

Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics



Diploma Thesis

Economic Analysis of Natural Resources of the Czech Republic

Andrea Komůrková

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Department of Economics

Faculty of Economics and Management

DIPL OMA THESIS ASSIGNMENT

Andrea Komůrková

Economics and Management

Thesis title

Economic analysis of natural resources of the Czech Republic

Objectives of thesis

The aim of this thesis is to provide readers with the economic analysis of natural resources in the Czech Republic which includes natural resources description, usage and effect on national economy.

Methodology

In this thesis, the economic analysis of natural resources will be provided by quantitative analysis including processing and evaluation of statistical data. The SWOT and PEST analysis will be also implemented and the results will be then represented by qualitative analysis.

The proposed extent of the thesis

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Recommended information sources

Czech Statistical Office www.czso.cz

Dovřák, Antonín: Kapitoly z ekonomie přírodních zdrojů a oceňování životního prostředí, 2007

Hackett, Steven C.: Environmental and Natural Resources Economics, 2011

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The Diploma Thesis Supervisor

doc. Ing. Mansoor Maitah, Ph.D. et Ph.D.

Electronic approval: 11. 3. 2014

prof. Ing. Miroslav Svatoš, CSc.

Head of department

Electronic approval: 11. 3. 2014

Ing. Martin Pelikán, Ph.D.

Dean

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Declaration

I declare that I have worked on my diploma thesis titled "Economic analysis of natural resources of the Czech Republic" by myself and I have used only the sources mentioned 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 31.3.2015

Andrea Komůrková

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Ekonomická analýza přírodních zdrojů České republiky

Economic Analysis of Natural Resources of the Czech Republic

Souhrn

Cílem této práce je seznámit čtenáře s hlavními charakteristikami přírodních zdrojů energie v České republice a definovat jejich ekonomickou roli na trhu. Vliv a hlavní ekonomické atributy budou analyzovány a detailně vysvětleny.

Práce je složena ze dvou částí. Teoretická část obsahuje informace o přírodních zdrojích v ekonomickém kontextu, definuje jejich cenění, tržní funkce a jejich hlavní vlastnosti při ekonomické analýze. Přírodní zdroje jsou v této práci rozděleny na dvě části, obnovitelné a neobnovitelné. Tyto dvě skupiny přírodních zdrojů jsou následně definovány a jejich současný stav v kontextu přírodního bohatství České republiky je popsáno.

Analytická část této práce se zabývá obchodováním s přírodními zdroji, jejich obchodní bilance je zhodnocena a vysvětlena. Stejně tak i domácí materiálová spotřeba, na kterou navazuje materiálová produktivita, je znázorněna v grafickém pojetí a jejich výsledky jsou detailně popsány. Vliv přírodních zdrojů a jejich podíl na konečné celkové spotřebě energie v České republice je taktéž graficky zpracován. V této souvislosti se také práce zabývá závislostí České republiky na dodávkách energie ze zahraničí. Tato analytická část je pak zakončena SWOT analýzou, která zhodnocuje využití přírodních zdrojů energie v České republice.

Klíčová slova: Česká republika, Evropská unie, ekonomická analýza, obnovitelné zdroje energie, neobnovitelné zdroje energie, životní prostředí, hrubý domácí produkt

Summary

The goal of this Thesis is to provide readers with main characteristics of natural energy resources of the Czech Republic and their economic role in the market. The influence and main economic features are to be analysed and described in details.

The Thesis consists of two parts. The theoretical part includes information about natural resources in the economic context. Their appraisal, function while trading with them and the main characteristics when evaluating from economic point of view. Also main energetic natural resources are split into two categories, such as renewable and non-renewable natural resources. These are then described in order to put the current state of the country's natural wealth.

Second part of the Thesis provides readers with analysis of trading with natural resources, their domestic consumption and productivity. The contribution of renewable natural resources are also a significant issue of this Thesis and their input in the final energy consumption will be analysed. In this context, the dependency of the Czech Republic on energy supply from abroad will be described and finally, SWOT analysis will provide overall view on the situation of using natural energy resources within the Czech Republic.

Keywords: The Czech Republic, the European Union, Economic Analysis, Renewable Energy Resources, Non-renewable Energy Resources, Environment, GDP

Contents

1. Introduction.....	11
2. Thesis Objectives and Methodology.....	12
3. Theoretical Part.....	14
3.1. Natural resources as a general concept	14
3.2. Natural Resource Market	15
3.2.1. Natural Resource Appraisalment	17
3.2.2. International Trade with Natural Resources	18
3.2.3. Dependency of State's Economy on Natural Resources Export.....	19
3.3. Natural Resources in the Economic Analysis	20
3.4. Use of Natural Resources from Economic Aspect.....	21
3.4.1. Renewable Natural Resources	22
3.4.2. Non-renewable Natural Resources	23
3.5. Selected Renewable Natural Resources of the Czech Republic	25
3.5.1. Solar energy	25
3.5.2. Wind energy.....	27
3.5.3. Water - Hydropower	31
3.5.4. Geothermal energy.....	32
3.5.5. Bioenergy.....	34
3.6. Selected Non-renewable Natural Resources of the Czech Republic	37
3.6.1. Crude Oil.....	37
3.6.2. Coal.....	38

3.6.3.	Natural Gas	39
3.6.4.	Uranium	39
4.	Analytical Part	41
4.1.	Trade Balance of Natural Resources in the Czech Republic	41
4.2.	Material Flows Analysis for the Case of the Czech Republic	47
4.2.1.	Direct Material Input of the Czech Republic	48
4.2.2.	Consumption of Natural Resources	50
4.2.3.	Resource Productivity	55
4.3.	Contribution of Natural Resources Rents to GDP in the Czech Republic	57
4.4.	Share of Renewable Energy to Gross Final Energy Consumption	59
4.5.	Dependency of the Czech Republic to Energy Supply from Abroad	63
4.6.	Environmental Tax Revenues Impact on the Czech GDP	65
4.7.	SWOT analysis of natural resources economic activity in the Czech Republic ...	68
5.	Conclusion	73
6.	Resources	77

List of Figures

Figure 1: Import of Material to the Czech Republic

Figure 2: Export of Material from the Czech Republic

Figure 3: Material Flow Trade Balance of the Czech Republic

Figure 4: Physical Trade Balance

Figure 5: Domestic Material Input of the Czech Republic

Figure 6: Domestic Material Consumption of the Czech Republic

Figure 7: Domestic Material Consumption of the Czech Republic in 2013

Figure 8: Domestic Material Consumption of the European Union

Figure 9: Domestic Material Consumption within the European Union in 2013

Figure 10: Total Domestic Material Consumption of Each Member State of the EU, 2013

Figure 11: Resource Productivity of the Czech Republic and European Union

Figure 12: Total Natural Resource Rents in the Czech Republic

Figure 13: Renewable Energy in Gross Final Energy Consumption in the CR and the EU

Figure 14: Renewable Energy in Gross Final Energy Consumption of EU MS

Figure 15: Dependency of the Czech Republic on Energy Supply from Abroad

Figure 16: Environmental Tax Revenues Impact on the Czech Gross Domestic Product

1. Introduction

Along with increasing population, there is also greater demand for economic production where natural resources play a key role. Such a phenomena of increasing demand for natural resources has been increasing significantly since the industrial revolution and the demand is exponential. That is a reason of a major interest of many national politics and even international organisations. Hence, that forces governments to place resource efficiency on the top of their national programmes. Natural resources are even defined as one of four production factors in macroeconomic theories and so their evaluation, management and deep understanding of such an economic element is very important and should not be underestimated.

At present, it is very important to balance efficient utilization of natural resources in order to support national economy and to consider environmental aspect of this activity. It is very important for any country to sustain as sufficient as it is possible, though clear and proper natural resource management is necessary and choice between renewable and non-renewable resource usage is a critical point in any decision-making process.

As a member of the European Union, the Czech Republic has commitments regarding environment and energetic issues. Under the so called "20-20-20" targets of European climate and energy package, the Czech Republic has to fulfil following certain criteria up to the year 2020. Such a criteria include energetic efficiency conducted with support of renewable energy resources. How the country fulfils its obligations at present and what are the predictions for the future is the reason of writing this thesis, hence.

This thesis evaluates the Czech Republic critical energetic natural resources, their usage and trading with them, along with assessment of their contribution into the Czech economy. Manipulating, extracting and trading with natural resources is very sensitive and it is usually connected with environmental problems. Energetic natural resources are, in order to follow analytical part, defined as renewable and non-renewable, and their features are described in detail. In the practical part, subservient analysis are calculated in order to examine the Czech Republic's overall efficiency in operating with natural resources.

2. Thesis Objectives and Methodology

Objectives

Objectives of this Thesis are to state the position of natural resources providing energy in the context of national economy of the Czech Republic. Theoretical basis will provide readers with allocation of natural resources within an economy in the context of macroeconomic theory, whereas in the second part selected natural resources located in the Czech Republic will be defined. As this thesis is focused on natural energy resources, the aim of the thesis is to analyse trade balance regarding given commodities and analyse its economic activity. In order to follow European Directives and Regulations, where Czech Republic has to fulfil its commitments, the contribution of renewable energy resources in final energy consumption will be analysed. Regarding the economic activity, the contribution and impact of environmental taxes on the Czech Gross Domestic Product will be analysed and the overall evaluation of the situation with natural resources in the Czech economy and its assessment will be summarized in SWOT analysis. Such an analysis will contribute to the overall explanation of natural resources economic situation within the Czech Republic.

Particular steps to fulfil Thesis objectives:

- Find out how the Czech Republic trades with natural resources and assess the level of dependency to energy supply of the Czech Republic
- Analyse the consumption and productivity regarding natural resources in the Czech Republic and compare the situation of the country with the rest of the European Union
- Verify contribution of renewable natural resources in the Czech economic activity, analyse their share in final energy consumption and how taxes from environmental activities contribute to the state's budget.

Methodology

The analytical part of the Thesis is composed from the qualitative analysis providing evaluation of Trade Balance of natural resources in the Czech Republic and its dependency on supply from abroad. The data evaluated has been taken from the online data providers and consequently processed in statistical functions of MS Excel.

Those are followed by consumption of natural resources and resource productivity. These are again processed by computing data taken from online data servers, which are finally processed by MS Excel functions in order to produce graph displaying clearly results described. Results of these analysis are compared with the situation in the European Union, since the Czech Republic is a part of it. The same process was followed when analysing the important contribution of renewable natural energy resources in final energy consumption is also analysed and result interpreted. The forecasts and prediction of trends are based on linear regression method.

Statistical program Gretl which provides all econometric computations was used in order to assess the impact of environmental tax revenues on the Czech Gross Domestic Product. For such an analysis, function of Simple Regression method was used and results are explained in details. P-value indicator is also interpreted from the reason of determine statistical significance of an outcome and coefficient of determination, assigned as R^2 , will consequently provide readers with quality of the interpretation of given model. Coefficient of determination is calculated form the fraction of SSR/SST , where SSR stands for sum of squares due to regression and SST stands for total sum of squares. (Sweeney, J. and collective, 2009)

Finally, the qualitative SWOT analysis is implemented in order to evaluate situation of using natural resources and their economic role within the Czech Republic. SWOT analysis, when precisely done, displays internal features of problem – its Strengths and Weaknesses. The second part examines external factors influencing given topic, in other words its Opportunities and possible Threats. SWOT analysis a practical tool which should be implemented in every strategic planning process. (Pahl, N., 2007)

3. Theoretical Part

In the theoretical part, natural resources in the economic context will be described. Its position within the national economies and trading with them will be explained, as well. In the second part of theoretical section, the main natural resources regarding energetic purposes and that are located in the Czech Republic will be described.

3.1. Natural resources as a general concept

It is very difficult to precisely define natural resources. There is a huge difference in how the natural resources can be reached and what intermediate or final product is then used. Hence, the border between what is natural resource and what is other good will be always very tiny. For the purpose of this diploma thesis and in terms of economic sphere, the natural resource will be defined as a material existing in natural environment. There is a certain scarcity of this resource and the one has to be economically useful and beneficial in production or consumption in any stage of its processing.

Natural resources in economic manner can be though classified as natural capital assets that are not created by human activity. In certain cases in certain countries, those natural assets play a main role in the country's production function, which looks like following one: $Y = f(K, L, \text{ and } N)$. Y is country's output, K stands for capital, L for labour and N is natural resource. There has to be taken under the consideration that there is a huge difference between natural resource takes as a production factor and natural resource as an internationally traded good. The natural resource can be traded in its raw stadium or can be processed and used in other sectors and after then finally enters the trade indirectly.

In a general concept, natural resources have certain similarities such as exhaustibility, uneven trading distribution, there can occur negative externalities, natural resources are also a main country's commodity and are of a price volatility. (WTO - World Trade Report, 2010)

According to OECD, the natural resource is a natural asset used in production or consumption of a given country and can be classified into 4 categories – mineral and energy resources, soil resources, water resources and biological resources. The secondary subdivision of natural resources is then according to its depletion. Based on this concept

we call natural resources either renewable or non-renewable natural resources and with by division, this thesis will be dealing with in the following text. (OECD – Natural Resources, 2005)

In order to manage trading with natural resources, their allocation and cover the concept of sustainability and responsible attitude in the sense of future possible depletion or negative environmental impacts, natural resource economics field of study is necessary to be aware of. For well manipulation with natural resources, the supply, demand and allocation on the Earth, should be primary objective of the responsibilities. (Hackett, S., 2011)

By irresponsible manipulation with natural resources, the environmental pollution is caused. This is a very important topic for many non-governmental movements or even governmental bodies. The economic definition of pollution is based on physical effect on the environment and reaction of society to that effect. These effect are defined within three categories. Those are biological (species changes), chemical (acid rain) or auditory (noise). (Pearce, D., Turner K., 1990)

3.2. Natural Resource Market

As natural resources are one of the main production factors in macroeconomic scheme, trading with them though is significant countries' economic objective. Natural resource has a homogenous character and it is possible to categorize it into the group of products in economic terms. To set the price of natural resource commodity is, however, not so easy. There are many factors influencing such a product, one example could be uneven distribution of natural resources within one country or even region.

According to World Trade Organisation, the natural resource can be classified as a commodity, although its definition usually refers to agricultural product. Commodity however in this sense refers to fuels, metals or minerals. The strong position of natural resources is in easy price setting, because the quality of the product can be easily proven and also usually there are centralized market places where it is traded with natural resources. Such a condition then reduces transaction costs, for example. (Thompson, S. and Kunda, E., 2000)

In the market with natural resources, there are several main players – local distributor, producers of a certain natural resource, trading companies and of course the customer. In the past, it was very difficult to sell commodity (considering natural resource) at one place, on time. The first known central market for commodities was the Chicago Board of Trade, established in 1891. By such a provision, all participated trading bodies were profitable, because of lower transactions cost, no sunk costs in terms of unsold materials and higher liquidity. There was simply a ready commodity market. (Chicago Tribune - Chicago Board of Trade, 2015)

After the Chicago Board of Trade, there were many other exchanging market places relating commodities established among the whole world. In every part of the world there can be also exchanging markets focused on a certain group of material, eg. Metals or minerals. The Chicago board of Trade was a great example how trading with agricultural product and natural resources can operate efficiently.

Centralized exchange markets of commodity also profits from healthier and relatively fast determining of the price, which is dependent on supplier and demander behaviour. Though those organisations enable higher competition and more profitable prices of natural resources, in this case.

The demander of a natural resource can also choose between so called spot purchase and future agreement. By a spot trade it is meant current purchase of a certain amount of a commodity, immediately. By agreement upon a future trade, the demander and supplier agrees on future supply of the natural resource, hence they set the price at the moment of agreement, hence the demander and supplier are aware of price risk. They have certainty of long contract for set price, which means higher security in their trading activity.

There exists also long-term contracts where two parties are setting a contract for several years. Both parties are then secure in its obligations. The seller, though, faces the price risk and the buyer faces the volume risk. Such contracts are typical for not very competitive products such as trading with oil or natural gas. For those commodities are also build special transportation means (pipelines) and so bilateral long term contracts are beneficial. (World Trade Organisation – World Trade Report 2010)

3.2.1. Natural Resource Appraisalment

In order to evaluate natural resource in an economic sense, natural resource has to be considered the same way as every other subject of economic functioning. If the natural resource then, satisfies customer's needs, it can be evaluated in a three ways, then.

- The first way of appraisalment is setting the price based on comparison of other, similar commodity. Such a method is call as comparative one.
- The second way of appraisalment of the natural resource is according to costs, which appeared during its acquisition. Such a method is then called cost method.
- The last option how to estimate price of the natural resource is by its utility. In this case the method is called yield method of evaluating the price. This method is, however, the most widely used and is based on summarizing of future rents from the whole time of using the natural resource. Such a time is either limited (regarding non-renewable natural resources) or is considered as infinite time horizon (including renewable natural resources – wind or solar power)

The most general formula for estimating natural resource price includes then the sum of discounted future market rents of natural resource for period of time of its usage. The formula is the represented as following, according Seják, J. 2005:

$$C = \sum_t \frac{r_t}{(1+i)^t} = \frac{r}{i}$$

C = natural resource price

R_t = awaited variable of annual rent effect in a year "t"

I_t = awaited variable of discount rate in a year "t"

In this formula, it is based on a fact that rent effects and discount rates are considered as variable in a time period that is why there is coefficient "t" included.

From the reason of the fact that annual rent effect is a function of many variables such as prices of yield, prices of products, taxes, interest rates and similar, and that the discount rate is as well function of many variables (inflation rate, risk, and so on.), it is not unusual, that the basic formula is shortened into the simpler version of $C = r / i$. In order to modify this formula into such an appearance, there has to be certain predictions fulfilled. In this case, the uniformity of rent effect and discount rate even in a period of time is supposed. In case of renewable natural resources, even the infinity time horizon has to be unified and concerned. Under these conditions, the simpler and widely used version of the natural resource appraisalment formula can be applied. (Sejak, J. and collective, 1999)

3.2.2. International Trade with Natural Resources

Trading with natural resources incredibly greater its importance within the last century. Thanks to the industrial revolution, distances are shorter thanks to everyday new technologies and so the global market can expand. Also population growth has increased its volume and so the demand increased rapidly.

The natural resources has been evaluated since the very beginning of a primitive market existence, however in the systematic economic sense, the real evaluating of natural resources is dated two hundred to three hundred years back to the past. The biggest influence on such an economic breakthrough has the industrial revolution and the reason of depletion of traditional natural resources, at that time. (Sejak, 2001)

As the population grew, governments started to intervene into the markets with natural resources according to the state's needs and wants. These interventions are usually bilateral contracts between two countries of interest. Other governmental interventions are for example supply restriction on a given commodity, governmental setting of a commodity price or to create a strategic position in a competition in opposite to other state rich in a certain resource. These interventions were often used during the World War, where the supply chain of many raw material was critical strategic advantage at that time. Also a Great Depression in 1930's was a rationale reason why the state should take the responsibility for the distributors and overall state supply. Interventions in each period were different as the needs of the inhabitants occurred. (World Trade Organisation – World Trade Report 2010)

In terms of international trade with natural resources, it is also important to mention an issue called foreign direct investment. Such an investment is very strategic in terms of natural resources due to their specific location. Foreign direct investment, hence, recorded increase in the 19th century and the beginning of the 20th century. The localities were mainly industrialised and developed countries investing in to less developed nations or areas. Trading with natural resources, including also their extraction and later operations, are held by great multinational companies, usually. From the reasons of higher prices of commodities, strong dependencies on natural resources supply and uncertainty in their distribution, the investment trend into natural resources increases, in the last years. (Henn, 2014)

3.2.3. Dependency of State's Economy on Natural Resources Export

There is a very important question, which is asked by many economists. The question is, how the state is dependent on export of natural resources? It is true, that when the country is rich in a commodity of a high price, then it brings its wealth. The problem occurs, when the country is focused only on this commodity export, and other industries fall behind.

One of the problem in trading with natural resource is the instability of commodity prices in such a competitive market. The prices tend to lower rather than incomes higher. And that is the problem with other countries development. For example, if the country trades with already manufactured good, not primary natural resource, the development in such market can have effect of higher incomes then. And as income grows, there is higher demand for manufactured goods, than for primary natural resources. At that moment, natural resources are exported form less developed country into a certain industrialized rich country, where it is processed and the final products are then sold in a market producing more wealth. Between these two countries (developing and industrialized – developed), it is significant to underpin the differences in labour power. In developing countries, the labour is less skilled, focused in one area. Where in developed country, the labour force is much specialized and skilled, able to create country's wealth. In terms of export, for developing country is such a country heavily dependent on developed country into which the commodity flows. (Barbier, E. B., Natural Resources and Economic Development, 2005)

3.3. Natural Resources in the Economic Analysis

Natural Resources are one of the main indicators of many world's economics and so the economic analysis is one of the major analysis of such a commodity to be considered when evaluating it. Natural Resources as a commodity has been already defined in the previous chapters, however, in this chapter it will be described, how such a commodity is analysed from the economic aspect.

In the sense of economic analysis, by commodity it is considered such an object with the ability to offer any service. By the service, the customer need is then satisfied. According to the customer preference, needs are satisfied in an adequate value. Natural resources are then provided as a consumer good or as production factor. Once the available supply of natural resource starts to be limited, it becomes to be an economic good. With an economic subject, it is possible to rationally and effectively manage it, which is also the main sense of every economic theory or economic practise. Along with the development of society, the natural resources started to become more and more limited, sometimes even scarce, and so most of the natural resources have become to be a subject of economy and were considered as economic good. (Dvořák A. and Collective, 2007)

The limitation of natural resources can be caused by following factors:

- By high intensity of available natural resource stocks utilization, when satisfying one concrete type of a need.
- By utilization of a natural resource good when satisfying alternative or mutually exclusive needs
- By combination of previous two factors

From the scarce availability of natural resources, naturally the competition during the usage of such a good appears. This competition can occur between various subjects, for example there can be competition between individual consumers, households or between companies or even governments.

Natural goods are then also defined as private or public. When distinguishing between these two features, concern of supply and demand has to be evaluated.

Regarding aspect of demand the goods are distinguished according to its ability whether:

- The good considered as the one to be consumed can be excluded from consuming. In other words this situation is defined as consumption exclusion.
- There are subject using the same goods are competing. In such a case the situation is defined as rival and non-rival consumption.

Good where the final user are excluded from consumption and are at the same time rival consumption to each other are then called private goods. On the other hand, goods where its users are not excluded from consumption and are not rivals at the same time in terms of consumption, are called public goods. If one of the criteria described above are not fulfilled, then the good is defined as mixed goods. . (Dvořák A. and Collective, 2007)

Regarding supply of natural resources as good, it is very important to evaluate the way of good's provision. The example can be presented on private good which is provided on a market. However, based on governmental decision, those can be provided from public resources. The main factors influencing the described situation are governmental decisions, ethical aspect or the amount of costs invested into exclusion of certain subjects from final consumption of a good.

Natural goods in the form of natural resources are then, from the economic point of view, understood as these goods that are really or potentially used in the production sphere or that are used immediately in the final consumption sphere. (Dvořák A. and Collective, 2007)

3.4. Use of Natural Resources from Economic Aspect

In this chapter, the problem of natural resources as subject in economic environment will be described. In order to allocate natural resource in such a meaning, basic division to renewable and non-renewable natural resources has to be implemented. Along with this

decision, economic theory can approach in solution of optimal usage of natural resources. The basic normative problem of natural resource allocation is the amount of those to be mined or harvested or used. In other words, it has to be defined, what determines the natural resources usage rate.

3.4.1. Renewable Natural Resources

Renewable Natural Resource has the ability to renew themselves when operating with them correctly and in sustainable manner. There is a big difference in how it should be operating with natural resources and how they are operate. The practise shows a lot of examples when the renewable natural resources become non-renewable or are even depleted only because of a bad management or their inappropriate use.

Economic theory is able to describe only such a situation where usage of renewable natural resources is such a source for which reproductive ability is dependent only on the size of its reserve.

Basic idea of economic thinking even in case of natural resources is to maximize profit. In order to do so in the case of renewable natural resources, there has to be difference between incomes and expenses maximized as well. When there is a profit, it bring to such a branch new subjects – owners, producers, etc. In case, the renewable resources is owned by only one owner, the entrance of other players is not possible and the profit reaches the optimal level, by other words maximal the difference between income and expense. If there exists ownership of more subjects, or the accessibility of the resources is not limited, the optimal level of profit is in the point, where competitive forces interacts, in other words where equilibrium exists. That is the point, where the difference between income and expenses is zero and so the profit is zero, as well. However, this is the situation of usual profit level in a given economy. When this situation occurs, it does not has to significate that the resource will be depleted, although, the resources stock or level of harvest will be lower than in case of ownership of only one owner. The principal based on situation of more owners, however, brings a risk of depletion, but significant role here plays the level of incomes and revenues. The natural resource is depleted only when the harvest permanently exceeds natural reproduction level or when expenses related to harvest are permanently at their minimal level. Along with this theorem, there is a possibility to apply

relevant economic means in order to protect natural resource stocks. Such tools then support increase of expenses related to natural resource gain and so it lowers the level of harvest and increase of natural resource stock. (Dvořák A. and Collective, 2007)

3.4.2. Non-renewable Natural Resources

Non-renewable resources are characterized by their disability of reproduction. Natural resources of mineral origin are all examples of these. This problem is closely connected to sustainable development topic, which solves the problem of how many of non-renewable resources should be used nowadays and how many of them should be used in the future. For non-renewable natural resources, there has been many theorems described in the situation of perfect competition and in the situation when not perfect competition occurs.

When there is any non-renewable resources discovered, certain questions arises. For example, how to spread its mining during the time, is it optimal to leave a mining area before its absolute extraction or if the absolute extraction is optimal at some time.

The first decision before any company starts to mine non-renewable natural resource is three-phase decision process. The first problem to solve is searching for a good locality with abundancy of natural resources, the second strategic point is preparation of mining and the last point to consider is mining itself. These three steps in such a business plan considers then, of course, much more elements to take into consideration. There also can appear two contradictory scenarios when a company starts to mine. The first scenario could be the depletion of non-renewable natural resources or reduce its stocks when mining in a certain locality. The second contradictory scenario can, surprisingly, lead to increase of intensity in exploratory activity connected with preparation of mining which leads to increase in level of future stocks of natural resources. However, as it is the same as for renewable natural resources, even non-renewable natural resources are often controlled and its mining influenced by governmental interventions. Those should help the economy to achieve its goals, the need of ensuring self-sufficiency of a state or available supply of natural resources and critical materials in order to constantly support internal economy's needs. Also environmental threats can be controlled by governmental interventions and necessity of protection of natural resources. (Dvořák A. and Collective, 2007)

From economic aspect, natural resources are capital assets. When those are in a ground, the owner can expect gains, because its price during a time period arises. For an owner, it is indifferent, whether he leaves the natural resource in a ground or whether he will mine it, when the capital gains is equal to interest rate of alternative assets. The reason is the then it is possible to invest the gain wherever in the economy. This theorem works only considering positive interest rate. Also discount rate is a significant factor, influencing the decision whether to mine or not. It is because non-renewable natural resources are not able to reproduce themselves, the increase of capital value is equal to discount rate. The situation considering perfect competition and when the relative increase of natural resource price is equal to discount rate is called as Hotelling's rule. However, this rule works only theoretically and in the case when the mining costs are equal to zero.

When there are any costs noted, theoretical basis differs a lot. Such a situation is explained on the example of the same raw material extracted from two different localities, where average unit costs differs. One locality is characterized by lower costs. When this resources is depleted, the other locality starts to produce a given material, however with higher costs. This is a case of so called backstop technology. For backstop technology, it is characteristic that resource of a given material is not limited. Consequently, competitive market price of the second resource is equal to constant production costs. At the time of depletion of the first resources, the backstop technology plays role, which affects strategy for mining and managing locality of the resource. The price, at which demand is equal to zero, is called backstop price. That is the price of a substitute (non-renewable resource). Backstop technology then represents economic development enabling control of new claims for non-renewable natural resources. (Dvořák A. and Collective, 2007)

Finally, the economic activity of mining is based on result of comparing of expected discounted price and discounted marginal costs of mining. Mining costs includes impact of actual mining and actual costs, but as well it includes impact of actual mining on future mining costs and gains. The total amount of resources, for which it is profitable to mine is dependent on expected future prices of a given source and on impact of actual mining and future mining costs.

3.5. Selected Renewable Natural Resources of the Czech Republic

Renewable natural resources are being a main point in a various global discussions about environment and similarly focused talks. Renewable natural resources are those, which can be used again and again and its benefits will not exhaust. Great examples of renewable natural resources are solar, wind, tidal, water, geothermal, and others. The features and usage of those examples that are also represented and used in the Czech Republic will be more precisely described in following chapters. (The Czech Ministry of Environment – Types of renewable natural resources, 2014)

3.5.1. Solar energy

According to data from the Czech Ministry of Environment, current consumption of primary energetic resources is 100% less than what is available from the renewable resources in the Czech Republic. The solar radiation could be directly transformed into the electricity by photovoltaic instalments, and either it could be directly transformed into the heat, of which is technically easier to achieve. In the Czech Republic it is popular of usage of the solar energy when realization of passive houses, which are current trend in architectural sector.

Photovoltaic instalments are on the Czech market available and are also actively used for about 50 years, currently. Production costs of photovoltaic panel decreases and costs for kWh generated from this mechanism notify constant decrease. On the other hand, the price for kWh from the net has increasing trend. According to the Czech Ministry of Environment, in 2030, both mentioned prices will be equalled. The payback period of investments into such mechanism is about two years; however the lifetime is 20 years, minimally.

From the reasons of consumers demand satisfaction regarding exploration of green energy, there are also plants from photovoltaic panels built in the Czech Republic. However, these plants face critiques. Photovoltaic plants are built on grasslands and take a lot from possible fields used for agricultural purposes. Opinion of the European Union is that there is a surplus of agriculture land and welcomes and supports such projects. The photovoltaic panels can be easily removed and do not damage the ground on which it is constructed, so it is considered by the EU that it can even protect the land and safe it for future purposes.

There are many innovations in photovoltaic systems, there could be individual units forced by energy from such equipment. Examples are ships, yachts, household electric devices, public lightening, parking automats and many others. (The Czech Ministry of Environment, 2014)

The solar energy systems collectors implemented in buildings are possible to integrate on the majority of newly constructed buildings. There could be obstacles only in position of the building (shadows, compass orientation...) or when the building is placed in the heritage areas, where in this case the issue should be properly considered. Those systems with liquid collectors are mainly used for purposes of water heating and hot water heating of the rooms in such building.

The energy gained from the solar systems is possible to accumulate, however the longer the period of accumulation, the higher the expenses are and this system starts to be less economical. From those reasons the most popular is the lower period accumulation. The other type of the system of solar energy utilization is by hot solar system, where the hot air can be shifted directly to the rooms. The advantage is higher efficiency from the reasons of getting the energy from the lower temperatures. However, disadvantage of this system is the need of more of the equipment when processing the energy and noise of ventilators. Also to accumulate the energy reached by this system is more complicated. (The Czech Ministry of Environment, 2014)

3.5.1.1. Natural conditions of the Czech Republic regarding solar radiation

The average amount of energy hit to the surface of the Czech Republic is 1100 kWh/m². It is possible to gain 300 – 800 kWh/m² of energy thanks to the liquid collectors of solar energy. However the climate of the Czech Republic affects the gains significantly. During the winter season in the country, there is a lack of solar radiation and in order to meet consumers' needs, larger area for collecting of solar energy is needed, despite of utilization of very effective collectors. On the other hand, during the summer season the amount of solar radiation hitting the Czech surface is significantly higher and so less effective collectors can be used for producing the energy. Even the surpluses are noticed during this season, they are not used. Under the Czech environmental conditions there is 380 – 420

kWh/m² average annual production of energy. (The Czech Ministry of Environment, 2014)

3.5.1.2. *Operating costs analysis*

The costs of production of energy by photovoltaic mechanism depend on the way of operating with it. In terms of bigger projects, there are huge investments also into the service and maintenance system during the whole lifetime period also insurance has to be considered. On the other hand, these costs are not so significant considering households. Purchasing price is set by the Energetic Regulation Office (www.eru.cz) for each year. And there is a guaranty of keeping the price same for the period of 20 years from the commissioning. If the energy from this resource is consumed in the household, that household can get so called green bonuses.

The real price of the heat got from solar systems is computed by comparing total heat amount from solar system gained in 20 years of its lifetime and purchasing costs considering also maintenance costs during those 20 years.

As positive externalities, we can propose not damaging of environment and so bettering health conditions of inhabitants; which is financed by the whole population, as a matter of a fact.

3.5.2. Wind energy

Wind as an energy provider is from all natural resources energy one of the oldest used. Wind can be easily transformed into energy; nowadays for this purpose are used wind power plants. There is a goal in the Czech Republic to cover 13% of total energy consumption by deriving energy from renewable resources in 2020. The target for the total energy consumption of the European Union is 20% of renewable resources usage. Under the climatic conditions of the Czech Republic, the wind is one of the most used energy resource and will significantly contribute to fulfilment of this target. (The European Commission, 2012)

3.5.2.1. *Wind power plants*

According to the Czech policy of environmental protection created by the Ministry of Environment, there is supposed to be produced 2.6 mil MWh of electricity from wind in

2020. This amount would be ten times higher than the total amount produced in 2008. However, when it is compared to total production of electricity, it is still only 3%. Although the wind power plant will probably never be the main mean of producing electricity, its importance still increases and becomes very important in order to lower amount of CO₂ and higher energy self-sufficiency.

The popularity of wind power plants in the Czech Republic still increases, the trend is to support every way of producing electricity by environmental friendly means. The usage of wind power plant exists since 1990s. In 2005, there was a law supporting energy production from renewable resources accepted, which guarantees the return of investment within 15 years. Thanks to this law, the popularity of wind power plant significantly increased and so the production of electricity from the renewable energy resources as well.

There also exist subsidy programmes also from the European Union; however most of the wind power plants were built without this support. The purchase price enables adequate return even without these support programmes. (The Czech Ministry of Environment, Wind Plants, 2014)

Most of the places where there are best conditions for producing energy from wind are in sensitive localities mostly belonging to protected areas, in terms of the Czech Republic. Then building of wind power plants is very complicated and sometimes not allowed in order to keep protected areas distorted. Another obstacle while building such a plant can occur when the locality is area of air traffic or even in the area of bird's migration canals. Also construction of electric power lines can be a complication for building wind power plant farm.

According to European Commission Directive, if the wind power plant has performance above 500kW (most of them, older ones with these performance are replaced by modern plants) and is higher than 35 metres, it is obligatory to undergo so called "screening procedure" based on Environmental Impact Assessment Directive. This procedure assesses the impacts on environment within the locality. (European Commission, Environment, legal context, 2014)

Significant advantages of wind power plant are limiting of CO₂ and other emissions and aside waste from the energy production. In terms of the Czech Republic, it is also major impact on lowered consumption of fossil fuels. One wind power plant with performance of 1MW can save within one year approximately 2,200 tonnes of CO₂ and production electricity for about 1 thousand of households.

There is no direct income from wind power plants to municipalities, if the municipality is not owner). Operators of plants can offer to municipalities some subsidies; however there are also indirect gains from wind plants as an attractive area for tourists or excursion for study purposes. In Bruck an der Leitha (Austria), there is an observation room available for tourists in one of the wind power plant in height of 60 metres, according to data from Austria largest electricity provider Verbund, 2014.

3.5.2.2. Natural conditions of the Czech Republic regarding wind

The Czech Republic is inland country surrounded by mountains so the usage of wind for energy purposes cannot be high. Fortunately, modern technology, popularity of usage of renewable energy resources and fast scientific development deal with problem of inland countries and modern wind power plants can be still very effective even in the country with worse natural conditions.

The most important parameter for electricity production is the wind speed. The wind speed cubed is equal to the wind energy. Wind power plant is able to be fully powered when the wind speed is about 10 to 15 m/s. When the wind speed is higher, the power plant has to be stopped. When the wind speed is lower (most cases in the Czech Republic) than the power plant is set on a lower mode. There also exist backup sources for the cases when the wind power plant does not work from reasons of low wind speed. The Czech Republic has enough capacity of those.

The wind speed is very dependent on the land surface. From these reasons the wind power plants are built usually in localities with higher altitude and there is a limited amount of those localities within the country. A big difference is also in the height of the power plant

itself, so the power plants are designed to be higher and higher. The usual height ranges between 80m and 100 m and the output of 2 – 3 MW. The best production can be achieved generally in the places where the annual average wind speed is 6 m/s in 100 metres above land surface. These conditions are usually achievable in higher altitude, more than 500 above sea level.

Most of the energy produced by wind is sold for commercial production. In order to lower the costs and make the production more effective, there is usually more wind plants built together and those are called wind power farms then. (The Czech Ministry of Environment, Wind plants, 2014)

3.5.2.3. Wind power plant in context of environment

Generally speaking, the negatives mostly mentioned in the new or broad casting are eliminated in terms of modern wind power plants. There are mostly mentioned complains about noise, disturbance of wild animals, stroboscopic effect or just disruption of landscape.

Regarding noise, the modern plants are not as noisy as old prototypes were. The wind plants are also constructed in sufficient distance from populated areas. Also under EIA Directive, the noise has to be evaluated and if any disturbing issue will be analysed, then the building of a plant will not be allowed. This includes both noise, as audible sound so infrasound. Problems with noise could appear in smaller and older prototype of wind plants.

Stroboscopic effect is essentially eliminated by constructions in sufficient distance from populated areas. The problem regarding also reflecting of sunbeams was also solved by matt coating on blades of wind plants.

Disturbance of wild animals cannot be considered as a big problem. Wild animals, cows or sheep are usually seen in the close areas of a wind plant. According to the Czech Ministry of Environment, there has been increase of birds recorded, in close areas of such a plants. The reason could be the noise of a rotor, which should disturb birds of prey.

Disruption of a landscape is, however, a big issue. There are supporters and there are also people with strong disagreement of seeing such a plant in the nature. However, it is

important to mention that on one wind power plant, there can be a lot of other signal broadcasting facilities installed and so it could finally reduce the amount of other masts in the locality. And also thanks to the height of the wind plant it would cover greater area of broadcasting. (The Czech Ministry of Environment, Wind Power Plants, 2014)

3.5.3. Water - Hydropower

Hydropower is one of the oldest resources used. Thanks to its access and easy conditions from producing energy, it has a long tradition even in the Czech Republic. The power is gained from the water fall or from running water.

3.5.3.1. Hydropower potential in the Czech Republic

The Czech Republic uses energy from water resources for a very long time, already. However, during the communist era, a lot of private water mills or other hydroelectric power stations were liquidated in order not to compete with centralized socialistic economy.

According to data from the Czech Ministry of Environment, 2.8% of total amount of electricity production was created from hydropower plants, which is exactly 2.4 mil MWh.

Nowadays, there are thousands of possible localities in the Czech Republic available for construction of small hydroelectric power stations, instead of construction of the big ones. The obstacle is, however, the investment costs. On the other hand, the advantage of hydropower plants in the country is in a density of them, so the transportation costs are not high and possible black-out of one station is then insignificant. Old and renovated or modernised hydroelectric power stations could be also possible attraction for tourists or students and it created the attractiveness and indirect income for the locality, as well. (The Czech Ministry of Environment, 2014)

3.5.3.2. Economy of operating small hydropower plants

Electricity produced form small hydropower plants can be supplied in to the grid. The purchasing price is set by Energetic Regulation Office (www.eru.cz) every year. It is guaranteed, similarly to photovoltaic devices, that the price will keep the same for 30 years

as it was in the year of commissioning. It is also more financially effective to split the supply of electricity. There is a higher price of electricity during the peak time of consumption, so the owner and supplier of the energy should increase the output of hydropower plant, if possible. On the other time during the day, on the other hand, lower the output. And if the small hydropower plant is a part of industry area, then it is usually more effective to consume the electricity immediately on spot and make a claim on green bonuses. Local electricity distributor pays out green bonuses, as well as the purchasing prices and. The supplier can also apply green bonuses on electricity supplied to one of his property, however is charged for distributing of the electricity via the grid. There is also a possibility so sell the energy to other, third party. (The Czech Ministry of Environment, 2014)

3.5.4. Geothermal energy

Geothermal energy deposits are place in the earth and are used as a heat. It could be discovered in rocks, vapour or water. It could be used directly as a heating matter or to generate electric power. Although extraction of the geothermal heat requires a lot of space and a certain amount of input, it guarantees reliability and, as a renewable resource, unlimited usage. (Eurostat, Geothermal Energy, 2014)

According to the Czech Ministry of Environment, the principal of using geothermal energy is to generate the heat from inside of the Earth which permeates on the surface. The most known are geothermal springs on Island, for example. There exist four groups of energy based on their usage.

- Energy from hydrothermal source of a high temperature, more than 130 °C, for purpose of electric energy production.
- Heat rocks energy of a high temperature, more than 130 °C, also for purpose of electric energy production.
- Energy form hydrothermal sources of a higher temperature, more than 130 °C, for purposes of heat production.

- Geothermal energy for purposes of low temperature systems (heat pumps)

The amount of heat that passes through unit area on the earth's surface is called average heat flux. The amount of such a flux regarding earth's surface is $60 \pm 10 \text{ mW/m}^2$. In terms of the Czech Republic, the amount of a flux can reach even up to 90 mW/m^2 on a certain localities, for example Ostravsko or in Krušné hory.

3.5.4.1. Geothermal power plants

There are plenty of geothermal power plants in the whole world; mostly they are built in the nearest area around volcanos, where the steam is used in order to drive turbines of a power plant. The power plants can be, however, built also in other places, but then drilling depth is almost 5km, where the temperature is around 150 to 180 °C. It is more difficult to find a place for using hydrothermal sources, because the locality has to fulfil specific geologic constraints. If there is no water in the drilled area, then the water has to be under pressure pushed to another drill. The method is called Hot-dry-rock or Fracture-dry-rock, in the Czech Republic planned to be used in Litoměřice, for example. The water in a drill is heated from the rock, created steam from this process drives turbines of the system and those then generate electricity. (Geothermal worldwide, Inc.)

The advantage of using such a technology is low operating costs, because the power plant does not need any additional fuel and energy from the drill should last for at least 30 years. The disadvantages are on the other hand high investment costs into the construction. Also before the construction, there has to be test drills in order to test future usage and those are very expensive and do not have to confirm the suitability for power plant construction.

3.5.4.2. Geothermal hot water sources

Groundwater is usually the common source of geothermal energy. This water is heated by the Earth's heat. The temperature then is higher than the annual average air temperature of the locality. Some of this type of water is categorized as spa water and is a subject to special controls; its use for energetic purposes is forbidden then.

3.5.4.3. The coefficient of performance of the heat pump

According to a fact, that in the Czech Republic, there is only heat of a low potential, the heat pump is usually needed. This pump can pump the heat from the level of the dig, the

higher temperature can be than used. However, in order to run the pump, the additional electricity is needed.

If the environment and operating economy is considered, there has to be calculated how much of additional electricity the heat pump needs to run and how much of heat it produces. The result is represented by Coefficient of Performance (COP). The higher the Coefficient of Performance is, the more productive the heat pump is and has lower environmental impact.

$$\text{COP} = Q/W$$

Q is a heat pump power (kW)

W is a power supplied to the heat pump compressor

(Grundfos.com, 2014)

3.5.5. Bioenergy

Bioenergy is one of the major players in usage of renewable resources. EU Regulation setting 20% of renewable energy contributed to total energy used in 2020 might be covered form 50 per cent right from biomass, according to experts. This fact also supports research and development field of bioenergy potential. Bioenergy is energy generated from raw biological materials and it is usually used for heating and electricity purposes, but also as a fuel. Generating energy from biological resources is one of the main issues in terms of energy supply in Europe and its ecological trends. Wood, as the oldest material used for extracting energy, is one of the main matters in this context. However, with developing modern technology, there are many other organic materials used in order to produce energy, for example in forestry or agriculture, it could be also agricultural products or organic components of waste and even manure. (RenewableEnergyWorld.com, Bioenergy, 2014)

Energy gained form biomass is very worthy because of the money that stay within the locality. If the region decides to use the energy from biomass, the money stays there because it is not worthy to transport fuel wood to destinations far away and so it is consumed locally and the money then stays within the region. It also brings many work places in such a locality. This way of thinking brings to region economic and energetic

independency. Thanks to many subsidies it is also very interesting to invest in such a project.

There are two types of biomass distinguished – solid and fluid. When the biomass contains too much of water, it is not used for burning processes. Fluid biomass, such as fume, sewage sludge and other agricultural waste are used then in biogas stations. (The Czech Ministry of Environment, Biogas Stations, 2014)

According to European Renewable Energy Council, for heating purposes there will be more than 60 per cent of bioenergy used in context of total energy consumption. It would also bring a lot of changes in the overall heating system regarding installations and development of new system mechanisms.

Very significant role of bioenergy potential is also in transportation. The usage of biofuels for transportation needs eliminates emissions. The advantage of biofuels is also in its production process. While processing biofuel, the side product is then used as a feed, which is rich in proteins. Not only from this reason have biofuels increasing strong position on a market. (European Renewable Energy Council, Bioenergy, 2012)

3.5.5.1. Biogas stations

For a long time, the biogas technology is used in wastewater treatment plants, where the heat gained is used for the treatment process. The energy is transformed into electricity which is used for the wastewater treatment plant itself or it is sold to a grid.

When burning biomass, the side product is only CO₂ of which amount has been absorbed by the plant and its life. Burning of the plant is even more positive impact on the environment, if we compare it with process of decaying. While the plant is left for decay, the side product methane is then more harmful than CO₂ and supports the greenhouse effect. From this reason, the energy from biomass does not contribute to global environmental changes.

Biogas arises from the decay of organic material in tanks without oxygen. The presence of the oxygen is the main difference in opposite to the process in nature and so the final products differ. Thanks to bacteria and other biological processes the gas arises then.

The most often used biomass in agriculture is manure followed by straw, grass or potato leaves. Green plants are more difficult to process, in general. Biogas potential is directly proportional to amount of dry matter content and composition and digest of food. (The Czech Ministry of Environment, Biogas Stations, 2014)

3.5.5.2. *Operating economy*

The original idea of using biogas stations was to eliminate amount of problematic waste such as manure or liquid municipal waste. Nowadays, thanks to convenient purchase price of electricity from biogas, it is economically worthy to build and manage biogas station.

During the running the biogas station, it is profitable to take into account and use the generated heat. If the heat is not processed as well, the economic and energetic effectivity is then lower. That is the crucial point in using biogas energy. There are difficulties to build heat line on places with biomass potential and on the other hand, where it is possible to build one, it is close to municipalities and inhabitants are usually against.

Nowadays, purchasing prices of electricity from biogas are so beneficial that considering side consuming of heat is not an object of interest. To build up a biogas station it is possible to use funds from Operational Programme Environment or Fund for Rural Development of European union. These programmes are an object of validation within the beginning of 2015. (eAgri - Subsidies, 2015)

3.5.5.3. *Weaknesses of biogas stations*

The most common problematic aspect of running the biogas station is the unpleasant smell, which can have many causes. If the biomass is decomposed for less time that it should be, it results in unkind smell. Every biomass has specific time of decomposing and the manager of biogas station has to be aware of it. Also the aspect of hygiene cannot be overlooked. It is very important to ensure safe and clean operating environment. From the very beginning of building the biogas station, it is important to take into account the smell and try to solve it when even planning stage. If inhabitants of a place where the biogas station is run, the Czech Inspection of Environment can, in the worst case, stop operating of the station. On the other hand, it is not very common in the Czech Republic, from the

reason of correctly planned and organised biogas stations. (The Czech Ministry of Environment, Biogas Stations, 2014)

3.6. Selected Non-renewable Natural Resources of the Czech Republic

3.6.1. Crude Oil

Oil is composed from natural substances transformed into a liquid substance during millions of year in the Earth surface. Oil is extracted from deep mines either on the seabed or Earth surface. There are basic modifications made on the mining spot and then the oil is transported for further processing into refineries.

At present, fossil fuels are globally main source of energy and oil creates the highest ratio together with coal. Oil is widely used even in chemistry industry and its products used in almost every day life.

Refineries in the Czech Republic purchases oil from mining companies at the place of mining and by pipelines the oil is then transported to the place of need. In the Czech Republic the main distributor is MERO Company, which also stores oil reserves. According to regulation from the European Union, the Czech Republic has to not only transport and directly use but also storage oil and oil product that could cover every day consumption for 90 days.

The Czech Republic is not very rich in oil deposits. If there are any, it is located in South Moravia near Hodonín region. The oil reserves that are in the Czech Republic are transported from the Russian federation. The beginning of oil mining in the Czech Republic is dated in the beginning of the 20th century and from that time there is more than 2000 exploratory wells noted in the Czech Republic. The trend of exploiting new mining areas and spots increased during the century with increasing tendency of need of oil in every-day life. The production of oil from Moravia, however, does not cover at all the whole oil demand in the Czech Republic.

3.6.2. Coal

Tradition of coal mining in the Czech Republic is dated already in the 18th century. It's mining, processing, and utilization is one of the most important industry within the country. Although, in the 90's of the 20th century the industry was declining, the nowadays importance significantly grows. The Czech Republic is rich in brown coal located in north-western Bohemia and black and hard coal located in northern Moravia.

Coal is one of the most important fossil fuels, sometimes called a black gold. The origin of this mineral fuel is in accumulated plants and small animals in a layer deep in the surface. (European Association for Coal and Lignite, 2015)

According to its composition, the origin and age, there are several basic categories stated. (Black coal, brown coal, Graphite, etc....)

The usage of coal was randomly detected in prehistorical times, however, the significant importance was noted in 18th century thanks to the industrial revolution, based on the steam engine invention. The coal at that time was the main source of energy and power and its importance grew more even during the electrification times.

The coal is in present major solid fuel and the most important source of electric power. In the Czech Republic, about one half of the total electricity produced is from the coal source. These numbers are similar for example in the United States of America, however there are countries, like Poland, where the total production of electricity is based from approximately 90% on coal. The world average is the about 40% of coal used in order to produce electric power, according to OKD – the major black coal producer in the Czech Republic.

The importance of usage of coal as energy resource is significant and the trend will increase. Coal reserves are bigger than oil reserves and at present, there are technologies processing coal in a more modern and ecologically friendlier way. Energetic industry and also new inventions of how to produce electric power from considering environmental impact is at present very big and popular business. The high prices of oil also make coal industry more widely held.

The popularity increases also side products like coke used in gas industry or mining industry and chemical industry. Another important side product is methane, nowadays used as very reliable fuel. Also mining water are basis for spa industry in Ostrava region. (OKD, 2014)

3.6.3. Natural Gas

Natural gas is the cleanest and the safest primal fuels. In its origin it is shapeless flammable substance without any colour or odour. During its combustion, there is minimal amount of pollution leakage. The energy produced from the natural gas is used than in household for cooking, heating, or for electric energy production. Very modern way of natural gas usage in driving of a car, where the air pollution is lower in opposite to oil.

On the opposite to, for example, source of coal or oil, resources of natural gas have increasing tendency. It is usually mined from the seabed, but in the Czech Republic condition it is mined classically from the Earth surface. The main deposits of natural gas in the country are in eastern and southern Moravia.

It is important to process natural gas before it is provided to a final consumer. On the other hand, such processing is not significantly costly, which makes natural gas very popular. It is provided to a customer 24 hours per day, 7 days per week and the customer does not need any storage room. The main advantage in opposite to other non-renewable natural resources is its minimal negative environmental impact. (RWE, Natural Gas, 2014)

3.6.4. Uranium

Uranium is a critical material in producing nuclear energy, though its importance arises and uranium mining is a big global issue. In the Czech Republic in the context of nuclear energy the supply for 2 local nuclear stations Temelín and Dukovany is not sufficient and the import of such a material is necessary, however, the mining within the country still exists and governmental plans are to sustain in this trend.

The Czech Republic is in comparison with other EU states relatively rich in uranium. The main uranium mining locality in this country is at present Rožná in eastern Bohemia, other localities rich in uranium are in area of northern Bohemia. The mining of uranium has been always very popular, its beginning are dated already in the 19th century. Domestic sources of uranium was in the past extensively mined for nuclear arsenal of Soviet Union purposes. Uranium was obtained in the way of direct mining subsidies or hidden subsidies in a way of purchases of production surpluses.

In the locality of Northern Bohemia, mining of uranium was stopped due to ecological reasons. However, the mining in Rožná is still operating and it is planned to mine there until 2017. At present, the volume of uranium production is slowly decreasing and the Czech Republic has been faced such a trend since 80's of 20th century. Still, the Czech Republic uranium reserves are significant and important in the context of European continent, and this position is also strong because of accurate questions of energetic sustainability and safety.

Mining locality Rožná was about to be closed several times in the past, however the global uranium situation and globally increasing popularity of nuclear energy forced the Czech government to re-evaluate this decision and sustain in mining. In January 2012 there were even new mining possibilities exploited and so the governmental decision only approved its correct decision. Still, it is necessary to invest into several researches in new mining possibilities, because resources in Rožná are as well limited. The question of mining uranium in the Czech Republic has been and definitely will be a critical question for the Czech government, because mining brings also a negative externalities into the environment. The reason of sustain domestic supply of uranium is the advantage of domestic producing nuclear energy, which is a very important part of the Czech energetic industry and it is also effective and emission-free resource of energy and its importance will increase also in the future. (The Czech Ministry of Industry and Trade – the Raw Materials Policy of the Czech Republic, 2012)

4. Analytical Part

The analytical part of this Thesis will provide readers with analysis of trade balance with materials in the Czech Republic. The Domestic Material Consumption will be also presented and its outcome will be compared with other states of the European Union. The Relation-ship of natural resources rents to the Czech GDP will be described, as well. As the Czech Republic has its commitments at the European Union, the contribution of renewable natural resources will be analysed and predictions based on linear regression will be processed. As the Czech Republic is characterized as mainly importing country, the dependency of the country to energy supply from abroad will be displayed. Environmental taxes as regular contributor to the Czech states budget will be processed through Gretl program and the correlation to the Czech GDP will be analysed. Finally, the SWOT analysis will provide readers with overall view on issue of consuming of renewables in the Czech Republic.

4.1. Trade Balance of Natural Resources in the Czech Republic

In In the following chapter, there will be the main material categories quantified in the context of import or export. The total trade balance of these two indicator will be finally compared and the results explained in details.

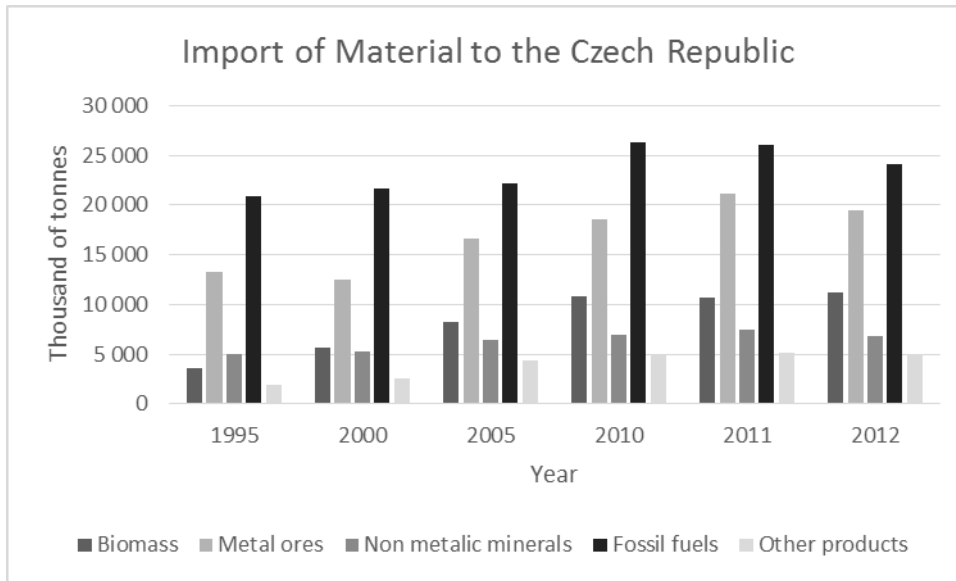
It is almost impossible for any country in the world to be absolutely sufficient in terms of its raw materials, though trading with materials is one of the main task for every government, so the economy of the state can sustain working well. For the case of the Czech Republic, trade with each raw materials has its specific, however, even there are some characteristic features defining trade with raw materials, according to the Czech Ministry of Industry and Trade.

- At first, the Czech Republic has always negative trade balance in terms of trading with non-renewable materials. This fact has always been the truth and in the future, there are no changes predicted. The reason is the lack of material deposits located within the country.

- These negative numbers, which were almost billions of Czech crowns in the last decade, would be possible to decrease. The way of decreasing such a big amount is in including to export all products from minerals, for example exported electric energy or products from ceramics.
- According the Czech Ministry of Industry and Trade, it is characteristic for the Czech Republic that there is minimum of raw materials imported from the European Union. Such a fact results in weak energetic and raw materials security for the whole European Union.
- On the other hand, in terms of export, the European Union plays a significant role for the Czech Republic. Majority, almost the total amount of raw materials is distributed to Member States of the EU. That is a very positive effect of the cooperation of the Czech Republic as a Member State of the European Union and its free trade area functioning. Although, it is important for the Czech Republic to diversify its final customers for the future, in terms of trading security, nowadays in terms of transportation and related costs it is profitable for Czech exporters to sustain in this situation.

Considering the table below, there are import data of raw material for the Czech Republic. The data are outsourced form the Czech Statistical Office and represents the main material categories for given years. As it is obvious, the main imported material category to the Czech Republic are fossil fuels for the whole time series. And the composition of material flow by the category did not change over these years. There is always fossil fuels imported on the first place, followed by metal ores. The main change occurred in 2000 when the biomass imported share started to increase rapidly and overcome even the import of metal ores.

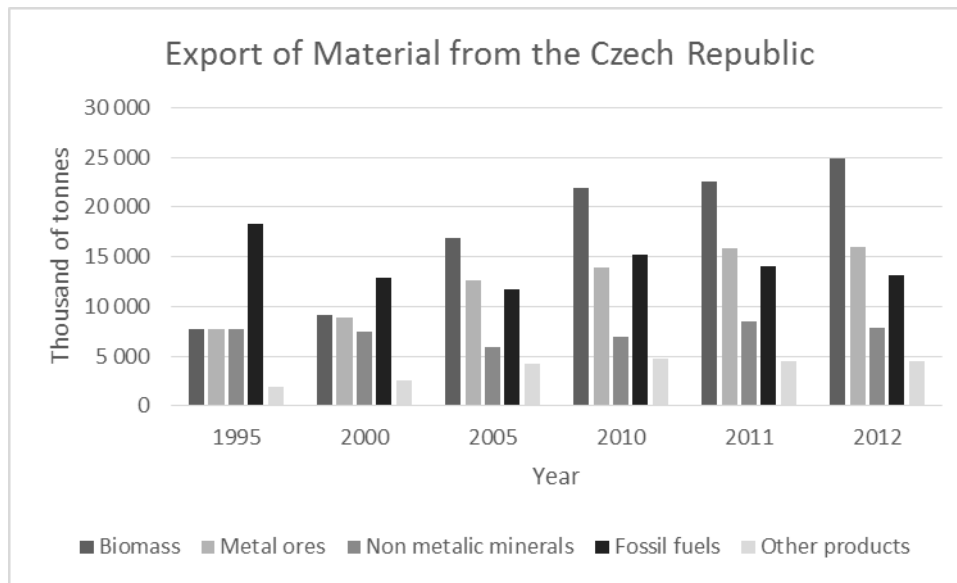
Figure 1: Import of Material to the Czech Republic



Source: The Czech Statistical Office - Material Flow Accounts, 2013; Own Processing

Regarding Export of Material by category from the Czech Republic, the table below expresses the main feauter is such a movement form the year 1995 until 2012. The Czech Republic in 90's exported mainly fossil fuels, however, the fossil fuels export decreased since that time significantly. Sunce 2005 the leading material category has become biomass followed by metal ores.

Figure 2: Export of Material from the Czech Republic



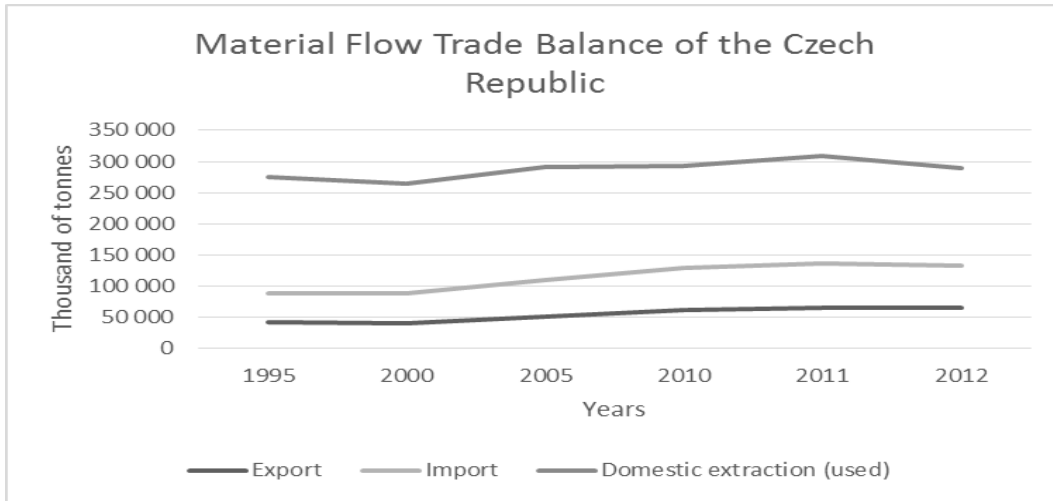
Source: The Czech Statistical Office - Material Flow Accounts, 2013; Own Processing

In terms of Physical Trade Balance of the Czech Republic, the tables below express the total amount of import and export of materials within the country and Physical trade Balance. Physical Trade Balance indicator can express whether there is an environmental burden change in the Czech Republic based on the international trade material flows. From the positive values of Trade Balance, the pure export of environmental burden can be deducted. By this environmental burden is meant such a burden, that the republic causes to other trading countries. And when such a burden is higher, than it is caused by other countries to the Czech Republic. The physical Trade Balance also indicates the material dependency of the Czech Republic to foreign countries. Highly positive values may cause issues, if there is lack of a certain commodities in a trade or if there is significant price increase of these commodities. According to these facts, the decrease noted in the year 2012 was very positive result.

The Czech Republic imports significantly higher amount of material than it exports, which is similar situation like within the whole European Union. From the data below, it is significant, that the amount of imports and exports increased since 2005, however, the

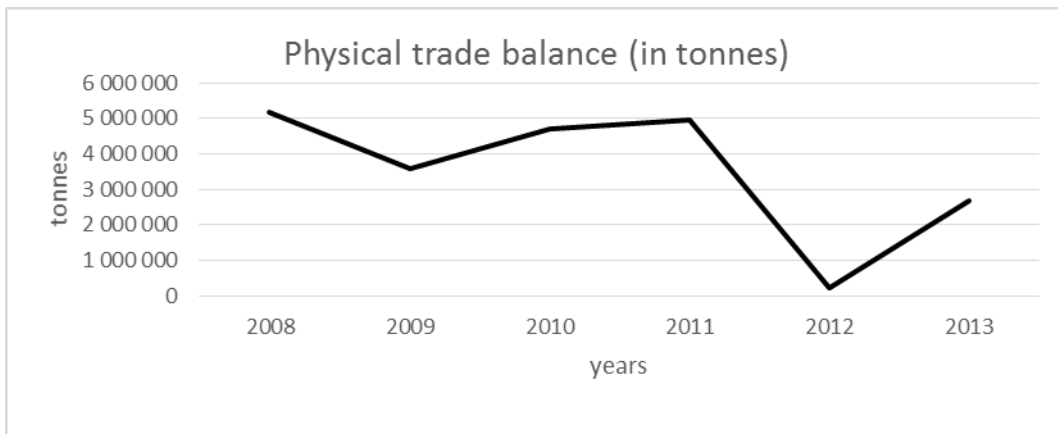
domestic extraction started to decrease in 2011. From such a data, the Domestic Material Consumption can be calculated, then.

Figure 3: Material Flow Trade Balance of the Czech Republic



Source: The Czech Statistical Office - Material Flow Accounts, 2013; Own Processing

Figure 4: Physical Trade Balance



Source: The Czech Statistical Office - Material Flow Accounts, 2013; Own Processing

The import from abroad is needed especially for consumption of natural gas and crude oil. Although, these commodities are very significant fuel energy raw materials, it's import is crucial even from the financial value of import point of view. Though it impacts the final

trading saldo of the Czech foreign trade as a whole. In the last decade, the import of crude oil has been increasing constantly, excluding the year of 2009 and 2010 when there were slight decreases noted. The domestic production of crude oil does not play significant role, though. It covers only 2 or 3 % of the final consumers needs and export of this raw material in abroad is negligible, hence.

Predictions of domestic consumption for crude oil is not easy, because it influence many contradictory factors. According to the Czech Ministry of Industry and Trade, domestic consumption will be dependent on the Czech economy effectiveness. It can be predicted that mining in locality of Břeclavsko will decrease, based on the fact that there is a significant decline in mining since 2004. Also refinery capacity limits affects decreasing trend of domestic consumption of crude oil. Other fact, supporting such a decrease is a trend of biofuels additives into fuels. On the other hand, the increasing demand for fuels can be predicted for the near future, comparing to other developed countries, which have higher consumption of fuels per capita than the Czech Republic has.

Russian Federation has been then one of the main distributor of oil to the Czech Republic for many years, already. However, its leadership slightly decreases in recent times. The share of oil imported from Russia declined from 100% (15 years ago approximately) to final 50%, approximately. As a second supplier of crude oil to the Czech Republic is the Azerbaijan, from where significant amount of oil is imported since 2001. Other importers are Kazakhstan, Libya, Sirya, Algeria, Norway, Iran, Turkmenistan and Nigeria. The amount from these countries are, nontheless, not so significant. However, a big diversity of oil importers guarantees to the Czech Republic relative safety in its industry and though the whole economy.

Similar situation is also noted for natural gas. There are not any great reserves of natural gas in the Czech Republic and domestic production covers minimum of domestic needs. Majority amount of natural gas is, though, imported from abroad. For about three quarters of natural gas are distributed by Russian Federation, the last quarter is then under the bilateral agreement with Norway. However, natural gas from Norway would be distributed only in case of crisis situation, physicly. Otherwise, it is still distributed only from Russia. The amount of imported natural gas, however, covers almost total domestic needs for this

raw material. And as the crude oil significantly affects trade balance of the Czech Republic in trading with materials, natural gas has a big share on it, as well.

The situation on the Czech trade with coal is, in opposite to crude oil and natural gas, totally diverse. The Czech Republic is important European producer of brown coal and is self-sufficient in its consumption. It means that foreign trade with brown coal is in relation to volume of mining almost negligible. Along with slight decline in brown coal reserves, the import of this material increases a bit. Import is then happening from countries such as Germany or Poland. However, still it is very little amount. The export of brown coal is then focused to Slovakia. More important is then trade with black coal also in relation to domestic production. Although, the country is self-sufficient in black coal consumption, it is still imported in a small amount from Poland. In opposite to this fact, black coal is a subject of export from the Czech Republic and it creates approximately 50% of domestic production. Export of black coal is then provided to Slovakia, Austria, Poland, Germany, Hungary and Bosnia and Herzegovina. Black coal is the most important exported commodity in terms of raw materials, regarding value of exports. The reason of increasing prices for black coal is the world trend for increasing prices of this commodity. Export of black coal, though, supports negative trade balance of the Czech Republic in terms of trading with natural resources, where the negative numbers are mainly caused by natural gas and crude oil imports. (The Czech Ministry of Industry and Trade, 2012)

4.2. Material Flows Analysis for the Case of the Czech Republic

The analysis of material flows is a useful tool for quantification of socio-economic sphere and evaluating environmental impacts, which are connected. At present, the main focus is concentrated on material flows on macroeconomic or national level, for which EW-MFA economy wide material flow analysis has been established. It was developed based on studies of several scientific organisations and its features were standardized and published by Eurostat. In this thesis, the data are taken from Eurostat server or the Czech Statistical Office, and data focusing on input indicators or indicators referring to consumption has been processed, based on usefulness outcome of data and their availability. The outcome of

the data processed, then, are a significant factor on which following problems can be evaluated. According to the Czech Statistical Office, the areas of interest are then:

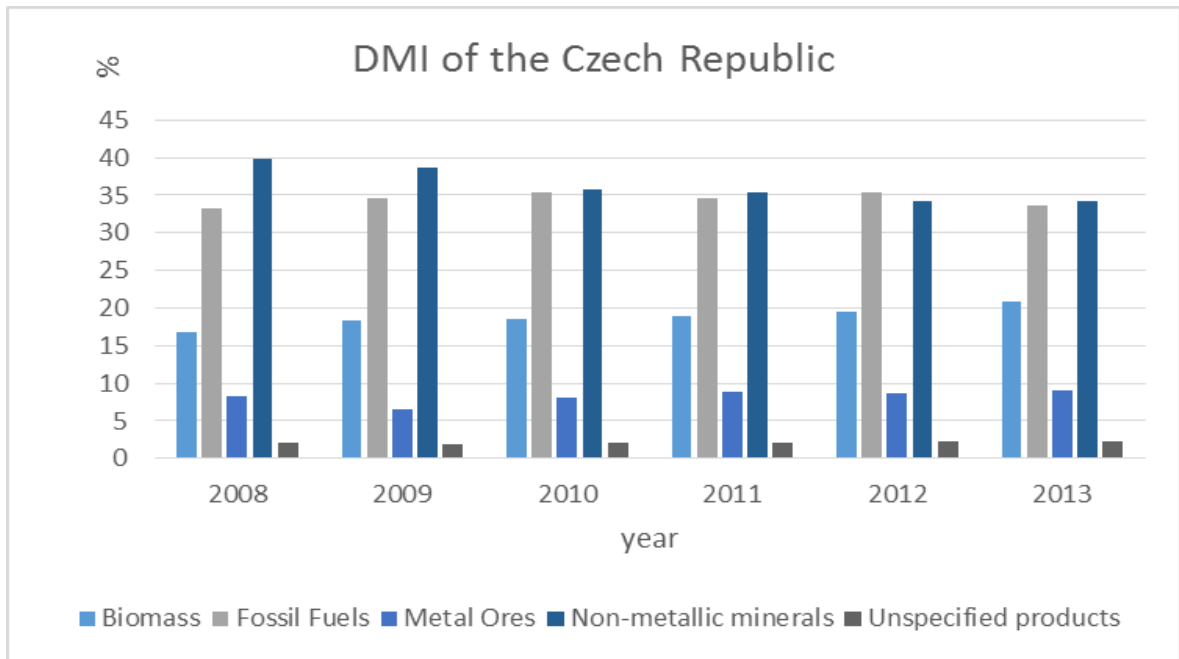
- Evaluating of total physical economic welfare and total environmental burdens connected to materials consumption
- Equality in natural resources sharing
- Land use intensity
- Effectiveness of natural resources usage and diversification of environmental burden and economic production rate
- Equal distribution of environmental burdens among states or regions
- Material dependency on foreign trade, security of supply
- Consumption of renewable and non-renewable natural resources

(the Czech Statistical Office, Material Flow Accounts, 2013)

4.2.1. Direct Material Input of the Czech Republic

Domestic Material Input indicator is one of the main variable, which represents the macroeconomic importance of material flow within a certain country or more countries. Direct Material Input indicator stands for direct input (extraction or import) of economic valued materials that are being used within a country for production or consumption purposes. These natural materials can be solid, liquid or gaseous and are then being processed into secondary products. In order to compute mentioned indicator, we have to sum imports of material and Domestic Extraction. By domestic extraction is meant any material from nature used in economy of the state. Direct Material Input has also close relation with Domestic Material Consumption, where the sum of these two indicators represents the amount of material resource inputs used for trading of a given economy. More precise explanation of Domestic Material Consumption and exact calculations for the Czech Republic and European Union are presented in the chapter called Consumption of Natural Resources.

Figure 5: Domestic Material Input of the Czech Republic



Source: the Czech Statistical Office, Material Flow Accounts, 2013, Own Processing

From the table above, representing Domestic Material Input of the Czech Republic, it is obvious, that the key player in domestic production or consumption use are fossil fuels and non-metallic minerals. In the most recent years, non-metallic minerals start to share similar proportion as the fossil fuels share. That is a fact, that fossil fuels play a key role in the czech economy, the consumption of natural gas, crude oil or trading with coal is a major economic activity in terms of trading with raw materials. And the consumption of those is predicted to increase, in the near future, according to the Czech Ministry of Industry and Trade. The reason of non-metallic minerals direct material input slight decrease is, nonetheless, the reason of increase in DMI of biomass. Biomass DMI increase from approximately 16% to incredibly 20.89%, whereas DMI of non-metallic mineral decreased from almost 40% to 34.19%. Though, it is obvious, that biomass popularity in the Czech trade with raw materials increases and the trend seems to be positive.

4.2.2. Consumption of Natural Resources

In the following chapter, there will be indicator called Domestic Material Consumption, which will be described for various localities. The Domestic Material Consumption is, according to European Commission, ratio of tonnes of material consumed per capita. In other words, it quantifies total amount of natural resources needed within the economy. The final number represents total sum of all materials gained from a given state plus total amount of imports without exports. Such an indicator then will be describing the situation in the Czech Republic, European Union in total and the comparison of EU member states in the year 2013. This indicator stands EW-MFA, in other words Economy-wide Material Flow Accounts. These contains all material inputs in to the state, changes of commodities' stocks and, as the last, material outputs to other states or areas or environment. In order to work better with data, natural resources has been split into 4 wider areas. Those are:

- Fossil fuels including all kind of coal, oil, natural gas or coke, etc.
- Metal ores including iron ore, basic metals and similar.
- Non-metallic minerals such as kaolin, graphite, limestone, cement, glass, etc.
- Biomass created from wood, food, agricultural by-products, cereals, etc.

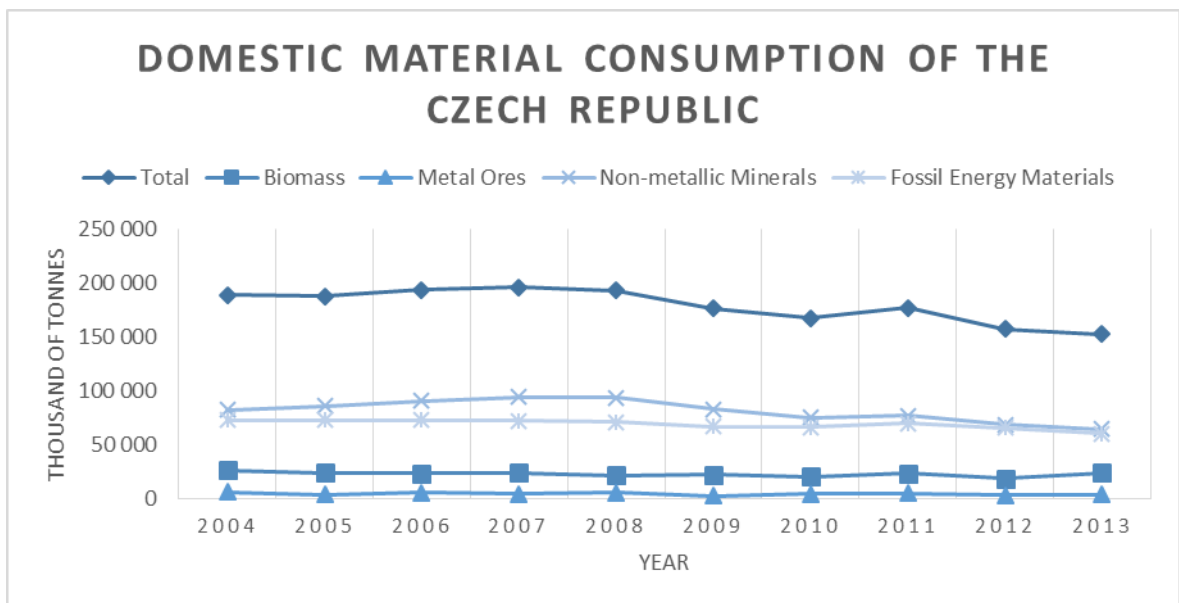
Domestic Material Consumption is indicator relating to evaluation of environmental issues. Manipulating, extracting and trading with natural resources is very sensitive and it is usually connected with environmental problems. These problems could be for example damaging of nature by mining, decreasing biodiversity or the global weather changes. By decreasing of material flows, there could be also decrease of environmental burdens, where the possible solution is achievement of sustainable consumption and production.

Based on Domestic Material Consumption, it is also possible to evaluate dependence of a given economy on export form abroad. The higher the domestic Material Consumption dependency is, the more sensitive the economy for any changes in foreign trade is. An example of such sensitive economy is the one abundant on strategic material resources like fossil fuels or precious metals. (Eurostat, Environmental Data Centre on Natural Resources, 2015)

4.2.2.1. Consumption of Natural Resources in the Czech Republic

The following graph displays the situation in the Czech Republic regarding total consumption of materials such as biomass, metal ores, non-metallic minerals or fossil energy materials or carriers. The numbers are shown in thousands of tonnes and data are collected since the year of 2004 to 2013. From the graph below, it is obvious, that consumption of natural resources in the Czech Republic was relatively stable from 2004 until 2008. However, from 2009 there is slight decline and the main change occurred in 2012, where the consumption was at its minimum. The Czech Republic, as the member of the European Union is obliged to lower the usage of non-renewable energy resources according to EU program supporting renewable energy usage. The declining change is caused by the world crisis, where related industries notified negative profitability. The year 2012 was is also a year of economic depression that is why the numbers are negative in the graph. Another reason of slow decline of consumption of these selected resources is substituting them by other resources such as wind or solar energy.

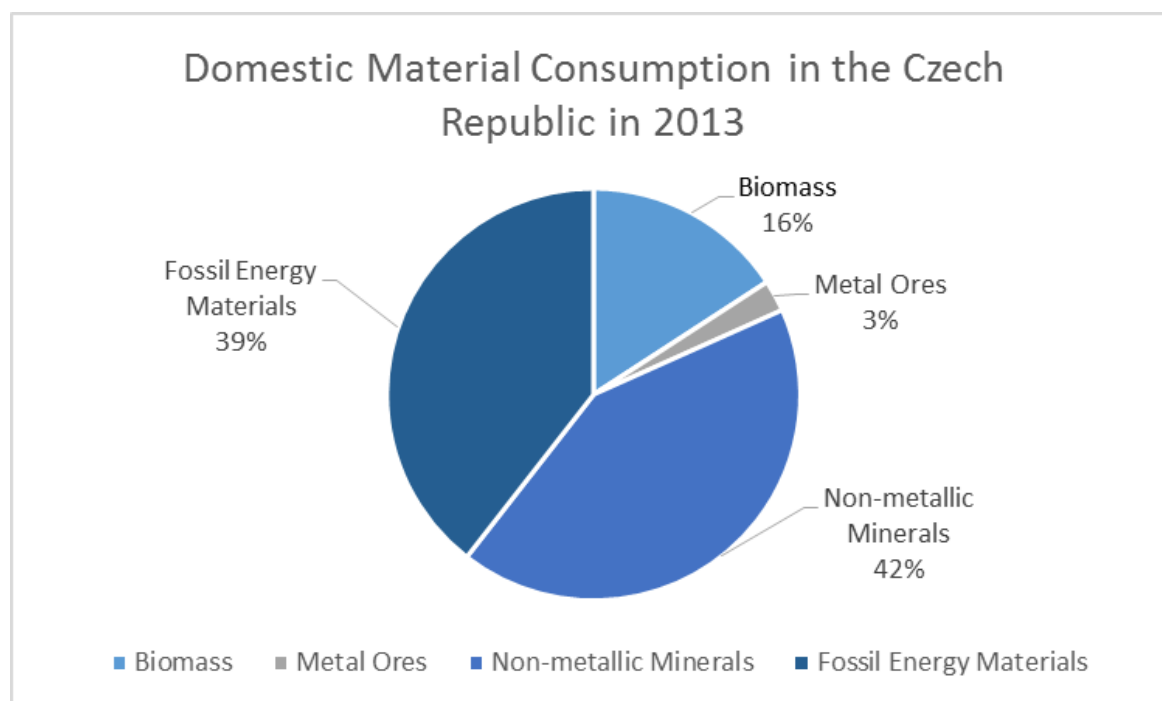
Figure 6: Domestic Material Consumption of the Czech Republic



Source: Eurostat, Material Flow Accounts, 2014, Own Processing

Regarding development of Domestic Material Consumption in the Czech Republic, the following graph represents ratio of the main natural resources consumed in 2013. The majority consumption represents Non-metallic minerals (42%), followed by Fossil Energy Materials. Biomass and metal ores then create less than one third of the total Domestic Material Consumption. The data are taken from the server Eurostat.

Figure 7: Domestic Material Consumption of the Czech Republic in 2013

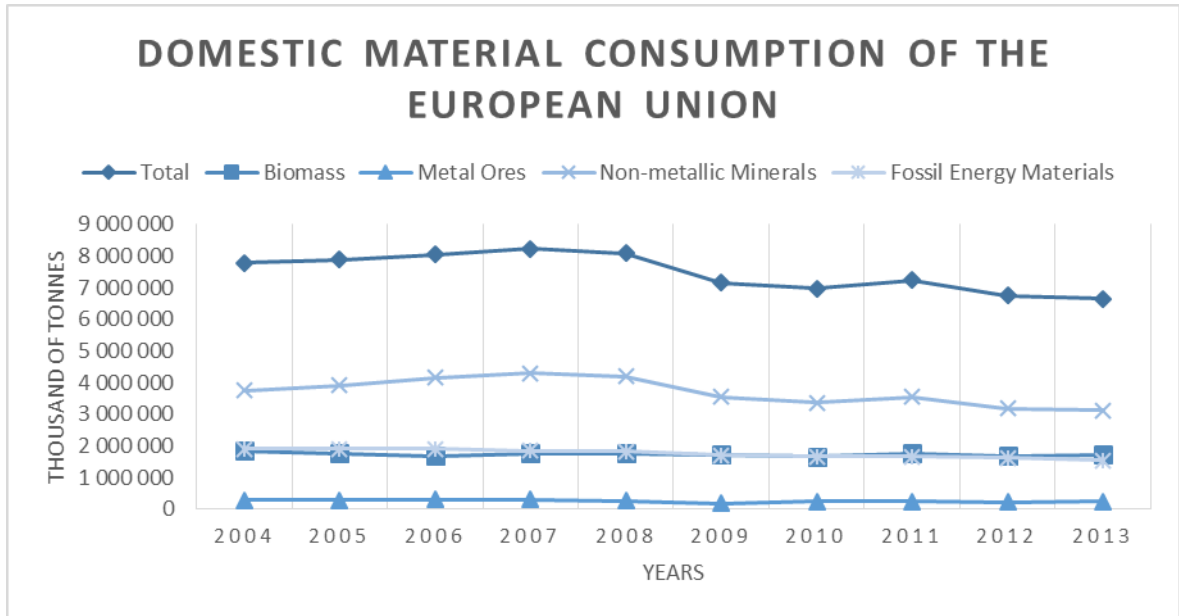


Source: Eurostat, Material Flow Accounts, 2014, Own Processing

4.2.2.2. Consumption of Natural Resources within EU

The consumption of Natural Resources within member states of European Union show relatively stable amounts for the last ten years. The gentle decrease in 2009 is caused probably by the economic crises, where the consumption of metallic ores and similar resources was affected. As the economy development lowers, the consumption and production secondary products from natural resources decreases as well. As it is visible from the graph below, the Total Domestic Material Consumption of the EU as a whole was strongly affected by consumption of non-metallic minerals.

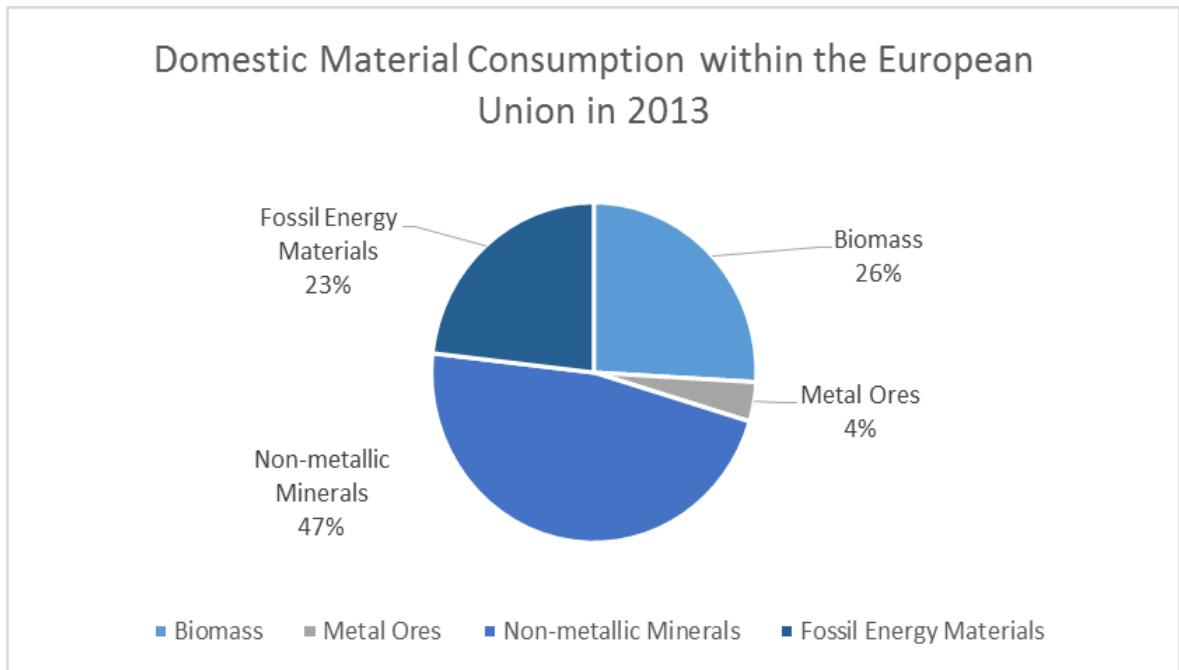
Figure 8: Domestic Material Consumption of the European Union



Source: Eurostat, Material Flow Accounts, 2014, Own Processing

In the graph below, each component of Total Domestic Material Consumption is presented and also its ratio in total amount in the year 2013 within the whole European Union. It is very important to mention that the majority of material consumed within whole area are non-metallic minerals, which is the same case as in the Czech Republic. However, regarding biomass consumption, in European union as total, it is consumed in a higher share, than it is recorded in the Czech Republic. (Eurostat, Energy, Transport and Environment Indicators, 2013)

Figure 9: Domestic Material Consumption within the European Union in 2013



Source: Eurostat, Material Flow Accounts, 2014, Own Processing

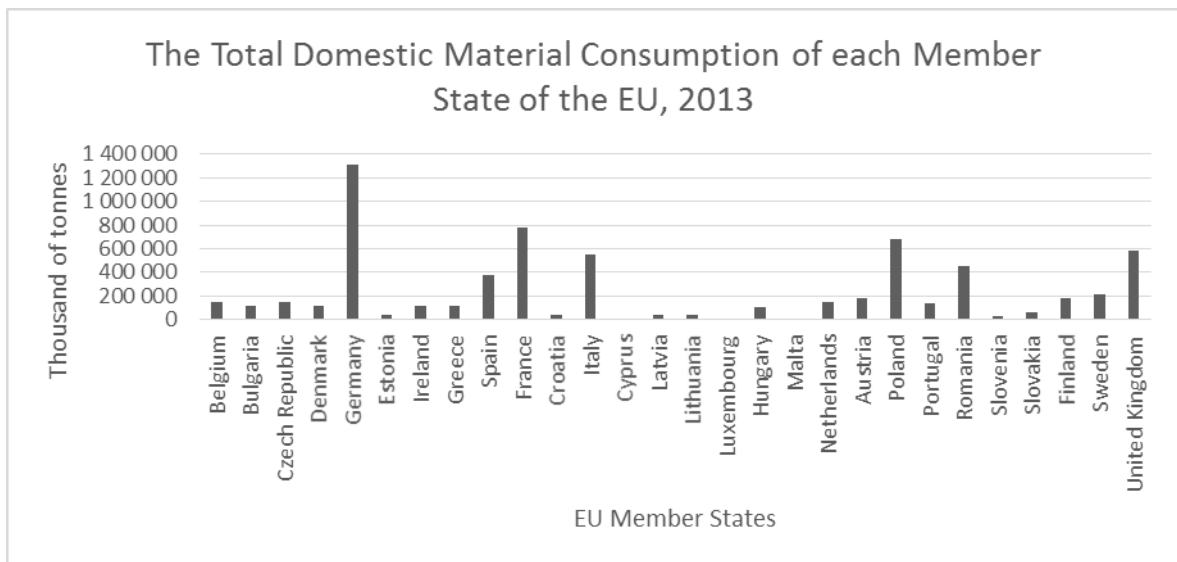
4.2.2.3. Total Domestic Consumption of Selected Natural Resources in EU countries in 2013

The total domestic consumption of selected natural resources for each EU member state in 2013 is displayed in the following graph. The consumption, of course, is strongly dependent on each countries' natural resources wealth. The leaders in material consumption are then according to the graph Germany, France, Italy, Poland, Romania and the United Kingdom. The Czech Republic, although, represents significantly lower consumption than the previous states described, on the other hand in comparison with the rest of the Member States it is considered as the average consuming country.

According to data and formulas outsourced from the European data server Eurostat, the Domestic Material Consumption depends on the extraction of each individual state and hence on the natural resources wealth of each national economy. That is a very significant fact for evaluating each states Domestic Material Consumption. States where biomass play a key role are Latvia, Ireland, Finland, Lithuania and Sweden. States, where the extraction

of fossil fuel belongs between the most important elements are Estonia with its oil shale. The Czech Republic together with Germany and Greece are the main extractors of black coal and Denmark represents natural gas and crude oil. Metal ore extraction are dominant, then, for Sweden, Bulgaria and Finland. Non-metallic minerals reserves extracted are recorded in Finland, Romania, Estonia and Ireland. The extreme numbers recorded for the state of Malta is caused then by low reserves of any natural resources and hence the need of imports. The value of Domestic Material Consumption is due to this fact so low. (Eurostat, Energy, Transport and Environment Indicators, 2013)

Figure 10: The Total Domestic Material Consumption for Each Member State of the EU, 2013



Source: Eurostat, Material Flow Accounts, 2014, Own Processing

4.2.3. Resource Productivity

Resource productivity is an indicator of a macroeconomic perspective. It is computed as a ratio of Gross Domestic Product to Domestic Material Consumption, which is in detail described in the previous chapter. Gross Domestic Product is then, for purposes of resources productivity analysis, referred to year 2005 and current exchange rate, in order to compare how situation changes over time.

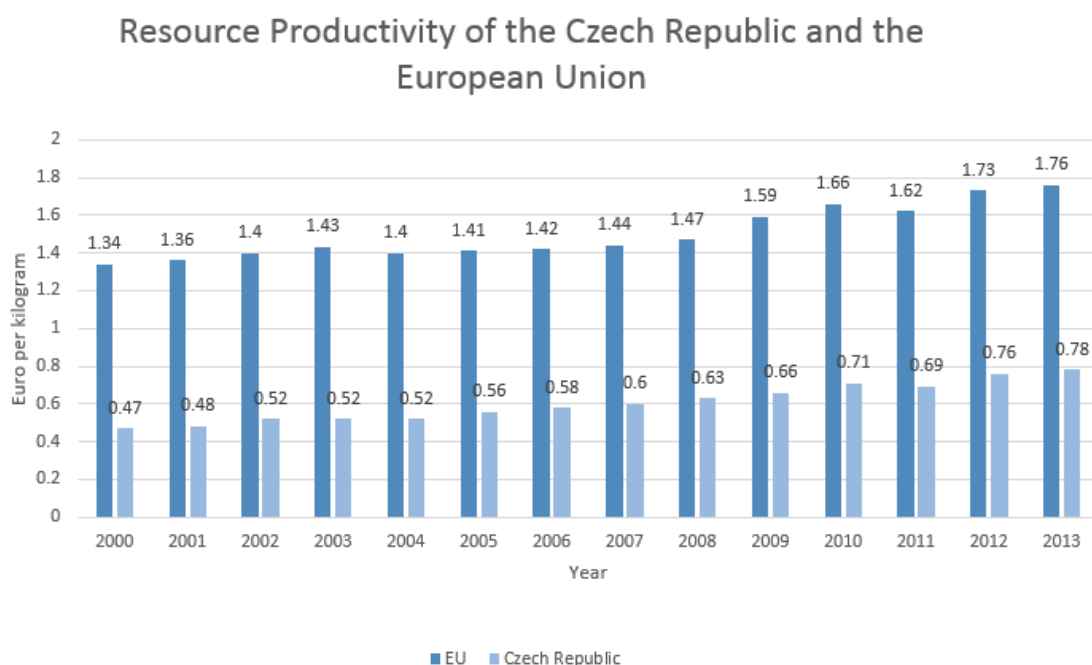
In greater details, the Resource Productivity represents total consumption of resources of metal ores, biomass, fossil fuels and non-metallic minerals or petroleum within the

economy of the state, which is then similar to domestic material extraction together with trade balance with these commodities. The result of this computation is presented as Euro per 1 kilogram. (Eurostat, Environmental Data Centre on Natural Resources, 2015)

In the following graph, there is comparison of Resource Productivity of the Czech Republic and in the European Union in period of the year 2000 to 2013. The increasing tendency and strong position is significant in EU from 2008. However, in context of the Czech Republic, the jump in 2008 was the most significant difference in the whole period of time. In the last years, the numbers stays similar.

The evolution in Resource Productivity within European Union was affected by world economic crisis in 2009 in the way of stronger position of service sector. Whereas, manufacturing and construction industries at that time realized decline in demand. In the graph, it is obvious, that the trend of European Union Resource Productivity data are similar to the data of the Czech Republic, where the country is apparently strongly influenced by Union's current situation.

Figure 11: Resource Productivity of the Czech Republic and European Union



Source: Eurostat, Resource Productivity, 2014, Own Processing

It the graph, there is obvious increase in the productivity of resources in the Czech Republic, which is a result of effective material usage. The increase was linear and quiet stable, except the year 2011, when there was slight decrease recorded. While the material productivity comes from the relation of GDP and material consumption indicator, it is logical, that the increase of resource productivity is the result of increasing GDP at the same period. The Czech Republic values of material productivity is about one third of the european average or OECD average, constantly. However, countrie's GDP is only about one fifth lower. Such an indices refers to the fact, that the Czech Republic focuses on heavy industry sector, which is then more material intensive, than other sectors.

4.3. Contribution of Natural Resources Rents to GDP in the Czech Republic

In this chapter, the contribution to the Czech Gross Domestic Product from Natural Resources rents will be defined and then in the graph, the data will be graphically processed so the trend of the contribution will be much clearer.

In terms of economy, the rent can be explained as a value that is left after the costs and returns are deducted. It is basically the difference between nominal costs and the prices at which the commodity from a resource is sold. Such a value is then in terms of natural resources call resource rent, sometimes expressed as abnormal profit.

It is always very difficult to estimate natural resource rent, because of lack information, market condition or system of property rights (in terms of forest areas or similar) related to natural resource management at that place. Than the economic rent of natural resource is characterized as value of capital services flows which are concentrated in the natural resources. (The World Bank, 2014)

In this chapter, the total natural resource rents are constructed from oil rents, natural gas rents, coal rents, mineral and forest rents. In this case, the final amount presented is the difference between the price of natural resource and its average production cost. It can be

done only by setting the price of a commodity unit for the whole world from which the average costs (production, harvesting, etc...) is abstracted. This result of calculation is then multiplied by the physical quantities that a given country extracts. After the whole process, the final values can be used to determine commodity rent as a share of Gross Domestic Product of a given country. (The World Bank, 2014)

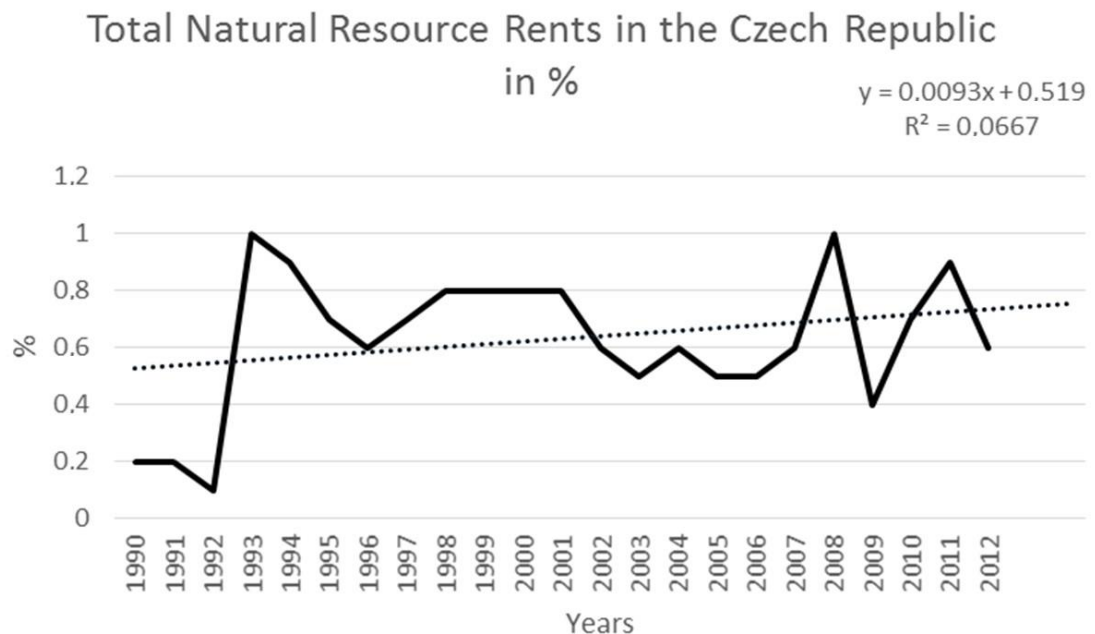
It is important to consider such a factor in a Gross Domestic Product because of constructing a framework for sustainable development, where the Czech Republic as a member of European Union has its commitments. For certain countries abundant in precious materials such as oil or natural gas, it is very important to know its contribution into a state's economy. Natural resources increases economic rents because they do not cost any production costs. On the other hand, when the county relies on the non-renewable natural resources rents and its contribution to GDP, then the country will face in the future a big issue considering economic crisis caused by depletion of its non-renewable resource. Every country where the contribution of non-renewable resource to the GDP is significant has to consider such a threat. (The World Bank, 2014)

For the example of the Czech Republic, the graph below represent the Total Natural Resource Rents for a given country in %. The numbers of rents as a share of GDP fluctuates every year. Rapid increase in share in 1992 is visible from the data processed. Another extremes are visible in the years of 2008 and 2009. In 2008 there is the amount of percentage share of natural resource rent to GDP on its maximum, however, in the next year, the drop is huge and was significantly caused by world economic crisis impact.

By using MS Excel functions, there can be also forecast and trend line generated by linear regression. The trend line in the graph below represents the tendencies of calculations and its increasing movement. It is readable from the curve that the dependency of the natural resource rents has increasing tendency. The calculation from MS Excel graph provide us information about reliability of the data which is expressed by R^2 . In our case, R-squared equals to 0.0667, which is pretty low and it actually expresses that the prediction of such a tendencies is very difficult to estimate. However, it is important to say that the Czech Republic is not pretty dependent on Natural Resources share in the Czech Gross Domestic

Product. The percentage values are maximal 1% of total natural resources rents, which is not very significant amount.

Figure 12: Total Natural Resource Rents in the Czech Republic



Source: the World Bank, Total Natural Resources Rents % of GDP, Own processing.

4.4. Share of Renewable Energy to Gross Final Energy Consumption

In recent years, the energy consumed from renewable natural resources increases. There are many reasons why this trend is being discussed almost every day on the highest levels of national or international organisations or governments. One of the reason is to start thinking about the future of the environmental aspect, the other is more politically interested and it is to be less dependent on other states in terms of import. The independence on imported fuel from outside the European Union, supporting clear environment and decoupling costs for energy from oil prices are then the main issue of the whole EU and it brings the reason of such a big concern. Latest incidents with oil prices or

imports of fossil fuels only approves and supports concerns and efforts of the European Union.

In the context of European Union, the major act regarding renewable resources usage in the energy consumption is included in so called 20-20-20 target where the legislation has been described. Upon this policy package it has been agreed in 2009. The Directive for Renewable Resources (Directive 2009/28/EC) establishes then the accounting criteria which has to be fulfilled in 2020.

This Directive concerns strategic plans for using renewable energy, for each state, there is individual action plan with targets to be achieved by a given economy within the year of 2020. These targets are set according to natural conditions of the country and their level of economy or it's potential. The range of renewable resources usage is very wide, it starts on the lowest 10% level for Malta and ends in Sweden with 49% to be achieved in 2020. For the Czech Republic, the target value has been set on the level of 13%. On the European Union level, a given Directive sets the target of 20% of renewable resources to be used in production or promotion of energy within 2020. Renewable Energy Directive also sets the rules for composition of transport fuels. Such a commodity has to be composed at least from 10% of renewable resources in 2020. The transportation targets can be achieved by supporting programs concerning biofuels and rules for processing and consuming them. Each European Union country is then obliged to present their results on the ground of European Commission, which will be controlling effort of every state. The results are then published in so called Progress Reports every two years. (European Commission, Renewable Energy Directive, 2015)

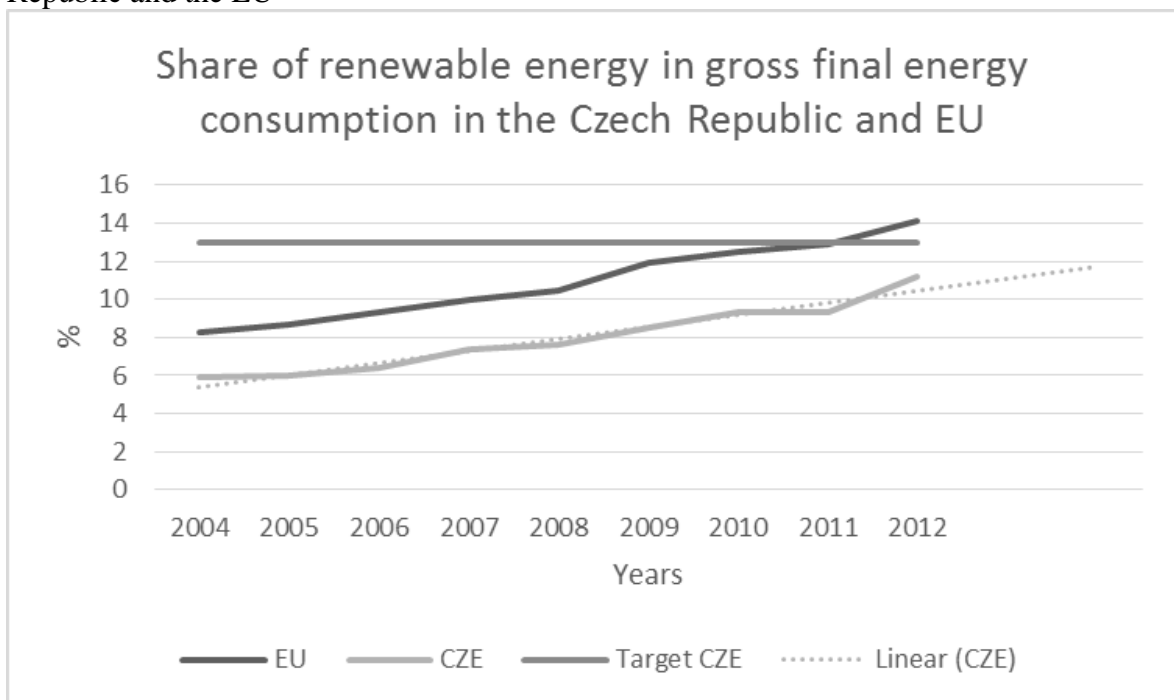
The Renewable Energy Directive is considered as a tool for EU Member States cooperation, and even for countries outside the EU (e.g. Norway or Iceland). The cooperation is based on statistical transfers of renewable energy, common projects concerning renewable resources and joint support mechanisms supporting achievement of the set targets. (European Commission, Renewable Energy Directive, 2015)

In the graph below, there is a share of energy from renewable resources in the final energy consumption presented. Such an indicator provides information about the level of renewable resources used in to total energy consumption. Such an indicator is very

important for any high state or union institution to follow from the reasons of evaluating trends and efforts of the states in terms of reducing dependencies of economies on resources imports.

The graph clearly shows the development of the Czech Republic, compared with total values of the European Union as a whole. The Czech Republic follows increasing trend of the European Union in consuming more of renewable energy in final energy consumption. Target of the Czech Republic, 13% of renewable energy consumed in 2020, is for this country clearly achievable, as the trend line shows. The Czech Ministry of Industry and Trade even predicts that 13% target will be achieved before 2020 and at that year, the Czech Republic will be able to use 14% of renewable energy. These visions of the Czech government are likely to be fulfilled. The Ministry of Industry and Trade then provides results of its efforts for every two years.

Figure 13: Share of Renewable Energy in Gross Final Energy Consumption in the Czech Republic and the EU

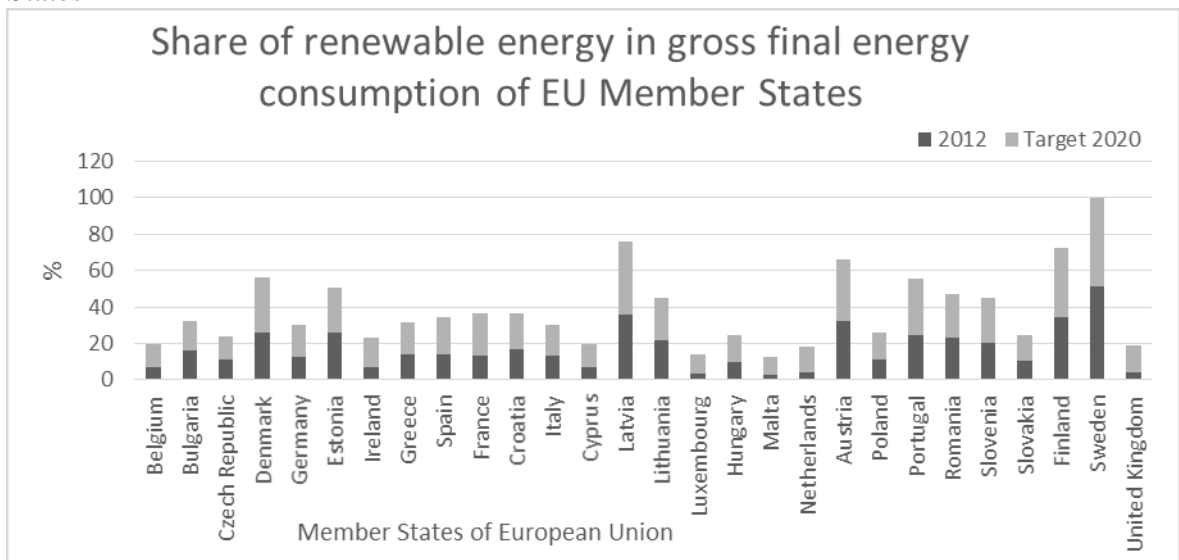


Source: Eurostat, Share of Renewable Energy in Gross Final energy Consumption, 2014

In terms of EU 20-20-20 targets, each member state is presented and compared with other member states within the European Union in the graph below. The first stage of every state

is current situation of using renewable energy in proportion to final energy consumption. The second stage is then an amount of what is left to be fulfilled in 2020. One of the biggest targets is set for Sweden which has to achieve 49% of renewable energy share. And as it is obvious from the data from Eurostat, it has already in the half of its efforts. On the other hand, Malta and Luxemburg have targets of 10 and 11 percent and even these targets are difficult for these countries to be fulfilled. In 2012, these countries fulfil only about 30% of their targets. Simliar situation is then in the United Kingdom, that faces troubles with fulfilling its targets. In 2012 this country has been at the level of 4.2% of renewable energy share, however, in 2020 it should use 15% of renewables. Situation of the Czech republic is quiet positive. The development of usage of renewable resources in energy consumption is on it increase and the targets are likely to be fulfilled even before 2020. the same target as the Czech Repulic has been set, for example, for Belgium. However, Belgium fulfilment of its target faces troubles. In 2012 this country was able to higher usage of renewables only to 6.8%, where in the Czech Republic achieved number of 11.2% in the same year.

Figure 14: Share of Renewable Energy in Gross Final Energy Consumption of EU Member States



Source: Eurostat, Share of Renewable Energy in Gross Final energy Consumption, 2014

4.5. Dependency of the Czech Republic to Energy Supply from Abroad

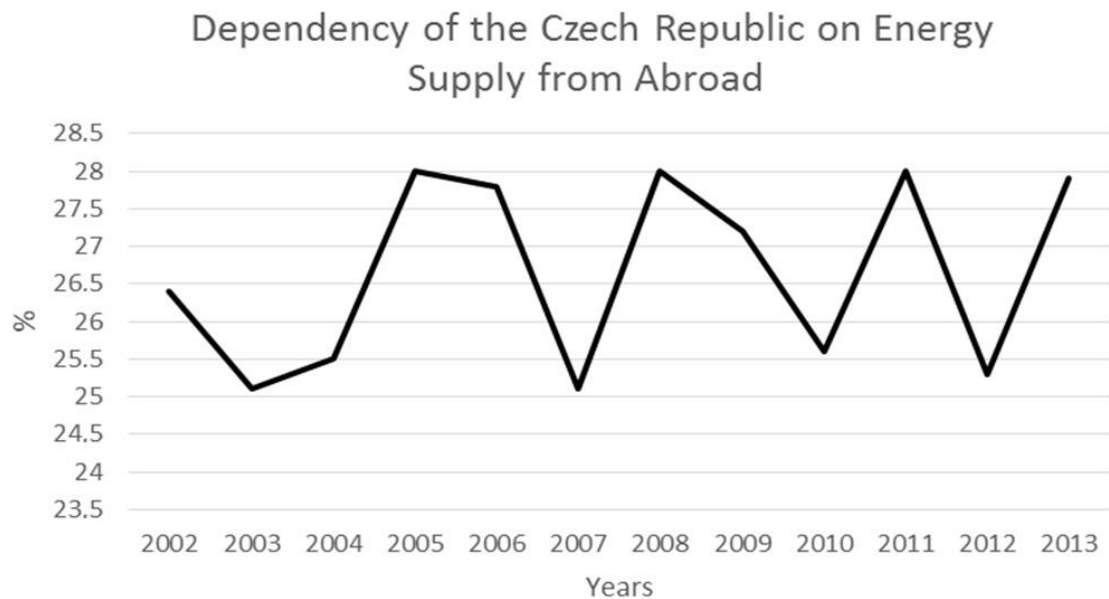
The concept of energy dependency is defining a degree of self-sufficiency of a country regarding to energy. It shows the degree of a country's dependency on imports of energy. Indicator of the dependency is calculated as net imports divided by the sum of country's energy consumption including maritime bunkers. If country's energy consumption is higher than its production, its dependency is rising and self-sufficiency declining. Net imports are in this context calculated as total energy imports minus total energy exports. Energy dependency can be either positive or negative. It is negative if country is a net exporter. On the other hand it indicates positive value (even over 100%) when country (or an economy) accumulates stocks during given period (usually a year).

Another important indicator is SDI, which refers to a Sustainable Development Index. This indicator assesses the progress towards targets and objectives of the Sustainable Development Strategy of the European Union. This progress can be also evaluated by REI-Resource Efficiency Indicator. This indicator shows the progress towards goals and targets of the European 2020 flagship initiative on Resource Efficiency. This indicator was presented in Resource Efficiency Scoreboard.

As it is visible from the graph below, energy dependence of the Czech Republic (or self-sufficiency in terms of energy) has been steady since 2002. It has been fluctuating from 25% to 28%. It means that the Czech Republic can satisfy approximately 72-75% of its energy needs (consumption) by its own production. The rest must be imported. The situation of the Czech republic is in comparison with EU average not bad, the state is less dependent then the European Union's average, which fluctuates around 50% of energy dependency. Then the range of 25% to 28% is very apperetiatiated on the floor of the European union, though. The Czech Republic, sustainably, is having a status of one of the least dependent countries within the European Union. Between others not so dependent countries belong Estonia, Romania and Sweden, as well. Denmark, for example, is the only state, at which dependency rate reaches negative values, which means that this country is totally self-sufficient and is able to sell its energy to other states. On the other hand, Malta, Luxembourg and Cyprus are almost entirely dependent on energy imports.

From these data, however, it is clear, that the whole European Union is very dependent on energy supplies and is classified as importing area and so actions taken or planned in order to support independency in such a sector are very welcomed. (European Commission, 16.2.2015)

Figure 15: Dependency of the Czech Republic on Energy Supply from Abroad



Source: Eurostat – Energy Dependence, Own processing

According to the data from European Commission, the most significant commodity, upon which dependency reaches the highest values, is a crude oil, followed by natural gas. The main distributor to the European Union of these commodities is for a several years Russia. Russia is a long-term partner to the European Union, while speaking about supply of natural gas and commodities, however, after recent incidents in 2009 and 2013, when Russia stopped providing its services, the European Union has decided to take certain actions in order to avoid such a threatens in the future. There are for example Directives for each Member States to keep reserves for a certain period of time in order to be able to keep state's economies running meanwhile short blackout. Also a wider range of suppliers to the European Union and better conditions for cooperation should ensure sustainable distribution of energetic materials and better coordination between each Member States in

this question. Between the major importers of crude oil to the European Union belongs Russia, Norway and Saudi Arabia. In terms of natural gas, Russia keeps the first position and is followed by Norway and Algeria. These suppliers and their positions keeps similar or the same over a long period of time, which doesn't have to be beneficial for the European Union. Speaking about solid fuels and hard coal, Russia holds the first place again, however, the rest changes a bit over time. Current situation is that the second main distributor is Columbia and the United States of America. There are efforts from the side of the European Union to wider the range of suppliers from the reason of safety of supplies when of the distributor interrupts its supplies. The countries of possible cooperation are Nigeria, Azerbaijan or Kazakhstan for reason of crude oil imports. Then there is Qatar as a possible partner for importing natural gas. (European Commission, 16.2.2015)

4.6.Environmental Tax Revenues Impact on the Czech GDP

One of the main composition of the GDP of any state in the world is the contribution of taxes. Taxes are one of the main state resources of money and so such an indicator is very significant to evaluate and not to underestimate its impact on the state's economy. For these purposes, the analysis in statistical program Gretl has been computed and the results will be described in this chapter.

Environmental taxes are taxes related to any physical unit that proves negative impact on the environment. For such a physical unit, it is also necessary to be defined an object of taxation in ESA95, in other words European System of Integrated Economic Accounts. Environmental taxes are composed from for subcategories, namely from energy taxes, transport taxes, pollution taxes and resource taxes. For purposes of this analysis, environmental taxes of the Czech Republic has been generated in millions of Czech crowns. (Eurostat, Environmental Tax Revenues, 2013)

Energy taxes are represented by production of energy and products related to transport or stationary. Main commodities characterized under this category are petrol and diesel, followed by natural gas, coal and electricity. Also biofuels are object of taxation in this case, or other renewables used. Carbon dioxide CO₂ and sulphur dioxide SO₂ taxes are also part of this category. As a new part of energy taxes, there exist emission permits. Emission

permits are part of governmental resources and are recorded as tax in every national account. (Eurostat, Environmental Tax Revenues, 2013)

Transport taxes are category of environmental taxes that include ownership or usage of vehicles with motor or any means of transportation. This type of environmental tax contains, as well, special taxes from insurance of such a mean. (Eurostat, Environmental Tax Revenues, 2013)

Under pollution taxes it is meant emissions to air or water, regarding also solid waste and noise. (Eurostat, Environmental Tax Revenues, 2013)

Any use or extraction of natural resources are described under the category of resource taxes. However, any taxes regarding resource rents are excluded. (Eurostat, Environmental Tax Revenues, 2013)

In order to see the effect of environmental taxes as a part of the state revenues, the correlation of this indicator has been evaluated in statistical program Gretl with Gross Domestic Product indicator. The GDP indicator is represented as a value computed according to production method, which fits the best to purposes of this analysis. Production approach of GDP is calculated from gross domestic output from economic activities. From this output, intermediate use is deducted. Margins and taxes on products are then added and from these, subsidies on products has to be excluded. (Czech Statistical Office, GDP Production Approach, 2015) The outcome is then represented in millions of Czech crowns, for purposes of following analysis.

In the statistical program Gretl, the Ordinary Least Square Method was used in order to analyse correlation between environmental taxes and the Czech Gross Domestic Product. GDP was estimates as dependent variable represented by “y” and Environmental Taxes are represented under the symbol of “x” as independent variable. Following table then represents results computed by a given program.

Figure 16: Environmental Tax Revenues Impact on the Czech Gross Domestic Product

Model 2: OLS, using observations 2004-2013 (T = 10)				
Dependent variable: y				
	coefficient	std. error	t-ratio	p-value
const	-1.34025e+06	703354	-1.906	0.0932 *
x	58.9536	8.09770	7.280	8.55e-05 ***
Mean dependent var	3770175	S.D. dependent var	365198.7	
Sum squared resid	1.57e+11	S.E. of regression	140273.6	
R-squared	0.868858	Adjusted R-squared	0.852465	
F(1, 8)	53.00267	P-value(F)	0.000086	

Source: Eurostat 2015, and Czech Statistical Office 2015, Own Processing

Gretl generated a relationship between given variables as equation of a following format:

$Y = 58.9536X - 1.34025e+06$ <p>Y = Gross Domestic Product of the Czech Republic X = Environmental Taxes</p>
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From the results generated by Gretl program, it can be deduced that if GDP of the Czech Republic rise by one unit, Environmental Taxes will increase by 58.93 units. Such a result proves a significant dependency of the Czech GDP on Environmental Taxes collected. While testing the goodness of fit of the model, the indicator R^2 is very important to evaluate. The closer to 1 the coefficient of determination is, the more precise the result is. In this case, R^2 is equal to approximately 0.87 which a very good result is. Another significant indicator, which has to be a point of the interest is so called P-value. P-value is a determinant of standard error based on confidence intervals. The closer to zero P-value is, the lower the possibility of error program generates. In the output of analysis above P-value was calculated as 0.000086. Such a result is very low and so the outcome is statistically significant. Gross Domestic Product is definitely influenced by wide range of various factors, however, income from Environmental Taxes is one of the important component, as well.

4.7.SWOT analysis of natural resources economic activity in the Czech Republic

In this chapter, SWOT analysis will be applied on the issue of using renewable and non-renewable natural resources for the purpose of the energy outcome. The SWOT analysis is very smart tool enabling evaluating such an issue as from the internal, so from external point of view. Strengths and weaknesses as well as opportunities and threats in problem with renewables will be described in details, and all of the features affecting this topic as well.

Strengths

Among all of the facts, about decreasing reserves, sometimes depletion of non-renewable resources and also problem with climatic changes, there are plenty of other strengths when using renewable natural resources as a primary energy resource. Along with these, non-renewable energy resources brings their positives as well, and so the situation of the Czech Republic based on the outcomes of this thesis will be analysed.

Between the first positive aspect of renewable natural resources are, that those cannot be depleted, there will be always source of energy from such a resource, though, a customer doesn't have to be scared of depletion. Along with the first argument, there is also one important point of view, that interests still more and more people, and that is the ecological principal of using renewables. From the reason of significant climatic changes and still bigger interest in different behaviour to the Earth, the ecological aspect brings to renewables a big popularity and hence, it helps to sustainable development. In many industrial areas, even in households, renewables are commonly used and replaced, in some way, non-renewable resources not only for energy purposes. Usually, the service of a machine producing energy form renewables is simple and user-friendly. And also the service life is very long so the primary investment is definitely returned in a short area when manipulating and managing it well. Regarding all of these and also wide offer of new technologies, the area of inventions and new technological developments is still opened and new possibilities are still on the way. There is also a space, where many young

workers and absolvents can work and not only in area of Research and Development. Such an industry offers many highly qualified work places with potential of further progress. There are many areas, where renewables bring work places, not only in IT technology or other mechanical industries, also in environmental industry, economy or in agriculture are new innovations needed. There is also a wide offer of educative programmes and specializations and new possibilities in a new fields or disciplines in terms of the best use of renewables are question of a near future. There is also a big support from government, in this area. And also the European Union offers subsidies in building and supporting active usage of renewables, in order to achieve its goals of 20-20-20 agenda. The reason of such an interest is then future independency on energy supply from other external states. Renewable resources hides a lot of potential and there are plenty of positives that force people to understand them and use them correctly.

The Czech Republic has very strong position in terms of distributing raw material to the European Union. The European Union is, actually, one of the main localities when exporting these commodities. The advantages are in traveling costs and the united market cost positives.

The Czech Republic is one of a few countries that has very strong position in coal industry. Not only that the Czech Republic has significant reserves of coal that is able to utilize, the country is even able to import its stocks.

In terms of consuming of fossil fuels, the positive effect from the environmental aspects is that the consumption of fossil fuels has been lowering since 2008. The strong position of the Czech Republic is also in its low dependency on energy supplied from abroad. The range is between 25% and 28% which is in comparison with the rest of Member States of EU below the average. By enhancing and supporting share of renewable energy resources, the dependency on energy supply can lower and the Czech Republic can become a key player as an energy producer.

Weaknesses

It has to be considered, that there are not only advantages on using renewable resources. Before using them, there has to be many aspect taken into account, so the resource is used correctly and return on investment will be fast and high. The initial investment is usually pretty high, hence it is not easy to afford to use energy form renewables for everybody or in every area in the Czech Republic. In terms of this country, there are not so many places, where it is possible to use energy from renewables in a bigger amounts and to operate big investments into larger projects. The sunshine is not so intensive and even during the whole year. Or, regarding wind plants, there are always not suitable conditions for those, because weak or lack of wind flows. And geothermal energy is the case of a certain localities, it is literally not possible to build it anywhere else, then where the geothermal bearing occurs. And these are only a few examples of complicating dependencies on natural conditions.

When there are, however, good natural conditions where would it be possible to run some kind of pant producing energy from renewables, it brings the disadvantage with mostly common need for very extensive area. IT is usually complicated to get all of the permissions and run the business, because of other weakness which is lack of information about renewables. There is need to inform people on a country side more, so they will not be afraid of any new technologies near to their households.

There is also lack of qualified work force in technical areas, however the potential and personal development are assured. Other problem where renewables struggles are big differences in economic level of the Czech regions, so the new projects cannot be run, even though there are great natural conditions in that area. And there is also a big risk to run a new business and, in this case, of a pretty big scale. Not only very big initial investments, but also low dynamics of running new businesses in the Czech Republic slows the development in renewables down. There is also very low communication and support with institutions in abroad in terms of Research and Development, which is subsidized by European Union by European Regional Development Fund.

There is also weakness in the negative trade balance with raw materials, in the Czech Republic. Unfortunately, the trend does not seem to be different in the near future. The

Czech Republic does not dispose of a big amount of material reserves and that causes the negative aspect of this problem.

Opportunities

Between the biggest advantages of using renewable resources is the independency on energy supply from foreign countries in the future. It is very important for any economy of a state not to be dependent on energy supplies at these time, because of latest affairs (eg crisis in Ukraine or oil crisis in 70's). Trade with non-renewables is very sensitive and small disruption can cause big changes in prices of such a commodity. It is a big opportunity though, for every country, to be less dependent on energy supply.

To be independent in terms of energy supply is also in interest of the European Union, not only on each state individually. There are many programmes from the side of European Union, which support development in renewables. Among other opportunities, there is also one in enhancing government to develop international cooperation net for new or existing projects regarding renewables, then even bettering the infrastructure would be a good point as well. The support of innovations in new technologies and overall support in research and development is a chance for renewables to become more popular, though the awareness about renewables and their pros will increase and people will then be more willing to live, for example, next to a wind power plants. When inhabitants starts to be comfortable with everyday contact with new technologies, it is then question of money to run new projects in a region. Though local businesses should be more informed about European supporting programmes and start to be more attractive for incoming investments. There is also an opportunity for universities and educating institutes and economic sphere, where those should be supported in communication and new students and then workers and professionals, interested in renewables in all the ways, not only in research or development, but also in an operating phase, they should be supported in communication and education.

In order to lower negative trade balance of raw materials in the Czech Republic, there is a possibility to intensify exports in products from minerals (e.g. ceramics) or to emphasis

export of electricity. Also in order to support the independency in terms of energy supply from abroad, it is essential for the Czech Republic to find more producers and not only a few. Following this strategy, the country will be aware of any possible energetic shutdowns and prices can be also compared and finally generated the most advantageous suppliers.

Threats

There can be many threats endangering new projects regarding sourcing of energy from renewables. One of those, and maybe the most complicated, is to be able to find a good locality for using a renewable resources. Not in every spot of the Czech Republic, there are good natural conditions and when there is a businessman, having purposes to invest into a plant, there is not always the locality.

Another threat for renewables is the lack of awareness about such a topic. From the low awareness, there are then conflicts between groups for and against new projects regarding renewables. These conflicts have negative impacts on the future plans with renewables and support negative consciousness about them. The reason of low popularity could be that the market with renewables is still pretty young and though people have not many experiences with them. The Czech government would also be willing to support renewables and awareness about them, in their own good and for all of the advantages described in the strong part of this SWOT analysis. Between other threats possibly affecting field with renewables can be weak cooperation between energetic and environmental companies.

Another threat could then be a fact, that well educated workforce is moving outside the Czech Republic to other countries from the reason of better financial evaluation, which is a future problem of many other fields, not only of renewables. However, this field needs highly educated and trained workers that is the reason why such a field could be threatened in the future. Also negative aspect is that there is lack of young workers in companies and the proportion of older increases.

When keeping the same trend in terms of energetic dependency to foreign supply, the situation can be crucial for economy of the Czech Republic. When the dependency is based on a few states, possible shutdowns or non-reasonable pricing of commodities is a very probable threat.

A different threat is in the majority of exports of raw materials from the Czech Republic to the EU area. The reason is in the united market, which reacts on outside economic situation similarly, as for example the world economic crises did. When the EU area will be negatively influenced by similar situation, trading partners of the Czech exporters will be weak in its trading possibilities and so the country will face economic recession.

5. Conclusion

In this Thesis, the main characteristic regarding natural resources in the context of economic activity has been states. Natural resources were defined as a trading commodity in the market. The appraisal and principles of trading with natural resources were clearly defined and the economic context was described. For the purposes of economic analysis, the main theoretical features were presented, as well.

In the second part of theoretical section of the Thesis, there were selected natural resources providing energy on the territory of the Czech Republic were described in detail. For better understanding the overall concept of the natural resources, those were split into two main categories – renewable and non-renewable natural resources. Based on this division, following objectives of the Thesis were feasible to evaluate and results assessed.

From the analysis of trade balance of natural resource in the Czech Republic, it is obvious, that the country faces negative values and according to its resources, the situation will not change significantly in the near future. The Czech Republic, however, does not import mainly from the European Union. The main distributors of materials are Russia and Scandinavian states, mainly Norway. Other important suppliers at which the Czech Republic is dependent are the states of eastern Asia, Libya or Nigeria. The main imported commodities affecting the whole trade balance are natural gas and crude oil. On the other hand, the Czech Republic exports mainly to states of the European Union. The advantages of such a trend are in lower transportation costs and related expenditures, however, to support the economic security, it is important for the Czech economy to find more customers in other states and try to diversify the Czech supply. In terms of export, coal is the main commodity with the Czech Republic trades with. From the graphical presentation of the Czech imports based on main material categories, it is clear that the main share form

imports creates imports of fossil fuels. Those are followed by metal ores. Such a situation is a trend of the last years and predictions does not change it. The situation differs a lot in terms of the Czech material export. In the 90's, the main exported commodity were fossil fuels, whereas in 2005 the situation dramatically changed and the main exported group of material became biomass, and the situation is the same until the present days. The physical trade balance represented in tonnes includes clearly shows, how the curve reacts on the economic situation of the state. Years 2009 and 2012 are the years of economic recession of the Czech Republic, these are also years, where the physical trade balance curve significantly falls down.

Domestic Material Consumption is another significant indicator of trading with natural resources. Based on data from DMC indicator, the dependency of the state's economy on material supply can be generated. That is a very significant reason of evaluating these data. Domestic consumption has been stable since 2004, however, the situation changed in 2009 and 2012, when the numbers decreased dramatically. The reason was definitely the economic situation of the country, when in these years the related industries noted lower profitability. However, the curve, representing total domestic material consumption slightly declines in the last years, the reason could be attributed to supporting renewable resources and their higher usage within the industry. In terms of domestic material consumption based on group of materials, the majority consumed in the Czech Republic in 2013 are non-metallic minerals (42%), followed after by fossil energy materials (39%). Data processed were put into comparison with trends in the European Union, where the total domestic consumption copies the same slightly decreasing trend, however in higher amounts. And the main materials consumed within the EU are non-metallic minerals, followed by fossil energy materials.

Resource productivity is an indicator based on relation-ship of Gross Domestic Product and Domestic Material Consumption indicator. Such a data are then very important in evaluating trade with natural resources. For the whole period of time presented, the trend of resource productivity increases, and was not significantly affected by world crisis. The trend of the Czech Republic copies trend of the European Union, from which can be deducted, that the Czech Republic reflects strongly economic situation of the Union. In 2009 the increase is not so significant, the reason is in the economic crisis, when the

situation of industries regarding services stronger their position. Heavy industry sector plays an important role in the Czech economy, which is an industry intensively using raw materials. That is the reason of GDP dependency on trading with natural resources.

In the chapter which analyse natural resource rents as a share of the state's GDP, there are outcomes as following. The trend line computed by MS Excel and its linear regression function expresses increasing tendencies of the share of natural resources rents to GDP, since 1990. In 1992, the major economic boom has been noted and natural resources started to play major role in the Czech economy. The natural resource rents are amounts based on difference between the production costs of the resource and its price on the resource market. The world crisis and economic situation of the Czech Republic at that time is clearly reflected in decreasing values for natural resource rents share, in 2009 and 2012. These dates were obviously very difficult for the Czech economy.

Share of renewable energy resources in final energy consumption is a part of the thesis, where renewable resources are set aside the total materials analysed in previous chapters. The renewable energy resources are a big issue for the Czech Republic from many reasons. The major one is the commitment to the European Union and its directives regarding this topic. The Czech Republic has to achieve 13% in 2020 of renewables in final energy consumption. The predictions are quiet positive, and 13% of renewables will contribute to final energy consumption before this set deadline. The European Union as a whole has the target of 20% at all in 2020. Last year, in 2014, there where new targets set for 2030. Those commit the European Union to use renewables from 27%. The situation of every Member State of the European Union has been compared in 2012 in this Thesis and it is important to say, that position of the Czech Republic is very positive, because it is one of the countries that are able to fulfil its obligations.

Usage of renewable energy resources is very important regarding dependency of the Czech Republic to the Energy Supply from abroad. Since the Czech Republic will be using own renewables providing energy, it will be more independent on supply from abroad, hence the economy will be more secured. Energetic dependency fluctuates from 25% to 28% since 2002, which means, that the Czech Republic is from 75 to 72% self-sufficient in energetic needs (consumption). Such a result is very positive in the context of the whole

European Union, where there are states such as Malta, Luxembourg, or Cyprus, which are dependent to energy supply from almost 100%. The absolutely independent state in the European Union is then Denmark, which is even able to sell its surpluses.

In terms of evaluating natural resources in terms of macroeconomic point of view, it is very important to analyse, how much economic activity of natural resources affects the Czech GDP. One of the major resource for any economy is collection of taxes that are included in production approach of the GDP computation. One of the type of taxes are those collected from ecological activities and are called environmental taxes. Their relationship was processed in the statistical program Gretl and its ordinary least square method, which generated significant dependency of GDP to this kind of tax, whereas results are statistically significant, according to this program.

SWOT analysis, at final, evaluates natural resources and their usage in the Czech Republic. Such an analysis was processed in order to deeply look at the issue of the economic activity of natural energy resources in the state. The positives of using renewables for energy purposes as well as the strong position of the Czech coal industry are described. On the other hand, strong dependency on material supply from abroad and for example forecast of negative trade balance of materials are attributed in the weaknesses of this analysis. Opportunities in new trading strategies with energy or new workplaces in the country are included as well as threats represented by environmental burdens and depletion of natural resources in the future. The output of SWOT analysis offers a view to internal issues of natural resources within the Czech Republic and external opportunities and threats were described in order to bring an outcome of possible scenarios regarding this problem.

6. Resources

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