sale and to a loss of trust by foreign investors that the state was even capable or willing to sell ČEZ in a principled manner.

12 See, for example, the statement of the then Deputy Minister of Industry and Trade, Zdeněk Vorlička: "If you take a look at the yearly profit of the Czech energy sector, then the sum of, for example, 300 billion CZK would not seem that much". (see Zajíček, 2001a, p. 12).

13 Next to the highest offered price, further terms which the Government set for privatization were not officially released and they ended up in the media only as a result of a leak. The Ekonom Weekly, for example, informed about the requirement to take a yearly amount of 27.74 million tonnes of brown coal from Northern and Western Bohemia for fifteen years and the condition to produce yearly at least 50.8 terawatt hours of electricity for ČEZ in the years 2005–2012. There was, moreover, the possibility of imposing a fine in the amount up to 100% of the purchase price. (see Geussová, 2001, p. 17)

The complicated situation was finally resolved by the realization of an idea proposed (mainly) by Minister of Industry and Trade Miroslav Grégr to form a strong domestic energy entity following the example of France's EdF. Following the unsuccessful privatization, Zeman's government made an offer to ČEZ that it would buy its shares in REAS in exchange for a 2/3 share in the Czech transmission system.

In 2002, however, this proposal was suspended by the Office for the Protection of Competition, which thwarted the plan to form an energy monopoly. The whole transaction was limited by several conditions. In the first place, it ordered ČEZ to get rid of REAS in which it had a minority share (Pražská, Jihočeská and Jihomoravská energetická) and one in which it had a majority stake. Instead of controlling of the entire distribution, the company was to maintain control of only four REAS. The Anti-Monopoly Office decided it was necessary as well to sell the remaining 34% of ČEPS stocks held by ČEZ, although it did not forbid its takeover by the state.[14]

Instead of the original scenario according to which ČEZ was intended to obtain a strong European partner that would guarantee the company's success on the European market, the consolidated company gained the potential to become a distinctive European actor on its own. But by doing so, the Government gave up on the quick and efficient liberalization of the Czech electricity sector and left a very strong structure which for end users (at least according to some experts) meant a higher electricity price and other negative outcomes inherent in a monopolistic market. "We can call it a Czech EdF", was the frank description of the situation given by Minister of Industry and Trade Milan Urban in 2003, by which he quite openly revealed the Government's priorities (see Zlámalová, 2003a, p. 9). The company's position was then confirmed as well by a new decision of the Anti-Monopoly Office in 2005, according to which the company could keep an interest also in one desired distribution company[15] in which it had a majority share (see ČEZ, a. s., 2005).

2.3.3 Transgas

The privatization of Transgas and the gas distribution companies, by contrast, proceeded more straightforwardly. A simpler ownership structure in which the state had full control of Transgas and six out of the eight distribution companies (all except Jihočeská plynárenská, owned by E.ON, and Pražská plynárenská, controlled by the City of Prague, including a minority state interest), proved to be a great advantage, so it became unnecessary to deal with minority shareholders.

Six companies had shown an interest in Transgas, among them the consortium of RWE Gas/Wintershall as favourite, already then invested in Pražská plynárenská (RWE) and Středočeská and Severočeská plynárenská (Wintershall), among others. The German company E.ON did not have as good a position, holding stakes in Jihočeská, Západočeská, and Jihomoravská plynárenská and generally striving to prominently expand into the Czech Republic (in the end joining the contest together with Duke Energy). SNAM/Ruhrgas/Gaz de France were interesting candidates, bringing into the competition a mixture of German and French ownership. The black sheep of the privatization was the Czech-Russian Gaz-Invest sponsored by Gazprom. Italian companies included Edison Gas, the second largest gas company, while Duke Energy was the American representative (see Zajíček, 2001c, p. 9).

It was primarily the French who entered the tender with confidence: "Gaz de France and Ruhrgas already use the Transgas networks, and the members of consortium wish to strengthen the position of the Czech Republic as the European gas intersection", was, for example, the comment of Jean-Luc Demanesse, the head of the GdF Branch in Prague (see Bautzová, 2001, p. 14).

The tender was quite surprisingly won by the rather underrated RWE, as it offered by far the highest price of CZK 133 billion, a figure that exceeded the Government's expectations of around CZK 100 billion. "With this increase by more than four million additional end users, RWE will become number four in the European gas market", was how Chairman of the RWE Board, Dietmar Kuhnt, justified the amount.

14 A certain discomfort was also aroused in the aftermath of deciding the individual traded companies' prices, which the Government commissioned from the only judicial expert during a three-week period. Economist Miroslav Zajíček in that context warned that while the German group E.ON was willing to pay CZK 22 thousand per share of Západočeská energetická half a year before the transaction itself, the expert valued the shares at 6,180 CZK each (see Zajíček, 2002, p. 9).

15 This was Severočeská energetika, which was initially to be sold.

2.3.4 Privatization of the Coal Sector

A separate comprehensive chapter is devoted to the change of ownership structures in the Czech coal companies. The bituminous coal company OKD, a. s. and three brown coal companies: Mostecká uhelná společnost (later Czech Coal, since 2013 part of Severní energetická group), Severočeské doly, a. s. and Sokolovská uhelná, a. s. were and remain the largest of their kind.

Starting with the first of these companies the former state enterprise Ostravsko-karvinské doly, it was replaced by a joint stock company of the same name on January 21, 1991, with a hundred per cent state share (see OKD, n.d.a). In 1997, the Government was preparing privatization of the company together with the brown coal fellow players noted above. Initial proposals called for a maximum 3% of OKD to be sold to the management of the company, another 34% to the strategic investor, and the remaining share to be sold on the stock market.

But early on, in the preparation stage of trading, it turned out that the state had lost part of its control over the company in the 1990s when the Investment and Post Bank collected roughly a fifth of the shares for an unspecified investor. (see Hospodářské noviny, 1997) At the beginning of the following year, there was a direct clash between the state and the company it controlled, when the National Property Fund (NPF), which was responsible for the state shares in the company, accused the company's management of damaging the its interests. "…the Fund has a serious suspicion that the management places significant orders with associated companies and behaves more than a little oddly", observed NPF spokesman Miloš Růžička about stock investments in Moravskoslezské teplárny and Teplárny Karviná. (see Lidové noviny, 1998)

Only at the general meeting of the company at the end of April 1998 did state representatives finally reveal that they had practically lost the control over the company. The issue was that an approximately 46% share was insufficient compared to the 46.3% share jointly held by the Bank Holding from IPB Group and the brokerage company Eurobrokers (see Němeček, 1998, p. 6).

A reminder of what was going on in the company in 1998 and 1999 can be found in the short summary published in the weekly Respekt in 2003, related to the charge levelled at the owners and managers of OKD, Viktor Koláček and Petr Otava. "Ostravsko-karvinské doly had bought from Koláček and Otava their private company K.O.P. for 3.9 billion CZK, which is in the experts' opinion an exaggerated sum. This is also confirmed by step number two: as soon as Koláček and Otava had the money in the account, they bought a deciding package of OKD stock for 2.4 billion CZK through a mediator and escaped the notice of the Government. The transaction was completed by the new coal barons by sending the remaining CZK 1.5 billion – apparently a commission – to the account of the mediator of the transaction, the secret Cypriot company Lagur Trading. In economic terms, the entire affair, of course, makes no sense: OKD first buys a private company for almost CZK 4 billion and afterwards allows its owners to seize control over it for a mere 2.4 billion? (see Bártek, 2003a, p. 8)

Nor did the situation settle down completely after this transaction had been made. Attention was aroused, for example, by the fact that immediately after seizing control of the mines, the company Karbon, owned by the above-mentioned managers, closed an advisory agreement with OKD, on which basis it received roughly a half a million CZK per year. "The difference between the real expenses for providing the services and the sum Karbon Invest had siphoned off thanks to these contracts from 1999 with OKD and Českomoravské doly goes beyond the figure of CZK 1.6 billion", was the comment on the possible damage made by state prosecutor Karel Kalda, who was running the criminal proceedings (see Bártek, 2003b, p. 8).

The entire saga continued into 2004, when the state sold its entire 46% OKD share to the dominant owner Karbon Invest, which in turn sold this share to the Cypriot RPG Industries, owned by financier Zdeněk Bakala (see Pokorný, 2004, p. 12). What seems interesting here is the price, since the Government, despite higher offers such as Penta's, sold its share for CZK 4.1 billion, which was then purchased from Karbon Invest by Bakala for an estimated 12.5 billion CZK (see Zajíček, 2005, p. 8).

In 2009, the Regional Court of Justice in Hradec Králové released Viktor Koláček, Petr Otava and (according to the prosecution) co-offender Jan Przybyl.

In recent years, the company has struggled with both weakening profitability and multiple legal cases. Regarding the first issue, OKD found itself unable to react to falling hard coal prices and a tightening sector economy, and it collapsed in 2016. Emphasizing the importance of the company for employment (the company directly employed about 9,500 people) and social stability of the region the government OKD via the state-owned company Prisko for 80 million Czech crowns in 2018. According to the Ministry of Finance, mining activity is to be gradually restricted and then terminated fully in 2023. (see iRozhlas, 2018)

During the same period of time privatization, has been the subject of yet unresolved legal cases between the Czech state, former management, and multiple corporations, legal, and physical entities involved in the case. Considering the intricacy of the case and the involvement of multiple prominent political figures, the chance for the successful, timely, and transparent rectification of these disputes is fairly low.

The transfer of Mostecká uhelná's (MUS) property proceeded in a similarly interesting manner. The company emerged in November 1993 from the unification of the former state enterprise Doly and Komořany preparation plants, Doly Ležáky and Doly Hlubina. A majority stake in MUS was then privatized during the second wave of privatization, while the state kept a minority share.

The privatization was meant to be completed by the end of 1997, again with the anticipated sale of a maximum 3% to the management of the company and 34% to the strategic investor (see Hospodářské noviny, 1997).

But there was no significant change before the spring of 1998, when, as was the case with OKD, the National Property Fund called for an extraordinary general meeting to check the economic activity of the company.[16] This, however, proved only that the role of state in the further running of the company was rather limited. In an effort to dismiss the MUS Board for alleged opaque economic activities, it proved that the company was controlled by the anonymous group Investenergy located in Switzerland, while the actual owner was the American Appian Group (see Marek, Zlámalová, Fiala, 1998, p. 14).

The state at that point had only 46.29% of the company's stock at its disposal. Accordingly, the suspicion that it was the company's management that was struggling to seize the control over it grew stronger. "Our suspicion that the management is associated with the new investors is confirmed", declared FNM spokesman Miloš Růžička after the general meeting (see Marek, Zlámalová, Fiala, 1998, p. 14). The transfer was then completed by the Ministry of Industry and Trade, which in May 1999 came to agreement with Appian Group concerning the sale of the state's share in MUS (see Mladá fronta DNES, 1999). The company thereby took complete control of the greatest Czech producer of brown coal without its management structure ever having been revealed. Appian then, in 2005, sold MUS to four managers of the company, namely to Antonín Koláček, Luboš Měkota, Vasil Bobel and Petr Pudil (see Hudema, 2005, p. 3).

The extent to which these members of corporate management took part in the previously described property transactions is evidenced by events at the end of 2011. Under media pressure, Petr Nečas' Government at that point abandoned its approximately eighteen-month-long disinterest and decided to join the legal action initiated by the Swiss public prosecutor against MUS management for money laundering. The prosecution's materials in fact quite plainly described the order of events leading to the change in ownership of the company.

"According to the prosecution, from December 1996 to June 1998 the managers of MUS misappropriated more than CZK two and a half billion from company accounts they were administering. In the second phase, from December 1998 to April 2002, the managers, later also the owners of MUS, misappropriated another CZK four and a half billion."

The managers used the first two and a half billion crowns for a well planned purchase of stocks executed in the greatest secrecy in an amount that, for the money they stole, gained them a 50% share in the state strategic company. According to the prosecution, the managers immediately afterwards misappropriated another CZK four and a half billion. They used part of that sum to return the money from the first misappropriation. The rest, CZK six hundred fifty million, went to the fraudulent and corrupt purchase of MUS stock from the Czech state, for which, according to the prosecution, they paid three and a half million less than its real value. The managers then sent CZK one hundred fifty million to an account which friends of the former ČSSD deputies Stanislav Gross, Pavel Musela and Jiří Martínek had access–the Government, which approved the state, sale was in ČSSD's hands. And finally, they sent a bit less than a million and a half to their private accounts," is how the weekly Respekt summed up the main points of the case (see Spurný, Kundra, 2011). After merging with Severočeská uhelná, a. s., the company then, in 2005, changed its name to Mostecká uhelná, a. s., and in 2008 to Czech Coal Services, a. s. Furthermore, in 2006 the investor Pavel Tykač entered the company, while the former owners (Antonín Koláček, Luboš Měkota) left.

16 The server Ceskapozice.cz in 2011 released an interesting document, in which the representatives of FNM management just before the mentioned general meeting had warned the relevant people, i.e. Minister of Finance Ivan Pilip, the head of the Industry and Trade resort, Karel Kühnl and the bodies involved in the criminal proceedings. The very first lines of the document were interesting: "In 1998, the National Property Fund of the Czech Republic obtained information which led to the suspicion that the members of Mostecká uhelná company's management were involved in activities that met the definition of the crime of information abuse during trading, breach of obligations during the management of another's property, potentially also the crime of fraud". This information referred to both "embezzlement" from MUS and its "hostile takeover" (see Léko, 2011).

While the company itself changed owners a few times and its assets are now part of the Severni energeticka group, the legal cases related to the privatization described above are still ongoing. As with OKD, the sheer complexity of the case and involvement of multiple former high-ranked politicians weaken any chance for a transparent, final resolution of the legal disputes in the foreseeable future.

Sokolovská uhelná, a. s., emerged in 1994 from the merger of Palivový kombinát Vřesová, brown coal mines Březová and remediation company Sokolov (see SUAS, n.d.). It met the same fate as its larger colleagues: a small stake was sold to management, 34% to the strategic investor, and the remainder was put on the stock exchange. The state prevented a repeat of the OKD and MUS scenarios by enhancing its previous minority stake in the company with the purchase of an additional 1.3% of the shares, giving it a 50% stake (see Žák, 2003, p. 6). There was, however, no sign of privatization during the 1990s.

In 2003, the Financial Times referred to the anticipated completion of privatization in an article starting with the following words: "The Czech Government plans to privatize brown coal mines in a competition in which the majority of foreign applicants will be eliminated" (see Zlámalová, Němeček, 2003, p. 9). In an effort to keep potential German companies in check,[17] from which the Government expected nothing less than limited mining and favouring local industry over foreign Czech, it came to the narrowing down of potential investors into two groups–company management and the owners of OKD, Viktor Koláček and Petr Otava. Through the company Metlimex, the latter two owned 36% of Sokolovská uhelná's stock (see Bártek, 2003c, p. 8).

Koláček and Otava's arrest and investigation then spiced up the situation, when the privatization commission eliminated all other applicants and had the state sell the company to management for approximately CZK 2.6 billion. This price was repeatedly criticized for being too low: "The price for the state share should be between 7 and 10 billion CZK", argued the analyst of Atlantik FT, Roman Cenek (see Pokorný, 2003, p. 8). This claim finds confirmation, for example, in the fact the company had CZK 4 billion just in accounts aimed at landscape recultivation, which it could have used practically until it was eventual spent, while the offer of the American firm Independent Power (over CZK 6 billion) or of the Slovakian investor Penta (over CZK 7 billion) should not be understated either. As previously indicated, the selection commission nonetheless eliminated both companies without providing them any detailed justification.

Severočeské doly, a. s., (SD), established with the merger of Doly Nástup Tušimice and Doly Bílina in 1994, had a somewhat different destiny. In terms of privatization, SD was meant to be taken over by a private owner as in the case of Sokolovská uhelná, first through the process of privatization in the second half of the 1990s, and then by being put on the market in 2003. Keeping the obstacles discussed above in mind, the focus was on the dominant offer of the company Appian Group (see the part devoted to Mostecká uhelná, a. s.). Only ČEZ could have presented serious competition, since it was both the most important minority shareholder–with 39%– and the leading consumer of coal (SD covered 80% of ČEZ's coal consumption). ČEZ's offer was not accepted in the end, something which is often linked to the removal of company chief Jaroslav Míl, who was replaced by Martin Roman (see Zajíček, 2003, p. 8).

The tender, which the Czech and foreign media saw as highly opaque due to a number of restrictive terms, an obscure selection process, and speculation over whether the Appian Group would be favoured, finally attracted three bids. The Slovak group Penta wished to buy SD for CZK 5.3 billion, J&T offered CZK 6.8 billion and Appian Group CZK 4.83 billion (see Šafaříková, Němeček, 2003, p. 9). The Government then cancelled the tender. The final decision was to give up the notion of selling the mines via the tender process and instead to execute a direct trade with ČEZ, which bought another 37.31% of SD stock for approximately CZK 9 billion in 2005, thereby increasing its stake to 93.1%. The purchase of the remaining stock took place in the succeeding year (see ČEZ, a. s., n.d.i.).

2.3.5 Issues Related to EU Accession–Liberalization of the Energy Sector

In the period after 1995, the so called European Agreement entered into effect. This Agreement codified the entry of the Czech Republic into the EU, on the basis of which the Czech Republic was obligated to adapt the local legal framework to the EU framework over the course of ten years.

17 "A German mining company cannot be the investor for it would be bringing coal from Germany," are, for example, the words of Deputy Minister of Industry and Trade Martin Pecina (see Zlámalová, 2003b, p. 3).

The Czech Republic's objectives in many respects corresponded to EU requirements, albeit the accentuation and above all the planned pace of change could have been somewhat different. Even without incentives from Brussels, there would have been movement towards a market economy, including the settlement of energy commodity prices and the complete removal of state subsidies. The same is true for the adaptation of the legal framework, for example treating the functioning of private energy companies, delimiting the state's role in the energy sector, for example in terms of preserving free competition and restricting monopolies, followed by the establishment and streamlining of the required monitoring agencies (ERÚ, State Energy Inspection). The energy sector had to undergo changes leading to greater efficiency, greater conservation of raw materials, and heightened environmental awareness. Nor would the outdated coal sector escape rebuilding. All of this would sooner or later have happened on its own, so every assessment report and other outcomes of the pre-accession negotiations really served as observations on ongoing changes rather than a means of imposing them.

There were actually only a few truly problematic issues. For financial reasons as well as for the adoption of necessary legislation, a requirement was set in place to secure 90-day reserves of oil and oil equivalents in case a supply crisis should arise. This was done by the Act on Emergency Oil Stocks 189/1999 Coll., which required a progressive increase in these reserves and led to the gradual resolution of the situation by 2005.[18] The transition period, which was arranged until December 31, 2005, was indeed only a reserve for fine-tuning and not an effort by the Czech Republic to needlessly prolong the issue. This is apparent from the country's current effort to increase these reserves to 120 days, notably beyond the level requested by Directive 2006/67/EC (of December 31, 2012 Directive 2009/119/EC) (see Černoch, Dančák, Koďousková, Leshchenko, Ocelík, Osička, Šebek, Vlček, & Zapletalová, 2012)

Tab. 2.1: The Process of Electricity Market Liberalization

Period	Eligible customers – customers entitled to choose an electricity supplier on their own	Offers can be provided by producers with a minimum production exceeding	% of total consumption
From 2002	End users whose yearly electricity use exceeds 40 GWh	10 MW	17.9%
From 2003	End users whose yearly electricity use exceeds 9 GWh	Any production level	29.8%
From 2004	End users with continuous metering, households excluded	Any production level	47.4%
From 2005	All end users, households excluded	Any production level	72%
From 2006	All end users	Any production level	100%

Source: ERÚ

The requirements entailed by market liberalization[19] were far more complicated, primarily in terms of enabling customers to choose natural gas and electricity suppliers on their own. The issue was first addressed by the Energy Act, No. 222/1994 Coll., while the Government had a detailed timetable only with the Energy Act of 2000 (458/2000 Coll.). The latter act also regulated other requirements included in the EU directives, for example delimiting the authorization principle for building new energy capacities or the obligation to keep separate accounting across single activities.

18 These reserves are provided by the Administration of State Mineral Reserves, which regularly submits reports on the state of these reserves to the European Commission.

19 Driven at the EU level by the Directive Concerning Common Rules for the Internal Market in Electricity No. 96/92/EC and the Directive Concerning Common Rules for the Internal Market in Natural Gas No. 98/30/EC. Both documents among other things required enabling third party access to the electricity and natural gas transmission networks, which are of a natural monopolistic character.

Tab. 2.2: Liberalization of the Natural Gas Market

Period	Eligible customers – the customers entitled to choose a gas supplier on their own
From 2005	End users with consumption exceeding 15 million m³ / year per single consumption site as well as all licensed electricity producers burning gas in thermal power plants or during the combined production of electricity and heat.
From 2006	All end users, excluding households
From 2007	All customers, including households

Source: ERÚ

EU liberalization requests were later emphasized in a new directive, 2003/54/EC Concerning Common Rules for the Internal Market in Electricity and Directive 2003/55/ Concerning Common Rules for the Internal Market in Natural Gas, which the Czech Republic had also incorporated into its legislation and, in line with their aims, also speeded up the opening up of the whole market.

Tab. 2.3: The Number of Electricity and Natural Gas Suppliers Changed During the Liberalization Process and Upon its Completion

	Electricity				Gas			
	High energy users	Low energy business users	Low energy households users	Others	High energy users	Medium energy users	Low energy users	households
2002	unknown	x	X	unknown	X	X	x	x
2003	16	x	X	0	X	X	x	x
2004	396	x	X	3	X	X	x	x
2005	1,650	1,829	X	32	2	X	x	x
2006	2,458	5,693	4,976	23	2	24	428	x
2007	4,353	15,991	25,644	28	104	9	62	6,524
2008	6,549	35,351	15,764	25	129	90	366	11
2009	9,105	33,487	54,089	63	152	267	4,506	28,402
2010	17,012	48,072	183,990	107	213	674	6,842	76,695
2011	9,518	50,770	250,903	662	476	892	16,144	158,840
Total	51,057	191,193	535,366	943	1,078	1,956	28,348	270,472

x – the market for the specific type of user so far unopened

unknown – statistics of the number of changed suppliers were not kept

2011 – data until August (electricity), resp. July (gas) 2011 (incl.)

others – inputting and producing consumption and transfer sites without continuous metering and with losses in the network, or excessive internal consumption.

Source: OTE, 2010

The liberalization trend in the single EU energy market, of course, did not end with the Czech Republic's entry into the EU in 2004. The most recent incentives came with the adoption of the Third Liberalization Package in 2009, predominantly consisting of directives and regulations controlling the rules of the internal market in gas and electricity[20]. This package, among other things, defines different types of ownership unbundling of the transmission networks from producers, specifically, absolute ownership unbundling and two more moderate models. The entire package also targets the authorities of the regulatory organs and the formation of its equivalent covering the entire EU (ACER) along with the rights of end users.

These new features entered the Czech legal framework though an amendment to the Energy Act (Act No. 211/2011 Coll.) on August 18, 2011 (see Pravda, 2011, p. 39). The general character of this amendment is discussed in other sections of this book. Here we confine ourselves to modifications concerning electricity and natural gas market liberalization.

20 The package consists of Directive 2009/72/EC on Common Rules for the Internal Market in Electricity, Directive 2009/73/EC on Common Rules for the Internal Market in Natural Gas, Regulation No 713/2009 establishing an Agency for the Cooperation of Energy Regulators, Regulation No 714/2009 on Conditions for Access to the Network for Cross-Border Exchanges in Electricity, and Regulation No 715/2009 on Conditions for Access to the Natural Gas Transmission Networks.

The greatest innovation, the ownership unbundling of network operators from production and trade, referred only to the electricity industry, in other words to ČEPS. Since 2011, ČEPS has been an independent entity and has no ownership relations with its former parent company ČEZ.[21] As far as the gas sector is concerned, the state intervened to ensure a more relaxed modification of ownership relations by means of the ITO (Independent Transmission Operator), in which a transmission system operator and a producer or supplier can remain in a joint concern, while being subject to major regulation by the supervising organ (ERU)–during the appointment of the company's management, the preparation of investment plans, or verification of the transmission system operator's independence. NET4GAS, as the operator of the core gas pipelines, was thereby forced to remain part of RWE (see Pravda, 2011, p. 39).

The situation in the gas sector has in recent months been changing significantly and it seems the debate over which regulation model to apply to NET4GAS has ceased to have much point. RWE Transgas, part of the German concern RWE, has actually sold transit pipelines (see Kubátová, 2012). The reason is the need to consolidate the company and obtain the means for investments in Germany itself, related to the pressure imposed there on energy companies due to the country's exit from nuclear energy. A consortium made up of the insurance company Allianz and the Canadian investment company Borealis has become the new owner of NET4GAS, by which the latter's (in)dependence on the initial parent company has become a matter of history.

2.3.6 Temelín Nuclear Power Plant

Although it represents but a single source of electricity, the nuclear power plant at Temelín (NPP Temelín) deserves a dedicated section, since this project affected and continues to affect the development of the entire energy sector to a great extent. We will not look at the importance the Temelín nuclear power plant has for the energy mix or its technical performance, but rather at the circumstances surrounding the power plant's completion as one of the most sensitive energy-related topics of the 1990s.

The decision to build the power plant came already in 1980, with plans for four 1,000 megawatt VVER 1000 blocks. Two years later, a supply contract for a Soviet technical project followed, with the construction permit issued in November 1986. When construction was initiated in February 1987 (to be realized by Škoda Praha), it seemed that everything would proceed without complication through to the launching of the power plant (see ČEZ, a. s., n.d.j.).

After November 1989, the project came to be modified, mainly after re-evaluating whether the Czech Republic needed such a massive power source and after calculating the cost. The Czech Government, under Decree No. 103/93 of March 1993, decided to build only two blocks (which produced their first electricity in 2000); in 2002 the first block went into test operation and, in 2003, the second. They were launched with full capacity in 2004. The power plant received final approval in 2006 (see ČEZ, a. s., n.d.j.).

This brief description, however, neglects the turbulent atmosphere which had persisted for more than a decade as construction took place. Temelín NPP prompted powerful reactions both at home and abroad, and its completion was more than once reconsidered.

The first serious obstacles it had to face presented themselves at the start of the 1990s, when opponents organized NGOs like South Bohemian Mothers against Atomic Danger. Demonstrations against completion were frequent, such as one on April 27, 1991 that was also joined by the citizens of Germany and Austria (see Petrlík, 1991, p. 8).

During the same period, the acuteness of the Temelín issue was confirmed as well by a decision of the government headed by Prime Minister Petr Pithart, who ended debate on Temelín's completion by leaving the final verdict to his successors. Two studies which emerged in 1992 made a contribution of their own; one commissioned by the Ministry for Economic Affairs and Development of the Czech Republic and the other ordered from the American company Power International by unidentified government agencies. Without going into detail, we may note that the studies were dramatically at odds with one another–the study ordered by the Ministry argued that the completion of Temelín nuclear power plant was necessary if the country was to escape an energy collapse. Power International, on the contrary, saw completion of the power plant as leading to a surplus of electricity and the need to close a significant amount of other energy capacity. A similar analysis was introduced concerning the estimated electricity price, which was supposed to be CZK 0.60 or even up to CZK 2.40 per 1 kWh (see Gruner, 1992, p. 5).

Further progress on the construction then continued in a similarly unsteady manner. Announcements of delays and rising prices were quite regular until the Government headed by Josef Tošovský intervened by asking an

21 ČEPS, a. s., is 100% owned by the Ministry of Industry and Trade, while the Ministry of Finance has a share in ČEZ, a. s.

independent commission to inspect the entire affair. Its final report released a final price in the neighborhood of at least CZK 110 billion, and the commission seized the opportunity to question the need for the Temelín nuclear plant in the first place in terms of expected energy consumption (see Hrubý, 1999; Švehla, 1999a, p. 6).

In terms of the economic profitability of the power plant, it was said that the investments would provide an economic return only if the plant were to be completed in three years. Traditionally reserved towards Temelín, the weekly Respekt commented on the conclusions of the report with open sarcasm: "Throughout the year ČEZ provided us with two sorts of information. First, that electricity from the nuclear power plant is absolutely the cheapest, and second, that the republic would break down in the aftermath of an energy collapse without this super-cheap electricity. Today marks the fourth year from when we were supposed to live in a country sunk in darkness, where trains do not run, factories stand still and hospitals are closed. This is how ČEZ experts painted the future of the Czech Republic after 1995, if Temelín were not completed. The power plant is still not standing, but dark forecasts, nevertheless, have been proven wrong. (...) Together with postponing the date of completion, the energy lobby also pushed its prophesy of an energy emergency further off. In the mid-1990s, ČEZ predicted it at the end of the decade, now in 2005 we will supposedly "make it" without Temelín" (see Švehla, 1999b, p. 5).

In any case, by the time of the Zeman government, it was decided to proceed with the unconditional completion of the Temelín plant, with a major role played by the persuasive proponent of the project, Minister Grégr. "I do not believe the arguments that Temelín is unnecessary," commented one of completion's proponents, Minister of Interior Affairs, Václav Grulich. "After all, we need to get industry on its feet. And then it will be necessary" (see Švehla, 1999c, p. 4).

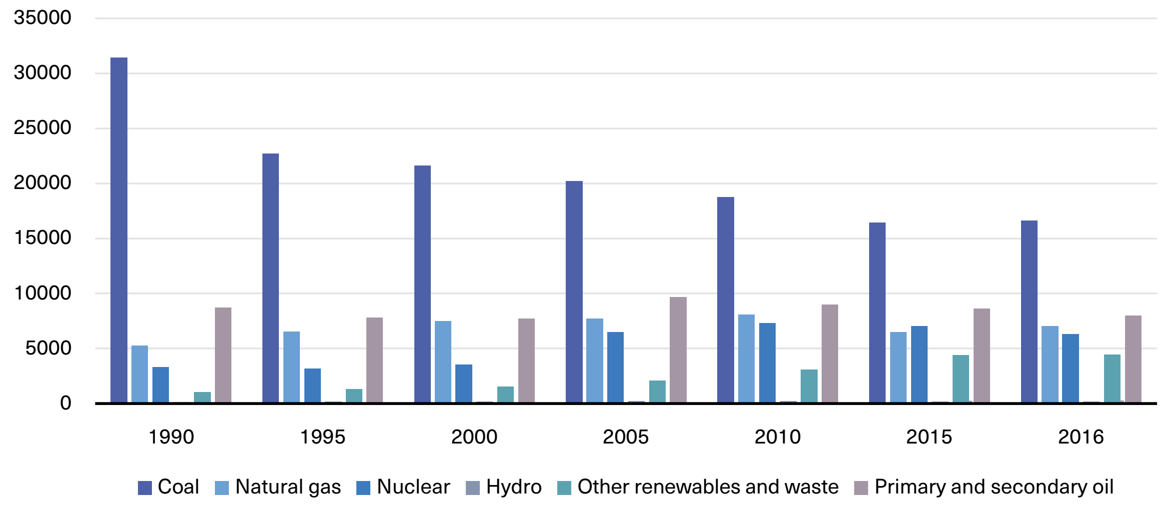
With this, the last obstacle to completion fell and on November 3, 2006, Temelín underwent final inspection.

2.4 The Third Phase of Development – EU Membership Through to the Present

Despite all the problems and delays, the Czech Republic succeeded in joining the European Union boasting a stable energy market with aggressive energy companies, a number of acquisitions abroad, and a significant improvement in the diversification of energy suppliers. While the details about the development of individual energy sectors in the period after 2004 are provided in subsequent chapters, here we would like to briefly comment on more general trends that have shaped the country's energy sector.

Firstly, some development may be observed in the composition of the energy mix (see Table 2.4). Decreasing energy intensity in the economy, the depletion of easily accessible deposits, a strenghthened position for other fuels, environmental mining limits, and environmental concerns in general contributed to a decline in coal consumption. Especially in heat production, coal was substituted to some extent by natural gas, a preferred fuel due to its practicality and cleanness. Nevertheless, coal is still king when it comes to meeting the energy needs of the country.

Tab. 2.4: Total Primary Energy Supply (TPES) by source (Ktoe)



Source: (IEA, 2019)

The commissioning of Temelín NPP in 2000–2002 significantly increased the share of nuclear energy in the mix. Since then the growth of the production has been driven primarily by incremental improvements in the existing technology, with the construction of new capacities being rather unlikely.

An orchestrated effort driven by EU legislation and domestic environmental pressure resulted in an increased use of renewable energy and energy produced from waste. Despite the damage done to the reputation of renewables in the 2008–2010 crisis and the noticeable hesitation of subsequent governments to reintroduce financial support schemes for producers, renewable energy is expected to slowly grow in the future. On the other side, the dominance of oil in transportation has remained practically unchallenged, with some variations in consumption resulting from changes in the price of oil products at petrol stations.

Secondly, there has been noteworthy evolution in the stance of ČEZ. Once a monopoly producer of electricity, the company faces multiple problems that erode its position. While still controlling a high percentage of generation, distribution, and supply, under domestic and EU-driven liberalization processes, new companies have emerged to offer intense competition. Comparing the situation in 2008 versus 2016, ČEZ´s share of total generating capacity has declined from about 75% to 67.7%; in terms of distribution, Prague, Southern Bohemia, and Southern Moravia are operated by PRE Distribution and E.ON Distribution respectively, while dozens of rival companies are actively trading in the country. (IEA, 2016) Of these ČEZ challengers, EPH stands out with an aggressive buying strategy and impressive pace of growth. Established only in 2009, the company has assets now in the Czech Republic, Slovakia, Germany, Italy, Great Britain, and Hungary, and is involved in production, trading, and distribution of electricity. It is also active in the natural gas sector, in heating, and in coal mining. To provide a rough comparison, EPH and ČEZ had 11,512 MW and 14,865 MW of installed capacity respectively. (EPH, 2018), (ČEZ, 2018)

ČEZ has also been notoriously incapable of successfully expanding outside the borders of the country. Between 2004 and 2019, the company invested about 72 billion Czech crowns abroad, buying assets primarily in Balkan countries, with questionable results. ČEZ´s acquisitions ran into problems in Bulgaria, Turkey, Poland, and Albania, where political and regulatory issues too often forced ČEZ to write some of its investments off. (Zenkner, 2019), (Lukáč, 2019) This is again in stark contrast to the regularly successful foreign investments of EPH.

Third, the Czech energy sector seems to be more and more influenced by the energy transition underway in neighbouring Germany, which aims to phase out of nuclear and coal sources, replacing them with renewables. When this transition was launched in 2010–2011, the main concern of various Czech energy stakeholders was that Germany would use its diplomatic and economic power to problematize nuclear energy in neighbouring countries. This concern never materialized, but other sources of pressure have emerged.

The price of electricity is an especially significant one. Due to integration processes underway in the EU electricity markets and the pronounced geographic proximity between the two countries, Germany and the Czech Republic have the same electricity prices. The price is created in Germany as a result of the huge imbalance between the sizes of the two markets. The market reality of the German electricity market, with a growing share of subsidized and intermittent renewable sources, is thus mirrored in the Czech Republic. This means, for example, that the wholesale price of electricity, under strong pressure due to the huge subsidies thrown at renewable sources in Germany, is instantly mirrored in the Czech Republic. While beneficial for end consumers, it affects the investment strategies of electricity producers and has a significant (negative) impact on the potential profitability of any new nuclear source in the country. (Černoch, 2017)

Fifth, a significant part of the future debate over the Czech energy sector will be dominated by environmental issues. The energy sector is one of the worst polluters, which is why it is exposed to progressively more intensive regulation at the level of the state and of the EU. To illustrate the situation, energy companies need to cope with the demands of the 2020 climate and energy package, which spurred support for renewable sources and intensified decarbonization of the sector via the EU Emission trading system. (European Commission, n.d.) This package was tightened further in 2014 with the 2030 Climate and Energy Framework (European Commission, n.d.b) Large combustion plants with a rated thermal input greater than 50 MW are obliged to fulfil stringent emission limits introduced by the Industrial Emission Directive (European Commission, 2010). Environmental and energy policies are slowly merging into one, and energy sectors in the Czech Republic and throughout the EU are being forced to decarbonize and be more efficient and environmentally friendly, regardless of the cost.

Finally, we observe significant development in the intensity of securitization of the energy sector. The Czech Republic depends heavily on supplies of natural gas and crude oil from foreign countries, mainly from Russia, and this dependency is traditionally perceived as a significant security threat. Import dependency concerns motivated the construction of the IKL pipeline and negotiation of gas contracts with Norway, both aimed at attracting non-Russian energy supplies. The worst fears came to pass during the New Year´s Eve quarrels between Ukraine and Russia over prices and gas volumes, which escalated in 2006/2007 and 2008/2009. The disagreement resulted in interruption of the flow of natural gas through Ukraine to Europe, causing ten states receiving supplies on the route to experience a serious shortage of gas. The securitization and nationalization efforts have been likely connected with the general development in the Czech party system, which, under the influence of the economic crisis, have become rather Eurosceptic as one of the consequences of the economic crisis. Euroscepticism is rooted in the Czech party system and in the public also due to the historical footprint and legacy of Václav Klaus, the former President of the Czech Republic (2003–2013). (see Havlík & Mocek, 2018; Havlík, 2019)

Since that time, however, the situation has slowly normalized. With the continuous integration of the EU's internal energy market and construction of a new gas interconnection to neighbouring countries, attention has shifted from the geopolitically framed security of (gas) supply to the technically framed security of (electricity) infrastructure. The issue of politicization of energy supplies by third countries still resonates with policy makers, but it is gradually being overshadowed by more pressing issues.

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Chapter 3: The Coal Sector

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3.1 Introduction to the Coal Industry

Thermal power plants (powered by brown coal, bituminous coal, biomass and light fuel oil) in the Czech Republic provide 11,075 MW of installed capacity, which makes up approximately 50% of the power-energy mix (see Energetický regulační úřad [ERÚ], 2018). The largest heating plants in the Czech Republic are Prunéřov II (1,050 MW), Počerady[1] (1,000 MW), Dětmarovice and Tušimice II (up to 800 MW). All of these power plants are under the ownership of ČEZ, a. s. (see ČEZ, 2019). Other large power plants include Chvaletice (up to 800 MW), formerly owned by ČEZ until its 2013 sale to Severní Energetická a. s. (also known as Sev.en Energy AG, formerly Czech Coal Group) (see Sev.en Energy, 2018a). The largest power plants involved in biomass combustion are Tisová I (1 57 MW block), Poříčí (1 55 MW block), Hodonín (1 55 MW block) and the Dvůr Králové heating plant (1 6.3 MW block), also owned by ČEZ, a. s. (see ČEZ, 2019). ČEZ, a. s. also built an entirely new supercritical coal unit with a 660 MW capacity at the Ledvice power plant.

All the coal-fired power plants in the Czech Republic are equipped with subcritical or critical boilers whose efficiency ranges from 30–38%. The first supercritical block in the Czech Republic, whose coal combustion processes are more efficient (up to 43%)[2] and cut pollution emissions, is a block of the Ledvice power plant. It's capacity is 660 MWe, and it was completed in 2017 (see ČTK, 2017). In terms of economics and environmental impact, operation of the subcritical blocks is comparable to that of steam power plants driven by natural gas.

Thermal power plants may be divided into two categories: condensing power plants and heating plants. Condensing power plants produce power, which means that, following the execution process, all the steam sent to the turbine condenses into water inside the condenser. Heating plants, in addition to producing power, also supply thermal energy (in the form of steam to heat water) for heating systems and similar purposes.

1 For several years there has been an ongoing discussion over the future of this power plant–whether ČEZ will sell it to Severní Energetická, which would be suitable in light of its proximity to the ČSA mine (see Brož; 2019) .

2 Terminology from Kolat, Roubíček, & Kozaczka, 2008, p. 20.

Tab. 3.1: Coal Power Plants in the Czech Republic with more than 150 MWe of Installed Capacity

Power Plant	Owner	Installed Capacity	Connected to the Network	Fired on
Dětmarovice	ČEZ, a. s.	800 MWe (4 × 200)	1975–1976	Bituminous coal
Chvaletice	Sev.en Energy AG	800 MWe (4 × 200)	1977–1978	Brown coal
Kladno	Alpiq Generation (CZ), s. r. o.	305.966 MWe (1 × 28, 2 × 135.533, 1 × 6.9)	1976, 2014	Bituminous coal, brown coal
Komořany	United Energy právní nástupce, a. s.	239 MWe (4 × 32, 1 × 20, 1 × 22, 1 × 34, 1 × 35)	1959, 1978, 1986, 1994, 1997, 1998	Brown coal*
Ledvice VI	ČEZ, a. s.	660 Mwe	2017	Brown coal
Mělník (II, III)	ČEZ, a. s.	720 MWe (2 × 110**, 1 × 500**)	1971, 1981	Brown coal
Mělník (I)	ENERGOTRANS, a. s.	352 MWe (4 × 60, 2 × 56)	1961, 1994–1995	Brown coal
Opatovice	Elektrarny Opatovice, a. s.	363 MWe (5 × 60, 1 × 63)	1979, 1987, 1995–1997	Brown coal
Počerady	ČEZ, a. s.	1,000 MWe (5 × 200)	1970–1977	Brown coal
Poříčí	ČEZ, a. s.	165 MWe (3 × 55)	1957	Brown coal, bituminous coal*
Prunéřov	ČEZ, a. s.	1,490 MWe (4 × 110**, 5 × 210)	1967–1968, 1981–1982	Brown coal
Tisová	Sokolovská uhelná, právní nástupce, a.s.[3]	295.8 MWe (3 × 57, 1 × 12.8, 1 × 112)	1959–1961	Brown coal*
Třebovice	Veolia Energie, a. s.[4]	174 MWe (2 × 72, 1 × 30)	1961, 1998	Bituminous coal, light fuel oil
Tušimice	ČEZ, a. s.	800 MWe (4 × 200)	1974–1975	Brown coal

* The Komořany power plant is also partially fired by natural gas. One 55 MW block of the Poříčí power plant and one 57 MW block of the Tisová power plant employ biomass combustion.

** In 2020, Prunéřov II, Mělník III and one block of Mělník II power plant should be decommissioned, thereby decreasing installed capacity by more than 1,050 MWe

Source: Energetický regulační úřad, 2010b, p. 88, 92; *"Kdo vlastní české uhelné elektrárny"*, 2016; *„ČEZ odstaví nejvíc uhelných elekráren"*, 2017

3.2 Deposits, Mine Production, Companies and Traders

3.2.1 Lignite

Lignite is one of the youngest caustobioliths[5] in the humolith series. Peat is an even younger caustobiolith, mined within Czech borders in the 1960s in the Vracov peat bog in Southern Moravia, an area now covered by a natural lake. Compared to brown coal, lignite has a higher water and lower carbon content, which naturally means it possesses a lower calorific value.

The extraction of lignite has a rich history tied to the region of South Moravia. If we ignore smaller deposits and the small-scale extraction efforts that took place in České Budějovice and the Žitavská Basins, by far the largest deposits are to be found in the Vienna Basin. The underground extraction of lignite started with the Kyjov and Dubňany coal fields in the South Moravian Lignite Basin. It was already underway by 1824 and terminated in 2009 with the closing of the last mine (Mír in Mikulčice). Between 1825 and 1994, 93,180,200 tonnes of lignite were mined (see *UVR Mníšek pod Brdy, a. s.*).

The work was done by Lignit Hodonín, s. r. o., with its headquarters in Mikulčice, which owned the Mír Mine. Its sole customer was the Hodonín power plant, which had been built in 1951–1957. To justify its existence, the obsolete

3 The ČEZ group sold the Tisová power plant to Sokolovská uhelná, právní nástupce, a.s. in 2017 (see *„Tisová patří již Sokolovské uhelné"*, 2017

4 Company has changed name from Dalkia, s.r.o. to Veolia Energie, a. s. in 2014

5 Combustible fossil, the term means a fossil fuel.

power plant in Hodonín with a capacity of 105 MWe (one 55 MWe block and one 50 MWe block) has in recent years begun to specialize in biomass combustion. One reason for the shift is the constantly rising price of lignite. The owner of the power plant, ČEZ, A. S., frequently took it offline and restricted its operations to reduce emissions. The result was that the sole supplier of lignite, Lignit Hodonín, s. r. o., which had already long struggled economically, was unable to cope with the loss of its only customer. Thus, in September 2009 it declared itself insolvent. Management was temporarily taken over by s. p. DIAMO, so that extraction in the Mír Mine actually ended on December 23, 2009. On August 31, 2010, as part of the tendering process, the company and its 60 employees were purchased by UVR Mníšek pod Brdy, a.s., which does not plan to resume mining. All the machinery has been removed from the mine, and it is slowly filling up with water (see "*Důl u Mikulčič*", 2019).

Tab. 3.2: Deposits, reserves and mine production of lignite in the Czech Republic

	2006	2007	2008	2009*	2010	2011**	2017
Deposits – total number	9	9	9	9	9	5	5
– exploited	1	1	1	1	0	0	0
Total mineral reserves	977	976	976	975	975	997	997
– economic explored reserves	205,030	204,412	204,221	203,780	203,780	619,652	619,652
– economic prospected reserves	615,273	615,273	615,273	615,273	615,273	229,932	229,932
– potentially economic reserves	156,682	156,682	156,682	156,682	156,208	147,645	147,645
– exploitable (recoverables) res.	2,544	2,107	2,165	1,903	1,903	1,903	1,903
Mine production	459	437	416	262	0	0	0

* Mine production of lignit has ended in 2009.

** Since 2011 numbers of reserves hasn't changed.

Note: reserves numbers in kilotonnes (kt).

Source: Ministerstvo životního prostředí / Česká geologická služba – Geofond, 2018, p. 261

3.2.2 Brown Coal

Brown coal is a humolith with 65–69% carbon and 17–24 MJ/kg of calorific value. Brown coal is the main source of energy in the Czech Republic, and domestic extraction presently provides complete coverage for domestic consumption. Brown coal is therefore not imported, and only insignificant amounts are exported (around 1–2 million tonnes per year, mainly to Slovakia). The largest deposits are located in the Mostecká (formerly North Bohemian), Sokolovská, Chebská and Žitavská basins. Only the first two are currently under exploitation.

Tab. 3.3: Deposits, reserves and mine production of brown coal in the Czech Republic

	2011	2012	2013	2014	2015	2016	2017
Deposits – total number	53	53	53	52	52	51	52
– exploited	10	11	11	10	9	10	10
Total mineral reserves	8,948,767	8,936,157	8,859,890	8,826,333	8,775,056	8,729,236	8,673,268
– economic explored reserves	2,361,825	2,347,268	2,308,649	2,273,951	2,239,329	2,203,911	2,210,477
– economic prospected reserves	2,063,444	2,063,444	2,062,445	2,062,445	2,062,445	2,059,589	2,059,859
– potentially economic reserves	4,523,498	4,525,445	4,488,796	4,489,937	4,473,282	465,466	4,402,932
– exploitable (recoverables) res.	871,142	862,202	825,322	796,277	749,075	714,356	681,540
Mine production	46,848	43,710	40,585	38,348	38,351	38,646	39,310

Note: reserves numbers in kilotonnes (kt).

Source: Ministerstvo životního prostředí / Česká geologická služba – Geofond, 2018, p. 163

There are four companies active in the extraction of brown coal in the Czech Republic: *Severočeské doly, a. s., Vršanská uhelná, a. s., Severní energetická, a.s.,* and *Sokolovská uhelná, právní nástupce, a.s.*[6]

6 The Czech Coal Group joins together three companies that are highly active in coal mining, namely Vršanská uhelná, a. s., Litvínovská uhelná, a. s., and Důl Kohinoor, a. s. Taken together with Severočeské doly, a. s. and Sokolovská uhelná, právní nástupce, a. s. there are, therefore, five coal mining entities in the Czech Republic.

Severočeské doly, a. s. is located in Chomutov. It is 100% owned by ČEZ, A. S. In 2017, it controlled a 55.26% share of the brown coal market in the Czech Republic, making it the largest brown coal company in the Republic. Extraction is underway at the Nástup Tušimice and Bílina Mines (see Severočeské doly, a. s., 2018, p. 55).

Vršanská uhelná a.s. and Severní energetická a.s. are parts of the Sev.en group. They are located in Most. Sev.en group emerged as a successor to Skupina Czech Coal. The Sev.en group is supported by financier Pavel Tykač as well as Jan Dienstl, who is also chairman of the board. The group gathers together Vršanská uhelná, a.s., Most; Severní energetická, a.s., Most; Czech Coal, a. s.; Důl Kohinoor, a. s., combustion power plant in place in Chvaletice since 2013, and approximately 30 smaller firms engaged in power and heat production and services. Extraction is underway at the ČSA Mine (Severní energetická, a. s.) and Vršany (Vršanská uhelná, a. s.) (see Sev.en Energy, 2018). One of the group's subsidiaries, Důl Kohinoor, a. s., also operates the last working underground brown coal mine in the Czech Republic, Důl Centrum. In 2017, the Sev.en group had a 27.13% share of the brown coal market in the Czech republic, divided between Severní energetická a.s. with 10.59% and Vršanská uhelná with 16.44 % (see Severočeské doly, a. s., 2017, p. 55).

The final company, Sokolovská uhelná, právní nástupce, a. s., located in Sokolov, is owned by František Štěpánek (57.14%) and Jaroslav Rokos (45.86%). The third owner, Jan Kroužecký, sold his past 30% share in 2015. In 2017, the company had a 17.71% share of the brown coal market in the Czech Republic (see Severočeské doly, a. s., 2017, p. 55). Extraction is underway in the Jiří mine, which EIA approved in 2018 for prolonged functioning until 2030 (see „V lomu Jiří", 2018). Other mines, such as Družba and Marie, have been closed. (see Ministerstvo průmyslu a obchodu, 2017).

It is brown coal in particular that must be monitored with regard to territorial environmental boundaries on mining (see below). According to the Czech Geological Survey, as of December 2016, exploitable reserves of brown coal amounted to approximately 784 million tonnes.

According to representatives of the coal industry, based on declining extraction trends, Czech reserves should last until 2050 (see Carbonunion, 2018). There are approximately 880 million tonnes of coal in Czech coal mines like ČSA, Bílina, and Vršany.

Tab. 3.4: Exploitable Reserves of Brown Coal and Their Limits

Basin	Company	Open Cast Mine	Exploitable Reserves			
			As of 1/1/1999	As of 31/12/2009	As of 1/1/2014	As of 1/1/2015
North Bohemian Basin	Vršanská uhelná a.s.	Slatinice			12	12
		Vršany	316	305*	272	266
		In total	316	305	284	278
	Severní energetická a. s.	Centrum**	–	0	1	1
		ČSA	92	37.3	38	28
		In total	92	37.3	39	29
	Severočeskédoly, a. s.	Nástup – Tusmice	412	247	219	210
		Bílina	232	196	145	136
		In total	644	443	364	346
Sokolovská	Sokolovská uhelná, právní nástupce, a. s.	In total***	271	127	137	131
The Czech Republic in total	1,323	607.3	824	784		

Note: figures indicated in thousands of tonnes.

* Including Šverma Open Cast Mine (with a lifespan of reserves until 2012).

** The underground mine Centrum was in April 2016 closed for any further coal mining.

*** Including mine Jiří. Družba Open Cast Mine was in August 2011 closed for any further coal mining.

Source: Ministerstvo průmyslu a obchodu, 2017

3.2.3 Bituminous Coal[7]

Bituminous coal is a humolith that is composed of 69–92% carbon, with a calorific value of 24–33 MJ/kg. In the Czech Republic, there are deposits of both energy and coking bituminous coal (see below), which makes bituminous coal an important component in Czech exports. Altogether there are nine bituminous coal basins; by far the largest and the only mine still active is the Czech section of the Upper Silesian Coal Basin, in particular the Ostrava-Karviná district.

Tab. 3.5: Deposits reserves and mine production of bituminous coal in the Czech Republic

	2011	2012	2013	2014	2015	2016	2017
Deposits – total number	62	62	62	62	62	62	62
– exploited	8	8	8	8	8	8	7
Total mineral reserves	16,339,004	16,324,263	16,315,667	16,304,609	16,304,846	16,285,605	16,283,583
– economic explored reserves	1,518,929	1,496,792	1,487,287	1,475,446	1,475,464	1,465,793	1,460,044
– economic prospected reserves	5,998,902	5,995,983	5,993,801	5,993,812	5,746,510	5,991,317	5,991,133
– potentially economic reserves	8,821,173	8,831,488	8,834,579	8,835,351	8,839,345	8,828,495	8,832,406
– exploitable (recoverables) res.	180,729	168,538	66,301	56,569	41,844	25,199	22,513
Mine production	10,967	10,796	8,610	8,341	7,640	6,074	4,870

Note: reserves numbers in kilotonnes (kt).

Source: Ministerstvo životního prostředí / Česká geologická služba – Geofond, 2018, p. 170

The only mining organization in the Czech Republic engaged in the production of bituminous coal is *OKD, a. s.* (known prior to January 21, 1991, as Ostravsko-karvinské doly, a. s.). As the only company in the Czech Republic to mine bituminous coal, OKD was struck hard by the global decline in demand for bituminous coal. As demand declined and the price of bituminous coal dropped by almost two-thirds, the company suffered economically and was forced to lay off employees (see "*OKD propustí ke konci roku tři stovky lidí*", 2014). At the start of 2015, OKD had approximately 11 thousand employees and an additional 3-thousand had close ties to the company. 1600 of these employees and external workers were let go. (see "*Unie schválila státní pomoc pro OKD*", 2015).

OKD was wholly owned by the Dutch company NWR (New World Resources N.V.), more than 50 % controlled by the entrepreneurs Zdeněk Bakala and Peter Kadas. After unsuccessful attempts to find a way out of the economic thicket by using state financial support or selling the company to the state, the two relinquished their stock in the company, with the main share going to the Ad Hoc Group (AHG) in 2016. The government stayed as involved as possible, even if its aid focused primarily on employees as opposed to saving the company itself, as had been claimed Treasury Minister Andrej Babiš and Prime Minister Bohuslav Sobotka (see "*Co bude dál s OKD*", 2016). There were several initiatives to support OKD workers by finding them new jobs, offering them early retirement, or even offering outright financial support (see "*Co bude dál s OKD*", 2016).

Not long after the change in company ownership, AHG offered to sell OKD back into state ownership, since with the drop in the price of bituminous coal, the company had taken on massive debt (see „N*ový vlastník OKD*“, 2016). But even AHG's offer of CZK 3.2 billion was more than the company's estimated value when its debts were taken into consideration. As a result, during 2016, OKD's dire economic situation led to a request that insolvency proceedings be initiated. OKD's presumed debt of CZK 17 billion was owed to more than 650 creditors, who decided to try to save the company by reorganizing those components that were still economically viable. Afterwards, the company was taken over by the state via Prisko (see "*OKD je znovu státní firmou*", 2018).

Currently, OKD conducts operations in mines at Darkov and Karviná (renamed Důlní závod 1), and ČSM (renamed Důlní závod 2), (all supposed to be closed until 2023 (ČSM is to be the last operational mine) (see "*OKD v roce 2017 dosáhlo tržeb*", 2018). The Paskov mine (renamed Důlní závod 3) was closed in 2017 because extraction was no longer profitable (see "*V Dole Paskov*", 2018). As a result, in 2017 OKD obtained a profit of CZK 3.4 billion.

7 Anthracite, the most calorific and best coal, is not produced in the Czech Republic.

Tab. 3.6: Development of OKD mine production and profits

Year	2012	2013	2014	2015	1. 1. 2016 – 8. 5. 2016	9. 5. 2016 – 31. 12. 2016	2017
Volume of mining (mil. of tons)	10.8	8.61	8.34	7.64	2.55	4.17	4.87
Profit (billions CZK)	1.2	-19.66	-10.1	-6.8	-2.68	-3.32	3.4
Average number of employees (external workers included)	17,639	16,073	14,749	13,755	12,445	11,341	ca. 9,500

Source: "*OKD v roce 2017 dosáhlo tržeb*", 2018

Almost 75% of OKD's production goes to five domestic users: ArcelorMittal Ostrava a. s., Třinecké železárny, a. s., Group – Moravia Steel, a. s., OKK Koksovny, a. s., Dalkia Česká republika, a. s., and ČEZ, a. s. The remainder is exported to Austria, Slovakia, Germany, Poland, and Hungary (see *OKD, n.d.a.*). The company plans to continue mining in the Karviná region until 2024. Coal may be extracted from the ČSM Mine in Stonava underground on the Polish side of the border by working under the river (see Januszek, 2010). The mine in question, Morcinek, is owned by the Polish company Jastrzebska Spolka Weglowa S.A., and was shut down around 1998, although it had not been mined to full capacity. In 2010, the mining company New World Resources N.V. unsuccessfully attempted a takeover of the Polish Bogdanka mine. Management of the mine rejected an offer of about CZK 21.3 billion (see Daniel, 2010), thus blocking the formation of what would have been one of the largest bituminous coal mining companies in Central Europe, a region in which 190 million tonnes of extractable coking coal reserves are situated. But the option has not been discussed since 2016, when the then-chairman and CEO suggested that OKD should maintain the ČSM mine for access to the Morcinek mine in Poland (see "*Rezerva – polský důl Morcinek*", 2016).

3.2.4 Exploitation of Coal and Trading

The exploitation of coal may be divided into two categories. The various types of brown coal, lignite and almost one-third of the domestic extraction of bituminous (so-called energy) coal serve as the primary resource for combustion heat and power production in heating plants, condensing power plants, and boiler houses, with heat in most cases being a by-product of power production. The quality of coal and the modifications made to improve it greatly influence the combustion process. In order to maximize coal combustion and make efficient use of its calorific value, fireplaces are constantly being developed. From the original grates, on which the coal simply lay without motion, the technology has advanced to more efficient grates that utilize a stationary or circulating fluid surface and a powdery fireplace (see Jirásek & Vavro, 2008).

The second category involves the exploitation of a particular variety of hard coal called coking coal for the indirect production of raw iron in a blast furnace. Through the process of regulated warming in the absence of air (carbonization), a metallurgical coke–a hard, steel-grey material with a very high calorific value–is extracted from bituminous coal[8], which simultaneously serves as a fuel and reducing agent. In addition to metallurgical coke (about 75%), there is a vast array of side products that emerge during the carbonization process (coking gas, tar, benzene, ammonia, naphthalene, etc.) that are utilized in the chemical, paper, pharmaceutical, textile, and leather manufacturing industries (see Jirásek & Vavro, 2008). In 2016, 6.7 million tonnes of bituminous coal were extracted, 3.4 tonnes of which were coking, with 2.7 tonnes of energy coal. The largest (and only) coking plants in the country are ArcelorMittal Ostrava, a. s.; OKK Koksovny, a. s. and Třinecké železárny, a. s.

In the Czech Republic, only entities with a permit from the applicable District Mining Authority may mine coal. Such entities must pay royalties for the mining site. Just for bituminous and brown coal, the state received more than CZK 703 million in 2017 from these remediation, recultivation, and mine damage royalties (see MŽP/ČGS-G, 2018, p. 110). All mineral materials that lie within Czech borders are under state ownership up to the point of extraction, and by means of these fees, the state gives a de facto mining permit to the traders. The coal which is extracted then becomes the property of the companies concerned.

8 In a blast furnace for the production of iron, temperatures must be in the range of 1,700 to 1,900°C. The calorific value of coke traded in the Czech Republic ranges between 26 and 29.5 MJ/kg.

In the Czech Republic brown coal is traded almost exclusively on a long-term contract basis. The user makes direct contact with the trading department of the producer with the intention of entering into a contract. Purchase agreements, which are typically concluded for several years (usually 10–15), specify the amount of material, means of supply, offtake location, transport, calorific value, qualitative parameters of supply (sulphur, water or ash), etc. These long term contracts provide supply and operational security for consumers and for suppliers, secure, stable extraction and income. The Počerady power plant, for example, burns about 4,000 tonnes of coal per day, the Prunéřov I power plant 8,000 tonnes, and Prunéřov II as many as 20,000 tonnes of coal daily (see "*Mrazivé počasí,*" 2010). Securing stable (and massive) supplies of coal is the top priority, to ensure the operating process proceeds problem-free.

The trade in bituminous coal, which is carried out on either a long-term contract basis, as is the case with brown coal, or via the commodity stock market HRAPRAKO (up until 1. 1. 2017, when the market was closed down; see "Haprako, komoditni burza v likvidaci", n.d.a.), is divided into two categories. Bituminous coal of a quality adequate for coke for the blast-furnace production of raw iron, and which may also potentially be used for heating purposes, is listed on the market as "coking coal". Other varieties of bituminous coal are marked "bituminous coal for energy purposes" and mainly serve in electric power production (see MŽP/ČGS-G, 2010, p. 162). These categories form two more or less independent markets.

Brown coal plays almost no role in foreign trade. Out of 39.3 million extracted tonnes in 2017, the balance of foreign trade registered only 0.99 million tonnes in exports (see MŽP/ČGS-G, 2017, p. 177). When it comes to bituminous coal, exports accounted for 2.3 million tonnes. Meantime, 228 tonnes of coke were imported, with 744 tonnes of exports and imports (see MŽP/ČGS-G, 2018, p. 156–157). Bituminous coal was formerly a lead item in Czech foreign trade.

3.3 The Regulatory Framework of the Coal Industry

Mining in the Czech Republic is guided legislatively by three acts. The key act is without doubt No. 44/1988 Coll., on the protection and utilization of mineral resources (the mining act, see Zákon č. 44/1988 sb.), followed by Act No. 61/1988 Coll., on Mining Activities, Explosives and the state mining administration (see Zákon ČNR č. 61/1988 sb.), and Act No. 157/2009 Coll., on the Disposal of Mining Waste and Amending Certain Laws (see Zákon č. 157/2009 Sb). The latter came into effect on April 5, 2012.

The Mining Act establishes the principles for the protection and economic exploitation of mineral resources, especially in prospecting and exploration work, in the opening, preparation, and extraction of mineral deposits, the processing and refinement of minerals carried out in connection with mining, as well as the safety and environmental protection in these operations. Under the Act, mineral deposits in the Czech Republic are owned by the Republic.

Under the Mining Act, to mine coal within the country, an organization must obtain the approval of the District Mining Authority, which delimits the mining area[9]. Prior to submitting a proposal for the delimitation of the mining space, an organization must obtain approval from the Ministry of the Environment, which is issued only after consultation with the Ministry of Industry and Trade. The Ministry of the Environment may make the issuance of such prior approval dependent on meeting conditions related to the creation of a unified raw material policy for the Czech Republic and on the return of money from the state budget spent for the search and exploration of reserve deposits.

An organization is obliged to pay the relevant District Mining Authority an annual fee for a mining claim on each ha or part of the area of the claim within its surface boundaries; a government order sets the amount of the fee within a range CZK 100 to CZK 1,000, graduated depending upon the degree of environmental protection present in the affected area, the characterization of activities carried out, and their impact on the environment. (see *Zákon č. 44/1988 Sb.*). Until the 2016 amendment of Act No. 89/2016 Sb., its Article §32 also set fees to which mining organizations were subject. The amendment process saw this article expunged, and currently the only fee is CZK 100 to CZK 300 per ha. This fee is paid once per calendar year, with the money going to the surrounding villages most affected by mining.

9 In terms of hierarchy, the mining area is a set of one or several deposits.

Act No. 61/1988 Coll., on Mining Activities, Explosives and the State Mining Administration places conditions on mining activity and activity carried out in conjunction with mining , as well as on the handling of explosives and explosive items, and the organization and scope of the State Mining Authority (see *Zákon ČNR č. 61/1988 Sb.*).

The organs of the State Mining Authority oversee mining activity, observe working conditions and the treatment of extraction waste, and supervise compliance with Acts Nos. 44/1988 Coll., 61/1988 Coll., 157/2009 Coll., and other regulations (ordinances issued by the Czech Mining Authority, Czech Authority for Work Safety, etc.) (see *Státní báňská správa České republiky*). The State Mining Authority is the chief supervisor of the mining sector in the Czech Republic. The organs of the State Mining Authority are the Czech Mining Authority (the Central Mining Authority), located in Prague, and nine District Mining Authorities[10]. The Czech Mining Authority is the central organ of the State Mining Authority of the Czech Republic, whose chair is appointed and dismissed by the Government. The Czech Mining Authority keeps an overall record of mining areas and changes to them, and executes obligations imposed by the European Commission.

Among other things, Act No. 157/2009 Coll., on the Disposal of Mining Waste and Amending Certain Laws sets out rules for the treatment of mining waste and preventing any adverse environmental impact therefrom (see *Zákon č. 157/2009 Sb.*). This act follows on two governmental decrees (see Nařízení vlády 167/2016 and Nařízení vlády 342/2016) that focused primarily on ameliorating the negative social impact of the decline of extraction mining.

Aside from the legislative and regulatory dimensions, there is also the Czech Geological Survey (originally the Czech Geological Institute), the body that collects and processes data concerning the geological composition of the land and then passes it on to administrative bodies for political, economic, and environmental decision making. The Czech Geological Survey is tasked by the Ministry of the Environment with performing state geological surveys. That makes it the only institution whose mission involves the comprehensive exploration of the geological structure of the Czech Republic (see Česká geologická služba). Worth mention also is the Brown Coal Research Institute, j. s. c. (VÚHU, a. s.) located in Most, which emerged as part of the transformation of the former state company of the same name. Shareholders in the Institute are Vršanská uhelná, a. s., (44.580%) and Severočeské doly, a. s. Chomutov (44.582%). VÚHU conducts exploratory, consulting, commissioning, and servicing activity, directed primarily at mining-related issues (see Výzkumný ústav pro hnědé uhlí, a. s.).

In terms of the supranational legislative framework, there are a few directives from the Council of the European Union and the European Commission that address explosives for civil use (for example 93/15/EEC or 2004/57/EC). The European Association for Coal and Lignite (EURACOAL), functioning outside the regulatory framework, emerged in 2002 as a result of the transformation of the European Committee on Solid Fuels (CECSO), covering the European coal industry. EURACOAL is a lobbying organization gathering together 31 production and import companies and research institutes in Europe. The goal of the organization, located in Brussels, is to warn about the importance of coal in terms of security, competitiveness and the sustainability of energy supplies in Europe, and to contribute to the establishment of a satisfactory European regulatory framework (see European Association for Coal and Lignite). EURACOAL is in no manner connected to the EU institutions, although *does* cooperate with the European Commission and the European Parliament. The member of EURACOAL in for the Czech Republic is the Employers' Association of Mining and Oil Industries of the Czech Republic, an independent voluntary organization whose chief mission is to protect the interests of its members and formulate and pursue their objectives in negotiations with state administrative bodies, unions, and other institutions. It consists of 24 companies, organizations, and institutes that together represent the entire coal sector of the Czech Republic (See Zaměstnavatelský svaz důlního a naftového průmyslu).

There is no legal mandate to maintain strategic reserves of coal in the Czech Republic; in reality, each coal power plant *does* have certain "strategic" loads of coal, but because of the enormous volume of coal burned every day, it is barely sufficient for a couple of days of operation. If coal freezes during the winter, the situation is resolved by rotting the upper layer and subsequent collection or extraction underneath, where the coal is powdery, in its normal state.

10 In Kladna, Plzen, Sokolov, Trutnov, Brno, Most, Ostrava, Pribram and Liberec.

3.4 Demand Forecast

The basic priorities declared in the 2015 State Energy Concept are security, competitiveness, and sustainability (See "*SEK*", 2015). This represents a significant turn away from the approach taken in the 2004 State Energy Concept, because the basic priorities declared include maximum independence from foreign energy sources and energy sources in risky regions, and reliable supplies from foreign sources (see "*SEK*", 2004, p. 3). This shift in priorities signals that the role of coal will inevitably decline, particularly in the electric power and heating industries, and be replaced by renewables, nuclear energy, biomass, and the small, decentralized cogeneration units of local heating systems.

Tab. 3.7: Shares of Solid, Liquid and Gas Fuels in Energy Resource Consumption According to the State Energy Policy of the Czech Republic from 2004 and Updates from February 2010 and August 2012 (in %)

Type of Fuel	Level in 2000	Level in 2016	Long-Term Goal (SEP 2004) by 2030	"Green" Scenario (SEP 2004) year 2030	Revised SEP (2/2010) Scenario by 2030	Revised SEP Scenario (2/2010) by 2050	Revised SEP (8/2012) Target Values by 2040	Revised SEP Scenario (5/2015) Scenario by 2040
Solid	**52.4**	**40**	**30–32**	**30.5**	**24**	**20**	**12–17**	**11–17**
Gas	18.9	16	20–22	20.6	20	21	20–25	15–25
Liquid	18.6	20	11–12	11.9	20	19	14–17	14–17
Nuclear	8.9	15	20–22	20.9	25	25	30–35	25–33
Renewables	2.6	10	15–16	15.7	11	15	17–22	17–22

Source: *Státní energetická koncepce, 2004*, p. 11–12, 40–49; Státní energetická koncepce, 2015, p. 44; Ministerstvo průmyslu a obchodu, 2010a, p. 77–92; Český statistický úřad, 2008; Ministerstvo průmyslu a obchodu, 2012, p. 20–21. Návrh vnitrostátního plánu ČR v oblasti energetiky a klimatu, 2018, p.14

While solid fuels in 2016 maintained a 40% share in total consumption of primary energy sources in the Czech Republic, this figure is to drop, according to the long-term goal declared in the 2015 State Energy Concept, to approximately 11–17%. A significant decline in solid fuel consumption since 2000 is already visible. The scenario predicted by the 2015 State Energy Concept seems possible given the anticipated phase-out of several power plants[11].

The coal industry is truly at present on the threshold of major change. The century of steam ended long ago and nowadays energy is produced in many different ways that are notably friendlier to the environment. In the competition between natural gas, renewables and biomass on one side versus coal on the other, coal for now is still the winner, mainly thanks to its substantially lower price. Emission allowances, the fervent interest of the European Union in renewables, and the rising price of domestic coal as a result of the initial phase of a shortage, however, are gradually eroding coal's competitive advantage, and it is highly likely it will cease being the cheapest fuel in succeeding decades.

Despite its future prospects, though, at present all system power plants in the Czech Republic depend on coal. Although these power plants will gradually terminate their activity over the next two decades, the end will not come abruptly[12]. A sign of this may be seen in the government's 2015 decision to extend mining across the territorial environmental limits on brown coal mining in the Bílina mine, thereby exending the exploitation of coal until approximately 2050 (See Ministerstvo průmyslu a obchodu, 2017). According to a OTE, a. s. study, we may expect a decline in coal consumption due to dwindling reserves in tandem with territorial limits. Taking into account greater pressure from ecological regulations, it may be anticipated that by 2050, around 1,400 MW will be generated using brown coal. An important milestone should come after 2020 when stricter emission limits are implemented and some power plants find themselves unable to meet regulatory requirements. One example is the Počerady plant (see OTE, 2017, 24 – 25).

No massive departure from the use of coal as energy is to be expected, but rather it is to be rationalized. Coal energy is anticipated to undergo a qualitative shift towards clean technologies, greater efficiency, and savings. Modern technologies expected to play a significant role in the power industry of the future include cogeneration with the use of fuel segments and combusting gas obtained via the gasification of coal (Hermann, Noskievič,

11 ČEZ plans say that after 2035 only new or modernized power plants like Ledvice, Prunéřov, Tušimice, and Mělník should be in operation (see „*ČEZ plánuje do roku 2035*", 2017)

12 Likewise, the global use of coal will not cease. Thermal power plants in China, for example, in 2008 made up 75% of installed capacity with 792,000 MWe. Between 2011 and 2015, China plans to build thermal plants with a total capacity of 270,000 MWe (see Hui, 2011).

& Kolat, 1998, p. 306). As Tables 3.8 and 3.9 show, a switchover to decentralized heating systems is underway. But still, coal power plants will maintain their significance in the thermal power plant system. Moreover, when it comes to coal production, the Czech Republic in 2018 is ranked third in the European Union (45,313 tonnes of coal extracted in 2016), behind Poland (130,631 tonnes) and Germany (175,625 tonnes)[13] (see Simplified Energy Balances, 2019). The sector faces further requirements from above in the form of EU insistence that Best Available Techniques (BAT) be implemented to improve the efficiency of coal use. But to preserve economic competitiveness, the Czech government has voted to seek for exceptions from the EU directive (see Parliament České republiky, 2018)

The December 2018 Draft of the National Energy and Climate Plan of the Czech Republic summarizes the greatest challenge faced by the energy sector at present. There is support for shifting to natural gas, biomass, and waste to operate heat power plants and even to use as a heat source in households, but with an emphasis on the use of domestic sources of coal. But this use is to be made in a circumspect manner that stresses BAT and the most efficient means of processing the coal.

In terms of energy security, it is unreasonable to build new power and heating plants that depend for their functioning upon raw materials the Czech Republic does not possess. Such plants increase import dependence and costs while they reduce energy security. The Czech coal sector is capable of enhancing the energy security of the country, limiting foreign dependence on fossil fuels, supporting the stability of the electrical energy system, all at an acceptable cost, while observing the mandate to protect the environment and fight climate change. State decisions should express a clear position, and not only to the private sector.

3.5 The Heat Supply Industry

Heat may be supplied via central heating facilities (in which case we speak of a central heating supply system), as the output of a collection of heat sources (a decentralized heating supply system), or by individual facilities (the local production of heat). A developed central heating system is driven by cogeneration plants, rating plants, and partially by power plants in the thermal mono-generation regime, but chiefly in a combined production regime of power and heat, which then sees thermal energy sold further to external users in the production sphere or public sector (see Slivka et al., 2011, p. 10).

Heat demand in the Czech Republic (approximately 330 PJ) is met by a practically even mix of central and decentralized systems. Heat pumps have recently come under discussion, but it is only expected to account for roughly 2% of households by 2050 (See Návrh vnitrostátního plánu ČR v oblasti energetiky a klimatu, 2018). The output of the central heating system is directed approximately two-thirds to the public sector (households and services), with the other third going to industry (See Návrh vnitrostátního plánu ČR v oblasti energetiky a klimatu, 2018, p. 241). In terms of thermal energy sources (plants), there are almost 2,000 heat generation facilities registered in the Czech Republic, 1,800 with over 5 MW of capacity. This infrastructure is connected by a network of over 10 thousand kilometres. (see Zpráva o vývoji energetiky v oblasti teplárenství, 2016).

13 Amount of extracted or produced fuel counted after the removal of ballast material.

Tab. 3.8: The Balance of Thermal Energy from the Central Heating Supply System in 2010–2017

Indicator	2010	2011	2012	2013	2014	2015	2016	2017
Total production of thermal energy	147	134	134	135	118	119	126	122
Thermal energy consumed for power production	28	27	26	26	23	22	23	21
Of which:								
power plants and thermal plants	149	136	136	137	120	121	128	123
heating plants	100	94	96	97	85	86	89	87
nuclear power plants	1.06	0.92	0.98	0.9	0.87	0.9	0.88	0.91
chemical and waste heat	0.97	1.29	1.31	1.28	1.36	1.39	1.41	1.51
electrical boilers	0.01	0.01	0.01	0.01	0	0.01	0.01	0.01
solar systems	0.37	0.48	0.56	0.63	0.69	0.74	0.79	0.83
thermal pumps	2.09	2.48	2.7	2.91	3.34	3.81	4.44	5.22
Export of thermal energy	0	0	0.11	0.1	0.09	0.09	0.07	0.08
Losses in the distribution lines	7	7	7	7	6	7	7	7
Final consumption	102	96	97	96	84	85	88	89
Of which:								
industry	27	27	27	25	23	23	23	24
households	52	46	49	50	42	43	44	45

Note: figure indicated in tera joules (TJ).

Source: Bufka, Veverková a Modlík, 2019

Table 3.8 clearly shows that renewables are starting to be employed more, although still not to a significant degree. During the last two years (shown in the table), heat exports have come to a halt. Over time there has also been more successful management of losses in the distribution lines (attributable to better technologies). Thermal energy consumption is also declining (one may assume as the result of greater heat savings, an emphasis on energy efficiency, rising thermal energy prices, and some users switching from central to decentralized heating systems).

Tab. 3.9: Fuel Mix for Production of Thermal Energy in the Czech Republic in 2017

Year	Brown coal	Bituminous coal	Natural gas	Biomass and waste combustion	Fuel gas	Other fuels
2018	46%	13%	25%	6%	5%	5%

Source: Bufka, Veverková a Modlík, 2019

The total share of coal in fuels for heat production in 2017 was 59%. As Slivka et. al. (2011, p. 14) have noted, the share of domestic sources in the group of fuels used in the central production of heat stands at 68%, with imported sources amounting to 32%. On this basis, we can conclude that there is (for now) rather low import dependence and thus significant raw material security (as far as the heating sector is concerned). It is, however, still not clear how large a threat a shortage of primary sources poses in the Czech Republic for the future. As table 3.8 shows, decentralized heating sources such as thermal pumps and electric boilers are rising in popularity. With this trend, there is palpable pressure to either become part of the central heating system or else substitute current household heating sources by low emission sources such as heat pumps utilizing, for example, grants for change of boilers.

There is also increasing support for the combined production of electric power and heat (CHP) since this represents a more efficient use of energy sources than condensation power plants. The latter are 30% to 40% efficient, while modern cogeneration power plants may reach 90% efficiency (see "*Kombinovaná výroba elektřiny a tepla*", 2017). In 2018, almost 102 PJ of heat was produced using cogeneration in the Czech Republic (Tables 3.7, 3.8, and 3.9 overlap, with each presenting thermal energy production from a different perspective).

Tab. 3.10: CHP of Thermal Energy by sources in the Czech Republic in 2018

Production	Brown coal	Bituminous coal	Natural gas	Biomass	Fuel gas	Other fuels
102,3 PJ	56 PJ	12.8 PJ	11.1 PJ	12.1 PJ	4.8 PJ	5.5 PJ
100%	54.8 %	12.5 %	10,9	11,8 %	4,7 %	5,3 %
Source: ERÚ, 2019						

As noted above, aside from these fuels, there are other sources of fuel being reconsidered as well. Nuclear power plants that could supply a broad area with thermal energy have great potential. There is an ongoing project that involves a heat line stretching from Temelín to České Budějovice that is intended to provide heat to more than one-third of the city. Temelín already provides heat to the nearby town of Týn nad Vltavou (see "*Nový teplovod přivede teplo z Temelína*", 2018). A similar project was proposed for the Dukovany nuclear power plant. The intent was that Dukovany would produce heat for Brno. But the existence of a newly-built biomass heating plant makes it unlikely the project will be realized anytime soon (see "*Obec Dukovany postavila teplárnu na biomasu*", 2017).

By far the greatest potential–so far unemployed–lies in the energy exploitation[14] of municipal waste[15]. Mixed municipal waste may be used for energy purposes in power and heat production facilities (combined cycle), while incineration plants are being connected to the central heating system. There are three mixed waste incineration plants in the Czech Republic: in Prague, Brno, and Liberec (see Zajíček, & Zeman, 2010, p. 27–29; Slivka et al., 2011, p. 114). In 2017, mixed municipal waste amounted to 4.2 PJ, of which industrial waste accounted for 0.61 PJ (see Bufka & Andronic, 2018). As Bufka and Andronic (2018, p.7) indicate, the percentage share of landfill municipal waste is growing (by almost double since 2007, from 391 tonnes to 702 tonnes)[16]. A waste-to-energy strategy may thereby contribute to the use of domestic energy sources and a reduction in import dependence at the same time it assists in solving the problem of landfill waste in the Czech Republic.

The average price of thermal energy for end users when coal is used to produce it is 571.87 CZK/GJ. For natural gas or biomass, it is 565.09 CZK/GJ (see ERÚ, 2019, p. 9). The price of thermal energy is by far the highest in the Prague region (623 CZK/GJ), with the second most expensive prices in the South Moravian region (601 CZK/GJ). Share of coal in heat generation in South Moravia is makes less than 1 % on contrary in Prague, there is up to 45 % share of coal in their heat generation.

The least expensive thermal energy is produced in the Pardubice region, followed by the Vysočina region. While coal is used as the source in up to 70% of heat production in Pardubice, in the Vysočina Region, it accounts for only 6%. No clear pattern emerges in these four regions that would reveal whether having coal power plants contributes to higher thermal energy prices–this despite the fact that ERÚ claims such a pattern exists (2019, p. 14).

Biomass is significant in that its share of thermal production is now at almost 6%. In assessing price as a function of source, the most important factor is the price at which switching from a central to a decentralized heating system proves profitable.

Central heating plants serve 40% of Czech households (see *Zpráva o vývoji energetiky v oblasti teplárenství*, 2016). The biggest competitor to the central heating system is local heating with natural gas. Heating plants and networks are usually the property of municipalities and the private sector in a 50:50 ratio. The largest producers (i.e. distributors) of thermal energy are companies that in most cases are owned by municipalities. Traditional producers of electrical power buying shares in various heating plants are, however, also struggling to enter

14 There are three de facto conditions which must be met in any discussion of waste-to-energy exploitation: the waste must burn by itself (aside from the ignition phase it does not require any fuel), the heat generated must be used for one's own or other people's purposes, and it must reach a minimum of 60%, or 65% of energy efficiency respectively (see Zajíček & Zeman, 2010, p. 31).

15 'Municipal waste' means all the waste produced in a community by people in their day-to-day lives, not by businesses (see "*Zákon č. 158/2001 Sb.*"). It consists of used items and mixed municipal waste. Reusable items like paper, glass, plastics, beverage cartons, and so on are separated out and sent for recycling. Waste separation operates at a high standard in the Czech Republic, meaning the enormous amount of municipal waste cannot be substantially further reduced. Mixed municipal waste may either be sent to landfills or put to further use (by combustion in incineration plants). Mixed municipal waste contains around 50 to 60% of biomass, with calorific value ranging from 8 to 15, but usually in the 9 to 11 range, of GJ/ton (see Zajíček, & Zeman, 2010, p. 25, 28, 37-38, 45).

16 Installed thermal capacity in incineration plants in 2008 amounted to 175.7 MWt, while electrical capacity was only 2.9 MWe. The exploitable supply of heat was at the 2,500 TJ level. The potential for further production is, however, much higher: 15,750 TJ of heat and 0.5 TWh of electricity per year (see Zajíček, & Zeman, 2010, p. 39-40, 45).

the market. The leading companies in the heat supply industry include, Pražská teplárenská, Teplárny Brno, Plzeňská teplárenská, Teplárna České Budějovice, and Teplárna Ústí nad Labem (see "*Teplárenství – Obchod a trh,*" n.d.).

The central heating supply system in the Czech Republic has a number of advantages compared to other sectors as well as a number of disadvantages. There are also some threats present that, if they come to pass, could undo the advantages the heating supply industry currently enjoys, or even result in its demise altogether.

That production sources are located outside residential areas is a primary advantage of central heating systems, one that has a positive impact on municipal air quality and reduces the volume of emissions compared to local heating facilities, generally allowing better management and elimination of emissions. By using domestic fuels (which are also less expensive), the heating industry achieves greater independence from imports and greater energy security. As part of the combined production of power and heat, the heat supply industry is proven to utilize fuels better (efficiency up to 60%) and is becoming more flexible. It also exploits renewable and secondary sources of energy. Its major liabilities lie in the demands of construction, the problem of heat loss in distribution lines, more complex measurement, management, and regulation requirements, and the demand for adaptation in the marketplace (mainly regarding thermal energy) (see Slivka et al., 2011, p. 20, 155).

There is, however, another real threat, and that is the lack of availability of domestic fuels at an acceptable price (an issue related primarily to related to brown coal). Coal supply contracts are being terminated, mining is gradually declining, and there is uncertainty about coal beyond the environmental limits of extraction. A positive is that not all available coal sources have yet been exhausted. Where there is a shortage of coal, the lifespan of plants (and not just thermal plants) diminishes rapidly. A study by Slivka, et al. commissioned by the Ministry of Industry and Trade, moreover, warns of the shortcomings of substituting coal by the potential alternatives natural gas, biomass, or coal imported from Germany or Poland. They center on such solutions' economic, waste, and security risks (see Slivka et al., 2011, p. 20, 23, 155). The greater the use of natural gas, the greater the dependence on external sources (quite likely the Russian Federation) which is unwanted. The potential of biomass is in decentralized and local heating systems; importing coal from abroad would lack profitability and negate the chief advantage of a central heating system, which is the local availability of sources. Such arguments were mostly heard in the discussion on extending across territorial environmental limits on brown coal mining.

A lack of coal would hit not only the production of thermal energy but of electrical power as well. Both processes are therefore interconnected technologically and economically, so a shortage of coal as a fuel would affect the final score of both forms of energy, as well as the prices and economics of heating plants. Accordingly, the present benefits of central heating supply could cease to be (see Slivka et al., 2011, p. 18–19). The Pačes Commission found a lack of fuel for heat supply systems to be a significant threat to the Czech energy economy (see ÚVČR & NEK, 2008, p. 169). In the Draft National Energy and Climate Plan of the Czech Republic the lack of fuel for heat is mentioned as well, but there is visible progress in that the Draft puts forth several proposals for overcoming a coal shortage. It must be borne in mind, though, that any shortage of coal would jeopardize the country's heat supply sector (see Návrh vnitrostátního plánu ČR v oblasti energetiky a klimatu, 2018, p. 42)

Without long term contracts to ensure fuel supplies, the majority of centralized sources would be doomed. This would then lead to the breakup of central heating system overall (see MPO, 2011b, p. 26). The following table presents the demand forecast for brown coal to the year 2050.

Tab. 3.11: Forecast Demand for Brown Coal According to EGU Brno

Year	2010	2015	2020	2025	2030	2035	2040	2045	2050
Production of brown coal	44,025	36,100	35,000	30,000	26,000	16,000	5,000	5,000	5,000
Future demand of ČEZ, A. S.	26,530	29,230	21,100	16,600	12,550	11,700	4,700	4,700	4,700
Future demand of independent producers	13,535	13,085	13,465	13,235	11,880	7,940	4,340	3,830	3,830
Future demand of other users	2,800	2,400	2,200	1,900	1,600	200	200	200	200
Possible export	1,160	200	–	–	–	–	–	–	–
Total demand	44,025	44,915	36,765	31,735	26,030	19,840	9,240	8,730	8,730
of which: for electricity	32,316	32,968	26,986	23,293	19,106	14,563	6,782	6,408	6,408
for heat	6,635	6,769	5,540	4,782	3,923	2,990	1,392	1,316	1,316
contracted	44,025	42,810	35,370	28,000	24,210	15,930	290	200	200
Difference between sources and demand	**0**	**-8,815**	**-1,765**	**-1,735**	**-30**	**-3,840**	**-4,240**	**-3,730**	**-3,730**
Difference between sources and contracts		-6,710	-370	2,000	1,790	70	4,710	4,800	4,800

Note: data indicated in 1,000 tonnes; For prediction of brown coal demand in 2015 (44,915,000 tonnes), an alternative lower calculation of demand has been processed, amounting to 40,885,000 tonnes. In the same brown coal extraction forecast, the difference between supply and demand would fall to -4,030,000 tonnes.

Source: Slivka et al., 2011, p. 43.

As is visible above, the production of brown coal would not practically be able to cover the demand of the heating industry from about 2015 without extending across territorial environmental limits in Bílina. Nor would it cover the needs of the heat supply industry. The difference between domestic coal production and demand depends on the further development of coal production – whether environmental limits will be breached at the ČSA mine, how other sectors of energy production will evolve, and to what extent emission limits will be implemented at the power plants.

Another significant problem for the Czech heating industry is the use of renewables as fuels. According to Slivka et al. (2011, p. 8), the importance and availability of renewables and savings on the consumption side are significantly overrated. The potential of renewables in the Czech Republic is practically exhausted, especially in terms of wood cut-offs, while the use of wood cut-offs remains competitive relative to its use in the paper and wood processing industry and local heating. Currently, the only non-exploitable potential (believably 500,000 to 1 million tonnes by 2020 expressed using a brown coal equivalent) then lies in mixed municipal waste, which could partially replace classical fuels. The energetic potential of fuels from other waste is fairly marginal with regard to applicable legislation (primarily environmental limits–emissions, the necessary modification of fuels that would require the purification of materials hazardous to health, and so on).

3.6 The Issue of Extraction Limits

Territorial environmental limits on brown coal mining are subject to Government Resolution No. 444/1991 on Territorial Environmental Limits on Brown Coal Mining in the North Bohemian Basin of October 30, 1991. This resolution specified boundary lines for limited mining and landfill in the quarries Merkur, Březno, Libour, Šverma, Vršany, ČSA, Ležáky, Bílina, and Chabarovice; in Ruzodolska and Radovesicka, for landfills; and in basins in the regions of Chomutov, Most, Teplice, Ústí nad Labem, and Louny, it set the limiting values for air pollution (see Vláda České republiky [VČR], 1991). The idea behind the limits was to provide these regions with some sort of governmental guarantee that the municipal environment would not worsen, and to give those who live there a stable basis for local investment, reconstruction, etc. Territorial environmental limits on brown coal mining have been a topic of political discussion for years now (see Lehotský, et al. 2019). The issue has gotten more urgent, however, as private coal companies have come closer to reaching these limits. Within the next few years, they will have reached the extraction limits, leaving local power and heating plants without an inexpensive source of energy. Accordingly, there has been a push since about 2003 to recognize the growing risk of a power crisis entailing massive blackouts and the collapse of power supplies.

The Government's position on the problem of extraction limits may be illustrated on the basis of its policy statements. In 2006, the Government declared it would maintain the territorial limits on brown coal mining and that it would not pursue the construction of new nuclear blocks (see VČR, 2006, p. 13). In 2007, the Government once more declared that it would maintain the territorial limits on brown coal mining. Also it announced that it would neither plan nor support the construction of new nuclear blocks. Based on a consensus of all three political parties in Government and consultation with the opposition, it was agreed to set up an independent expert commission to assess the long-term energy needs of the Czech Republic (see VČR, 2007, p. 9). In 2010, the Government announced that it would urge the territorial limits on brown coal mining be maintained along with their legal specification, but also proposed a new mining act conditioned upon the economic exploitation of raw materials reserves.

This Independent Expert Commission for the Assessment of the Long-Term Energy Needs of the Czech Republic (the Pačes Commission) declared in 2008 that it was "*… likely that the existing mining limits would sooner or later be breached to the point of the geological stability of the region. (…) Disproportionately large-scale mining and the export of electricity were according to the Commission therefore profitable, accounting for the equivalent of approximately 20 million tonnes of brown coal per year, which would rapidly bring us closer to the limits and push the coal companies to breach them*" (see ÚVČR & NEK, 2008, p. 65). The Pačes Commission supported the government program, which did not recommend breaching the coal limits, simply pointing out that due to the trend in the Czech energy sector, mining beyond the limits should be expected sometime soon. In that context, it also recommended considering whether to give an advantage to the use of local coal for the production of heat (see ÚVČR & NEK, 2008, p. 65).

The 2015 State Energy Conception called for the Ministry of Trade and Industry to present a report on the socioeconomic impact of further exploitation on the environment and on the health of inhabitants. A focus of the study was the heat supply industry (See "*SEK*", 2015). That study led on October 19, 2015 to a government document entitled "*Further Approaches to the Territorial Environmental Limits on Brown Coal Mining in the North Bohemia Area*" (See Hospodářská komora České republiky, 2015).

Four options were considered based on these results: a) maintaining the limits as is, b) shifting the limits for the Bílina mine, c) shifting the limits for the Bílina mine and partially shifting the limits for the ČSA mine, and d) shifting the limits for the Bílina mine and completely shifting the limits for the ČSA mine.

The Government decided for option b), shifting the current limits for the Bílina mine. A new limit line was set approximately 500 metres from the built-up area of the village. The territorial environmental limits stayed put in the ČSA mine but even there, there is the chance they will be extended across. The document also stated that if the Government decide to shift the limits only for the Bílina mine, there will be a further evaluation of the shift at the ČSA mine. The decision on the shift should come in 2020 and be based on the construction of new nuclear power units that would replace a significant part of the power generated by thermal power plants (see Ministerstvo průmyslu a obchodu, 2017). Even the Policy on Raw Materials of the Czech Republic notes that coal mining is an important source of energy, because it contributes to energy security and partial self-sufficiency.

There are three general opinions on mining limits in the Czech Republic. One group is clearly opposed to their breach. This group includes the Czech Green Party[17], the Christian and Democratic Union – Czechoslovak People's Party and, more recently based on their policy statements, TOP 09 and the Mayors and Independents party, as well. A second group by contrast is in favour of breaching the mining limits, primarily motivated by social factors such as regional unemployment rather than energy policy reasons. This group consists of the Communist Party of Bohemia and Moravia. Finally, a third group has no clearly defined stance, sometimes even acting inconsistently. It centres on the Civic Democratic Party and the Czech Social Democratic Party (see Ocelík et al., 2019). ANO party demonstrated this inconsistency by claiming it did not support breaching the limits at the same time the Minister of the Environment, party member Richard Brabec, voted to do so (see Parlament ČR, 2016).

It goes without saying that aside from the affected municipalities, by far the greatest opponents of breaching the limits are environmental organizations. Their argument is based on both the perceived potential of renewables, decentralization, insulation and savings, diversification and cogeneration (see Polanecký, Rovenský, Sequens, Sedlák, & Kotecký, 2009) and on legal aspects. They also base their arguments on what has occurred in foreign countries that have abandoned the rhetoric of the security of electricity supply and seen their energy sectors transition towards low emissions (see Černoch et al., 2019; Energynautics, 2018).

17 The Czech Green Party has had no deputies in the Chamber of Deputies since the 2017 election.

The problem of the Czech coal (and, therefore, heat supply) sector lies primarily not in territorial environmental limits on brown coal mining, but in the lack of preparedness of consumers, above all heating plants. They speak of basic uncertainty regarding the behaviour of mining companies and the future of coal prices. The mining companies, however, behave in a relatively predicable manner as they follow market principles. Coal is slowly running out, so its price may be logically expected to rise, since not even a nearly thirty-year period from 1991, when the limits were approved, has been adequate for the majority of heating plants to prepare and replace their fuel bases. That means unprepared heating plants have to buy coal, which plays right into the hands of the mining companies. They can afford not to prolong long-term contracts, which are mostly about to expire, and offer coal on the market on a short-term basis in smaller volumes. It is therefore likely that the mining companies will greatly benefit from setting the coal price on an auction basis. Moreover, if the heating plants do not buy coal, there are always steam power plants also interested in energy coal[18].

The policy of not prolonging contracts with heating plants started with the Czech Coal Group (the predecessor of the Sev.en group). It mines the coal in the ČSA mine, which has the largest volume of coal lying outside the limits. If the limits are maintained, Sev.en Energy AG will be without coal in the ČSA mine by 2021 and in Vršany by 2058; if the limits are exceeded, mining in the ČSA mine will be prolonged until 2068 in the first stage, 2115 in the second, and 2145 in the third (see *Czech Coal*, 2012). Both state companies, Severočeské doly, a.s., and Sokolovská uhelná, právní nástupce, a.s., extract coal and via their owners own coal power plants and heating plants. On the one hand, they have a sure base of coal sales; on the other, they are unable to supply free coal to the market. The Sev.en group did not have this vertical ownership infrastructure, which made it dependent on market forces.

This resulted in the Sev.en group refusing to prolong existing contracts, failing to close new ones,[19] and offering its coal on the market in an effort to lift the price of coal as high as possible. Accordingly, it struggled to acquire its own power plant or heating plant to increase the value of its coal. The biggest dispute was between Sev.en Energy AG and the ČEZ Group. Sev.en Energy AG, originally the Czech Coal Group, terminated a letter of intent with ČEZ, A. S. to provide it with coal for the coming decades, which then led to a complaint by the ČEZ Group (see Adámková, 2010a, p. 68). In 2013, the two companies came to an agreement and the ČEZ Group sold the Chvaletice thermal power plant (4 × 205 MW) to the Sev.En Group (see "*ČEZ prodá elektrárnu Chvaletice*", 2013).

It would therefore be best to divide the entire issue into 1) territorial environmental limits on brown coal mining, the future of the coal sector, the heat supply industry and the State Energy Concept on the one hand, and 2) the business strategies of the Czech Coal Group, which came undone with the influx of territorial limits, on the other. Unfortunately, it seems that the Ministry of Industry and Trade to a degree has bowed before the lobbying pressure from the Czech Coal Group as well as from the Association for District Heating of the Czech Republic.

The shortage of coal can certainly be resolved over the long-term, for example using imports, priority heat production, the exploitation of biomass, the development of nuclear power or the waste-to-energy method. It is unfortunate that these companies did not address the problem in 1991 when the territorial environmental limits initially entered into effect. Along with these pressing long-term problems, new issues have arisen in conjunction with emissions permits that hinder the competitiveness of the coal industry and the global climate change movement, which has already given rise to European directives on best available practices and seen emissions limits set for medium combustion plants (e.g. Directive 2015/2193 on the Limitation of Emissions of Certain Pollutants into the Air from Medium Combustion Plants).

3.7 Coal War

A significant dispute arose in the Czech energy sector over coal for Czech heating plants and received prominent media coverage in the 2009–2013 period. The quarrel involved the Czech Coal Group (currently known as a Severní energetická), represented by Pavel Tykač and Jan Dienstl; a trio of billionaire associates (Daniel Křetinský, Petr Kellner (PPF) and Patrik Tkáč (J&T)), representing Energy and Industry Holding (EPH, s.r.o.) as the strongest

18 At auction in May 2009, a tonne of several sorts of brown coal was sold for 1,696 CZK, while the price of brown coal based on the place of origin, calorific value, and category regularly ranged between 1,740 and 3,690, or respectively CZK 5,000 (briquettes) per tonne (see "*Přehled cen*", 2011). Thus auction trading has not raised the coal price at all.

19 The company's argument is that, due to the 1991 limits, there is a lack of coal for all interested parties (see Adámková, 2010a, p. 68).

actor[20] within the Association for District Heating of the Czech Republic; and the parastatal ČEZ group headed by Daniel Beneš (until September 2011, by Martin Roman). The ČEZ Group took from Czech Coal approximately 8.5 million tonnes of coal per year, a significant share of Czech Coal's overall production (14.15 million tonnes in 2011). The majority of this coal went to the Počerady power plant near Most, whose position and importance will be addressed below.

What was the nature of this clash of Czech energy titans? At first glance, it would seem like an effort by Czech Coal to press for higher prices. Czech Coal demanded an initial purchase price of 70 CZK/GJ and that the future price be fixed at 80% of the average global coal price. The Group justified this sharp price hike by pointing to the requirement to have the funds necessary to restart mining if and when current limits on the ČSA mine were removed.

This move naturally met with strong resistance from ČEZ and the Association of District Heating, headed by EPH, s.r.o. They highlighted the high gains the Group had generated over the long-term while stressing that the request to peg the coal price to that of the global markets was excessive. Although ČEZ's leadership (predominately under Martin Roman) struggled to find an alternative solution[21], the lack of a compromise in 2012/2013 would provoke disastrous consequences in terms of limited production in the Počerady coal-fired power plant. The plant depended entirely on Czech coal. According to ČEZ, the contract was to be maintained until 2060, but prior discussions had been turbulent. Here one must bear in mind that as Počerady was and still is dependent upon coal, so were Czech Coal's sales dependent upon Počerady. The sparring parties arrived at a dead end from which there seemed no return, while media attacks put increased pressure on both sides. "*If there is further disagreement, we are prepared to limit mining, even at the cost of temporarily foregoing any profit*" is, for example, how Jan Dienstl reacted in March 2012 when asked where the present coal war might lead (see "*Hoši z Motoinvestu roztáčejí kola*").

Although it might seem so at first glance, the conflict was not initially just a price dispute. It was really centred on redrawing the ownership map of Czech power plants. One option often raised during the coal war was a merger between the Počerady power plant and Vršany Mine. Czech Coal had given notice it was interested in purchasing Počerady during talks with ČEZ as far back as 2009. It likewise expressed interest in the Chvaletice power plant as well, and this becamethe key issue later in 2013. The opencast mine's owner found this a logical step, one which would ensure a sale.[22] As noted below, the holder of both power plants, ČEZ, in this case, had to contend with EPH's interests as well.

The rivalry between EPH and Czech Coal related to another case–the sale of International Power Opatovice, a company which took in both the Opatovice power plant and the Mělník heating plant and, in parallel, Pražská teplárenská. Czech Coal expressed interest in the purchase, but the buyer was a subsidiary of the J&T Group (a shareholder in EPH which was made part of its newly created structure), East Bohemia Energy Holding Limited. Although the decision to sell Opatovice came as early as June 2009, it was put on hold until a decision by the Office for the Protection of Competition prompted by Czech Coal. The argument was that after the purchase, the J&T Group could abuse its dominant position in the market. The Office, however, did not deem this a serious threat, and the entire transaction was executed by 2009. It amounted to 22.5 billion CZK, which might seem rather overpriced when compared to the actual company's value.

Czech Coal did not give up its battle against EPH and ČEZ. It passed the investigation initiative on to the European Commission. Specifically, Czech Coal complained that J&T could have secretly bought International Power with the ČEZ Group's money, because by itself it lacked the CZK 22 billion needed to assume control of the property, while the Office for the Protection of Competition would not allow ČEZ itself to execute the purchase. The European Commission, therefore, in September 24, 2009, raided the HQs of ČEZ, EPH, and Severočeské doly.

After the raid, ČEZ terminated negotiations. In 2012, EPH was fined 2.5 million EURO (around CZK 60 million) by the European Commission. The Commission justified the penalty by the company's failure to cooperate with regulators during the 2009 raid and, therefore, to provide them with relevant documentation.

The coal war was a personal matter for EPH, s.r.o. also since it is coal from Most that it uses for its Opatovice

20 Energy and Industry Holding emerged in 2009 from the fusion of capital by powerful investment groups. It is further internally subdivided, with energy matters overseen by EP Energy. It gathers together Plzeňská energetika, United Energy, Elektrárny Opatovice, Slovenské elektrárne, Mibrag, Větrné elektrárny Pchery, Pražská teplárenská, Aise, Powersun and United Energy (see Energeticky a průmyslovy holding).

21 By a resolute increase of finances, the supplies for Počernice might have been remediated from the North Bohemian Basins, owned by ČEZ.

22 Should the existing power plants fail, Czech Coal is considering building its own facilities.

power plant in, obtained via the purchase of International Power Opatovice noted earlier. The long-term contract for the plant was to expire in 2015. On July 7, 2012, though, the Czech Coal Group, cancelled the contract because of an alleged debt of CZK 500 million. The Regional Court in Usti nad Labem nonetheless concluded that Czech Coal Group had to continue to provide power supplies for at least a year, which was until the end of 2013 (this provision was a part of the contract) (see Vlček & Černoch, 2013, p. 467). After this date, from the second half of 2013, Opatovice had no ensured coal supplies.

In talking about the dispute between these energy titans, we should also note another issue related to the events above. In 2011, Czech Coal reported ČEZ to the European Commission requesting an administrative proceeding. The European Commission suspected ČEZ was accumulating capacities in the transmission system in order to prevent the competition from entering the market. Specifically, the company was suspected of reserving capacity to connect its power plants with the operator of the Czech transmission system CEPS to such an extent that other projects were precluded from taking their own share from CEPS. Czech Coal thus gave the impression that the speculative circumstances prevented it from developing its own project involving the construction of a coal-fired power plant in Počerady (see "*Czech Coal poskytl Evropské komisi podklady*"). ČEZ defended itself by arguing that it reserved the capacity for construction of the combined cycle power plant in Počerady, which began in March 2011. According to recent estimates, Czech Coal wants to connect its power plant to the network by 2021. With that in mind, at the end of 2011 it closed a contract with CEPS for the allocation of 660 MW of capacity.

Links between the Czech political scene and the energy business are ever-present. In case of the coal war they were apparent in the selection of former Prime Minister Mirek Topolánek as Chairman of the Association of District Heating.[23] The selection of Topolánek, who was proposed for the post by Opatovice power plant (EPH), where he sat on the Supervisory Board, provoked a range of emotions. Specifically, the long-term relationship between EPH (the dominant player in the Association for District Heating), its co-owner, the J&T Group, and the former Prime Minister were brought up.[24]

Immediately after his selection, Topolánek began to lobby actively against Czech Coal's effort to raise the price of coal. The Association for District Heating at the beginning of 2012 then filed a claim that argued Czech Coal was using its dominant position on the brown coal market to manipulate prices (see "*Teplárny si v Bruselu stěžují*").

Thus the situation in 2012 was rather chaotic, with little chance to predict further developments. By the end of the year, though, everything had changed as it became clear that Czech Coal would come to an agreement with the parastatal ČEZ. The agreement between Czech Coal and ČEZ had accordingly paved the way for further business, even though both contracts were presented as mutually independent. In particular, the Chvaletice brown coal power plant was sold. Very few observers would have expected in 2012 that Czech Coal would get the plant (the sale price was CZK 4.12 billion) instead of EPH. But it was definitively EPH that by mid-2013 had got the short end of the bargain, and this naturally had a negative impact on the leading position of Křetinský in the EPH.

The agreement provisions were as follows: the price of coal for the Počerady power plant was fixed, with its maximum to remain below 40 CZK/GJ. The agreement anticipated linear growth in prices to at least 2023. That was originally supposed to be the last year of Počerady's lifespan, but in 2019 Sev.en Group (formerly Czech Coal) once again tried to buy the plant and thereby increased the chances that its lifespan would be extended (see "*Počerady: Získá Tykač*", 2019). The most workable option to do so would seem to be to modernize the plant, but given current EU emission limits, this does not seem to be economically recoverable, which leaves only putting Počerady out of operation. Under the contract, ČEZ could sell the power plant to Vršanská uhelná, that is to Severní energetická. Such a sale is currently under consideration. But this would mean that that the modernization would have to be implemented by ČEZ alone, as Počerady in its current state would not be able to achieve the emission standards.

The disputes within the Czech energy market didn't come to a close in 2013 even though that may have been the peak year for heated discussions. In 2019, for example, competition focuses on the sale of the Alpiq power plants in Czech Republic. The same three companies–ČEZ, Sev.en Energy AG, and EPH– have shown interest in buying the natural gas power plant in Kladno (524 MWe) and the coal power plant in Zlín (64 MWe) (see "*ČEZ, Sev.en Energy a EPH*", 2019).

23 The Association for District Heating is an interest group of legal entities doing business in the field of heating supply, founded in 1991 and currently consisting of 89 members.

24 A link between Topolánek and J&T was implied already during the so-called Tuscan affair, during which high political officials were photographed on a joint vacation with the top representatives of J&T.

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Chapter 4: The Oil Sector[1]

Tomáš Vlček, Ľubica Bodišová, Jana Červinková

4.1 Introduction

The Czech Republic enjoys diversified oil supply routes via the Druzhba and IKL pipelines. By 1962, oil was already flowing through the primary pipeline in Czechoslovakia, routed from the Soviet Union through the southern branch of the longest pipeline in the world – the Druzhba. The Druzhba Pipeline was the first to operate over Czech territory. It was brought down to Bratislava in 1962 (in present-day Slovakia) and extended to Záluží u Mostu (now Litvínov-Záluží in the Czech Republic) in 1965. In 1990, the Adria pipeline was launched in south-western Europe. It had been "ready" since 1984 and was built as a joint venture between Yugoslavia, Hungary, and the Czechoslovakia. Soon afterwards, however, the pipeline was already unable to handle the required capacity and there was a real threat that Czechs would be excluded from its offtake as a result of increasing offtake by Slovakia and Hungary. Because of this, and because of emerging issues with Russian oil companies and potential subsequent troubles with oil supplies via the Druzhba Pipeline, in 1990–1992 it was decided to build another pipeline, the IKL, to run a route from Ingolstadt via Kralupy nad Vltavou to Litvínov) (see *MERO ČR, a. s.*). The IKL Pipeline was opened on March 13, 1996. The Druzhba Pipeline provides the Czech Republic with 60–70% of its import volume, with the remaining 30–40% supplied over the IKL Pipeline (for more details, see Table 4.1).

Tab. 4.1: Pipeline Routes in the Czech Republic

	Druzhba	IKL
Start of Supply	1962 (Slovakia), 1964 (Czech Rep.)	1996
Transport Capacity (Mt/y)	9	11
Supply Volume (Mt, 2014)	3,729	3,640
Percentage Rate (%, 2014)	50.6	49.4
Supply Volume (tonnes, 2015)	3,929	3,202
Percentage Rate (%, 2015)	55.1	44.9
Supply Volume (tonnes, 2016)	3,439	1,884
Percentage Rate (%, 2016)	64.6	35.4
Utilization (%, 2014/2015/2016)	41.4 / 43.6 / 38.2	33 / 29.1 / 17.12
Source	Russia, Kazachstan	Algeria, Azerbaijan, Italy, Kazakhstan, Libya, Nigeria, Norway, Russia, Syria
Pipeline Transit Countries	Russia, Belarus, Ukraine, Slovakia	Italy, Austria, Germany

Note: The southern branch of the Druzhba Pipeline, which transports supplies to the Czech Republic, crosses Almetevsk–Kuybyshev–Unecha–Mozyr–Brody–Uzhhorod–Sahy–Litvinov. Also, crude oil coming from Russia is not necessarily Russian.

Sources: MERO, n.d.a; Ministerstvo průmyslu a obchodu, 2015b, p. 2; Ministerstvo průmyslu a obchodu, 2016, p. 2; Ministerstvo průmyslu a obchodu, 2017, p. 2;

1 This chapter makes reference in some places to the publication of the research project The Future of the Druzhba Pipeline as a Strategic Challenge for the Czech Republic and Poland (see Černoch, Dančák, Koďousková, Leshchenko, Ocelík, Osička, Šebek, Vlček, & Zapletalová, 2012) and the document Current Issues and Projects in the Field of Storage and Transportation of Oil to the Czech Republic (see Vlček, & Černoch, 2013).

4.2 Deposits, Production, Companies and Traders

The Czech oil market may be divided vertically into four main levels. At the top is *international carrier oil*, followed by *processing plants*, with *distributors at the third level*, and finally *traders in crude oil and oil products* at the lowest level. In addition to these four main levels, there is a fifth located somewhere between international carriers and processing plants. This level is made up of Czech *production companies*, whose share on the oil industry is too small to affect the integrated structure of the remaining four levels.

4.2.1 Deposits and the Production of Oil in the Czech Republic

There are no significant oil resources in the Czech Republic. Oil is present only in small deposits in the Vienna Basin and in the Carpathian Foredeep Basin in South Moravia. Oil deposits are mostly tied to natural gas deposits. Domestic production accounts for two to three per cent of the volume of oil supplied to the Czech Republic over the long-term.

Tab. 4.2: Deposits, reserves and oil well production of oil in the Czech Republic

	2011	2012	2013	2014	2015	2016	2017
Deposits – total number	33	34	39	37	38	39	39
– exploited	27	27	30	29	28	33	33
Total mineral reserves	30,891	30,781	28,811	27,094	28,953	28,959	30,546
– economic explored reserves	20,326	20,108	21,236	21,100	21,402	21,428	21,386
– economic prospected reserves	3,983	4,092	1,758	1,747	1,735	3,355	3,345
– potentially economic reserves	6,582	6,581	5,817	5,816	5,816	5,816	5,815
– exploitable (recoverables) res.	1,664	1,628	1,534	1,449	1,379	1,504	1,401
Oil well production	163	150	152	148	126	116	107

Note: reserves in kilotonnes (kt).

Source: Ministerstvo životního prostředí / Česká geologická služba, 2016, p. 189; Ministerstvo životního prostředí / Česká geologická služba, 2018, p. 167.

There are three oil-producing companies in the Czech Republic: MND, a.s., LAMA GAS & OIL s.r.o. and UNIGEO. *MND, a.s., Hodonín*, was formed by transformation of the state enterprise MND Hodonín, s.p. in 1992. Since July 2010, it has been 100% owned by the KKCG group of the entrepreneur Karel Komárek, whose parent company KKCG SE is based in Cyprus. It is part of the MND Group AG. The company holds licences for six exploration sites covering 2,241 km^2, and 77 production licences for deposits in South-East Moravia (see MND, n.d.). The group also holds exploration licenses in the Russian Federation, and it operates in multiple countries, including Germany, Slovakia, Ukraine, and Georgia. *LAMA GAS & OIL, s.r.o.*, Hodonín is part of the LAMA ENERGY GROUP, a.s. The company operates 13 active wells for both oil and gas, and extracts on average 15–20 m^3 of oil per day. Based on experience and know-how gained in the Czech Republic, the company is currently planning to expand its activities to Alberta, Canada (see LAMA Energy Group, 2018, p. 9, 12). *UNIGEO, a.s., Ostrava-Hrabová*, which as of 2014 is 100% owned by TOUZIMSKY KAPITAL, s.r.o., has been extracting oil since 2003 from a single deposit, Krásna pod Lysou horou, in the Moravian-Silesian Beskids. The oil is then exported to Polish refineries (see UNIGEO a.s., n.d.).

4.2.2 International Carrier Oil

The exclusive operator of international oil pipelines in the Czech Republic is MERO ČR, a.s. The company, based in Kralupy nad Vltavou, owns and operates the Czech section of the Druzhba and IKL pipelines. It is the sole carrier of oil to the Czech Republic and the most important company providing emergency storage of strategic oil reserves. MERO ČR, a.s. is the 100% shareholder in a subsidiary named MERO Germany GmbH which is based on the Danube in Vohburg, Germany, and operates and maintains the IKL pipeline in Germany as well as a 200,000 cubic metre crude oil tank in Vohburg. The 100% owner of MERO ČR, a.s. is the Ministry of Finance. The company also owns and operates the Central Crude Oil Tank in Nelahozeves, with a capacity of 1,550,000 cubic metres, where the operational and strategic reserves for the Administration of State Material Reserves are stored (see Zaplatílek, 2007, p. 69).

The total length of the Druzhba Pipeline is 3,840 km (see "Druzhba Pipeline", 2009, p. 56). On Czech territory, it has a maximum throughput capacity of 9 Mt of oil annually. It is 357 km long in the Czech Republic (or 473 km including doublings and branches), and the pipe diameter is 528 mm (700 mm in the Moravian section) with a flow rate of oil of 1–1.4 m/s (see MERO CR). The pipeline brings oil from the Russian regions of Western Siberia and the Volga-Urals.

The IKL pipeline has a maximum throughput capacity of 11 Mt a year. It is 168.6 km long in the Czech Republic, and the pipe diameter is 714 mm with a flow rate of 0.5 to 1.2 m/s. The total length of the pipeline from Vohburg to the Central Crude Oil Tank Nelahozeves CCOT is 347.4 km (see MERO CR).

In 2016, Unipetrol RPA, a.s. signed a framework contract with Jadranski Naftovod, d.d. (so-called JANAF) for oil to be carried over the Adria oil pipeline. According to Unipetrol, this oil pipeline could become an alternative supply route for the Czech Republic. The Adria Pipeline starts at Omišalj terminal in Croatia and goes through Hungary to Slovakia, where it is connected to the Druzhba (see Unipetrol, 2016). In February 2019, an amendment to the gas contract was signed, extending it to 2021. Nevertheless, Unipetrol does not have signed framework contracts for the Slovak and Hungarian sectors of the pipeline; thus gas cannot be carried into the Czech Republic (see "Do Česka nyní ropovodem", 2019).

Tab. 4.3: The Oil Pipeline Network of the Czech Republic

Source: *MERO ČR, a. s.,* (http://www.mero.cz/).

MERO ČR, a.s. is the sole provider of transportation services for oil to the Czech Republic. It does not own any oil. Processor plants realizing contracts with crude oil suppliers also must arrange transport contracts with MERO ČR, a.s. This company provides its services based on tariff charges fixed in the long-term contract with the oil processor. Oil is traded on the basis of long-term (up to five-year) contracts, quarterly, and on the spot market (i.e. monthly), with about half of demand supplied through spot transactions.

4.2.3 Processing Plants

There are two processing companies in the Czech Republic - Unipetrol RPA, s.r.o. and Paramo, a.s., both part of the Unipetrol Group. Each is divided into two more oil refineries that make up the four oil refineries in the Czech Republic.

Unipetrol RPA, s.r.o., based in Litvínov, is the largest producer of crude oil and the largest processor of oil products in the Czech Republic. It operates oil refineries in Litvínov and Kralupy nad Vltavou. The processing capacity of these refineries is 5.4 Mt/year and 3.3 Mt/year respectively. Unipetrol RPA, s.r.o. is part of the Unipetrol Group, fully owned by the Polish PKN Orlen Group.

Unipetrol RPA, s.r.o. not only owns the two reprocessing refineries, which concentrate on the production of oil products, it also focuses on the purchase of resources and sale of oil products.

Unipetrol RPA, s.r.o. is supplied with oil via the Druzhba and IKL pipelines (via the Nelahozeves central crude oil tank). The refinery complex is also supplied with small volumes of oil extracted by Moravské naftové doly, a.s. in the Czech Republic via the Druzhba Pipeline. The refinery in Litvínov processes the Russian oil mixture REB (Russian Export Blend – medium sour oil imported from Russia via the Druzhba Pipeline in particular), while the refinery in Kralupy processes sweet oil, low sulphur crude oil that is imported into the Czech Republic via the IKL Pipeline (Ingolstadt - Kralupy - Litvínov) and domestic oil extracted by Moravské naftové doly a.s. (see Ministry of Environment / Czech Geological Service - Geofond [ME / CGS-G], 2009, p. 180). Products resulting from the processing of crude oil are then distributed to Czech or foreign markets via state-owned ČEPRO, a.s. (see below), oil product pipelines, or overland transport. Refinery products of Unipetrol RPA, s.r.o. include aviation kerosene, automotive petrol, sulphur, LPG, heating oil, diesel, propylene, asphalt, hydrogenated oil, and various intermediate products for further processing in the Litvinov refinery.

Paramo, a.s., based in Pardubice, operates two plants, one in Pardubice and the other in Kolín. Paramo focuses on refining crude oil into refinery and asphalt products and on the production of lubricating and processing oils, including related and auxiliary products. The company also buys and processes hydrogenated oil from Unipetrol RPA, s.r.o. The acquired intermediate products are used in the production of base and lubricating oils with very low sulphur content (see Paramo, 2010, p. 10). The refinery products of Paramo are motor fuels, heating oil, asphalt and other asphalt products, lubricating oils, and greases. The company operates a fuel refinery in Pardubice that is engaged in the processing of Russian crude oil primarily for fuel, lubricating oil, and asphalt. It also operates an oil refinery that produces lubricating oil in Kolín (see ME / CGS-G, 2009, p. 180). In May 2012, company management in Pardubice stopped the processing of oil meant for fuel production and turned to the production of asphalt, oils, and lubricants. The main trading partner in refinery products in the period in question was the sister company Unipetrol RPA, s.r.o., to which supplies of primary petrol and vacuum distillates went (see Paramo, 2010, p 11). Despite the uncertainties that the company was facing (such as a temporary suspension of activity in 2011/2012) due to declining demand for the products in company´s portfolio, Paramo, a.s. was able to stabilize its financial situation and is currently generating a profit (see Paramo, 2019).

4.2.4 Distributors

The products are distributed after processing. Petroleum products serve as material for other technologies in the petrochemicals, agrochemicals, and plastics industries or are picked up directly from the refineries' shipping terminals by end customers and distributors. This is particularly true for sulphur, LPG, bitumen, fuel oil, and jet fuel, as well as for normal fuel. ČEPRO, a.s. is the exclusive distributor through product pipelines in the Czech Republic. The Ministry of Finance has been the sole shareholder in the company since 2006. It is engaged in the transport, storage, and sale of oil products; provides transport, storage and other specialized services in this area to external entities; protects the Administration of State Material Reserves (ASMR); and operates the EuroOil petrol station network (see CEPRO, 2010, p. 4).

The oil products pipeline system connects the company's storage depots and centres with refineries in Litvínov, Kralupy nad Vltavou and Bratislava (owned by the Slovak company Slovnaft). The system allows direct pumping and supply between its various depots. ČEPRO central dispatch monitors the operation of oil product pipelines, monitors basic technical operational parameters (e.g. quantity of supply in the centres, pumping modes) and data from security systems (see Zaplatílek, 2008). Due to the nature of the oil products produced in Pardubice and Kolín (asphalt products, oils, etc.) there is no entry point into the system of oil product pipelines in these refineries. The company is primarily engaged in the transportation of oil products according to the customer's needs (through the oil product pipelines, rail tankers, tank trucks, and trucks) and the wholesaling of fuel.

4.2.5 Traders in Oil Products

The final level consists of oil product traders. The most important in the Czech Republic are Unipetrol, a.s., BENZINA, s.r.o. (a subsidiary of Unipetrol, a.s.), MOL Česká republika, s.r.o., Shell Czech Republic, a.s., OMV Česká republika, s.r.o., ČEPRO, a.s., Eni Oil Česká republika, s.r.o. RoBIN OIL, s.r.o., and LUKOIL Czech Republic, s.r.o.

Unipetrol is a subsidiary of PKN Orlen (Polski Koncern Naftowy Orlen) and is an important player in the Czech oil market. In addition to processing crude oil in the refineries of Unipetrol RPA –(100% ownership, RPA stands for refineries, petro-chemistry and agro chemistry)[2] and Paramo a.s. (100% ownership), the company is primarily engaged in the sale of fuel through BENZINA s.r.o. (100% ownership).

BENZINA, s.r.o. has the largest number of petrol stations in the Czech Republic, with 405 stations as of 1st June 2018. Aside from sales at its own petrol stations, it manages direct bulk deliveries of fuels to other business partners and entities (see Benzina, s.r.o.).

MOL Česká republika is part of the MOL Group, in which the Hungarian government holds a 25% stake. The remaining shares are held by investment companies or traded on the stock exchange. MOL operates 306 petrol stations across the Czech Republic, making it the second largest player in the petrol retail market. MOL has enlarged its market share largely by rebranding the petrol stations of its subsidiary, Slovnaft (Slovak refinery based in Bratislava), and by acquiring stations from other brands such as Lukoil, Pap Oil, and the network of Agip petrol stations that MOL Group purchased from its Italian partner (see Finance.cz, 2019).

EuroOil, the third largest brand in the fuel retail market is 100% owned by ČEPRO. It runs 200 petrol stations in all (see ČEPRO, n.d.a). The main part of the company's petrol station network consists of the former network of Benzina s.p., created during privatization in the early 1990s when a portion of Benzina was merged with Unipetrol; the rest was acquired in 2001 by ČEPRO (see Petrol media, 2017).

The sole shareholder in Shell Czech Republic is Royal Dutch Shell plc. Shell Czech Republic operates a network of 175 service stations (as of 31st December 2017) in the country. It also refuels aircraft at the Brno and Ostrava airports, sells automotive and industrial oils and lubricants, asphalts, and chemical intermediate products for further processing, and operates as a fuel wholesaler. This makes the company one of the highest valued in the Czech market and in the industry as whole. It entered the Czech market in 1991 and took over the business of DEA Mineraloel, Lukoil, and Total in the Czech Republic. (see Shell Czech Republic, a.s., 2018, p. 1–3)

OMV Česká republika is a 100% subsidiary of the Austrian group OMV A.G. Wien. It launched independent activity in 1993 (after having been part of OMV ČSFR since 1990). The activities of OMV ČR, s.r.o. may be divided into two main areas: construction and operation of OMV petrol stations and trade with consumers (including fuels, fuel oils, lubricants, and other products) (see OMV, n.d.). OMV Česká republika currently operates 139 petrol stations (see OMV, 2019, p. 4).

4.2.6 Use of Oil

Oil is processed in the Czech Republic primarily for use in the transport and industrial sectors. Total oil consumption was 8.3 mtoe in 2016 and 9.67 mtoe in 2017. In 2017, 9.1 mtoe was available for final consumption, out of which 66.8% was consumed by the transport sector and 27.4% was consumed for non-energy purposes in which oil was used as a raw material instead of as a fuel (mainly in the petrochemical industry). Energy generation (electricity and heating) accounted for less than one percent of total oil consumption. In 2016, 5.3 Mt of crude oil and 4.7 Mt of oil products were imported into the Czech Republic. In the same year, the country exported 2.3 Mt of oil products (see Ministerstvo průmyslu a obchodu, 2017, p. 1, 3).

Tab. 4.4: Oil Consumption in the Czech Republic by Sector

Total Consumption	**404,966.0**
International air transport	**14,851.9**
Transformation Purposes	**359,319.3**
Refineries and petrochemical industry	357,091.1
Electricity and heat generation	2,228.2
Energy Industry	**10,121.4**
Distribution Losses	**0**

Note: Data is in TJ.

Source: Ministerstvo průmyslu a obchodu, 2019, p. 21

2 This subsidiary also acquires resources for the petrochemicals production of the Unipetrol group including foreign crude oil purchasing for refinery products.

Tab. 4.5: Final consumption of oil products in the Czech Republic

Available for final consumption	**381,330.2 (100%)**
Final non-energy consumption	**104,700.6 (27.4%)**
Final consumption	**277,721.6 (72.8%)**
Industry	5,365.2 (1.4%)
Transport	254,792.7 (66.8%)
Other Sectors	17,563.7 (4.6%)

Note: Data is in TJ. Statistical differences -1,092.1

Source: Ministerstvo průmyslu a obchodu, 2019, p. 21; Percentage conversion by J. Červinková

Fuels for transport sold or distributed through the network of public and private petrol stations in the Czech Republic take a big share of the country's total oil and petroleum products consumption. The remainder of the oil in the Czech Republic is used in the petrochemicals industry to produce pharmaceutical products, detergents, dyes, explosives, fragrances, coatings, sealants, adhesives, rubbers, fertilizers, etc.

4.3 The Regulatory Framework of the Oil Industry

In terms of extraction, the exploitation of oil is guided by Act No. 89/2016 Coll. which amended Act No. 44/1988 On the Protection and Utilization of Mineral Resources (The Mining Act) (see Zákon č. 89/2016 Sb., 2017) and by the Czech Mining Authority, as in the case of coal. Trade in oil and oil products is treated in Act No. 458/2000 Coll., on Business Conditions and Public Administration in the Energy Sectors and on the Amendment of Other Laws (The Energy Act).

The Czech Republic fulfils its EU and IEA[3] membership obligations through the Administration of State Material Reserves (ASMR). The obligation to the IEA among includes maintaining the reserve levels as of 31 December 2005, and maintaining a reserve equal at a minimum to 90-days' average daily net oil product imports over the last year. The obligation to the EU involves securing oil reserves of 90 days average of daily crude oil imports or 61 days average of daily domestic consumption of oil (it depends which figure is greater, calculated in the preceding year) as of 31 December 2012, based on EU directive 2009/119/EC[4]. The implementing legislation in the Czech Republic is Act No. 189/1999 Coll. as amended by later regulations[5].

The storage and protection of oil, oil products and intermediate products is realized by state-owned business entities in the Czech Republic. MERO CR is responsible for crude oil storage, while CEPRO a.s. stores oil products. Petrol, diesel, aviation kerosene, lubricating oils and heating oil are protected products (see ČEPRO, n.d.b.). CEPRO has 16 centres and stores which are connected by oil products pipelines. The construction of pipelines and warehouses began during World War II (ČEPRO, n.d.a).

MERO ČR, a.s. operates the Nelahozeves Central Crude Oil Tank (CCOT), which is part of the IKL pipeline. It is used to receive oil from the Druzhba pipeline to and from the IKL pipeline; for storage and mixing of different types of oil according to customer needs and capacities; and for oil distribution to the customer. Most of the CCOT's capacity is used by the State Material Reserves Administration to store strategic reserves of crude oil. The total storage capacity is currently 1.55 million cubic metres and consists of four tanks with a single volume of 50,000 cubic metres, six tanks with a capacity of 100,000 cubic metres, and six tanks with a capacity of 125,000 cubic metres, for a total of 16 tanks. These steel tanks are above-ground, with a steel protection pool and floating roof (see Zaplatílek, 2007, p. 70; Cieslar, 2008a).

3 The Czech Republic joined the International Energy Agency on 5 February 2001.

4 The directive also modifies the rules of operation for storage organization. The central administrators of reserves are chosen exclusively by the state, and the European Commission is in charge of controlling these reserves under the directive (see Nowak & Hnilica, 2010, p. 7).

5 In July 2012, the Government passed a bill introducing the changes to Act No. 189/1999 Coll., as amended. The Act no longer operates with the term strategic reserve, but it adds to the emergency reserves at the level of a minimum 90 days of net imports specific reserves that may include emergency reserves. The Czech Administration of State Material Reserves (SSHR) can form specific reserves from seventeen products in an amount corresponding to at least 30 days of average daily domestic consumption in the reference year for at least a one-year period. Specific reserves accordingly expand emergency reserves, but also cover the potential needs of the business sector in the form of an SSHR loan without endangering the quota of obligatory reserves and the requirement to give the EU notice of their reduction. Specific reserves also enable the disposal of ad hoc reserves relative to market development without necessarily increasing all products' blanket reserves as indicated by the EU and IEA legal acts.

The strategic petroleum and petroleum products reserves were stored in quantities which would last 91 days, meeting the EU requirements, as of 31 December 2016 (see MPO, 2016, p. 7). Since that time, however, the oil stocking obligations of the IEA and the EU have not been met by the Czech Republic. As of January 2019, the reserves were down to almost 86-days average of daily net imports (see IEA, 2019).

4.4 Demand Forecast

Oil consumption in the Czech Republic oscillated around 8.8 millions of tons a year until 2017, when it rose significantly (see Table 4.6). Generally, it is expected that the share of oil in the TPES of the Czech Republic will decrease (see Table 4.7).

Tab. 4.6: Gross oil consumption in the Czech Republic in 2010–2017

Year	2010	2011	2012	2013	2014	2015	2016	2017
Gross oil consumption [millions of tons]	9.0	8.9	8.7	8.4	8.9	8.7	8.1	9.5

Source: Ministerstvo průmyslu a obchodu, 2019, p. 21; Unit conversions by J. Červinková.

For preparing the forecast of oil demand and to forecast energy demand in the Czech Republic, it is necessary to consult the sources which affect demand most directly. In the Czech Republic, these include 2004 State Energy Concept and its revision of December 2014. The State Energy Concept works with a forecast of 2030 conditions. The 2014 Revision of the State Energy Concept provides data to 2040.

Tab. 4.7: The Shares of Fuels in Energy Resource Consumption in 2000 and 2017 and the Shares According to the State Energy Policy of the Czech Republic from 2004 and Its Update from 2014 (in %)

Type of Fuel	Level in 2000	Level in 2017	Long-Term Goal (SEP 2004) by 2030	Long-Term Goal (USEP 2014) by 2040
Solid	52.4	36.7	30–32	11–17
Gas	18.9	16.7	20–22	18–25
Liquid	**18.6**	**21.7**	**11–12**	**14–17**
Nuclear	8.9	16.3	20–22	25–33
Renewables	2.6	10.5	15–16	17–22

Source: Státní energetická koncepce, 2004, p. 11–12, 40–49; Aktualizovaná státní energetická koncepce, 2014, p. 44; Ministerstvo průmyslu a obchodu, 2019, p. 14

The 2004 State Energy Concept predicted almost 50% less consumption, while its 2014 revision has a notably different outlook, estimating a decline of several percent in consumption versus 2017. Even with demand declining by several percent, we should take into consideration the predicted long-term trend of increasing energy consumption in the Czech Republic. Nominally, we may therefore count on a steady increase in oil consumption (see the forecasts in table 4.8).

Even if oil consumption were to reach the level of 14–17%, there would be a need to partially substitute this sort of fuel. Given the purposes of oil use (almost 67% for transportation services), it is assumed that the replacement of oil will take place precisely in the transportation sector. According to the State Energy Concept, natural gas is to become an increasingly important element in the energy fuel mix of the Czech Republic. Aside from its use in the generation of heat and electricity, it will be exploited primarily for transportation purposes. In 2018, there were 22,600 CNG vehicles in the Czech Republic[6] with consumption of 75 mcm/y (see CNG4you, 2019). The National Action Plan for Clean Mobility of 2015 predicts there will be 200 – 300 thousand CNG vehicles by 2030 in two of the highest consumption scenarios presented[7]. The number of CNG vehicles would then

6 There are basically no LNG-fueled vehicles in the Czech Republic. In 2018 it was, according to CNG4you, only 2 vehicles (see CNG4you, 2019).

7 In the National Action Plan for Clean Mobility there are 4 scenarios presented altogether. The data used are results of scenarios 1 a 1A which are called *optimistic* and *moderately optimistic*. The data from other two scenarios are not used as they assume an imposition of 50 % and 100 % tax as conventional fuels which is unlikely considering the set goals and ambitions of state in a transport sector.

correspond to approximately 450 – 680 mcm/y of gas consumption in 2030. The scenarios are based on the development of several factors including state support, taxation, infrastructure development etc. The same document expects there will be 1,361 LNG vehicles with consumption of approximately 89.4 mcm/y in 2030. (see Ministerstvo průmyslu a obchodu, 2015a, p.49–51; 54). Nevertheless, in 2018 approximately 6.6 million passenger cars, vans and buses were registered in the Czech Republic (see SDA, 2019). This means CNG vehicles currently represent 0.34% of the car fleet in the country. Thus, even though the number of gas-fuelled vehicles is predicted to substantially increase compared to current levels, CNG and LNG vehicles will probably account for no more than 5% of the car fleet by 2030.

Another fuel which is predicted to partially substitute oil in the transport sector is electricity. In 2017 there were 1,525 registered electric passenger cars in the Czech Republic (see Ministerstvo dopravy, 2017, p. 52). Even though this number is increasing rapidly, and the fleet of electric vehicles is growing by many percentage points every year, the share of electric passenger vehicles in the Czech Republic is still very low at less than one per cent of the car fleet. In agreement with this, the National Action Plan for Clean Mobility of 2015 predicts moderate growth (see Ministerstvo průmyslu a obchodu, 2015a, p. 27). NAP for Clean Mobility expects plug-in hybrid electric vehicles to represent a greater share of the car fleet than electric vehicles in the few years of development of electric mobility. By 2030, NAP for Clean Mobility predicts there will be 255 thousand electric and plug-in hybrid vehicles in the Czech Republic (see Ministerstvo průmyslu a obchodu, 2015a, p. 33). Similar to gas-fuelled vehicles, this would represent only a few percent of the Czech car fleet. In conclusion, the substitution of oil in the transport sector will be a long term process, and it is most probable that oil will remain the chief fuel in the Czech transport sector even beyond 2030.

Consequently, even though the share of oil in the TPES is expected to decrease, it is predicted that overall consumption of oil refined fuels will grow moderately (see Table 4.7). The growth is attributed to a growing vehicle fleet and strong activity in the industrial sector.

Tab. 4.8: Oil Consumption Prediction

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Consump. 1	199	203	207	211.2	215.4	219.7	224.1	228.6	233.2	237.8	242.6	247.4
Consump. 2	27.15	27.69	28.24	28.81	29.39	2997	30.57	31.19	31.18	32.44	33.09	33.75
Year on year % change	–	2	2	2	2	2	2	2	2	2	2	2

Note: Consumption 1 signifies thousands of barrels of oil per day; Consumption 2 signifies thousands of metric tonnes.

Source: Fitch Solutions, 2019, p. 13. The calculation to metric tonnes by the author.

4.5 Current Issues and Proposed Projects in the Czech Oil Sector

4.5.1 Infrastructure Projects

With respect to the developing perception of Czech energy security, the construction of a third pipeline which would enhance its diversification of oil sources has been considered, with two potential options in play.

The first option is to interconnect the refinery in Litvinov with Spergau, Germany in the vicinity of Leipzig. *TOTAL Raffinerie Mitteldeutschland GmbH Spergau* (in the literature also called *Leuna*[8]) is connected to the Druzhba Pipeline. This project is being pursued by MERO ČR, which also initiated it and which would provide the necessary funding. The pipeline is planned to be about 160 km long with a diameter of 700 mm and the capacity of 5–6 MTA (though industry experts speak of capacity needs of at least 10 MTA). In 2013, the Litvínov-Spergau Pipeline was first awarded Project of Common Interest (PCI) status by the EU and has received this status twice again since (2015, 2017). Having PCI status means the pipeline is considered a key cross-border infrastructural project[9] (see European Commission, n.d.). The final investment decision is expected in 2021, with commissioning of the project

8 Both Spergau and Leuna are small neighbouring towns west of Leipzig.

9 The PCI (Projects of Common Interest) status automatically means shorter and streamlined permit and granting procedures. It also allows the promoter to apply for specific EU grants supporting energy network development and integration. Apart from the financial support, these granting schemes provide the related projects with a de facto formal EU backing, which may consequently make them more reliable for potential investors.

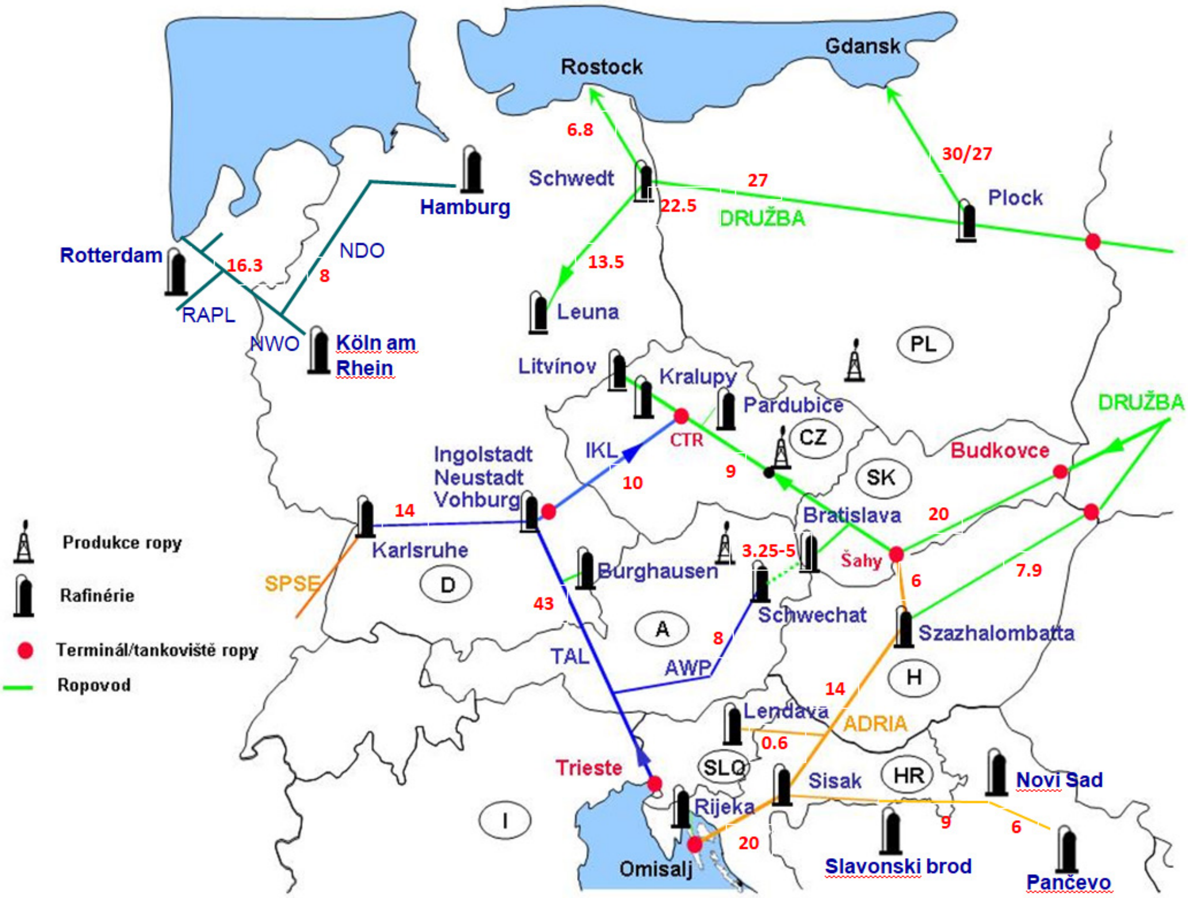
in March 2025. The feasibility study has been in progress since January 2019, however, according to the MERO ČR's official website "*realization of the project has not yet been decided on*" (see MERO, n.d.). Similarly, no information is available about the planning process and also the front-end engineering design study is yet to be commenced with no concrete end-date available.

The aim of the Litvínov-Spergau pipeline is to increase the oil security of the Czech Republic in terms of supply routes, not only by closing the gap between the two branches of the Druzhba Pipeline but also by providing Czech refineries with access to oil terminals on the Baltic coast: Rostock (Germany) and Gdansk (Poland). In connection with the Litvinov-Spergau pipeline, the Czech Republic could become a transit country for oil. Moreover, the extent to which Czech oil security would improve is also questionable, as Russia's Lukoil and OAO Gazprom Neft have (among others) shown interest in the past in the German refinery at Spergau. These companies want the products produced there to be sold on the Polish market (see Sušanka, 2010; Žižka, 2010; "*Czech Republic: Oil pipeline*", 2010; *Čarek*, 2009).

The second option is a pipeline connection from Klobouky u Brna to the Austrian OMV refinery Raffinerie Schwechat near Vienna. Historically, this project was also designed by MERO ČR, but there is no current information on its development. This proposal is linked to development of the planned Bratislava-Schwechat Pipeline (BSP). The BSP pipeline has been discussed since 2003 as part of diversification in Slovakia. This project was proposed by the Slovak state-owned company Transpetrol and could potentially affect the Czech Republic as well. It could diversify the oil sector in terms of pipeline routes (through Schwechat, Austria via the Druzhba or TAL Pipeline), but not in terms of resources. However, the project also meets the limited capacity of the TAL pipeline. The BSP pipeline is planned as a link between the Slovnaft refinery in Bratislava and the Austrian OMV Raffinerie Schwechat near Vienna. The purpose of this project is to expand the existing Russian pipeline network to Austria, which would allow delivery for the first time of cheap Russian oil directly to Austria. For Austria, it is an important diversification project, since the country is currently supplied only by TAL (Transalpine Pipeline) and AWP (Adria-Wien Pipeline).

The Slovaks perceive this pipeline as an essential project that aims to enhance the country's energy security. The new connection is foremost intended to motivate Russian companies to send more oil via the southern branch of Druzhba (because there would be also other countries at its end in addition to the Czech and Slovak Republics). Secondly, the planned capacity of the pipeline route would be able to cover a potential total loss of oil supplies via the Druzhba Pipeline in the event of loss of supplies from the East, but only if there were spare capacity in the TAL-AWP section. Also, consumption at the Schwechat refinery would have to decrease to compensate for oil intended for Slovakia in this case. The BSP oil pipeline received Projects of Common Interest status in 2013, 2015 and 2017. The final investment decision is to be made in July 2019, and the project will be commissioned in November 2022 (see European Commission, 2018). There are no obstacles on the Austrian side of the project. On the Slovak side, however, the routing of the pipeline is a serious issue. There were several proposed routes which were very problematic in terms of environmental risk (the contamination of an aquifer) and/or social impact (as the project will go through the city of Bratislava) (see Správy Pravda, 2018). In 2015, the municipal authority of Bratislava rejected the proposed routing of the BSP pipeline through the city (see "Informacia o projekte", 2017) and the Slovak government gave the project's operator Bratislava-Schwechat Pipeline GmbH a deadline by which to submit new detailed documentation, including new alternative routes, by June 2019 (see Správy Pravda, 2018). A breakthrough in the project is not expected, shelving is more likely.

Tab. 4.9: Central European Oil Infrastructure



Note: red numbers stand for pipeline capacities in million tonnes annually

Source: T. Vlček based on map from Doprava a skladování ropy, n.d.

In addition to the above-mentioned projects, Czech entities are involved in other existing pipelines.

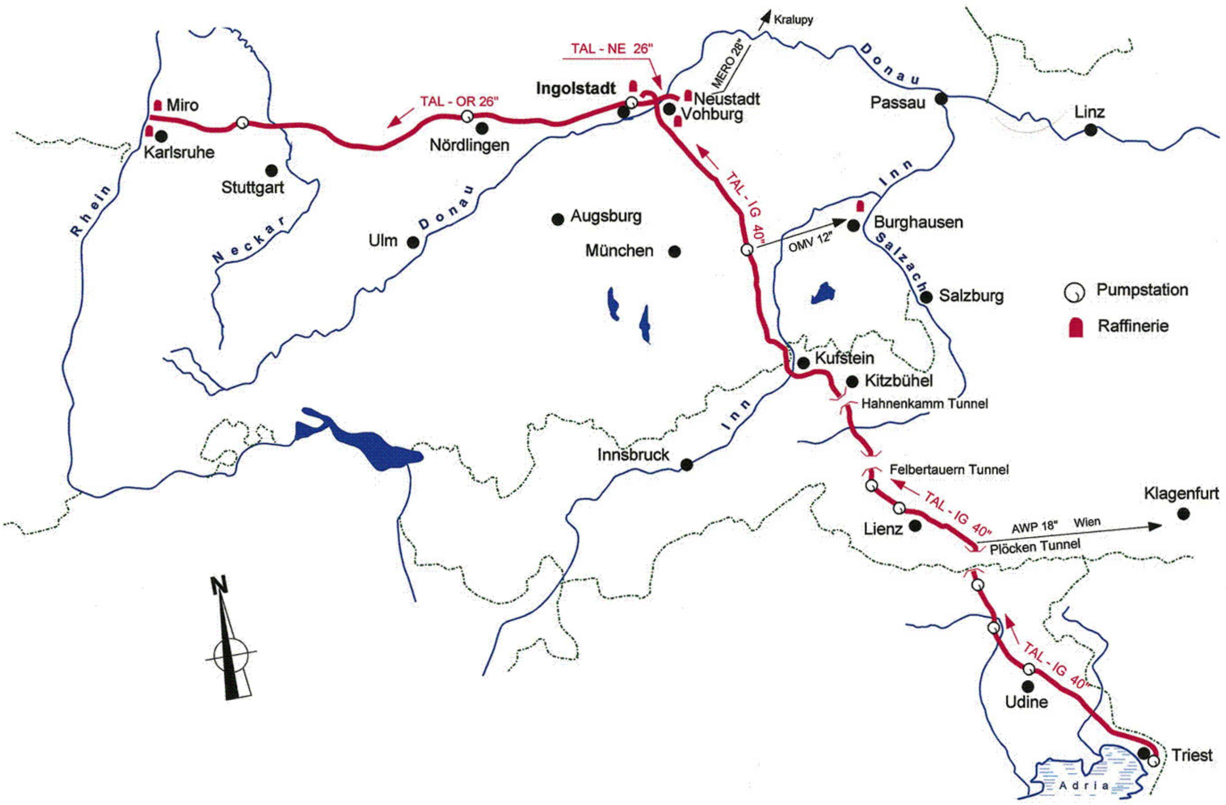
A proposed by MERO CR calls for the reverse operation of the IKL Pipeline, with the aim of delivering Russian oil through the Druzhba and IKL pipelines to German refineries, and in so doing to increase interest by the Russian Federation in exports via the southern branch of the Druzhba and increase its own profits from the transport of oil. However, the project faces difficulties and is not feasible (see Vlček, 2015, p. 88).The Czech government is trying to secure a secondary oil supply in the event of disruption of the Druzhba Pipeline. The IKL Pipeline is a rational choice; it follows the Italian-Austrian-German TAL pipeline (Transalpine Ölleitung). Utilization of the IKL pipeline hovers between 20–40%, so it would seem there is enough space to increase supply. However, the pipeline is linked to the TAL pipeline, which is used to almost 100% capacity, and the possibility of increasing the supply to the Czech Republic is thus minimal. This issue was resolved in September 2012, when MERO ČR acquired a 5 % share in a joint-venture involving the TAL Pipeline. The TAL oil pipeline is currently owned by ten companies[10] (see Vlček, 2015, p. 85). Each owner has preferential rights to access TAL's spare capacity in case of a crisis. (see MERO, 2014)

The Druzhba Pipeline may only be utilized at up to 12-months nomination of capacity in advance with a flexibility of +/- 10%. The IKL Pipeline may only be utilized with 18-months nomination of capacity in advance. In addition, shareholders in the pipeline are served first. Delivery takes 6 to 8 weeks from loading an oil tanker in the Persian Gulf through unloading in Trieste for delivery to Kralupy nad Vltavou. Pipeline capacity is 42 Mt per year, but there is the potential to increase this to more than 50 by restarting operation of the pumping stations on route that have been taken out of service. Two out of the six stations are currently operating, and the cost of

10 OMV AG (25 %), Royal Dutch Shell plc (19 %), Ruhr Oel GmbH (11 %), C-Blue Limited (Gunvor Group Ltd.; 10 %), Eni S.p.A. (10 %), BP p.l.c. (9 %), Exxon Mobil Corporation (6 %), MERO ČR, a.s. (5 %), JET Tankstellen Deutschland GmbH (subsidiary of Phillips 66; 3 %) and Total S.A. (2 %).

restarting each of the four remaining stations would be on the order of hundreds of thousands of euros. The increase of capacity of the TAL Pipeline has Project of Common Interest status (see European Commission, n.d.) and the planned commissioning date is March 2023.

Tab. 4.10: TAL Pipeline



Source: *The Transalpine Pipeline*

4.5.2 The Druzhba Pipeline

In June 2007, the Polish newspaper Dziennik broke a story with information that has been frequently repeated since indicating that Russia was considering shutting down the Druzhba Pipeline (see Roškanin, 2007, p. 8). It is very likely that Russia will gradually start favoring exports of processed and, to the extent possible, finished materials at the expense of unprocessed materials (see Kavina, 2009, p. 322).

The Czech Republic has experienced several oil supply disruptions involving the Druzhba Pipeline. These have been attributable to disputes between Russia and Ukraine on the transportation fee for oil in 1990, 1991, 1994, 1995, and 1996 and because of difficulties in license issuance and internal problems in the Soviet Union (in 1990), as well as to technical issues. Oil supply through Belarus was cut off in 2007 because of disputes over the rate of duty between Russia and Belarus. Oil supplies via the Druzhba Pipeline were curtailed on Czech territory by 50% in the summer of 2008. The Russians explained the situation as an issue in a complex chain of interconnected suppliers. However, the curtailment came just one day after (9th July 2008) the Czech Republic signed an agreement to establish a missile defence radar base in Brdy with the U.S. The situation was easily resolved by increasing deliveries through the TAL/IKL pipeline system (in addition to the use of state petroleum reserves, additional supplies were secured from Iran, Norway, and Saudi Arabia, all in one day). The July curtailment had much more unpleasant consequences for Russia than for the Czech Republic, since Germany and Great Britain questioned Moscow about the curtailment, and Russia's reputation as a reliable supplier was damaged. The risk of oil supply disruption reappeared when Russia got into a dispute with Ukraine on transit fees once again in December 2009, but the situation was resolved by agreement between Moscow and Kiev under a new contract and no disruption occurred (see Nowak & Hnilica, 2010; "Rusko hrozí Evropě", 2009; Roškanin, 2008a, p. 9).

Another problem in the oil supply via Druzhba took place in April 2012. During the first ten days of the month, oil supplies from the East to the Czech Republic fell by 31% versus the amount logged by Russia. Transneft, which coordinates exports of Russian oil, announced on 9 April that Russian companies did not deliver any orders for the transfer of oil to the Czech Republic. However, the following day, Transneft added that in the second quarter, supplies would be delivered according to the contract. The most likely reason for this decrease in oil supplies was the reorientation of Rosneft and Lukoil towards transporting oil through the BTS-2 pipeline system. This system was opened at the end of March 2012 and exported Russian oil while bypassing transit countries. It is also likely, though, that Russian companies used this opportunity to test how owners of Czech refineries would react to decreased oil supplies in the context of the newly-opened BTS-2 and how flexible they might be in accepting a hike in the oil price. The oil curtailments lasted for several months, during which most oil to the Czech Republic was imported through the IKL Pipeline. Price negotiations between Czech refinery owners and the Russian oil companies were ongoing until autumn 2012 (see "Ropa z Ruska neteče", 2012; "The future of Russian oil", 2012).

The most recent problem occurred in April and May 2019 when the supply through the Druzhba was halted due to polluted crude oil inside the pipeline. The contamination was caused, according to Russian representatives, by technical problems. This presented a problem mainly for the refinery in Litvínov, which is configured for Russian oil. (see "Do Česka nyní ropovodem", 2019)

Tab. 4.11: Oil Curtailment to the Czech Republic

Year	Reason for Curtailment
1990	Domestic problems in the Soviet Union.
1991	Curtailment solved by additional supplies via IKL Pipeline.
1994	Curtailment of oil supply due to a stop in license issuance.
1995	Dispute between Russia and Ukraine over the rate of oil transit fee.
1996	Dispute between Russia and Ukraine over the rate of oil transit fee.
2007	Dispute between Belarus and Russia over the rate of oil transit fee. Russia imposed export duty on oil exports to Belarus, which imposed countermeasures resulting in another curtailment of supply.
2008	Russia decreased oil supply to the Czech Republic to approximately 50% of volume. The reason for this might have been the signing of an agreement between the Czech Republic and the U.S. on establishing a missile defence radar base in Brdy. Curtailment solved by additional supplies via IKL Pipeline.
2009	A blackout in western Ukraine caused the curtailment of Russian oil to Europe. The risk of curtailment was due to a dispute between Russia and Ukraine over the rate of oil transit fee.
2012	Curtailment of oil supply through Druzhba due to lengthy price renegotations
2019	The supply through the Druzhba was halted due to polluted crude oil inside the pipeline. The contamination was caused, according to Russian representatives, by technical problems.

Source: "Rusko hrozí Evropě"; Nowak & Hnilica, 2010; "Ropa z Ruska neteče", 2012; "Do Česka nyní ropovodem", 2019; edited by T. Vlček.

The state does not have oil supply contracts for the Czech Republic under control and has almost no way to regulate supply. Oil contracts are fully under the control of private enterprises in the Czech Republic. "Oil is not contractually guaranteed over the long term. In this context, we are more dependent on the global oil situation, to which we must respond by monitoring the overall situation, good diplomatic relations with several producers, the extension of strategic reserves, and by a savings programme and the next generations of Biofuels" (see UVCR & NEK, 2008, p. 65). Due to its high utilization, not even the IKL Pipeline is a completely reliable insurance policy (see above).

The Czech Republic negotiated two important agreements with regard to oil supply curtailments in the summer of 2008. The first is a memorandum between the carriers MERO CR and OAO AK Transneft (ОАО АК Транснефть) intended to secure a steady supply of resources to the Czech Republic. The Russians are to inform the Czech side of their future intentions with the Druzhba Pipeline and provide early warning of any disruption on the basis of this memorandum. Similar contracts are already held with the other operators of the Druzhba including the Ukrainian firm BAT UkrTransNafta (ВАТ УкрТрансНафта), Belarusia's RUP Gomeltransneft Druzhba (РУП Гомельтранснефть Дружба), and Slovakia's Transpetrol, a.s. (see Roškanin, 2009, p. 6; MERO, 2010). The second contract, signed on 23rd November 2010, was between MERO Germany AG, a subsidiary of MERO CR, and the German Deutsche Transalpine Oelleitung GmbH[11], one of the three companies that operates the TAL pipeline. This contract extended the existing contract allowing the transport of more oil via the Western European TAL Pipeline for Czech refineries at a time when there were problems with the Druzhba. MERO CR could use the free shipping capacity of the TAL pipeline system beyond the usual long-term liabilities in this case, without no exorbitant extra costs. The new amendment to the contract was valid until 2015 (see "Výpadky ropovodu Družba," 2010; Jones, 2010).

Switching the direction of oil flow in both pipelines has been discussed in the oil sector in the past. The Czech government stopped work on the transit of oil via the Druzhba Pipeline over Czech territory to Germany via the IKL Pipeline in 2006, since this would undermine the route diversification that had been achieved during the 1990s (see Roškanin, 2006, p. 6). Slovakia negotiated with the Czech Republic for the possibility of switching the oil flow of the Druzhba pipeline. Switching the direction of pipeline oil flow is technically possible at a fairly limited cost– on the order of several million euros, which would have to be provided by the Slovak side (see Roškanin, 2008b, p. 7). The project nevertheless made no further progress.

There are several possible solutions, which Tomáš Hüner of the Ministry of Trade and Industry briefly summarized: "There are a number of solutions, from a technology change solution in the Litvínov and Pardubice refineries that would allow them to process light oil, through the transport of Russian or similar crude oil via the IKL Pipeline, to the transport of Russian oil via another pipeline in Ukraine up to the section of the Druzhba pipeline that passes through Slovakia to the Czech Republic" (see Roškanin, 2008b, p. 9). Czech refineries are now specialized. The oil refinery in Litvínov processes the Russian REB oil blend imported via the Druzhba Pipeline, while the refinery in Kralupy nad Vltavou focuses on processing sweet domestic and imported crude oil supplied via the IKL; finally, the refinery in Kolín uses resources from the Litvínov refinery.

Overall technological change is of course possible, but expensive and time consuming. The transfer of Druzhba oil pipeline capacity to the IKL pipeline is problematic due to its full capacity utilization (see above). The option of transporting oil via the Druzhba junction in Ukraine, i.e. via the Odessa-Brody pipeline (also-called the Sarmatia pipeline) has been discussed but not acted on for the past ten years. The pipeline was originally supposed to be extended to the Polish city of Plock, but only that section that runs from the city of Odessa to Brody has actually been constructed. The pipeline has also been used for completely different purposes than it was built for. Until 2010, it was used fto transport Russian oil from the Druzhba via Brody and the Sarmatic to Odessa, where it was then shipped via tankers at the oil terminal in Odessa (Одеса) and Pivdennyi (Південний). According to an agreement signed in the beginning of 2011, the Odessa-Brody pipeline was also used to transport Azeri crude oil (Azeri Light) to the Belarusian refinery in Mozyr. However, since the beginning of 2012, the deal has been suspended. The infrastructure projects described above are also in response to reports about the possibility of curtailing or cutting off the Druzhba Pipeline.

Efforts to transfer the export of oil to oil tankers and the transition from the export of crude oil to the export of oil products are real aspects of Russia's energy strategy. A different issue is whether and to what extent this declared strategy can pressure importers so that they themselves use their resources more intensively to put political pressure on transit countries.

4.6 Summary

There is strong know-how and experience present in the Czech oil sector, based on an oil industry which has more than a hundred years' history in the country. The Czech oil market is dynamic. Among other things it records constant growth in petrol stations. On the one hand, this is an indicator of the market's vitality and raises refining and distribution demand; but in the final result, the volume of imports from abroad is boosted as well,

11 In addition to Deutsche Transalpine Oelleitung GmbH, the pipeline is operated by Austria's Transalpine Ölleitung in Österreich Ges.mbH and Italy's Societá Italiana per l'Oleodotto Transalpine SpA (see The Transalpine Pipeline, available on http://www.tal-oil.com/).

especially from Russia,[12] and the country's dependence is mounting. In the supply crisis of 2008, it became evident that the Czech Republic was far from dependant on the Druzhba Pipeline, as usually thought, and that it was able to resolve the situation completely without affecting the trade sector. Domestic sources are, however, insignificant and import dependency for the major volume of oil, along with all the issues that entails (for example, transit fees[13], curtailment of supply, etc.), will remain a long-term feature of the Czech oil sector. According to estimates, the Czech Republic expects slightly increasing oil consumption.

Russia's future plans call for the transport of oil materials that have been processed and finalized to the maximum extent, but the reality in the Russian refinery sector shows these plans to be little more than empty proclamations. Instead of the restriction of supplies as the result of a deliberate decision by the Russians, it would seem a greater threat lies in the failure of trade negotiations either between oil owning and transit countries, or between the owner of Czech refinery capacity and the oil supplier. PKN Orlen SA negotiates with the Russian Federation for regular oil supplies based on a joint contract that covers all of its refinery facilities (i.e. in addition to the Czech facilities, PKN Orlen SA in Płock, Trzebinia, and Jedlicze (all in Poland), and Możejki (Lithuania). Should PKN Orlen SA not reach an agreement with the Russian Federation, this could easily cause trouble with oil supplies to the Czech Republic.[14]

As previously indicated, the Czech refinery companies are configured for a particular sort of oil. This does not mean that, for example, the Russian type of oil could not be imported from somewhere in the West, as well. Generally, refinery companies manage to process any kind of oil. But the more it differs from the character of oil these refineries were originally configured for, the lesser its utilization, while unit costs rise in tandem. From the refinery's viewpoint, processing significantly different oil is economically pointless. Czech refineries are, moreover, not dependent on Russian oil but on medium heavy oil, whose producer, among others, is in fact Russia. While substituting for potential supply restrictions through the Druzhba Pipeline, refineries would look not for Russian oil in western pipelines, but rather for oil most like it: a heavy, sulphurous grade. Oil from Iran, for example, would be adequate. In this regard, it must be emphasized that the oil diversification of a country is sufficient unless the capacity of the TAL Pipeline becomes restricted. For this reason, we should laud the successful purchase of an ownership share in the TAL and potentially support further diversification projects that diversify only oil supply routes and not the regions rich in oil.

Due to its geographical context, the Czech Republic is isolated from other markets. The mountain massifs at the borders and the lack of a pipeline connection (except to Slovakia) limit the import of products from abroad and raise the price. Consequently, the Czech Republic has slightly higher prices on the domestic trade market due to limited import alternatives and must utilize cargo or train routes that make imports more expensive. According to unofficial information, the prices of products are higher by 10 USD per barrel than when obtaining them beyond the borders without counting in transport price, which has a positive impact on Czech refineries' competitiveness. Connection to pipelines from abroad (Germany, for example) would considerably simplify the entry of foreign products to the Czech market, which would lead to a general reduction of fuel and other product prices by, as noted above, 10 USD. On the other hand, this development could lead to the refineries' collapse and the decay of the Czech refinery sector.

The Czech refineries leverage this situation and try to limit activity that would lead to the simplified cross-border transport of products. The only real competitor to the Czech refineries is the Slovak company Slovnaft, a.s.,

12 The Czech Republic has a unique relationship with the Russian Federation stemming from 40 years of Soviet domination as well as the development of politics following 1989. Maximum effort was invested in breaking away from and dissociating from Russia and connecting with the West as quickly and as profoundly as possible. On the right of the political spectrum, similar affiliations are still maintained. At the international level, the typical Czech approach to Russia has been and still is represented primarily by the figure of Alexandr Vondra (former Foreign Minister of the Czech Republic, former Deputy Prime Minister for European Affairs) and Václav Bartuška (the Czech Republic's Special Envoy for Energy Security, appointed in 2006 by Alexandr Vondra). Such Czech political thinking to a great extent limits even "casual" trade relations of both countries.

13 In the case of the Druzhba Pipeline, the supplier pays the transit fees already at the transfer point Budkovce at the Slovak-Ukrainian border. From there, first the consumers of the Slovak transit company Transpetrol and then of the Czech MERO CR pay the transit. In the case of the IKL Pipeline, the supplier pays the transit fees for reaching Augusta Port in Sicily (the orientation point for the Mediterranean Sea). The consumer then pays for the transit from Augusta to Trieste for transportation through the TAL and IKL pipelines.

14 Here we should add that the Czech market approximately presents a mere 1.5% percent of Russia's oil export volume. Motivation for maintaining these exports can be of two kinds: political, related to the EU and the market, since the Czech Republic pays the market price of oil and its payments are punctual - in other words it represents certain income.

as it is connected to the ČEPRO product pipeline network via the pipeline from Bratislava. Of total PHM imports to the Czech Republic, approximately two-thirds are imported via the Slovak pipeline network, which is owned by Slovnaft.

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Chapter 5: The Natural Gas Sector[1]

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5.1 Introduction

The peak development of the gas industry in the Czech Republic came in the 1960s. In addition to the launch of the gasification process (the shift from coal gas to natural gas, culminating in the gasification of the entire Republic in 1996), there were also both structural and contractual efforts to ensure that gas supplies would come in from abroad. In 1967, the Brotherhood pipeline was launched (in 1969, the connection from Slovakia to Austria's Baumgarten and der March followed), extended to Germany in 1970 under the name Transit Pipeline (see Blažek, 2009, p. 134). It went into operation in 1972. Beginning at that time, the Czech Republic, owing to its geographic position, served as an important transit country for Russian gas directed westwards until the commissioning of the Nord Stream pipeline and subsequent infrastructure in 2011 (see Reuters, 2012). With new volumes of gas coming through the Northern transit route into the Czech Republic, the flow of natural gas has turned. The gas flow from west to east will be enhanced when the Nord Stream 2 is commissioned, something which is expected in 2019 (see Gazprom, n.d.a)

In the 1990s, the Transit pipeline was opened up to privatization but no purchase was made until 2002, when the pipeline was bought by Germany's RWE.[2] (see Jirušek, 2017, p. 212) In 1996, the Government of Prime Minister Václav Klaus announced the need to diversify natural gas supplies and to remedy the country's total dependence on the Russian Federation[3]. The importance of that decision is tied to the announcement by then-Minister of Industry and Trade Vladimír Dlouhý that the Norwegian company Statoil had won a supply contract in the presence of that country's King Harald V (see Strašíková, 2009). On May 1, 1997[4], when the contract[5] came into force, it brought the Czech Republic a substantially enhanced security of supply. (see Jirušek, 2017, p. 204–206) The Czech Republic thus became the first Central European country to diversify its natural gas supply. In 2017, 8.527 bcm/y (see ERÚ, 2018a, p. 20) of natural gas were consumed in the Czech Republic. More than 98 % of demand was satisfied by imports, less than 2 % from domestic production. Approximately two-thirds of that was from Russia, with the rest purchased on the spot markets, mainly in Germany (see OTE, 2018, p. 25).

1 The chapter in some of its parts makes reference to the publication of the research project The Future of Natural Gas Security in the V4 Countries: A Scenario Analysis and the EU Dimension (see Černoch, Dančák, Kovačovská, Ocelík, Osička, & Vlček, 2011).

2 No less interesting is that OAO Gazprom has several times showed interest in the Transit pipeline. Even though their offers were equal to the competition's and they even committed to engage in the further development of the gas network (and the Benzina network of petrol stations), the offer was each time rejected for political reasons (for more details see Blažek, 2009, p. 152–153).

3 Ironically, in 2009, already as a president, Václav Klaus did not see energy relations with Russia as a threat, even after the infamous gas crisis that took place in January of that year (see Holzer, Jirušek, & Kuchyňková, 2020, p. 69).

4 RWE Supply & Trading CZ, a.s., a. s. has concluded contract with a consortium of Norwegian producers (ExxonMobil Production Norway Inc., Statoil Hydro ASA, Norske ConocoPhillips AS, TOTAL E&P NORGE AS and ENI Norge AS) until 2017.

5 Aside from Norway, there were numerous offers of gas supplies to the Czech Republic: by Dutch N. V. Nederlandse Gasunie; German Wintershall Holding GmbH; multinational consortium of companies BEB, Mobil and British Gas; Russian OAO Gazprom and German E.ON Ruhrgas AG. The fact that it was the only variant granting partial independence from supplies from Russia nevertheless spoke in favour of the Norwegian offer (see Strašíková, 2009).

Tab. 5.1: Natural Gas Supplies

	Russian Federation	Kingdom of Norway[6]
Launch of Supply	1967	1997
Resource Areas	Mostly from the fields of Urengoy, Yamburg,Medvezhye, Zapolyarnoye	Fields Draupner E, Sleipner, Troll A, Mikkel, Kristin and other fields in the continental shelf of the Norwegian Sea
Transit Countries	Ukraine, Slovakia	Germany
Conclusion of Contract	October 1998, 2006*	May 1st, 1997
Contract	Until 2035**	Expired in 2017
Volume of contract	8–9 bcm/y	53 bcm in total, ca. 3.0 bcm/y

* In October 1998, a contract between Transgas, a.s. and OOO Gazexport signed to supply 8 to 9 bcm/y of natural gas for a period of 15 years. The contract, with a defined price and transport route, was to run until 2013. In 2006, RWE Supply & Trading CZ, a. s. (successor to RWE Transgas, a.s.) extended the contract until 2035. But the extension did not specify the gas price or transport route.

** This at the same time means definitely securing the Czech Republic's transit position until this year, since one-third of the natural gas supplied by Russia to Western Europe will continue to be transported through Czech territory.

Source: T. Vlček; Ministerstvo průmyslu a obchodu, 2010, p. 4–5; Kastl, 2008.

5.2 Deposits, Mine Production, Companies and Traders

In terms of categorization, the Czech natural gas industry may be divided into two levels. The first of these consists of the Czech gas pipeline operators who participate in the gas market and includes three kinds of player: those involved in gas transit, in gas distribution, and in gas sales. The current holder of an exclusive license for gas transit is NET4GAS, s.r.o., which operates more than 3800 km of gas pipeline. There are three operators of regional distribution networks who own their own facilities and are directly connected to the transit network[7]. And there are approximately 65 operators of local distribution networks who own their own facilities but are not connected to the transit network.

The second level of categorization breaks down the gasworks' individual components on the Czech gas market: *mining companies, holders of purchase contracts, transport providers, the transit and distribution of natural gas and, finally, natural gas traders.*

5.2.1 Deposits and the Production of Natural Gas in the Czech Republic

Natural gas is a mixture of gaseous and liquid alkanes ranging from methane to butane (respectively CH_4 - C_4H_{10}), which makes natural gas, unlike oil, basically the same regardless of where in the world it it is found, differentiated only in terms of the content of other hydrocarbons, dust, water and sulphurous materials, things which in any event are purified out before the extracted natural gas is sent for long distance transport. Czech natural gas deposits are minor, located in Southern and Northern Moravia. The natural gas deposits are almost exclusively tied to oil deposits.

6 Norwegian gas was meant to enter the Czech Republic at the Hora Sv. Kateřiny station. In reality, the supplies from Norway remained "virtual" or "trade" gas during periods of continuous Russian gas flow rather than physical supplies. Norwegian gas was swapped for Russian gas, which was supplied to the Czech Republic either through the gas pipeline from Berlin to Hora Sv. Kateřiny, through the Transgas system, or through the Nord Stream. In a nutshell, all gas came to the Czech Republic through Germany. Norwegian gas was only to be supplied to the Czech Republic in the case of cutbacks or interruptions to supplies from Russia. During the crisis of January 2009, Norwegian gas was in fact the only gas actually flowing into the Czech Republic (see Mejstřík & Marková, 2010, p. 19; Jirušek & Kuchyňková, 2018, p. 823).

7 GasNet, s.r.o., E.ON Distribuce, a.s., and Pražská plynárenská Distribuce, a.s.

Tab. 5.2: Deposits, reserves and production of natural gas in the Czech Republic

	2013	2014	2015	2016	2017
Deposits – total number	96	93	95	96	96
– exploited	40	40	46	64	64
Total mineral reserves	31,085	27,949	30,948	30,839	30,546
– economic explored reserves	7,646	7,491	7,494	7,381	7,236
– economic prospected reserves	20,458	20,458	20,456	20,481	20,479
– potentially economic reserves	2,981	2,956	2,998	2,977	2,951
– exploitable (recoverable) res.	5,512	5,064	5,057	4,918	4,801
Production	207	198	200	169	171

Note: reserves numbers in mcm.

Source: Ministerstvo životního prostředí / Česká geologická služba – Geofond, 2018, p. 176

Five companies are engaged in gas extraction, these being MND, a.s., Green Gas DPB, a.s., LAMA GAS & OIL, s.r.o., UNIMASTER spol. s.r.o., and Unigeo, a.s. (see Ministerstvo životního prostředí / Česká geologická služba, 2018, p. 192). The major producer is MND, which in 2017 extracted 116 million m^3 of natural gas (see MND, a.s., 2017, p. 4). Green Gas DPB is active in surface degasification, which is the mining of adsorbed natural gas (sometimes known as coal mine gas). Adsorbed natural gas is a less traditional source tied to black coal, whose genesis is not precisely known. Either it is released from coal or like other caustobioliths, it emerges as the result of sufficient pressure and temperature in sediments over a longer period. Green Gas DPB extracts this gas in the depths of the closed black coal mines of OKD Degasification involves air being released into the mine wells and the ensuing drainage of the pumped gas. Adsorbed gas accounts for 88% of total deposits of natural gas in the Czech Republic.

5.2.2 Holders of Purchase Contracts

The largest holder of a purchase contract in the Czech Republic is RWE Supply & Trading CZ, a. s.[8], a gas and power wholesale trader. Trade in gas still proceeds mostly on the basis of long-term contracts, in spite of developing EU liberalisation activities. The long term contracts provide consumers with stability of supplies, while as far as suppliers are concerned, they represent the grounds and capital necessary for extraction, transportation, research and other activities. Generally, the wholesale price of natural gas then to a certain measure depends upon the cost of extraction and transportation itself. The wholesale price of gas used to be largely dependent on the price of oil, oil products, and electricity. This method of pricing was introduced in the 1980s and fully implemented in the 1990s. Before then, the price of natural gas had been fixed on a production costs basis. As a result of the very low price of natural gas (compared to oil), increasing demand and use, and pressure exerted by the producing countries, this form of pricing has been in use since 1980, when natural gas pricing based on the price of oil and oil products was proposed at the OPEC session in Vienna (see Kysilka, 2007, p. 22–23). 85% of the price was based on the commodity price, with the remaining 15% tied to transport costs, distribution, market operator fees, etc. Nevertheless, lately a new type of contract has emerged which indexes natural gas prices to hub prices[9]. This results in less predictable and potentially more volatile prices, something that is, of course, not attractive to suppliers. There are three traditional gas pipeline suppliers in Europe: Russia's Gazprom, Norway's Equinor ASA (formerly Statoil), and Algeria's Sonatrach. Of these, only Equinor offers non-traditional contracts with hub price indexation. Gazprom and Sonatrach aim to preserve traditional price indexation to oil, which ensures more predictable future revenues (see Theisen, 2014, p. 11). In the Czech Republic, the gas trade is based mostly on long-term contracts. The remainder of Czech gas demand is covered by short-term purchases and domestic production, which amounts to approximately 2 % of total demand. The most important contract for the Czech Republic is that concluded by RWE Supply & Trading CZ, a.s.

8 A successor of RWE Transgas, a.s.

9 Gas hub price indexation means that gas prices are based on the prices on various gas hubs, i.e. on spot prices, and therefore reflect the development of gas markets in contrast to gas prices based on oil prices.

with OOO Gazprom Export, the supplier of Russian gas, which runs until 2035[10]. For information about other gas traders, see subchapter 5.2.4.5.

Historically, long-term contracts have supplied a large share of Czech gas market. Lately, however, the share of purchases on gas hubs has risen along with the number of shippers who supply the Czech consumers.

5.2.3 The Transportation, Transit and Distribution of Natural Gas

The only holder of a natural gas transport license in the Czech Republic is NET4GAS, s.r.o. (known before March 3, 2010 as RWE Transgas Net, s.r.o.). NET4GAS, s.r.o. owns the gas transmission network in the Czech Republic. In addition to the transit of Russian natural gas to other countries, it also provides transmission of gas to particular regions of the Czech Republic, as it is connected to the distribution network through delivery stations.

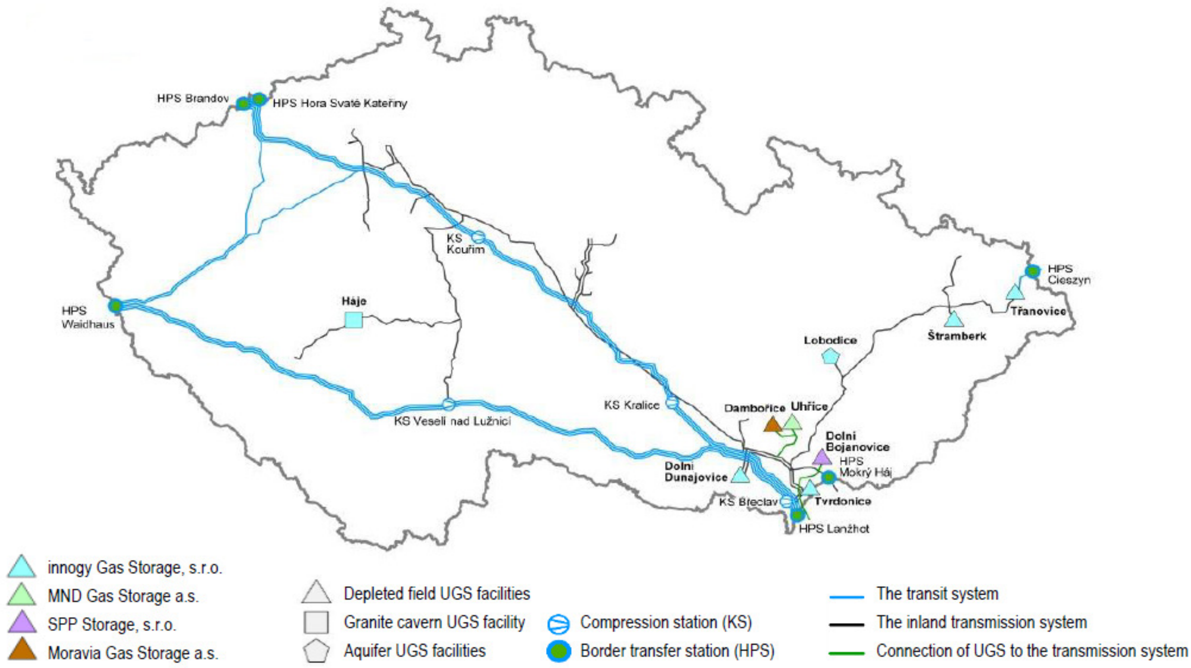
Most natural gas exported from the Russian Federation to the Czech Republic comes from the Russian Urengoy, Yamburg, Medvezhye, and Zapolyarnoe giant gas fields. (Koďousková, Kuchyňková, Leshchenko, & Jirušek, 2014, p. 148–149) The existing pipeline networks for gas are built on foundations dating from the Cold War. The first pipeline was the multipurpose Brotherhood pipeline, completed in 1967. It fetched natural gas from the Tyumen region of western Siberia. In the 1970s, the Transgas Company emerged in Czechoslovakia, starting to develop and run pipeline networks, while the Transgas pipeline went into operation in 1972, consisting of several parallel pipelines set in different time intervals.[11] Gas then flowed to Europe through the Brotherhood and Yamal gas pipelines, which join the Soyuz pipeline in the Western Ukraine. These three bundles then become the so-called Transgas system. Ever since, this road has been named the “Transgas System” (sometimes also known as the “classic route”). Historically, before the commissioning of the Nord Stream pipeline in 2011, gas travelled mainly through transit countries Ukraine and Slovakia, while the Transgas System was also partly supplied via the connector between the Yamal Pipeline and the Brotherhood from Belorussia to Ukraine. The gas was supplied from Slovakia to the Czech Republic using the Lanžhot border point, where it was delivered by the Slovak network operator Eustream, a. s. Gas was supplied to Germany through this point from November 1999 (earlier, it had transited solely through Poland using the Yamal pipeline). But after the Russian gas crisis in 2009, the Czech transmission network was adapted to reverse-flow, and after the commissioning of the Nord Stream in 2011, the flow of natural gas through the Czech Republic was reversed, with the majority of natural gas now transiting in the west-east direction. Russian gas coming from the Nord Stream is received at the Hora Sv. Kateřiny border point. From there, it flows to the Lanžhot border point, from where it flows through the Slovak transmission network to the Baumgarten gas hub[12] in Austria. From Lanžhot it also can either be supplied to Slovak customers or continue on to Ukraine. Nord Stream brings natural gas from Russia, through the Baltic Sea, to the Greifswald interconnection point in Germany. The first line was commissioned in November 2011 and the second line in October 2012 (see Reuters, 2012).

10 Such a long-term contract between RWE Supply & Trading CZ, a.s. and OOO Gazprom Export (until 2035) is nothing exceptional in Europe, as similar long-term contracts are concluded by OOO Gazprom Export and other suppliers with all major gas companies in the EU (such as ENGIE (former GDF Suez), E.ON Ruhrgas AG, VNG Verbundnetz Gas AG, OMV Group, N. V. Nederlandse Gasunie, Eni S. p. A., Wintershall Holding GmbH, etc.) (see Kysilka, 2007, s. 22).

11 For more details on the transit pipeline see Čech & Tichý, 2001

12 Central European Gas Hub (CEGH) AG, originally named Gas Hub Baumgarten, is a joint-stock company whose shareholders are OMV Gas & Power GmbH (65%), Wiener Börse AG (20%), and Eustream a.s. (15 %).

Tab. 5.3: Transmission system and underground gas storages in the Czech Republic



Source: ERÚ, 2018b, p. 52

The transmission network of the Czech Republic is connected to neighbouring countries through border points at four locations. The first is the Lanžhot border point with Slovakia, which is mainly used for the transit of Russian gas from the Czech Republic to Slovakia. But it can also be employed for gas purchases on the spot market from the hub at Baumgarten an der March in Austria (Central European Gas Hub/CEGH). The Czech Republic is not connected to the CEGH directly (but there is a project to construct an interconnecting gas pipeline from Břeclav, see chapter below); as a result, purchased gas is sent through the Slovak gas network Eustream, a.s. to the Baumgarten hub in Austria. The second location is on the border with the German Federal Republic of Saxony. Through the border points Hora Sv. Kateřiny and Brandov,[13] gas flows predominantly from the Nord Stream pipeline, along with gas bought on the German spot markets (the Gaspool virtual trading point); in both cases the gas is of Russian origin. The third existing border station is Waidhaus[14], which is mainly used to transfer Russian gas from the Czech transmission network to Germany. It connects the Czech transmission network with European pipelines using the MEGAL[15] pipeline. The station may also be used for gas purchased on the spot market. The fourth location is the interconnection point with Poland at Cieszyn/Český Těšín. The Czech transmission system is connected to Poland via the Stork pipeline, which was commissioned in 2011 (see NET4GAS, n.d.b).

In 1972, the transit gas pipeline from Russia came into operation. Historically, it took natural gas to Germany and France through the Czech Republic, but currently it is used to transfer gas to Slovakia and further on to the hub at Baumgarten and Ukraine. Since 1972, therefore, the Czech Republic has served as an important transit link due to its location. The transit fees for transmission of gas are set by the Energy Regulatory Office in regularly published Price Decisions. Based on the legislation of the European Union, the gas transmission sector is a regulated business (see chapter 5.3). Natural gas shippers pay a standardized transit fee to the transmission system operator, NET4GAS, s.r.o., for gas to be transmitted through the system.

The volume of gas transited reached 42.5 bcm per year in 2017 and 48.1 bcm per year in 2018. In 2018, 8.2 bcm of gas (out of 48.1 bcm/y) was transported for the Czech gas market. (see NET4GAS, 2019, p. 15)

13 The subsequent German transmission network is operated by the ONTRAS–VNG Gastransport GmbH company and by GASCADE Gastransport GmbH.

14 The subsequent German transmission network is operated by GRTgaz Deutschland GmbH and Open Grid Europe GmbH.

15 The capacity of MEGAL Süd is 22 bcm/y and is fully used year after year. MEGAL (Mittel-Europäische-Gasleitung) is operated by GRTgaz Deutschland GmbHand Open Grid Europe GmbH.

5.2.4 Important Actors on the Czech natural gas market

After the privatization of the Czech natural gas industry, the German concern RWE was the dominant player on the gas market for several years. It controlled key sectors of the Czech natural gas market. RWE Transgas, a.s. was a company involved in the transmission, distribution, storage, and trade of gas for several years. But because of legislative requirements imposed by the European Union,[16] the Czech natural gas market underwent a so-called unbundling process[17]. In 2006, RWE Transgas Net, s.r.o. was split off from RWE Transgas, a.s. as the Czech transmission system operator. In 2007, RWE Gas Storage, s.r.o. was established as the storage system operator and RWE GasNet, s.r.o. as the distribution system operator.

As a result of the so-called gas legislative packages, the gas market throughout the European Union has been divided into several levels.

5.2.4.1 Transmission system operator

RWE Transgas Net, s.r.o. was renamed NET4GAS, s.r.o. in 2010 as a further step in the liberalization of the gas market. NET4GAS is the sole holder of a transmission system operator (TSO) licence in the Czech Republic. It conrols the international transit of natural gas across the Czech Republic and national transmission of natural gas.

A consortium consisting of the German Allianz Insurance Company (50 %) and Canada's Borealis Investment Fund (50 %) bought NET4GAS in 2013 from RWE for more than CZK 41 billion (see E15, 2013).

5.2.4.2 Distribution system operators

There are three distribution system operators (DSOs) in the Czech Republic. The biggest is GasNet, s.r.o.,[18] which was created in 2007 by unbundling from RWE Transgas, a.s. Several regional distributors of gas[19] were merged into GasNet over the course of time (see GasNet, n.d.). Nowadays GasNet operates across most of the Czech Republic except for the Southern Bohemia and Prague regions (see Table 5.4).

Pražská plynárenská Distribuce, a.s. is a DSO operating in Prague. It was created in 2005 by unbundling from Pražská plynárenská, a.s. (see PPD, n.d.). Today, it is a 100 % subsidiary of Pražská plynárenská, which is wholly owned by the City of Prague (see Pražská plynárenská, 2014). The final Czech DSO is E.ON Distribuce, a.s., which operates in Southern Bohemia. It is a subsidiary of E.ON Česká republika, s.r.o., from which it was unbundled in 2005 (see E.ON, n.d.).

16 The so-called Three Energy Packages aim at creating a single electricity and gas market in the European Union. Three gas directives are included in the Energy Packages whose focus is the liberalization of the European gas market – Directive 98/30/EC, Directive 2003/55/EC, and Directive 2009/73/EC.

17 According to the official website of the European Commission, unbundling 'is the separation of energy supply and generation from the operation of transmission networks'. This means a company cannot simultaneously operate in the transmission, distribution, and generation of energy. (see European Commission, n.d.a)

18 The company was called RWE GasNet, s.r.o. until September 2016.

19 Středočeská plynárenská Net, s.r.o., Severočeská plynárenská Net, s.r.o., Západočeská plynárenská Net, s.r.o., Východočeská plynárenská Net, s.r.o., Jihomoravská plynárenská Net, s.r.o., Severomoravská plynárenská Net, s.r.o.

Tab. 5.4: Distribution system operators in the Czech Republic

Source: ERÚ, 2018b, p. 53

5.2.4.3 Storage system operators

Three operators of underground gas storage facilities are active on the Czech gas market. Innogy Gas Storage, s. r. o.[20] owns six reservoirs in the country (Háje, Dolní Dunajovice, Tvrdonice, Lobodice, Štramberk and Třanovice; see Picture 1). Another storage system operator (SSO), MND Gas Storage, a.s. is fully owned by MND, a.s. , which is itself part of the European firm MND Group AG. It works in oil and gas production, gas storage, and power and gas trading,[21]. MND Gas Storage owns the Uhřice Reservoir. This company also operates the Dolní Bojanovice reservoir. MND and Gazprom Export LLC own a further company operating an underground gas storage facility (Dambořice) in the Czech Republic – Moravia Gas Storage, a.s. (see Gazprom Export, 2016).

5.2.4.4 Gas producers

Five companies in all are engaged in gas extraction (see Ministerstvo životního prostředí / Česká geologická služba, 2018). As indicated above, MND, a.s. is fully owned by MND Group AG. Green Gas DPB, a.s. is a part of Green Gas International B.V., which operates several clean energy projects in Europe. Another drilling company is LAMA GAS & OIL, s.r.o. owned by LAMA ENERGY GROUP, a.s. holding. UNIMASTER spol. s.r.o. and Unigeo, a.s., whose sole shareholder is investment group Touzimsky kapital, s.r.o.

5.2.4.5 Wholesale and Retail Traders

In addition to several companies who supply the Czech Republic with natural gas at the wholesale level, there are many companies who supply gas, either purchased, acquired directly from abroad, or already transported to the Czech Republic, to retail consumers.[22]

20 In October 2016 the RWE concern in the Czech Republic (but not only in the Czech Republic) changed its name to innogy and completely rebranded its company identity. The new company innogy was created as a subsidiary of the global RWE concern with aim to focus its activities in trade, networks and renewable sources. All companies previously operating under the RWE concern are now under Innogy. (see innogy, 2016) In March 2018 RWE sold its 76.8% stake in innogy SE (European energy company) to E.ON (see RWE AG, 2018). The concrete consequences of this transaction in regard to possible change of names and rebranding are still not clear, nevertheless some changes can be expected.

21 The sole shareholder is private investment group KKCG a.s.

22 In a few cases traders can operate on both levels, for instance RWE, E.ON, ČEZ.

The largest holder of a purchase contract in the Czech Republic is RWE Supply & Trading CZ, a. s.[23], a gas and power wholesale trader. VEMEX s.r.o. was the main alternative supplier of natural gas in the Czech Republic. As of 2011, Gazprom Germania GmbH was the majority owner of VEMEX (50.14 %) and is itself fully owned by Russia's Gazprom Export LLC, a subsidiary of PAO Gazprom. Due to economic problems, however, VEMEX was replaced by Wingas GmbH, fully owned by Gazprom Germania. Wingas took over most of VEMEX's existing contracts, including at the wholesale level. Consequently, Wingas is currently the main alternative supplier after RWE Supply & Trading (see euro, 2018; Jirušek, 2017, p. 204–208)

Important gas traders include Innogy Energie, a.s., Pražská plynárenská, a.s., E.ON Energie, a.s., ČEZ Prodej, a.s., Wingas GmbH, BOHEMIA ENERGY Entity, s.r.o., and Centropol Energy a.s. There are dozens of other gas-trading companies as well, but most have only a handful of end consumers. Their impact on the Czech gas market as a whole is therefore negligible.

5.2.4.6 National Regulatory Authority

The Energy Regulatory Office (Energetický regulační úřad, ERÚ) is a Czech National Regulatory Authority. The ERÚ is an independent administrative body that is responsible for regulating the entire energy sector. The ERÚ is run by the Board of the ERÚ (ERÚ Board), which has five members and is appointed and dismissed by the government at the behest of the Ministry of Industry and Trade. The ERÚ is funded independently under the state budget and is in no way linked to any domestic or foreign entity. Its main competency within the gas industry includes regulating fees for the transmission, distribution, and storage of gas[24], granting licences[25], and approving legislation and documents pertaining to the gas market.[26] (see ERÚ, n.d.)

5.2.4.7 Gas Market Operator

OTE, a.s. is the Czech electricity and gas market operator. It was created in 2001 and its sole shareholder is the government of the Czech Republic. OTE operates a day-ahead gas market and intraday gas market. Another key role of OTE is processing data used to settle imbalances between contracted and metered volumes of gas. (see OTE, n.d.)

5.2.4.8 Czech Gas Association

In the natural gas sector, there is also the Czech Gas Association, which aims at increasing expertise in the natural gas, mediating the transfer of information related to the gas industry, and representing the Czech industry at the international level (for example, in the International Gas Union) (see Český plynárenský svaz, n.d.).

5.2.5 Underground Natural Gas Storage

Innogy Gas Storage s.r.o. operates six out of nine storage facilities (Háje, Dolní Dunajovice, Tvrdonice, Lobodice, Štramberk and Třanovice) that are connected to the gas pipeline network and treats them as a single Virtual Gas Storage Reservoir (see Innogy Gas Storage, n.d.). The reservoir Uhřice is operated by MND Gas Storage, a.s. and the reservoir Dambořice by Moravia Gas Storage, a.s. The final underground gas storage facility, Dolní Bojanovice, is owned by SPP Storage, s.r.o. The reservoir at Dolní Bojanovice is not currently connected to the Czech gas pipeline network, but it is connected to the Slovak transmission network. It follows that Czech market participants cannot utilize the capacity of this underground storage. Nevertheless, there is a plan to connect it to the NET4GAS' transmission network (see SPP Storage, 2016).

If we do not take into account the Dolní Bojanovice reservoir, which is used by Slovakia, the overall capacity is 3.2 bcm. With respect to Czech gas demand, which in 2017 produced 8.527 bcm (see ERÚ, 2018a), this amount covers more than a third of the yearly demand for natural gas (37.5%). Security positives (in addition to coverage for any potential curtailment of supply, there is also the capability to balance the differences between supply and demand and resist weather impacts) based on the existence of underground reservoirs are, however, closely tied

23 A successor of RWE Transgas, a.s.

24 The fees are being regularly published in the so-called Price Decisions.

25 Based on Act No. 458/2000 Coll. Of 28 November 2000, on the Conditions of Business and State Administration in Energy Industries and Changes to Certain Laws (the Energy Act) the ERÚ grants licenses for the following: transmission of gas, distribution of gas, storage of gas, gas trade, gas production, market operator.

26 Among others, the Gas Market Rules, operators' codes, commercial terms and conditions, Ten-Year Network Development Plan of the Czech Republic.

to the amount of gas which is stored in them. Traditionally[27], natural gas has been injected into reservoirs during the summer months, when demand and therefore spot prices decline because of the warm weather. The injection process lasts 2–3 months. Important information is, however, to be read in total daily extraction performance. During the winter, the reservoirs are capable of covering the total daily consumption of the Czech Republic only at the beginning of the season. The maximum daily performance of reservoirs is 59.7 mcm, and decreases as a function of decreasing pressure inside the reservoir. Maximum daily winter consumption in the Czech Republic in 2017 was around 54.9 mcm (see ERÚ, 2018b, p. 4). In the case of possible disruption to supplies from Russia, the shortfall between extraction from reservoirs and consumption may be covered using supplies from Germany. The speed of extraction from reservoirs is determined by the extractability curve. Because of declining pressure in reservoir, the speed of extraction declines proportionately with the length of the extraction process.[28]

The storage of gas has several uses and advantages. First, stored gas may be used to balance peak demand, mainly during the winter. Second, traders may buy gas when prices fall with the drop in summer demand and sell it during the winter months when demand and spot prices rise. Third, underground gas storage facilities serve as an important element in securing the national supply because they provide necessary flexibility in the face of fluctuations in supply or outright disruptions. Overall, underground reservoirs present an important component of the instate gas system.

Tab. 5.5: Underground Natural Gas Storage Reservoirs in the Czech Republic and their Maximum Capacity as of March 31, 2018

Reservoir	Owner	Type of Reservoir	Peak Withdrawal / Injection Capacity (mcm/d)	Capacity (mcm)
Lobodice	innogy Gas Storage, s. r. o.	Aquifer*	42.2 / 35.7	2,707
Tvrdonice	innogy Gas Storage, s. r. o.	Depleted Field		
Štramberk	innogy Gas Storage, s. r. o..	Depleted Field		
Dolní Dunajovice	innogy Gas Storage, s. r. o.	Depleted Field		
Háje	innogy Gas Storage, s. r. o.	Cavern**		
Třanovice	innogy Gas Storage, s. r. o.	Depleted Field		
Uhřice	MND, a. s.	Depleted Field	10 / 5.4	280
Dambořice	Moravia Gas Storage, a.s.	Depleted Field	7.5 / 4.5	250
		Total for the Czech gas market:	**59.7 / 45.6**	**3,237**
Dolní Bojanovice	SPP Bohemia, a. s.	Depleted Field	9 / 7	566
		Total in the Czech Republic:	**68.7 / 52.6**	**3,803**

* An aquifer is an underground layer of water-bearing permeable rock from which groundwater can be extracted using a well. An aquifer reservoir functions by pushing gas into the underground water-bearing bedrock so that that the pressure artificially causes the water to be pushed to the lower layers thus creating space for natural gas to be stored.

** A cavern reservoir is created artificially, usually in former salt and coal mines. Háje reservoir is built where uranium mines originally lay.

Source: NET4GAS, 2018, p. 14; SPP Storage, 2019

27 Recently, this principle has not been strictly followed. Withdrawal from and injection into underground storage facilities is done by traders following an economic imperative, who therefore inject gas into the storage facility when its price falls so they can wait to sell it later at higher price.

28 Underground reservoirs alone would not have been able to cover the loss during the January 2009 gas crisis without affecting the population. On January 5, 2009, a day before the outbreak of the gas crises, 15 million m^3 of natural gas were supplied to the Czech Republic from Russia through the Slovakian network Eustream, a. s., another 4.3 million m^3 from the underground gas reservoir in Slovakia Láb I–III, 5.3 million m^3 from Norway via Hora Sv. Kateřiny, 1.0 million m^3 from Germany through Olbernhau, 0.5 million m^3 from Germany through Waidhaus, and 20 million m^3 from the Czech underground reservoirs, for a totals 46.1 million m^3 of natural gas. A week later, on January 12, 2009, when the crisis reached its peak, the composition of supplies was as follows: zero from Russia and Slovakia, 1.8 million m^3 from PZP Láb I–III (another 3 million m^3 were left to Slovakia), 19 million m^3 from Norway and Germany via Hora Sv. Kateřiny (for Slovakia), 33 million m^3 from Germany through Olbernhau, 0.5 million m^3 from Germany via Waidhaus (at the same time, 27 million m^3 was exported along that route to Germany to cover its shortage as a result of the restriction of Russian gas supplies), and 34 million m^3 from Czech underground reservoirs. During this period, the extraction capacities of the reservoirs were used to the maximum effect. At the peak of the crisis, total gas supplies therefore jumped to 58.3 million m^3. Because of freezing temperatures, average consumption in December 2009 ranged around 47 million m^3. With respect to the physical characteristics and extractability curve, the maximum extraction of reservoirs at the peak of the crisis reached 34 million m^3. It is therefore evident that the reservoirs alone would be insufficient to cover consumption and that the importance of diversified supplies of natural gas from Norway was demonstrated during the crisis (For data see Petržilka, 2009b).

Underground gas storage capacity in the Czech Republic is more than adequate and there are no projects currently underway aimed at increasing capacity or building new storage facilities. Moreover, overall interest in underground storage capacity has fallen. This leaves little (economic) justification for new projects.

5.2.6 The Use of Natural Gas

Czech consumption of natural gas reached 8.527 bcm/y (see ERÚ, 2018a) in 2017. Industry was the largest consumer, mainly the non-metallic materials, food and tobacco, engineering, iron and steel, and chemicals industries. Households make up almost as big a share of consumption with their use of gas for cooking, home heating, and warm water. Some consumption also takes place for heat generation, electricity generation, and for the combined generation of heat and electricity (cogeneration)[29]. However, this volume is not substantial and there is significant space for growth, especially for the generation of electricity. The use of natural gas inside the transportation sector, both in the form of compressed natural gas (CNG, 200 bars of pressure) and as a liquid (LNG at -162 °C), is only at the beginning. The CNG version is currently more common. The use of natural gas in the transport sector has been minimal so far, although the size of the automobile fleet is growing. In 2010, there were 2,500 CNG vehicles in the Czech Republic. By 2018, that figure had grown to 22,600. But this is still a minimal number that leaves significant potential (see CNG4you, 2019).

Tab. 5.6: Natural Gas Consumption in the Czech Republic by Sector

Total Consumption	**301,491.0 (100%)**
Transformation Purposes (electricity and heat generation)	**58,443.3 (19.4%)**
Energy Industry	**3,983.4 (1.3%)**
Distribution Losses	**3,843.0 (1.3%)**
Final non-energy consumption	**3,715.2 (1.2%)**
Industry	**89,631.0 (29.7%)**
Transport	**2,928.6 (1.0%)**
Other Sectors	**138,946.5 (46.1%)**
Trade and Public	49,825.8
Households	83,923.2
Agriculture (inc. Fisheries)	2,739.6
Other	2,457.9

Note: Data is in TJ.

Source: Ministerstvo průmyslu a obchodu, 2019, p. 22; Percentage conversion by author.

The exploitation of natural gas for electrical power production is rather modest in the Czech Republic. In 2017, natural gas had a 3.9 % share in electricity generation (see ERÚ, 2018b, p. 8). Currently, the biggest natural gas combined cycle power plant in the Czech Republic is Počerady, owned by ČEZ. Its installed capacity is 838 MWe. The plant was finished in 2013, but during its construction, the situation on the energy market changed drastically. Electricity prices dropped so low that electricity generation in Počerady was no longer cost-effective[30]. It follows that the plant has been used less than expected. (see ČEZ, n.d.a) Another combined cycle power plant is owned by Sokolovská uhelná, právní nástupce, a.s. in Vřesová, with an installed capacity of 400 MWe. It was built in 1995–1996 (see Sokolovská uhelná, 2018) and is currently undergoing modernization (see Sokolovský deník, 2018). The enormous advantage of this power plant is its ability to limit electricity output in an instant. It is able to

29 When it comes to the generation of electricity from gas, we must be careful how we interpret the data and differentiate between the categories "gas" and "natural gas", because a substantial portion of electricity is generated not only from natural gas but from biogas and other gases, as well. In 2017, gross electricity generation from natural gas was 3,388.2 GWh (a 3.9 % share of gross electricity generation), from other gases 2,879.7 Gwh, and from biogas 2,639 GWh. It follows that natural gas makes up only around 38 % (in 2014, the share was only ≈19 %) of electricity generation from gases in the Czech Republic (ERÚ, 2018b, p. 8).

30 The project for the Mochovce, at that time owned by RWE, was canceled because of these market developments, which would result in the plant being unprofitable (see Čelákovice, 2014).

cut its output from 180 MW to 2 MW in one second[31]. Another gas power plant with a combined cycle is located in Kladno, owned by Alpiq; its installed capacity is only 110 MWe (see Alpiq, n.d.). And the final gas power plant, with an installed capacity of 58 MWe, is in Prostějov (see Gama Investment, n.d.).

ČEZ plans other power plants using the combined cycle. The Mělník power plant in Horní Počaply has a planned capacity of 800 MWe, and is intended to supply Mělník and Prague. Nevertheless, due to changes in the energy sector, the project is currently under review. Another project is Úžín, on the outskirts of Ústí nad Labem (220 MWe). It, too, is currently under review. Thus, there is no time schedule or any details available. (see ČEZ, n.d.b)

Combined cycle power plants and gas and combustion power plants are not one and the same thing. While the gas and combustion power plant's functioning is based on the simple principle of natural gas combustion and the use of generated energy to start the turbines and produce electricity, the combined cycle power plant employs two cycles. During the first (gas) cycle, natural gas is mixed with air and sent under pressure into a turbine, where it burns and produces heat and consequently electrical power. High temperature flue gasses are brought to a different boiler in thesecond cycle, where thermal energy (steam) is produced and, as a consequence, electrical power. This production method increases energy efficiency, since the generation of steam for the steam turbine uses the heat of the flue gases released from the gas turbine.

In 2018, combined cycle plants produced 3,648.3 GWh of electricity and the total installed capacity was 1,363.5 MWe (of which 838 MWe represents the installed capacity of the Počerady power plant). In 2017, 533.9 mcm of gas were consumed in combined cycle plants, 316.3 mcm in the Počerady power plant only. The remaining gas was consumed elsewhere among the 680 existing facilities, including the power plants in Vřesová and Kladno (see ERÚ, 2018b, p. 27). Considering this high number and comparatively minimal gas consumption, it may be assumed that there are many local sources with low capacity, such as gas boilers in homes.

Gas-fired power stations in 2018 produced 3,648.7 GWh of electricity and their total installed capacity was 895.9 MWe that same year (see ERÚ, 2019a, p. 21–22). Natural gas is a minor fuel in gas-fired power plants compared to biogas.

Natural gas also figures significantly in heating. In 2018 18.9% of heat in the Czech Republic was produced from natural gas, 2.6% from biogas, and 6.8% from other gases (see ERÚ, 2019b, p. 6).

Sources with more than 50 MWe include Teplárny Brno, a. s., (95 MWe) and Teplárna Trmice, a. s., (70 MWe).

5.3 The Regulatory Framework of the Natural Gas Industry

5.3.1 The Legislation

In terms of mining, the exploitation of natural gas is guided by Act No. 89/2016 Coll., which amended Act No. 44/1988 On the Protection and Utilization of Mineral Resources (The Mining Act) and by the Czech Mining Authority, as in the case of coal. Trade with natural gas is treated in Act No. 458/2000 Coll., on Business Conditions and Public Administration in the energy sectors and on Amendments to Other Laws (The Energy Act).

Czech natural gas legislation has been closely linked to EU legislation since 2004. EU legislation in the gas sector is presented mostly in the form of regulations[32] and directives[33] and covers all parts of the sector. The crucial fact is that EU legislation has precedence over Czech legislation. This means the Czech Republic must transpose EU legislation into its national legislation and abide by it. The Czech gas sector may generally be considered properly regulated in terms of legislation. It reacts well to the legislative framework and conceptual materials and deals appropriately with European legislation. In terms of natural gas, it is also clear that domestic and EU legislation do not contradict each other and do not deviate from the long-term course, thus contributing to the stability of he sector as well as to the anticipation of and preparation for further developments.

31 This is a general advantage of gas-fired power plants (but not combined cycle power plants) which increases the importance of these plants in terms of their contribution to the management and stability of the entire electricity network. It is during the first (gas) cycle, where natural gas is mixed with air and sent under pressure into a turbine where it burns, that it is easy to change the output in an instant. The second cycle is as slow as in coal-fired power plants. When a gas combined cycle power plant must be regulated in an instant, the second cycle must be shut down.

32 A legal act of the European Union which sets out a goal i.e. requires member states to achieve a particular result but does not determine the means of achieving that goal. A member state therefore must devise its own legislation to reach the goal.

33 A binding legal act of the European Union. It is enforceable immediately after coming into force which means that it does not have to be transposed into national legislation.

All EU directives have been adopted in the Czech Republic and implemented in its laws. The most important EU legislation includes Directive 94/22/EC of 30 May 1994 on the Conditions for Granting and Using Authorization for the Prospection, Exploration and Production of Hydrocarbons, which focuses on the upstream sector. Directive 2009/73/EC of 13 July 2009 Concerning Common Rules for the Internal Market in Natural Gas is part of the so-called Third Liberalization Package in gas. It creates basic rules for the establishment and functioning of the single gas market, such as the unbundling principles, third party access to gas infrastructure, and market opening and definition, and it increases the powers of national regulatory authorities.

After the gas crisis of 2009, the EU came up with new security of supply concepts which were introduced into regulations in force at that time. The current valid Regulation (EU) 2017/1938 of 25 October 2017 Concerning Measures to Safeguard the Security of the Gas Supply includes among its provisions infrastructure standards directed at the security of supply, gas supply standards for protected customers in member states, and describes levels of crisis. It also introduces the concept of solidarity.[34] (see EUR-lex, n.d.) In addition, at the European level, there are 'network codes',[35] which are legal acts (regulations) that aim at harmonizing the rules across European gas markets to facilitate market integration and create a single gas market.

5.3.2 The Energy Regulatory Office

One of the most concrete consequences of European regulation is the existence of national regulatory authorities. In the Czech Republic, this is the Energy Regulatory Office (see chapter 5.2.4.6). The ERÚ oversees the functioning of the energy market, with an emphasis on the implementation of legislation. In addition, the ERÚ supports the use of alternative fuels in the energy industries and protects the interests of both consumers and licence holders. Moreover, the ERÚ regularly issues a so-called Price Decision[36]. Historically, there were vertically integrated companies that dominated the gas and electricity sectors in Europe. The purpose of unbundling, therefore, was to divide such vertically integrated companies into distinct companies working along a supply chain. Nevertheless, there was gas infrastructure for gas transportation already in place and no logical reason to build another infrastructure to enable competition. Hence, aside from implementing concrete rules such as TPA[37], price regulation was introduced in the sectors of transmission and distribution of gas in the Czech Republic to prevent companies from engaging in monopolistic behaviour.

5.3.3 Security of supply

On November 12, 2009, the simulation of a state of crisis took place as part of preparations for new legislation on emergency situations. Under the simulation, it was found that gas supplies were continued to flow to all customers. Then-Minister of Industry and Trade Vladimír Tošovský argued that "in the event of curtailment of natural gas supplies from Russia, the Czech gas industry would be capable of handling the situation in an adequate manner" (see Akrman, 2009). The Czech state of emergency follows Act No. 344/2012 Coll. as amended by Act No. 215/2015 Coll., on States of Emergency in the Gas Industry.

34 Solidarity means a member state may request help from other member state(s) in the form of solidarity gas supplies to solidarity protected customers in the requesting member state when this state is not able to supply them by itself. Solidarity is provided on the basis of compensation. This may be seen as a direct consequence of the gas crisis in 2009. It represents the embodiment of help and cooperation among member states in 2009 in EU legislation.

35 The Capacity Allocation Mechanism Network Code (CAM NC; Regulation (EU) 2017/459) on the capacity allocation mechanism, e.g., rules of auctions, capacity calculation, the standardization of offered capacity products, in gas transmission systems. The Balancing Network Code (BAL NC; Regulation (EU) 312/2014) on gas balancing rules, nomination procedures, settlement processes etc. in transmission networks. The Tariff Network Code (TAR NC; Regulation (EU) 2017/460) on harmonized transmission tariff structures, which aims at creating transparent, non-discriminatory calculation of tariffs. The Interoperability and Data Exchange Network Code (Regulation (EU) 2015/703) that focuses on an appropriate degree of harmonization in technical, operational and communication areas which may possibly complicate or block the free flow of gas in the EU. (see ENTSOG, n.d.)

36 The ERÚ regularly issues so-called price decisions in which it sets out regulated prices for gas transmission and distribution, prices for the market operator's services, and the prices of supply of last resort.

37 Third-party access is a policy in which the owners of natural monopoly infrastructure (transmission system operators, operators of storage or LNG facilities) must grant non-discriminatory access to their infrastructure. This way TPA supports competition where it has been impossible due to the existence of a monopoly.

The obligation (both local and supranational) to keep strategic reserves emerges from Regulation (EU) 2017/1938. Among other things, it sets out an obligation to ensure gas supply to protected customers[38] in a member state in specific cases[39]. Czech Act No. 344/2012 Coll. follows Regulation (EU) 2017/1938 and includes a definition of the protected customer category in the Czech Republic, as well as defining the calculation methodology for the security standard traders must maintain for those of their customers that qualify as protected customers.

Regulation (EU) 2017/1938 does not specifically state that a member state must maintain strategic reserves in underground gas storage facilities. Nevertheless, Act No. 344/2012 Coll. specifically says that the gas security standard for protected customers shall be fulfilled by keeping at least 30 % of the security standard in underground gas storage facilities located within the European Union. Thus there is a legal obligation to store a certain (changeable) amount of gas in underground storage facilities.

5.4 Demand Forecast

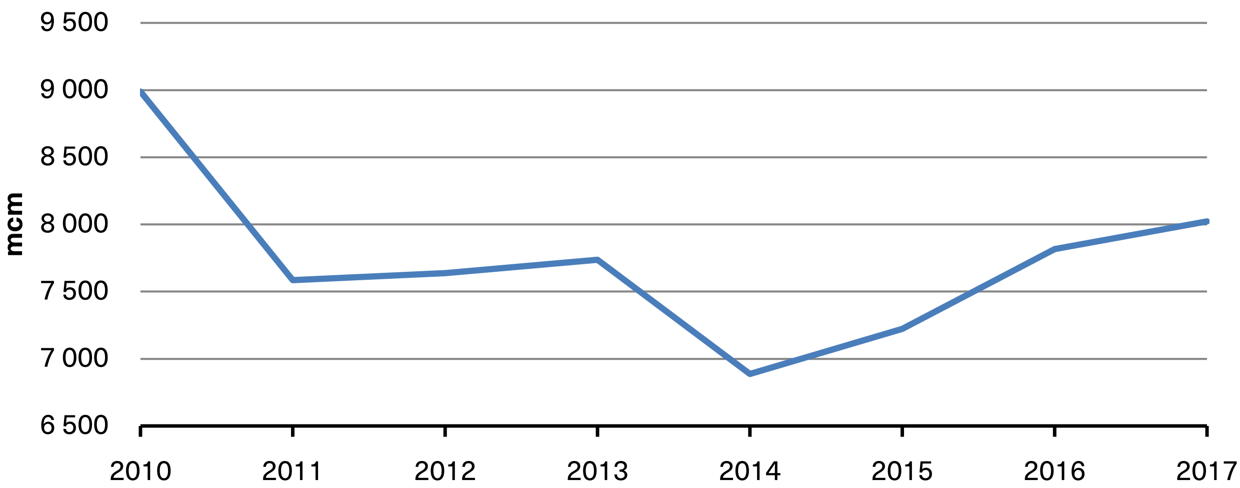
The Czech Republic saw a decrease in gas consumption up to 2014 and very modest growth after that point. This could change in the near future with an expected decrease in the share of liquid and especially solid fuels in the TPES mix, mainly due to the implementation of energy and environmental policies.

Tab. 5.7: Gross gas consumption in the Czech Republic (in mcm)

	2010	2011	2012	2013	2014	2015	2016	2017
Consumption	8,989	7,585	7,638	7,738	6,887	7,222	7,816	8,022

Source: Ministerstvo průmyslu a obchodu, 2019, p. 22

Tab. 5.8: Gross gas consumption in the Czech Republic (in mcm)



Source: Ministerstvo průmyslu a obchodu, 2019, p. 22, visualisation by J. Červinková

The decrease in the share of liquid and especially solid fuels in the TPES mix will be most likely compensated by nuclear energy, renewable resources and natural gas. Natural gas will then, according to the updated SEP, become a more important part of the TPES mix in the Czech Republic, accounting for approximately one-fifth of its makeup (see Aktualizovaná státní energetická koncepce, 2014, p. 44).

38 A specific category of customers under the Regulation (EU) 2017/1938. Among others, there are households and essential social services included. Each member state defines the category itself based on the rules set in Regulation 2017/1938.

39 Specifically (a) extreme temperatures during a 7-day peak period occurring with a statistical probability of once in 20 years; (b) any period of 30 days of exceptionally high gas demand, occurring with a statistical probability of once in 20 years; (c) for a period of 30 days in the case of disruption of the single largest gas infrastructure under average winter conditions (Art. 6, par. 1, Regulation (EU) 2017/1938).

Tab. 5.9: The Shares of Fuels in Energy Resource Consumption in 2000 and 2017 and the Shares According to the State Energy Policy of the Czech Republic from 2004, including the 2014 Update (in %)

Type of Fuel	Level in 2000	Level in 2017	Long-Term Goal (SEP 2004) by 2030	Long-Term Goal (USEP 2014) by 2040
Solid	52.4	36.7	30–32	11–17
Gas	**18.9**	**16.7**	**20–22**	**18–25**
Liquid	18.6	21.7	11–12	14–17
Nuclear	8.9	16.3	20–22	25–33
Renewables	2.6	10.5	15–16	17–22

Source: Státní energetická koncepce, 2004, p. 11–12, 40–49; Aktualizovaná státní energetická koncepce, 2014, p. 44; Ministerstvo průmyslu a obchodu, 2019, p. 14

The expected growth in natural gas demand is well illustrated in the of Fitch Solutions forecast (see table 5.10), which predicts increasing consumption from real consumption of 8.5 bcm/y in 2017 and expected consumption of 8.8 bcm in 2018 to 12.4 bcm/y in 2028 (Business Monitor International, 2019, p. 15).

Tab. 5.10: Natural Gas Demand Prediction for the Czech Republic

Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Consumption	8.8	9.0	9.6	10.3	10.7	11.0	11.4	11.7	12.1	12.4
Year on year % change	–	2	7	7	4	3	3	3	3	3

Note: figures in bcm.

Source: Fitch Solutions, 2019, p. 15

Aside from its use for heat and electric power generation, gas will be used mainly in transport. In 2018, there were 22,600 CNG vehicles in the Czech Republic[40] with consumption of 75 mcm/y (see CNG4you, 2019). The National Action Plan for Clean Mobility of 2015 predicts there will be 200 – 300 thousand CNG vehicles by 2030 under two scenarios[41]. This means approximately 450 – 680 mcm/y of gas consumption in 2030. The scenarios are based on the development of several aspects such as state support, taxation, infrastructure development etc. The same document expects there will be 1361 LNG vehicles with approximately 89.4 mcm/y consumption in 2030. (see Ministerstvo průmyslu a obchodu, 2015, p.49–51; 54).

When it comes to LPG, there are currently about 200 thousand LPG-powered vehicles in the Czech Republic (see Ministerstvo průmyslu a obchodu, 2015, p. 23). Nevertheless, LPG in the Czech Republic is really an oil product, since LPG production tied to natural gas extraction is basically non-existent in the country. Because of this, it is expected that LPG production will decrease together with petrol and diesel, i.e. conventional fuels. Further development of LPG as a fuel will thus not be supported by the state (see Ministerstvo průmyslu a obchodu, 2015, p. 45).

The draft Czech National Energy and Climate Plan submitted to the European Commission at the start of 2019 predicts that between 2026 – 2030, there will be 100 – 160 thousand CNG vehicles and 500 – 1000 LNG vehicles. The total consumption for gas-fuelled vehicles is expected to be 509 mcm/y. (see Národní klimaticko-energetický plán, 2018, p. 81) In 2018 there were approximately 6.6 million passenger cars, vans, and buses registered in the Czech Republic (see SDA, 2019), meaning that CNG vehicles currently represent 0.34% of the car fleet in the country. Thus even though the number of gas-fuelled vehicles is predicted to substantially increase compared to current levels, CNG and LNG vehicles will probably account for no more than 5% of the car fleet by 2030.

Besides consumption for transportation purposes, reasons for increasing demand for natural gas may emerge from the development of combined cycle and gas and combustion power plants (for currently planned projects see chapter 5.2.6). In 2017, the share of natural gas in the TPES was 16.7 % (see Ministerstvo průmyslu a obchodu, 2019, p. 16, 22) and the Updated SEP expects that by 2040, gaseous fuels will have an 18–25 % share in the Czech

40 There are basically no LNG-fueled vehicles in the Czech Republic. In 2018 there were, according to CNG4you, only 2 such vehicles (see CNG4you, 2019).

41 In the National Action Plan for Clean Mobility, four scenarios are presented in total. The data used here represents the results of scenarios 1 and 1A, which are labeled *optimistic* and *moderately optimistic*. The data from the other two scenarios was not used as it assumes the imposition of a 50 % and 100 % tax on gaseous fuels, which is unlikely considering the declared goals and ambitions of the state in the transport sector.

energy mix. At the same time, approximately 10.2 % of electricity was generated from gases, i.e. natural gas, biogas and other gases (see ERÚ, 2018b, p. 8), whilst the Updated SEC has set a range of 5–15 % for gaseous fuels for electricity generation by 2040 (see Ministerstvo průmyslu a obchodu, 2014, p. 44). This would suggest there is still some room to increase natural gas in both the energy mix and in electricity generation. Nevertheless, it is important to notice the term 'gaseous fuels' – in the end there may be an increase in biogas/biomethane and the use of natural gas might remain stagnant or even fall. The use of natural gas in general will depend on many variables which are hard to predict. In the Czech Republic, the development of other energy sectors[42] is crucial to the development of the gas sector. The same holds for development in renewable energy, because gas is a highly suitable fuel to accompany power generation from intermittent renewable sources (see chapter 5.5.2).

5.5 Current Issues and Projects in the Czech Gasworks Industry

5.5.1 The development of the Transmission System and of Cross-Border Interconnectors

Over the past decade, there have been several infrastructure projects planned and completed in the CEE region, including in the Czech Republic. (see Osička, Lehotský, Zapletalová, Černoch & Dančák, 2018; Osička & Ocelík, 2017; Mišík & Nosko, 2017) In September 2011, the first interconnection between the Czech Republic and Poland, called STORK, was commissioned (see NET4GAS, n.d.b.). NET4GAS, s.r.o. and the Polish transmission system operator GAZ SSYSTEM S. A. built a high-pressure gas pipeline that connects the Ostrava region to Cieszyn County in Poland. The pipeline is 32 km long and has a capacity of 0.5 bcm a year.

The Gazela gas pipeline project was the biggest gas pipeline project (with capacity amounting to approximately 33 bcm per year) that has had a direct impact on the Czech Republic during the last ten years. It is a direct extension to the planned German pipeline OPAL (Ostsee Pipeline Anbindungs-Leitung), which follows the Nord Stream project[43], bringing natural gas over the seabed from Russia's Vyborg to Germany's Greifswald.[44] The pipeline has a capacity of approximately 30 bcm/y and the route connects two border points, Hora Sv. Kateřiny and Waidhaus. The Gazela pipeline, 166 km in length, was put into operation in January 2013 (see "Plynovod Gazela startuje", 2013). Gazela pipeline supplies natural gas to southern and south-eastern Germany. Gas pipeline connections between former East and West Germany are markedly underdeveloped due to the separate development of the states during the Cold War. Thanks to this interconnection, however, the Czech Republic is connected to the so-called Northern Route. (see Jirušek, 2017, p. 207)

NET4GAS, s.r.o. currently plans two cross-border projects. The first of these will mark the first interconnection between the Czech Republic and Austria. The Bidirectional Austrian Czech Interconnection (BACI) will be a 61 km long (of which 12 km will cross the territory of the Czech Republic) gas pipeline that connects the Břeclav compressor station with the Baumgarten gas hub. Planned capacity is up to 6.57 bcm/y (see European Commission, 2017). This pipeline would enable further market integration and competition between the two countries. A final investment decision has not yet been taken (see NET4GAS, n.d.a). When built, BACI will represent competition for the Slovak transit gas pipeline owner Eustream, a. s. (see Petříček, 2009). Since 1 October 2018, the one-year pilot phase of the so-called Trading Region Upgrade (TRU) service has been ongoing. TRU is a special capacity product directly connecting the Austrian and the Czech gas markets through the existing Slovak transmission system. The Ten-Year Network Development Plan 2019–2028 states that the commissioning of BACI is to be postponed depending on the results of the pilot-phase of TRU (see NET4GAS, 2018, p. 50).

Another planned cross-border project is the Czech-Polish Gas Interconnector (CPI), a bi-directional gas pipeline connecting the Czech Republic and Poland. The project's aim is to increase transmission capacity between the neighbouring countries as well as to enable source diversification for the Czech Republic, since it will gain access to gas from the LNG terminal in Świnoujście and the planned Baltic pipe project. The CPI consists of two pipeline projects. The first is the STORK II pipeline connecting Libhošť in the Czech Republic with Kedzierzyn,

42 There are plans to build a new nuclear power plant. Then there is the issue of limits on coal production and the waves of decommissioning of several coal power plants in coming years. And finally, the development of renewable energy will be a determining factor.

43 The following companies are participating in the Nord Stream AG consortium: OAO Gazprom (51%), Wintershall Holding GmbH (15.5%), PEG Infrastruktur AG (PEGI/E.ON subsidiary; 15.5 %), N.V. Nederlandse Gasunie (9%), and ENGIE (9%).

44 Nord Stream is 1222 km long, with a capacity of 55 bcm/y, and OPAL 470 km long, with a capacity of 35 bcm/y.

Poland; the second is an intrastate pipeline called Moravia, connecting Tvrdonice and Libhošť. The pipeline is part of the north-south connection and would play an important role in the potential growing independence of the Czech Republic from eastern supplies. Commissioning is planned for 2022, but a final investment decision has not yet been taken. Both BACI and STORK II are currently part of the so-called North-South interconnection in central eastern and south-eastern Europe which is one of the priority infrastructure corridors in the EU. This gas infrastructure is to form regional connections and to enhance the diversification and security of the gas supply (see European Commission, n.d.b.). Historically, gas flowed almost exclusively in the east-west direction. Currently, aside from the fact that the flow has been reversed, the so-called Northern route, consisting of Nord Stream (and in the future Nord Stream 2) infrastructure, was created along with the Southern Gas Corridor, currently under construction.[45] Nevertheless the interconnections in the north-south direction (and the reverse) are weak and must be created or strengthened so that these new sources of gas can be evenly distributed throughout the EU.

The so-called Capacity4Gas project has several sub-projects whose general aim is an increase in the capacity of the Czech transmission network, thus increasing the security of gas supplies in the Czech Republic and the Central and Eastern European region. Among other things, the new gas infrastructure includes a new gas pipeline to connect the planned German EUGAL pipeline to the Czech transmission network, and a new compressor station (see NET4GAS, 2018, p. 53–54). The EUGAL pipeline will be connected to Nord Stream 2 at the Greifswald interconnection point. The Czech Republic, therefore, will be connected via a new gas pipeline on its territory and the EUGAL to Nord Stream 2 infrastructure; and similarly to the Nord Stream system through the Gazela and OPAL pipelines (see EUGAL, n.d.).

5.5.2 Decarbonisation of the gas sector

Natural gas has lower CO_2 emissions than coal and oil, but it is still a fossil fuel and still emits harmful emissions during burning and combustion. Thus, in the context of the energy, environmental, and climate policies and goals of the EU, especially for 2050, there is an ongoing debate about the future role of natural gas and gases in general.

According to some, natural gas should be used as a “bridging fuel” during the transition of energy systems. As stated above, natural gas has lower emissions than other fossil fuels. Gas power plants can be used as sources of dispatchable power complementary to intermittent renewable sources of energy. Considering that the generation of nuclear power plants is not easily made subject to regulation and that its future is unclear in the EU (especially in some countries), greater use of gas power plants becomes logical with a rising share of renewable energy in the energy mix. At the same time, unlike electricity, gas can be stored easily in existing underground gas storage facilities. Thus, sector coupling of the electricity and gas sectors could lead to optimizing the use of existing infrastructure as electricity cannot currently be stored cost-effectively. Technologies such as power to gas[46] could, again, provide flexibility to the electricity sector with a high share of renewable energy.

Nevertheless, opinions differ and some maintain that natural gas, as a fossil fuel, should be continually completely phased-out and to a certain extent replaced by bio-gases, bio-methane and/or hydrogen as soon as possible (Anderson, Broderick, 2017, p. 19, 46; ECOFYS, 2018, p. 2; Simon, 2019). These zero-emission gases could be transmitted within the already existing infrastructure, but especially in case of hydrogen the infrastructure would have to be adapted.

None of the scenarios or projects mentioned above can be described as the one that will be indisputably implemented in the EU or anywhere else in the world. Energy systems around the globe are undeniably in a process of transition. The concrete characteristics of these transitions will differ and will take place at a varying pace in different countries and regions. Also, concerned stakeholders looking out for their own interest will have varying outlooks on energy transition and the role of (natural) gas in the transition process. It is in any event a hot topic in the gas sector, since the outcome of the debate will decide the future of the entire sector over the long-term.

45 The Southern Gas Corridor is a new gas supply route to Europe. It will bring sources of gas from the Caspian region (and in the future possibly also from the Middle East or Central Asia) to Southern and South-Eastern Europe. The current Southern Gas Corridor infrastructure goes from Azerbaijan through Georgia, Turkey (TANAP pipeline), Greece, and Albania to Italy (the TAP pipeline). The whole infrastructure should be completed and put into operation by 2020 (see TAP AG, n.d.)

46 Power to gas (also P2G) is a technology in which electricity is transformed into gaseous fuels such as methane or hydrogen. Because storing gases is easier and more cost-effective than storing electricity, power to gas technology can be used when there is an excess of renewable electricity from intermittent sources such as wind and solar power plants. This renewable electricity is used to create hydrogen through electrolysis and then possibly methane through methanation. In other words, this renewable electricity is stored in a form of gas (hydrogen or methane) that can be used later, for example during peak demand.

5.6 Summary

The domestic gas transmission network is owned and managed by a strong private company, which invests in the maintenance and development of infrastructure as well as in new projects that enhance the security of natural gas supplies to the Czech Republic. Underground storage facilities that have a capacity of more than a third of Czech annual consumption are an important element in the security of gas supplies.

Most of the gas for the Czech Republic is provided with supplies on the basis of a long-term contract which provides stability and guarantees to both exporters and importers. The remaining gas supplies are secured by trading on the spot market, mainly in Germany. The geographical position of the country in providing gas transit to other European markets is equally important. With the commissioning of the Nord Stream and the upcoming commissioning of the Nord Stream 2 in 2019, the typical flow of gas has changed to an west-east direction. Therefore, the transit role of the Czech Republic is preserved, and while this position does not provide the country with any significant economic gains (although the money paid for transit goes to NET4GAS, s.r.o. and partly flows also to the State Treasury via taxation), it does strengthen the country's geopolitical role in Europe.

In the Czech Republic, natural gas is seen as an important resource that lowers dependence on oil as well as the share of coal in the TPES. The gas industry is currently being supported. The Czech Republic is thus heading towards more intensive use of natural gas while maintaining security and stability of supply. This increased awareness of the need for security not only pertains to projects related to natural gas, but is also a general trend in the Czech energy sector. When it comes to domestic consumption, most gas is used by industry, then by private households and, finally, in heat and electric power generation. The potential of natural gas lies mainly in the secondary regulation of the fuel and energy base for the coverage of fluctuations within the networks and in relation to renewable energy; in the long-term, the transport sector is also a promising area for growth. By following the established course, natural gas will, as part of the Czech fuel energy mix, become an even more important energy commodity in the future with a complete range of positive properties.

The synthesis and analysis of the information noted above allows us to make the following summary of the Czech gas industry regarding the security of gas supplies. The Czech Republic benefits from good transit diversification of supplies. The ongoing integration of the Czech pipeline network and the planned development of transit routes from/to resource regions in Northern (Nord Stream 1 and 2, Gazela, LNG Świnoujście) and Southern (Baumgarten, Southern Gas Corridor infrastructure) Europe will enhance the geographical diversification of supplies. The great capacity of reservoirs that are capable of covering as much as 37.5% of domestic gas consumption represents an important guarantee of consumer security should a crisis related to the reduction or restriction of supplies take place. A positive, not-insignificant impact on the security of gas supplies to the Czech Republic comes from the fact that not only has the country closed long-term supply contracts, it has also signed long-term agreements for transit through the Republic. The Czech Republic therefore remains an important transit country, while natural gas producers will continue using Czech territory for transit purposes. Another contributing factor is that the Czech Republic is a reliable, unproblematic transit country.

Long-term contracts with suppliers, however, limit liberalization efforts. If the greatest portion of natural gas is provided to the Czech Republic on the basis of long-term contracts, intrastate liberalization and the growth of new traders would de facto confront the fact that one and the same gas is being traded, only with more mediators in-between. Nonetheless, there are exceptions when traders arrange their own contracts for natural gas supplies from exporters. But the range of contracts is so insignificant that it has no significant impact on the gas market. Liberalization is further promoted and supported by the Czech National Regulatory Authority, the Energy Regulatory Office (ERÚ). Among other things, the ERÚ regulates transmission, distribution and gas storage fees, grants licences, and approves legislation and documents pertaining to the gas market.

Insignificant domestic production (app. 2%) means constant dependence on natural gas imports, with all the negative impacts that brings. If there is excessive extraction of natural gas at the expense of other energy resources, the Czech Republic will be even more exposed to the risk of natural gas price fluctuations tied to oil. Moreover, the risk of a potentially unbalanced energy mix and the impact of a potential curtailment of the natural gas supply will grow. A significant level of total import dependence also means an increase in Czech sensitivity to threats related to supply disruptions, fluctuations in energy commodity prices, and the increasing financial costs of ensuring sufficient energy materials.

The profile of the Czech Republic as a transit gas country will increase once the numerous infrastructural interconnecting projects with Austria (BACI project), Poland (increased connection with LNG Świnoujście via the Moravia and Stork II pipelines) and Germany (increased connection to the Nord Stream 2 Pipeline via the EUGAL and subsequent pipelines) will be completed. The Czech Republic will benefit from its strong geographical and geopolitical position within Central Europe. If the sector develops in the desired direction, one may expect growing transit dependence by other European countries on the Czech pipeline system. The result could be stronger support of Czech gas diplomacy for exporters, primarily the Russian Federation. The Czech Republic takes an active part in solving problems within the natural gas sector, both at the state level by providing sufficient political support for natural gas and at the EU level by providing relatively unproblematic implementation of EU legislation in acts and regulations. This approach has so far impacted positively on the development of the Czech gas industry. Its future development depends on the general development of energy in the Czech Republic and on the trend toward decarbonisation in the EU. Solving the issues in the nuclear and coal industries, as well as in renewable Czech industries, will have a crucial impact on the use of (natural) gas in the country. Next, the use of renewable gases (that would to a certain extent substitute for fossil gas), such as biomethane and hydrogen, could significantly alter the future development of the gas sector, as the arguments against using fossil fuels in a decarbonized energy system would no longer hold.

5.7 Sources

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Chapter 6: The Nuclear Sector

Tomáš Vlček, Tereza Stašáková

6.1 Nuclear Power Plants in the Czech Republic

After coal, nuclear energy is the second most important source of energy in the Czech Republic, generating base-load electricity. The annual production of nuclear power plants has been around 28–31 TWh since 2016, covering one-third of the country's total electricity production of 87 TWh. Nuclear energy also serves as an important emission-free form of energy and accounts for 80% of Czech emission-free electricity production.

There are two nuclear power plants in the Czech Republic, with a total of six pressurized reactors cooled and moderated by light water. The Dukovany nuclear power plant is located in the Vysočina region, with four VVER[1]-440 (V-213 type) pressurized water reactors. It first provided electricity in May 1985. The Temelín nuclear power plant is located in Southern Bohemia and has a pair of VVER-1000 (V-320 type) pressurized reactors. It was completed in December 2002. Both plants are owned by ČEZ, a. s. Both have undergone modernisation to increase their installed capacity, lifetime, and to heighten safety measures.

Tab. 6.1: Review of ČEZ, a. s. Nuclear Power Plants as of December 31, 2012

Locality	Blocks marked as	Installed capacity (MWe)	Type of reactor	Total installed capacity (MWe)	Total installed capacity (MWt)	Start up	Distribution company	Voltage (kV)	Distribution point
Dukovany Nuclear Power Plant	1	510*	VVER 440, V 213 type	2,040	5,776	1985 – 1988	ČEPS	400	Slavětice
	2	510	VVER 440, V 213 type						
	3	510	VVER 440, V 213 type						
	4	510	VVER 440, V 213 type						
Temelín Nuclear Power Plant	1	1,082**	VVER 1000, V320 type	2,164	6,240	2000–2002	ČEPS	400	Kočín
	2	1,082**	VVER 1000, V320 type						

* In May, 2012, all units at the Dukovany power plant were modernized, boosting its installed capacity from 4 × 440 MWe to 4 × 510 MWe.

**In 2013, the Temelín power plant underwent modernization that placed its capacity at the 2 × 1,055 level. Since September 2014, the first block's capacity has been increased to 1,078 MWe. A further modernisation was undertaken in 2018, when installed capacity was increased to 1,082 MWe depending on circumstances (such as, for example, the temperature of the cooling water). Another capacity increase is planned for 2020.

Source: Energetický regulační úřad, 2010b, p. 89; revised and modified by T. Vlček.

1 VVER means water cooled, water moderated energy reactor (or water – water energy reactor), in Russian Vodo-Vodyanoi Energetichesky Reaktor.

6.2 Deposits, Mine Production, Companies and Traders

Uranium mining has a long history in the Czech Republic. Until April 27, 2017, it was one of the last European countries to mine uranium. All seven registered deposits are now closed, with the Rožná Deposit being the last to go. The only company engaged in uranium mining was DIAMO, s. p. (a state enterprise[2], until May 1, 1992, known as the Czechoslovakian Uranium Industry, State Enterprise).

DIAMO was founded in 1946, and was under the full control of the Ministry of Industry and Trade of the Czech Republic. Now that mining has come to a close, DIAMO offers other services connected to mining, specifically, remediation work, neutralization of the consequences and impact of mining and the processing of uranium ores, base metals and coal, and the technical and biological recultivation of devastated properties after decommissioning (see *DIAMO, s. p.*).

The Czech Republic was formerly one of the leading world producers of uranium. Between 1946 and 2009, its production of almost 111,000 tonnes of uranium in the form of sorted ores and chemical concentrates made it the 9th largest producer in the world. Without doubt the dominant source of uranium was the Rožná deposit in Dolní Rožínka. The Rožná mine was supposed to be shut down in the mid-1990s, when uranium sales experienced a crisis when a previously significant customer, Slovenský energetický podnik, š. p. (later Slovenské elektrárne a. s.), refused to purchase Czech uranium and started obtaining enriched nuclear fuel directly. Governmental Decrees from 1994, 1997, 2000, 2002, 2005 and 2007 gradually prolonged the mining period in Dolní Rožínka, while with Decree No. 1086 on December 22, 2014, the government extended the mining and processing of uranium in the deposit for as long as it was economically efficient[3], and the termination of mining was pegged to the results of a profitability assessment[4]. After its closure, there are still around 112,000 tons of un-extracted uranium, mostly in Liberecký region and Vysočina region. But most likely uranium mining will not be renewed, because it is not currently economical. The contemporary global uranium market is large enough to cover demand. The Czech contribution to global production was minimal, decreasing from 1.3% in 2003 to 0.1% in 2017.

Tab. 6.2: Deposits, reserves, and mine production of uranium in the Czech Republic

	2011	2012	2013	2014	2015	2016	2017
Deposits – total number	7	7	7	7	7	7	5
– exploited	1	1	1	1	1	1	1
Total mineral reserves	135,276	135,214	135,144	135,071	135,037	135,015	134,948
– economic explored reserves	1,406	1,323	1,327	1,321	1,330	1,337	1,300
– economic prospected reserves	19,402	19,458	19,427	19,463	19,448	19,448	19,448
– potentially economic reserves	114,468	114,433	114,391	114,287	114,259	114,230	114,200
– exploitable (recoverable) res.	338	312	284	314	308	313	276
Mine production	252	222	232	165	134	128	56
Production of concentrate	216	219	206	146	122	137	59

Note: reserves, mining and the production of uranium concentrate expressed in tonnes; the production of uranium concentrate resulting from remediation works is not included in these values.

Source: Ministerstvo životního prostředí / Česká geologická služba – Geofond, 2012, p. 102; Ministerstvo životního prostředí / Česká geologická služba – Geofond, 2018, p. 172.

The processing of uranium ore consists of several steps. First it must be cleansed of waste rock (clean uranium in the Czech Republic accounted for an average of 0.16% of uranium ore[5]). The cleaned ore is then grounded and, following chemical treatment with sulphuric acid, processed into uranium concentrate – triuranium octoxide

2 The term DIAMO is an abbreviation for ammonium diuranate, in Czech *Diuranát amonný*.

3 According to its methodology, the International Agency for Atomic Energy considers economically efficient such mining as does not exceed a cost of 130 USD per to mine 1 kg of uranium.

4 DIAMO, s. p., carries out a mining profitability assessment every half year, and when it reaches negative figures, activity will be immediately terminated. Mining can be ended in several months on a regular basis, while remediation can, however, last for decades.

5 In the mid-19th century, when uranium mining was first initiated, uranium ores consisted of 65% uranium (see Majer, 2004, p. 183).

U_3O_8 (or yellow cake[6]). DIAMO's intermediate product was purchased by ČEZ, which was one of DIAMO's exclusive users of uranium concentrate. Domestic production, however, did not satisfy ČEZ's demand, and so the company either bought additional supplies on the world market or directly purchased enriched fuel.

At the start of 2000, domestic mining covered approximately 93% of domestic demand. However, as a result of the inhibition program, only around a third of consumption was provided by DIAMO until 2009, with the remaining supplies bought on the global market in the form of a concentrate of previously enriched fuel (see Ministerstvo životního prostředí / Česká geologická služba – Geofond, 2010, p. 200). Since the end of 2009, when the Russian company OAO TVEL began supplying fuel for both the Dukovany and Temelín nuclear power plants, ČEZ has purchased only the final product, enriched fuel, while DIAMO has sold its domestic production on the global market.

Tab. 6.3: Uranium Futures Price of Uranium Concentrate (U_3O_8)

2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
113,41	96,63	140,84	115,32	94,25	77,63	79,65	76,32	48,70	53,35	61,75

Note: Values always as of January of the particular year. Data indicated in USD per kilograms.

Source: indexmundi.com, tradingeconomics.com, calculated by T. Stašáková.

When ČEZ began to make exclusive use of purchased concentrate following the shift to uranium hexafluoride UF_6, it had to seek out processing plants on the global market that could perform enrichment services. These can be obtained in only nine countries in the world[7], and ČEZ bought from France. Enrichment plants are capable of enriching supplied uranium hexafluoride according to the client's requirements. Uranium has a constant ratio of isotopes: 99.284% ^{238}U, 0.711% ^{235}U, and 0.005% ^{234}U. However, it is isotope ^{235}U that is employed in fission reactions and used in the nuclear industry. Enrichment is a process during which uranium gets a greater concentration of the ^{235}U isotope at the expense of ^{238}U, varying, for Czech civilian nuclear needs, between 3.6 and 4.4%.[8] From the point of mining through to enrichment, the volume of exploitable uranium rapidly declines in this manner. For initial processing, only 0.16% of mined material is employable, while during the enrichment process at the level of approximately 4% ^{235}U, the volume of material lessens eight to eight-and-a-half times. In the case of uranium this is nevertheless an enormous energy density, since 1 kg of nuclear fuel generates 2,100 GJ of energy compared to 0.033 GJ for coal[9] (see "*Fyzikální aspekty,*" 2008, p. 24).

Enrichment is followed by fabrication, where fuel gets processed into pellets (roughly 1 cm in diameter and height) which are then fitted into fuel rods[10], a specific number of which are then placed into fuel assemblies (segments, cassettes[11]). In the active zone of each reactor in the Dukovany nuclear power plant, there are 312 fuel assemblies, each weighing 215 kg and consisting of 137 kg UO_2 in 126 fuel rods, while the Temelín nuclear power plant has 163 fuel assemblies (cassettes) in each reactor, each weighing 766 kg and consisting of 563 kg UO_2 in 312 fuel rods (each rod consists of approximately 370 pellets). In the active zone of one unit of the Dukovany nuclear power plant, there is, therefore, 42.7 tonnes of UO_2 fuel, and 91.8 tonnes in one unit of the Temelín nuclear power plant. The fuel made in this manner is then supplied to the client, ČEZ.

6 Yellow cake does not always have a consistent chemical formula U_3O_8 or yellow colour. It got its name from the appearance of uranium concentrate in the early mining and production period. Yellow cake now tends to be brown or black, but U_3O_8, for example, has an olive-green colour. The chemical formula of yellow cake can take forms such as: U_3O_8, UO_2, UO_3, $(NH_4)_2U_2O_7 \times n\ H_2O$ or $Na_2U_2O_7 \times 6\ H_2O$. Yellow cake is transported in blue barrels.

7 Sorted by capacity, the order is: Russia, the USA, France, Canada, the Great Kingdom, China, Iran, Brasil and Argentina. But in all 12 countries are internationally recognized by the nuclear industry as holders of uranium enrichment facilities with different industrial production capacities, adding Pakistan, Netherlands and Germany (see INB 2018; WNFF 2018).

8 The Dukovany plant has always used fuel supplied by the Russian company OAO TVEL, which went through major developmental changes. Initial fuel with 3.6% ^{235}U enrichment was employed in a three-year cycle, with an average calorific value of 30 MWd/kg U. A gradual improvement brought the plant to the zone of low neutron spillage and 3.8% ^{235}U enrichment. In the further phase, enrichment was lifted on 4.25 resp. 4.38% ^{235}U, while a burning absorber started to be used in the fuel cassettes (see ČEZ, a. s., 2010b, p. 31) lowering fuel reactivity.

9 Calculated by T. Vlček.

10 The length of a fuel rod for the VVER 440 reactor is 242 cm.

11 Cassette is a Russian term for a fuel assembly.

The long-term permanent fuel supplier for the Dukovany plant is the Russian company OAO TVEL, which fabricates the fuel and also provides a comprehensive array of conversion and enrichment services under contract (ČEZ, a. s., n. d.). From 2002, when the plant was launched, to the end of 2009, fuel for the Temelín nuclear power plant was supplied by Westinghouse Electric Company, LLC[12]. In 2010, the selection process for a new supplier was won by the Russian company OAO TVEL, which submitted the best offer from a financial standpoint. The result is that until 2023, OAO TVEL will be the exclusive fuel supplier for both Czech nuclear power plants. Despite the contract, there have been changes to the fuel supplied as ongoing research brings some innovations to the field. Since 2018, OAO TVEL has supplied Czech nuclear power plants with a new type of fuel (Gd2M+) said to be more mechanically resistant and which allows for longer fuel-campaigns, since enrichment levels are slightly higher and the overall amount of uranium is also increased. Also, six new fuel assemblies (LTA – Lead Test Assemblies) from Westinghouse Electric Sweden have been in testing at Temelín NPP since March 2019 as a preparatory step for testing compatibility with the potential supplier before signing a new contract. Licensing this new type of fuel took Westinghouse three years (see ČTK, 2019).

Fuel was formerly delivered to the Czech Republic by air from the USA or Russia[13]; at present, it is also transported by air from the Russian Federation and then by railway to the target power plants[14].

6.3 Spent Fuel and the Nuclear Waste Repository

Fission chain reaction transmutes the uranium isotope ^{235}U. Spent fuel contains approximately a quarter of the original value of that isotope, which means that it remains enriched at a level of around 1% ^{235}U. Spent fuel consists of around 95% of uranium dioxide (UO_2) and of newly emerged ingredients of plutonium oxide (PuO_2) amounting to approximately 1%, along with other compounds (4%)[15], whereas the majority of fission products are highly radioactive isotopes (see Laciok, Marková & Vokál, 2000, p. 190; Otčenášek, 2005, p. 536, adjusted by T. Vlček). Fuel assemblies with spent nuclear fuel that are removed from reactors look like fuel assemblies with fresh fuel. Nuclear reactions take place even after the fuel is discharged from the reactor, as well as the release of alpha, beta and gamma radiation, neutrons, and heat, which must be exhausted out in a controlled manner.

The Dukovany nuclear power plant initiated operation on the basis of a three-year fuel cycle. The increase of ^{235}U's share in cassettes enabled it to reach a full five-year cycle (with a six-year cycle under consideration). Currently, this means that during the annual refuelling, only 1/5 of the spent fuel is replaced out of the overall charge, i.e. 72 fuel assemblies (see ČEZ, a. s., 2010a, p. 31).

The active zone at the Temelín nuclear power plant includes 163 fuel assemblies, while the plant's operation is set on a four-year fuel cycle, meaning a quarter of the spent fuel is replaced each year, i.e. 41–42 fuel cassettes (see ČEZ, a. s., n.d.a).

After removal from the reactor, three phases of fuel deposition follow. The first phase includes the collection of spent fuel after its removal from the primary circuit and subsequent cooling until it reaches treatable form. The second phase includes safe transport to the location of final waste deposition. The third phase, deposition, is understood as the final operation, which is why the depository needs impenetrable protection shields (see Marek, 2007, p. 4).

In *the first phase*, fuel elements are actively cooled in a spent fuel pool next to the reactor. After a minimum five years, they are moved into dry containers and then passively cooled in interim storage. After being removed from the reactor, the thermal capacity of spent nuclear fuel in the Dukovany plant is 223.5 kW and then drops to 1 kW over the course of only one year (see Nachmilner, 2002, p. 12). The Dukovany power plant uses CASTOR 440/84[16]

12 Temelín NPP experienced massive malfunctioning related to the geometric stability of this fuel, which eventually led to the premature unloading of all of Westinghouse's fuel assemblies despite financial losses, and replacement with TVEL fuel. Problems with fuel also occurred in Ukraine to a lesser extent, but still enough to cause a lengthy unscheduled outage at two of the units, which eventually led to technological adjustments to the fuel and consequent relabeling to Robust (TVS-RW). (see Vlček 2016, p. 81)

13 In the 1990s, transport by sea via the Polish port Gdańsk (from Russia) and then by railway to the final destination was also considered.

14 In Dukovany's case, for example, a cargo plane lands at Brno Tuřany International Airport, goes through the requisite customs and technical inspections and is then loaded onto the wagon for transport to the power plant under police escort.

15 Exact numbers depend on the level of original fuel enrichment.

16 Or modernized Castor 440/84M.

containers, which were formerly supplied by the German Consortium GNS Gesellschaft für Nuklear-Service mbH and RWE Nukem GmbH,[17] but are now supplied by Škoda JS. A simple calculation based on this data leads to the conclusion that the Dukovany power plant produces less than a container of spent fuel per year. An empty container weights 93.7 tonnes and 116.1 tonnes when filled.

There are two interim storage facilities for spent fuel at the site of Dukovany nuclear power plant. The total capacity of the original Dukovany storage, opened in 1995, amounts to 600 tonnes of spent fuel stored in 60 CASTOR 440/84 containers. In 2006, once this storage capacity had been completely used, new storage was set up with a capacity of 1,340 tonnes of spent fuel. In comparison to the first storage facility, the newer facility contains approximately twice the capacity. The storage portion of the facility can receive 133 CASTOR 440/84M containers, allowing the Dukovany plant to store spent fuel for 50 to 60 years, that is, for a period exceeding the lifespan of the power plant itself[18] (see ČEZ, a. s., n.d.d; Marková, 1996, p. 626–627).

The Temelín nuclear power plant uses CASTOR 1000/19 containers from the original German supplier and from Škoda JS[19]. These are 5.5 metres tall and when filled weigh approximately 116 tonnes. The Temelín power plant produces two full containers and 3–4 fuel assemblies of the third container of spent fuel per year. In 2010, a new interim storage facility was opened with a capacity of 1,370 tonnes (152 CASTOR 1000/19 containers).[20] The capacity of a dark wet pool for spent fuel is 680 fuel assembly places and 25 places for hermetic cases. Spent fuel may thus be stored in the pool for around ten years, which is why interim storage did not prove necessary before 2010. The Skalka facility for the central dry storage of nuclear fuel in the vicinity of Bystřice nad Pernštejnem was built as backup storage, with an overall capacity of approximately 2,900 tonnes of fuel.

The second phase, transportation, is currently by rail and is subject to very strict monitoring by the State Office for Nuclear Safety. It is likely that spent fuel will also be transported by rail for a few decades if deposited in deep geological repositories. This, however, cannot be claimed with certainty because it will depend on available technologies as well as the locality and access to the future deep geological repository. Fuel is stored in dry interim storage for a period of approximately 80 years. The final deep geological repository (*third phase*) in the Czech Republic will not be available before 2065.

There are three surface repositories in the Czech Republic: the Richard Radioactive Waste Repositories near Litoměřice, Bratrství near Jáchymov, Dukovany, and one closed repository, Hostim near Beroun[21]. These repositories store institutional radioactive waste that comes from medical, industrial, agricultural and research activities and is therefore composed of waste containing natural radionuclides and low-activity radioactive waste from nuclear power plants. One deep geological repository is planned as well.

In 1990–2005, the SÚRAO (Radioactive Waste Repository Authority)[22] originally selected 27 potential localities for building a deep geological repository of radioactive waste. It narrowed them down to 13, then to 11, and finally to the current 9: Březový potok near Pačejovo, Čertovka near Lubence, Horka near Budišov, Hrádek near Rohozná, Čihadlo near Lodhéřov, Magdalena near Božejovice, Kraví hora near Moravské Pavlovice, Janoch near Temelín, and Na Skalním near Dukovany.

But construction has lagged behind schedule. The original plan consisted of four phases: starting with a basic land survey and research phase from 2010–15, a second exploratory phase from 2015–25, and a third detailed exploratory phase from 2025–50. After postponements, four candidate localities were to be chosen in 2018; one is

17 Spent nuclear fuel from the Dukovany nuclear power plant used to be transported to an interim storage site at the Jaslovské Bohunice nuclear power plant in Slovakia. From this location, it was meant to be used up gradually on the basis of an interstate agreement with the Soviet Union. Following the demise of the Soviet Union, the Russian Federation, however, withdrew from these commitments. After 1993, nuclear fuel from Dukovany was brought back to the country and placed in interim storage at the Dukovany plant.

18 The present power plant was licensed only until 2025. The first unit received a prolongation for 10 years and the second unit for an indefinite duration, conditioned upon the submission of regular reports. But Dukovany´s shutdown is expected by 2045 at the latest.

19 CASTOR 440/84 and CASTOR 1000/19 containers are presently produced in the Czech Republic as well. Their licensed producer is Škoda JS, a. s.

20 In addition to the Dukovany and Temelín power plants, another high-activity radioactive waste repository is operated by ÚJV Řež, a. s., where there are two research nuclear reactors in operation (LVR-15 and LR-0). The capacity of the high-activity radioactive waste repository in Řež is substantially lower, as the ÚJV produces only about 15 spent fuel segments per year. In 2007, all waste was transported to the Russian Federation, so this repository is currently empty.

21 The repository was closed in 1997 and has been monitored since.

22 Due to the transience of private companies, the final radioactive waste repository is not ČEZ's but the state's responsibility under Decree No. 263/2016 (the Atomic Law).

to be selected by 2025 as the new location for the repository, with a second chosen as a backup (MPO 2018). But at the end of 2018, the decision was postponed once again and, according to SÚRAO, will be decided in the first half of 2020. After obtaining adequate data to prove the safety of locality finally chosen, submission of the application for a construction permit for a deep geological repository will follow, with construction to take place in 2050–65 (see Správa uložišť radioaktivních odpadů, n.d.). When this period has ended, it will also be decided whether to process spent fuel from nuclear power plants and to use it as energy material for the production of new fuel, or if it is to be permanently stored in a deep geological repository.[23] But the process has so far been delayed, particularly when it comes to shortlisting potential locations.

Obstacles for the deep repository are several. First, the localities chosen are close to populated areas, which means 53 municipalities involved in the discussion of the deep nuclear repository. None of them is willing to accept the repository. Quite the contrary: most have started movements[24] against it or organized protests (see Ocelík et al. 2017). One of the main arguments is that the government does not provide enough information or guarantees. It is also seen as a danger to the local environment. Second, there is a criticism towards procedure of the State and the SÚRAO[25]. Third, the political situation is unfavorable. The issue incurs into the discussion of constructing a new nuclear power plant in the Czech Republic and, most importantly, its financing. Finally, there is the economic side of the repository. Plans call for construction to cost CZK 36.7 billion. Together with operating costs and containments, the price tag will reach CZK 111.4 billion[26] (see MPO 2017, p. 42), while the very future of nuclear energy, especially in Europe, remains uncertain.

Processing of nuclear waste is currently technically, energetically, and financially a costly process, one few countries[27] can afford, but the technology and initial costs could change over the next 50 years to bring it within broader reach. A deep geological repository is meant to be a final repository of spent nuclear fuel. It is questionable whether it should be technologically implemented so as make it impossible for already deposited waste to ever be picked up again or to enable deposited waste to be extracted and processed in the distant future. Even though experts incline to the second alternative, because spent nuclear fuel represents a valuable material that can be used as fresh fuel after being processed or even as fresh fuel without previous processing[28], the economic reality is in favour of the first alternative. The most expensive feature of a repository is its operation, which makes it economically infeasible to keep a repository open for decades. This means it is better to store spent fuel on a long-term basis in interim storage facilities and only when so decided, to deposit high-activity radioactive waste at once, and to do so finally (opening the storage facility and using it again would be impossible). A deep geological repository is constructed under the assumption it will work for the next hundred years.

So far there is only deep geological repository of spent fuel under construction in the world. That pioneer project is in Finland, where the first waste management program was initiated in 1983. In 1987, the final disposal of used nuclear fuel was included in the Nuclear Energy Act. Final disposal is managed by Posiva Oy. Following the Government's 1983 policy decision on used nuclear fuel, site selection and environmental impact assessment work was carried out. And four locations were chosen and investigated by Posiva Oy (see WNA 2019). The government approved the project in 2000 and it was ratified by Parliament in 2001. The project has strong local community support. Construction started in 2004, with licensing expected in 2020. The first nuclear waste will be stored in 2023–25 (see WNA 2019).

23 Constructing a deep geological repository is a complicated process that requires sure data about the locality. In terms of radioactivity, spent fuel becomes safe at least 300 years after its removal from a reactor, which is accordingly the period for which a repository must function without difficulty. 300 years is the period of time during which radioactivity decreases to the values of normal radiation in nature. It is also noteworthy that spent fuel is essentially safe from abuse, because to remove it from the protective containers would, during this period, mean a deadly dose of radiation.

24 One of the most important is Platforma proti hlubinnému uložišti, involving 31 municipalities and cities and 14 movements.

25 For example, the dispute from 2017, when SÚRAO wanted to continue in exploratory activities, even though they were authorised to do so only until the end of 2016 (see ČTK iDNES.cz 2017; Lejtnarová 2017).

26 The price of the final waste repository in Finland is estimated at around €3.3 billion for waste from five nuclear reactors. The operation cost will be around another €2.4 billion and decommissioning around €200 million (see WNA 2019).

27 In 2019, this was China, France, the Great Britain, India, Japan, Pakistan, Russia and the USA.

28 Some current fourth generation reactor projects, such as the Fast-Neutron Reactors (also known as Breeders), plan to use previously spent fuel as a fuel.

The owner of spent nuclear fuel in the Czech Republic is ČEZ. It is responsible for storage only, with the final deposition being the responsibility of the state. This was the purpose of founding the Radioactive Waste Repository Authority, which on the basis of the Atomic Act is responsible for treating spent or radioactive fuel into a form adequate either for deposition or for further use. When to deliver spent nuclear fuel to the state is exclusively up to ČEZ. So far, it is not radioactive waste but potentially exploitable material that is involved (see Laciok et al., 2000, p. 190–191).

Tab. 6.4: Scheme of the End of the Nuclear Cycle in the Czech Republic

Spent fuel dwell	App. 5–13 years	App. 80 years	Permanently or until potential reprocessing
Location	Spent fuel pools in the Dukovany and Temelín nuclear power plants	Storage in the Dukovany and Temelín nuclear power plants, backup repository Skalka	Deep geological repository
Responsible	ČEZ, a. s.		SÚRAO
Supervised by	State Office for Nuclear Safety		
Financial means	Corresponding budget ČEZ		Nuclear account (ČEZ contributions)

Source: Otčenášek, 2005, p. 540; modified by T. Vlček.

ČEZ finances the deposition of spent fuel out of its own budget, while the Radioactive Waste Repository Authority (SÚRAO) finances its activities from the nuclear account kept in the Czech National Bank and administered by the Ministry of Finance. The nuclear account is a financial account contributed to by all producers of radioactive waste in the amount laid down in Part V of the Atomic Act , which establishes the amount of the levy and the manner of its payment by radioactive waste agencies to the nuclear account and the annual amount of the contribution for municipalities, as well as the rules for permits to be granted. ČEZ, for example, pays CZK 55 for each MWh produced in nuclear power plants, while other producers of radioactive waste pay CZK 33,189 for each barrel of 200 l, which is the basic depositing unit in repositories. At the end of 2018, there was approximately CZK 28.4 billion on the nuclear account (SÚRAO, n.d.). Besides payments to the nuclear account, each operator of a nuclear facility in the Czech Republic runs an individual financial reserve for dismantling and remediation of that facility, as prescribed under the Atomic Act.

The warranty for temporary deposits of spent fuel is, therefore, provided by ČEZ until the fuel is delivered to the Radioactive Waste Repository Authority. At that point, the state assumes responsibility.

6.4 The Regulatory and Safety Framework of the Nuclear Industry

The key document for the Czech nuclear sector is unquestionably the Atomic Act (Act No. 263/2016 Coll.), which entered into force on 1 January 2017, amending the Act of January 24, 1997 on the Peaceful Use of Nuclear Energy and Ionizing Radiations (the Atomic Act), amended on 1 July 2017, 183/2017 Coll. Also relevant are Act No. 19/1997 Coll., Act No. 281/2002 Coll., and Act No. 44/1988 Coll. on the protection and utilization of mineral resources (The Mining Act) (see "Zákon č. 44/1988 Sb.").

The Atomic Act regulates basically all aspects of not only the nuclear industry, but of ionizing radiation in general, which includes the regulation of the method of utilizing nuclear energy and ionizing radiation and conditions for the performance of practices related to nuclear energy utilization and radiation-producing activities, conditions for the safe management of radioactive waste, the performance of state administration and supervision within nuclear energy utilization, within radiation activities and over nuclear items, etc.

The Mining Act, by contrast, treats uranium mining and, as in the case of coal, it is the Czech Mining Authority and District Mining Authorities who oversee mining activity, observe working conditions, manage mining waste and supervise adherence to Acts Nos. 44/1988 Coll., 61/1988 Coll. and 157/2009 Coll. and other regulations (see Státní báňská správa České republiky).

Section II, Part IV of The Atomic Act commissions the State Office for Nuclear Safety (SUJB) to carry out the public administration and supervision of nuclear energy and ionizing radiation use for radioactivity and nuclear, chemical and biological protection. The SUJB is the central organ of public administration subordinated to the Government, which means that the regulatory role in the nuclear industry is held strictly by these two bodies, the Government and the SUJB.

The SUJB implements the regulation process through decrees, addressing the physical protection of nuclear materials and facilities; then quality in nuclear energy use and radiation-generating activity, the criteria for facilities and the distribution of selected facilities across safety categories as well as criteria for siting nuclear facilities and of sources of significant ionizing radiation. It furthermore treats the issue of radiation protection and the emergency preparedness of nuclear facilities and workplaces exposed to sources of ionizing radiation. The SUJB is responsible for the functioning and organization of the National Radiation Monitoring Network. Organization of the National Radiation Monitoring Network as amended by Decree 360/2016 Coll. currently consists of 495 different monitoring points (the early warning network, thermoluminescent dosimeter networks, and the air contamination monitoring point network), 12 laboratories, and a range of mobile groups (see *Státní ústav radiační ochrany, v. v. i.*).

Tab. 6.5: Regulatory and Safety Bodies for the Czech Nuclear Sector and Their Role

Body	**State Office for Nuclear Safety (SÚJB)**
Headquarters	Prague, Senovážné namesti 9
Web	www.sujb.cz
Role	Its scope of authority, given under the Atomic Act No. 263/2016 Coll., Act No 19/1997 Coll. and Act No. 281/2002 Coll., among others, includes the state supervision of nuclear activity and items, the physical protection of nuclear facilities, radioactivity protection and emergency preparedness at nuclear facilities and work sites with sources of ionizing radiation; issuing authorizations for activities governed under Act No. 18/1997 Coll., for example, the siting and operation of nuclear facilities and work sites exposed to sources of high-level ionizing radiation; the management of sources of ionizing radiation and radioactive waste; transporting nuclear materials and radionuclide emitters; and approving documentation with reference to nuclear safety and radioactivity protection set by the Atomic Act; to limits and terms of nuclear facility working procedures, the means for assuring physical protection, emergency rules for the transportation of nuclear materials and particular radionuclide emitters, internal emergency plans of nuclear facilities and workplaces exposed to sources of ionizing radiation; monitoring the level of radiation affecting residents and workers utilizing sources of ionizing radiation; working together competently with the International Atomic Energy Agency; coordinating and securing activities while following the mandates of the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction within the meaning of Act No. 19/1997 Coll. and from the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction within the meaning of Act No. 281/2002 Coll., as well as performing the function of a national authority according to the Comprehensive Nuclear Test Ban Treaty, from the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction, and the Convention on the Prohibition of the Development, Production and. Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction.
Organ	**The National Institute for Nuclear, Chemical and Biological Protection (SÚJCHBO)**
Headquarters	Milín, Kamenná 71
Web	www.sujchbo.cz
Role	The National Institute for Nuclear, Chemical and Biological Protection is a public research institution founded by the State Office for Nuclear Safety on the basis of Act No. 281/2002 Coll. aimed at providing research and development activity involving chemical, biological and radioactive substances, ensuring the safety of technical support for the supervision and inspection work performed by the Office in radioactivity protection and monitoring the ban on the development, production, stockpiling and use of chemical and biological weapons. Research activity targets the identification and quantification of radioactive, chemical, and biological materials and assesses their impact on people and the environment, including the assessment and development of individual and collective means of human protection from these substances, and decontamination and safety research as part of the fight against terrorism and protecting against severe industrial accidents.
Organ	**National Radiation Protection Institute (SÚRO)**
Headquarters	Prague, Bartoškova 28
Web	www.suro.cz

Role	The main subject of the Institute's activity is research into protection from ionizing radiation, including the infrastructure of this research, specifically in the fields of safety research, research into the Radiation Monitoring Network and research into exposure to artificial sources of ionizing radiation (nuclear facilities foremost), research into medical exposure and research into exposure to natural sources of radiation. Other activities include supporting state supervision and monitoring prevention efforts, and supporting inspectors in their monitoring work in radiation protection and emergency preparedness, including departures and interventions, serving as an analytical and conceptual site for the analysis of impact following nuclear and radioactive accidents, drafting measures, and providing advisory and consulting services, education and public enlightenment, etc.
Organ	**Radioactive Waste Repository Authority (SÚRAO)**
Headquarters	Prague, Dlážděná 6
Web	www.surao.cz, www.rawra.cz
Role	The Authority's major tasks and activities are to prepare, construct, operate, initiate, and shutdown radioactive waste repositories and to monitor their environmental impact; to ensure that spent or radioactive nuclear fuel is processed into a form adequate for depositing or further use; to keep records of received nuclear fuel and of fuel producers; to manage levies of radioactive waste sources on the nuclear account; to prepare proposals with reference to the establishment of payers' levies on the nuclear account; to manage radioactive waste brought to the Czech Republic from abroad that cannot be returned, etc. Since 2000, it has regulated all radioactive waste repositories in the Czech Republic: Richard, Brotherhood, Dukovany, and Hostim. It coordinates all work aimed at preparing and constructing a deep geological repository of high-activity radioactive waste and spent nuclear fuel, the launch of which is estimated in around 2065.

Sources: *Zákon 458/2000; Zákon ze dne 24. ledna 1997; Státní úřad pro jadernou bezpečnost.; Státní ústav radiační ochrany, v. v. i.; Správa úložišť radioaktivních odpadů*; composed by T. Vlček.

The SÚJB is the founder of two public research institutes, namely the National Institute of Nuclear, Chemical and Biological Safety (SÚJCHBO) and the National Radiation Protection Institute (SÚRO). Their role is not regulatory, but they play a vital role in protecting against ionizing radiation. The Radioactive Waste Repository Authority (SÚRAO) has a similar protective role.

The important agents at the level of the supranational legal framework are the European Atomic Energy Community (EURATOM) and the United Nations mediated by the International Atomic Energy Agency (IAEA).

EURATOM was founded on March 25, 1957 in Rome and it has its headquarters in Brussels. Given that nuclear safety, naturally, represents one of the priority fields of EURATOM, it issues a vast number of directives and recommendations aimed at unifying the practice of radiation protection in all member states, and the directives cover radiation protection in comprehensively, from basic principles and medical use of radioactive materials through to the transport of radioactive substances. These directives were implemented in the Czech legal framework on the *acquis communautaire* basis either through the Atomic Act amendments or SUJB decrees.

The most complex legislative changes imposed from the outside took place as a result of the accession negotiations of the Czech Republic to the European Union, on which occasion a White Paper of the European Commission on Preparing the Associated Countries of Central and Eastern Europe for Integration into the Internal Market of the Union was adopted in 1995 (see Commission of the European Communities, 1995). The White Paper brought several important directives with reference to the nuclear energy field: the Directive on shipments of radioactive waste No. 92/3/EURATOM, supplemented by Directive No. 93/552/EURATOM (both were then altered by Directive No. 2006/117/EURATOM), the Directive on basic safety standards No. 96/29/EURATOM (later altered by 2013/59/EURATOM), referring to maximum permissible doses of radioactive contamination of food arising after a radioactive emergency (accident), the import of agricultural products following the accident in Chernobyl and shipments of radioactive materials. Besides the White Paper, the Czech Republic also adopted a string of directives addressing the radioactive protection of the public, workers, patients and the information standard for residents.

The IAEA emerged on June 29, 1957, in Vienna, which is also its current location. The former Czechoslovakia was a member from the Agency's founding, while the Czech Republic joined on January 1, 1993. The Mission of the Agency is to enforce the safe and peaceful use of nuclear technologies. Unequivocally the key bearer of this mission is the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which entered into effect on March 5th, 1970 and was prolonged in 1995 for an indefinite period. With respect to nuclear safety, one of the goals of the Treaty is monitoring and cooperation in peaceful nuclear activities (see Závěšický 2005, p. 132). IAEA is the exclusive monitor in the field of the peaceful use of nuclear energy, resting on a unique monitoring mechanism based on the political will of states to make their nuclear facilities available for monitoring. By doing so, states demonstrate that they have fulfilled their obligations under the Non-Proliferation Treaty and its additional protocols.

By its mandate given by the Articles of Association/Statute, the IAEA is obliged to promote the peaceful use of nuclear energy and to make sure that secret abuse for military purposes does not take place. A special inspectorate was set up for monitoring on the basis of bilateral agreements called Safeguard Agreements between member states and EURATOM that executes regular inspections of all declared nuclear facilities in countries do not possess nuclear weapons and non-military facilities in countries that do (see "*Stálá mise,*" 2010). Until 2009, the initial agreement between IAEA and Czechoslovakia from March 1972 was in effect; on October 1, 2009 the Czech Republic approached a Trilateral Safeguard Agreement (INFCIRC/193 or also 78/164/EURATOM). The Czech Republic, therefore, accepted the commitment to approach trilateral agreements between EU member states not possessing nuclear weapons, EURATOM and IAEA as part of the IAEA safeguard system (see SÚJB, n.d.a). Based on the Trilateral Safeguard Agreement and within the meaning of Commission Decree No. 302/2005/EURATOM from February 8, 2005, on the implementation of EURATOM safeguards, starting from 2005, inspections of nuclear facilities are performed by both IAEA and EURATOM inspectors.

In speaking of supranational regulation, the influence of the European Nuclear Safety Regulators Group (ENSREG), an independent body established in 2007 under from a Decision of the European Commission should not be underestimated. ENSREG consists both of EU members and officials from national nuclear safety offices, radioactive waste management offices, and radioactive protection offices in all EU member states. ENSREG's goal is to reach mutual understanding and development in the fields of nuclear safety and management of radioactive waste (see The European Nuclear Safety Regulators Group).

6.4.1 The safety framework after the Fukushima accident and change in the perception of nuclear power in the European Union

After the devastating earthquake in Japan on the 11th of March 2011, which caused a major nuclear accident rated at 7 on the International Nuclear Event Scale (INES) at the Fukushima Daiichi nuclear plant, the safety measures of nuclear power plants were widely discussed around the world[29]. Many states, including the member states of the European Union, underwent a major re-examination of nuclear reactor safety, and a series of stress tests were carried out in 2011 and 2012 in the EU[30]. The accident was also followed by reconsideration of using nuclear power and some Member States (including Germany, Belgium, and Spain) decided to abandon nuclear energy entirely. The most important directive related to nuclear safety reflecting the Chernobyl accident (also INES 7) was Nuclear Safety Directive 2009/71. In the wake of the Fukushima accident, the directive was rapidly revised, and it was amended by Directive 2014/87. This directive "reinforced the role and effective independence of the national regulatory authorities. It has enhanced transparency on nuclear safety matters. It has strengthened principles, and introduced new general nuclear safety objectives and requirements, addressing specific technical issues across the entire life cycle of nuclear installations, and in particular, nuclear power plants. It has extended monitoring and the exchange of experience by establishing a European system of peer reviews. Finally, it established a mechanism for developing EU-wide harmonized nuclear safety guidelines" (see Dehousse 2014, p. 3–4).

Despite the increased security measures, nuclear energy remains controversial among the Member States. Nuclear power plays an important role in 14-member states, and around 25.1% of electricity was generated from nuclear plants in the EU in 2017. But production is o the downslope: between 2009 and 2017, total production of heat from nuclear sources fell by 10%. France, Germany, the UK, Sweden, and Spain are the largest nuclear producers, but only the UK plans to further develop its nuclear sector, while Germany will be the most rapid at phasing out nuclear energy, intending to do so by December 2022. The nuclear accident in Fukushima speeded up the nuclear phase out in Germany and Belgium. By contrast, 12 EU states joined together to form the *Nuclear Like-Minded Group* to promote the role of nuclear energy in the EU's energy mix in March 2013. With the Czech Republic coordinating the group, with the participation of the UK, Bulgaria, Finland, France, Hungary, Lithuania,

29 As regards the nature of the Fukushima accident, it should be added that each Czech nuclear unit has backup sources of power in the form of three separate diesel aggregates that are further secured with batteries.

30 These tests were done in three parts. The first was implemented on individual nuclear plant operators (i.e. ČEZ), the next executed by national regulators (SÚJB), and the third involved monitoring inspectors from other countries (European Nuclear Safety Regulators Group, hence the European Commission) (see Macková, 2011; SÚJB, n.d.b). The final report following the process of mutual evaluation of nuclear plant resistance by the members of the EU27 both for Temelín and Dukovany power plants was as follows: "No conditions were identified that would require immediate resolution. The power plant is able to safely manage even highly improbable extreme emergency conditions without posing any threat to its vicinity" (see ČEZ, a.s., 2011a; ČEZ, a.s., 2011b).

the Netherlands, Poland, Romania, Slovakia, and Spain. Nine of these countries plus Slovenia sent a letter to EC in July 2014, demanding "a level playing field for nuclear power among other low-emission sources in the EU so that it could play a greater role in energy security, sustainability, and emissions reduction" (see WNA 2019b).

Recently, support for nuclear power has been uncertain in Spain and France. There are tendencies towards phase-out, but nuclear power plays a major role in generating electricity in both countries. In February 2019, the government of Spain decided to close all seven nuclear plants between 2025 and 2035, but this step will require a large investment into RES and also depends on the strong position of the Socialist party to uphold its commitment (see Binnie 2019). In France, a plan to cut nuclear energy reliance by 50% was postponed from 2025 to 2035 and the future is uncertain, as French power plants face water shortages during the summer months. By contrast, construction of new power plants is being considered in the Czech Republic and Poland, and construction is underway or about to start in the UK, Slovakia, Finland, France, and Hungary.

The Czech Republic is cooperating closely with the Visegrad countries (V4) on nuclear energy at the EU level and an important ally used to be the United Kingdom[31]. All (apart from Poland, which has no nuclear power plant at present) are planning to continue producing electricity and heat from nuclear power plants and must maintain a strong common position within the EU. The V4 countries are all keen on increasing or sustaining their energy self-sufficiency and reducing dependency on Russian natural gas through the nuclear power (see Szalai 2013; Szalai 2018; Denková et al. 2017).

However, the clash between these two opposing camps is reflected at the EU level, as there is no support for nuclear energy comparable to that for renewable energy, even though it is a zero-emission source of energy. Further, there is an effort by the European Parliament to label nuclear power a polluting industry. The European Parliament voted on the 28th of March 2019 to exclude nuclear power from being acknowledged as a clean technology, thus complicating the approval of investments into this sector on the financial markets. Together with the strong opposition and problems with financing and completing construction, the nuclear sector is in a crisis and further development is in jeopardy.

6.5 Demand Forecast

According to long-term forecasts, power use will increase in the Czech Republic and electricity demand will increase by 25–33% by 2050. The energy mix of installed power is currently 46% dependent on coal, with 19% of the installed capacity from nuclear energy, 19% RES, and 8% natural gas. The share in electricity generation is 82% from coal and nuclear energy and only 11% from RES (see OTE 2019). Table 6.6 displays a comparison of goals declared in the State Energy Policy and its revisions with reference to the consumption of energy sources by 2050. It is evident that the role of the nuclear sector in the Czech power industry will likely improve to make up a third of all energy sources in the Czech Republic. In terms of the installed capacity of nuclear power plants, scenarios also count on the increased capacity of existing units, with the actual installed capacity of nuclear power plants at 4,204 MWe as of the 31st of December 2018 (see table 6.1); under the State Energy Policy, which calls for Dukovany to be completed in 2037 and 2039 and Temelín's to be completed in 2043 and 2045, by 2050 installed capacity will be approximately 7,050 MWe.

Tab. 6.6: The Shares of Solid, Liquid and Gas Fuels in Energy Resource Consumption According to the State Energy Policy of the Czech Republic of August 2012 and Its Revisions of December 2014 (in %)

Type of Fuel	Long-Term Goal (SEP 2004) by 2030	SEP (8/2012) Target Values by 2040	SEP (12/2014) Targets by 2040
Solid	30–32	12–17	11–17 %
Gas	20–22	20–25	18–25 %
Liquid	11–12	14–17	14–17 %
Nuclear	**20–22**	**30–35**	**22–33 %**
Renewables	15–16	17–22	17–22 %

Source: *Státní energetická koncepce, 2014*, p. 44; Ministerstvo průmyslu a obchodu, 2012, p. 20–21; *Státní energetická koncepce*, 2004, p 40–49.

31 With the complicated situation around Brexit the pro nuclear group has lost an important ally.

The Government has declared a clear stance on the development of the nuclear sector (and completion of the Temelín or Dukovany nuclear power plants) under several prime ministers, beginning with Petr Nečas, who declared at the 11th Energy Congress of the Czech Republic that the country "intends to continue to run the Temelín and Dukovany nuclear power plants and to continue the process that will lead to the construction of additional nuclear units" (see Nečas, 2011, p. 199), continuing with Bohuslav Sobotka (of the political party ČSSD) and so far enduring with Andrej Babiš (from political party ANO. All have agreed on the necessity of building the new nuclear, but had differing opinions on financing. Current plans call for the construction of new unit(s) in the Dukovany nuclear power plant, which has a much greater potential as there is, according to its ex-chairman, Tomáš Žák, "producing potential at the site of Dukovany given by exterior conditions of around 3,000 to 3,500 MW by applying existing technologies, and there are more possibilities than that" (see Cieslar, 2010e).

Confidence in nuclear energy and interest in its development and completion stable, as visible in the consensus among political parties on the issue and wide acceptance and support by the people.

In 1980, Ludvík Kopačka wrote that "nuclear energy is truly becoming a developing energy source in the Czechoslovak context that will gradually assume the role of covering increasing energy demand and gradually the increasing consumption of primary sources, as well" (see Kopačka 1980, p. 214–215). This basically remains applicable even in the second decade of the third millennium. The Pačes Commission argues that "around 2020–30, the lifespan of existing nuclear power plants should be prolonged for at least 60 years, while the increase in energy consumption in the Czech Republic and the replacement of gradually closing coal-fired power plants in terms of their basic capacity should be covered by building new nuclear power plants, reaching the share in power production already present in France, for example (77%)", and "around 2040–2050, starting construction of fast reactors" (see Úřad vlády ČR & Nezávislá energetická komise 2008, p. 108–109). Ten years later the perception is similar, though a share of nuclear power is projected by around 50–60% by 2050 and the rest is planned to be covered by RES and natural gas.

Based on this, it is evident that the Czech Republic has a firm position regarding the development of the nuclear industry, that the sector is not indifferent to it and that it has important potential for energy and the supply safety of the Czech Republic and that the Czech Republic counts on increasing its use of this type of energy both over the short- and long-term. We may state that state energy policies as well as the State Energy Policy and their revisions support the development of the nuclear industry. There is a gradual growth in share in primary sources consumption, from 20% under the 2004 State Energy Concept to 34% in primary sources consumption and 50–60% in final consumption in the revised version of State Energy Policy.

Unlike with coal and natural gas, there is no international legal obligation to keep reserves of uranium (see OECD Nuclear Energy Agency / IAEA 2008, p. 171), not even resulting from the membership in IAEA or EURATOM. Nor was there under Czech law until the 2014 State Energy Concept. In the 2004 State Energy Concept, there was a non-binding recommendation to have "nuclear fuel strategic reserves in a form adequate for loading the reactor" (see SEP 2004, p. 27). In the new State Energy Concept, under Priority V related to energy security, the target is to "permanently ensure adequate emergency stocks of all the basic primary sources" (SEP 2014, p. 57) and to "ensure that nuclear power plant operators maintain stocks of fuel assemblies that guarantee facilities will be able to operate at full capacity for four years, or use reserve capacity backup contracts for fuel supplies or maintain the corresponding stocks of enriched uranium and the country's own fuel fabrication within the Czech Republic. The accomplishment of this objective is to be scheduled in line with increasing the proportion of nuclear energy to a target level of 50–60 % of final consumption" (see SEP 2014, p. 58). With regard to the high density of nuclear power plant fuel, the relative stability of its price and the vast number of active producers of uranium concentrate, as well as the substantial number of processing institutions, it is possible to stock up for a decade in advance.

Tab. 6.7: Forecast of Uranium Concentrate Demand in the Czech Republic (tonnes per year)

2015	2016	2017	2020	2025	2030	2035
582	566	700–705	700–705	725–730	725–730	725–1,120

Source: OECD Nuclear Energy Agency 2018, p. 199.

6.6 The long road to a new nuclear source of energy for the Czech Republic

Building a new nuclear power plant has been under discussion in the Czech Republic since 2004. To make a long story short, the plan was included in the State Energy Policy of 2004, with a new unit at each location under consideration, a public tender for construction at Temelín in 2009 prepared then cancelled in 2014, and a new State Energy Policy presented in 2014 that highlighted once again a plan for a new nuclear unit and a waste repository to be built. By 2019, both plans had already been delayed for three years.

Since the financial crisis of 2008, the nuclear industry has suffered its own "nuclear crisis". Conditions for financing have worsened due to new bank policies, the electricity price has decreased due to electricity generation from renewable sources, many projects have been delayed and have gotten more expensive. Also, the Fukushima accident represented a limit on nuclear sector development.[32] Because of this and some failed projects, two of the biggest companies, Westinghouse and Areva, faced deep structural problems. As a result, Chinese companies and the South Korean company KEPCO increased their share on the world market. Russia's Rosatom also found its way by means of construction works and complete supply chain offers as well as the financing of their projects. This constitutes a strategy for building and eventually exploiting path dependence to secure orders for future years (see Minin, Vlček 2018; Jirušek et al. 2015).

The majority of the Czech Republic (including government, industry, and a high percentage of population[33]) is convinced that a new nuclear source is needed in order to secure electricity production in upcoming years, especially after the closure of Dukovany power plant and most of the coal plants, around 2037 – depending on its lifetime extension[34]. The question of whether to build or not is not the issue; the consensus is clear. The problem is who is going to pay for it. This proved to be an issue in 2014 and it is proving to be an issue again today.

6.6.1 First attempt, an unsuccessful tender for Temelín nuclear power plant

On August 3, 2009, ČEZ announced a tender for two new nuclear blocks for the Temelín nuclear power plant. To some extent it was based on the investment plan for the construction of the Temelín power plant with 4 × 1,000 MWe of installed capacity, adopted in February 1979, replicating the construction site itself and some already existing auxiliary systems. Total capacity of the new nuclear plant remained at 2 × 1,200 MWe after elimination of AREVA SA from the tender[35]. It is not just the project that is part of the tender, but the construction work itself, which makes the entire endeavour, therefore, a turnkey power plant.

After it was awarded, the overall administrative tender process should have lasted for roughly 7 to 8 years (together with the construction, 15 years), which meant that the connection of new Temelín units was estimated for around 2024. The tender's finale and the signing of the contract by the winning bidder were planned for the end of 2011. In October 2010, however, everything was postponed until 2013 due to the unpreparedness of suppliers, which would naturally lead to a delay in the entire process. But the deadlines were impossible to meet without altering the applicable construction and permit legislation. The job of the Government's Commissioner for the ČEZ nuclear tender was given to Václav Bartuška, Special Envoy for Energy Security of the Czech Republic.

Three entities took part in the tender. These included a consortium of the companies ŠKODA JS, a. s., of the Czech Republic, Atomstrojexport, a. s., from the Russian Federation (a subsidiary of the Russian company

32 On the other hand, the accident in Fukushima Daiichi means new business and development for Czech nuclear physicists as the escalation of monitoring and various tests of existing nuclear power plants will most probably become an interesting business, which the ÚJV Řež is preparing for at the level of the Czech Republic (for more details see Korbel & Kostka 2011, p. 30).

33 In May 2018 49% supported construction of new nuclear unit, 32% were against and 19 % undecided. Comparing to the previous two years, the number of people supporting the new unit decreased, people against stayed and percentage of people who do not know increased (see cvvm 2018).

34 The lifetime of Dukovany power plant was designed to be 30 years but it has been extended until the power plant will not stop comply the safety test. Expected lifetime is 50 years, some are speculating about 60 years, but the pressure from the European Commission is to decommission nuclear power plants after 40 years. Nevertheless, the institutional approach could change as for example IEA is supporting nuclear power plants as a clean source of energy (see IEA 2019).

35 AREVA SA had a variante of 2 x 1,700 MWe unit.

ZAO Atomstroyexport[36]) and OKB Gidropress, a. s.[37] from the Russian Federation, offering the project a MIR 1200 (Modernized International Reactor) with 1,198 MWe of capacity[38]; the French company Areva SA[39], which offered an EPR (European Pressurized Reactor) with 1,700 MWe of capacity[40]; and the American Westinghouse Electric Company, LLC[41], which offered an AP1000 with 1,200 MWe of capacity. In each case, the reactors were of the III or III+ generation.

Tab. 6.8: Technical Characteristics of the Projects Proposed by Single Nuclear Tender Applicants

Company	Westinghouse Electric Company, LLC	Areva SA	ŠKODA JS, a. s., Atomstrojexport, a. s., OKB Gidropress, a. s.
Project	AP1000	EPR™	MIR 1200 (AES 2006)
Thermal capacity(MWt)	3,415	4,590	3,200
Electrical capacity (MWe, net / gross)	1,117 / 1,200	1,590 / 1,700	1,113 / 1,198
Efficiency (%)	33	36	33.7
Capacity factor (%)	93	90.3	>98*
Number of cassettes in the active zone	157	241	163
Number of rods in cassettes	264	265	312
Number of steam generators	2	4	4

* Such a high value results from shorter maintenance and refuelling breaks and prolonged fuel campaigns.

Source: Bílý, 2011, p. 268; Company's official documents; selected and modified by T. Vlček.

On October 5, 2012, ČEZ announced the elimination of the French company Areva from the competition for building new blocks at the Temelín nuclear power plant because it did not meet the basic commercial and legal terms of the competition (see "*ČEZ vyřadil AREVU*"). Areva submitted an appeal to the Czech Office for the Protection of Competition, but in February 2013, it upheld the decision.

In the first round of the tender, the subjects of evaluation included technology, price, and safety. According to the results of March 2013, the American company Westinghouse Electric Company, LLC, was the first in this aspect, but the lowest price was offered by the Russian-Czech consortium. The AP1000 reactor was in many aspects revolutionary, with an advantage stemming from its modular construction, which, on the other hand, posed a problem in that it had not been tried before and could, therefore, limit the inclusion of domestic companies in the project. MIR was an evolutionary reactor based on the long history of VVER reactors as well as on Russian experience with breakdowns. It is a tested and reactor and is cheaper, but it is technologically older.

Although ČEZ argued that the construction of new nuclear blocks arose from the State Energy Concept, Policy of Spatial Development, and the conclusion of the Paces energy commission (see ČEZ, a. s., 2009a), the company

36 ЗАО Атомстройэкспорт is the leading Russian organization building and modernizing nuclear power plants abroad. It is supervised by the Federal Agency for Nuclear Energy, Rosatom (Федеральное агентство по атомной энергии России, РосАтом). A majority of its shares (50.2%) are held by VPO Zarubezhatomenergostroy (44%; Всероссийское производственное объединение "Зарубежатомэнергострой") and OAO TVEL (6.2%; ОАО "ТВЭЛ"), which Rosatom controls on behalf of the state. 49.8% of shares are held by Gazprombank (ОАО "Газпромбанк").

37 A subsidiary of the Russian company OAO OKB Gidropress (ОАО ОКБ "Гидропресс").

38 Based on talks with the Russian side, it is interesting that the tender should have included a serious offer to build a manufacturing plant in the Czech Republic, i.e. a plant for assembling fuel cassettes out of single pallets. According to the Russian calculation, this sort of plant proves profitable for the state if there are at least eight reactors, which is the number the Temelín power plant will reach upon completion. This is accordingly an opportunity for fuel fabrication for the Russian type of power plant in Slovakia and elsewhere. The paradox is that in this manner the most frequent comment on the Russian project, i.e. intensification of Czech energy dependence on Russia, to some extent ceases to be logical.

39 The ownership structure at the time of the tender was as follows: 73.03% Commissariat à l'énergie atomique (technological research institution financed by the French Government); 10.17% French state; 4.82% Korean car industry Kia Motors and the remaining 11.98% other companies, employees and publicly traded stocks.

40 The great advantage of this reactor may be found in the high rate of capacity maneuverability.

41 At that time belonging to the Japanese companies Toshiba Corporation (67%) and Ishikawajima-Harima Heavy Industries Co. Ltd. (3%), American mechanical companies The Shaw Group (20%) and Kazakh state company Kazatomprom NAC (Казатомпром НАК 10%).

was criticized for its poor communication with the majority stakeholder in preparing the tender. At that time, it was the largest tender in the world and, according to Deputy Minister of Industry and Trade Tomáš Hüner, the state was planning to have its own part in it to ensure full control: "The state has very strong options. It can change the Statute and it can directly express its opinion regarding the tender, bypassing the General Meeting of Stakeholders, where 70% of shares are owned by ČEZ It also has the bluntest tool in its hands; that is the ability to replace the management" (see Rafaelová, 2009).

In terms of the nuclear sector, the Government's policy statement was clear during the first tender. It expresses the state's will to support both the construction of new blocks at the Temelín nuclear power plant and the modernization of the Dukovany nuclear power plant, including the accompanying range of buildings so as to achieve a balanced energy mix. The state will furthermore proceed with its transparent approach while searching out sites for radioactive waste repositories, including supporting other options leading to their decommissioning (see VČR, 2010a, p. 37). The Government, with respect to the development of the nuclear industry, behaved in a very coherent and conceptual manner, based on from state energy policies and the State Energy Concept and its so far unapproved revision.

When the Expert Working Group for Energy Security submitted its conclusions in 2006 regarding Czech energy to the Committee for Foreign Security Policy Coordination, it recommended prolonging the lifespan of the Dukovany and Temelín nuclear power plants, for the state to create the conditions for further quantitative and qualitative development of the nuclear sector, and seeking to increase electricity production through the framework of the existing localities–in other words, to complete the Temelín nuclear power plant and, more broadly, the facilities in the originally planned localities (Blahutovice), as well. For diversification reasons, the recommendation was to have the new technologies supplied by EU countries (see Odborná pracovní skupina pro energetickou bezpečnost [OPSpEB], 2006, p. 14). The document also recommended "the restoration of uranium mining, because for the major construction of nuclear sources in the Russian Federation and unchanging capacity of nuclear fuel production, there could be a shortage of that fuel. A country capable of supplying its own uranium and asking only for its processing into fuel will be unambiguously at an advantage compared to those who must ask for the complete purchase of fuel" (see OPSpEB, 2006, p. 8–9). The discussed revision of the Atomic Act also advocated the development of uranium mining, which would enable the allocation of funds from the nuclear account also to municipalities affected by mining exploration related to a deep geological repository, which could be a good way to reach a consensus between state and municipal interests while searching for a proper to build this deep geological repository.

"Preparation of and proceeding with a schedule of a supplier selection process for the completion of Temelín nuclear power plant has been approved, and I hereby wish to confirm that this plan remains unchanged. 'The Government wishes and, because of its share in ČEZ, will be able to arrive at a winning bidder by the end of 2013', were the words of Prime Minister Petr Nečas at the 11th Energy Congress of the Czech Republic (see Nečas, 2011, p. 199–200). ČEZ had been preparing very seriously for the Temelín project. The preparations included, on April 1, 2009, a new division, called the Division for the Construction of Nuclear Power Plants, to coordinate the preparation of nuclear projects not only within the Czech Republic (Temelín and Dukovany), but also abroad (Jaslovské Bohunice – Slovakia) (see ČEZ, a. s. 2010b, p. 5). Circumstances such as the expected shut down of large coal power plants in the Czech Republic, Poland and Germany by 2020, difficulties with building any larger units (only the Počerady combined cycle power plant and Ledvice power plant were built), problems with the integration of renewables, and the political decision to depart from nuclear energy in Germany,[42] played into the hands of the Temelín's completion with nuclear blocks of 2 × 1,700 MWe of installed capacity.

Final offers for the tender were submitted in July 2012 and an agreement was supposed to be signed by the end of 2013, but the final decision was postponed by 18 months. In the meantime, ČEZ was deciding on the form of financing and searching for a strategic partner. Rosatom offered full financing and in the middle of 2013, while the American Exim bank offered to finance half the project if Westinghouse technology was used. In the end,

42 After the accident in Fukushima Daiichi, Germany immediately suspended the operation of its eight oldest nuclear power plants, while the expert commission assessing their re-launch in May 2011 recommended leaving them closed. The Ethics Commission then decided to shut down all nuclear power plants by 2021, resp. 2022. The departure from the nuclear industry is not new for Germany, as it had six nuclear reactors closed within the territory of German Democratic Republic immediately after the unification of Germany in 1990, while the construction of five reactors already in the building process (Stendal nuclear power plant) was postponed and then entirely terminated a year after.

the Czech government under with Prime Minister Petr Nečas planned to offer a contract for difference for the electricity from the new units. The Ministry of Finance was offering a strike price of 60 EUR per MWh, while ČEZ requested 70 EUR per MWh (the price of electricity was around 40 EUR in 2013). The situation changed after elections. The Government of Prime Minister Bohuslav Sobotka decided against state aid to the project, especially after the poorly handled state aid to RES. ČEZ announced that it would not be possible to build a new nuclear unit without state aid and cancelled the project in April 2014 (see WNA 2019a).

According to Ladislav Blažek, Former Development Deputy of the Federal Ministry of Energy and one of the leading Czech experts in the field of mechanical mine installations, energy, and gasworks, the prospects for this sector are evident. "Without developing the nuclear industry, the Czech Republic can barely make do, if it wishes to achieve energy independence, and complete its commitments to do with emissions reduction if it does not wish to waste the experience gained. No responsible politician can deny the need to construct additional sources of nuclear energy in the shortest time possible if he or she does not wish to speculatively weaken the hard-won energy self-sufficiency of the Czech Republic" (see Blažek 2009, p. 68).

6.6.2 Second attempt, the new trajectory

On the 1st of January 2015, the new *State Energy Policy* came into force, showing a clear trajectory for the nuclear sector. "Within the timeframe of the State Energy Policy, what is important in terms of predicting the balance of production and consumption is completing the construction of additional nuclear power units to produce around 20 TWh by 2035, extending the lifetime of the existing four units at the Dukovany power plant (to 50 to 60 years) and later the possible construction of another unit to compensate for the decommissioning of the Dukovany plant. In the long term, nuclear energy could provide in excess of 50% of the electricity generated, thus replacing a large proportion of the coal sources. It is also advisable to start making greater use of heat energy from nuclear sources to heat larger urban agglomerations" (see SEP 2014, p. 14). The document also sets long-term priorities in relation to the EU, since the goal for nuclear energy is to "promote nuclear energy as an accepted carbon-free technology which may be supported in the policies of the various member countries" (see SEP 2014, p. 98). Among other things, it sets a deadline for selecting sites for the final repository of spent nuclear fuel, which are to be submitted to the government so a decision may be made by 31.12.2025 (see SEP 2014, p. 93).

The document refers to the *National Action Plan for the Development of Nuclear Energy in the Czech Republic* (NAPJE) of May 2015 which converts the targets of the State Energy Policy into concrete implementation steps. It says 'to ensure the energy security of the Czech Republic and overall social benefit, from the perspective of the state preparations must begin immediately for the siting and construction of one nuclear unit at the Temelín site and one unit at the Dukovany site, while protecting against potential risks by obtaining the necessary permits/licences for the possible construction of two units at each site. In particular, maintaining the continuation of production at the Dukovany site, constructing a unit at the Dukovany site, and commissioning it 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" (see NAPJE 2015, p. 6).

NAPJE is discussing three options for financing the new units and has drawn up a SWOT analysis. The options are:

- Construction of a facility/facilities through the investor ČEZ and possibly its 100% owned subsidiary: from the perspective of the state, investment through the existing owner and operator of nuclear power plants, ČEZ and possibly its 100% owned subsidiary
- Association of investors: a private investor consortium, i.e. an association of investors formed in order to achieve a certain goal (ČEZ, financial investor, large customer, contractor of nuclear unit, etc.).
- State-owned enterprise: direct construction by the state through a newly established state-owned enterprise (NAPJE 2015, p. 74–76).

From the state's perspective, the first option is the preferred option for the investment model for constructing new nuclear facilities, but not for ČEZ. But the document also says that 'in the event that the investor plan drawn up by ČEZ is not 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 SEP, through the selection of two alternative options' (see NAPJE 2015, p. 6). The third option involving direct construction by the state through a newly established state-owned enterprise is, due to the large number of negatives entailed, chiefly the high impact on the state budget and the increased national debt, 'the least likely and it is therefore mentioned only for the sake of completeness' (see NAPJE 2015, p. 76). A Contract for Difference is considered as a possible guarantee mechanism; the document suggests three scenarios, for 15 years, 35 years, and 60 years (see NAPJE 2015, p. 84–85).

The document sets tasks and priorities for the development of the nuclear energy sector and related to the construction of a new nuclear unit. The most important are: make sure that strategic partners are identified and contacted for the construction of a new nuclear facility in the Czech Republic by 31/12/2015; open negotiations with the European Commission on the method of supplier selection, financing, rate of return guarantee and state support by 31/12/2016; and decide on the investment and business model for the construction of a facility by 06/2016 (see NAPJE 2015, p. 97–115). Expected costs and a projected timetable are shown in table 6.9.

Tab. 6.9: Limit costs incurred from 01/2015 in individual sub-milestones of the project

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

Note: costs in billion CZK

Source: National Action Plan for the Development of Nuclear Energy in Czech Republic 2015, p. 91, modified by T. Stašáková

6.6.3 Second attempt, who is going to pay?

The motivation for the construction remains the same as for the first tender. In addition, there is less time to start the construction project and more pressure on clean energy sources. Yet the Czech Republic is lagging behind schedule, frozen on deciding on the investment and business model for construction of a new nuclear unit, three years behind schedule as of June 2019.

In June 2015, by approving NAPJE, the Czech Republic government decided on reopening preparations for a new nuclear power plant to be built under the government of Prime Minister Bohuslav Sobotka and Minister of Finance Andrej Babiš (the current Prime Minister). But this time, the new construction was planned for Dukovany, as Dukovany will be decommissioned sooner; it is more strategic to have a nuclear power plant in two locations than it is to have one big unit; employment is also provided this way at both locations. New construction at Temelín has not been completely cancelled; it remains under continuous preparation next to the Dukovany construction and follows the development of nuclear energy in the Czech Republic.

According to newspaper headlines in 2015, the new units were supposed to be finished by 2025. Reports also mentioned potential obstacles such as financing, the changing European attitude to nuclear energy, disagreement from Austria and a water shortage in the Jihlava River, which is the main source of water for cooling the Dukovany plant. (see Voříšek 2015, Budín 2015, Ševeček 2015). In 2015, the Prime Minister was expecting to open the tender by the following year and the Minister of Finance had a clear view as to how the project should be financed. Babiš said that since ČEZ operates both nuclear plants, it should also complete/secure the new construction; the government would not offer a contract for difference or any financial support (see Budín 2015). And although the schedule for the whole process was given by NAPJE, the final decision about the new nuclear unit and its financing was and still is seen as a sensitive political topic and thus was not broached before the parliamentary elections of 2017.

In 2016, ten companies were addressed by the Ministry of Trade and Industry, six of which showed interest in building a new nuclear unit in the Czech Republic. These were the Russian state company Rosatom, EDF from France (Electricité de France), the American-Japanese Westinghouse Electric Company, Korea's KHNP (Korea Hydro&Nuclear Power), China's General Nuclear Power, and a joint project submitted by Areva and Mitsubishi Atmea. These companies started bilateral discussions with the Ministry of Trade and Industry in the form of consultations and with involved municipalities in the form of roundtables. But they were strictly discussions, mostly of technical particulars, because prior to the government decision on financing, none of these companies was able to provide an offer (see ČTK 2016b). During these discussions an intergovernmental agreement was considered, following the example of Hungary and its agreement with Russia on financing the Paks II nuclear power plant. Petr Závodský (Director of ČEZ Group's Nuclear Power Plant Construction Department) stated that the intergovernmental agreement allows more flexibility than a tender and could include the form of financing (see ČTK 2016a). But in the end, a tender was chosen because it is more transparent and does not require European Commission approval.

Among the parties included in the discussion was a group of ČEZ minority shareholders representing 30% of the company's stock (the remaining 70% is owned by the Ministry of Finance) and were mostly against this risky investment. One possible solution was to divide the company into smaller firms (se ČTK 2017a). In 2018, the question of breaking up ČEZ once again arose, with six possible variants. After a SWOT analysis, the option of the state owing the "dirty" part (including the nuclear, coal, and trade sections of the company) and shareholders the "green" part was, according to ČEZ, seen to be optimal (see ČTK 2018a).

Discussions continued with the six companies during 2017 on the location of the project and the involvement of Czech companies. In addition to discussing the financial model, the companies said that they could not envision the project proceeding without some level of state involvement (see Žižka 2017). Even though the project received government support, this has consisted only of a declaration of support, since nuclear financing was considered too risky and the length of time required by legal procedures to approve the project was perceived to be another obstacle by PM Sobotka (see ČTK 2017b). Moreover, in the middle of January 2017, the Minister of Finance, Andrej Babiš, stated that as long as he was Minister of Finance, the state would not financially back a new nuclear unit (see ČTK 2017c). An important milestone for the new nuclear power plant at Dukovany was the beginning of the EIA process on the 13 November 2017. ČEZ wished to have all administrative documentation prepared in case the government decided on the financial model (see ČTK 2017d).

The decision process was also influenced by governmental instability. After the autumn elections in 2017, won by the political party "ANO" of ex-Minister of Finance Andrej Babiš, who became Prime Minister, found itself unable to form a new government. A second election was held, which ANO once again won, and they were finally able to form a government on 27 June 2018. This government continued the rhetoric of CSSD from the previous term.

In March 2018, Jan Štuller, the Special Envoy for Nuclear Energy, said 'the Standing Committee on Nuclear Energy supports the financial model of state financing of the new power plant' (see ČTK 2018c). By contrast, after the second elections, the new Minister of Trade and Industry, Marta Nováková, replacing Tomáš Hüner in June 2018, spoke again about an intergovernmental agreement and opposed further state involvement. Also, the Standing Committee on Nuclear Energy changed its structure and name on 18 February 2019. It was now called the Standing Committee on New Nuclear Construction and would be chaired by the Prime Minister (instead of the Minister of Industry and Trade) and the Minister of Industry and Trade and the special envoy for nuclear energy were to be the two vice-chairpersons of the committee. Membership of the committee was extended to include the relevant ministers (instead of deputy ministers), representatives of the opposition political parties, and representatives of the NPP operator – ČEZ to secure broad agreement on all sides (see MPO 2019).

The question of the financial model remained opened until June 2019, four years after approval of the NAPJE. The tender is now planned to begin by the end of 2020 or the start of 2021 and should not be open for more than three years. The main criterion will not be only the price according to the new Special Envoy for Nuclear Energy Jaroslav Míl[43] (see ČTK 2019). The first phase is expected to be finalized by 2024, when the result of tender should be known. The first phase also means obtaining permission from SÚJB and a zoning decision. Since the construction of a new nuclear unit is far away but the reasons for building it remain, a partial solution in the form of prolonging the lifetime of Dukovany up to 60 years is being considered.

6.6.4 Opposition to the new nuclear unit

The strongest protest against the first attempt of the Temelín nuclear power plant completion came from the Green Party, Greenpeace, South Bohemian Mothers, Calla - Association for Preservation of the Environment,

43 Jaroslav Míl was formerly a general director of ČEZ, a. s. and president of the Confederation of Industry of the Czech Republic.

the Citizens' Initiative for Environmental Protection, Green Circle and the DUHA Movement. These organisations have also been active during the second attempt at completing the Dukovany nuclear power plant.

The idea common to all these organizations are summed up by the words of Martin Sedlák of the DUHA Movement: "The Czech Republic will make do without additional reactors. Green sources in combination with the enormous potential of increased efficiency can ensure enough energy for Czech households and industry. The new nuclear power plant looks like a mere footnote in comparison to these clean solutions. They also have an indisputable advantage, as the costs of renewables decline. Over the course of a decade, they will be at the heels of atomic power" (see Jihočeské matky 2011).

Their arguments should definitely be taken into consideration, as one of the pressing issues these organizations are warning about is the limited liability of the operator running nuclear power plants across the Czech Republic for nuclear damage. "Should a serious accident occur in Temelín, all affected would together receive only six billion CZK. ČEZ would in such a case, paradoxically, receive 35 billion CZK from the insurance companies," said Sedlák (see Sedlák 2009, p. 31). According to environmental organizations, ČEZ must assume full financial responsibility for nuclear damage, because the current limit of 8 billion CZK is insufficient and does not correspond to international conventions (see Jihočeské matky 2011).

According to Edvard Sequens of Calla, "the politicians are looking into a rearview mirror and want to deal with challenges of the 21st century with tools of the 20th century" (see ČTK, 2018c).

South Bohemian Mothers and Calla sued the state, opposing new nuclear power plant construction in Temelín, first in 2015 and after failure again in 2017 and 2018 because of procedural mistakes by SÚJB and flaws during the EIA process (see ČTK 2018b).

There is also a strong opposition on the international level from Austria. In 2000, the Austrian parliament passed a resolution against Temelín and the issue was later discussed at the European level. The solution was the Melk Protocol of 12 December 2000, increasing cooperation between the two countries and increasing security and environmental measures. But even though this document improved the cooperation between the two states at the diplomatic level, Austria is still against any new construction of nuclear units in Europe. This results in many protests, citizen´s initiatives, and lobbying at the European level for a European nuclear phase-out (*Atomausstieg*), with no exception. The Upper Austria region even financially supports Czech non-governmental organizations that are against nuclear energy (including the DUHA Movement, South Bohemian Mothers, Calla, and others).

Tab. 6.10: Comparison of Some Economic and Environmental Advantages and Disadvantages of Nuclear and Thermal Power Plants

Subject of Comparison	Nuclear Power Plant	Thermal Power Plant
Fly ash emissions	No	Only coal power plants
SO_2 and NO_x emissions	No	Yes
Operational spillage of radioactive materials	Yes (small amount)	Yes (small amount)
Ratio of produced energy per mass unit of fuel	2,100 GJ / kg	0.033 GJ / kg
Costs of fuel transport	Low	High
Exhaustibility of fuel sources	Yes (later than in the case of fossil fuels)	Yes
Amount of "ash", or spent fuel	Small	Great
Costs of spent fuel liquidation	High (mainly resulting from the danger and necessity of long-term deposition)	High (mainly resulting from greater volume)
Risk of a significant accident	Small	Great
Consequences in case of big accident	Great	Small

Source: *Fyzikalni aspekty zatězi zivotniho prostredi*, 2008, p. 24; modified by T. Vlcek.

The safety of nuclear power plants has also come under criticism, especially when it comes to spent nuclear fuel. Table 6.10 clearly illustrates that nuclear power plants are much less risky during regular operation than thermal plants under conditions of notable energy density. In the event of a major accident, a nuclear power plant is, nonetheless, unequivocally the riskiest type of power plant and the criticism is here substantiated. The State Office for Nuclear Safety regularly and strictly monitors existing nuclear power plants.

6.7 New development in nuclear sector: smaller and modular

Thoughts about a nuclear reactor for every municipality were popular during 1970s and 1980s, when nuclear technology was expected to be the future of the energy sector. Development, though, went in a different direction, towards bigger, more efficient units, mostly due to economies of scale. But in the face of current issues in the sector such as construction delays and rising prices, small modular reactors (SMR) have once again come under discussion. They are also an interesting option for remote locations.

Though still in the early stages, the number of countries developing their own model is indicative. There are around 50 SMR designs in development around the world and 20 of these are in the advanced research phase. Leading countries are the United States, Russia, the United Kingdom, South Korea, China, Canada and Argentina.

According to the IAEA classification, all reactors with installed power of 15–300 MWe are to be considered small reactors. The main characteristic of SMR is modularity and an integrated system[44]. The main idea is to simplify the technology to allow manufacturing and thus simplifying construction on site. This would also allow the installed power to the site to be adapted to needs and allow reaction on demand in the future by adding an additional unit. Also, the exchange of fuel is easier, and some models have longer fuel cycles. It is possible to build them on a brownfield and is easier to connect them to the grid. This is also a suitable option for power and heat generation for island operations (see IAEA 2018; ÚJV Řež 2014).

SMRs are supposed to be safer due to passive security measures such as cooling without the need for operator involvement. Another advantage lies in the smaller installed capacity and lower radiation danger in case of an accident. The emergency planning zone (EPZ) is also smaller: while the EPZ for a normal unit is 16 km in radius in the US (around 20 km in Europe), the plan for SMRs calls for 16 hectares in US. In Europe, it has not yet been specified. To minimize the impact of an accident, some models are planned for underground (NuScale). This requires that more attention be paid to the geological surface.

From the economic standpoint CAPEX (capital expenditures) are lower and financing is thus easier compared to normal units. But it is expected that the investment per kW will be higher, at least at the beginning. The price could decrease as the units are standardized and manufactured, but this is an assumption. The price of current models is influenced by the technology and the development of new components. Models using known and already marketed technology are supposed to be competitive (NuScale); models using novel technologies, where additional research has been done and which are considered FOAK[45] (Carem or KLT-40) are not planned at the current stage, due to bad economics.

In terms of licensing and regulation, SMRs are not treated in Czech regulations or law, nor in the regulations or law of the European Union. The situation has only been monitored by the EU since 2017 (see EC 2017). IAEA established a regulatory forum in 2015 and working groups in November 2017. IAEA identified a number of problems for licensing and design certifications related to the wide number of designs and many possible construction variants. But in general, SMRs based on marketed technology, with PWR designs, are going to have a shorter licensing period than SMRs that utilize new technologies. Also, it is possible to expect that models with lower installed capacity will obtain a license faster (see IAEA 2018). An easier licensing process will have a positive impact on the final price or SMR model and might increase its competitiveness.

Four of the most developed projects are worth mentioning:

The KLT-40 is a small-scale Russian floating nuclear cogeneration plant. It is a part of the RITM-200 series reactors developed by Afrikantov OKBM. The unit can generate up to 70 MW of electric energy. This SMR was already installed on icebreaker Akademik Lomosov at the end of 2018 and is planned to be connected to the grid in December 2019. It is going to be connected to the coastal infrastructure in Pevek and, after being put into operation, will replace the Bilibino nuclear plant and Chaunskaya thermal power plant, which are technologically outdated. Its lifecycle is 40 years, with the option of being extended. The project is FOAK and so far, it is not competitive on the market due to a high construction and development price (see Rosatom 2018; Rosatom 2019). Apart from this project, there are several others under development in Russia: ELENA by the Kurchatov Institute National Research Centre, RUTA-70, KARAT-45 and 100 by NIKIET, and others. Most of these are developed for the military (see IAEA 2018).

44 Integrated system means that all primary components are in the reactor pressure vessel.

45 First of a kind.

Carem 25 is an Argentinian FOAK project, a small pressurized water reactor with an installed capacity of 25 MWe and 100 MWt. Its lifecycle is 40 years. It is being developed and built by Combustibles Nucleares Argentinos jointly with other leading nuclear companies in Argentina and coordinated by the National Atomic Energy Commission. The project was licensed in 2009 and has been under construction since February 2014. It is located close to Buenos Aires next to the Atucha nuclear power plant, and it is expected to be connected to the grid in 2020. Following successful operation, Argentina intends to build units (CAREM 100 and CAREM 300) for domestic use and export (see WNN 2018; Nuclear Engineering International 2018; IAEA 2018, p. 7).

HTR-PM is a Chinese project developed by Tsinghua University. It is a high-temperature gas-cooled reactor with an installed capacity of 2 × 210 MWe and 2 × 250 MWe. The project has been under construction since December 2012 in the Shandong area and is expected to be connected to the grid in 2019.

ACP100 is also a Chinese project, developed by China National Nuclear Corporation. It is an integral PWR, cooled and moderated by light water. With an installed capacity of 125 MWe and 385 Mwt, the ACP100 is based on existing PWR technology adapting verified passive safety systems (see IAEA 2018, p. 11). Other Chinese projects include CAP200, DHR, ACPR50S by CGN. Also, Japan and South Korea (SK) are developing their own SMR, DMS by Hitachi-GE Nuclear Energy and IMR by Mitsibishi Heavy Industries in Japan, as well as SMART by KAERI in SK (see IAEA 2018).

NuScale, an American project involving a light-water-cooled pressurized-water reactor, developed by NuScale Power Ic. with installed capacity of 50 MWe and around 160 MWt. The project will likely be licensed in September 2020. The construction period is planned for three years and the first reactor should be connected to the grid in 2025 in Idaho Falls (see Nuscale n.d.). There are also other projects in the USA, such as SMR160 by Holtec International or Westinghouse SMR by Westinghouse Electric Corporation (see IAEA 2018).

There is also one SMR model under development in the Czech Republic, called **Energy Well**, a project of ÚJV Řež. It is supposed to be a model of the fourth generation, a high temperature reactor cooled by molten salt with an installed capacity 20 MWt and 8.4 MWe, the size of a shipping container. The fuel cycle is seven years and the type of fuel is TRISO, enrichment 15% (see Research Centre Řež 2018).

6.7.1 SMRs in the Czech Republic

In 2012–2014 ÚJV Řež, a. s. prepared a study for the Czech Ministry of Industry and Trade, analysing the suitability of SMRs for the Czech Republic. The study considers the technology to be highly suitable for the country and selected a list of power plants generating electricity and heat using coal that would be appropriate for replacement by an SMR. The criterion for inclusion was that it be a heat source burning solid fuels, supplying heat to a centralized heat system, and with an installed thermal output over 100 MWt. Accordingly, the following sites were recommended as optimal for such a substitution:

- Elektrárna Opatovice – Elektrárna Opatovice, a.s. (9 km from Pardubice),
- Elektrárna Melnik I – ČEZ, a. s. (expected in areal EME III),
- Elektrárna Porici – ČEZ, a. s. in Trutnov,
- Teplárna Komořany – United Energy, a.s. in Most (ÚJV Řež, 2014).

Currently, the discussion of SMRs in the Czech Republic is once again active as a part of the discussion of a new nuclear unit. Considering the current trend towards decentralisation, an SMR could be used particularly as an important source of heat in a decentralised system in the future. Optimistic talk (by SMR innovators, construction companies, and enthusiasts) targets 2030; the more realistic view (of investors, transmission system operators, and lawmakers) sees it happening around 2050, but only if the technology succeeds on the market. ČEZ might be considering an SMR in its next tender.

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Chapter 7: Renewables

Tomáš Vlček, Eliška Trmalová

7.1 Introduction

"Renewable natural resources have the ability, when gradually consumed, to be restored partially or completely by themselves or with man's contribution. Non-renewable natural resources perish with consumption" (viz "*Zákon č. 17/1992 Sb.*"). This is the definition of renewables as amended by the Czech environmental legal framework.

The renewable energy sector is by far the oldest in the world, with a history dating back to the Stone Age, when people initially started to combust biomass to heat and light the space they lived in. On the other hand, except for hydroelectric power plants, renewables represent a young, relatively new sector with perhaps the greatest pace of development, reacting to the world trend of fighting climate change, protecting the environment, reducing harmful greenhouse gas emissions and increasing energy self-sufficiency by limiting the import of energy materials. Although the research, development and increasing use of renewables had been recorded throughout the twentieth century, not before the 1990s did the renewables sector start to truly develop.

Activity related to climate change and environmental protection issues may be seen as the primary driver for this massive development. Issues related to a lack of fossil fuels and projections that the hydrocarbon era would come to a close by the 21st century (coal, oil, and natural gas depletion) also played a role. The terms for renewables development are de facto determined and to the greatest extent impacted by the United Nations and, eventually, by the European Union. The basic terms set by these organizations are then addressed by single states, energy sectors, and private entities.

In the renewable energy sector, one may generally distinguish two policies, namely *a low carbon policy* and an *environmental policy*. A low carbon policy does not a priori reject different and fossil energy sources, but rather tends to move toward adapting the present power industry so that it approximates the low carbon principle as closely as possible, that is so that it achieves minimum production of CO_2 as the main greenhouse gas. This policy does not exclude (or even advocates) the use and development of nuclear energy as an emission-free source.[1] Renewable sources of energy may have different levels of perceived importance, but they are always seen as more or less complementary alongside primary sources. A perfect example of this policy is that of France. The country's environmental policy highlights renewable energy and essentially removes fossil fuels from any further consideration. A complete shift to renewables appears as an evident interest indicated by this policy, while the existing obstacles emerge in the form of the permanent nature of human knowledge and technology, technical aspects, and finances. The policy on renewables is demonstrated by transition in Norway and Germany.

The Czech Republic propagates a low carbon policy in an unambiguous manner, primarily for economic reasons.

According to the definition in the Czech legal framework (in Act No. 165/2012 Coll. on Promoted Energy Sources and on Amendment to Some Laws), "renewable sources are understood as renewable non-fossil natural sources of energy, namely wind energy, solar energy, geothermal energy, water energy, soil energy, air energy, biomass energy, landfill gas energy, sludge gas energy from wastewater treatment and biogas energy" (viz "*Zákon č. 165/2012 Sb.*"). The further text of this chapter will convey the understanding and classification of renewables as amended by the previously cited legal act.

1 Meant in the field of evaluated types of emission, excluding water steam which is, naturally, the most extensive greenhouse gas.

7.2 Renewables Use for Electricity and Heat Generation

Hydroelectric power plants (HEPP), pumped-storage hydropower plants (PSHPP), solar power plants and wind power plants are renewable sources of energy in the Czech Republic used for power generation, while solar collectors, biomass, biogas[2] and geothermal power plants serve for the generation of heat.

The operation of *hydroelectric power plants* and *pumped-storage hydropower plants* is the most environmentally friendly[3]. We divide hydropower plants into hydroelectric power plants, small hydroelectric power plants[4], pumped-storage hydropower plants and tidal power plants (not present in the Czech Republic). Power production is a simple process based on a gradient water flow that spins a turbine sharing the shaft with an electrical generator. The kinetic energy of the flowing water is converted into electrical energy and delivered to consumption points (see *Hydroelectric power Plants in the Czech Republic*).

Pumped-storage hydropower plants have the advantage that they can store electricity. Pumped-storage hydropower plants have two tanks, an upper and a lower. During a regular daily regime or at peaks of performance, the plant produces a gradient water flow in which water from the upper tank falls through penstock to the tank below and thereby spins the turbine[5]. If there is a surplus of electrical power left in the electrical network (mainly at night), water is drawn from the bottom tank towards the upper tank and is usable for further take-off during daytime peaks. It is necessary to have a regular water supply for the lower tank due to evaporation and leaks.

In 2017, there were 1,090 MWe installed in hydroelectric power plants and 1,146 MWe in pumped-storage power plants in the Czech Republic. Hydroelectric power plants have a 5 % share in the total installed capacity in the country, with pumped-storage power plants having another 5 % (see ERÚ, 2018, p.25). Approximately 70 % of these hydroelectric power plants and 100 % of the pumped-storage power plants belong to ČEZ. The largest hydroelectric power plants are Orlík (364 MWe), Slapy (144 MWe), Lipno I (120 MWe), Kamýk (40 MWe), and Štěchovice I (22.5 MWe), all owned by ČEZ. The largest hydroelectric power plants not belonging to the company are MVE Střekov (19.5 MWe) and MVE Práčov (9.75 MWe), owned by its subsidiary ČEZ Obnovitelné zdroje, s. r. o., MVE Vranov nad Dyjí (18.9 MWe) and MVE Vír I (7.1 MWe) owned by E.ON Trend, s. r. o., MVE Nechranice (10 MWe) belonging to the state company Povodí Ohře, MVE Štvanice (5.67 MWe) of the state company Povodí Vltavy, and MVE Meziboří (7.6 MWe) owned by ENERGO - PRO Czech, s. r. o. (see ERÚ, 2010b, p. 90–91, in 2019 still correct).

There are only four pumped storage hydroelectric power plants in the Czech Republic and all of them belong to the ČEZ Group. These are the Dlouhé Stráně power plant (650 MWe), the Dalešice power plant (450 MWe), the Štěchovice II power plant (45 MWe) and the Černé Jezero I power plant (1.5 MWe). The first three belong to ČEZ and the latter to ČEZ Obnovitelné zdroje, s. r. o.

Solar power plants[6] have a 9 % (2,069.5 MWe) share of the entire installed capacity (see ERÚ, 2018, p. 25). Solar power plants acquire energy as a result of the photovoltaic effect, the process which converts solar radiation into electricity[7]. The capacity of photovoltaic cells is expressed in kWp (kilowattpeak), designating the maximum possible (peak) capacity of a photovoltaic power plant under laboratory solar conditions.

Generally, 1 kWp occupies 8–10 m^2 of surface area and (under ideal conditions) produces approximately 1 MWh of electricity per year (see "*Fotovoltaika,*" n.d.). A photovoltaic power plant runs even in the absence of direct sunlight, for example, in shadow, however efficiency is in that case considerably lower. The intensity of solar radiation falling

2 Biomass and Biogas are usually used for cogeneration of heat and electricity

3 Of course we need to take into account construction work that impacts on the surrounding environment. However, in terms of operation, it is a very environmentally friendly source.

4 A hydroelectric power plant with less than 10 MW of installed capacity.

5 For example, the Dlouhé Stráně power plant with 650 MWe of installed capacity has a 534.3 metre fall between the upper tank with 2,580,000 m^3 of volume and the bottom tank with 3,405,000 m^3. A comparison with the Chinese hydroelectric power plant Three Gorges Dam (San-sia Ta-pa) might be interesting here, having a 113 m fall and 26 × 852 MWe of installed capacity, which is all together 22,152 MWe, while active capacity amounts to 18,460 MWe (26 × 710 MWe). There are, moreover, another six 710 MWe units being built at the site. Once they are online, active capacity will reach 22,720 MWe, which is more than the entire capacity installed in all power plants in the Czech Republic.

6 Solar power plants are basically split into photovoltaic power plants, using photons to produce power, and solar heating power plants, which use solar thermal energy to heat a thermal transmitting medium for further use (heating water, power production, etc.).

7 The particles of light, photons, fall on a cell and "boot" electrons out of it. The semiconductor structure of a cell then regulates the movement of electrons as utilizable direct current (see Beranovský a kol., 2007).

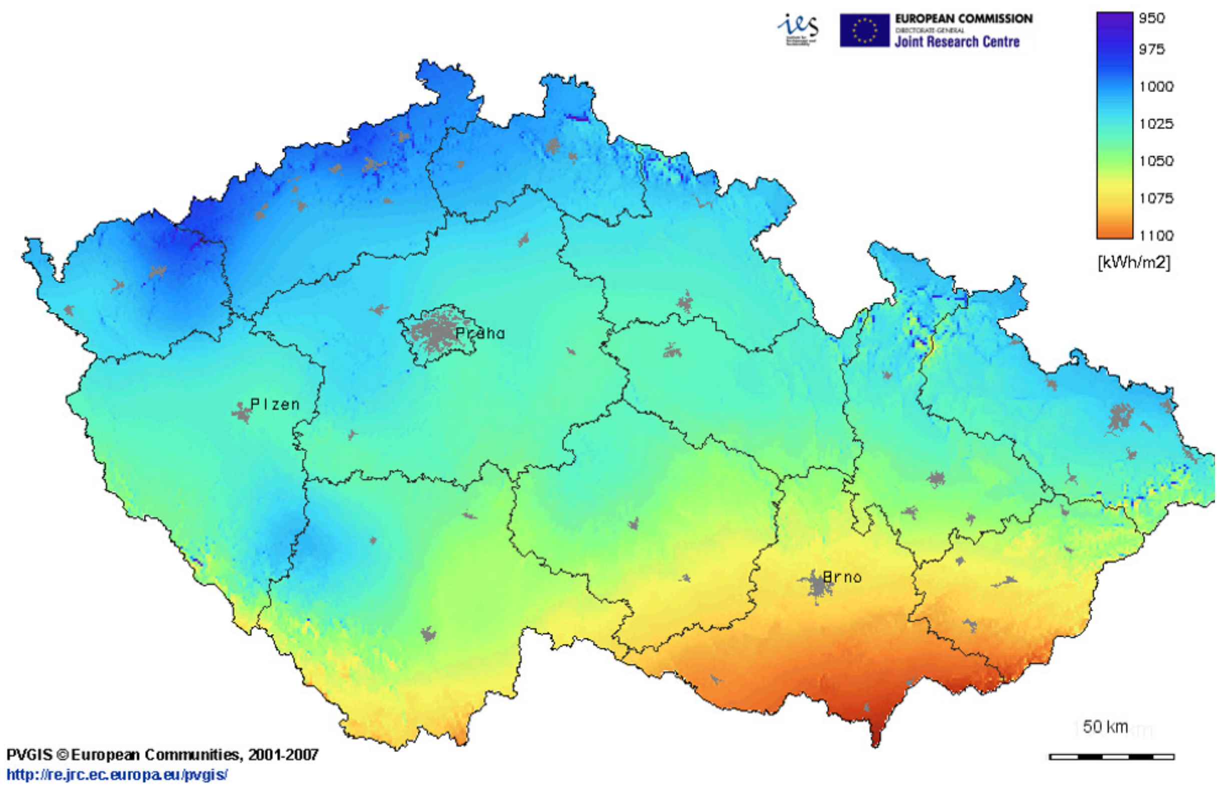
on 1 m² at the height of the atmospheric boundary (800 km) is 1,360 W/m² per second. This value is named the solar constant and describes the limits of solar energy. While passing through the atmosphere, part of the energy is reflected, and part is absorbed and scattered, striking the Earth's surface both directly and as scattered (diffusive) and radiation reflected from the clouds. When skies are clear, the capacity of solar radiation at the Earth's surface does not exceed 1 kW/m². When skies are cloudy, only scattered radiation is present, striking with a considerably lower (approximately 10 times lower) intensity (see Murtinger, 2008). The following table, Table 7.1, and the map provide insight into solar irradiance in the Czech Republic on a daily (angle of 40° south) and yearly basis (horizontal surface).

Tab. 7.1: The Amount of Solar Energy in the Czech Republic Striking a Square Metre of Surface Bent at an Angle of 40° South (Wh/m²/day)

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Praha	1,228	2,027	3,034	4,149	4,846	4,644	4,930	4,577	3,475	2,729	1,140	833	3,141
Brno	1,247	2,111	3,163	4,262	4,953	4,877	5,211	4,774	3,679	2,918	1,309	872	3,288
Plzeň	1,238	2,087	3,036	4,147	4,755	4,618	4,975	4,604	3,587	2,735	1,182	828	3,155
Ostrava	1,321	2,138	2,990	3,890	4,689	4,556	4,916	4,471	3,370	2,858	1,372	976	3,135
Břeclav	1,343	2,204	3,315	4,429	5,046	5,100	5,411	4,925	3,990	2,975	1,441	935	3,433
Aš	1,255	2,215	2,941	4,180	4,662	4,431	4,837	4,459	3,544	2,639	1,327	840	3,115
Ústí n. L.	1,231	2,080	2,956	4,063	4,788	4,507	4,751	4,405	3,365	2,677	1,207	841	3,078

Source: European Commission – Joint Research Centre, n.d.

Tab. 7.2: Yearly sum of global irradiation on horizontal surfaces in the Czech Republic



Source: European Commission – Joint Research Centre, n.d.

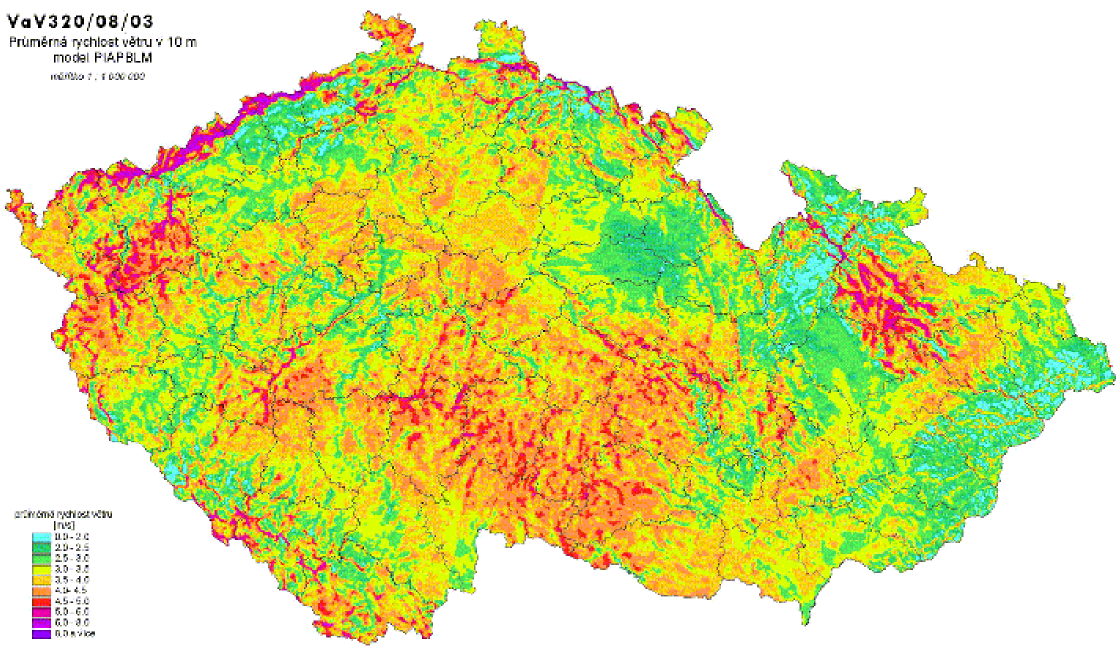
The average daily amount of solar energy, for example, in Brno is 3,288 Wh/m², which is 3.288 kWh/m². The other limitation of solar panels is their efficiency which currently resides at values of around 15%. Therefore, a square metre of solar panels can, under ideal conditions and a given efficiency, produce approximately 180 kWh yearly. This low capacity is enhanced by adding a surface of solar panels; the massive production of power and its transmission to the electrical network has given rise to solar parks, which are photovoltaic power plants with higher capacities (above 500 kWp).

The best known solar parks in the Czech Republic are Ostrožská Lhota (0.702 MWp) and Bušanovice I (0.693 MWp). In terms of the number of projects, the most successful company is Photon Energy[8], which as of July, 2016, owned and ran projects in the range of 93.8 MWp, for example Brno-Tuřany 21.2 MWp (see "*Photon Energy*"). Energy 21 Group is another example of a successful company operating solar power plants in Divčice 2.9 MWp, Rozvadov 2.9 MWp, Držovice 3 MWp, Určice IV 3.4 MWp, Tasov 3.2 MWp, Bojkovice 4.1 MWp, Kojetín 4 MWp, etc. Czech and foreign investment groups and banking institutions also participate in the realization of the projects (see Vinšová, 2009). ČEZ Obnovitelné zdroje, s. r. o. also owns several solar power plants, for example, Bežerovice (3.013 MWp), Buštěhrad (2.396 MWp), Čekanice (4.48 MWp), Hrušovany (3.73 MWp), Žabčice (5.6 MWp) and Chýňov (2.009 MWp) (see ČEZ, a. s., "*Provozované fotovoltaické elektrárny*"). Hundreds of other firms and households build, install and run solar power plants.

The very first solar power plant in the Czech Republic was the photovoltaic power plant Mravenečník in Jeseníky, which was built in 1997 by ČEZ with 10 kWe of installed capacity. In 2003, it was moved to the site of the Dukovany nuclear power plant, where it produces electricity to this day. The largest solar plant in the Czech Republic is the photovoltaic power plant Ralsko Ra 1 with 38.3 MWp of installed capacity[9]. Since 2010, the plant has been in the ownership of ČEZ, which bought it from eEnergy Ralsko, a. s. (see "*Největší solární elektrárny,*" 2010, still valid in 2019). The second largest power plant is the Vepřek photovoltaic power plant with 35.1 MWp. It was built by Decci, a. s., which in February 2010, by closing an agreement on in-kind contribution of business, placed the operation of the Vepřek power plant and the Vraňany transmitting station into the main capital of FVE CZECH NOVUM, s. r. o., owned by the companies Decci, a. s., (63 %) and Berlanga Uzbekistan B.V. (37 %). In 2014, Berlanga Uzbekistan B.V. sold its share to a Dutch-based company, PH ENERGY B.V. Finally, the third largest power plant is the Ševětín photovoltaic power plant, belonging to ČEZ.

Wind power plants are power plants which produce electricity by utilizing the flux of air. The air spins propeller blades attached to an electrical power generator. Wind power plants require a region with an average wind speed higher than 6 m/s, which is fairly rare in the Czech Republic (Tab 7.3 below shows the average wind speed in hundreds of meters to better illustrate how few windy areas there are). The regions in the Czech Republic that qualify as adequate sites for building wind power plants are Krušnohorsko, Jesenicko and Českomoravská vrchovina. Some locations in these regions revertheless cannot be exploited since they qualify as protected areas (see Poncarová, 2008).

Tab. 7.3: Average wind speed in hundreds of meters in the Czech Republic



Source: Global Energy Network Institute (GENI), Wind Energy Potential in the Czech Republic, n.d.

8 In 2016, Photon Energy took over 17 solar projects of Energy 21 Group of total installed capacity 28.5 MWp. Nevertheless, Energy 21 Group is still operating.

9 This is a group of four photovoltaic power plants kilometres distant from each other with an installed capacity of 14.269 MWp, 12.869 MWp, 6.614 MWp and 4.517 MWp.

In order to increase operating efficiency, wind farms emerge (groups of up over ten wind power plants). In the Czech Republic, wind power plants have a 2 % (308.2 MWe) share of installed capacity in the power system (see ERÚ, 2018, p. 25). Wind energy is also an intermittent source (i.e. with oscillating production) which functions only in the presence of wind. For this reason, there has to be an adequate reserve for each megawatt from wind power plants, since their production is unpredictable and varies quickly[10]. Wind power plants are coupled with fast, stable, and cheap sources, i.e. most frequently with gas fired power plants and hydroelectric power plants.

The companies owning the largest wind power plants in the Czech Republic are Ecoenerg Windkraft GmbH & Co. KG (42 MWe at Kryštofovy Hamry), Větrná energie HL, s.r.o. (18 MWe at Horní Loděnice), APB-PLZEN, a. s., (19.15 MWe – Petrovice, Pavlov, Břežany and Žipotín), WIND FINANCE, a.s., (10 MWe), ČEZ Obnovitelné zdroje, s.r.o. (8 MWe – Janov, Věznice), and Green Lines Rusová, s.r.o. (7.5 MWe) (see ERÚ, "Licence"). There are dozens of wind power plants in the Czech Republic. The majority of installed turbines are made by the Danish technology company Vestas (see Česká společnost pro větrnou energii, 2018).

Biomass is simply the most traditional source of energy, tied to the history of human kind. The initiation of plant combustion for heating and light purposes reaches back into the past. Biomass has four main positives: 1. it is a renewable, theoretically inexhaustible source, if rationally used; 2. if rationally used, it is CO_2 neutral; 3. it can be transformed into different solid, gaseous, and liquid biofuels as well as stored and then used when needed; 4. its use contributes to the development of agricultural regions by exploiting manpower, mechanization and by enhancing the local economy (see Weger, 2008, p. 9).

Biomass can be divided into two basic categories, residual and purposefully grown biomass. Residual biomass consists of logging waste, straw and other harvesting residues, cowshed manure, and organic residues from the manufacturing industry (paper and wood processing, sawmill, milk and food processing, etc.). First generation energy crops (for example, oilseed rape, oil palm tree, wheat or corn), second generation energy crops (poplar and willow trees, eucalyptus, sorrel, millet, etc.) and third generation energy crops (algae) are deliberately grown biomass.

Biomass power plants are, in principle, the same as steam power plants (see the chapter addressing the coal sector). The difference is that they combust (or combust in combination with fossil fuels) biomass, which is "the biodegradable fraction of products, waste and residues from the operation of agriculture and forestry and related industries, agricultural products grown for energy-production purposes, as well as the biodegradable fraction of separated industrial and municipal waste" (see "*Zákon č. 165/2012 Sb.*"). In terms of energy use, the Czech Republic uses mainly wood (or separated waste), straw, and other agricultural residues and livestock excrements, and separated municipal waste possible to utilize for energy purposes or gas products arising during wastewater cleaning treatment (see ČEZ, a.s., 2006, p. 37). Biomass intended for use in power or heating plants usually goes through a process of modification (grinding, drying, pressing, pelletizing, gasification, etc.), while the calorific value reaches 10–15 MJ/kg, depending upon the plant, with humidity levels maintained at 15–30 % (see ČEZ, a.s., 2003, cited according to ČEZ, a.s., 2012, p. 39–40).

Biomass has great promise as a source of energy. The combustion of deliberately grown crops arouses controversy when they happen to share a field with crops intended for the food industry. The result of state subsidies for renewable energy is that farmers find the growing of energy crops more beneficial than the growing of classic agricultural crops. Forest owners start selling wood and wood residues to heating and power plants, because the profit is, with state support included, higher than if the same materials were sold to paper mills and other wood processing sectors. So far, there is no need to be concerned about the security of food supplies in the Czech Republic, because should the utilization of biomass be rational and should the plans of the Ministry of Industry and Trade be executed, approximately 2/3 of arable land will remain for the production of food. The Ministry of Agriculture has allocated 2.07 million of hectares out of a total 3.05 million hectares of arable land (or 4.26 million hectares of all agricultural land) for security of food supplies purposes (see ÚVČR & NEK, 2008, p. 123).

From an environmental perspective, biomass combustion is based on the principle of a zero carbon cycle. During combustion, CO_2 is released in an amount equal to that a plant used for its growth. This design, unfortunately, does not recognize the harmful emissions emerging during agricultural work, such as the planting, treatment, and harvesting of crops, their modification for energy exploitation, or their transportation. For this reason, the particular procedures require a thorough assessment (for example, local use) in order to get as close as possible to the zero carbon cycle principle. The advantage of biomass combustion, if it is not combusted in

10 It is the same with photovoltaic power plants.

combination with fossil fuels, is the use of ashes as a highly quality manure. Biomass combustion in most cases also releases fewer sulphur fumes than fossil fuel combustion.

The largest power plants in the Czech Republic active in biomass combustion are Hodonín (105 MWe, 107 t/steam per hour), Poříčí (2 units of 55 MWe each), Teplárna Dvůr Králové (1 unit of 6.3 MWe and 1 unit of 12 MWe) and others such as Tisová I and Jindřichův Hradec, all in the hands of ČEZ (see ČEZ, "*Biomasa*"). These were formerly brown coal fired power plants, and they are among the oldest power plants in the Czech Republic.

In the Czech Republic, biomass is however used for *heat generation* (or *cogeneration*) purposes–in 2018 it saw the greatest use in the Vysočina, Plzeňský, and Ústecký regions (see Teplárenské sdružení České republiky, 2018). In recent years a major discussion has arisen on the use of waste combustion in the EU, as some environmental groups believe it should not be recognized as a renewable source of energy.

Biogas produced in biogas stations has been a very popular product in the biomass economy recently. Biogas stations are facilities that process a wide range of materials or waste of organic origins via anaerobic digestion[11] in the absence of air inside closed reactors (see Bačík, 2008, p. 27). This activity may split into three categories: agricultural biogas stations, co-fermentation (industrial) biogas stations, and municipal biogas stations. Agricultural biogas stations process dung or manure, co-fermentation biogas stations process slaughterhouse waste, sediments from specific facilities, sediments from wastewater cleaning treatments, fats, fleshed bone meal, blood from slaughterhouses, etc., while municipal biogas stations use biological waste from households, restaurants, canteens, the maintenance of public green spaces, etc. (see Trnavský, 2008a, p. 24; Bačík, 2008, p. 28).

Biogas can be utilized in many different ways: direct combustion, power and heat generation, in internal combustion engines, etc. Biomass processing can deliver various products, such as biogas, synthetic oil, ETBE[12] and MTBE[13], vegetable oil, biomethanol, engine oil and others.

Unlike the use of sun or wind (for power or heat production), biogas has one indisputable advantage – it is possible to store and perfectly manageable and usable when necessary. When the intensity of solar radiation is lower in winter and at night when the sun is absent–those times we need energy the most for heating and light–stores of biogas or biomass may provide power without interruption. Moreover, by increasing methane content above the 98 % level, biogas can be modified to acquire a natural gas-like quality, which enhances its value. Biogas stations are constructed in keeping with the contemporary trend towards energy decentralization. With regard to their size, they are utilized like local sources and, since they process waste materials, also count as very environmentally friendly. Power production from biogas in 2017 reached 389 MW of installed capacity (2,639 GWh) (see MPO, 2016 p. 90; ERÚ, 2018, p. 8, 23). Its potential in terms of environmental protection, renewables development, and the production of power, heat and other products, is not insignificant. For instance, the biogas station in Číčov operated by ČEZ has an installed capacity of 526 kWp and annually produces 3,372 GWh of electricity and heat for over 1000 households (see ČEZ a.s., "Číčov"). According to the National Action Plan, development should reach 403 MW of installed capacity (3,041 GWh) by 2020 (see MPO, 2015, p. 90). Since 2014 biogas has been the number-one RES in electricity production in the Czech Republic (see the chart 7.4).

Solar collectors are another renewable source used in the Czech Republic to generate heat. A solar collector is a device serving for the direct absorption of solar radiation and heating fluids for direct use or for heating another fluid in a heat exchanger, which may then circulate through a central heating supply system. The solar collector is composed in such a manner as to absorb solar radiation to maximum effect, then to convert it into heat without reverse emission and deliver this heat to the heating fluid with a minimum loss of thermal energy during the transmission and streaming processes (see Eckertová, 1996, p. 9). A solar collector is a closed, thermally insulated case consisting of permeable glass, an absorber placed underneath the glass (usually a black plank which warms up to 120°C), a system of tubes with a thermal transmission medium (water, oil, air, or gas), thermal insulation and an adequate exchanger (see ČEZ, a.s., 2006, p. 12). There is no larger solar collector in the country and, because of weather conditions, it is unlikely there will ever be one. Solar collectors are therefore used on local bases by single households, mainly to heat water and rooms, but this can bring significant savings in total energy consumption.

11 Anaerobic digestion is the biological degradation of organic materials in the absence of air. The result of this process is a biologically stabilized substrate with a highly fertilizing effect, and biogas with a 55–70% share of methane and a calorific value around 18–26 MJ/m^3 (see Mužík & Kára, 2008, p. 22).

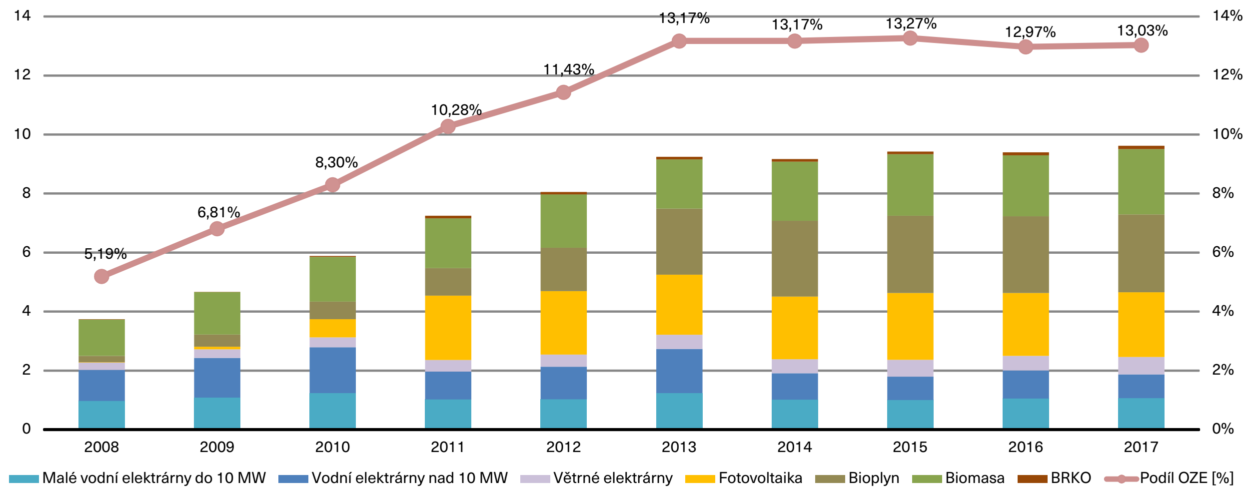
12 Ethyl Tertiary Butyl Ether

13 Methyl tertiary butyl ether

Geothermal energy is simply power derived from the Earth's internal heat, often used for heating or cooling. Geothermal power plants use steam turbines to generate electricity. This approach is very similar to other thermal power plants that use sources of energy other than geothermal. Water is either heated or used directly in case of geothermal dry steam power plants. Very deep wells (sometimes exceeding 1.5 km) are drilled into underground reservoirs to tap steam and very hot water. This then drives a steam turbine which converts the thermal energy to electricity with a generator through an electromagnetic induction. The next step in the cycle is to cool the fluid and send it back to the heat source (see Energy Informative, n.d.). So far, there is one *geothermal power plant* in Děčín (owned by Termo Děčín a.s.) with a well 545 meters deep which supplies heat to half the city´s households. Three other plants are planned within the Czech Republic (at Litoměřice, Tanvald, Dětřichov) and should be operational by 2021 (see MPO, 2019a, p.65).

Table 7.4 shows the distribution of renewable energy sources over gross electricity production and its share in total gross national consumption (see ERÚ, 2018, p. 8). As we can see, most of the electricity from renewables in the Czech Republic was produced by biogas followed by solar power plants and biomass.

Tab. 7.4: Evolution of gross electricity production from RES and its share of gross national consumption (TWh)



Source: ERÚ, 2018, p. 24

Renewable energy in the transportation sector is also gaining importance, with biodiesel in the lead. Other important sources of final consumption in RES in transport in the Czech Republic are bioethanol and electricity from RES. The recast of the Directive on the promotion of the use of energy from renewable sources obliges the EU member states to a uniform goal of 14% in the transportation sector. In 2016, the Czech Republic had a share of RES in final consumption of 7.4%. (see MPO, 2019a, p. 71)

7.3 The Regulatory and Safety Framework of the Renewables Industry

The local legal framework for renewable sources of energy is formulated in four legal acts. These are Act No. 180/2005 Coll., on the Promotion of Electricity Production from Renewable Energy Sources and Amending Certain Acts (and its Executive Regulations), Act No. 406/2000 Coll., on Energy Management (and its Executive Regulations), Act No. 458/2000 Coll. on Business Conditions and Public Administration in the Energy Sector and on Amendments to other laws (and its Executive Regulations) and Act No. 165/2012 Coll. on Supported Energy Sources and on Amendments to Other Laws.

Under Act No. 180/2005 Coll., the level of subsidy (green bonus; feed-in tariff) is determined by the Energy Regulatory Office, which by virtue of its ordinance-making power and, primarily, cost regulation, constitutes the main regulatory body overseeing renewable energy sources (together with the Ministry of Industry and Trade). The Office is, among other things, engaged in support of the exploitation of renewable and secondary sources of energy, the combined production of power and heat, and protection of consumer interests in these energy sectors, in which competition is not possible.

Aside from state aid supporting the utilization of renewables, Act No. 180/2005 Coll. also obliges the operators of regional distribution systems and the transmission system "to purchase all electricity from renewable sources eligible for promotion and to conclude a supply contract, if a producer has offered electricity from renewable sources... Assumption of responsibility for deviation pursuant to special regulation" is of extreme importance, as well (see "*Zákon č. 180/2005 Sb.*"). Act No. 180/2005 Coll. Spells out the obligation for preferential purchases of electricity from renewables for all licensed third parties with a license approved by the Energy Regulatory Office and, accordingly, the responsibility of CEPS to maintain network stability in the event of unstable production of electricity from renewables. But Act No. 180/2005 was rescinded by Act No. 165/2012, which is currently in force (the above terms were transferred to this new Act). This meant the end of support for newly installed renewable sources with a few exceptions–small hydroelectric power plants with an installed capacity of <10 MW and transitional provisions for wind, geothermal, and biomass power plants (established by amending Act No. 165/2012 1 January 2014). Also, the 2012 Act revoked the previously established obligation for operators of the transmission system to purchase all electricity from renewable sources eligible for promotion. Lots have changed due to the so-called "solar boom" described below, yet Act No. 180/2005 remains a milestone in the promotion of renewable energy sources. The amendment of Act No. 165/2012 is expected to come into force during 2019. It concentrates mainly on prosumers, the transportation sector, heating and cooling, the combined production of electric power and heat, the accumulation of energy, overcompensation, and RES auctions as a way to attain RES targets for 2030. (see Denková, 2018; Ministry of Industry and Trade, 2018).

At the supranational level, there is the Directive of the European Parliament and of the Council 2009/28/EC of April 23, 2009, on the Promotion of the Use of Energy from Renewable Sources and Amending and Subsequently Repealing Directives 2001/77/EC and 2003/30/EC (see "*Directive 2009/28/EC*"), also called "RED". This directive was fully implemented in the National Renewable Energy Action Plan starting July 2010 (see MPO, 2010c), a document which, as amended by the Directive, sets the national goals of member states regarding the share of energy from renewables in the transportation, power, and heat generation and air conditioning sectors by 2020. In December 2018, "RED II" came into force as part of the EU´s Winter Package, which aims to provide *clean energy for all Europeans*. It establishes a binding EU target of at least 32% RES for 2030 with a review in 2023 to assess whether this figure should be increased (while the Proposal for a Directive of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources from 2016 saw a 27% share of RES as the most efficient solution). It and the Energy Efficiency Directive, the Energy Performance of Building Directive, and the Governance Regulation, make four out of eight legislative acts in the Winter Package approved by 2018 (see EC, 2018). The four remaining directives were approved in mid-2019[1].

The climate and energy framework for 2030 was set mainly by the Winter Package. The 2030 target of 32% is officially binding only at the EU level. This is in contrast to the 2020 targets that were legally embedded in the mandatory National Action Plans. The realization of 2030 targets will be met through the Energy Union Governance Regulation, which imposes an obligation to draw up a National Climate and Energy Plan and national long-term strategies for individual Member States from 2021 to 2030 outlining how to achieve the targets. The European Commission will then observe whether the national targets accommodate the overall goal of 32%.

Due to dynamic changes in the RES sector and in keeping with Czech Act No. 165/2012, it was decided to periodically update the National Renewable Energy Action Plan. The latest Action Plan is from February 2016 and anticipates a 15.3% share for RES in total gross energy consumption and a 10% RES share in total gross consumption in the transport sector (see MPO, 2016). After 2021, this document will be replaced by the Intrastate Energy and Climate Plan.

In terms of obligations deriving from membership in international organizations, the Czech Republic has become subject to seven significant legal obligations (see Table 7.5). The first and third may be considered to have been satisfied, while the second has actually been exceeded by 0.3%. The fourth obligation seems at this point hardly to be achievable. The fifth obligation, although very ambitious, should be achievable (according to Zámyslický, 2009). The sixth and seventh obligations may be seen as new challenges for the Czech Republic, the EU, and the whole world struggling against climate change.

1Namely: Electricity Directive, Electricity Regulation, Risk-Preparedness Regulation, Regulation for ACER.

Tab. 7.5: Obligations Resulting from Membership in International Organizations

	Obligation	Obligation as Amended by
1.	Reduction in greenhouse gas emissions by 8% by 2012.	Kyoto Protocol (1997) 2005
2.	A greater renewable energy share in gross final consumption, reaching a level of 8% by 2010 and a level of 15% by 2030.	EU Accession Agreement (Athens, April 16, 2003)
3.	A greater renewable energy share in gross final consumption, reaching a level of 13% by 2020.	Directive of the European Parliament and of the Council 2009/28/EC
4.	Reaching a renewable energy share of 10% in all sorts of transportation displayed in gross final energy consumption in transportation in the Czech Republic by 2020.	Directive of the European Parliament and of the Council 2009/28/EC
5.	Emissions from sectors not covered by the EU ETS will not exceed 2005 levels + 9% by 2020.	EU Climate and Energy Package 2009
6.	The main aim is to hold the increase in the global average temperature to well below 2°C ideally to 1.5 °C) above pre-industrial levels.	The Paris Agreement (UNFCCC[2]) 2016
7.	A greater renewable energy share in gross final consumption, reaching an overall target of 32% by 2030 for the EU as a whole (20.8% for the Czech Republic, see below).	The EU Winter Package[3] – Directive (EU) 2018/2001 on the Promotion of the Use of Energy from Renewable Sources & The Regulation on the Governance of the Energy Union and Climate Action

Source: T. Vlček and E. Trmalová from publicly available sources

7.4 Demand Forecast

In comparison with the objective declared in Directive 2009/28/EC, the National Renewable Energy Action Plan of the Czech Republic of 2016 foresees a renewable energy share in gross final energy consumption of 15.3% and a renewable energy share in gross final consumption in transportation of 10% by 2020 (see MPO, 2015, p. 4). The plan for the following years under the proposed Intrastate Energy and Climate Plan is presented in the following tables.

Tab. 7.6: Scenario of renewable energy share in final energy consumption by sector (%)

Year	2016	2020	2023	2025	2027	2030
Electricity	13.6%	14.0 %	14.3 %	14.5 %	14.3 %	14.2 %
Transportation	6.4%	8.8 %	8.6 %	9.5 %	11.3 %	14.0 %
Heating & Cooling	19.9%	22.0 %	24.6 %	26.0 %	27.5 %	30.0 %
Total	14.9%	16.3 %	17.9 %	18.6 %	19.4 %	20.8 %

Source: The Ministry of Industry and Trade, 2019b, p. 25

Tab. 7.7: Anticipated development of renewable energy sources in electricity sector (TJ)

Year	2016	2020	2023	2025	2027	2030
Biomass[4]	7,443.9	8,431.2	8,525.1	8,607.8	8,635.3	8,988.4
Hydroelectric power plants	8,205.5	7,944.5	7,664.7	7,299.8	7,236.9	7,106.7
Biowaste[5]	354.8	432.8	1,241.0	1,354.4	1,354.4	1,479.1
Biogas stations	9,320.5	9,469.5	9,109.6	8,970.0	7,831.2	5,683.0
Geothermal energy	0.0	152.1	152.1	152.1	309.6	404.1
Wind power plants	1,867.1	2,424.8	3,041.8	3,572.3	4,119.8	5,115.7
Solar power plants	7,673.2	8,050.8	8,169.6	8,374.8	8,713.2	9,490.8
Total	34,865.0	36,905.7	37,903.9	38,331.2	38,200.4	38,267.8

Source: The Ministry of Industry and Trade, 2019b, p. 24

2 The United Nations Framework Convention on Climate Change

3 Clean Energy for All Europeans

4 not used by households

5 The biodegradable portion of municipal solid waste

Tab. 7.8: Scenario of renewable energy share in final energy consumption according to the Ministry of Industry and Trade of the Czech Republic for the purposes of the Intrastate Plan (TJ)

Year	2016	2020	2023	2025	2027	2030
Electricity	33,247.7	36,905.7	37,903.9	38,331.2	38,200.4	38,267.8
Transportation	14,197.3	18,557.9	21,021.7	22,491.6	25,048.8	29,421.2
Heating & Cooling	117,220.8	127,351.1	140,697.1	146,854.9	153,579.2	164,483.4
Total	164,665.8	182,814.7	199,622.7	207,677.7	216,828.4	232,172.4

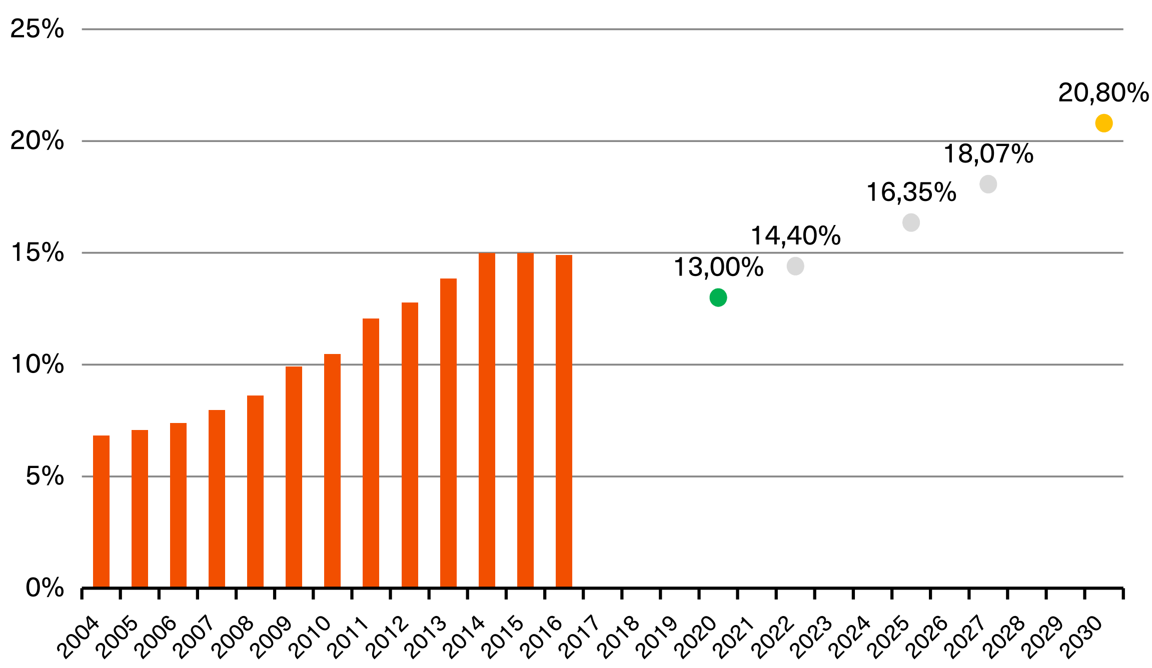
Source: The Ministry of Industry and Trade, 2019b, p. 23

Based on obligations resulting from the EU Winter Package, namely the Directive (EU) 2018/2001 on the Promotion of the Use of Energy from Renewable Sources and the Regulation on the Governance of the Energy Union and Climate Action Setting Targets Until 2030, the Czech Republic has proposed the goal of a 20.8% share for RES by 2030 as stated in the Development of the Supported Sources by 2030, which serves as background material for the preparation of the Intrastate Energy and Climate Plan. This document also sets a target for the transportation sector of 14%. (see MPO, 2019a, p. 3–4, 22)

The Ministry of Industry and Trade has determined that the share of renewable energy sources must be increased to approximately 6% by 2030 (see MPO, 2019b, p. 67). But the document warns that for such a low percent increase of new sources, it will be necessary to keep efficient plants in operation. Terminating support for these plants might then leave them incapable of remaining in operation without aid. The major threat is to biomass and biogas plants, without which it would be necessary to increase the RES share even above 12% in order to meet the 20.8% target. Thus it is anticipated that efficient plants will be given support to continue electricity production or to modernize (see MPO, 2019b, p. 26, 145). The DUHA movement, Zelený kruh association, Calla z.s., Glopolis think-tank and Centre for Transport and Energy do not agree with official 2030 target of the Ministry of Industry and Trade. They believe that the proposal should be at least 24%, as there is potential for RES to account for 22–28% of expected energy consumption in 2030 even without advanced biofuels or other new technologies in the transport sector. The proposal is to be discussed with the European Commission; thus it is possible that the Czech Republic might be asked to set a higher goal. (see Euractiv.cz, 2019)

The Proposal of the Intrastate Plan of the Ministry of Industry and Trade sees development as shown in Table 7.9. The green dot at 13% shows the EU 2020 target; the yellow dot at 20.8% shows the 2030 target (see MPO, 2019b, p. 22):

Tab. 7.9: Development of the RES according to the Proposal of the Intrastate Plan of the Ministry of Industry and Trade



Source: MPO, 2019b, p. 24

Under the amended Act No. 165/2012 Coll., the state intends to reach these levels mainly by using the auction mechanism (described below) to install a new RES over 1 MW, while smaller sources will be able to apply for an hourly green bonus. Many states already use RES auctions as a way to promote renewable energy for their market base. It also helps to decrease the price of electricity by using a "price-only criterion", which means the cheapest projects succeed at auction. RES auctions should start in the Czech Republic in 2020. Investment support is often spoken of as part of state programs of support. There are two main programmes aimed at investment support, Nová zelená úsporám ("New green for savings" which is focused on housing, for example using thermal insulation) and OP PIK (the Operational Program of the Ministry of Industry and Trade financed by the European Regional Development Fund, focused on small- and medium-sized firms[6]) (see Enviweb s.r.o., 2017). Other options are investment support for research and development, structural funds drawing on EU financial resources, changes to waste management policy and support for the waste-to-energy principle, suitable and adequate operational support for power production, raising public awareness, simplifying and shortening the approval process for building electrification facilities, and other means. (see MPO, 2010c, p. 89–97).

Forecasts for decades in advance are, however, always too broad to pinpoint events that could actually come to pass. Any significant development of renewables is obstructed by a string of objective and subjective obstacles, which will be discussed in the following section.

7.5 Criticism and Development of Renewables

The Czech Republic was obligated to abide by a goal of deploying RES by 2020, and so Act No. 180/2005 established a system of support. The state system to promote renewables was set up to be very generous and allowed only a 5% annual decrease in the purchase price. This generosity is visible in the following example: while in 2005 the purchase price of electricity from photovoltaic power plants was 6.04 CZK/kWh, the Energy Regulatory Office more than doubled this value in 2006 to 13.2 CZK/kWh (which was about twelve times the market price of electricity) (see Zajíček, 2010, p. 62). This well-meant plan unfortunately did not foresee the events of 2008, when the price of PV technology decreased radically due to the mass production of PV panels in China. This led to a "solar boom" in the Czech Republic, which because of its limited suitability in terms of natural conditions had not anticipated strong development of solar technology (see Vobořil, 2015). For example, the target of 1,695 MWe of installed capacity in photovoltaic power plants, which the Czech National Renewable Energy Action Plan set for 2020, was already surpassed in 2010.

The originally well-planned program was supposed to motivate citizens to accept renewables, to trust their potential, and increase renewable energy's share in the total production and consumption of electricity in the Czech Republic, in order to meet the commitments required under international agreements. In reality, however, citizens and the industrial sector identified the opportunity and prospect of easily obtainable and guaranteed state money over the course of several years, and photovoltaic plants consequently experienced an incredible expansion. Not even the Energy Regulatory Office was able to manage the situation, since the law allowed it to lower the purchase price of electricity from renewables by at most 5% per year. An amended version of the law allowing more substantial reductions did not come into force until 2011.

These events naturally led to growing risk from problems arising inside the transmission system and even more so inside the distribution system. The progress predicted by the National Action Plan called for a notably easier pace and would thus have allowed for the simultaneous development of infrastructure. Given that the installed capacity of photovoltaic power plants preceded the National Action Plan, but the development of infrastructure and facilities was running according to plan, it came to a collision between renewables development and the potential of existing technical foundations. This discrepancy finally led to a situation Jan Zeman describes as a "renewable energy crisis" (see Zeman, 2011, p. 44–48).

The discrepancy triggered the crisis, which erupted on February 16, 2010 when ČEZ Distribuce, a.s. and E.ON Distribuce, a.s. acceded to the request of CEPS to stop approving applications for the installation of new photovoltaic and wind power plants in the network (see Zeman, 2011, p. 44–45). If we observe Table 7.10, it is clear that it was impossible to react to this unexpected and unanticipated development of photovoltaic (and wind) power plans in a timely manner by developing the technical base of the electrification system.

6 The program is focused on accumulation, biogas, biomass, rooftop PV installations, energy saving, smart grids, e-mobility, and small hydroelectric power plants

Tab. 7.10: Installed Capacity of Photovoltaic Power Plants in the Czech Electrification System (MW)

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Inst. capacity	0.13	0.13	0.74	3.4	39	465	1,959	1,971	2,086	2,132	2,067	2,075	2,068	2,069

Source: Energetický regulační úřad 2018, p. 25 (note: data for 2004–2007 are from the previous reports)

These figures are the basis for specific total expenditures intended for photovoltaic and wind power plants inside the Czech electrification system, which are outlined in Table 7.11. Miroslav Zajíček argues that this figure is approximately equal to the figure which would cover pension reform, or to two to three times the estimated costs for completion of the Temelín nuclear power plant (see Zajíček, 2010, p. 63). Energy for industry in the Czech Republic became the most expensive in Europe, which negatively impacted the competitiveness of Czech firms (see Vobořil, 2015).

Tab. 7.11: Total Expenditures for Photovoltaic and Wind Power Plants in the Czech Electrification System, 2010 – 2030

Gross Costs	Total 2010 – 2030 (mil. of CZK)	Share of Total (%)
Direct costs of electricity purchased in photovoltaic power plant	509,916	72.6
Direct costs of electricity purchased in wind power plant	44,836	6.4
Costs of the provision of sufficient PpS	48,948	7.0
Costs of induced investments	18,035	2.6
Costs of additional regulatory energy	80,380	11.4
In Total	702,116	100

Source: Zajíček, 2010, p. 66; modified by T. Vlček.

The state was, of course, aware of the situation and fighting it in its typical manner. In November 2010, Amendment No. 330/2010 Coll. and, in December 2010, Amendment No. 402/2010 Coll. to Act No. 180/2005 Coll., on the Promotion of Electricity Production from Renewable Energy Sources and Amending Certain Acts, were passed and entered into force on March 1, 2011. The amendments introduced several changes, among them that from now on the state would support only those photovoltaic power plants connected to the distribution network, i.e. photovoltaic systems producing electricity or heat only for household purposes would not be supported. Solar farms were also to be cut off from support, and state support will go only to photovoltaic power plants placed on roofs and buildings with installed capacity of no more than 30 kWp. A retroactive solar tax of 26% was introduced for all photovoltaic facilities launched in 2009 and 2010 and 10% for photovoltaic facilities launched after 2010. An exemption was approved only for devices on house rooftops with a capacity reaching less than 30 kWp. The changes also affect the regulation of purchase prices performed by the Energy Regulatory Office. For example, should renewables in the year the new regulations affecting purchase prices apply reach a return on investments of less than 11 years, they are subject to not more than 5% of the yearly reduction in purchase prices. In 2011, the purchase price of electricity from renewables was set at 7.5 CZK/kWh.

These amendments were understood as a temporary solution, while the conceptual solution found its expression in a bill on supported sources of electricity which replaced Act No. 180/2005 Coll. It entered into force on January 1, 2013, as Act No. 165/2012 Coll. on Supported Energy Sources and on Amendments to other laws, and simultaneously annulled Act No. 180/2005 Coll. Following its approval by the Chamber of Deputies and the Senate on January 31, 2012, the president, Vaclav Klaus, vetoed it in March of the same year. The arguments for his position were the widening of the scope of supported sources of energy to include biomethane and low legislative quality requiring "a string of regulations implemented through the means of the relevant legislature", where "such regulations would represent a violation of the Constitution and of the Charter of Fundamental Rights and Freedoms, since the law permits the setting only of technical details of enforcement via ordinances and regulations and not citizens' own rights and obligations" (see "*Stanovisko prezidenta*"). Act No. 165/2012 Coll. was nonetheless passed on May 9, 2012, when the Chamber of Deputies overrode the president's veto with an overall majority.

The Act in reality adds some new promoted sources, namely support for heat generation from renewables, biomass, and geothermal with a capacity of more than 200 kW connected to the system of central heating. The Act was closely tied to Directive 2009/28/EC. Under the National Renewable Energy Action Plan, the connection of renewables to the network was to be, from that point forward, capped with a yearly capacity. Though Directive

2009/28/EC understands the levels of the National Action Plan to be the minimum, the new Act No. 165/2012 Coll. takes them as the maximum. These caps, in keeping with the National Action Plan, are calculated every year not only for the entire Czech Republic, but for individual regions, as well. Should they reach the upper limit, no further connection approvals will be granted until the following year. It must be added that the National Renewable Energy Action Plan by 2020 was already fulfilled in 2010 due to the solar boom. In reality, this meant the end of newly installed capacity (see table 7.10). Support for photovoltaic power plants has recently been limited to a production capacity of less than 30 kWp located on the roof or perimeter wall of a building attached to the ground via firm foundations registered in the real property registry (see "Zákon ze dne 31. ledna 2012").

From September 2013, the amended act stopped support for all RES put into operation after 2014. This meant the end of support also for more efficient sources such as small hydroelectric power plants of less than 10 MWe and biomass plants that could have been used instead of PV (see Svoboda, 2017). The amendments and the new act contributed to the stabilization of the renewables sector that used to be beneficial mainly for photovoltaic power plants. The price to be paid is, naturally, high. The subsidy for RES costs approximately CZK 40 billion yearly (roughly €1.6 billion). The state budget pays approximately CZK 26 billion annually of the total sum; another portion is paid out of the solar tax; and the rest is paid by customers through the contribution to renewable energy. This contribution amounted to CZK 28 /MWh in 2006 but in 2013 it was already CZK 583/MWh. Due to this increase, it was capped in 2014, mainly due to the pressure of industry representatives who were afraid they would not be competitive on the international level. The contribution cannot grow beyond CZK 495/MWh. This means the Czech Republic pays the highest subsidy per MWh versus other European states. The precise figure is € 198.29/MWh (see Oenergetice, 2019a, 2019 b). The abrupt suspension of the sector and a significant change in terms led to the bankruptcy of about ten companies trading in photovoltaic technologies, while the state will be financially burdened with support for decentralized production and renewables for decades (see below). Renewables have been discredited in the public eye to a great extent. In 2004, the production of electricity from renewables reached a figure of 2.61 TWh and a 3.80% share in consumption. In 2012, production of electricity from renewables amounted to 8.06 TWh, while the share in consumption was 11.43% (see Energetický regulační úřad, 2013). In this context, it depends upon whether we are really speaking of positives figures. It is also worth saying that after the "renewable energy crisis" there has been visible stagnation in efforts to install new capacity. Now there are efforts to change this, besides other things to meet the 2030 EU targets. The amended Act No. 165/2012 Coll., in force from 2019, aims to support new installations of RES above 1 MW via auctions (starting in 2020) and smaller installations will be supported through the green bonus in an hourly regime. It also calls for compensating existing efficient RES power plants for their increased expenses. The National Renewable Energy Action Plan also deals with the share of RES and the Intrastate Energy and Climate Plan concentrates, aside from RES, on GHG emissions, energy efficiency and the interconnectivity of transmission systems.

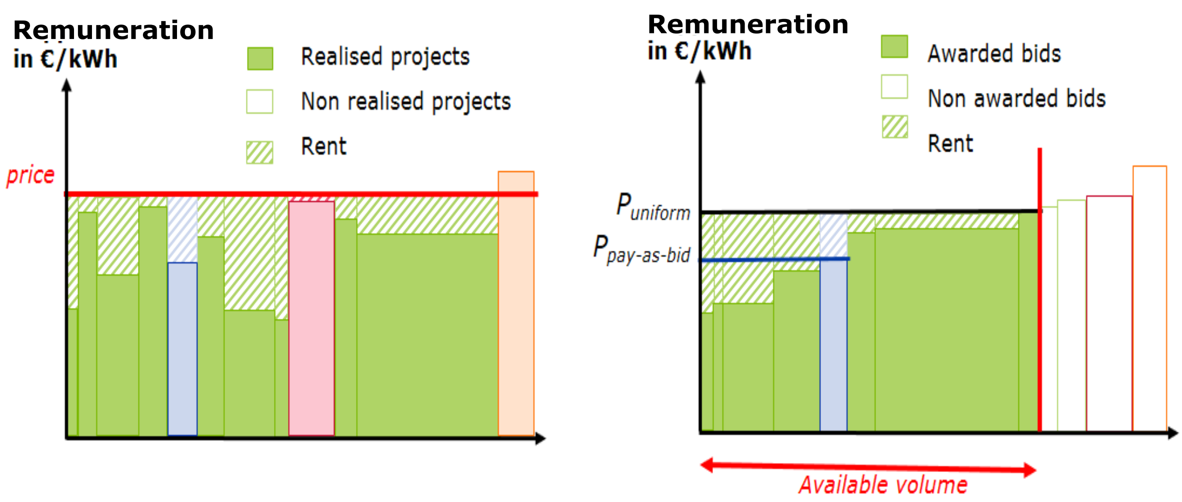
7.6 Current State of Renewables

Currently under Act No. 165/2012, there are two types of support for RES plants installed before 2013: the feed-in tariff and the green bonus. The two subsidies cannot be combined. The feed-in tariff is a regime in which a producer of energy from RES gets a fixed amount per MWh from the state. A producer who decides instead for the green bonus consumes his energy and sells his surplus to the electricity trader of his own choice and receives a bonus, that is the financial amount increasing the market price of electricity. The level of the green bonus is stated by the Energy regulatory office and works in hourly or yearly regime (Amended Act 165/2012 will allow only the hourly regime as a more market-oriented choice).

Establishing support for RES and changing support levels are the riskiest factors affecting investments in RES in the Czech Republic and influence installation costs versus other countries (see Kučera, 2016). This has resulted in a lack of new RES installations, making the situation unsustainable in the long-term. Although feed-in tariffs once had a dominant position as the chief subsidy tool for RES, in 2017 auctions gained the upper hand. Table 7.12 helps to better understand the difference between the feed-in tariff and the auction mechanism. With a feed-in tariff (FIT[7]), the government sets the price and markets set the quantity, which makes the newly installed capacity hardly predictable. This was the stumbling block for the Czech Republic. With an auction, by contrast,

7Or its mutation – Feed-in premium (FIP) the government sets the volume and the market then determines the price, which is usually lower, reflecting real investment costs. Winners then get a guarantee on the price of electricity for a certain number of years, equal to the price they bid at auction (*pay-as-bid pricing*). With *uniform pricing*, usually the final successful bidder determines the price for all selected projects. However, this description is highly simplified. There are many design elements that determine the course of the auction.

Tab. 7.12: The difference between FIT and Auction mechanism



Source: IRENA, 2017, p.4

RES auctions, when properly set, can solve the problem of supporting RES on the market principle (since 2017, the EU has required competitive tender procedures as the sole means of new RES subsidy mechanisms[8]) and not excessively burden the state budget. Also, well designed auctions can support higher deployment of community and municipal projects. Directly involving people may increase public support for RES once again. The Czech Republic aims to gradually decarbonize its economy, have sustainable growth, protect the environment, moderate the impact of climate change, increase energy independence and energy security, and fulfil its international commitments. Taking into account the uncertain future of nuclear power plants and the decline of many major coal power plants is another reason to boost the share of RES, and legislators are aware of the changes that must be made. It is still not likely that RES will be cheap enough to survive without support, which opens the door for auctions in the Updated State Energy Concept from 2015 as a way of supporting RES. Czech legislators are readying the first auction round(s) for 2020. The major inspiration was found in German auction design (pay-as-bid pricing formula, price-only winners selection criterion; see IEA, 2018). The auction mechanism will be put to the Czech legislature as a minor amendment to the Energy Act and Act No. 165/2012 Coll. on Supported Energy Sources. The draft of this Act excluded large solar power plants from the auctions. It is also probable that future auctions will take place at the cross-border level, as well–another reason to start with auctions soon in order to get used to the mechanism.

In addition to the uncertain business environment with regard to RES, there is another pressing current issue. According to a Notification Decision of the European Commission, Member States must examine the issue of possible overcompensation. States will be monitored as to whether public support for RES has been accumulated. Not to do so would disproportionately increase the profit of producers instead of making for level conditions. This together with the stigma of RES within Czech society has resulted in the process of RES installation stagnating.

The Czech Republic accepted an obligation to increase the share of renewable energy in gross final energy consumption to 13% by 2020 and to at least 20.8% by 2030. It should be noted that with respect to unstable production of electricity from renewables, information about installed capacity does not provide many insights, because gross final energy consumption is what counts. The unknown quantity is clarified by the *capacity factor*, which provides information on real electricity production compared to the installed maximum. It detects what

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percentage of the installed capacity can be utilized, e.g. when there is a good wind or sunny conditions, etc. In the Czech Republic, solar power plants´ capacity factor is around 12%. Wind power plants can reach up to 20%, but the numbers fluctuating significantly throughout the year. Small hydroelectric power plants reach around 50% or greater, depending on annual rainfall. Biomass and biogas may reach around 80–90% (see Bechník, 2014; averages from publicly available sources).

"Its geographical location and geological and climate conditions give the Czech Republic a perpetual but significantly limited potential for the development of renewable sources. The Czech Republic does not have sufficient potential at its disposal to develop the wind, solar, or geothermal power. The environmental contribution of the developing combustion of emission biomass is questionable, since the theory of the zero CO_2 balance is, in the case of biomass, only a play on words. The only relevant renewable sources in the Czech Republic are hydroelectric power plants, although a great measure of their potential has been already exploited" (see Kavina, 2009, p. 321, still valid in 2019). This is how Pavel Kavina, Director of the Raw Materials and Energy Security Department of the Ministry of Industry and Trade, assesses the state of renewables in the Czech Republic. The Paces Commission (see the chapter on history for more details) is notably more positive, claiming that the Czech Republic, at the current level of knowledge, possesses the potential to increase power production from the 0.15 TWh per year recorded in 2010 to 5.67 TWh per year by 2030 and as much as 18.24 TWh per year by 2050 in the photovoltaic sector (see ÚVČR & NEK, 2008, p. 123). According to the analysis of the RES Chamber, wind power has big potential that could cover over one-third of electricity consumption. Currently it amounts to around 0.7 %. The limitation on this potential might be the high installed capacity in neighbouring Germany, which pushes prices down would thus make Czech wind farms uncompetitive. Also, photovoltaics have the potential to reach 5,500 MW of installed capacity in 2030. With the decreasing price of solar panels and the growth of electricity storage options, expectations for their share in the energy mix are high. It is also worth mentioning that biogas, which accounted for 332 MW in 2018, has the potential to reach 485 MW of installed capacity in 2030. (see Europeum think-tank, 2018, p. 2–4)

Within Czech society, the opinion is often expressed that renewable energy is too expensive and should not be promoted. Of course, after the renewable crisis, it is unsurprising that people tend to see only the negatives of renewable energy. But it must be realized that every industry sector has gone through birth pangs and required subsidies to become competitive. Every industry sector has gone and must go through its own development. Should support reach the levels enjoyed by the nuclear power industry, we may expect a considerable increase in stability, operational security, efficiency, and other features of renewables (see Šafařík, 2000, p. 59). The problem the renewable sector presently faces is that subsidies push it onto the market artificially to speed up the process without first letting it go through its own developmental period.

Renewables are not essentially bad–quite the contrary. It is, however, always necessary to take the security of entire energy sector and a balanced energy mix into consideration. The objective limits for the development of renewables may be found in the inadequate natural conditions, climate and geography of the Czech Republic and the still low efficiency and stability of energy production from renewables, as well. There is moreover always a shortage of renewables for completing the binding goals set by the EU, and therefore massive development is required. This will, however, mean a consequent rise in the massive risk induced by implementing renewables into the operating process of the entire electric power industry and the power industry in the Czech Republic. With growing flexibility in the network (smart grids, aggregator of flexibility, demand side response) and with higher implementation of less fluctuating RES such as biogas, biomass or waste, it will be possible to work with decentralized sources such as RES much better and use them to cover peak loads.

Power should be produced in large amounts in a stable manner over the smallest surface area possible, all of which renewables are incapable of providing. Vladimír Vlk, Director of the Department of Sustainable Energy and Transport at the Ministry of Environment argues that "we anticipate the exploitation of alternative and renewable sources of energy will first take place in the municipal power industry and only then in smaller locales and municipalities. (...) We should aim at (...) setting up less centralized sources inside municipalities–for example, a facility for wood cut-offs and pellet production or a biogas station" (see "*Podporuji využívání,*" 2008, p. 8). It is exactly here that we should recognize by far the most appropriate utilization of renewables as well as by far the greatest contribution of renewables to the entire state power industry.

Renewables will remain complementary sources for a long time. This should not be taken negatively; the sharply dialectical character of present energy sector is directed towards the increasing use of renewables anyway. Attention should, however, be paid to recklessness and imprudent support. The focus should be on supporting the field, which would impose almost zero costs. Even a relatively profitable biomass economy appears uneconomic compared to waste-to-energy, that is, the exploitation of waste which is "made by itself". Support and conceptual and rational development should go to projects implementing geographical and national particularities, adequate conditions, and with prospects for the future. Comparing waste-to-energy, for example, with a project for geothermal energy utilization in terms of their potential on our soil, it is entirely clear which of the projects would have an advantage.

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Chapter 8: The Electric Power Industry

Tomáš Vlček, Patrícia Brhlíková

8.1 The Electricity Grid of the Czech Republic

According to the Grid Code of the transmission system operator, the *power system* (distribution, transmission) is "interconnected equipment for the generation, transmission, transformation, and distribution of electricity including electrical connection and direct lines, measurement systems, protection, control, safety, information, and telecommunications" (see ČEPS, 2018b, p. 5). The power system consists of several parts, specifically *electricity generating facilities, electricity stations, electricity grids,* and *electricity supply lines*. Electricity generating facilities are power plants, meaning the industrial stations serving for the transformation of any kind of energy into electricity. *Electrical stations* are a set of buildings and equipment at the nodes of the power system. They enable transformation or distribution of the same voltage levels in several directions, transformation of alternating current to direct or vice versa, occasionally also providing the transformation of alternating current into current of different frequency or compensation of a blind current. *Electricity grids* are sets of interconnected electricity stations and electricity supply lines aimed at transmitting and distributing electricity. They are divided into *transmission grids (transmission systems)* for remote distribution at the levels of 220 kV and 400 kV and *distribution grids (distribution systems)* for distribution from the transmission system to end users carrying 110 kV, 35 kV and 22 kV of voltage. 110 kV grids are sometimes marked as primary, because they can sometimes serve for transmitting capacity into the system from power plants with less capacity (for example, hydropower). Industrial grids also belong in this category, with voltage levels of 22 kV, 10 kV, 6 kV and 0.4 kV. Grids transmitting power directly to the consumption site are marked as *local*, ranging around the voltage level of 0.4 kV. Electricity supply lines are the basic items of the grid, connecting two points, made of a set of conductors, insulation, and structures for mechanical reinforcement. The basic division *differentiates exterior supply lines*, i.e. uncovered lines on pylons with insulators, from *cable supply lines*, placed in the ground, in passages, or on pylons (see Elektroenergetika I, p. 2).

There are several types of *power plants* in the Czech Republic. These vary from steam, water, nuclear, combined cycle, gas, solar, wind and geothermal. Table 8.1 displays installed capacity across these power plants in the Czech Republic as of December 31, 2018.

Tab. 8.1: Installed Capacity in the Czech Electricity Grid on December 31, 2018

Type of Power Station	Installed Capacity (MWe)	Percentage (%)
Thermal	11,075.4	49.7
Gas Combined Cycle	1,363.5	6.1
Gas Fired	909.7	4.1
Hydropower	1,088.7	4.9
Pumped-storage Hydropower	1,171.5	5.3
Nuclear	4,290.0	19.3
Wind	316.2	1.4
Solar	2,048.9	9.2
Geothermal Power	0	0
Total	22,263.9	100

Source: (Energetický regulační úřad, 2018a, p. 12)

Installed capacity provides limited information about the consumption of electric power. Table 8.2 displays the gross electricity consumption in the Czech Republic recorded in 2018. In terms of electricity production, power plants are divided into *base load* and *peak load*. Base load, i.e. the stable minimum load of the power system, is the provision of uninterrupted daily electricity for consumption. Based on the nature of operational processes, base load is predominately covered by nuclear and thermal power plants whose regulation of operation is limited (mainly nuclear power plants, see below). Peak load, by contrast, is the load of the power system that exceeds the standard minimum level, supported by power plants that can quickly respond to changes on the demand side, connect to the grid and ramp-up their production–mainly pumped-storage hydroelectricity, gas, combined cycle, and some steam power plants. There are a vast number of peaks in the course of a single year, mainly depending on weather, season, and time of day. For example, two peaks occur every day (mainly working days), specifically, one between 5 AM and 8 AM, when people get up and turn on electric appliances, causing a rapid rise in electricity consumption, and a significantly more moderate one between 4 PM and 6 PM, when people return to their homes.

Tab. 8.2: Gross Electricity Production in 2018

Type of Power Station	Electricity Production (GWh)	Percentage (%)
Thermal	45,070.8	51.2
Gas-fired and Gas Combined Cycle	7,378.7	8.4
Nuclear	29,921.3	34.0
Hydropower (incl. Pumped-storage Hydroelectricity)	2,677.8	3.0
Wind	609.3	0.7
Solar	2,338.6	2.7
Total gross production	**87,996.4**	**100**
Total net production	**81,896.4**	**93.1% of gross production**

Source: Energetický regulační úřad, 2018a, percentages by P. Brhlíková

An *electrical station* is “a complex of buildings and equipment of the grid serving for the transformation, compensation, conversion or transmission and distribution of electricity, including facilities needed to secure the operation thereof” (see ČEPS, 2018b, p. 43). Electrical stations are functional facilities at the distribution electrical nodes. They are the centre of the majority of distribution system functions, including switching, securing, measuring and control. Substations with transformer function “serve to change electrical voltage at the same frequency and distribution of electricity or to execute galvanic separation of one part of the network from another”; switching stations serve to “distribute electricity at the same voltage without transformation and converting”; converter stations serve to “convert the type of voltage or its frequency”; and compensation stations serve to “counterbalance reactive segments in the alternating current or line parameters” (see Elektroenergetika I, p. 5). Electrical stations may be divided into those stations with less than 1 kV AC (alternating current) and those with more than 1 kV AC.

Electricity supply lines represent “the important component of every power system, enabling remote transmission of electric energy and signals. Electrical supply lines are made of conductors, which serve to pipe electrical current, and insulation separating the live parts from their surroundings (excluding naked lines)” (see Vrána & Kolář, 2000, p. 2). We differentiate between four types of electrical line: naked wire lines (predominantly installed outdoors rather than indoors, such as, for example, trolley lines), tube and bar lines, wire-bridge lines, and cable lines (see Vrána & Kolář, 2000, p. 2).

As previously indicated, *electricity grids* are divided into transmission systems and distribution systems. A *transmission system* is “[a] mutually interconnected system of 400 kV and 220 kV lines and equipment and selected 110 kV lines and equipment (see appendix in Part VII of the Grid Code) serving for the transmission of electricity throughout the Czech Republic and interconnected with the power systems of neighbouring countries and including protection, measurement, monitoring, safety, information, and telecommunications systems” (see ČEPS, 2018b, p. 41). A Distribution system is a “mutually connected set of lines and equipment with voltage levels of 0.4 to 110 kV (with the exception of selected 110 kV lines which are part of the transmission system), providing the distribution of electricity in a specified area of the Czech Republic; responsible for measurement systems, protection, monitoring, safety, information, and telecommunications” (see ČEPS, 2018b, p. 36). Transmission and distribution systems are organized and operated in the public interest in line with the Energy Act.

The transmission system in the Czech Republic is operated by ČEPSF, a. s., established in 1998 by splitting off the Transmission System Department from ČEZ (and merger with the dissolving company ENIT, a. s.). ČEPS, in the role of a natural monopoly, is the holder of an exclusive license for the operation of the transmission system in the Czech Republic. Since September 29, 2009, the Ministry of Industry and Trade was majority shareholder in the company with an 85% stake. The holder of the remaining 15% of stock was the Ministry of Labour and Social Affairs. The exercise of shareholder rights was state-commissioned to the Ministry of Industry and Trade (see ČEPS, 2010, pp. 18–19). Since 2012, the Ministry of Industry and Trade has acted as the sole shareholder. (see ČEPS, 2018a)

The transmission system with voltage levels of 400 kV, 220 kV and a limited number of 110 kV lines owned by ČEPS serves for the transmission of electricity both within the Czech Republic to the broader European electricity market. The Czech Republic is interconnected with the transmissions systems of all neighbouring countries by means of 17 cross-border lines, thereby cooperating with the whole electric power system of continental Europe in a synchronized manner. This high level of interconnectedness brings reliable operation and extensive cross-border trading on the one hand, but it also exposes the Czech grid to unscheduled transit overflows or operational failures in neighbouring grids. (see ČEPS, 2018a, p. 39). The ČEPS transmission system is a set of 43 substations with voltage levels of 400 kV and 220 kV, four 400/220 kV transformers, 49 400/110 kV transformers and 21 220/110 kV transformers. Moreover, there are currently four phase-shifting transformers (PST) installed on interconnectors with German transmission system operated at 50 Hertz. Furthermore, the transmission grid of the Czech Republic consists of 3,735 km of 400 kV lines, 1,909 km of 220 kV lines, and 84 km of 110 kV lines (see ČEPS, 2018a).

Distribution systems serve to distribute electric power from a source (the superordinate system or the local power plant) to appliances. The voltage of distributed electricity at the public distribution point may be 110 kV, 22 kV, 0.4 kV, with the different voltage networks separated from each other via substations where the voltage is transformed (see Elektroenergetika I, p. 3). If electricity is distributed at the same voltage, transformation is not necessary and the distribution proceeds by means of switching stations.

There are four companies operating distribution systems in the Czech Republic: ČEZ Distribuce, a subsidiary of ČEZ; E.ON Distribuce, a subsidiary of E.ON Czech Holding AG; PREdistribuce, a. s., a subsidiary of Pražská energetika, a. s.; and LDS Sever, in the Unicapital portfolio. The companies are designated as regional operators of distribution systems (RPDS) and are subject to regulatory oversight by the Energy Regulatory Office (ERÚ) (see ERÚ 2018).

In addition to the regional distribution systems (RDS), the Czech Republic has local distribution systems (LDS), even though the term itself is not embodied in any legal act. Local distribution systems are subordinate to regional systems, providing that the regional operators deliver electricity supplies to local operators. Local distribution systems are not directly connected to the transmission system. They are connected to the particular regional system and run based on license provisions. There are rather large local distribution systems both in terms of geographical scope and consumption or production of electricity, usually located at the sites of former industrial agglomerations, such as mines, steel mills, or large industrial facilities. There are, naturally, also very small local distribution systems (see Chemišinec, Marvan , Nečesaný , Sýkora , & Tůma, 2010, p. 30).

8.2 The Regulatory and Safety Framework of the Electric Power Industry

8.2.1 State Regulatory Framework

According to The Energy Act, the exercise of public administration in the energy sectors and therefore in the electric power industry falls under the purview of the Ministry of Industry and Trade, Energy Regulatory Office, and State Energy Inspection Board. Besides these primary regulatory bodies, there are the Czech electricity and gas market operator (OTE), and from a technical standpoint, ČEPS and the Czech Office for Standards, Metrology and Testing (UNMZ).

Tab. 8.3: Regulatory Organs in the Electric Power Sector and Their Role

Organ	**The Ministry of Industry and Trade (MPO)**
Headquarters	Prague, Na Františku 32
Web	www.mpo.cz
Role	The MPO issues state approval to build selected gas facilities and gives its opinion on the building of new sources and direct lines in the electric power sector in accordance with the conditions specified in a special section of the Energy Act, develops the energy policy of the state, ensures adherence to obligations arising from international agreements binding on the Czech Republic or obligations arising from membership in international organizations, provides information to the European Commission, arranges tenders for new generating capacities, is for supply safety reasons entitled to decide whether to give preference to the connection of those electricity and gas plants that employ domestic primary energy fuel sources to an extent not exceeding 15% of the aggregate primary energy necessary for the generation of electricity and gas in a given calendar year, has the right to give opinions on landscape development policy, and submits the national report to the Commission on the Situation in the Electricity and Gas Sectors.
Organ	**Energy Regulatory Office (ERU)**
Headquarters	Jihlava, Masarykovo náměstí 5
Web	www.eru.cz
Role	The main tasks of the Energy Regulatory Office are to support economic competition, to support the use of renewable and secondary energy sources, to protect the combined production of electric and thermal energy as well as the protection of consumers' interests in those areas of the energy sector where competition is impossible. The Energy Regulatory Office exercises the authority of a regulatory institution pursuant to the regulation on conditions for access to the network applicable to the cross-border exchange of electricity and regulation on conditions for access to gas purchasing systems. The Office sets the grounds for granting, amending, and suspending licenses, imposes a supply obligation beyond the scope of the license as well as the obligation to let another license holder use energy facilities in cases of emergency to exercise the supply obligation beyond the scope of the license, regulates prices based on special legal regulations, and may temporarily suspend the obligation to enable third party access. The Office also decides on disputes, monitors compliance with the obligations of license holders, imposes fines based on the special act, approves or establishes the Transmission System Operating Rules and the Distribution System Operating Rules for the electricity sector, as well as business conditions for electricity market operators, the Transmission System Operator Code and the Distribution System Operator Code for the gas sector.
Organ	**State Energy Inspection (SEI)**
Headquarters	Prague, Gorazdova 24
Web	www.cr-sei.cz
Role	The State Energy Inspection, upon the impetus of the Ministry of Industry and Trade of the Czech Republic, Energy Regulatory Office or under its own initiative, oversees compliance with Acts Nos. 458/2000 Coll., 406/2000 Coll., 526/1990 Coll., 180/2005 Coll. and Regulation No. ES/1228/2003 of the European Parliament and the Council. Based on its own findings, it imposes fines for breaches of legal regulations. SEI's expertise takes in the entire energy sector (electric power industry, heating supply, and gas sectors), and is well-established as an authority among both energy suppliers and users. SEI also performs a vast number of specific professional activities for the Ministry for Industry and Trade as well as for other predominantly state institutions.
Organ	**The Czech Electricity and Gas Market Operator (OTE)**
Headquarters	Prague, Sokolovská 192/79
Web	www.ote-cr.cz
Role	Among its other responsibilities, OTE organizes the short-term electricity and gas markets in cooperation with the transmission system operator, as well as organizing the regulating energy balancing market, evaluating and settling imbalances throughout the Czech Republic and doing the accounting. It prepares documents for draft Electricity Market Rules and Gas Market Rules, drafts and, following the approval of the Energy Regulatory Office, releases the market operator's business terms for the power and gas sectors with remote access and administers the National Register of Greenhouse Gas Emissions.
Organ	**ČEPS, a. s.**
Headquarters	Prague, Elektrárenská 774/2
Web	www.ČEPS.cz
Role	ČEPS, a. s. has an inherent monopoly over electricity transmission. It is regulated by the above-mentioned bodies and accordingly, on the basis of the Energy Act, regulates the technical aspects of the power system by means of the Grid Code. The company's scope as a transmissien system operator is embedded in this document.
Organ	**Czech Office for Standards, Metrology and Testing (UNMZ)**
Headquarters	Prague, Gorazdova 24
Web	www.unmz.cz
Role	The main mission of the Office is to perform tasks arising from Czech legislation on technical standardization, metrology and testing, and tasks related to the harmonization of Czech technical regulations and standards with the technical regulations of the European Union. Since 2009, the Office has provided for the development and publication of Czech standards.

Source: *Zákon 458/2000; Česká republika – Státní energetická inspekce; Energetický regulační úřad; ČEPS, a. s.; OTE, a. s.; Úřad pro technickou normalizaci, metrologii a státní zkušebnictví*; composed by T. Vlček.

8.2.2 Supranational Regulatory Framework

The first EU Directive whose implementation was requested as part of the harmonization of the Czech legal framework with the legal framework of the European Community was Directive 96/92/EC (see "*Directive 96/92/EC,*" 1997, p. 0020–0029) of December 19, 1996, on electricity market liberalization. The directive became part of the Czech legal system when it was implemented in Act No. 458/2000 Coll. This directive was the first to define unbundling, i.e. separation of electricity trading from the trade in its transmission and distribution. Chapter VI established the unbundling of accounts, i.e. keeping separate the production, transmission, and distribution accounts in energy companies. However, Directive 96/92/EC allowed for alternative options regarding Third Party Access (TPA) to be adopted within Member States, and hence diverse market conditions across Europe emerged. This is despite the fact that the electricity and gas markets may appear open to some extent in all Member States. (see Asociace energetických manažerů, 2016)

Directive 96/92/EC was replaced by Directive 2003/54/EC of the European Parliament and the Council (Directive 2003/54/EC, 2003) from June 26, 2003, Concerning Common Rules for the Internal Market in Electricity and Repealing Directive 96/92/EC, which had requested an even higher degree of market openness. The idea behind this request was to hasten the liberalization process. This document required that energy related activities be separated at the managerial level, and that electric companies be divided legally (so-called legal unbundling) into two entities (transmission traders and electricity traders). The directive even shortened the deadlines for market opening. On this basis, the member states were required to separate transmission networks from the generation and sale of electricity, either by *ownership unbundling* (i.e. the creation of new companies trading in electricity transmission) or as *an independent system operator – ISO* (meaning that the transmission network would remain in a company's ownership, but only after previous approval by the European Commission).

Directive 2009/72/ES of the European Parliament and the Council of July 13, 2009, Concerning Common Rules for the Internal Market in Electricity and Repealing Directive 2003/54/EC entitles users to change electricity suppliers free of charge within a three-week period or to receive reimbursement from their energy company. The undertaking of operators of electricity markets was broadened so as to also include the gas sector (see OTE, 2010a, s. 8–9).

Tab. 8.4: The Process of Electricity Market Liberalisation in the Czech Republic

Stage	Eligible customers
From 1/1/2002	Customers whose yearly electricity use exceeds 40 GWh (eligible customers) are entitled to choose a supplier.
From 1/1/2005	Customers whose yearly electricity use exceeds 9 GWh are entitled to choose a supplier.
From 1/1/2005	Customers whose yearly electricity use exceeds 100 MWh are entitled to choose a supplier.
From 1/1/2006	All customers (end users) are entitled to choose a supplier.

Source: (Müller, 2002, pp. 53–55), (Energetický regulační úřad, 2011)

The formation of a single electricity market was generally criticized on the grounds that it was unnatural. Generation, transmission and distribution systems did not emerge as independent units, but had simply undergone interconnected joint development. The monopolistic position of the entire electricity sector was, therefore, natural. Under the liberalised market concept, a natural monopoly[1] applies only to grids (electricity transmission and distribution systems) and system dispatchers (unbundled from generation). Miloslav Píha, however, for example, thinks that production also falls under the category of a natural monopoly. In his mind it is absurd to have "production, (whose integration gave the incentive for the emergence of the transmission system) and the system dispatcher which gave birth to the monopoly, denied their natural monopoly character and instead to be recognized for activities (of transmission and dispatching) caused by this integration as auxiliary mediums. For the producing system to be competitive, it would have to be split into several independent producing entities, or find more independent producers and suppliers of electricity and thereby create more production entities to compete in supplies for the transmission system; this would, in turn, employ the competition through the system dispatcher" (see Píha, 1994, p. 69). Based on this thinking, one might, for example, argue that the most frequently criticized

1 A natural monopoly emerges if a company in a particular region produces and sells its products cheaper, i.e. with fewer costs, than the competing company or group of companies, but never for power or institutional reasons (see Kubín, 2009, p. 238).

position of ČEZ in the field of electricity production in the Czech Republic, which shows some monopolistic features, is basically a reflection of the development the Czech electric power sector has seen through its history.

Kubín, by contrast, understands a natural monopoly (in the mid-term horizon) only in terms of the transmission and distribution of electricity, because “within the chain production – transmission – distribution – consumption, a combined cycle, pressurized fluid combustion or the new generation of nuclear reactors meeting safety and environmental requirements represents a fiercely competitive setting for production, with competition also arising also at the final consumption level” (see Kubín, 2009, p. 238).

20 years later, we may say that ČEZ still maintains a strong position (60.2% of installed capacity, 67.1% of gross electricity production and 64.1% of electricity distribution (see Energetický regulační úřad, 2018a), but the opening of the electricity market has led to an increase in the number of electricity producers and distributors, while other companies on the market are expected to thrive because of the increasing interest in renewables. In the long term, it therefore seems that competitiveness can be achieved even within a production system with a heavily burdened history, though with certain restrictions.

If we are to at least marginally assess the current position of ČEZ in the electricity sector of the Czech Republic, we should note that the majority stake in the company is held by the state[2], but it is still a trading company whose chief objective is profit. The company always seeks to respond to the state energy papers in a flexible manner; but the latter are changed and updated too frequently to have the company rely on them entirely. Václav Bartuška, Ministry of Foreign Affairs of the Czech Republic’s Special Envoy for Energy Security, has very aptly warned about this situation. “The state does not have a long-term strategy, it does not have its own long-term vision of what it wants to do with CEZ, so the company, of course, alone looks for what to build or what to do business with” (see “*Otázky Václava Moravce,*” 2009). Such a company, naturally, requires a strategic plan for decades ahead and is incapable of functioning in an entirely flexible manner. Its dominant position together with an effort to seek out a clear direction for the Czech energy sector, which cannot be found in state papers changed or updated with every incoming government, is, in consequence, often the target of criticism. The company thus noted that the conceptual documents included a rather steady approach to the issue of coal and nuclear use, which also suited it in economic terms. Because the company was taking part in preparing these documents, it strove to promote a steady path as well. This also furnished the incentive to open a discussion on environmental mining limits, to make some foreign acquisitions, to retrofit coal power plants, prepare and call for a tender for the new Temelín nuclear units, cooperate with Serbia and Slovenia in the future construction and operation of new nuclear units, etc. Simply put, ČEZ does business where it sees long-term, consistent prospects. The demonization of the company by the media has not always been justified (see Černoch, Vlček, & Zapletalová , 2010, p. 276–277).

In June 2009, during the Czech Presidency of the Council of the European Union and the European Council in the first half of that year, the Third Energy Liberalization Package was adopted (Directive 714/2009/EC). The Package harmonized the authorities and responsibilities of the regulatory agencies while requesting their complete independence (i.e. the unbinding of the regulatory fund from other parts of the state budget). In the Czech Republic, this body was the Energy Regulatory Office. Regulatory agencies are supposed to be overseen by the Agency for the Cooperation on Energy Regulators (ACER).[3] The main objective of ACER is to coordinate regional and pan-European initiatives, and to give guidance and develop network codes with ENTSO-E. Moreover, the new 2019 regulatory package extends ACER´s powers to a degree. The transmission system operators are supposed to harmonize their activities and coordinate at the EU level through the organization ENTSO-E (European Network of Transmission System Operators for Electricity) (see Třetí liberalizační balíček v energetice, 2009). ENTSO-E currently brings together 43 system operators (TSOs) from 36 countries. The previous associations of system operators in Europe were dissolved upon the emergence of ENTSO-E (thus the previous CENTREL and UCTE as well). ENTSO-E’s ambition is to become the focal point for all European technical, business, and political aspects of operation and cooperation between transmission system operators. ENTSO-E, together with participating transmission system operators, endeavours to build pan-European electricity trading based on cooperation, security of supplies, safe integration of renewable energy sources, and the development of modern, reliable networks (see ENTSO-E, 2019).

2 The ownership structure as of June 30, 2018, is as follows: The Ministry of Finance of the Czech Republic – 69.78%, other legal persons – 19.39%, natural persons – 10.16%, ČEZ, a.s. 0.67% (see ČEZ, 2019b)

3 ACER was established in 2011 and is headquartered in Ljubljana, Slovenia.

Liberalization of the electricity market led to significant multiplication of new electricity traders. As of 2011, there were 37 suppliers in the Czech Republic, with more than 100 consumption and connection sites and a total of 64 entities taking part in the OTE platform. In 2019, there are 78 suppliers and a total of 117 entities taking part in the OTE electricity trading platform. The market has truly experienced a massive response, since by January 2012 the Czech Republic numbered already 1,105,274 low and high energy users who had changed their electricity suppliers. Change of electricity supplier is significant on yearly basis–570,511 consumption and connection sites registered supplier changes in 2018 compared to 57,689 in 2008. Moreover, OTE reports that during the first two months of 2019, a new maximum was reached, with as many as 160,984 cases in which users changed supplier. (see *OTE, 2019a*)

Tab. 8.5: Total Consumption and Connection Sites That Have Changed Supplier

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
57,689	96,744	249,181	448,860	473,128	374,440	333,542	277,756	359, 536	357,847	570,511

Source: OTE, 2019a

The largest alternative electricity suppliers as of March 2019 were innogy Energie, s.r.o. (424,246 users) Bohemia Energy Entity, s. r. o. (389,784 users); Centropol Energy, a. s., (227,985 users); COMFORT ENERGY s.r.o. (84,795 users), X Energie, s.r.o. (74,016 users), MND a.s. (50,343 users), and LAMA energy a.s. (42,740 users) (see OTE, 2019a).

What these sorts of companies have in common is a similar strategy for reaching potential users. They employ door-to-door salespeople and call centres that offer products and services directly to users. In general, growing competition is the main driver for a more aggressive and often deceitful strategy to persuade customers to change suppliers. In this highly competitive environment, with electricity prices relatively higher than in previous years, unsuccessful suppliers are being forced out of the market. Losing the licence is often caused by the fact that a strategy based on yesterday's low spot-prices leads today to an inability to secure supplies at the new higher price. From the customer's point of view, security of supply in the case of bankruptcy is then ensured by the supplier of last resort according to the Energy Act for a maximum period of 6 months[4]. (see Energetický regulační úřad, 2017)

We should recognise this as a contemporary trend triggered by the liberalization of the electricity market. It hits a centralized electricity sector that has been settled for decades, one founded on the principle of large centralized power plants and complex distribution grids. We may therefore expect that the transition to a modern decentralized system that embraces small production units, numerous electricity traders, and suppliers to end users–and with a large share of electricity from renewable sources, directed to the system more by consumption than production– will for these reasons proceed at a notably slower pace than was the case in neighbouring Germany.

8.3 The Transmission and Regulation of Electricity

Due to the specific characteristics of electricity, the power system is a dynamic, permanently active system, changing every second. Most production facilities and appliances are currently optimised at a frequency of 50 Hz. "This frequency in the grid means that the active power produced (equal to the total of all active power from each producing generator in the system) equals the power consumed (the total inputs of all appliances and losses in grids)" (see Šolc, 2008, p. 50). A state of balanced electricity supply and its off-take is the optimum condition in the grid, and is mandatory if the power system is to remain stable.

A change in both demand and supply is the logical order of events when these changes must be reflected immediately on either the supply or demand sides; else there is a risk of initial frequency deviation followed by overvoltage or undervoltage, and this may shortly thereafter lead to the collapse of the power system and brownouts[5],

4 Supplier of last resort is defined as the distribution system operator in the respective area – hence for majority of czech consumers it is CEZ. The tranfer in case the original supplier is not able to secure the supply is performed automatically via the market operatot. (see Energetický regulační úřad, 2017)

5 A brownout is a partial outage or larger forced interruption or limited electricity supply within a larger area.

blackouts[6], or island operation[7]. At the point when consumption (or demand) rises, there is a shortage at the production level (i.e. supply), resulting in an immediate drop in frequency and a consequent drop in voltage. In order to maintain frequency, the production side must react forthwith to increase the volume of power produced and stabilise the frequency at the desired 50 Hz level. Likewise, if consumption drops and production does not respond to the situation, or rises without taking into actual consumption, the result will be an increase in frequency and, consequently, overvoltage of the grid. Such a situation must be rapidly regulated through attenuation or disconnection of the production of certain power plants. Balancing energy is not used for regulation of electricity from renewables only, although its use has significantly increased with respect to Act No. 180/2005 Coll., on the Promotion of Electricity Production from Renewable Energy Sources and Amending Certain Acts, *which adds to the previous obligation of electricity purchase to all licensed third parties within the meaning of the Energy Act No. 458/2000 Coll. an obligation for preferential purchase of electricity from renewables to all licensed third parties (TPA), provided that they have a license issued by the Energy Regulatory Office.*

The reasons behind the above-mentioned situations vary, starting with planned and unplanned maintenance and the decommissioning of production blocks, unexpected damage to transformers, networks, or distribution lines, weather impacts (for example, snowdrifts, sharp drops in outdoor temperatures, etc.) through to really drastic changes in electricity production from renewables (i.e. from wind and solar power plants). The cross-border interconnection of systems contributes to the safety of the power system because the larger the system is, the harder it is to significantly affect its frequency by increasing or decreasing consumption or production in some of its components. On the other hand, considerable interconnectedness of transmission systems is accompanied by the risk of “import/export” of these operational situations to the adjacent control areas, which may lead to grid destabilisation of a larger area.

Different types of power plants have different capabilities for swift reductions or increases in production capacity. For example, Czech nuclear power plants can change capacity in a relatively flexible manner by up to approximately 10% of installed capacity.[8] Regulation above 10% would require a major intervention in production, which would become apparent at the point where it is necessary to return to the previous capacity level, depending upon the demanded regular interruption for tens of hours, days or even weeks. Power plants powered by water (pumped-storage hydroelectricity, hydropower plants) are, in turn, capable of connection or disconnection in just a few seconds up to tens of seconds[9], while power plants powered by gas (combined cycle, gas and fuel-fired) take several minutes to reach this efficiency. Following the power balance, the Czech Republic reserve and balancing resources provide so-called ancillary services. These are an inherent tool to make sure system services are provided by the transmission system operator. In this respect, the transmission system operator is obliged to secure the power balance, a reliable supply, and operational security via the availability of necessary ancillary services and the interoperability of interconnected transmission systems. In other words, ancillary services predominantly ensure frequency stability, adequate voltage levels, restoration from a total or partial system blackout (black start), and island operation[10].

In the Czech Republic, ČEPS is entirely responsible by law for power balance, and the only provider of the aforementioned system services on the transmission level. For this purpose, ČEPS procures ancillary services which cover three main types of reserves (these are in more details displayed in table 8.6):

- primary control – represented by units which are able to detect frequency deviation automatically within seconds. Primary control activation in Europe is governed by the solidarity principle of all synchronously interconnected transmission system operators. The primary reserve in Continental Europe is estimated at approximately 3,000 MW[11]. Therefore, respective TSOs contribute to this reserve by means of domestic sources on

6 A blackout is a total or larger outage of electricity as a result of grid failure.

7 Island operation is a disconnection of a part of the grid and its operation as an independent system. The quality of supplies is usually significantly worse and unstable.

8 The Temelín nuclear power plant, therefore, up to 100 MWe per block, i.e. 200 MWe, Dukovany NPP up to 80 MWe per block, i.e. 320 MWe (see ČEPS, a. s., 2010d, p. 20). The Temelín nuclear power plant is in reality, however, as a result of technical limitations, capable of regulation at the level of +/- 5%, while the Dukovany NPP undergoes regulation only exceptionally.

9 For example, the Dlouhé Stráně pumped-storage power plant is capable of moving from sleep mode to full capacity in 100 seconds.

10 It is capable of running the blocks without the support of an external voltage source, of reaching the given voltage, connecting to the network, and running in island operation mode.

11 This reserve must cover an outage of two major generation units within the synchronous area.

a pro rata basis. The main aim of the primary reserve is to automatically adjust production in case of frequency fluctuation. (see Asociace energetických manažerů, 2016)

- secondary control – serves for upward/downward regulation with an activation time of between 30 seconds and 15 minutes provided by secondary reserves directly activated by the TSO, all of which must fulfil certain technical requirements and certification criteria.
- replacement reserve – which allows exhausted secondary reserves to be restored. Tertiary reserves are usually manually activated based on the specific request of the TSO, with a ramping-up time of up to 30 minutes.

Tab. 8.6: A Simplified Division of Regulation Reserves as part of ČEPS System Services

System Service	Mark	Time Framework	Description
Frequency Containment Process (Regulation Reserve Seconds)	RZV	30 seconds	Serves for automated primary frequency control (PR)
Minute Reserve available within 5 minutes (positive)	mFRR5	5 minutes	Minute reserve available within 5 minutes (manual Frequency Restoration Reserve, mFRR5)
Regulation Reserve available within 10 minutes (positive)	aFRR+	10 minutes	Serves for secondary regulation; it consists of sources available within 10 minutes (automatic Frequency Restoration Reserve positive, aFRR+)
Regulation Reserve available within 10 minutes (negative)	aFRR-	10 minutes	Serves for secondary regulation; it consists of sources available within 10 minutes (automatic Frequency Restoration Reserve aFRR-)
Minute Reserve available within 15 minutes (positive)	mFRR15+	15 minutes	Minute reserve available within 15 minutes (manual Frequency Restoration Reserve, mFRR5)
Minute Reserve available within 15 minutes (negative)	mFRR15-	15 minutes	Minute reserve available within 15 minutes (manual Frequency Restoration Reserve, mFRR5)
Regulation Reserve available within 30 minutes (negative)	RZ30	30 minutes	Serves for tertiary regulation; it consists of regulation reserve for power reduction within 30 minutes
Regulation Reserve available in over 30 minutes	RZN>30	Over 30 minutes	Consists of dispatch reserve, regulation energy, and regulation energy from abroad, all available in over 30 minutes EregZ>30+, EregZ>30-)

Note: a positive reserve means an increase in capacity, while a negative reserve means an increase in consumption.

Source: ČEPS, a. s., 2018, p. 117; modified by P. Brhlíková

Table 8.7 shows the maximum necessary balancing reserves recorded for 2019. If the installed capacity of the Czech power system as of December 31, 2018 was at a level of 22,263.9 MW (see table No. 8.1) and total daily regulation during the working days was at a level of 1,835 MW (night regulation 1,675 MW), the potential of the regulation capacities would be 7.72% of installed capacity (excluding Frequency Containment Reserve). In the case of the regulation of electricity from renewables (a total of 2,349 MW), then it is 67.48% of installed capacity. (For more detail, see below).

Tab. 8.7: Maximum Regulation Reserves in the Czech Republic in 2019

	aFRR				mFRR					
	aFRR+		aFRR-		mFRR5		mFRR15+		mFRR15-	
	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day
Working days	335	365	335	365	505	505	280	330	220	270
Non-working days	330	345	330	345	505	505	275	315	215	255

Note: All data indicated in MW

Source: ČEPS, a. s., 2018, p. 118; Modified by P. Brhlíková

System services are predominantly provided by means of ancillary services contracted directly by ČEPS via tenders, resulting in long-term contracts with eligible ancillary service providers at bilaterally agreed prices (currently approximately 90% of FCR, aFRR and mFRR ancillary services is provided on this basis). The flexibility of producers, i.e. their ability to change the output of the generating facility, can be also procured by ČEPS via the short-term market in the ancillary services it organises. Additionally, OTE and ČEPS organise a "balancing market" in which necessary balancing electricity can be purchased by ČEPS as the only "customer" active on this type of market. Balancing energy is offered at the marginal price given by the highest bid for the trading hour in question. In 2018, 25.2 GWh of positive and 34.7 GWh of negative balancing energy was traded via the platform. (see OTE, 2019)

With regard to the requisite swift activation time of reserve sources, pumped-storage hydroelectricity, gas and combined cycle, and some steam power plants are key resources. ČEPS purchases roughly 30% of its ancillary services from the ČEZ Group (for contracts for 2021, there has been a slight decrease to 20.41%). (see ČEPS, 2019) The cost of system services is paid by users of those services on the consumption side via tariff, i.e. by end users. The price is regulated and is established by the decision of Energy Regulatory Office on a daily basis (see ČEPS, 2019).

In likewise manner, ČEPS also covers the losses within the distribution system and, based on its own predictions, purchases electricity to cover the losses at tenders for single products and on the special short-term electricity market organized by OTE (see ČEPS, 2019).

8.4 The Price of Electricity and the Trade in Electricity

The final price of electricity supplies on the liberalized retail market for eligible customers is composed of regulated prices for activities that are of a natural monopolistic character, i.e. activities associated with the transmission of electricity to a producer via transmission and distribution systems to an end user. This regulation is performed by the Energy Regulatory Office, which on a regular basis issues a Price Decision. The provision of a stable electric power system in technical and business terms has its own impact on the price. The second substantial component of the final electricity price is the price of electrical energy itself, which is set by suppliers (producers and traders) using single customer categories as a contractual matter. This portion of the price is *not* regulated by the Energy Regulatory Office (see *Energetický regulační úřad*).

The final price of electricity supplies for all categories of end user is composed of five basic elements. The first element of price is the unregulated price of the commodity, i.e. electrical energy, the price of which is set in line with market principles and the trading strategies of single electricity suppliers. Other price elements encompass regulated activities of a monopolistic character, among them the transmission of electricity from the production facility via transmission and distribution systems to an end user, as well as activities tied to ensuring a stable energy system in technical (the provision of system services) and business terms (mainly the activity of an electricity market operator in the field of imbalance accounting). The final element of the final price of electricity supplies is then a contribution to the promotion of electricity from renewables, the combined generation of electricity and heat and secondary sources. In this manner, the price of electricity is set for all customer categories, in effect from January 1, 2006, when Czech electricity was completely liberalized (see Energetický regulační úřad, 2009; Dufková, 2005, p. 2).

Tab. 8.8: Share of Main Components of the Price of Electricity Supplies to Households in 2019 (excluding VAT)

Electrical energy including a trading margin	45.58%
Market operator	0.80%
ČEPS system services	2.15%
Renewables and cogeneration	13.35%
Distribution and transmission	38.12%

Source: (Energetický regulační úřad, 2018b)

In terms of stock market standards, trading in electrical energy proves to be very specific. For physical laws, the trade proceeds in real time and under the conditions of balanced supply and demand in the power system. This means that the volume of demand in MWh must be equal to the volume of supply in MWh, otherwise the regulation reserve to cover fluctuations in the power system enters into play.

Trade with electricity in the Czech Republic takes place via Power Exchange Central Europe, a. s., (PXE), initiated in March 5, 2007, as the Prague Energy Exchange, while a daily market has been running since April 1st, 2009, exclusively on the OTE platform. In terms of cross-border trading, OTE started trading with the Slovakian Power System (SEPS) on the joint daily electricity market as part of the Market coupling CZ-SK framework on September 1, 2009 (see OTE, 2010b, p. 12). Day ahead market coupling was organized by OTE and OKTE as the respective market organizers by means of an algorithm (market-coupling algorithm) that was part of their business system. On the TSO side, it was supported by ČEPS and SEPS. In order to extend functioning market coupling in the region, national regulatory authorities, regulators, market operators, and the transmission system operators of the Czech Republic, Slovakia and Hungary signed a Memorandum of Understanding on 30 May, 2011. Subsequently, operation of the CZ-SK-HU MC Project (3MMC), an ATC based day-ahead implicit allocation, was launched on 11 September 2012. Further extension followed in 2014 Romania joined the market-coupling project with evolved design using European algorithm (PCR). Operation of the market coupling solution on four bidding zone borders has been launched successfully on 19 November 2014 for the first delivery day of 20 November 2014. (see HUPX, 2017) Today, 4MMC, together with MRC (Multi-regional coupling), forms the basis for the single day-ahead coupling which allows full integration of day-ahead markets in Europe, using a single allocation solution in line with the electricity market target model defined under European legislation.

Trading on the PXE platform was launched on July 17, 2008. On 1 July, 2009, the platform changed its name to PXE and was transformed into a joint stock company. The PXE Exchange facilitates the trade in electric power (also gas) and operates internationally–the platform offers products on the Czech, Slovak, Hungarian, Romanian, and Polish[12] markets, while being a subsidiary company of the Prague Stock Exchange. PXE was also a part of the CEE Stock Exchange Group, which brings together four Central European stock exchange markets: the Vienna Stock Exchange (Wiener Börse), Budapest Stock Exchange (Budapesti Értéktőzsde), Ljubljana Stock Exchange (Ljubljanska borza) and the Prague Stock Exchange. Since 2016, PXE has been part of the EEX Group and its offered power derivates are operated via the EEX Trading system. Today, EEX connects more than 500 trading participants worldwide. Therefore, "EEX trading participants are able to trade Czech, Hungarian, Slovakian, Romanian, and Polish power futures alongside contracts for 11 power markets in Central Western Europe". (see Power Exchange Central Europe, 2019)

Trading within the PXE framework and under EEX licence (covering domestic as well as international trading) may be performed only by actors that meet the requirements (concluding the exchange in line with applicable legal regulations, i.e. becoming an EEX member. (see Power Exchange Central Europe, 2017; Power Exchange Central Europe, 2019) Other prerequisites are Non-Clearing Membership in the clearing house European Commodity Clearing AG (ECC) and a clearing agreement with an ECC Clearing Member (a bank). Then the entity must possess a license for electricity trading (for foreign actors issued by their home institutions)[13], be a subject of clearance with its own market operator,[14] and close an agreement with a clearing bank.[15] Trading participants are, moreover, obliged to purchase electricity only for resale purposes and not be the end user. (Power Exchange Central Europe, 2017) Even though the participants' names are publicly disclosed, the trading itself proceeds anonymously. Trading is regulated, the currency is EUR, and closed trades are guaranteed and cannot be cancelled.

Physical settlement is based on "the obligation of both parties to the trade to deliver/pay for a certain volume of MWh in a given future delivery period and for an agreed price." *Financial settlement* is based on "the obligation of both parties to the trade to provide future financial settlement of the price differences regarding the subject of the trade, during the delivery period" (see Burza cenných papírů Praha, a. s. , 2011, p. 35)

Depending upon the length of the period of delivery of the agreed volume of electricity, individual contract trades at the PXE are daily, weekly, monthly, quarterly or annual. Furthermore, contracts are divided into two basic groups according to whether the electricity is to be supplied at all hours of all days during the distribution period (the base load) or only Monday through Friday between 8 AM and 8 PM (peak load), where state holidays and days off are considered work days.[16] Finally, contracts are divided into futures or long-term (i.e. annual,

12 Products on the Polish and Romanian markets were first introduced in 2014). (see Power Exchange Central Europe, 2019)

13 The Energy Regulatory Office (ERÚ) for the Czech Republic, the Regulatory Office for Network Industries (URSO) for the Slovak Republic, and the Hungarian Energy and Public Utility Regulatory Authority (MEKH) for Hungary.

14 OTE, a. s. for the Czech Republic, OKTE in Slovakia, HUPX in Hungary and OPCOM in Romania.

15 A bank which is in line with the PXE Rules of Clearing responsible for unconditional fulfillment of an obligation resulting from the clearing of an exchange trade performed by a trade participant has a closed agreement with the bank on exchange trade clearing, among others including the bank's obligation to cover trading and clearing fees. (see Power Exchange Central Europe, 2017)

16 OTE, a. s., moreover, offers an off-peak load, which is supply during working days from midnight to 8 AM and from 8 PM to midnight.

quarterly, and monthly base loads and peak loads) or spot market commodities traded for immediate delivery (i.e. day-ahead and intraday peak loads and base loads).

The result is the nine basic products that are the subject of PXE trade. Electrical energy is then supplied at the constant value of an hourly output of 1 MW at all hours of all days during the agreed period of delivery or consumption. For cross-border trading, the transmission of electricity is not included in the contract price. Trading is therefore classified as an explicit auction (see Power Exchange Central Europe, 2019; Horová, 2009). Electricity trading on the PXE Exchange is also limited in terms of order volume (see table 8.9) and the volume of contracts traded (fixed at the level of 1 MW).

Tab. 8.9: Minimum and Maximum Volume Orders at PXE Exchange

Type of contract	A Minimum Order Volume	A Maximum Order Volume
Daily (D, peak and base)	1 MW	50 MW
Monthly (M, peak and base)	10 MW	25 MW
Quarterly (Q, peak and base)	5 MW	25 MW
Yearly (CAL, peak and base)	5 MW	15 MW

Source: Power Exchange Central Europe, a. s. Modified by T. Vlček.

Once the trade has been closed, it is followed by settlement, executed by the designated clearing house, i.e. European Commodity Clearing (ECC AG). The participant's clearing bank is in charge of his or her financial liability, thereby ensuring financial clearance. In terms of the physical transmission of electricity traded, OTE is responsible for the commodity, receiving information about trading events at the PXE a day ahead. It also performs the imbalance settlement process (see Horová, 2009; Power Exchange Central Europe, 2019).

In parallel, short-term trading in the Czech Republic is organised via OTE, whether as cross-border day-ahead market coupling or domestic intraday trading. It is important to mention that the day-ahead spot price is currently generated using a single algorithm within Europe, PCR EUPHEMIA, which allows for marginal and non-discriminatory price formation in line with the EU electricity market target model. This algorithm is operated by the Nominated Electricity Market Operators (NEMO) as defined by the EU legislation and provides benchmark prices in most bidding areas in Europe. OTE is one the owners of the algorithm, together with seven other NEMOs in the EU. (see Asociace energetických manažerů, 2016) The parameters of short-terms organised by OTE are summarised in table 8.10.

Tab. 8.10: Parameters of short-term markets

Type of market	Block market[17]	Day-ahead market	Intraday-market
Traded period	12/24 h	1 hour	1 hour
Minimum volume	1 MW × 12/24 h	1 MWh	1 MWh
Maximum volume	50 MW × 12/24 h	99,999 MWh	99,999 MWh
Currency	CZK	EUR	EUR
Market opens at	9:30 D-5	unlimited	15:00 D-1
Market closes at	13:30 D-1	11:00 D-1	H-1:00

Note: The abbreviation D-5 refers to the time window five days prior the physical delivery of electricity. The same logic then applies to D-1, where the activity in question is performed one day prior the delivery date. H-1 then refers to the intraday time period and indicates that the activity is performed 60 minutes before the physical delivery of electricity.

Source: OTE, 2019c; modified by P. Brhlíková

17 According to OTE (2019), the block market is based on the priciple of the continual trading of fixed electricity blocks on specific trading days. On the block market, base type blocks (0:00–24:00), Peak type (8:00–20:00) and Off-peak type (0:00–8:00; 20:00–24:00) are traded. (see OTE, 2019c)

8.5 Stability and Development of the Transmission System–Crisis or a Revolutionary Change in the Electric Power Industry?

Even though a number of current topics in the Czech electric power system have already been addressed in other parts of the text, the phenomenon of the stability and development of the transmission system deserves its own section. The stability of the transmission and, hence, of the distribution system is simply the key factor in the electricity sector, both in terms of a balanced level of production and consumption, as well as from the purely technical standpoint. Electricity lines and other parts of the power system need to be kept in good condition, which is impossible to achieve without investing in repair, maintenance and development services. The stability of the transmission network is presently affected by several events, among them the integration of electricity from renewables into the grid and the problem of sudden fluctuations due to volatile electricity production from wind power plants in northern Germany, which flows through the Czech transmission grid. ČEPS, as the holder of an exclusive license to operate the transmission system, is bound by law to maintain and develop the transmission system.

ČEPS is obliged to publicly release the expected development of the transmission system. However, as a result of the demanding allocation of investment in infrastructure, transmission system operators create development plans that span to 10 or 15 years (see Vnouček, 2010, p. 30). Moreover, Regulation 714/2009 provides a clear mandate to ENTSO-E to create a ten-year network development plan on a biennial basis. Network development plans have their basis in national network development plans and must identify potential investment issues, for example with regard to cross-border capacity increases. These development plans must include "the modelling of the integrated network, scenario development, a European generation adequacy outlook and an assessment of the resilience of the system". (see European Parliament, 2009)

Based on defined grid development plans, ČEPS is responsible for constructing and maintaining new lines. However, the need to react to changes on the production side, especially with respect to reacting to the development of renewable sources, may be hindered by complex permit procedures for line constructions, which in the Czech Republic last between seven and 10.5 years (see table 8.11). The National Renewable Energy Action Plan of the Czech Republic has set the goal that the Czech Republic will have a power system with 743 MWe of installed capacity by 2020 in public power plants and 1,695 MWe in photovoltaic power plants (see Ministerstvo průmyslu a obchodu, 2010, p. 69) By 1 January, 2011, however, there were already 217.8 MWe installed in wind power plants and 1,959.1 MWe in photovoltaic plants. In 2017, the share of renewables in final electricity consumption in Czech Republic was 14% according to Eurostat (the share of RES in total energy consumption was 14.8%) while the installed capacity of solar power plants stood at 2,048.9 MWe at the close of 2018. (see MPO, 2018)

Tab. 8.11: Example: the Construction Process of an Extra High Voltage Line

Activity	Duration
Feasibility studies, route location and spatial issues	6–12 months
EIA "Environmental Impact Assessment" Study and public discussions	12–18 months
Depiction of the routes on the cadastral map (of a local plan), preliminary agreement with the property owner, preliminary construction project, request and provision of access to the local plans	12 months
Public discussion and addressing objections	6 – 12 months
Agreements with property owners	6 months
Construction Implementation Project	6 months
Designing and construction procedures	12 – 18 months
Purchase of properties	3 – 6 months
Call for tenders, selection of a contractor, including the resolution of other applicants' objections	6 – 12 months
The construction itself	12 – 24 months
Total duration	81 – 126 months (approximately 7 – 10.5 years)

Source: Vnouček, 2010, p. 33.

The regulation of the unstable, volatile and hard-to-predict production of these power plants will cost the Czech Republic almost CZK 50 billion delivered to ČEPS for its ancillary services.

The technical limit of electricity regulation potential in the Czech Republic, after totalling positive and negative regulation capacity, is 1,585 MWe during daytime regulation and 1,395 MWe during nighttime regulation. According to a study by EGU Brno, a. s., the technical limit will reach 2,000 MWe in 2013–2015. Meantime, distribution company records reveal that the summed potential capacity (based on connection approvals issued) as of January 31, 2010 was 8,063 MWe from renewables (5,277 MWe from photovoltaic plants and 2,786 MWe from wind plants) (see Jabůrková, 2010, pp. 320–321).

Currently, the Czech Republic has peak and semi-peak electricity regulation plants. Peak power plants include the Orlík wind power plant, the Dlouhé stráně pumped-storage hydroelectricity, hydropower plants with more than 1 MWe and the Vřesová combined cycle power plant. Semi-peak power plants include the Mělník, Prunéřov I, Tisová, Chvaletice, Dětmarovice, and Hodonín power plants (see Růžička, 2009). These sorts of power plants are selected for their capability to quickly change capacity and connect to the grid, as previously described (see comparison in table 8.12).

Tab. 8.12: Comparison of Different Types of Power Plant

Type of Power Plant	Price of Electricity	Capacity	Speed of Connection to the Network	Share of Fuel Costs	Provision of Raw Material Supplies
Nuclear	Very low	Constant, a low degree of regulation capacity	Hours up to days	20–25% of total costs	20 tonnes of fuel per year for 1,000 MW of capacity
Hydroelectricity (pumped-storage hydroelectricity, hydropower plants)	Low	Constant capacity, dependent on the flow, can be well regulated	Tens of seconds	0%	Without problem
Brown coal, Bituminous coal	Similar to nuclear power plants	Constant capacity, a medium degree of regulation capacity	Tens of minutes	50–66%	Storage problems, requires its own source in the vicinity, consumption ranges around a train of coal per day
Gas (combined cycle, gas and fuel power plant)	High	Constant capacity, can be well regulated	A matter of minutes	66–75%	Demands its own source or a pipeline
Wind	Potentially low	Varying capacity, cannot be regulated, completely dependent on regulation capacity	Unstable, unreliable and hard to anticipate, under windy conditions, tens of seconds.	0%	Without problem
Photovoltaic (Solar power plant)	Potentially low	Varying capacity, cannot be regulated, completely dependent on accumulation capacity	Unstable, unreliable and hard to anticipate. Should the sun shine (therefore, during daytime), tens of seconds.	0%	Without problem

Source: Škoda, 2010; For capacity figures, see Štěrba, 2006. Modified by T. Vlček, reprinted with the approval of R. Škoda.

With regard to the planned increase in photovoltaic and wind power plants, we may thus assume that coming years will see greater production of electricity from wind and photovoltaic facilities than enabled by the current technical regulation limit, without jeopardizing the stability of the power system. Generally, for example, there is a need to boost ancillary services by around 20% of total capacity installed in wind power plants (see Belyuš, 2009, p. 582). Based on the findings of the national generation adequacy outlook from 2017, ČEPS indicates that based on modelled scenarios the availability of ancillary services may decrease in the future. (see ČEPS, 2017) Over the long-term, the main reason for such development is the slow phase-out of coal fired power plants and a reduction in installed capacity of nuclear sources in the future. From the operational security perspective, the transmission system operator must prepare for such a scenario. Therefore, ČEPS investments focus on increasing the capacity of substations, reinforcing existing transmission lines, and constructing new lines, as well as on innovations in digitalisation, decentralisation and accumulation. (see Budín, 2019)

The present (European and thus Czech) trend is rather clear. It takes the direction of the developing renewable energy sources, striving to obtain greater energy efficiency and energy savings, and taking initial steps towards shifting to a decentralized energy sector. The so-called “Clean Energy Package”, which recasts the Third Energy Package of 2009, sets an ambitious European goal of 32% renewable energy sources by 2030. (see European Commission, 2018) But from an operational point of view, integrating intermittent sources and shifting from conventional base load generation can lead to a lack of flexible sources for balancing purposes and stability of supply.

Another issue is the profitability of these conventional generation units. Decarbonisation and the introduction of support schemes for RES have distorted the market, as traditionally competitive sources experience an inability to compete with supported intermittent generation. The main reason is that marginal production costs are very low or absent in the case of renewables and support schemes implemented to steer the deployment of new renewable technologies. (see ČEZ, 2019a) There is no investor that would be interested in building large new classic sources (with the exception of Ledvice), because the return on investment is far from certain. With respect to where development is directed and to gradual termination of existing large coal blocks, the Czech electric power industry in upcoming years may expect either a state of crisis associated with a drop in electricity production from coal and electricity regulation (from renewables, from the development of electric vehicles and necessary infrastructure, etc.) in the grid, or a revolutionary change. The latter would rest on the ability to manage the increasing electricity consumption in the Czech Republic (see table 8.13) in shifting to a new order in the electric power industry. More recently, OTE reported that long-term, net consumption might increase by 25%–33% by 2050 compared to 2018. Taken together, this would mean 78–83 TWh of electricity consumed (incl. electric mobility) depending on the scenario. (see OTE, 2019b)

Tab. 8.13: Forecast of the Future Course of Electricity Consumption in the Czech Republic (GWh)

	2010	2011	2012	2013	2014	2015	2020	2030	2040
High Energy Users	35,547	36,059	36,566	37,177	37,963	38,788	42,461	45,752	47,249
Low Energy Users	23,319	23,649	24,144	24,636	25,018	25,393	27,131	29,245	30,593
Household Low Energy Users	8,375	8,525	8,840	9,165	9,377	9,597	10,571	11,543	12,027
Business Low Energy Users	14,944	15,124	15,304	15,472	15,640	15,796	16,560	17,702	18,566
Net	**58,866**	**59,708**	**60,710**	**61,813**	**62,981**	**64,182**	**69,592**	**74,997**	**77,842**
Loses	4,666	4,729	4,806	4,890	4,979	5,070	5,477	5,854	6,028
– in the transmission system	747	758	770	783	796	810	872	927	949
– in the distribution system	3,919	3,972	4,035	4,107	4,182	4,260	4,605	4,928	5,079
Net incl. loses	**63,531**	**64 437**	**65,516**	**66,703**	**67,960**	**69,252**	**75,069**	**80,851**	**83,870**

Source: OTE, a. s., 2011, p. 10.

Capacity shortages, a low level of investment on the side of conventional generation and growing consumption may lead to generation adequacy concerns.

The electricity grid will be under enormous pressure. In 10 to 15 years, ČEPS expects the emergence of a qualitatively new energy sector, which will include, among other things, “a change in primary sources’ capacity structure and a partial shift of production capacity to the level of distribution networks,[18] developed mechanisms of use control through smart systems and their interconnection with the market, the integration of national network control into supranational aggregates, and the interconnection of the market with electricity, services, and regulation energy” (see Kovačovská, 2011, pp. 26–27). The Czech electricity grid was not built for such major unanticipated electricity transmission changes in which users become electricity suppliers, while their modernization in terms of modern smart grids will require sky-high investments.

The Czech Republic is the second largest electricity exporter in Europe, behind France. If it wishes to maintain this position, it will be necessary to replace aging nuclear power plants and increase the installed capacity of nuclear. This requires an even higher investment, but it will increase the safety of electricity supplies in a similarly steep fashion. This situation in the nuclear power industry is very aptly summarised by Petr Otčenášek, who says: “The expected nuclear renaissance stopped at the instant the combustion of oil, natural gas, and coal faced problems related to their exhaustion in the 21st century, and with potential negative impacts on the biosphere” (see Otčenášek, 2011, p. 271).

Table 8.14 displays the problems, risks and advantages inherent in the potential construction of a new large power plant. Although decentralization and renewables are part of the modern trend, with strong support from the EU, the Czech Republic is not at this point prepared to undergo a massive shift to this sort of electricity production.

18 Based on the “Renewable Scenario” OTE predicts production at the distribution level will achieve 19 TWh by 2050

Tab. 8.14: The Potential Construction of New Electricity Sources

Source	Effect
Brown coal	Increasing pressure to breach the environmental territorial limits of mining; absolute surrender on reduction of greenhouse gas emissions.
Bituminous coal	Uncertain supply (in comparison to brown coal, reserves of Czech bituminous coal have an even lower lifespan). Should imports of coal prove necessary (Poland, Ukraine), the environmental dimension would be totally lost to the project due to the overwhelming environmental effects of transporting an enormous amount of materials, and there would be no attempt to greenhouse gas emissions.
Gas	Given that the Czech Republic has no relevant source of natural gas and given that the only real supplier, Russia, levers a dependence on raw material imports for its political interests, such a decision would signify giving up on the energy security of the Czech Republic.
Nuclear	Although demanding both technically and time-wise, this is the solution that would enhance Czech energy security.

Source: Kavina, 2009, p. 326

The investment necessary to modernize and maintain the stability of the transmission system would be astronomical. A more realistic development would be one in which electricity (and heat) is produced from renewables within households (photovoltaic power plants, solar thermal exchangers, biomass boilers, biogas stations, waste-to-energy processing, hydropower plants, etc.) in order to reduce consumption from the central power system. This direction has already been set and, despite significant problems (see the chapter on renewables), it is likely that the energy sector will continue on this course. But even in the distant future, it will be impossible to entirely resign from having a centralized network, as renewables and smaller co-generation units will never be able to provide the massive amounts of electricity required by blast furnaces, ironworks, and other large undertakings that place high demands as electricity consumers.

Of course, with large scale deployment of renewable sources, some level of market distortion is apparent. Low competitiveness and an absence of conventional flexible sources can cause major problems with regard to the balancing of the grid. The new regulatory package (Clean Energy Package) places obligations on the transmission system operator to identify and tackle concerns over generation adequacy, and sets a common framework. If all these solutions together with improved market environment and the removal of any distorting elements are still not effective in addressing generation adequacy issues, the EU Member State may implement the so-called capacity mechanism. The aim of capacity mechanisms is to incentivise the construction of new sources as well as to provide direct financial support for existing generation capacity which is not competitive on the market, thereby ensuring supply will be able to meet demand. There are several schemes already in place across Europe. (see Huhta, 2018) But the Czech Republic has not introduced any capacity mechanisms yet. Considering all the challenges and a persistent push for a cleaner electricity sector more based in renewables and implemented capacity support schemes in neighbouring countries, capacity mechanisms may be an inevitable solution for addressing these generation adequacy concerns and ensuring competitiveness among domestic sources.

The entire regulation issue is, moreover, impacted by so-called cross-border loop flows of electricity from Germany. The Czech Republic is currently connected to neighbouring grids via six 220 kV and eleven 440 kV cross-border lines. Unplanned flows resulting from the volatile production of wind farms in northern Germany enter the Czech Republic via the V445 and V446 lines from Röhrsdorf. (see ČEPS, 2017b)

The installed capacity of German wind power plants located to the north in 2009 amounted to approximately 23,000 MWe; by 2030, this should increase by another 30,000 MWe (see Belyuš, 2009, p. 582), a truly massive capacity of up to 53 thousand MWe (for comparison, the total installed capacity of the Czech Republic as of December 31, 2012 was 20,520 MWe). In reality, the total installed capacity of wind power plants in Germany (both onshore and offshore) was already equal to 55,718.6 MW by 2017. (see Bundesnetzagentur, 2017)

"This problem is far from being the Czech Republic's concern only. The production of wind power plants in northern Germany overloads the lines of system operators in Poland, Slovakia, the Czech Republic, the Netherlands, Belgium, and Switzerland. In the Czech Republic's case, this amounts to 1,500 to 1,700 MWe of unexpected flows. The main reason is the problem of transmitting the electricity produced from northern Germany to users in the central and southern parts of Germany" (see Cieslar, 2010; Cieslar, 2010c). Germany lacks 3,600 km of electricity lines (see Neuerer, 2011). A surplus of German electricity from wind, which for technical and infrastructural reasons cannot be supplied to German users, is usually purchased by Austrian and Swiss pumped-storage hydropower plants, which thereby obtain less expensive electricity for pumping water during the day. In addition to significant expenses associated with power system regulation in the event of a flow of wind electricity from Germany, ČEPS over the long haul (approximately after 2015) plans to modernize and increase the capacity of 400 kV lines, which are the most loaded routes during transfers from Germany to Austria, while these investments would require more than CZK 3.8 billion. The present model of financial regulation of transmission system operators in the EU is solved separately, i.e. “there is no possibility of financial compensation for investment stimulated by external conditions and any compensation of flows from Germany is, therefore, paid for by the Czech user” (see Belyuš, 2009, p. 582).

In response to this issue, ČEPS installed four phase-shifting transformers between 2015 and 2017. The transformers are installed on each side of the 440 kV interconnectors with Germany. These PST transformers are operated in a coordinated manner by German and Czech transmission operators and play a crucial role in regulating loop flows from Germany, thereby maintaining secure operation of the power system within the broader region. The total investment amounts to CZK 1,588 billion. (see ČEPS, 2017a)

Another way to tackle the issue of unscheduled flows in the region is to revise the configuration of bidding zones. The Czech Republic has articulated the urgent need to split the former bidding zone consisting of Germany and Austria. (see Budín, 2019) In practice, it has meant that there was no limit set for cross-border trading between Germany and Austria. Hence, based on a regulatory decision, this large bidding zone was divided on October 1st, 2018. (see TenneT Holding B.V., 2018) Moreover, based on the EU electricity market target model, transmission system operators from Central and Western Europe are obliged to cooperate in order to establish the cross-border capacity calculation method based on coordination which allows for more accurate capacity allocation and operational planning throughout the region. (see ČEPS, 2018)

In 2006, the Expert Energy Security Working Group under the Committee for Foreign Security Policy Coordination prepared a report for the National Security Committee in which it noted that “despite the liberalization of the electricity market, the market is dominated by a very strong company, which causes a low level of competition” (see Odborná pracovní skupina pro energetickou bezpečnost Výboru pro koordinaci zahraniční bezpečnostní politiky, 2006, pp. 8–9). The working group was correct in both cases, but these claims may be assessed anew with respect to the events of the last five years.

This demonstrates that even though the dominant position of ČEZ remains untouched, its position is increasingly being disrupted as the result of non-state market regulation. The character of the Czech electric power sector is very strongly affected by the sector’s historical development, given that it was originally built for purposes of centralized production and transmission. The requirements current sector development imposes on the electric industry are, therefore, limited predominantly in technical terms (in addition to the evident rigid attitude of the national electricity elite, especially in relation to renewables and decentralization). It is entirely evident that ČEZ has no intention of losing its dominant position, responding to the developing situation in its own manner by, for example, initiating producing electricity from renewables or by fighting newcomers to the marketplace.

If we do not set a clear long-term direction for the Czech power industry (under a State Concept) soon, the country will experience either a great electric power industry crisis resulting from hesitancy and inconsistency, or a major, financially enormously demanding change in the electric power industry, should renewables remain supported at current levels in coming years.

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The authors' opinions are their own and do not reflect those of the institutions in which they work.

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