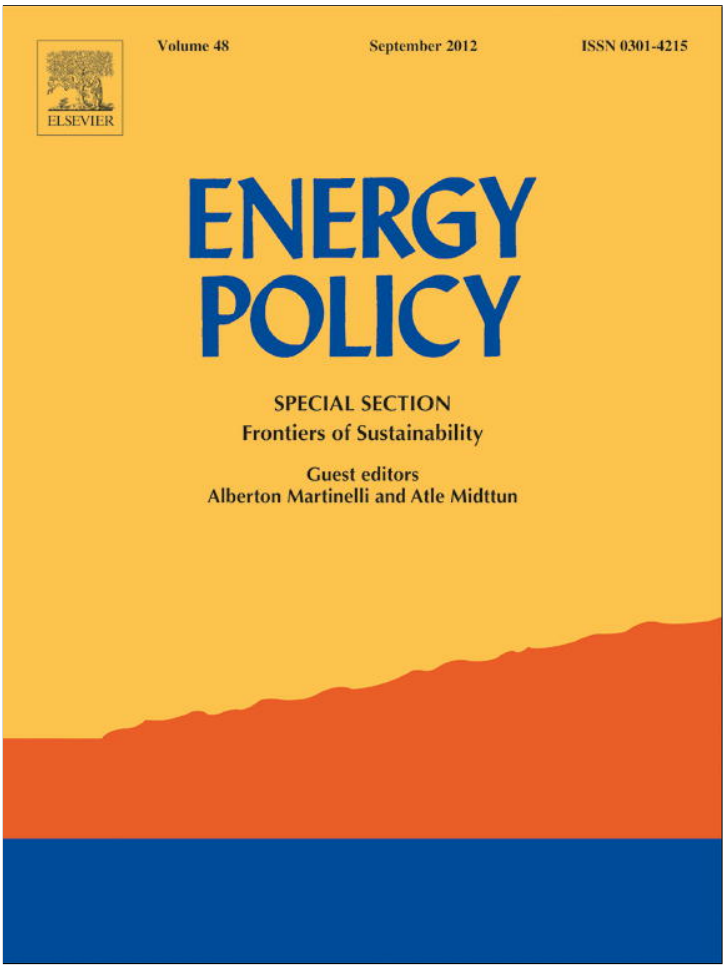

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Factors influencing the selection of the past and future strategies for electricity generation in the Czech Republic

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HIGHLIGHTS

- Czech Republic ranks sixth in the world and fourth in Europe in electricity exports.
- Sub-bituminous coal accounts for 47.7 % of electricity generation, nuclear energy for 32.7%.
- Accessible sub-bituminous coal reserves are decreasing significantly.
- Oil and gas reserves are marginal, uranium reserves are inadequately explored.
- A new energy strategy must be found.

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ABSTRACT

The Czech Republic is the world's sixth largest exporter of electricity. It currently faces a fundamental decision on a new orientation of its energy strategy. Current electricity generation is based on coal (54.7%) and nuclear energy (32.7%). Nowadays the lifespan of the recoverabe reserves is less than 20 years in case of sub-bituminous coal and less than 2 years in case of uranium. Also the original lifespan of all 4 blocks of the power station Dukovany, one of county's two nuclear power plants, is approaching. These are the main reason why the Czech Republic is forced to revise its future energy strategy as well as its current optimal energy mix. This paper analyses the role of individual energy minerals in the future electricity generation portfolio of the Czech Republic. From the point of the energy security, it seems to be optimal to increase the availability of domestic sub-bituminous coal and continue with the preparation of new nuclear energy blocks and extending the lifespan of existing ones. These actions should be supported by investments to the geological survey of domestic uranium deposits. Impartial evaluation of RES potential and impact of their use on the electricity price is advisable simultaneously.

1. Introduction

The Czech Republic has limited reserves of its own energy minerals. Of these energy minerals (bituminous coal, sub-bituminous coal, lignite, crude oil, natural gas and uranium), it is self-sufficient only in sub-bituminous and bituminous coal production (Kavina et al., 2009), because domestic production of crude oil accounts for only 2–4% of domestic consumption, and the percentage is even lower in the case of natural gas (Starý et al., 2010). Production of lignite ceased at the end of the year 2009. The situation is more complex in the case of uranium. The Czech Republic was an important uranium producer in the second half of the 20th century. Although production was gradually phased out since the 1990s, the Czech Republic still has uranium reserves that are of relative interest (Starý et al., 2010; OECD Nuclear Energy Agency & International Atomic Energy Agency, 2010).

The Czech Republic currently faces a fundamental decision on a new orientation of its energy strategy. Current electricity generation rests on two pillars: coal-fired and nuclear power plants. Both changes in the mineral resource base of the Czech Republic, particularly the limited reserves of sub-bituminous coal, are the reason why the Czech Republic, and shortening lifespan of nuclear reactors in Dukovany nuclear power station (years 2015–2017 for 4 reactors in case of original timing, installed capacity 1897 MW), will be forced to revise its future energy strategy. The purpose of this paper is to evaluate the importance of individual energy minerals in the future energy portfolio for generating electricity in the Czech Republic and to define the most important factors, which influence its selection. Foundations of this work, i.e. present state of the electricity generation and resource base of energy minerals, are described in Sections 2 and 3. Section 4 is devoted to the renewable energy sources. Elements affecting possible future scenarios of the electricity generation are

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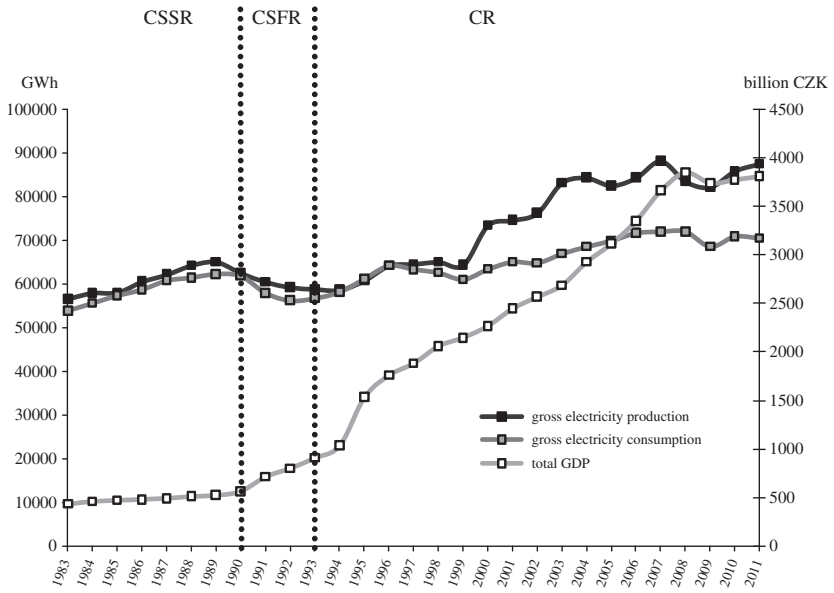

Fig. 1. Summary of the gross electricity production, gross electricity consumption and gross domestic product (GDP) in the time period 1983–2011. Major turning points: 1990: country returned to a liberal democracy in 1989 and was transferred from Czech and Slovak Socialist Republic (CSSR) ruled by the Communist Party to the Czech and Slovak Federal Republic (CSFR), 1993: country peacefully split into the independent Czech Republic (CR) and Slovakia.
Source: Czech Statistical Office (2012), Energy Regulatory Office (2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011), Outrata et al. (1994).

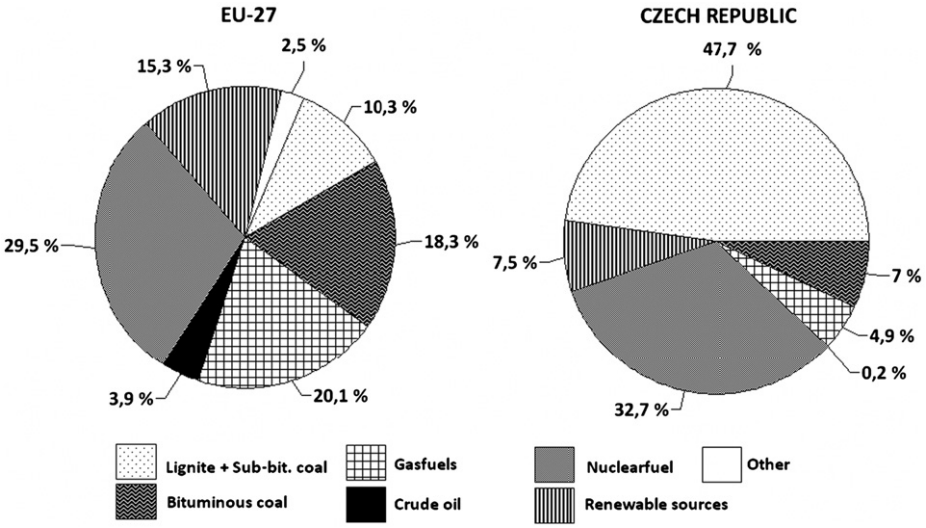

Fig. 2. Electricity generation structure in the EU27 in 2009 and in the Czech Republic in 2010.
Source: Eurostat (2011), Energy Regulatory Office (2011).

characterized in Section 5. Conclusions and possible solutions are summarized in Section 6 (Fig.1).

2. Current structure of electricity generation in the Czech Republic

In 2010, gross electricity generation in the Czech Republic amounted to 85–910.1 GWh (Energy Regulatory Office, 2010). Today's electricity generation structure of the Czech Republic (Fig. 2) reflects a combination of geological, technical as well as political factors, which existed in the mid-1960s. The balance of energy mineral reserves and the life expectancy of the country's energy mineral deposits, which are based on the balance, played an important role in its selection.

In the framework of maximum possible self-reliance in the energy production was in the mid-1960s preferred extensive exploitation of all types of coal by the political decision. Main reasons were their large reserves and resources, unlike those of crude oil and natural gas. Thanks to the significal reserves of uranium and highly developed industry of its exploration and utilization (for military purposes) construction of nuclear power plants was set up. International treaty dealing with construction of first two of them between Czech and Slovak Socialist Republic and Union of Soviet Socialist Republics was signed in 1970. Crude oil and natural gas were mostly imported from the USSR or its satellite states. These are the main reasons why the structure of electricity generation in the Czech Republic differs more or less from the structure of EU-27 (Fig. 2). Individual EU countries always differed in mineral resource bases and political views on electricity generation, so the EU is very non-homogenous in this aspect.

Table 1
Balance of bituminous and sub-bituminous (+lignite) coal reserves (as of 31 December 1965 and 31 December 2009, unit: 1 kt (coal), 1 t (uranium), 1 year (lifespan)) Note: Recoverable reserves and lifespan as of 31 December 1965 are estimated (recoverable reserves were not inventoried in the balances at that time); NA—not available. *Source*: Balance of reserves of the mineral deposits in the Czechoslovak Socialist Republic to January 1st (1966), Starý et al. (2010).

Category of reserves	Classification according to the degree of exploration (kt)		Bituminous coal (kt)		Sub-bituminous coal+lignite (kt)		Uranium (tU)	
	As of 1965	*As of 2009*	*As of 1965*	*As of 2009*	*As of 1965*	*As of 2009*	*As of 1965*	*As of 2009*
Economic	A+B+C1C2	Explored	5,665,055	1,543,177	7,366,911	2,789,379	NA	1426
		Prospected	5,314,944	6,011,682	2,207,614	2,168,466	NA	19,420
	A+B+C1+C2	Explored+prospected	10,979,999	7,554,859	9,574,525	4,957,845	NA	20,846
Potentially economic	A+B+C1+C2	Explored+prospected	1,798,687	8,900,448	2,527,652	4,097,445	NA	114,579
Total (geological) reserves			**12,778,686**	**16,455,307**	**12,102,177**	**9,055,290**	**NA**	**135,425**
Recoverable reserves			**754,585**	**205,630**	**2,277,849**	**862,633**	**NA**	**377**
Production (1965, 2009)			**27,793**	**10,621**	**66,115**	**45,354**	**NA**	**286**
Lifespan (1965, 2009)/years			**27**	**19**	**34**	**19**	**NA**	**1.32**

The status of the mineral resource base of the Czech Republic is evaluated on a regular basis over the long term as part of the inventory and balance of reserves of reserved mineral deposits (reserved minerals are defined in Act No. 44/1988 Coll and are owned by the Czech Republic). At the present time, the results are presented annually in the Mineral Commodity Summaries of the Czech Republic (Starý et al., 2010). Yet unfortunately, the energy mineral reserves inventoried in the mid-1960s (Table 1: as of 31 December 1965) cannot be duplicated in a structure corresponding exactly to today's approach (Table 1: as of 31 December 2009). For one thing, recoverable reserves were not inventoried in the state balance in that time period (Sivek, 1998), and uranium reserves were categorized as classified information. However, different rules for classifying mineral reserves were in effect as well. Although we were not able to find any uranium reserves inventoried in 1965, it may be rightly assumed that they must have been of significant amounts. After all, the Czech Republic historically ranks tenth in the world with a total production of 111,000 t of uranium mined in 1946–2009 (OECD Nuclear Energy Agency & International Atomic Energy Agency, 2010). Of that total, 70,850 t of uranium were produced between 1965 and 1993, when uranium mining was phased out within the territory of the country and only the Rožná underground mine remained in operation (Starý et al., 2010). Based on information available today (Table 1) on the country's energy mineral reserves as of 31 December 1965, it is possible to conclude (crude oil and natural gas reserves are not included in these conclusions due to their entirely marginal significance) that their amount must have undoubtedly been a serious argument for accepting the concept of generating electricity in sub-bituminous coal-fired and nuclear power plants.

Table 1 shows final states of reserves and their dynamics between years 1965 and 2009. Essentials are predicted lifespans for single commodities, which are first dozens of years mostly. Crucial is relatively short lifespan of lignite+sub-bituminous coal reserves, which shares almost 50% of electricity generation.

We are using the reserves data in the categories on exploration (*prospected*, *explored*) and economic use (*economic*, *potentially economic*), as stipulated by relevant statutes (Act No. 44/1988 Coll and connected legislation). Reserves include *economic* reserves, i.e. reserves which are (or could be) currently profitably recovered, and *potentially economic* reserves, i.e. reserves which are currently not recoverable. Used categories of reserves according to the degree of deposit exploration are: (A) reserves explored in detail by mining works and/or boreholes, with known geological setting and technological properties and resolved hydrogeological and mining conditions; (B) reserves explored and delimited by mining works and/or boreholes in sparser network than in category (A), with not known detailed distribution of geological and technological properties and only basically evaluated processing method and hydrogeological and mining conditions; (C1) reserves determined by a sparse network of boreholes and/or mining works or reserves which adjoin the reserves of categories (A) and (B), also reserves of complex deposits or partially mined-out deposits, with hydrogeological and mining conditions defined just generally; (C2) reserves are assumed based on geological and geophysical data, confirmed by sporadic sampling. *Total (geological) reserves* are quantity of mineral assumed to exist in the area. *Recoverable (extractable) reserves* are part of the total reserves whose extraction is economically efficient at market conditions and use of up-to-date technology as of the date of calculation and taking into account compliance with the environmental protection (Starý et al., 2010).

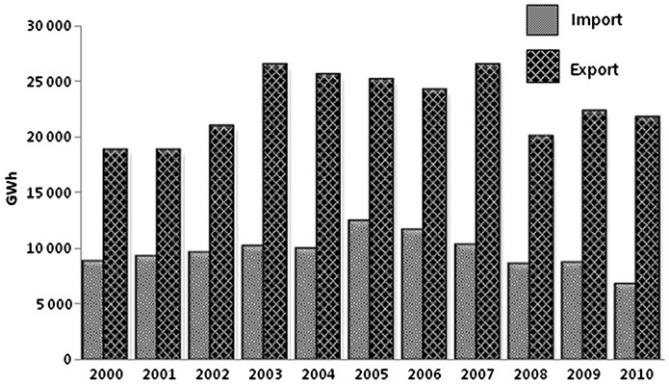

Fig. 3. Czech Republic's import and export of electricity.
Source: Energy Regulatory Office (2010, 2011).

The chosen orientation of electricity generation (the combination of coal-fired and nuclear power plants) laid the foundation for the current position of the Czech Republic as a country with an electricity surplus, i.e. an exporter of electricity (Fig. 3), which is rather an exception in today's Europe, when electricity is imported by the majority of neighboring countries.

By contrast, the Czech Republic ranks sixth among the world's largest exporters of electricity (Fig. 4). For example, in 2010, the Czech Republic exported 21,591 GWh (Energy Regulatory Office, 2011), which represents approximately 18% of domestic electricity generation.

3. The country's mineral resource base as the basis for the future electricity generation portfolio

The approaching end of the lifespan of some coal-fired power plants, and the change in the levels of reserves of domestic energy minerals, primarily of economic sub-bituminous coal reserves

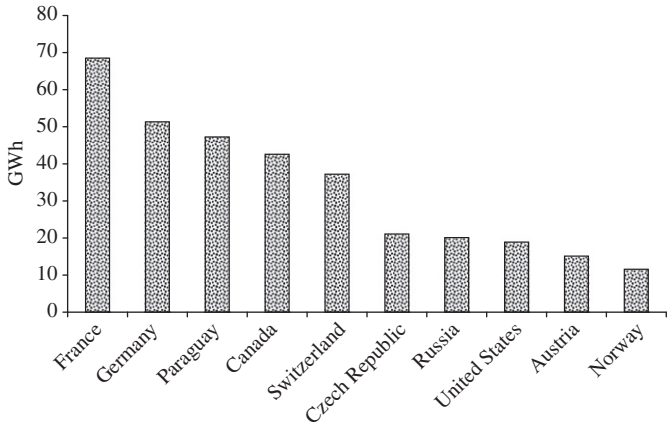

Fig. 4. Top 10 world exporters of electricity. Average export values per year in the time period 2000 to 2011.
Source: The World Factbook (2009).

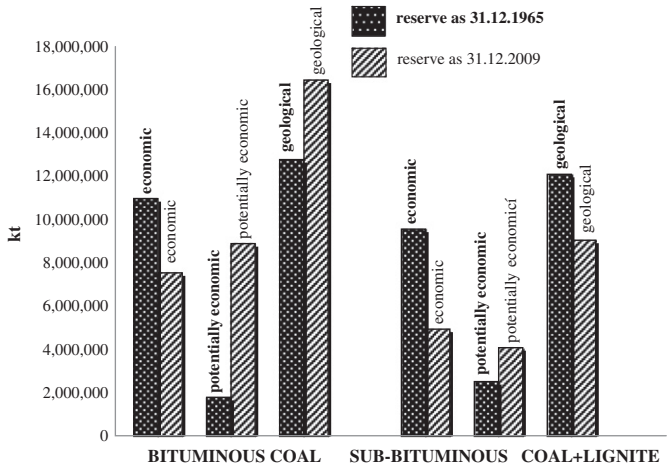

Fig. 5. Comparison of coal reserves in 1965 and 2009.
Source: Balance of reserves of the mineral deposits in the Czechoslovak Socialist Republic to January 1st (1966) a Starý et al. (2010).

(Fig. 5), require that the Czech Republic revise its energy strategy and change the current portfolio of exploited energy sources.

Predictions regarding the future development of electricity demand and production in the Czech Republic clearly point out the fact that the Czech Republic will convert from an exporter to an importer of electricity, if one or more energy sources are not developed in a relatively short time. This situation may already occur around year 2020 (State Energy Conception, 2004), which is a very undesirable development from the viewpoint of energy self-sufficiency and energy security, particularly with respect to the already-mentioned fact that the Czech Republic is the only country with a significant long-term electricity surplus in the Central European region.

The Czech Republic therefore faces an important strategic decision on the orientation of electricity generation in future years. The structure and status of the country's mineral resource base play and will play a major role among the factors and influences evaluated in this decision-making process.

The structure of energy mineral deposits of the Czech Republic and some issues regarding their lifespans were dealt with, for example, by Kavina et al. (2009). It is precisely the lifespan of reserves (19 years both for bituminous coal and lignite, less than 2 years for uranium—Table 1) that is proving to be fundamental for selecting an electricity generation mix.

A comparison of the status of the Czech Republic's mineral resource base in the mid-1960s (Table 1) with its current status (Fig. 5) clearly indicates that current decision making on the future orientation of electricity generation is taking place under different conditions than those in the 1960s. Fundamental is slump of economic reserves of both types of coal in particular. Above all, the levels of energy mineral reserves in both time horizons are substantially different. Differences exist in the case of both bituminous coal (however the share of electricity generated from bituminous coal in the Czech Republic was never significant) and sub-bituminous coal.

It is precisely the reserves and lifespan of sub-bituminous coal deposits, which are decisive for electricity generation in the Czech Republic that show the biggest differences. The differences in the sub-bituminous coal segment, but also in uranium, where the differences are primarily the result of inadequately explored reserves, exert the greatest influence on the decision making concerning the future composition of the energy portfolio. The differences between both time horizons can be seen above all:

(1) in the current lower levels of sub-bituminous coal reserves and thus also lower lifespan of production capacities;
(2) in the phase-out of uranium mining and in fundamental changes in the status and structure of uranium reserves, and in the varying degree of exploration of inventoried reserves.

The lower levels of available sub-bituminous coal reserves are, on one hand, the result of depletion due to production and, on the other hand, partially connected with the adoption of the so-called territorial ecological limits on mining. The limits, which establish boundaries for individual mines, may not be transgressed by open-pit mines and overburden disposal operations. These limits were gradually adopted by the government of the Czech Republic through three resolutions (Government Resolution No. 331/1991; (Government Resolution No. 444/1991); Government Resolution No. 490/1991), which applied to individual areas of sub-bituminous coal basins. The aim of assignment of these limits was emphasizing the landscape and environment protection and enabling long-time planning in localities above the coal seams. Period of validity of these limits was not specified in original texts. The future of the territorial ecological limits has been debated for a number of years. On the top level of our political representation the issue is discussed since 2005, when prime minister Jiří Paroubek stand for their breakthrough at specific conditions (ČTK, 2005). That is to say, the lifting of the limits would significantly prolong the lifespan of sub-bituminous coal production capacities in the region of the sub-bituminous coal basins in the foothills of the Krušné Hory Mts. Reserves of about 0.9 billion tonnes are bound by this limits and thus represents about 18-years mining (Starý et al., 2010). If, on the other hand, the mining limits remain, the lifespan of mines will shorten and reduce their output. Production is therefore expected to decline by 2050 to less than 20 million tonnes from 45.354 million tonnes produced in 2009 (Report of the Independent Expert Commission for Evaluation of the Energy Demand of the Czech Republic in the long-term time horizon, 2008; Proposal of the Update of the State Energy Conception, 2010).

The development in the case of uranium was more complex. In the 1960s, the former Czechoslovakia (however, all of the uranium was basically mined within the territory of today's Czech Republic) was an important world producer of uranium. In historical statistics, it ranks tenth in the world with a total production of 111,000 tonnes of uranium, which were produced in 1946–2009 (OECD NEA & IAEA 2010). However, the mining of all vein-type deposits (except for the Rožná deposit) was terminated in the early 1990s and the mining of sandstone-type

deposits in 1993 as well. Uranium production thus declined from an annual rate that fluctuated between 2000 and 2900 tU/yr to today's rate of 286 tU/yr, and mining at the Rožná deposit is expected to terminate roughly in 2014. Then, starting in 2014, uranium will only be recovered from remediation of closed mines, specifically at a rate of about 30–40 t U/yr (Starý et al., 2010). However, the potential for uranium reserves in the Czech Republic still remains sound. According to official statistics (Starý et al., 2010), the amount of total uranium reserves reported in the Czech Republic as of 31 December 2009 was 135,425 t. Yet, approximately 85% of this amount is inventoried as potentially economic reserves, which is also partially the result of an administrative re-evaluation of reserves in connection with the phase-out of uranium mining. These reserves may significantly influence the energy security of the Czech Republic, regardless of the fact that potential tapping of the mentioned reserves requires renewed deposit exploration, a new technical-economic evaluation of individual deposits, and use of the latest technologies for their potential exploitation.

Under such conditions, the Czech Republic is deciding on the future structure of electricity generation. However, one more important difference exists between the present-day conditions and those of the mid-1960s, which is of vital importance in selecting an energy generation concept. It is the fact that, today, the Czech Republic has an open market economy contrary to the centrally planned economy of the 1960s. Also, today's political situation is incomparable with the situation in the 1960s. At that time, during the existence of the Iron Curtain and mineral embargo, the Czech Republic was a member of the Eastern Bloc as part of the former Czechoslovakia.

4. Renewable sources in the Czech optimal energy mix

A reliable prediction regarding the composition of the future optimal energy mix, but also regarding the volumes of energy minerals necessary for electricity generation, requires a thorough assessment of the realistic possibilities of generating electricity from renewable energy sources (hereinafter RES). Increasing the share of electricity generated from RES is one of the priorities of the European Union in the electricity generation sector. In order to achieve this goal, Directive 2001/77/EC (2001) of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market was adopted. Consequently, in connection with the mentioned directive, individual Member States of the European Union set their national indicative targets for the share of electricity from RES in 2010. These targets were based on the technical and climatic possibilities of individual states, and their collective goal was the fulfillment of commitments that arose from the Kyoto Protocol. During talks on accession to the European Union, the Czech delegation negotiated an indicative target of 8% in 2010 for the Czech Republic. Subsequently, Directive 2001/77/EC (2001) was partially incorporated into an amendment of Energy Act No. 670/2004 Coll. The 8% share of electricity generated from renewable sources also became part of the State Energy Conception of the Czech Republic currently in effect, which was approved in March 2004. However, it was primarily the subject matter of Act No. 180/2005 Coll., entitled "Act on the promotion of electricity production from renewable energy sources and amending certain acts (Act on Promotion of Use of Renewable Sources)".

In January 2008, the European Commission presented an "Climate & energy package", which proposed another increase in the targets of the European Union in the area of RES development and climate protection by 2020 (The EU climate and energy package, 2012). These proposals were subsequently incorporated into Directive 2009/28/EC (2009) of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directive 2001/77/EC (2001) and 2003/30/EC. In the area of energy from renewable sources, the European Union thus committed to increase the share of RES in gross energy consumption to 20% by 2020. The Czech Republic's target for 2020 is set at 13%. The national overall targets for individual Member States of the European Union vary considerably. They range 10–49%, which is, however, logical with regard to historical levels, the economic and technical potential and fairness considerations in individual Member States of the EU (in particular The EU climate and energy package, 2012, individually e.g. Tol, 2009; Ericsson and Nilsson, 2006; Pryor et al., 2006; Krasuska et al., 2010). The EU climate and energy package goes further than Directive 2001/77/EC (2001) and involves e.g. large reduction of greenhouse gases.

In the Czech Republic, the structure and amount of electricity generation from RES and its outlook is specified more accurately on a regular basis as part of mineral policy updates. It is also dealt with by a number of studies, and was even included in the findings of the Independent Expert Commission for Assessing the Future Energy Demand of the Czech Republic in the Long-Term Horizon (2008). The structure of electricity generation from RES in 2010 and a comparison with 2007 is shown in the chart in Fig. 6. The share of RES in total electricity generation in 2010 is given in the chart in Fig. 2. In 2010, the gross share amounted to 7.5%. This value means that the Czech Republic met the national indicative target, which from the perspective of electricity generated from RES is monitored through gross domestic consumption. In 2010, this value amounted to 8.3% (the indicative target was 8%) (Sivek et al., 2012).

The Czech Republic is often criticized for the fact that its adopted indicative targets for the share of electricity generation (for year 2010) and, generally, of energy from RES are relatively low (Tolón-Becera et al., 2011; Sivek et al., 2012). However we believe that, in this regard, it should rather be acknowledged that during negotiations the representatives of the Czech Republic always strove for targets that were realistic and that corresponded to the realistic possibilities of the country (e.g. economic).

The use of renewable energy sources undoubtedly contributes to environmental protection and sustainable development. From the perspective of national energy security, RES unquestionably represent a stabilizing factor, since they are "domestic sources" of energy, which consequently lower the country's dependence on imports in the energy minerals sector. But RES represent a

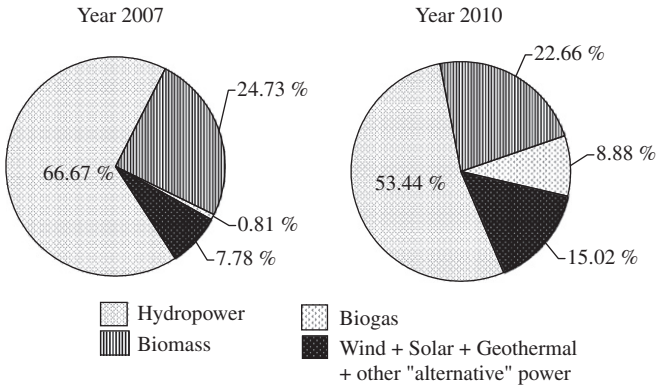

Fig. 6. Comparison of net electricity generation from RES (in GWh) in 2007 and 2010.
Source: Energy Regulatory Office (2010, 2011).

relatively broad spectrum of sources and, in the case of some of these, long-term experience with their large-scale integration into distribution networks is lacking (e.g. Shaw et al., 2010; Barton and Infield, 2004). With the exception of hydropower and biomass, it will probably still be necessary to find a way so that a number of these technologies are optimally represented in the structure of electricity and heat generation in the country. That is indicated by the latest reactions of electricity distribution grid operators in the Czech Republic to the massive expansion of photovoltaic electricity generation in the country, when they warn of potentially serious grid stability problems. This is creating problems between the distribution grid operators and producers of electricity from RES, who point out the fact that Articles No. 60 and 61 of the already cited Directive 2001/77/EC (2001) speak of "priority access to the grid", which assures the producers of electricity from renewable energy sources, "that they will be able to sell and transmit the electricity from renewable energy sources in accordance with connection rules at all times, whenever the source becomes available". However, the latest development (see Sections 2 and 5 in Sivek et al., 2012) indicates that the directive was adopted at a political level without sufficiently considering the realistic technical possibilities of distribution grid operators.

5. Key factors in selecting the energy portfolio for generating electricity in the Czech Republic

Although the country's mineral resource base forms the fundamental platform for selecting an optimal energy mix, it is not the only factor in this decision-making process as we have demonstrated in the example of the share of energy generation from renewable sources. Therefore, when developing individual scenarios for the future orientation of the country's energy portfolio, the national mineral and energy policy must also consider:

1. the availability of domestic energy minerals and access to foreign energy minerals;
2. the structure of consumption of primary energy sources (i.e. energy mix) including the realistic potential of renewable energy sources, as mentioned above;
3. the energy demands of the economy and its anticipated development, the potential of energy savings;
4. the development of consumption in the industry, household and services sectors, the anticipated development of the energy balance in neighboring countries, and the anticipated economic development of the country and the entire region (Kavina, 2008).

The combination of the mentioned factors forms the basis for selecting the structure of future electricity generation in the Czech Republic. It is beyond dispute that national energy security, which under current conditions is becoming more significant factor in the national mineral and energy policy, must also be included in this selection process by the Czech Republic.

The role of natural gas in Czech energy mix should might mentioned, since it is usually considered cheap, easy to use and environment-friendly. Problem is that the Czech Republic has only minor domestic production and gas is imported dominantly from Russia by old (1963–1965) Druzhba pipeline through Belarus and Ukraine. As Černoch et al. (2011) pointed out—the Russian gas is not as cheap as sometimes considered and there is no assurance that Russian reserves are good enough for export to Europe in a long time horizon? Since the bad experience from the gas crisis of January 2009, when Czech Republic (together with other European countries) was cut off from gas supplies for 13 days, our State energy conceptions does not count with massively growing share of natural gas in energy portfolio.

6. Conclusion: Coal- or nuclear-based future of the Czech electricity generation portfolio?

If the Czech Republic is to maintain the existing measure of energy security and not dramatically increase its energy dependency, it must find an answer to the fundamental question concerning the future orientation of the structure of electricity generation when considering the future development of its energy portfolio in the electricity generation sector. It is a question of a coal- and/or nuclear-based future of electricity generation in the Czech Republic. Other options for the electricity generation mix would represent a significant increase in energy dependency (or in case of RES energy price) for the Czech Republic.

The approved State Energy Conception of the Czech Republic from March 2004 as well as the findings of the Independent Expert Commission for Assessing the Energy Demand of the Czech Republic in the Long-Term Horizon from 2008, whose chairman was the then president of the Academy of Sciences of the Czech Republic Václav Pačeš, came to similar conclusions.

1. The planned construction of new units at nuclear power plants, including an assessment of the realistic role of domestic uranium deposits in terms of their use in the entire uranium cycle, should not be delayed.
2. The possibility of increasing the availability of domestic subbituminous coal should be considered.

The same principles even served as the basis for a Proposal of the Update of the State Energy Conception (2010) prepared by the Czech Minister of Industry and Trade during the period of the caretaker government under the guidance of the then Minister Vladimír Tošovský, himself a well-respected expert in the field of energy. However the fact is that the decision making will be considerably more complex, given the present situation influenced by the latest events in Japan.

Whatever the decision-making outcome may be, it is impossible to ignore the proven fact that the limited reserves of primarily sub-bituminous coal require a revision of the country's future energy portfolio. The expansion of nuclear energy, just as the relatively substantial reserves of uranium ore, is one of the alternative solutions to future electricity generation in the Czech Republic.

At the same time, this decision will also have international repercussions. If in fact the planned shutdown of German nuclear power plants takes place by 2022, then the loss of two of the five largest electricity exporters in Europe may be expected in this time horizon.

Acknowledgments

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