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Diploma Thesis

Analysis of Foreign Trade with Coal in the Czech Republic

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DIPLOMA THESIS ASSIGNMENT

Kristýna Dvořáková

Economics and Management

Thesis title

Analysis of Foreign Trade with Coal in the Czech Republic

Objectives of thesis

The aim of this diploma thesis is to describe foreign trade and the significance of coal. It mainly focuses on determining how the future import and export of hard coal and lignite will be developed and on analyzing the future trade situation in the Czech Republic.

Methodology

The theoretical part of this thesis is based on the descriptive and comparative methods of research. The practical part predicts the future structure and development of foreign trade in the Czech Republic by using a trend analysis.

The proposed extent of the thesis

60 – 80 pages

Keywords

coal, import, export, production, consumption, Czech Republic, foreign trade, trend analysis

Recommended information sources

GLOWIK, Mario. Market Entry Strategies. Oldenbourg Wissenschaftsverlag, 2009. 279 p. ISBN 978-3-486-58412-7.
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Declaration

I declare that I have worked on my thesis called “Analysis of Foreign Trade with Coal in the Czech Republic” on my own and I have used only the scientific literature and other information sources that are mentioned in the references at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any third person.

In Prague on 24 March 2016

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Kristýna Dvořáková

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Analysis of Foreign Trade with Coal in the Czech Republic

Analýza zahraničního obchodu s uhlím v České republice

Summary

This diploma thesis deals with foreign trade with coal and primarily focuses on the Czech Republic.

The theoretical part describes the structure, entry modes, importance, functions, theories and trade organizations of foreign trade. It also examines the significance of coal, such as the basic information about coal, its connection to the environment, safety, energy sector and the foreign trade with coal worldwide. The theoretical part is intertwined with the practical part and continues to the analysis of foreign trade with both main types of coal in the Czech Republic. First of all, it defines the current structure of production, consumption, import and export of hard coal and lignite, then it describes a prognosis of production and consumption between the period 2015 and 2045. The crucial part of this thesis focuses on the prediction of the future import and export of hard coal and lignite thus the foreign trade balance in the Czech Republic by using the trend analysis.

This work concludes that the import of both types of coal will be increasing and oppositely the export will continuously decrease. The main reason is securing the stability of the energy supply but also the mines/quarries closures.

Key Words: coal, import, export, production, consumption, Czech Republic, foreign trade, trend analysis

Souhrn

Tato diplomová práce se zabývá zahraničním obchodem s uhlím a primárně se zaměřuje na Českou republiku.

V teoretické části práce popisuje zahraniční obchod, jeho strukturu, formy vstupu, důležitost, funkce, teorie a obchodní organizace. Dále zkoumá důležitost uhlí, základní informace o uhlí, jeho napojení na životní prostředí, bezpečnost, energetický sektor a celosvětový zahraniční obchod s uhlím. Teoretická část se prolíná s částí praktickou a pokračuje k analýze zahraničního obchodu s oběma druhy uhlí v České republice. Za prvé definuje současnou strukturu těžby, spotřeby, dovozu a vývozu černého a hnědého uhlí, poté popisuje prognózu těžby a spotřeby mezi roky 2015 a 2045. Stěžejní část této práce je zaměřena na predikci budoucího dovozu a vývozu černého a hnědého uhlí a bilance zahraničního obchodu České republiky pomocí analýzy trendových funkcí. Tato práce dochází k závěru, že dovoz obou typů uhlí se bude zvyšovat, zatímco vývoz se bude postupně snižovat. Hlavním důvodem je zajištění stability dodávek energie, ale také uzavírání uhelných lomů a dolů.

Klíčová slova: uhlí, dovoz, vývoz, těžba, spotřeba, Česká republika, zahraniční obchod, analýza trendových funkcí

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List of Abbreviations

BP	British Petroleum
BTU	British Thermal Unit
CCTs	Clean Coal Technologies
CDAS	Severočeské doly, a.s.
CSO	Czech Statistical Office
ČSA	Československá armáda
e.g.	*exempli gratia,* for example
EIA	U.S. Energy Information Administration
etc.	*et cetera*, and so one
EU	European Union
GATT	General Agreement on Tariffs and Trade
ICC	International Chamber of Commerce
IEA	International Energy Agency
IEF	International Energy Forum
IMF	International Monetary Fund
IU	International Unit
JODI	Joint Organizations Data Initiative
Kg	kilogram
MFA	Ministry of Foreign Affairs of the CR
ME	Ministry of Environment of the CR
MIT	Ministry of Industry and Trade of the CR
MT	Million tonnes
MW	megawatt
MWH	megawatt hour
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of the Petroleum Exporting Countries
SEP	State Energy Policy
UNECE	United Nations Economic Commission for Europe
U.S.	United States
WTO	World Trade Organization

1 Introduction

In the modern age, the demands of the world's industrial, commercial, and residential sector would not be able to function without energy supplies. In order to cover all the world needs, there are several methods how to produce energy, but worldwide, one of the most used is coal. According to International Energy Agency (2014), the share of coal in the global primary fuel mix has risen significantly and it has become the second most important fuel behind oil. Czech Republic (CR) is a perfect model of this trend, as coal is still an essential part of the energy mix and is a very important energy source. Although there are many discussion and studies about the renewable energy sources (RES), which could replace the primary energy sources, coal still holds its crucial position and will hold it until a fundamental change in the market appears or the RES are more widely developed and applied to national infrastructure. The foreign trade with coal in the CR has always been essential to both infrastructure and trade needs in the region. In the past, coal was the least imported and the most exported commodity linked to energy production. Unfortunately, this situation has changed recently and it is assumed that will change more in the future. The coal reserves depletion and related mines/quarries closures or the permanent reduction in production and consumption are examples, why the situation with coal differs and changes in the CR. Another reason is the global approach to the environmental protection which has changed significantly in recent decades worldwide. Emphasis is placed on reducing the emissions and pollutants that are released during the combustion of coal or the negative impact of coal mining on the landscape. Therefore, there are many efforts underway to find adequate substitutes, such as for instance biomass for heating plants.

This thesis, among other things, focuses on the description of the significance of coal, particularly, on the prognosis of the future import and export of hard coal and lignite in the Czech Republic.

2 Aim and Methodology

2.1 Aim

This thesis deals with foreign trade with coal in the Czech Republic. First of all, its aim is to describe the structure, entry modes, importance, functions, theories and trade organization of foreign trade as well as the significance of coal. Second and its main aim is to determine how the future import and export of hard coal and lignite will be developed as they are an integral part of the Czech foreign trade and energy security, and analyze the future of the market development connected with foreign trade in the Czech Republic.

2.2 Methodology

This thesis uses descriptive and comparative methods of research of foreign trade with coal in the Czech Republic.

In the theoretical part, the author has aimed to understand the basic phenomena and facts regarding the foreign trade, furthermore to examine the significance of coal. The author has used the publications by the experts in the field of foreign trade and energy, publications issued mainly by the Ministry of Industry and Trade, International Energy Agency, World Coal Association, Czech Statistical Office and Czech Geological Survey. The author has also used the Internet resources and consultations with the experts.

In the practical part, the author has focused on the foreign trade with coal only in the Czech Republic. First, the author has examined the current state of production, consumption, import and export of coal and then predicted the future structure and development. A trend analysis served as a main part of the practical part, and the author has considered it as the most important because the model showed the future movement of hard coal and lignite's import and export for the years 2020, 2025, 2030, 2035, 2040 and 2045.

3 Theoretical part

3.1 Foreign Trade

According to BusinessDictionary.com (2015), foreign trade is "*the exchange of goods and services along international borders*".

Foreign Trade is the oldest and still the most common form of the external economic relations. It is a part of the manufacturing sector which focuses on the exchange of tangible and intangible values between two or more countries. (Kubišta *et al*., 1999) The main purpose of the foreign trade lies in the enrichment of both sides, or in spreading other cultures. While foreign trade and commerce as such had a great significance from the perspective of history, its economic, social and political importance have grown in recent centuries, mainly because of advanced transportation and globalization of multinational corporations. (Machková, *et al.*, 2014)

3.1.1 Structure

The structure of foreign trade is divided into two categories. The first one is called a commodity structure of foreign trade (Fialová, Plchová, 1994), where the share of individual groups of imported and exported goods is examined. It means that we seek which goods we export and import. (Jelínek, *et al*., 1984)

The second one is called territorial structure of foreign trade. (Fialová, Plchová, 1994) According to Jelínek, *et al*. (1984) the territorial structure is defined as "*the share of individual territorial country units, country groups and continents of the total business operations expressed in value or quality."* Basically, it means with which countries our state most frequently trades.

3.1.2 Entry Modes

According to Singh (2009), when a company decides that wants to do a business abroad, it has to explore the possible ways. To do it, the company has to choose one of the entry methods, such as exporting, licensing, franchising, joint venture, strategic alliance, turnkey project and wholly owned subsidiaries.

1. Exporting

   Exporting is one of the most commonly used modes. The companies produce their products or services in their domestic countries or in a third country and then move them to a foreign market. The transfer can be made by two options, directly or indirectly.

   a) Direct export: a production firm manages all the export activities (*e.g.* pricing, documentation, delivery, and selling) by itself and is in direct contact with the intermediary in the host market.
   b) Indirect export: a production firm does not manage directly all the export activities. During this process, a third domestic company takes care of all activities connected with export. (Singh, 2009)

2. Licensing

   Licensing is not a risky mode. It works on a permit principle. A manufacturing company (the licensor) offers to a foreign company (the licensee) its knowledge, technology, patents, copyrights, trademarks or something similar in return for a fee. A license is intangible and requires only a little investment. (Glowik, 2009)

3. Franchising

   Franchising works also on a trademark principle, similarly as licensing. A fee has to be paid from franchisee (an independent organization) to franchisor (owner of the trademark). The independent organization runs business under the name of the owning company but has to respect and observe its rules, standards, reputation, *etc*. and franchisor provides, for example, employee training, operating system, and support. (Glowik, 2009)

4. Joint Venture

   A joint venture is a business agreement where two or more companies agree to pull their resources together for the purpose of accomplishing a task. The task can be, for example, a new business activity or a new project. This mode is riskier because each of the companies is responsible for the joint venture's losses, profits, and costs. (Singh, 2009)

5. Strategic Alliance

   Strategic alliances are favored, mainly because the partner companies have the ability to learn and engage in knowledge management, they are willing to share and

develop their technology, IT and research and development. Also, they can move more easily to new markets and reduce risks. (Glowik, 2009)

6. Wholly Owned Subsidiaries

   Wholly Owned Subsidiaries is a company which is owned and totally controlled by a parent company – its common stock is 100% owned by the parent company. The subsidiaries are distinctive entities which have their own human resources, liabilities, operations and taxes of the country they serve. They can be managed by a parent company. (Singh, 2009)

3.1.3 Reasons

According to Rusmichová, *et al.* (2002), there are several reasons why foreign trade is used:

1. Difference of production conditions

   Each country has different natural resources, lies in different climatic and geographic conditions and has different labor. All these conditions affect the production and consumption possibilities of a company. Worse domestic manufacturing conditions make a product of lower quality or more expensive. Also, for the domestic production can be used the resources that are not found within the national territory or occur in limited quantities. (Rusmichová, *et al.,* 2002)

2. Decreasing cost of mass production

   In different countries, there are various goods produced with different costs. When a country specializes in the production of a product, the production of large economies of scale occurs, the average cost of production by increasing production volume declines. Then there is the possibility to optimize the size of output due to the cost. The size of the domestic market ceases to be a limiting factor. (Rusmichová, *et al.,* 2002)

3. Differences in consumer taste

   Residents of different countries have different preferences in consumption. A part of the domestic consumption has become products that cannot be produced in the local climatic conditions. On the other hand, domestic consumption of certain products may not exist at all, and yet such products may be produced in the country exclusively for foreign consumption. (Rusmichová, *et al.,* 2002)

4. Conflict between production and consumption

   Individual countries are unable, in the producer role, to satisfy their requirements. Foreign trade enables specialization in production and at the same time wide structure of consumption. Thanks to specialization, it is possible to achieve growth performance of the economy and the possibility of more favorable patterns of consumption than those offered by domestic production. When engaging in the international exchange the countries that trade with each other have better results than if they have made all the necessary goods themselves. (Rusmichová, *et al.*, 2002)

3.1.4 Importance

According to Svatoš, *et al*. (2009) foreign trade serves as a support tool for appeasement, and for reducing the risk of conflict between countries. It contributes to the education of people who are constantly forced to study technical innovations and develop their language skills while creating the conditions for their mobility.

The importance of foreign trade consists mainly in finding that the greater economy coherence between two or more countries, more valuable and stable overall relations are. External economic relations can be described as a form of relationship that reduces the risk of conflict and also supports peaceful cooperation. Within the internal economic relations, we use the criteria of effectiveness, proportionality or the demonstration effect.

1. Effectiveness

   The term effectiveness is an effort to focus on sources or products in the export area, where a country can achieve maximum savings. The individual country then focuses on promotion, research or various economic technologies for these sources or products. The economy of the country should be competitive. The countries which have less open economy should be particularly competitive. If the economy in a country is less open, this country should focus its effort on maintaining and increasing the competitiveness. (Svatoš, *et al*., 2009)

2. Proportionality

   Proportionality identifies countries that have a sufficiently developed domestic market and industry and which are able to sufficiently cover their own domestic needs. The proportionality of countries like the United States, Russia, China, and

India is primarily engaged in comprehensive resources base and its own domestic industrial production. (Svatoš, *et al*., 2009)

3. Demonstration effect

   The demonstration effect can be also explained as a country import program, which represents certain status and level of economic development of the individual countries. However, on the other hand, the demonstration effect shows the lack of proportionality of a country. It is a demonstration of the technical, scientific, design and fashion trend, which can stimulate social and economic progress. (Svatoš, *et al*., 2009)

By the export of resources a country represents its advanced level of the economy and vice versa by the importation solves the lack of goods a country does not have. Anyway, by import, a country also ensures its economic growth.

3.1.5 Functions

The importance and functioning of foreign trade vary widely among the individual countries as well as the significant differences in the size and the level of these economies. Despite this fact, we can specify some generally applicable functions of foreign trade, such as:

1. Transformation function

   The transforming effect of foreign trade represents a historically primary sense of economic relations with foreign countries. This means that foreign trade is changing the structure of domestic production (domestic sources) to the structure which is needed in the area of use (manufacturing or final). Every country, especially, the small ones, has limited resources and thus domestic production is pretty limited. If there were no foreign trade and the possibility of imports of certain products, the countries would not be able to use other resources. Using imports can help us to regulate and overcome these problems, which are given by the natural conditions (limited resources, soil and climatic conditions) and also by the economic conditions *e.g.* size of the internal market. Another meaning of the transformation function can be seen in increasing state economic maturity that is actively involved in foreign trade. In these more mature economies is reflected

the growth of productive specialization, which in an expanding range of consumption necessarily requires import growth. (Plchová, *et al.*, 2007)

2. Transmission function

   While the transformation function is about domestic production and domestic sources substitution by the import of commodities, the transmission function deals with the transfer of information (quality, new technologies, performance, and know-how), criteria and incentives from across the border environment to the domestic economy. The information mentioned above help to domestic subjects in decision-making processes. This function is often referred as the process of "learning in relation to foreign countries" and it is seen as the most dynamic and the most important factor of the external economic relations of the world economy over the past decades. (Plchová, *et al.*, 2007)

3. Growth function

   The growth function is related to the creation of a specialized country profile, especially in relatively small economies because there, the structure of the domestic economy is influenced more by the product competitiveness of the country in foreign markets and the economy performance. The result is a saving of national labor for participation in the international division of labor. However, under certain conditions, it can lead to a situation where foreign trade can have a negative impact. The sense of foreign trade under such conditions turns into its opposite – expanding foreign trade reduces sources and national income, instead of getting bigger. (Fojtíková, 2009)

3.1.6 Advantages and Disadvantages

Even though every country wants to become the wealthier the use of natural resources, capital, land and labor have to be made in the most efficient way. However, everything has its pros and cons and so does the foreign trade.

The advantages can be, for example:

- the possibility of the development of information technology, science or infrastructure
- the possibility of obtaining the production factors for changing the structure of the economy

- the possibility of new trends and ideas
- the promotion of cultural and political cooperating between economies (Brown Consultancy Services, 2015)

The disadvantages can be, for example:

- competition can cause a destruction of the traditional domestic production
- worse enforcement of the rights
- economies can experience increasing unemployment
- weak self-sufficiency in the events of political unrest (Rusmichová, *et al.*, 2002)

3.1.7 Theory of Foreign Trade

The theory of foreign trade is a product of the long-term development of economic thoughts. In this chapter, the mercantilism, classical and neoclassical theories will be explained.

1. Mercantilism

   Mercantilist economic thinking belongs to the period from the 16th to the 18th century. Already in the 17th and 18th century, there were scientific studies about the role of the foreign trade in the reproductive process (production-distribution-barter-consumption). It was the time when the mercantilist economic thinking was prevailing. The Mercantilist theories had a major impact on business and state economic policy for centuries. (Svatoš, *et al.*, 2009) The historical context is very important in explaining the mercantilist way of thinking. The Colonial expansion, (especially after the rediscovery of America by Columbus in 1492), was very expensive. Although its aim was mainly the recovery of precious metals, the former rulers had to invest a lot of money (precious metals) at first. (Kubišta, *et al.*, 2009)

   Main considerations were built on the idea of the national interest. Its essence was the claim that a state should regulate trade with foreign countries in the meaning that the country should achieve and maintain a positive trade balance because such a condition produces and provides the influx of gold, silver or money into the country. (Svatoš, *et al.*, 2009)

   Mercantilist doctrine is based on the belief that the outflow of precious metals or money diminishes the country's wealth while the influx enhances the wealth

of society and increases state power. Thus, the basis of state prosperity was the accumulation of precious metals. (Svatoš, *et al*., 2009) They did not realize that foreign trade is based on the international division of labor and leads to an increase in overall wealth and that all participating countries can capitalize from it. (Kubišta, *et al.,* 2009)

The most radical leaders of mercantilism can be identified the early mercantilists, who even promote a ban on exports of precious metals from the country. The mercantilist prominent representative was Thomas Mun. He was more restrained in his opinions. His book "England's Treasure by Forraign Trade" was released after his death. He maintained that it is not necessary or expedient to have an active trade balance with all countries, it is just enough to have an active overall trade balance. Mun also apparently understood the main principles of the functioning of the price mechanism of countervailing the balance of payments, alleging from quantity theory of money. (Neumann, *et al.*, 2010)

Although later mercantilism was disproved by classics, famous British economist John Maynard Keynes followed it in the 30s of the 20th century. He pointed out that active trade balance may actually boost domestic production and employment when the economy is below its production potential. (Kubišta, *et al.,* 2009)

During the reign of Louis XIV., mercantilism reached its peak, mainly due to Colbert the former minister of finance. (Neumann, *et al.*, 2010)

2. Classical Theory

In the late 18th and early 19th century, the English classics (Hume, Smith, Ricardo, Mill) had continued in the Mercantilist theory. And they disproved the mercantilist policies in their theories. They proved that trade increases the wealth of all participating nations regardless of what their trade balance is. That the essence of the foreign trade benefits is not cash flows but the benefits are the labor divisions among nations. (Svatoš, 2009) The classical political economy is based on the philosophy of liberalism and laissez-faire ideas. (Neumann, *et al.,* 2010)

Probably the most significant contribution to the international trade theory was submitted by David Hume in his essay called "Of money", where the principles of the quantity theory of money are explained. In this essay, he explains that the growth in the quantity of money in the economy due to active trade balance also

leads to price increases, and thus to the deterioration in price competitiveness of domestic companies. He wrote other two essays called "Of the Balance of Trade" and "Of the Jealousy of Trade", which deal directly with the international trade matters. (Kubišta, *et al*., 2009)

Manufacturing conditions of a country may represent absolute advantage compared to other manufacturers. These conditions were formulated by Adam Smith in his theory of absolute advantage. The most significant contribution of Smith was the book called "An Inquiry into the Nature of the Wealth of Nations" which states that countries should specialize in production (export) of goods that is able to produce cheaply (at a lower cost). The cause of the wealth of nations is in obtaining the absolute advantages resulting from the exchange of the products in foreign markets. (Svatoš, 2009)

Another classical theory is from David Ricardo called the theory of comparative advantage. Ricardo proved that not only countries that have absolute advantages can enter the market. His theories have proposed that countries should specialize in the production of such products, whose production reached higher comparative advantage as a partner country. Each country should specialize in producing those goods that can be produced at a comparatively lower cost. He summarized the results of his studies in the book called the "On the Principles of Political Economy and Taxation". (Svatoš, 2009)

Ricardo's theory was then further developed by John Stuart Mill. He expanded the theory of comparative advantage by the reciprocal demand and the exchange rate. (Svatoš, 2009) According to the theory of reciprocal demand, the international trade should be, theoretically, more beneficial for small and less developed countries which generally have a lower demand for imports than large and developed economies.

In his book "Principles of Political Economy" deals with the question of determining the level of international exchange ratio. (Pipek, 1996)

3. Neoclassical Theory

Neoclassical theories are mainly linked to the classical concept of foreign trade. Neoclassical theories belong to the period from the 70s of the 19th century to the 30s of the 20th century. Compared to classical theories, which worked only with

one production factor (labor), the neoclassical theory also includes capital in the model. The theory is based on the differences in the amenities of production factors between countries. (Pipek, 1996)

The most important supplements of the neoclassical theories of foreign trade are mainly the Heckscher-Ohlin Model, Stolper-Samuelson Theorem, and Rybczynski Theorem. (Neumann, *et al.,* 2010)

During the 20th century, the modern theory of comparative advantage followed the Ricardo's theory of comparative advantage. The new modern theory is called the Factor Endowment model or the dynamic theory of comparative advantage. It is based on the approach to the analysis of foreign trade, which was formulated by neoclassical representatives Eli Heckscher and Bertil Ohlin and later on, their thoughts were supplemented by Paul Samuelson. This approach which is called the **Heckscher-Ohlin Model** follows the theory of comparative advantage and expands it by adding another production factor – capital. (Svatoš, 2009) The model "*emphasizes how countries with comparative advantages should export goods that require factors of production that they have in abundance, while importing goods that it cannot produce as efficiently*." (Investopedia, 2015)

Another important model which should be mentioned is the **Stolper-Samuelson Theorem**, written by Wolfgang Stolper and Paul Samuelson, is based on the Heckscher-Ohlin Model. This theorem assumes that if there is a reason for the growth of world prices for a capital-intensive commodity, then the price of capital increases and vice versa. The rise in prices of capital-intensive products will have different impacts on a country targeted in accordance with Heckscher-Ohlin Model for the production of capital-intensive products and on a country targeted for the production of labor-intensive products. In a country targeted on capital-intensive products will further expand and there will probably be an increase in exports and improve terms of trade. (Kubišta, *et al*., 2009)

The last theorem which is going to be mentioned in this thesis is **Rybczynski Theorem**. What happens if there is a significant change in the ratio of capital and labor within a country? It will lead to a relative decrease in the price of capital and increase the relative price of labor. This should lead to a change in the structure of domestic production in favor of capital-intensive products. (Kubišta, *et al*., 2009)

3.1.8 Alternative Theory

The predecessors of the alternative theories can be the publications of mercantilists, works of the English classical economic theory and neoclassical books. (Pipek, 1996) The alternative theories notice especially the failures of the most important assumptions of known theories. They do not deny the theoretical correctness but their usefulness for practical economic policy. (Kalínská, *et al*., 2010) In this chapter will be mentioned: the theory of infant industry, theory of immiserizing growth, increasing returns to scale, technology gap theory, the theory of overlapping demands, product life cycle theory.

1. Theory of Infant Industries

   This theory was formulated by German economist Friedrich List. The theory says that a country should fully open its impingement to foreign competition only after its industry becomes "an adult" - capable of competition. It is almost impossible that an underdeveloped country builds domestic industry without having a temporary protection from the competitors from developed countries. The theory recommends that the underdeveloped countries should have the temporary protection of their domestic industries until they are able to achieve the competitiveness in the global market. Although this theory is hardly questionable, its practical use is doubtful. (Kubišta, *et al*., 2009)

2. Theory of Immiserizing Growth

   The theory was written by Indian economist Jagdish Bhagwati. He noticed that the companies from developing countries responded differently to a change in world prices for their products than expected. When there is a decrease in world prices they increase the production and export so they replace the reduction of their incomes due to the drop in the world prices. Based on this thinking, the terms of trade in developing countries are getting worse. While the physical volume of domestic production and exports in increasing, their total value does not change or decreases. People must expend more work to keep their current incomes. (Kubišta, *et al*., 2009)

3. Increasing Returns to Scale

   In classical and neoclassical theories were used constant returns to scale, where for example, doubling the number of inputs leads to doubling the number of outputs. While more useful is increasing returns to scale, where for example, doubling the

number of inputs lead to tripling the number of outputs. It means a reduction of unit costs. Increasing returns to scale contribute to the increase of competitiveness of large companies. For the firms from developing countries is then almost impossible to enter the global market where there are the multinational companies, which realize significant savings. (Kubišta, *et al*., 2009)

4. Theory of Overlapping Demands

   This theory was formulated by Swedish economist S. B. Linder. The basis of this theory is the idea that a country will export the industrial products for which has the assertion on the domestic market. These are the reasons why:

- the domestic market allows a producer is aware of the possibility of achieving profit from the product
- the companies effectuate a research and a development for satisfying the needs of domestic market
- the adaptation of an unknown product is very expensive

   The reasons do not apply to agriculture and export of raw materials.

   According to this theory, the exported products will be almost the same as those produced for the domestic market. At the same time, the imported products will resemble the products manufactured in the importing country and a consumer will decide by the price. This opinion leads to the conclusion which is a contrary to the classic theories – the more products will overlap, the greater are the possibilities for foreign trade. This theory may partly explain the exchange of goods between countries with large internal markets. (Prachař, Šabata, 2011)

5. Technology Gap Theory

   This theory was formulated by British author V. Posner. According to this theory, the new innovations are significant for exports. A producer develops the new products that gain profit and provide a temporary monopoly to the innovative company. All these allow more profitable access to the foreign markets.

   In the initial phase, the export is growing but soon the higher profits lead to imitation from the other producers. By this, the original producer loses his comparative advantage. It leads him to improve his innovations so he gains the new advantage again. All these innovations create time-limited technology gap. (Prachař, Šabata, 2011)

6. Product Life Cycle Theory

   The author of this theory is American professor Raymond Vernon. At the end of the 60s, he extended, generalized and elaborated the technology gap theory. According to Vernon, production of the new products passes through 3 phases:

   1. Initial phase: corporations have the monopoly advantage based on the technical dominance. At the same time, they are able to satisfy the foreign demand by their own export.
   2. Adolescence phase: demand abroad is growing, the technical knowledge associated with the production spread abroad to the potential competitors and the original producer loses the comparative advantage, their technical superiority. If the producer wants to maintain its market share and prevents the creation of competitions, he must create an affiliated company or similar businesses abroad.
   3. Standardization phase: production has become common and the comparative advantage is transferred to economies with relatively less skilled labor and lower wages, most likely to the developing countries.

   The model had a number of deficiencies. For instance, in the developed countries a producer usually keeps a monopolistic position – the point of maturity of the product. It is, particularly, if the product is based on the specific experiences of the producer, patents, trademarks, *etc*. According to this theory, when a production and a research of a product, is made in the developed countries, the developing countries gain the comparative advantage although it also means their dependence on the developed countries. The developed countries have to be willing to share the technical knowledge with them. (Prachař, Šabata, 2011)

3.1.9 International Trade Organizations

International trade organizations affect foreign trade by the creation of rules and conditions for conducting international business transactions. These organizations join states or non-governmental entities whose aim is among others to encourage foreign trade and facilitate the producers. Membership in the organizations is voluntary. The organizations that are mentioned in this thesis are divided into two parts, the intergovernmental and non-governmental. There will be mentioned the World Trade Organization, General Agreement

on Tariffs and Trade, Organization for Economic Cooperation and Development, United Nations Economic Commission for Europe, International Monetary Fund, International Chamber of Commerce. (Kubišta, *et al.*, 2009)

General Agreement on Tariffs and Trade (GATT)

GATT was signed the 30 October 1947 and came into force on 30 June 1948. The initiator was the United States. (Kubišta, *et al.*, 2009)

GATT is a multilateral agreement which contains rules for managing trade, the WTO, the negotiations on trade matters and resolves trade disputes among members. It is important for both, businesses and consumers. Its rules and procedures provide a framework for foreign trade and trade policy. It has a real impact on the selection of goods available for consumers and its price. (Businessinfo.cz, 2015)

World Trade Organization (WTO)

WTO is an intergovernmental organization. The members may not always be the countries but also unified tariff areas (tariff unions or customs territory). (MIT, 2010)

WTO was signed the 15 April 1994 and came into force on 1 January 1995, is located in Geneva and has 162 members since 30 November 2015. (WTO, 2016)

According to WTO (2015), the World Trade Organization is *"the only global international organization dealing with the rules of trade between nations. At its heart are the WTO agreements, negotiated and signed by the bulk of the world's trading nations and ratified in their parliaments. The goal is to help producers of goods and services, exporters, and importers conduct their business".*

Organization for Economic Cooperation and Development (OECD)

OECD is an intergovernmental organization. It was signed on 14 December 1960 and officially came into force on 30 September 1961. Its headquarters are in Paris and it has 34 member countries. (OECD, 2015)

The OECD is a recognized international organization that provides comprehensive analysis in many areas for its members. For instance, it supports the development of the world economy through the liberalization of foreign trade, investment, and finance. (MFA, 2015)

It is the successor of the Organization for European Economic Cooperation (OEEC), whose goal was to manage the US and Canadian aid for post-war economic recovery (the Marshall plan). (Kubišta, *et al.*, 2009)

United Nations Economic Commission for Europe (UNECE)

UNECE is "*one of the five regional commissions of the United Nations".* The others Economic Commissions also act for Africa, Asia and the Pacific, the Western Asia, Latin America and the Caribbean. It was founded in 1947 by the Economic and Social Council. It has 56 member states and is located in Geneva. (UNECE, 2015)

In general, its activity is focused on the economic cooperation and integration, specifically is focused on the cooperation in energy, environment, housing policy, statistics, trade, forestry, and transport. (Kubišta, *et al.*, 2009) *"UNECE also sets out norms, standards and conventions to facilitate international cooperation within and outside the region"* (UNECE, 2015)

International Monetary Fund (IMF)

IMF was invented at a conference in Bretton Woods in July 1944. (IMF, 2015) It started to work in 1947. IMF has 188 member states and its headquarters are in Washington D.C. (Kubišta, *et al.*, 2009)

"The IMF is working to foster global monetary cooperation, secure financial stability, facilitate international trade, promote high employment and sustainable economic growth, and reduce poverty around the world." (IMF, 2015) The main activity of the IMF is to supervise the international financial system (surveillance), undertaken through surveillance of the economic and financial developments of the member states. It also provides loans to countries with balance of payments difficulties and technical support for countries which create and implement effective economic policies. (Kubišta, *et al.*, 2009)

International Chamber of Commerce (ICC)

ICC is a non-governmental organization. It was established in 1919 and is located in Paris. (ICC, 2015) It is a worldwide organization, which brings together and represents the entrepreneurial entities or their associations. Member companies and associations come from about 130 countries worldwide. The aim of ICC is to promote and facilitate an open international trade, investments, and market economy. ICC is cooperating with many international organizations which are connected to foreign trade, such as WTO and OECD. (Kubišta, *et al.*, 2009)

4 The Significance of Coal

4.1 Coal

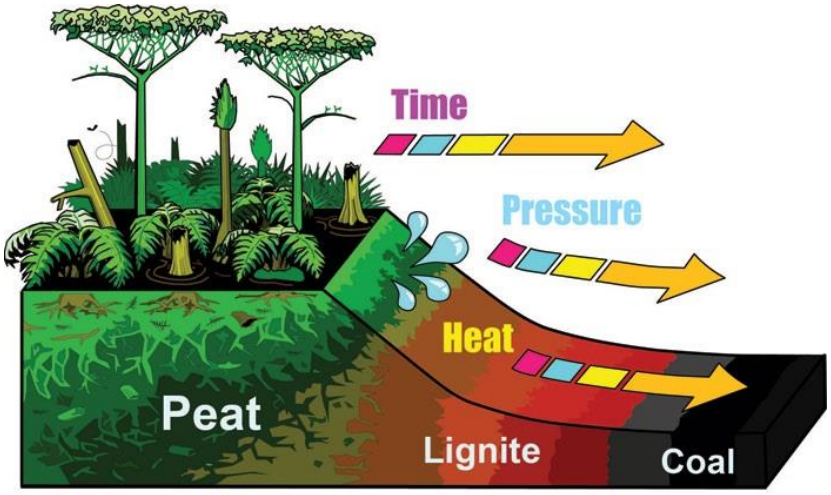
According to World Coal Institute (2005), *"coal is a fossil fuel. It is a combustible, sedimentary, organic rock, which is composed mainly of carbon, hydrogen and oxygen. It is formed from vegetation, which has been consolidated between other rock strata and altered by the combined effects of pressure and heat over millions of years to form coal seams."*

4.1.1 Coal Formation

There were two geological periods in which coal deposits were formed the most. The first one called the Paleozoic period, in which the hard coal was mostly formed due to better conditions, especially until the Carboniferous and Permian period. The second one called the Mesozoic period, in which the lignite was formed, especially until the Jury and Cretaceous period. The oldest coal deposit that is known is attributed to the age of 300 million years. (Bratrych *et al.*, 2004)

In the lignite deposits, the imprints of deciduous and coniferous trees have been preserved. In the hard coal deposits, there have been preserved imprints of other plants which were usual in this period. Due to change of chemical composition and loss of plant structure at plant residues, especially because of combined effects of microbial degradation in the environment, where air did not have access, an enormous rise of pressure and temperature happened. The proportion of oxygen and hydrogen slowly decreased and in contrast, carbon content increased. The first thing formed was the peat, then after covering with clay and sand and with continuing declines, lignite was formed and from it anthracite and hard coal. This process is called coalification and as can be seen in the scheme No. 1, in this transformation is important time, pressure and heat. The coal, which is the most transformed and the oldest, has the greatest proportion of carbon. However, younger coal has a larger proportion of oxygen and hydrogen, in other words, it contains residues of the original materials and also complex chemical compounds. (Bratrych *et al.*, 2004)

Scheme No. 1 – Explanation of Coal Formation



Source: Kentucky Geological Survey, University of Kentucky, 2012

4.1.2 Types of Coal

There are two main categories of coal, which are divided into two subcategories. The first one is hard coal its subcategories are *anthracite* and *bituminous* coal, the second one is low-rank coal and its subcategories are *sub-bituminous* coal and *lignite*. (IEA, 2012)

Geologically the oldest coal is *anthracite*, which is black with a metallic luster. It has a low content of volatile matter (less than 10%) and contains most of the carbon (above 90%). Anthracite has the highest calorific value and the highest quality of all kinds of coal also it burns without any smoke. On the other hand, it is the type of coal that occurs least. Anthracite can be used for domestic and industrial application and also like a smokeless fuel. (Bratrych *et al.*, 2004)

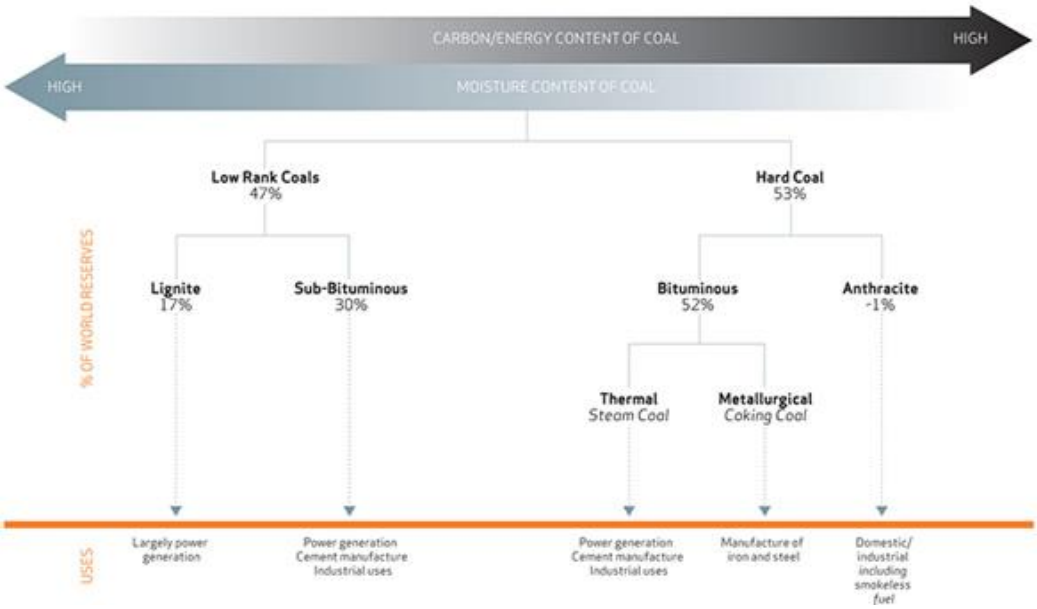
Bituminous coal has a glossy black color, is hard, volatile matter content is below 50% and the carbon content of combustible share above 73.5%. It can be divided into two subcategories, which are coking coal and other bituminous coal (*e.g.* steam coal). It is used for industrial uses or power generation and also for manufacturing steel and iron. (IEA, 2015)

Low-rank coal has lower quality and also has lower calorific value, it is quite soft. Its carbon content is about 70%, there is found a mixture of resin materials and some species also contain a significant part of mineral substances that remain after burning like ash. It is stored below the surface in shallow depths and can be obtained by opencast coal-mining.

(Bratrych *et al.*, 2014) It is mostly used as a fuel for electricity production, cement manufacture and also for domestic and industrial uses. (IEA, 2015)

Lignite has the lowest quality and is the youngest type of coal. Its color can be from brown to various shades of dark black, usually without brightness. It has no excessive use and is primarily used as fuel in heating power plants. (World Coal Association, 2015)

Scheme No. 2 – Types of Coal



Source: World Coal Association, 2015

In the scheme above, types of coal and their uses can be seen, which have been explained in this chapter also the percentage of the world resources.

An important characteristic of each type of coal is the calorific value. The calorific value is the heat released by burning fuel to carbon dioxide CO2, sulfur dioxide SO2, nitrogen N and water H2O. The following table shows the comparison of each type of coal according to the proportion of carbon and the calorific value. (OKD, 2012)

Table No. 1 Carbon Content and Calorific Value of the Main Types of Coal

The Carbon Content and Calorific Value of the Main Types of Coal		
Type	Carbon proportion (in %)	Calorific value (in IU/kg)
Lignite	30 to 50	around 13
Sub-Bituminous	50 to 80	15 to 20
Hard coal	80 to 90	18 to 30
Anthracite	above 90	26 to 30

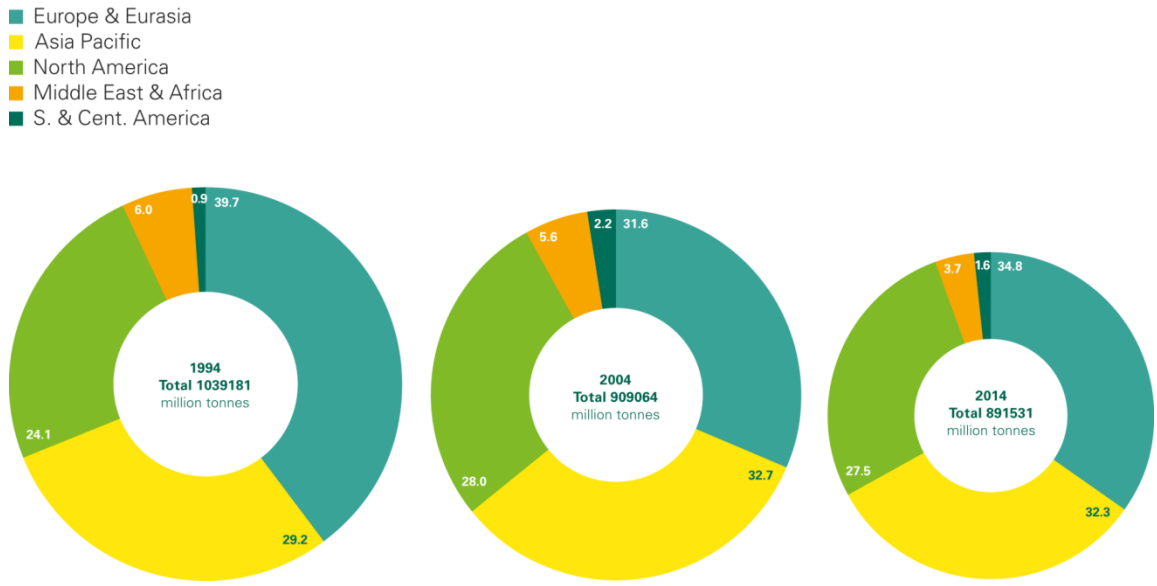
Source: OKD, 2012

4.1.3 Coal Reserves

According to the British Petroleum (BP) Statistical Review of World Energy (2015), the total proved reserves at the end of 2014 were 891,531 million tonnes. While maintaining the current global production, this amount is sufficient for another 110 years. In comparison with other energy sources, it is about twice as much. Specifically, oil is estimated to be sufficient for another 52.5 years of global production and natural gas about 54.1 years of global production.

In the graph No. 1, there is shown a distribution of proved coal reserves in percent and their comparison among years 1994, 2004 and 2014. As can be seen, in 1994, the total proved reserved were 1,039,181 million tonnes, in 2004, it was 909,064 million tonnes.

Graph No. 1 Distribution of Proved Coal Reserves

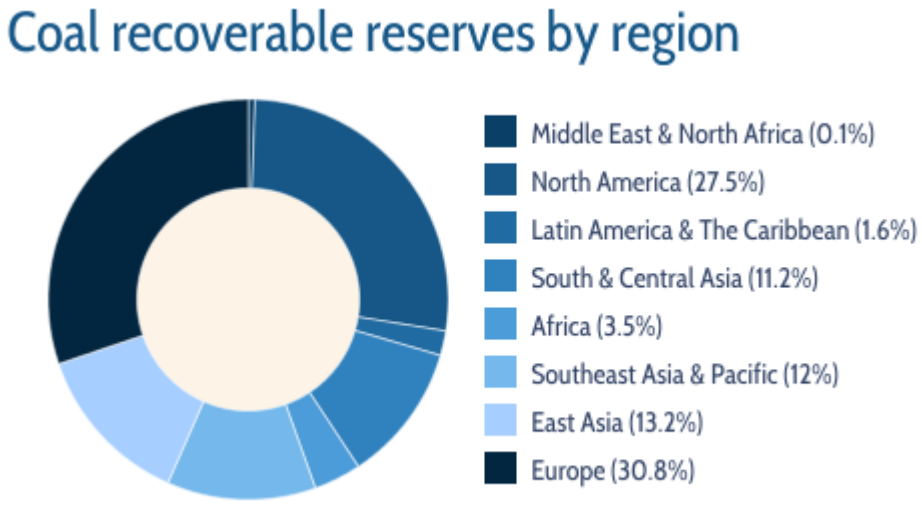


Source: World Energy Council, 2013

4.1.4 Where Can Be Coal Found

One of the biggest advantages of coal deposits is that they can be found in almost every place in the world, coal is mined in about 70 countries worldwide. The top coal producing countries are China, the United States of America, India, Australia, Indonesia, Russia, South Africa, Germany, Poland and Kazakhstan. In the graph No. 2, coal recoverable reserves by region in percent can be seen. *"Proved recoverable reserves are resources remaining in known coal deposits that have been shown to be accessible under current local economic and technological conditions."* (World Energy Council, 2015)

Graph No. 2 Coal Recoverable Reserves by Region



Source: World Energy Council, 2015

It is important to notice that all fossil fuels will eventually deplete, that is why it is necessary to use them as effectively as possible. However, coal reserves could be extended by the development involving a discovery of the new deposits, either through the existing ones or through an advanced mining technology which would allow getting to deposits that appear to be unreachable. (World Coal Association, 2015)

4.1.5 Coal Mining

Coal has been used for thousands of years; it is known that since the caveman coal has been used for heating. Also, some studies believe that they were the Chinese who first used coal for business purposes. Romans in England used coal before AD 400 years. In the North America, the Hopi Indians used coal in the 1300s. (U.S. Department of Energy, 2013)

To focus more on Europe, it is known that coal has been mined since the 12th century in Aachen (today's Germany) and Liége (today's Belgium), in the 13th century in Newcastle (England) and as from 14th century in several parts of Germany. In the 15th and the 16th century was coal well known and mined in almost every part of Europe. However, the major role had the Industrial Revolution in the 18th and the 19th century because coal has expanded around the world the most. (Kárníková, 1960)

There are two methods of coal mining, which are influenced by the geological attributes 'of the site. To choose the right one depends on the depth of coal deposits.

The first method is called the *surface mining* or it can be called as "opencast" or "open cut". It is used when the coal seam is located close to the surface. This method is more efficient and faster than the second one (underground mining) and usually manages to exploit more than 90% of the coal reserves. When surface mines are used, a large area (usually several square kilometers) it is necessary because it might cover it all and large equipment is required as well. This method is used for example in Australia or in the United States of America. However, this method can be costly and problematic, for instance, issues with near residents can be there and of course, it is harmful to the environment, which will be explained in this thesis later. Further will be explained how exactly this method works: *"The overburden of soil and rock is first broken up by explosives; it is then removed by draglines or by shovel and truck. Once the coal seam is exposed, it is drilled, fractured and systematically mined in strips.*" (World Coal Association, 2015)

The second method is called the *underground mining*, or it can be called deep, which is subdivided into room-and-pillar and longwall mining. These methods are used when coal is situated deeper in the ground. *Room-and-pillar mining* is a method in which several "rooms" are cut into the coal seam and they leave "pillars" to protect the roofs of the mines. Sometimes they can be recovered (only by 40%) but mostly they stay buried underground. That is why this method is quite inefficient. By using *longwall mines*, a long wall is extracted into the ground. The mechanical shearers are used to mine coal from the walls as one piece. This method is more efficient but is very costly and needs more time to install and plan the equipment because of the stability. The big advantage however, is, that can be extracted up to 75% of the coal deposits. (World Coal Institute, 2009)

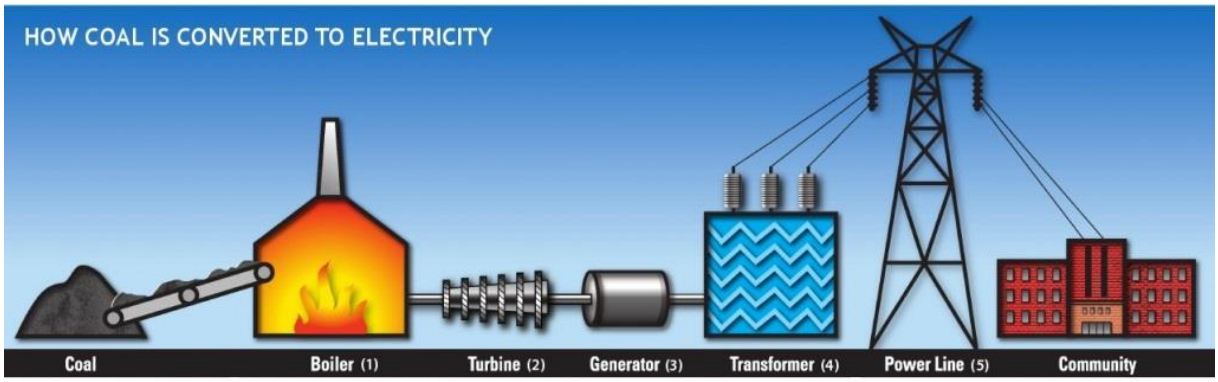
To find the right place for mining coal reserves, the exploration activities are used. First, a geological map of a specific area is created then geochemical and geophysical surveys are conducted and finally, the drill exploration can begin. If everything went well, the specific area would be ready to become a mine/quarry of course, other details must be accurate. For instance, if the area is large enough to be profitable for several years, the mine costs, type of coal, *etc*. (World Coal Association, 2015)

4.1.6 Use of Coal

Coal has several uses in the world. As from the Industrial Revolution, coal was used in steel and iron production and rail and steamship transportations. Also, coal started to be used for lights in most of the cities in a form of gas. (World Coal Institute, 2009) Nowadays is mostly used in the energy sector, production of steel, manufacturing of cement, as a liquid fuel, in pharmaceutical and chemical industries and others. (World Coal Association, 2015)

Electricity is an integral part of our lives that is why it is necessary to understand how coal is transferred to electricity. It is explained and shown below.
First, coal is mined then is milled to a fine powder and transported to the boiler through a conveyor belt, in the boiler it is burned at the temperature 900°C, during this process coal is converted from chemical energy into heat energy. Coal does not produce only heat but also ash and waste gases. The ash is then removed and usually sold to other industries, for example, the building industry. How coal is burning in the boiler, it heats water in the pipes and it is turning into steam. The water steam is driven into the turbine where pushes its blades due to high pressure and causes rotation. This converts heat energy into mechanical energy. A steam turbine shaft is connected to an electrical generator. The generator uses an electromagnetic field to convert the mechanical energy into electrical energy. Finally, the electrical energy from the generator is transformed to a high voltage and then into our homes. (EP Energy Trading, 2015)

Scheme No. 3 How Coal Is Converted to Electricity



Source: American Coal Foundation, 2012

However, the percentage of coal used in electricity generation is different in many countries. For example, South Africa, Poland, Australia or China produce electricity much more from coal than other countries, which rely more on nuclear power or renewable energy. (IEA, 2012)

Steel and Cement are really necessary for our lives nowadays. Steel is a material which is part of many goods and services, for instance, it is used in the telecommunication industry, healthcare, transport networks *etc*. It should be also mentioned that steel is 100% recyclable. Cement, on the other hand, is important for the construction industry. (World Coal Association, 2015)

4.2 Coal and the Environment

The use and combustion of coal have a major impact on the environment. Its mining and related changes in the surrounding environment are phenomena which need to be reckoned in every mining area. Ever since the 18th century, mining changed the landscape, demographics, social conditions and environmental quality of the regions drastically. It is the most polluting fuel. (Czech Geological Survey, 2014)

4.2.1 Emissions

Coal generates a lot of environmental problems, including the pollutant emissions, such as nitrogen oxides (NOx), sulfur (S), or even the trace elements, like mercury. To decrease the volume of these emissions, many studies with possible solutions have been created. However, recently, the focus is mostly on the greenhouse gas emissions, which contain methane (CH4) – *"a gas formed as part of the process of coal formation. It is released*

from the coal seam and the surrounding disturbed strata during mining operations" and carbon dioxide (CO_2) – *"a colorless, odorless, incombustible gas formed during decomposition, combustion and respiration"*. (World Coal Institute, 2009) Even though carbon dioxide emissions are lower in 2015 than 2 years ago, their connection to the climate changes still worries many scientists. (BP Statistical Review of World Energy, 2015) To try to minimize the greenhouse gas emissions, especially reduce carbon dioxide emissions, new technologies have been invented. The new technologies are called the Clean Coal Technologies (CCTs) they contain several technological possibilities which make coal environmentally better. For example, these technologies help to reduce waste and emissions. (World Coal Institute, 2009) According to World Nuclear Association (2015), "*the greatest challenge is bringing the cost of this down sufficiently for "clean coal" to compete with nuclear power on the basis of near-zero emissions for base-load power."* It would also help to use coal for future generations without worsening the global warming.

Finally, only one key strategy should reduce the negative environmental impacts of coal in the world. This key strategy should lead to improving the energy efficiency of power plants, such power plants are able to consume a smaller amount of coal per unit of produced energy and be more environmentally friendly. (Czech Geological Survey, 2014)

4.3 Transportation and Safety

Coal transportation and safety of employees are very important parts of the foreign trade with coal. It is further explained below.

4.3.1 Transportation

There are several types of possible transportation ways. All ways are dependent on the distance between a mine/quarry and a final destination. For short distances lorries or conveyors are generally used. For long distances cargo ships or trains are used. Another possibility is to mix coal with water and create coal sludge, in this form can be transported through a pipeline.

Coal is mostly used domestically – transportation is significantly cheaper and easier. Long distance transportation can be very expensive, especially due to coal storage and its

manipulation. (World Coal Institute, 2009) To make the transport easier, the world trade is divided into two regions. The first one, the Atlantic region, is made up of importing countries of Western Europe. The second one, the Pacific region, is made up of developing and OECD. (World Coal Association, 2015)

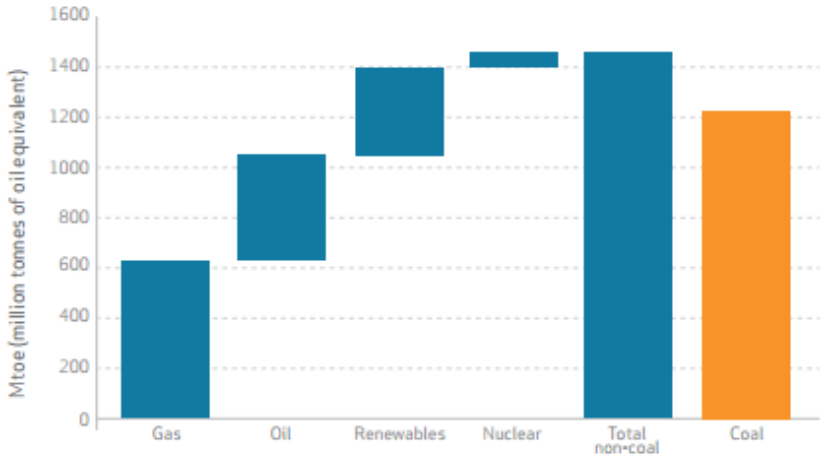
4.3.2 Safety

Employee safety is as important in this field as in the others and it is taken very seriously. However, the health risks occur more often – respiration problems, lung cancers, heart failures, *etc*. Even though modern coal mines/quarries have better health and safety standards, employees (from a mine/quarry worker to a manager of a mine/quarry) are well educated and trained to be prepared for every situation which can occur, some issues can be still seen, *e.g.* frequent accidents in China. Of course, every country which has coal mines/quarries tries to protect their inhabitants by law. Most of the laws are very similar in every country and it is not necessary to explain them in this thesis. (World Coal Institute, 2009)

4.4 Energy Sector

Coal has been the most important energy source during the period 2000 - 2010, as can be seen on the graph No. 3, this trend continues also nowadays. Nearly half of the world's energy demand for new resources was covered with coal. The second half was formed with other sources, *e.g*. nuclear energy, renewable resources, oil and natural gas. Coal accounts for about 40% of world's electricity production and is 2nd largest primary energy source in the world after oil. (World Coal Association, 2014)

Graph No. 3 Incremental World Primary Energy Demand by Fuel (2000-2010)



Source: IEA World Energy Outlook 2011

Coal has a significant role in the global energy mix it is mainly because its reserves can be found in many places around the world in large quantities and it is quite affordable.

4.5 The Foreign Trade with Coal

Coal is a global industry, its mining, unlike oil or gas takes place in more than 40 countries and is consumed in more than 70. Coal is available from a variety of sources and available on a well interconnected global market. A large number of suppliers are active in the global coal trade and ensure a competitive and efficient market. (World Trade Institute, 2009)

4.5.1 Coal Production and Consumption

The production of coal is not concentrated only on one continent. Coal is mined all over the world, as it is already mentioned in this thesis. Coal has been the fastest growing primary energy source in the world since the 21st century. However, it seems that the growth of coal will not continue as much, it is because of India and mostly China. Their consumption is growing but in the OECD countries is most likely slowing. (IEA, 2015) According to the BP (2015), the world coal production dropped by 0.7% in 2014, meanwhile, the world coal consumption raised by 0.4%.

To show clearly the percentages of total coal production and consumption of each region the table No. 2 has been created.

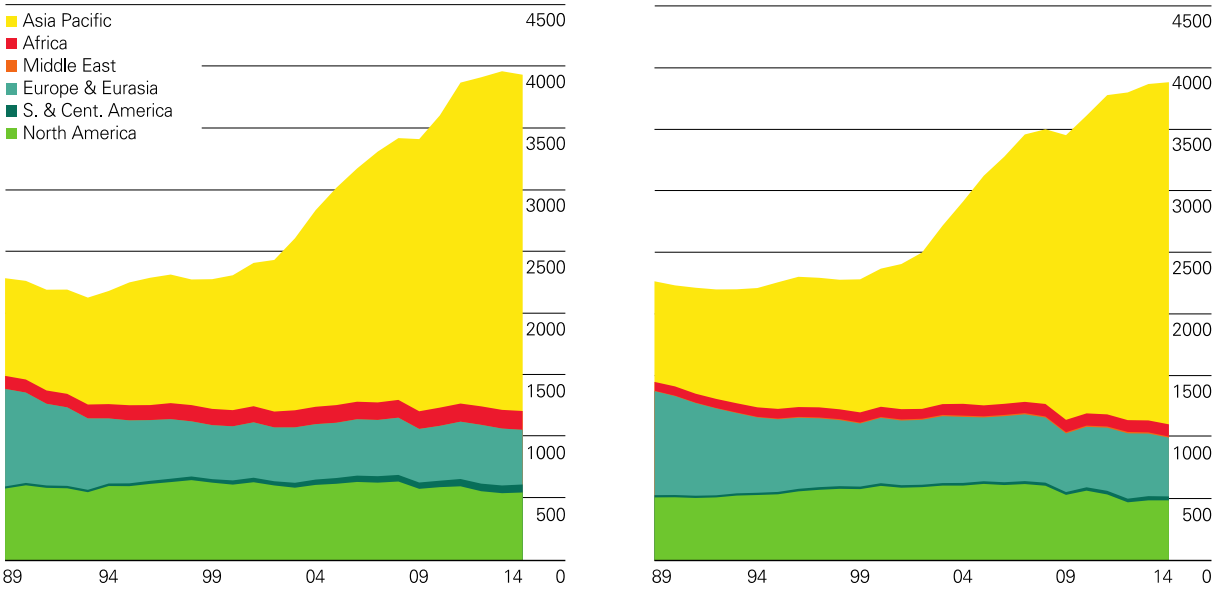
Table No. 2 World Total Production and Consumption

World Total Production and Consumption (in %)		
Region	Production	Consumption
Asia Pacific	69.2	71.5
North America	14.0	12.9
Europe and Eurasia	11.2	12.3
Africa	3.9	2.5
South and Central America	1.7	0.8
Middle East	0.05	0.3

Source: own illustration according to BP, 2015

The table No. 2 shows that the Asia Pacific region produces and consumes significantly more than other regions. To use better visualization, the scheme No. 4 has been used. The chart shows the total production and consumption of coal between years 1994 and 2014, which is relatively constant on most of the continent, except the Asia Pacific. This region currently accounts more than two-thirds of world production and consumption.

Scheme No. 4 Coal Production/Consumption by region

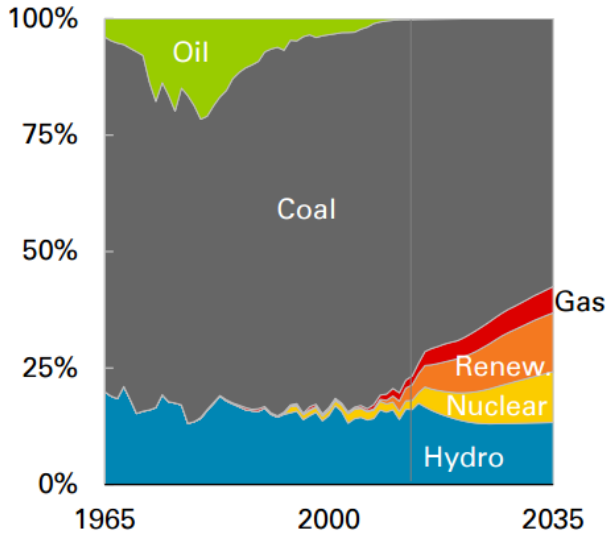


Source: BP Statistical Review of World Energy, 2015

As already mentioned above, the top ten producing countries have a significant role in the foreign trade, their role in consuming is important as well.

To mention some, China has been the largest producing and consuming country in the world for many years. The country produced more than 1,844 million tonnes of coal in 2014 it is 46.9% of total world share. It consumed more than 1,962 million tonnes of coal, which accounts for 50.6% of total world share. The United States of America is the second largest producing and consuming country in the world. It produced around 507 million tonnes of coal in 2014, which is 12.9% of total world share and consumed 453 million tonnes, which makes it 11.7%. South Africa produced and consumed the most from all the African countries. It produced approximately 147 million tonnes of coal (3.8% of total world share) and consumed around 89 million tonnes of coal (2.3%). Russian Federation produced around 170 tonnes of coal, which accounts for 4.3% of the world share. And it consumed approximately 85 tonnes of coal, which accounts for 2.2% of total world share. Germany produces and consumes the most from all the European Union's countries. In 2014, Germany produced approximately 43 million tonnes of coal which are 1.1% of total world share and it consumed around 77 million tonnes (2% of the world share). (BP, 2015)
To show how important is coal for China compared to other energy sources, scheme No. 5 has been used. It is mostly due to industry and power sector but as you can see natural gas, renewable energy and nuclear power start to slowly increase their market share.

Scheme No. 5 Chinese Energy Share

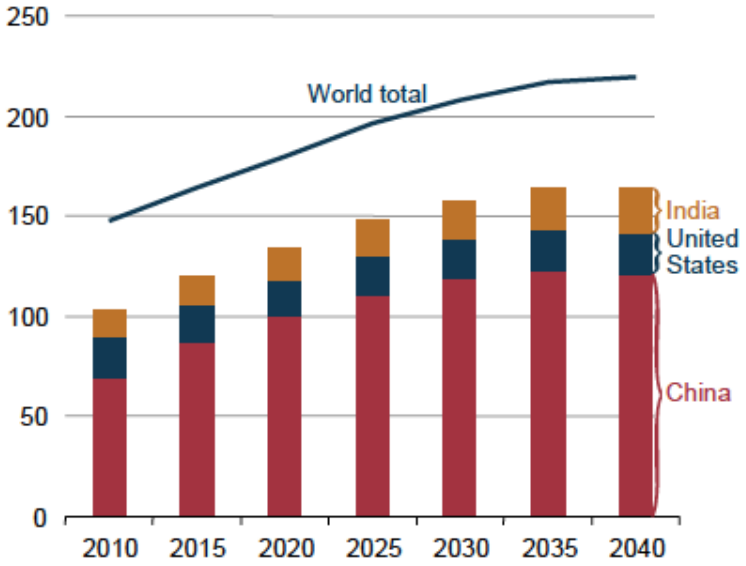


Source: BP Energy Outlook 2035, 2015

Another very important distribution is whether the consuming countries are members of Organization for Economic Co-operation and Development (OECD) or not. The state members have more political constraints, mainly due to environmental reasons, *e.g.* CO2

emissions, so there are more to move away from the coal consumption. On the other hand, China has not solved these restrictions yet and continues in the growth of coal consumption enormously. It should be noted again, that the consumption of China accounts for almost half of the total consumption worldwide. On the next graph, the expected consumption of the three largest coal consumers is compared, (which supposed to increase to 75% in 2040) with the total world consumption. (EIA, 2013)

Graph No. 4 World Coal Consumption by three leading countries 2010 – 2040 (quadrillion BTU)



Source: EIA, 2013

4.5.2 Import and Export of Coal

Although China is the largest coal producer in the world, it is not enough to cover its huge demand. To cover it China needs to import coal. It is not a negligible part because China is the largest importer of coal in the world. The table No. 3 refers to the comparison of the largest importers in the world, which account together for 55 percent of the imports. (IEA, 2014)

Table No. 3 Top Coal Importers (in million tonnes)

Top Coal Importers	
Country	Total
China	327
Japan	196
India	180
South Korea	126
Taipei	68
Germany	51
UK	50

Source: World Coal Association, 2014

The table No. 4 provides information from the export area. In 2011, Indonesia overtook the long-term exporting leader – Australia and has become the largest global exporter of coal. Together, with the United States and Russia account for 79 percent of the exports.

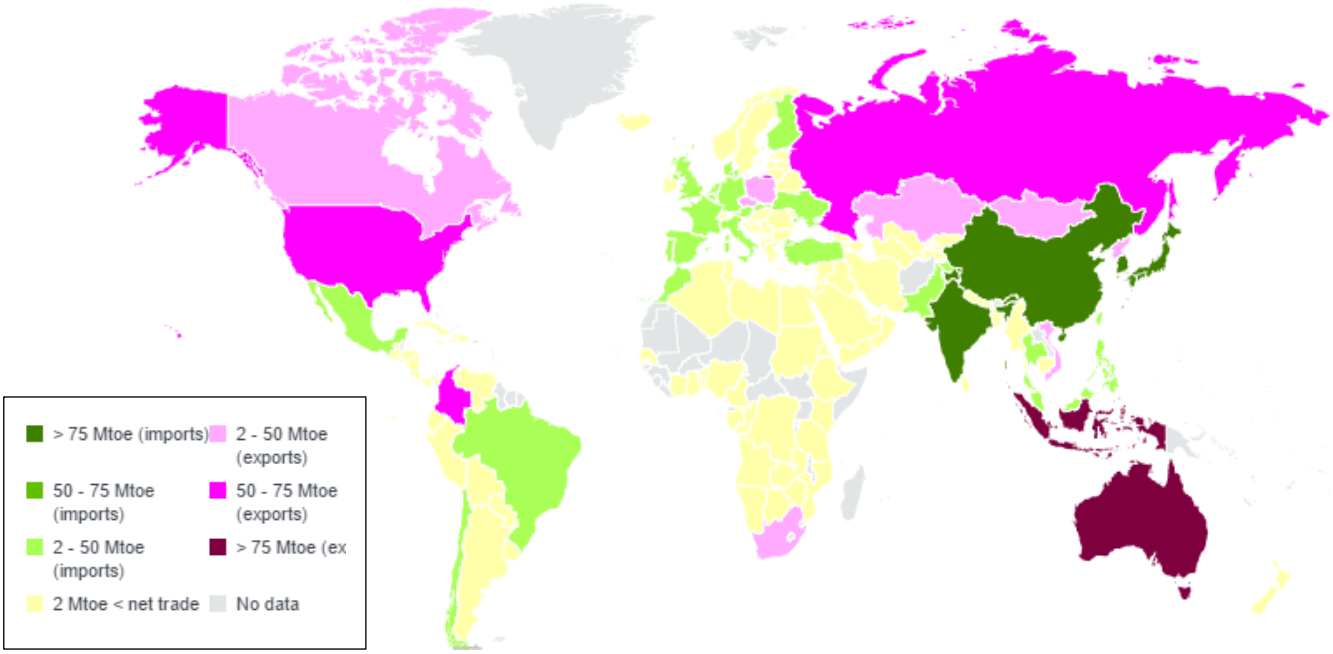
Table No. 4 Top Coal Exporters (in million tonnes)

Top Coal Exporters	
Country	Total
Indonesia	426
Australia	336
Russia	141
USA	107
Colombia	74
South Africa	72
Canada	37

Source: World Coal Association, 2014

The map of net coal trade below shows the top exporting/importing countries.

Scheme No. 6 Net Coal Trade Map (in Mtoe)



Source: IEA Energy Atlas, 2014

The scheme No. 7 shows the coal's most important international export hubs, the mostly used are in Australia (Newcastle), in the Netherlands (Rotterdam) and in South Africa (Richards bay).

Scheme No. 7 Coal International Hubs

Source: The ICE, 2015

4.5.3 Coal Prices

When speaking about the coal prices, the question should be which price because coal price is not easy to determine. Even though coal is mostly consumed in the state where it was mined, its market is still influenced by international prices. And there are several aspects which affect the price, for example, the quality of coal/type, regulations, contracts, region, time for delivery, *etc*. These all aspects can change the price of coal significantly. (IEA, 2013)

Coal is not a unique product it is a group of different kinds of stones. As already mentioned in chapter No. 4.1.2. Types of Coal, coal is divided into four basic types (bituminous coal, anthracite, lignite and sub-bituminous coal) according to the proportion of carbon, which contains and the quantity of heat which is able to produce. Coal with higher calorific value is usually more expensive.

According to EIA (2015) the average coal sale prices on American market were divided by their type in 2013 were:

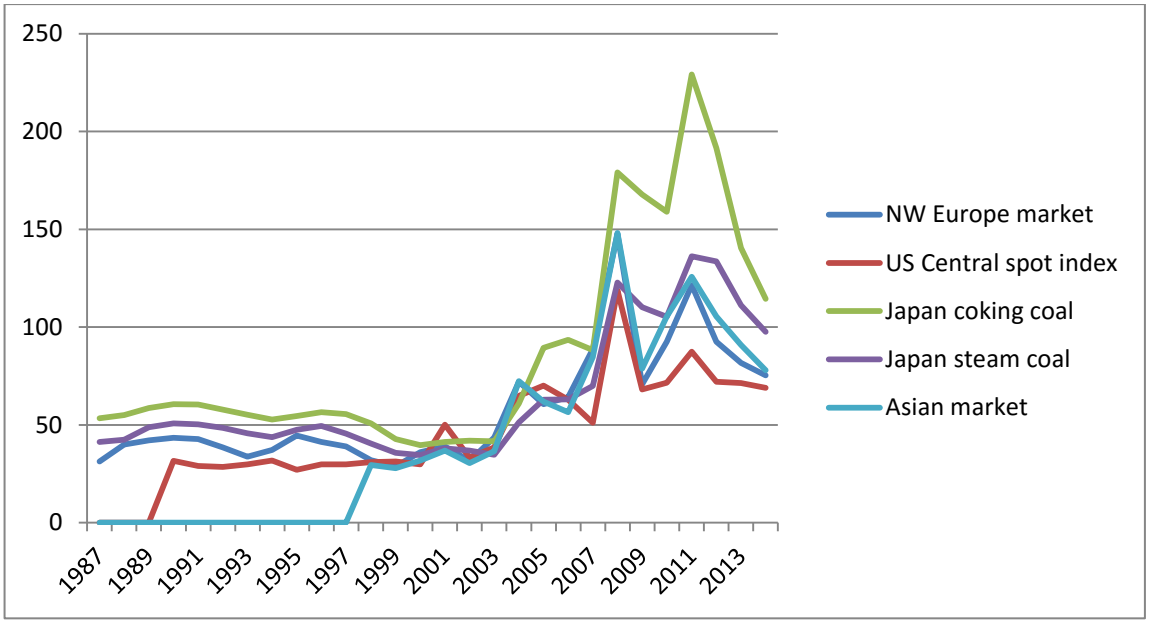
- Anthracite $87.82/ton
- Bituminous coal $60.61/tonne
- Lignite $19.96/tonne
- Sub-bituminous $14.86/tonne

The price of coal is also affected by the type of mining. The surface mined coal is usually cheaper than underground mined one. It is because the underground mining needs more miners and the conditions are more difficult.

Another classification, maybe the most important for prices is coking and non-coking (thermal, steam, lignite) coal. Coking coal is used for making iron and then steel, it has better quality, so the price is much higher. While non-coking coal, lower quality coal, is burned and produces electricity or heat, it is significantly cheaper. (IEA, 2013) The average price of coking coal in the American market was $190.55 per tonne in 2012 almost four times as much as the non-coking coal. (EIA, 2015)

In the graph No. 5 can be seen the annual coal prices from 1987 to 2014. In 2014, the highest prices were in Japan and the lowest in the US. Anyway, during the last three years the prices of coal declined in every region.

Graph No. 5 Annual Coal Prices (in USD per tonne)



Source: own illustration according to BP, 2015

The graph No. 5 shows Northwest Europe and Asian market prices, US Central coal spot price index and Japan coking and thermal coal import prices.

The costs of transportation have to be added to the price of coal too. In some cases, the transportation costs are higher than the actual price of mined coal. The types of transportation have been already said, however, mostly used are lorries, conveyors, cargo ships or trains. They all use diesel as a fuel, it means that the fuel has to be added to the final price.

To show it in an example, from the US in 2012: the average coal sales price was $39.45/tonne after the mining procedures (in the mine), the average distributed coal price to the power plants was $45.77/tonne, it means $5.82/tonne for costs of transportation or 13% of the final price. (EIA, 2014)

Nowadays, the different markets are very well connected. For instance, the seaborne transport costs are quite low at the moment. However, the coal prices are different in every region.

4.5.4 Price Impact on the Coal Industry

In the countries where there are many energy-intensive industries both the price of fuel and electricity influence its market. The rise in prices can cause a loss of competitive advantages and it the worst scenario can lead to closing the industry. The countries with

a possible access to energy resources whether from direct mining or available supply from the foreign trade, can overcome these negative phenomena and promote economic growth and development. (World Coal Association, 2015)

4.5.5 Factors which Influence the Prices

Coal is traded around the world and its price is influenced by several factors. To understand it better the factors are divided into two main categories, the first one is called demand side factors and the second one is called supply side factors. Also, there has to be another (a third) category to explain factors which cannot be placed into these two. (Futures Knowledge, 2014)

Demand side factors

As already mentioned, coal is a significant power source it means that the demand for it is a very important factor which influences the coal price, China and India are good examples, where the need for coal is growing since 2010 and they are the largest consumers of coal in the world. The change in price and demand for natural gas and oil can affect the price of coal. If the price of these commodities grows, the demand for coal rises and its price changes as well. Another factor is weather, mostly the weather temperature. If the weather during winters is very cold the demand for coal rises because people need to heat more. The last demand factor which will be mentioned is currency. The exchange rate can affect the demand for coal.

Supply side factors

The supply of coal is not a problem, even though it belongs to the group of non-renewable sources, its reserves are very large and should last at least 100 years. The price from the supply point of view is not too much influenced but it can be changed in the future. However, the supply of coal can be sluggish if other factors will not be prepared effectively, for instance, labor, transportation, fuel, equipment, *etc*. and then the coal price can be affected. (Future Knowledge, 2014)

Other factors

Government regulations are the biggest influences of the coal price. They can affect environmental restriction, change laws or put taxes on coal higher than now. Other factors which can change the prices are climate events, *e.g.* floods, fires.

All these factors affect the price of coal enormously, it is not usually only one but they are all combined. (Tradition, 2013)

4.5.6 Transparency of Coal Market

Coal market transparency is a very frequently discussed topic. For oil, the focus on transparency started around the 1990s but since 2012, the IEA, IEF, and OPEC started to focus more on the market transparency for gas and coal. Joint Organizations Data Initiative (JODI) was invented for gas. It is a gas world database, which helps to enhance the natural gas transparency in the international markets. In the future, this database should be extended to cover coal data as well. (JODI, 2014)

To increase international coal transparency, there are several things which can be done. The first thing, major consumers of coal have to establish better outlooks of their consumption otherwise all the incoming data are biased and global statistics are not relevant. The local transparency would have a great benefit on the global one. The second one, the over-the-counter contracts should improve their transparency because almost two-thirds of the trade goes through these operations. It should, however, be also improved by government regulations. The third one, establish future markets and risks managing. The four one, there should be an improvement of contracts and price indices. Finally, market transparency should be improved to help to reduce price volatility. (IEF, 2013)

4.5.7 Coal Price Index

Indices already mentioned are part of coal market transparency. Nowadays, they are an integral part of the coal market. There are two companies which provide index services and are the source of the API prices; those are Argus and IHS McCloskey. The API prices are *"the key indexes used for international physical and derivatives coal business"*, in other words, the standard industry benchmarks. (Argusmedia, 2015)

The types of API indices are API 2, 3, 4, 5, 6, 8, 10 and 12. They together cover the most important markets, which are Australia, Colombia, India, Northwest Europe, South Africa and South China.

Each number of the index means where it is used, and if it is a weekly, monthly or daily coal price. Probably the most important ones are the indexes API 2 and API 4, which are used on daily basis. Around 90% of the traded derivatives worldwide use these indexes to

determine a price of coal. They are also used as a standard price in international contracts. (Argusmedia, 2015)

The API 2 index is the standard price used for imported coal into Northwest Europe, the API 3 index is used for trading in South Africa (Richards Bay), the API 4 index is the standard price used for coal exported from South Africa (Richards Bay), the API 5 index is used for high-ash coal exported from Australia (Newcastle), the API 6 index is used for coal exported from Australia (Richards Bay), the API 8 index is used for coal delivered to south China, the API 10 index is used for coal trading in Colombia and lastly, the API 12 index is used for coal delivered to India. Every index price is calculated as either the average of the Argus CIF (Cost, Insurance, and Freight) or fob (Free on Board) x/kcal/kg assessment and the equivalent from HIS McCloskey. (Argusmedia, 2015)

4.5.8 Supply and Demand

In 2013 the supply of coal worldwide raised by 0.4% to 7,823 million tonnes, however, it is still lower growth than in 2012 and the average growth in the past 10 years. (Coal Medium-Term Market Report 2014)

As can be seen in the table No. 5, the supply of both India and China grew but not as much as in the years before. For China, the growth was only 0.8% and for India 1.5%. The second largest producer of coal in the world is the U.S., where the supplies decreased. In Indonesia, the supplies grew but not as much as in previous years and the same trend has been seen in Australia where the supplies grew.

Table No. 5 Coal Supply Overview

Coal Supply Overview			
Country	Total Demand (Mt)		Share (%)
	2012	2013	2013
China	3 532	3 561	45.5
United States	932	904	11.6
India	604	613	7.8
Indonesia	444	489	6.2
Australia	431	459	5.9
OECD members	2 024	1 994	25.5
non-OECD members	5 770	5 828	74.5

Source: Coal Medium-Term Market Report 2014

The coal supply trends in OECD and non-OECD member countries are different, it will be further explained below.

OECD members

The production of coal in OECD member countries declined by 1.5% in 2013, it was mainly due to the production of lignite, which decreased by 5.1%. The steam coal experienced a change in supplies as well. Globally it decreased by 0.8% but there was a difference in every region. For example, the production of OECD Europe and America decreased by 12.7% and 2.6% but the production of OECD Asia Oceania increased by 11.7%. The coking coal experienced a change in supplies too it was because of the rise in production in OECD Asia Oceania by 3.1%. Australia has the largest proportion of the supply increase of coal, the opposite are the United States, where especially the production of hard coal declined, and the OECD Europe where the decrease of production is because of closing very important mines. The production in OECD member countries of lignite declined the same happened in lignite consumption. Although, Germany produces the most lignite in the world and its supplies stayed stable, in other countries the production of lignite declined either due to environmental aspects or tax increasing. (Coal Medium-Term Market Report 2014)

Non-OECD members

The production of coal in non-OECD member countries rose by 1% to 5,828 million tonnes in 2013, which is the lowest increased since 2000. Also, for the hard coal, the growth was not as good as in previous years, the supply of lignite declined by 6.3% in 2013. To mention some of the non-OECD member countries, China had production increase only 0.8% and India had only 1.9% both lower than in the past years. The same experienced Indonesia where the production rise was 10.1% in 2013 which is much less than in previous 10 years. In Kazakhstan and Russia, the coal production stayed the same and South Africa and Colombia experienced fall by 1.1% and 4.1%. (Coal Medium-Term Market Report 2014)

In 2013 the demand for coal worldwide raised by 2.4% to 7 876 million tonnes, which is more than in 2012 where the growth was only 2%, anyway, the demand growth is still lower than in the past 10 years. This can be caused by several things; even though, in the OECD non-members countries, demand of coal raised by 3.6%, in OECD members countries demand declined by 0.6%. (Coal Medium-Term Market Report 2014)
As can be seen in the table No. 6, China has the biggest share of the coal market worldwide. With regard to demand, it raised by 5.3% in 2013. The second largest consumer is the United States, where the coal demand increased by 2.8%. The coal demand growth in India was 2.1% in 2013, which is from the statistical point of view weird because the growth was significantly higher in previous years. In 2013, the coal demand for the European Union and Russia declined rapidly, anyway Russia, and from the EU, especially Germany uses coal for many purposes.

Table No. 6 Coal Demand Overview

Coal Demand Overview			
Country	Total Demand (Mt)		Share (%)
	2012	2013	2013
China	3 698	3 894	49.4
United States	820	843	10.7
India	775	791	10.0
Germany	246	241	3.1
Russia	254	235	3.0
EU	768	726	9.2
OECD members	2 148	2 136	27.1
non-OECD members	5 539	5 740	72.9

Source: Coal Medium-Term Market Report 2014

The coal demand trends in OECD and non-OECD member countries are different, it will be further explained below.

OECD members

The OECD's global demand share of hard coal was 22.4% in 2013. The global lignite demand share was 67% in 2013. In comparison, OECD Europe's demand for hard coal declined, whereas the demand for hard coal in OECD Asia Oceania and OECD Americas increased. The consumption of lignite in OECD countries decreased, it was mostly because of the environmental aspects. (Coal Medium-Term Market Report 2014)

Non-OECD members

The non-OECD's global demand share of coal was 72.9% in 2013. By 3.6% to 5,740 million tonnes the demand of coal raised in non-OECD member countries in 2013 but it is still less than in the last 10 years. A similar matter as happened in OECD countries, the consumption of lignite decreased rapidly however the consumption of hard coal increased by 4.1%. (Coal Medium-Term Market Report 2014)

5 Practical Part

5.1 Hard Coal Market in the CR

Hard coal has a long-standing tradition in the Czech Republic and it is one of its strategic commodities. The CR has never had a problem with its price or supplies and was always self-sufficient. However, recently, the Czech hard coal market started to face a problem with decreasing prices of coal and decreasing exports. This was strongly influenced by a drop in demand and by cheaper imports from the United States. The reason why the cheaper coal is exported from the US is mainly due to the replacement by a very popular shale gas. Worldwide, the coal prices are declining since 2008. This leads to the situation that production has been becoming unprofitable. The amount of the Czech coal production and consumption is continually decreasing.

5.1.1 Hard Coal Production

In the Czech Republic, the production of hard coal is provided only by one company called OKD. The company's mines are in the area of Ostrava-Karviná in the Upper Silesian Basin. They are using the underground method of mining. Nowadays, there are 3 mines in operation with yearly production of 9 million tonnes. (OKD, 2016)

As can be seen in the table No.7, the coal production has been declining. A big difference became in 2013, where the hard coal production dropped from 11,439 thousand tonnes to 8,594 thousand tonnes. The reason is that the market has become saturated by the American export of the cheaper coal. The decline of prices has caused that the management of OKD decided to decrease the production to the level of 8k to 9k million tonnes a year. The decline in production still covers the needs of the Czech Republic and the CR still remains self-sufficient.

Table No. 7 Hard Coal Production (in thousand tonnes)

Hard Coal Production											
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Total	14 648	12 778	13 017	13 017	12 650	11 001	11 435	11 265	11 439	8 594	8 683

Source: own illustration according to MIT, 2007-2014

5.1.2 Hard Coal Consumption

As can be seen in the table No. 8, the hard coal consumption in the Czech Republic is decreasing but is still quite stable during long-term. In the monitored period, the consumption decreased from 9.3 million tonnes in 2004 to 6.9 million tonnes in 2014. The hard coal is mainly used in the energy sector and heavy industry (namely steel and chemical). In the energy sector, it is used by power plant Dětmarovice (according to CEZ (2016), its consumption is 2.3 million tonnes per year) and heating plant Vítkovice for energetic purposes. Utilization of hard coal is decreasing due to the incoming environmental policy from the European Union that leads to the replacement of coal by green energy (*e.g.* heating plant Vítkovice will be decommissioned after 2019 if no ecological modernization takes place).

Table No. 8 Hard Coal Consumption (in thousand tonnes)

Hard Coal Consumption											
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Total	9 328	9 099	9 257	9 304	8 848	6 603	7 490	7 296	6 806	6 979	6 930

Source: own illustration according to CSO 2005, 2006, 2015

5.1.3 Hard Coal Foreign Trade

The hard coal trade and its long distance transportation are seen more often. It is due to its better quality, the rarer number of deposits around the world and its importance in the industries, for example, the steel or chemical industry.

According to Hlinomaz (2015) even though, it seems now that the CR is exporting more, in the future it will be necessary to import the hard coal to the Czech Republic, mainly due to the mine closures. The Czech Republic's main importers are Germany and Poland. Nevertheless, it is presumed that other suppliers will take a part in the trade, for instance, the United States because their hard coal has a very good quality and price.

As can be seen in the table No. 9, in 2014 exports accounted about 4,287 thousand tonnes and imports only 2,257 thousand tonnes, in the future, these number should be the opposite. In case, that power plant Dětmarovice will be in operation longer than it is expected now (decommissioning in 2025), there will be the lack of hard coal for covering industry needs and import of hard coal will be an important part of the foreign trade.

The heavy industry has a long-term tradition in the Moravian-Silesian region and there is a perspective that the industry will continue in the future thus the hard coal will be needed

and according to the production prognosis by MIT (2016), import of hard coal must take place.

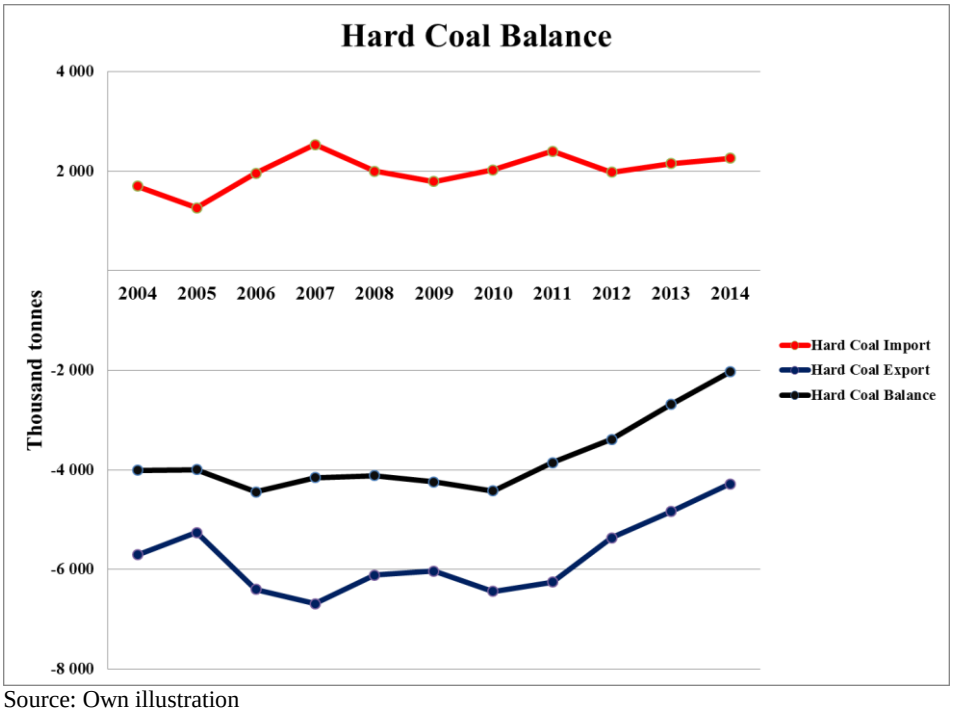
Table No. 9 Hard Coal Import and Export (in thousand tonnes)

Hard Coal		
Year	Import	Export
2004	1 695	5 707
2005	1 264	5 261
2006	1 959	6 401
2007	2 532	6 687
2008	1 997	6 112
2009	1 789	6 032
2010	2 022	6 445
2011	2 398	6 257
2012	1 979	5 369
2013	2 153	4 837
2014	2 257	4 287

Source: own illustration according to Czech Geological Survey 2005-2014; MIT, 2015

As can be seen in the Graph No. 6, the hard coal balance is decreasing. While import remains analogical during the monitored period, the decrease of the export took place. The change happened around the year 2011 when the information about future mine closures started to appear and since then the hard coal became more used for internal demand. Also, there is quite obvious that the situation will not change and is base for a calculating trend.

Graph No. 6 Hard Coal Balance



Source: Own illustration

5.1.4 Prognoses of Future Imports and Exports of the Hard Coal

The main goal of this thesis is to calculate future imports and exports thus the balance of foreign trade with hard coal. The prognosis is based on predicted data of hard coal's consumption and production in the monitored period that were made by relevant stakeholders (Ministry of Industry and Trade, Czech Geological Survey, Czech Statistical Office). According to the current data of foreign trade with hard coal that is part of this thesis from 2004 to 2014, there will be used a trend analysis to calculate the future balance of hard coal's foreign trade. The results will be adjusted in accordance with future predicted production and consumption. The results could be used for ensuring an adequate supply of hard coal for the energy sector and industry named above.

The thesis focuses on the foreign trade with currently known partners (Germany and Poland) and has no ambitions to find any other partners for the future (although the cheaper coal from the US is mentioned several times).

5.1.4.1 Hard Coal Production in the Future

The production is based on the information from the Ministry of Industry and Trade and its State Energy Policy. The table No. 10 shows the decline in production of hard coal due to

the plans of OKD and the run out of stocks in all respective mines. The nearest plans show that one of the mines - Paskov is planned to be shut down around 2018.

Table No. 10 Hard Coal Production in the Future (in thousand tonnes)

Hard Coal Production in the Future	
Year	Total
2015	7 889
2020	7 017
2025	6 974
2030	6 150
2035	6 111
2040	5 825
2045	5 577

Source: MIT, 2014

5.1.4.2 Hard Coal Consumption in the Future

The table No. 11 represents the consumption data of hard coal that are based on the prediction of MIT and are modified by the author's decision. The long-term prediction of the consumption of hard coal is very unsure because there are a lot of different inputs that can change the prediction year by year. It is predicted that the consumption of the industry sector will remain almost the same during the monitored period because there are no other information regarding the business plans in the industry. On the other hand, consumption of energy sector depends on the power plant Dětmarovice that is planned to be decommissioned around 2025. However, last year's information mentioned the decommissioning will be around 2019, this shows the uncertainty in the prediction process.

Table No. 11 Hard Coal Consumption in the Future (in thousand tonnes)

Hard Coal Consumption in the Future	
Year	Total
2015	7 200
2020	6 700
2025	5 600
2030	4 800
2035	4 600
2040	4 500
2045	4 500

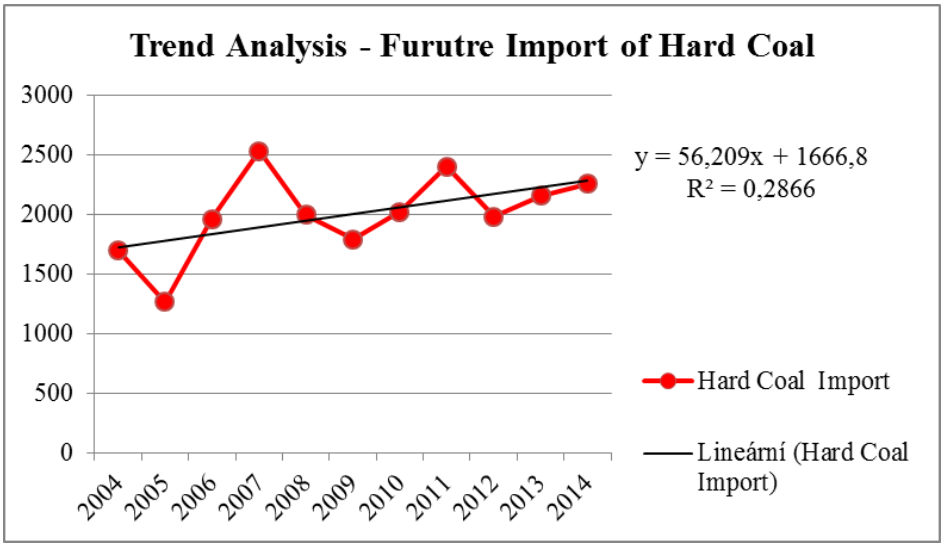
Source: Own prognosis based on MIT, 2014

5.1.4.3 Estimation of hard coal's import and export

To calculate the future import and export of hard coal in the Czech Republic, the trend analysis has been used, for its correction, the author used Forecast function. According to Investopedia (2016), "*a trend analysis is an aspect of technical analysis that tries to predict the future movement of a stock based on past data. Trend analysis is based on the idea that what has happened in the past gives traders an idea of what will happen in the future."* For the calculations have been used data from the table No. 9, which helped to predict the import and export for the years 2015, 2020, 2025, 2030, 2035, 2040, 2045. The calculations have been made in program Excel (procedure add Trendline) and then calculated by an equation y = mx + b. The least squares method is used by Excel to find a line that matches the point the best. If the R-square value equals 1 then the line matches the data better.

Results of this estimation will be shown in the chapter No. 6 Results and Discussion.

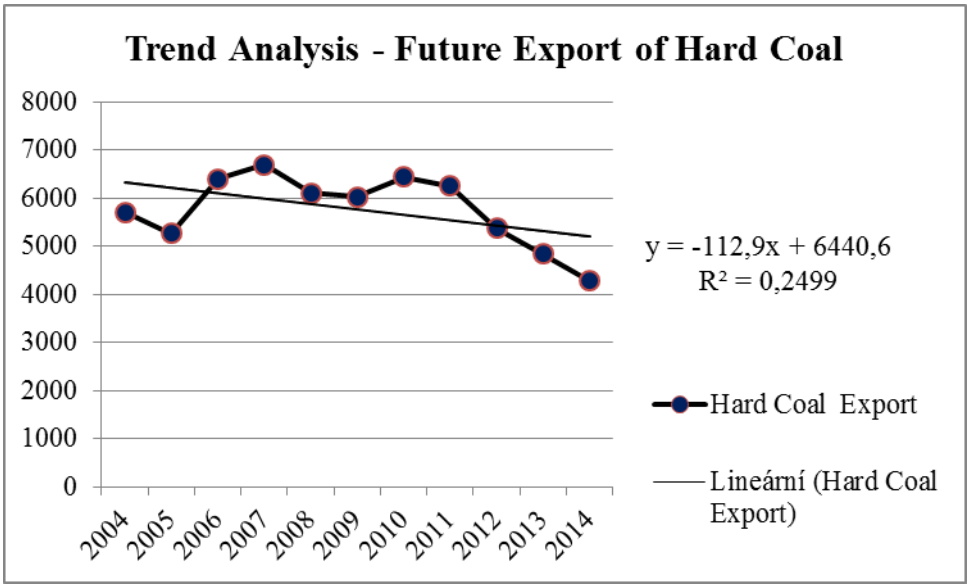
Graph No. 7 Trend Analysis – Future Import of Hard Coal (in thousand tonnes)



Source: own illustration according to Czech Geological Survey, 2014; MIT, 2015

The graph No. 7 shows the equation y = 56.209x + 1666.8 and R-square value 0.2866, whose value, in this case, shows that about 29% of variability of these values can be explained by this model. That means that there is a lot of variability thus the deviation of the real data from the model can be up to 70%.

Graph No. 8 Trend Analysis – Future Export of Hard Coal (in thousand tonnes)



Source: own illustration according to Czech Geological Survey, 2014; MIT, 2015

The Graph No. 8 shows the equation y = -112.9x + 6440.6 and R-square value 0.2499, whose value, in this case, shows that about 25% of variability of these values can be explained by this model. That means that there is a lot of variability, thus the deviation of the real data from the model can be up to 75%.

5.2 Lignite Market in the CR

The importance and use of lignite have been concluded in many discussions. In the Czech Republic, there are more lignite quarries than hard coal mines as can be seen in the appendices No. 1 and 2. That means the lignite quarries affect the Czech environment more and it is also more tradable commodity than the hard coal. Also according to MIT (2015), the lignite in the CR is a primary fuel involved in the electricity production by more than 46%. Although lignite is more tradable than hard coal, it is almost always traded to the power plant next to the mine; this is due to the low price of lignite and that it is not viable to transport lignite on long distances. The characteristic of units of power plants is always set up to the calorific value of the low-rank coal, thus the lignite cannot be usually replaced by another type of low-rank coal. The specific part of the market is a trade with heating plants that are located in the cities to provide heat to population, contracts for these trades are usually set up for long-term and it is always a subject of tough negotiation.

5.2.1 Lignite Production

As can be seen in the table No. 12, the lignite production has been quite stable from 2004 to 2008 then the production has been declining and the only rise happened in 2011, where the production increased quite rapidly to about 46,620 thousand tonnes. In 2014, the production was 38.18 million tonnes. In total, between the years 2008 and 2014, the production decrease was about 8.9 million tonnes. The reasons why the production has decreased during the monitored period are due to the demand decrease and because of the mentioned below:

- the European Commission has introduced a new European policy (for climate change and energy sustainability) called Europe 2020, which contains “20-20-20” targets, within which is the EU committed to reduce its greenhouse gas emissions by 20% (base year 1990), to have a 20% share of renewable sources in energy consumption and improve its energy efficiency by 20% all by the year 2020. (European Commission, 2015)
- increase of renewable energy sources and its share of electricity production in the Czech Republic
- continuous decrease of produced amount of lignite for the prolongation of mine life cycle

Table No. 12 Lignite Production (in thousand tonnes)

Lignite Production											
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Total	47 840	48 658	48 915	49 134	47 121	45 162	43 773	46 620	43 533	40 387	38 177

Source: own illustration according to MIT, 2007, 2009, 2015

According to Vupek-Economy, (2015), the Czech lignite market produces mainly for the Czech Republic. In numbers, the CR covers 96.2% of its own consumption.

In the Czech Republic, there are four companies which produce lignite. They belong to the supply side of the market. These are:

Severočeské doly, a.s. (CDAS) – the company is a part of ČEZ Group since 2005 and it is the biggest producer of lignite in the CR. The quarries are called Nástup Tušimice and Bílina. In 2014, Severočeské doly produced about 21.5 million of tonnes of lignite. (CDAS, 2016)

Sokolovská uhelná, právní nástupce, a.s. – this is an independent coal company and also the smallest one. Its quarry, called "Jiří ve Vintířově" is located in the Northwest part of the CR and it produces about 6.5 million tonnes of lignite per year. (Sokolovská uhelná, 2016)

Czech Coal Group – or still called Vršanská uhelná, a.s. produces the lignite in the area of North Bohemia in Vršany, it yearly produces about 5.5 million of tonnes. (Czech Coal Group, 2016)

Severní energetická, a.s. – the mining sites called "Československá armáda or ČSA" and quarry Centrum are located in the area of North Bohemia and produce about 5 million tonnes of lignite per year. (Severní energetická, 2016)

Table No. 13 Production of Lignite by Companies

Production of Lignite by Companies		
Mining company	Production (in million tonnes)	Share (in %)
Severočeské doly	21.5	55.8
Sokolovská uhelná	6.5	16.9
Vršanská uhelná	5.5	14.3
Severní energetická	5.0	13.0

Source: own calculation according to mining companies, 2016

5.2.2 Lignite Consumption

As can be seen in the table No. 14, the consumption of lignite in the Czech Republic was quite stable between the period 2004 and 2008, however between the period 2008 and 2014 the production has been decreasing, there were only rises in 2010 and 2011. That was caused by the return of rising curve of demand in the economy after the world economic crisis. Even though, the consumption is declining, lignite is still one of the most important energy sources the Czech Republic uses, mainly because of its mining deposits and a significant share of electricity consumption. The reasons for its decrease are especially the increasing production of electricity from renewable energy sources and decommissioning of old power plants that do not worth to be upgraded (a process of desulphurization) because of economic reasons and a modernization of two units of heating power plants. The modernization will be finished approximately in 2016 or 2017. (ČEZ, 2016)

Table No. 14 Lignite Consumption (in thousand tonnes)

Lignite Consumption											
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Total	44 938	45 429	44 337	47 304	44 053	41 146	43 622	42 800	41 061	37 324	37 490

Source: own illustration according to CSO, 2005, 2006, 2015

The main consumers are heating power plants, ČEZ Group is the biggest owner of power plants in the CR. Another big group of consumers are power plants that are owned by the mine owners and the third group, are the independent heating plants located in the cities that buy lignite directly from the producers. (Vupek-Economy, 2015)

5.2.3 Lignite Foreign Trade

The situation of lignite imports and exports is the complete opposite from the hard coal. Firstly, its quality is significantly lower and its long-distance transportation is not so common, mainly due to its costs, dustiness and environmental aspects.

As can be seen in the table No. 15, the Czech Republic has always been exporting more lignite than importing it, the situation has changed recently. It is obvious from the table No. 15, that there has been an increase in import of lignite. This increase in imports was caused by growing tensions on the lignite market in the CR and was also possibly made by changes in the German market. (MIT, 2015) The reason is that some of the quarries are

about to close its operation because they are running out of its reserves. One of the entities on the Czech energy market also owns quarries in Germany and uses them for importing his own coal to his heating plant as a tool for better competitiveness.

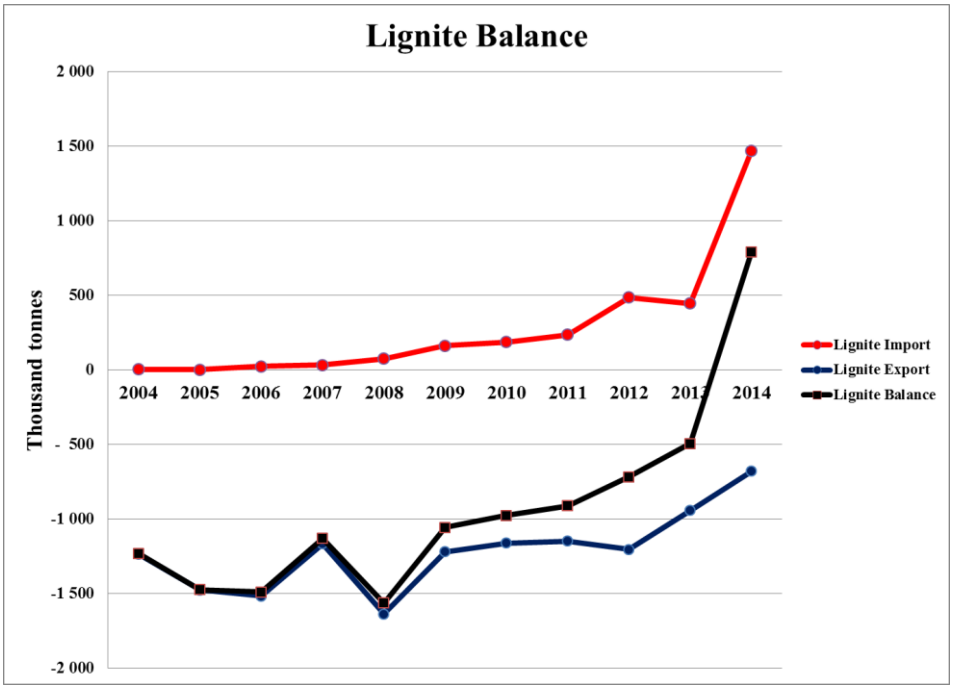
Table No. 15 Lignite Import and Export (in thousand tonnes)

Lignite		
Year	Import	Export
2004	4	1 233
2005	2	1 475
2006	25	1 514
2007	34	1 164
2008	75	1 636
2009	163	1 219
2010	187	1 161
2011	236	1 146
2012	486	1 203
2013	447	941
2014	1 470	678

Source: own illustration according to VUPEK-ECONOMY, 2015; Czech Geological Survey, 2012 and 2014

Anyway, lignite is still exported by all Czech mining companies because of its good quality. The exported amount decreased because of the need of lignite for the independent heating plants that try to conclude contracts of supplies for several years ahead. The heating plants face the problem of future lack of high-quality lignite from the Czech quarries. Before they will be able to replace the fuel (lignite) by another greener source (biomass, biogas, *etc*.), there is an expectation that the import will rise accordingly to their needs.

Graph No. 9 Balance of Lignite



Source: own illustration according to VUPEK-ECONOMY, 2015; Czech Geological Survey, 2012 and 2014

As can be seen in the graph No. 9, the lignite balance is decreasing and indicates the continuous switch to the opposite side in the future when import becomes more valuable. The forthcoming trend will be seen in chapter No. 6 Results and Discussion.

5.2.4 Prognoses of Future Imports and Exports of Lignite

The main goal of this thesis is to calculate future imports and exports thus the balance of foreign trade with lignite. The prediction could serve mainly to the independent demanders that there is not so much lignite in the Czech energy market to cover all needs, and that there is a possibility to buy demanded amount through foreign trade from other countries and not to be dependent on main producers in the CR. The prognosis is based on predicted data of consumption and production of lignite in the monitored period that were made by relevant stakeholders (Ministry of Industry and Trade, Vupec-Economy, Czech Geological Survey, Statistical Office). According to the current data of foreign trade with lignite that are part of this thesis from 2004 to 2014, there will be used a trend analysis to calculate the future balance of lignite's foreign trade. The results will be adjusted in accordance with future predicted production and consumption, because of the specificity of the market, the lignite market will remain primarily in the same manner. That means that there will always be several big suppliers and consumers that will trade between each

other within the Czech borders. The results could be used for ensuring an adequate supply of lignite for the energy sector and especially for the independent heating plants that cover heating of population.

5.2.4.1 Lignite Production in the Future

The production is based on the information from the Ministry of Industry and Trade and its State Energy Policy. The table No. 16 shows the decline in production of lignite due to several reasons. The reasons are the decrease of lignite reserves in the Czech Republic and the decrease of demand for the lignite in the energy sector. A lot of heating power plants will reach the end of operating life cycle and will be decommissioned in the following years according to the well-known plans (OTE - long-term balance, State Energy Policy and the mining companies). For instance, a quarry Bílina will be decommissioned around the year 2035 and a quarry Nástup Tušimice in 2029, both owned by Severočeské doly. (SDAS, 2016) Severní energetická has also a problem with decommissioning, its quarry Centrum should be closed by the end of 2016 or 2017 and ČSA by the year 2022. (Severní energetická, 2013)

There are plans for commissioning the new highly efficient power plants but they will not cover the consumption of lignite in the recent years.

Table No. 16 Production of Lignite in the Future (in thousand tonnes)

Lignite Production in the Future	
Year	Total
2015	40 095
2020	35 619
2025	26 206
2030	24 396
2035	20 119
2040	11 905
2045	10 234

Source: State Energy Policy, 2014; Mining companies, 2016

5.2.4.2 Lignite Consumption in the Future

The table No. 17 represents the consumption data of lignite that are based on the prediction of Ministry of Industry and Trade, Czech Geological Survey and Vupek-Economy. The long-term prediction of the consumption of lignite is based on the operating life of heating power plants in the CR. There are power plants that will be decommissioned in the following years as it has been already mentioned in the previous chapter. ČEZ Group and other companies (*e.g.* Mostecká uhelná) are in the preparation phase of new heating power plants that will hold the level of lignite used for energy sector as a dominant fuel. According to the prediction from power plant owners, the use of lignite can be predicted easily than hard coal. Everything is connected to the territorial environmental limits of lignite in two localities in the CR. If the limits are kept there is a big possibility that the independent heating plants will not cover their consumption by Czech supply. On the opposite way, it is very hard to predict the situation if limits were shifted because there would be enough lignite for everyone in the Czech Republic and its price will not rise as it was seen during last years.

Table No. 17 Consumption of Lignite in the Future (in thousand tonnes)

Lignite Consumption in the Future	
Year	Total
2015	43 174
2020	39 032
2025	36 671
2030	34 901
2035	33 553
2040	25 073
2045	15 621

Source: Czech Geological Survey, 2014; Vupec-Economy, 2015

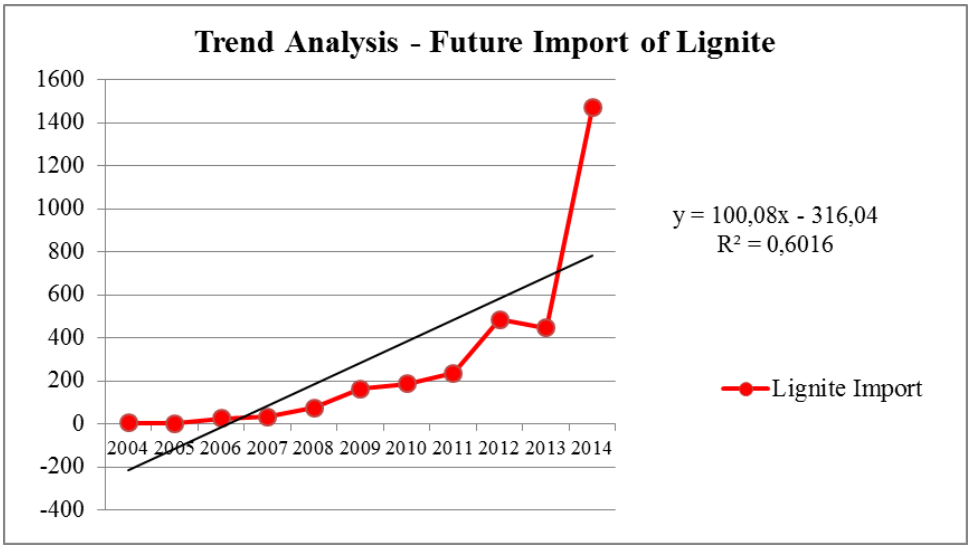
5.2.4.3 Estimation of Lignite's import and export

To calculate the future import and export of lignite in the Czech Republic, the trend analysis has been used, for its correction, the author used the Forecast function. For the calculations have been used data from the table No. 15, which helped to predict the import

and export for the years 2015, 2020, 2025, 2030, 2035, 2040, 2045. The calculations have been made in program Excel (procedure add Trendline) and then calculated by an equation y = mx + b. The least squares method is used by Excel to find a line that matches the point the best. If the R-square value equals 1 then the line matches the data better.

Results of this estimation will be shown in the chapter No. 6 Results and Discussion.

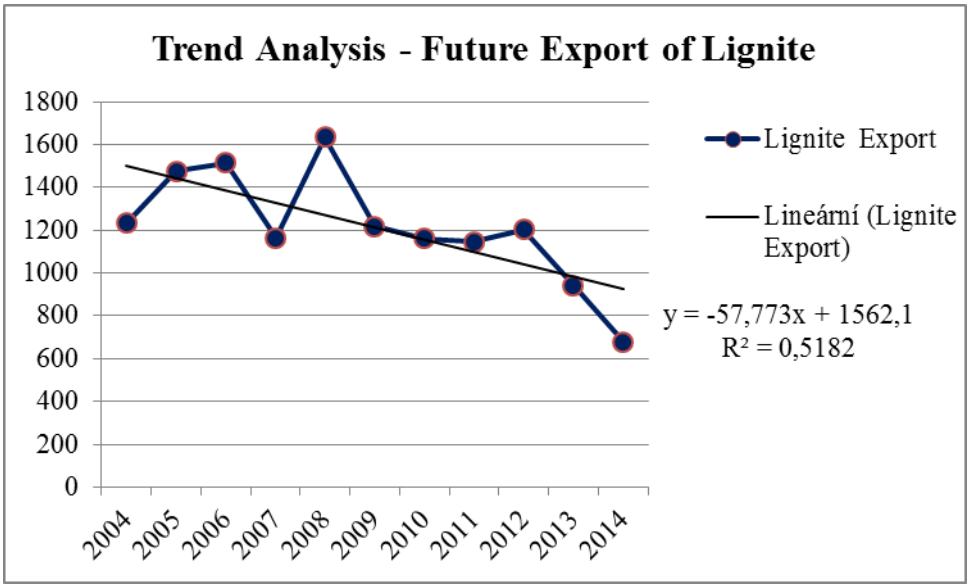
Graph No. 10 – Trend Analysis – Future Import of Lignite (in thousand tonnes)



Source: own illustration according to VUPEK-ECONOMY, 2015; Czech Geological Survey, 2012 and 2014

The graph No. 10 shows the equation y = 100.08x – 316.04 and R-square value 0.6016. In this case, this value indicates that more than 60% of the variability of these values can be explained by this model.

Graph No. 11 – Trend Analysis – Future Export of Lignite (in thousand tonnes)



Source: own illustration according to VUPEK-ECONOMY, 2015; Czech Geological Survey, 2012 and 2014

The graph No. 11 shows the equation y = -57.773 + 1562.1 and R-square value 0.5182. In this case, this value indicates that more than 51% of the variability of these values can be explained by this model.

6 Results and Discussion

6.3 Hard Coal

By using the trend analysis, the author calculated the future import and export of hard coal in the Czech Republic.

6.3.1 Future Import of Hard Coal

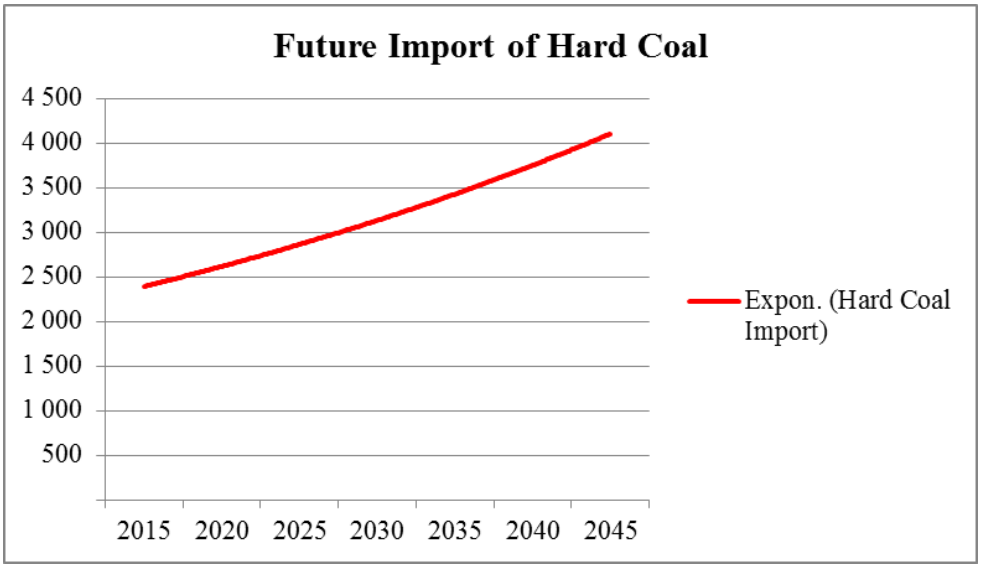
The result of the calculation of hard coal import can be seen in the table No. 18 and graph No. 12. The model shows a rising trend, which indicates an increase of hard coal import between the period 2015 and 2045. The reason is that imported hard coal will be needed for covering the consumption of the CR and is also connected with the mine closures, especially with the problems in the mine Paskov. There is an assumption that hard coal consumption will decrease after the power plants decommissioning that use hard coal as a fuel. It corresponds with production decrease because of the lack of mining abilities. It also leads to the increase of import of hard coal that will help to cover the industry consumption.

Table No. 18 Future Import of Hard Coal (in thousand tonnes)

Hard Coal	
Period	Import
2015	2 341
2020	2 622
2025	2 903
2030	3 184
2035	3 466
2040	3 747
2045	4 028

Source: own calculacting

Graph No. 12 Future Import of Hard Coal (in thousand tonnes)



Source: own illustration

6.3.2 Future Export of Hard Coal

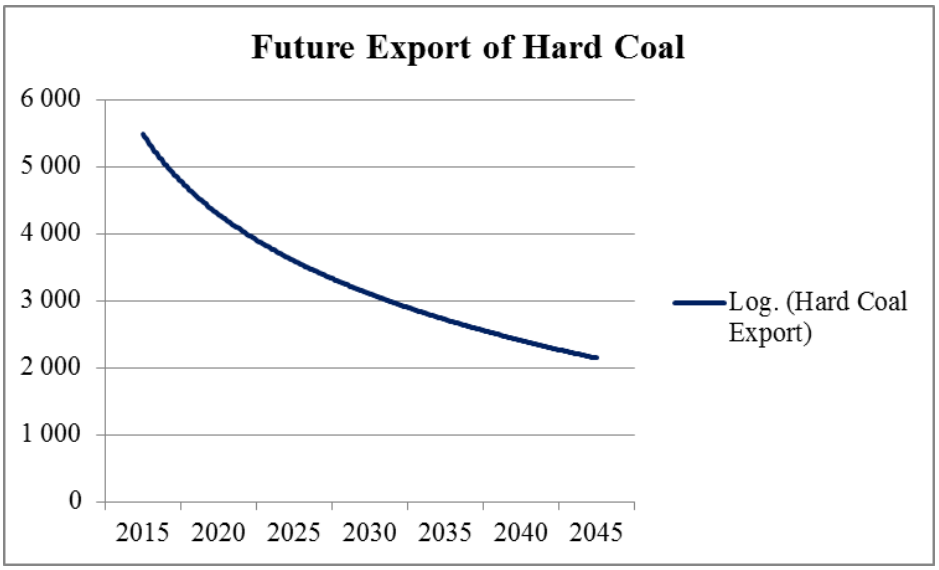
The result of the calculation of hard coal export can be seen in the table No. 19 and graph No. 13. It shows that between the period 2015 and 2045, hard coal will indicate a decreasing trend, which is caused mainly by mine closures and the need to be able to cover (at least partly) the consumption of the Czech Republic and its energy security. The decrease is based on calculations but can be very close to reality because the price of coal can rise in the future and that will cause that the market will not completely cease. The necessity of hard coal mainly in Moravian-Silesian region and in Poland close to this region will ensure an ongoing market.

Table No. 19 Future Export of Hard Coal (in thousand tonnes)

Hard Coal	
Period	Export
2015	5 086
2020	4 521
2025	3 957
2030	3 392
2035	2 828
2040	2 263
2045	1 699

Source: own calculating

Graph No. 13 – Future Export of Hard Coal (in thousand tonnes)

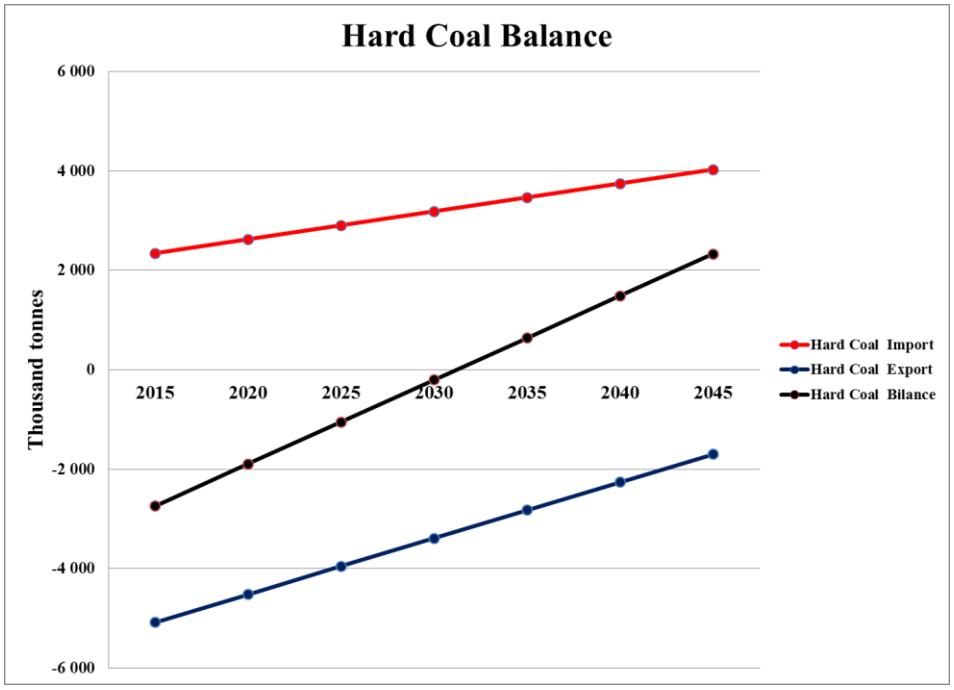


Source: own calculating

6.3.3 Future Balance of Hard Coal

The Graph No. 14 shows that the future hard coal balance will be decreasing. Even though import will remain analogical and will be growing, export will be significantly decreasing. The use of hard coal will be still necessary for power plants and the industry, especially in the Moravian-Silesian region and it will be imported mainly from Germany or Poland.

Graph No. 14 Future Balance of Hard Coal



Source: own illustration

6.4 Lignite

By using the trend analysis, the author calculated the future import and export of lignite in the Czech Republic.

6.4.1 Future Import of Lignite

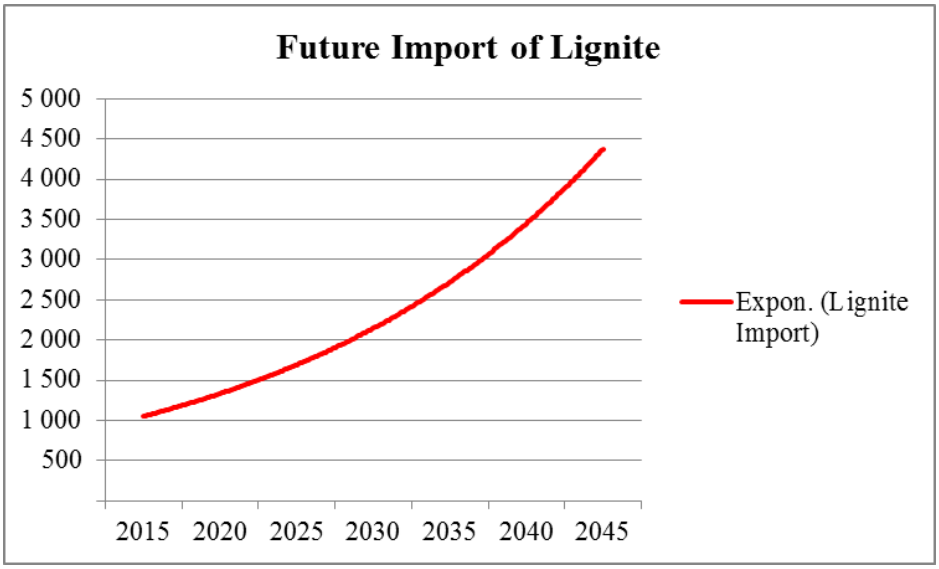
The result of the calculation of lignite import can be seen in the table No. 20 and graph No. 14. It shows that between the period 2015 and 2045, lignite will be imported more to the Czech Republic. Even though the European Union wants to decrease the consumption of coal in its Member States, the need will be still significant in the future. As already mentioned, the quarries will be closing in the area of the CR but the need of lignite will be necessary. That is why the import from, for instance, Germany or Poland, will be rising. As an example, lignite will be primarily used for the heating plants, which consumption will be still growing until coal will be transformed or modernized to a different type of fuel, such as biomass.

Table No. 20 – Future Import of Lignite (in thousand tonnes)

Lignite	
Period	Import
2015	885
2020	1 385
2025	1 885
2030	2 386
2035	2 887
2040	3 387
2045	3 887

Source: own calculating

Graph No. 15 – Future Import of Lignite (in thousand tonnes)



Source: own illustration

It is possible that the reality can vary from the author's analysis, for instance, the tension can stabilize in the meaning that some of the quarries will be able to extend their life cycle (*e.g.* shifting the mining limits). Nevertheless, for covering the coal consumption in the CR, the lignite import has to be increased as the trend shows.

6.4.2 Future Export of Lignite

The result of the calculation of lignite export can be seen in the table No. 21 and graph No. 15. It shows that between the period 2015 and 2045, lignite will be exported less than

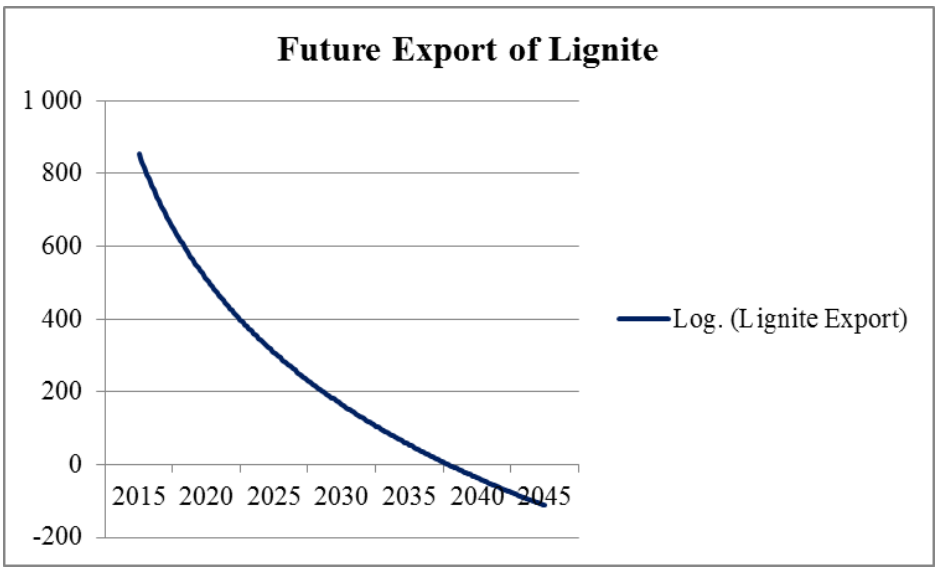
in the past. The first reason is that there will be seen the quarries closures and the second one is that lignite will be still necessary for the domestic consumption. That is why the CR has to make sure its energy security will not be affected and the export has to be decreased. Further can be seen that as from the year 2035 the values are 0 in table, the author had to add 0 instead of the calculated values because they resulted in negative numbers, which is not possible because it can be expected that the CR will still export at least a small amount of lignite. Nevertheless, this amount cannot affect the energy security. These negative values, as the trend shows, equal to a statistical deviation and they do not correspond with the reality of the trade though this deviation cannot be observed in this model.

Table No. 21 – Future Export of Lignite (in thousand tonnes)

Lignite	
Period	Export
2015	869
2020	580
2025	291
2030	2
2035	0
2040	0
2045	0

Source: own calculating

Graph No. 16 – Future Export of Lignite (in thousand tonnes)

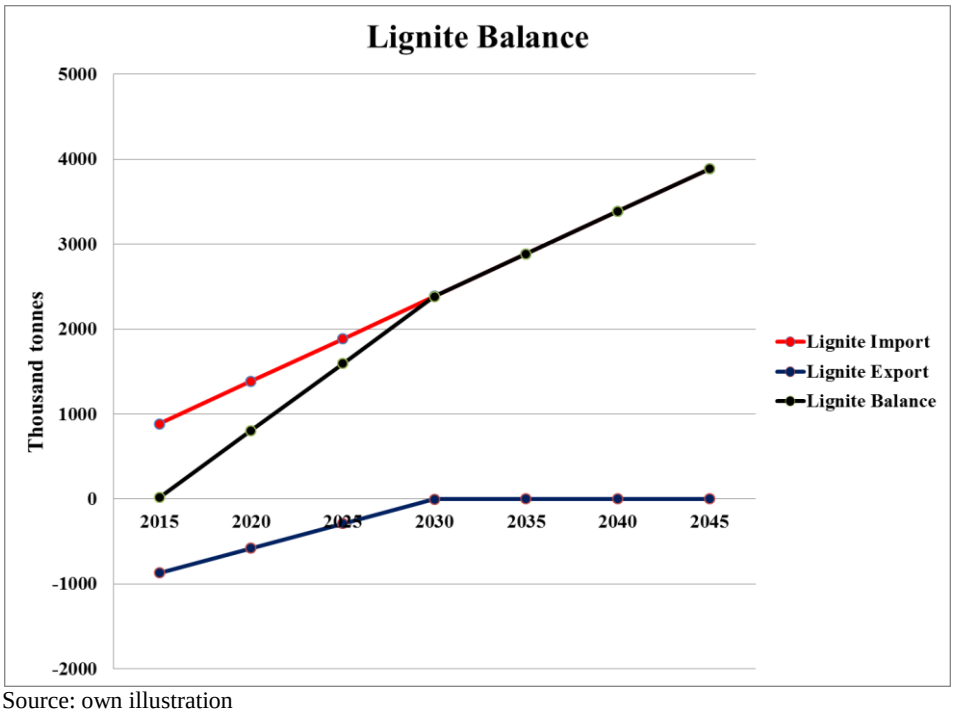


Source: own illustration

6.4.3 Future Balance of Lignite

The graph No. 17 shows the future balance of lignite, which will have a decreasing trend. It is mainly due to the fact that the data of export resulted in negative numbers and the author had to add 0 instead of them. Also, it can be seen the import and balance curve became one, this is because of the value 0 in the table. Lignite will be primarily used for the heating plants and will be mainly imported from Germany.

Graph No. 17 Future Balance of Lignite



Source: own illustration

7 Conclusion

Both types of coal have a long-standing tradition in the Czech Republic; their importance in the Czech energy mix is as significant as their role in the Czech foreign trade. Worldwide the coal market position has changed recently and the Czech coal market is no exception. The decreasing prices of coal, decreasing coal reserves, decreasing exports and demand have affected the Czech market quite significantly. All these have caused a decrease in production and consumption of hard coal and lignite. According to the author's assumptions, it seems like the trend will continue. In the CR, the production of coal will decline primarily due to the fact that the mines/quarries will stop their operation and will be decommissioned, as a large number will run out of their stocks or will reach the end of operating life cycle. The reasons for the decrease in consumption will be mainly affected by the incoming environmental policy from the EU that leads to replacing coal by the renewable energy sources and the unknown future with the territorial limits of lignite.

The statistical data have played a significant role in this thesis, however, every subject has shown differences in the coal data and it might have caused fluctuations in the calculations. Finally, according to the market prediction, the import of both types of coal will be increasing and obviously, on the other hand, the export will continuously decrease. It is based on the author's calculations but there are several reasons that confirm this development as well. The main reason is securing the stability of the energy supply and ensuring enough sources for heat and power plants. In the future, the Czech Republic will have to accept the fact that it will not be a coal self-sufficient country in the foreseeable future and must vehemently seek energy security through different methods and power sources.

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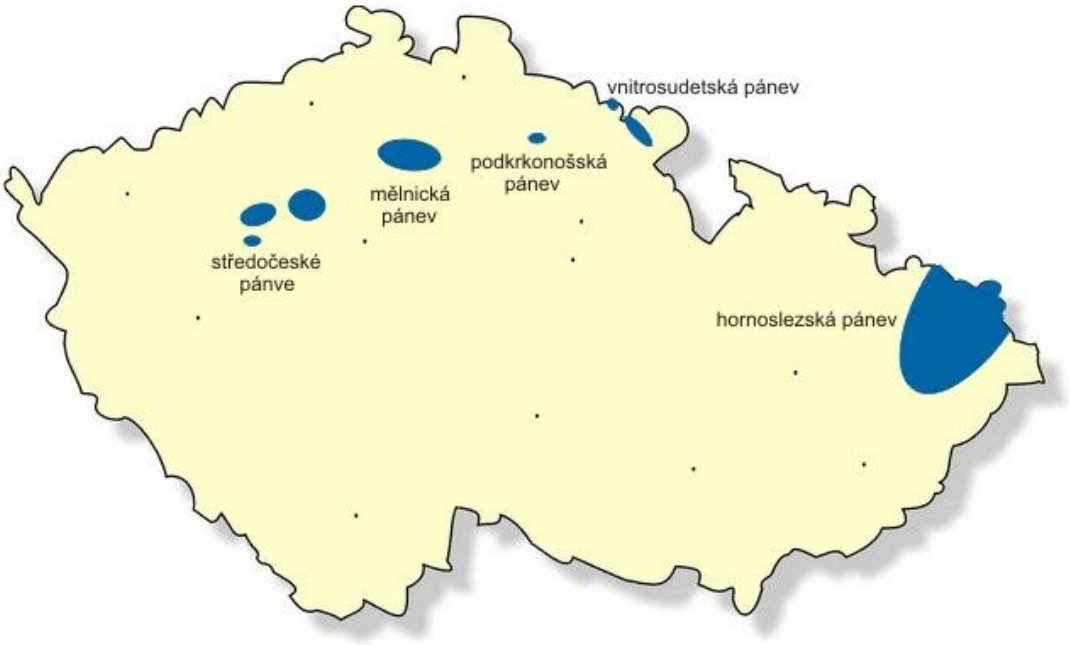
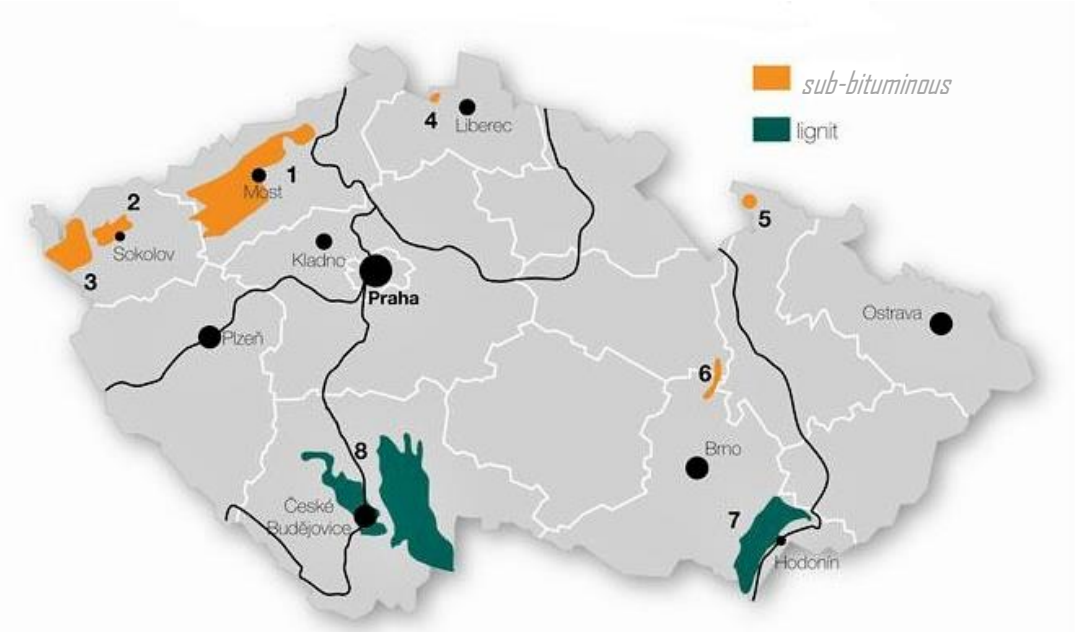
9 Appendices

Appendix No. 1 Deposits of Hard Coal in the Czech Republic



Source: Czech Geological Survey, 2014

Appendix No. 2 Deposits of Lignite in the Czech Republic



Source: naseuhli.cz, 2016