

## Czech-Austrian Winter and Summer School

### Independence of the Energy – System in Austria and the Czech Republic

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## **ABSTRACT**

When in winter of 2009 the supply of natural gas from Russia to Europe discontinued, the dependence on foreign countries and hardly controllable circumstances in the whole energy supply was again pushed into public discussion. To analyze the background of this issue, a general evaluation of possible energy sources will be made in this paper. This consists of criteria as independence, cost and environmental aspects and leads to the application to the countries of the Czech Republic and Austria. A most probable way to achieve an independent energy-system in the countries of investigation will be suggested under consideration of certain socio-economic and political situations.

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## LIST OF ABBREVIATIONS

ČEPS	Czech Transfer System
CO <sub>2</sub>	Carbon Dioxide
ČSÚ	Czech Statistical Office
EU	European Union
GWh	Giga Watt Hour
IEA	International Energy Agency
MPO	Ministry of Industry and Trade
Mtoe	Million Tonnes of Oil Equivalent
MWh	Mega Watt Hour
MZP	Ministry of Environment
TOE	Thousand Tonnes of Oil Equivalent

## INTRODUCTION

Fossil fuels such as coal, oil or natural gas create the basis for Europe's energy sources. All three raw materials are non-renewable sources of energy. Due to a soaring demand in Europe and also worldwide it should make us wonder what will be the consequences of their exhaustion. Availability and security of energy and raw materials are one of the basic conditions for existence of any society. Provision of energy and raw material needs to society is one of the most important tasks of any state. A reliably functioning energy sector is an essential condition of national security, economy and its competitive potential prosperity.

The Czech Republic and Austria are heavily dependent on imports of raw materials. Our goal is to find out what options each country has to reduce its dependence on Russia and other countries which are exporting oil, gas and coal. Each country professes different approaches to solve the current problem. The reasons may be different beliefs and diverse geographical conditions. The purpose of this work is to find resources that will respect economic and environmental requirements while reducing dependence on imported raw materials.

In order to do so, we will firstly illustrate the current situation in each country of investigation and show the most relevant figures for this approach. After that, an evaluation of environmental as well as economic aspects for the different sources of energy will be accomplished. Finally, country-specific possibilities to reach a more independent energy-system will be suggested.

## 1. CURRENT ENERGY SITUATION

The Energy Policy of the Czech Republic is based on the State Energy Policy adopted in 2004. In these days is preparing an updated version which should be published in June 2012. The main goal of it is the pursuit of independence from foreign energy sources, promoting sustainable development and ensuring energy security (MPO, 2011). Referring to the Energy Strategy for Austria designed by the Ministry of Life and the Ministry of Economy, Family and Youth, the goals are quite similar as they include security of supply, CO<sub>2</sub>-Reduction and cost-efficiency (Lebensministerium, 2010). Simply put, it is important to guarantee the citizens in both countries a reliable energy supply in crisis situations, which are also environmentally friendly.

In the Czech Republic the main energy sources are currently coal and nuclear energy. Almost 60% of the electricity is produced by coal power plants and another 32% by the nuclear power plants. Coal mining caters the country from some own stocks. Brown coal is mined in northern Bohemia and black coal in northern Moravia. It is one of the most important raw materials. In particular, thanks to nuclear power plants Dukovany and Temelín the Czech Republic is the third largest net exporter of electricity in Europe, after France and Germany. Renewables do not have a very strong position, even if this state has changed in the last few years. Alternative energy sources are gaining importance, especially photovoltaic and wind power. Hydroelectric power plants accounts in the total electricity production for about 3%. Unfortunately, there are only very low natural conditions to increase this share (IEA, 2010b).

About the reversed situation occurs in Austria, where facilitated by the good geographical conditions, hydroelectricity accounts for about 30% of total energy production. Nuclear power is no part of the production and also coal accounts only for a negligible small amount of the production. About 40% are produced by combustible renewables and waste while other renewables as well as oil and natural gas are the sources for the residual 30% of Austrian energy production. (Streicher et al, 2010, p.7)

The biggest problem, in terms of independency for the Czech Republic, creates oil. Although it has deposits of oil, they are really small. The extracted oil is used exclusively in the chemicals industry (IEA, 2010b). Also Austria has only rather small resources of usable oil and gas, what results in high import quotes. The total energy imports increased strongly over the last decades, so that actually 2/3 of total consumption comes from foreign countries and only 1/3 is produced domestically.

Outlook for the future suggests that given the decline in coal production and increasing energy consumption, the Czech Republic will be more dependent on imported energy sources. At the moment the Czech Republic stands quite well in terms of imported energy raw materials on a level of 40% where else Austria is on the average of the European Union of 70% (cf. Mohelník, J., 2012).

## 1.1. CURRENT PRODUCTION AND CONSUMPTION

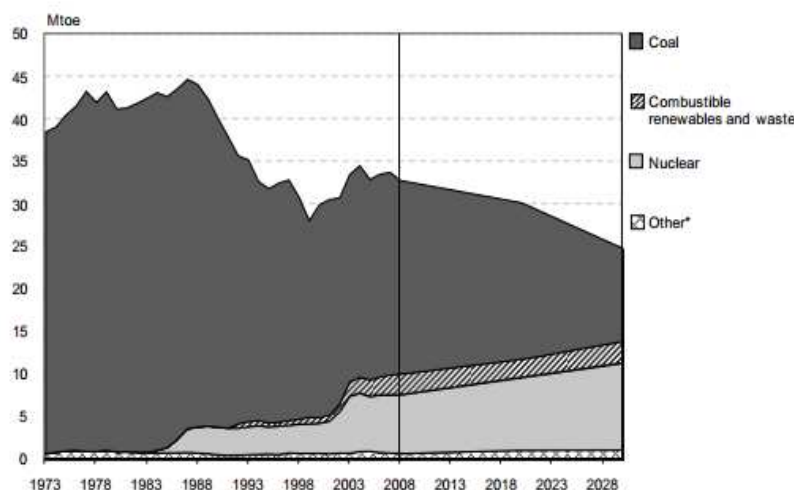
In the following subchapter a more detailed look will be taken on the current situation of production and consumption in Austria and the Czech Republic, which will lead to the balance of trade in energy imports.

As already mentioned above, the situation of production of energy in the Czech Republic and Austria is fundamentally different. This is underlined in Figure 1a and 1b, which shows the energy production by source of each country in the years 1973 up to 2005 respectively 2008 and gives also a more or less reliable outlook for the future by the IEA.

For the Czech Republic, shown in Figure 1a, it is obvious that the main production is based on coal. It currently accounts for nearly 70% of the energy production, with the total production of 32,82 Mtoe. In the late 1980s and 1990s there was a drop of output caused by a government decree. It entailed that mining activities were ceased because of the environmental impacts of the mining. It is clear that the production of nuclear energy in 1985 started by the opening of the first nuclear power plant Dukovany. After the year 2003 there was the accrual of the nuclear production caused by the new nuclear power plant Temelín.

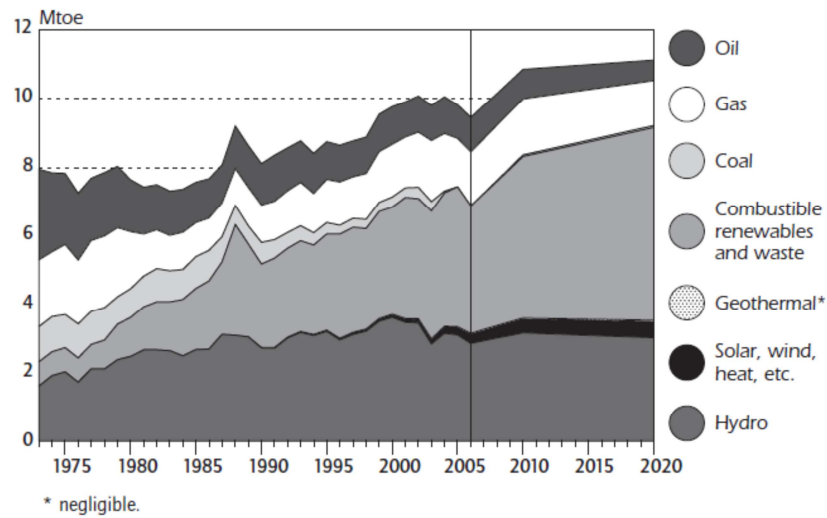
Figure 1b shows the situation in Austria, where the sources of production are more diverse. As stated by the government, nuclear power is no opportunity for the country neither to secure energy supply nor to fight climate change (Lebensministerium, 2010). While the share of coal went down in the last decades to nearly zero, the production out of combustible renewables and waste strongly increased. So that by a rather constant amount of hydro, oil and gas the total domestic production also increased over this period for about one quarter. Although renewables like wind, solar and heat multiplied since 1990, the share in total production is still below 5%.

**Figure 1a: Energy production by source in the Czech Republic, 1973 – 2030**



Source: (IEA, 2010b)

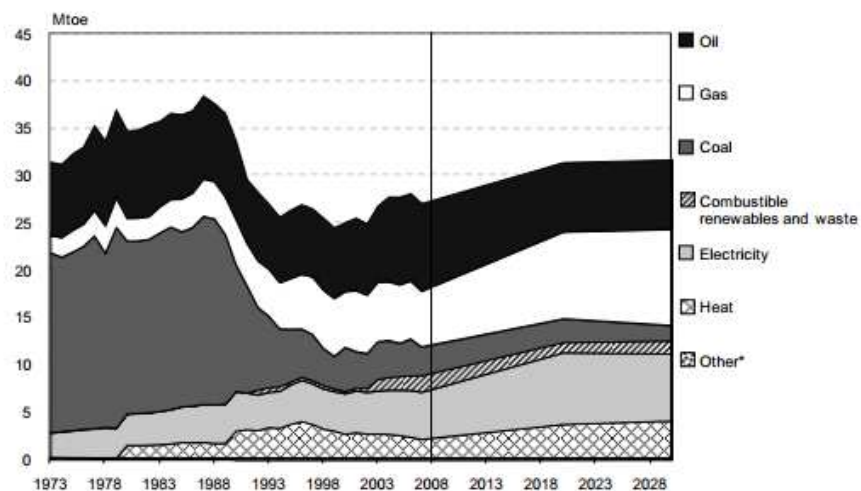
**Figure 1b: Energy production by source in Austria, 1973 – 2020**



Source: (IEA, 2008)

Considering the consumption side of the two countries of investigation, the situation is not that different. The current total and even more the final energy consumption per capita are very close, as also the total population is not much higher in the Czech Republic than in Austria (data.worldbank.org). Nevertheless, the history and composition are not the same. In the Czech Republic the fuel-energy resources include black and brown coal, natural gas, oil and uranium ore. All mentioned raw materials are possible to extract and consume. Caused by the large decrease in the production of coal, the total consumption went down in the early 1990ies and then slowly grew again, as shown in Figure 2a. The Austrian total consumption, displayed in Figure 2b steady increased as nearly all of the sources except for coal did. As oil and gas are the main drivers for the increases in both countries, and their domestic assets of these sources are only little existing, the dependence on these two raw materials is striking.

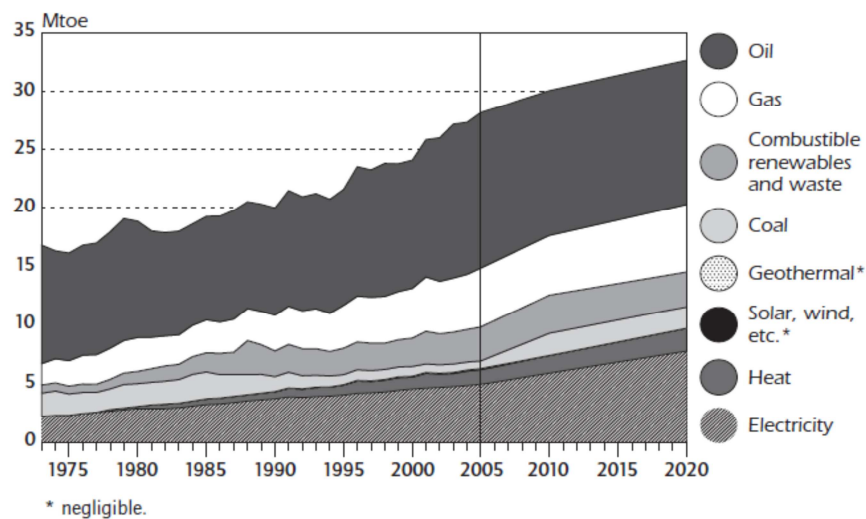
**Figure 2a: Total final consumption by source in the Czech Republic, 1973 to 2030**



Source: (IEA, 2010b)



**Figure 2a: Total final consumption by source in Austria, 1973 to 2030**



Source: (IEA, 2008)

It is also important to know which sectors have the major shares. Therefore the three sectors of industry, transport and residential are considered. Probably nobody will be surprised that in the Czech Republic, the most significant part in consumption is caused by the industry (34%), followed by residential (26%) and transport (25%). For Austria the situation is a bit different, as industry accounts for 32%, transport for 31% and residential for 25% of total consumption. (epp.eurostat.ec.europa.eu)

The comparison of production and consumption leads to the analysis of exports and imports for each fuel-energy raw material, as displayed for each country in Table 1. A key figure in Table 1 is the home coverage. It shows the ratio of domestic output to the volume of materials that remain in the country after addition of imports and subtraction of exports. It is obvious that the Czech Republic is self-sufficient in the production of black and brown coal. Most imports of black coal come from Poland. Brown coal is processed almost exclusively in the Czech Republic. For oil and natural gas the situation is reversed. Although these raw materials are extracted in the country, they can only satisfy a small level of the demand. For that reason the majority is imported. Nearly all the depleted uranium is exported and then imported back in the form of processed uranium as nuclear fuel. For Austria the coverage of fuel-energy raw materials is only positive for oil and gas, as there is no coal-mining anymore and no existence of nuclear resources. Also the share of domestically produced oil and gas is not higher than 20% for any of those, what leads to high import rates.

**Table 1: Balance of trade in fuel-energy raw materials, 2010**

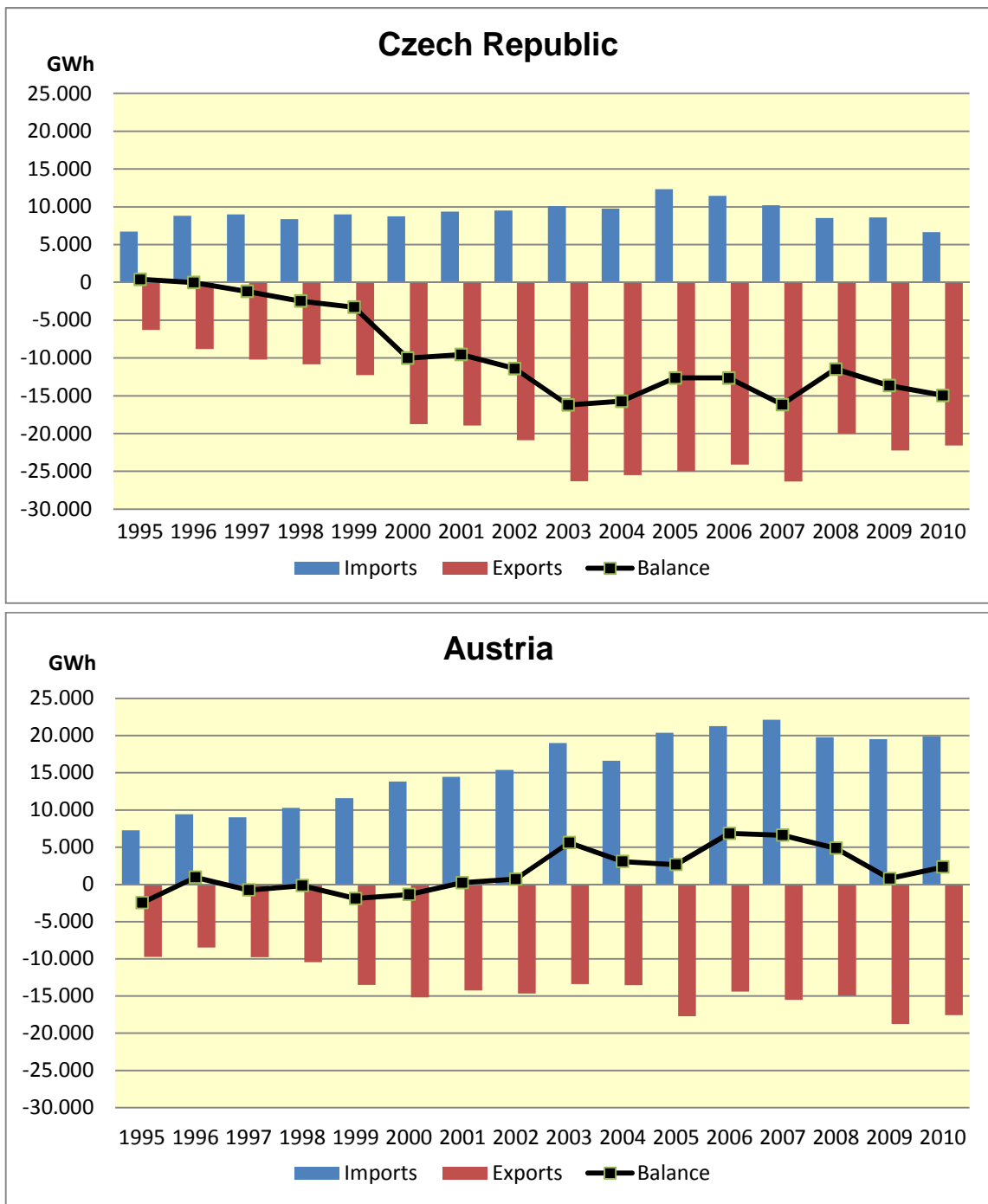
Raw material	Black coal [kt]	Brown coal [kt]	Oil [kt]	Natural gas [TOE]	Uranium. [t]
Czech Republic					
Output/year	11.435	43.774	272	167	322
Import/year	3.170	207	10.454	6.976	N/A
Export/year	7.157	1.127	1.614	130	316
Gross domestic consumption	8.142	43.807	9.162	8.019	N/A
Gross domestic consumption [TJ]	218.370	555.082	390.839	335.723	7.248
<b>Home coverage</b>	<b>140,4%</b>	<b>99,9%</b>	<b>3,0%</b>	<b>2,1%</b>	<b>N/A</b>
Austria					
Output/year	-	1	1.011	1.486	-
Import/year	4.390	53	13.621	10.192	-
Export/year	13	8	2.187	4.078	-
Gross domestic consumption	4.985	43	12.841	8.214	-
Gross domestic consumption [TJ]	141.505	717	548.075	343.922	-
<b>Home coverage</b>	<b>0,0%</b>	<b>2,3%</b>	<b>7,9%</b>	<b>18,1%</b>	<b>-</b>

Source: (epp.eurostat.ec.europa.eu, 2012), (MŽP, 2009)

## 1.2. IMPORTS AND EXPORTS OF ELECTRICITY

For the assignment of the independency in the Czech Republic and in Austria it is also important to know the situation of imports and exports of electricity. It is an essential part of every developed state. Without electricity is impossible to grow and that is the aim which everybody wants to achieve. In the Czech Republic ČEPS (Czech Transfer System) provides the cross border transfers for exports, imports and transit of electrical energy (ČEPS, 2012). In the following figure the balance of imports and exports will be pointed out for Austria and the Czech Republic.

**Figure 3: Electricity imports and exports as measured between 1995 and 2010**



Source: (CSU, 2012) (Eurostat, 2012)

It is obvious, from Figure 3, that the Czech Republic has a positive balance of electricity imports and exports. We can also see a higher capacity of electricity exports after the year 2002. This accumulation was caused by the opening of the new nuclear power plant Temelín. Particularly thanks to the two nuclear power plants Temelín and Dukovany, which are situated in the south part of the state, the Czech Republic is after France the second largest exporter of electricity in Europe (Topolánek, 2011).

In Austria a relative strong rising demand and a less strong increasing domestic production enlarged the need for imports of electricity over the last decade. With a share of about 60% of total domestic production of electricity coming from hydro plants, a respective large range of imports and exports could be the result, as the capacities are hardly controllable. Nevertheless, one third of this production by hydro power was produced by pump storage plants, which reduce the need for imports. Further, storages of natural gas, in the amount of 50.000 GWh, in Austria exist, what reduces the risks of imports (Energie-Control Austria, 2011).

The biggest amount of electricity exports from the Czech Republic flows to the neighboring countries, in the concrete 70% was transferred to Slovakia and Germany. On the contrary 90% of the Czech import comes from Poland and the rest from Germany, Austria and Slovakia (Ihned.cz, 2008). The mostly unknown fact is that the Czech Republic disposes of reserves in power capacity to the extent of 15% (Drábová, 2012). The positive information is that the Czech production of electricity is only dependent on imported fuels from 40% (VUPEK, 2012). This low import-dependency is created mainly by using domestic coal reserves. Nevertheless, it should be taken into account that this situation can change progressively. Therefore this source should be consumed effectively and thriftily and also try to increase share of renewable energy.

## 2. ECOLOGICAL ASPECTS OF ENERGY SOURCES

In this chapter the ecological potential of each energy source will be discussed, namely oil, gas, coal, renewables and nuclear. A country cannot focus only on available sources when reducing dependency, but also on sources which are environmental friendly. The EU countries as the Czech Republic and Austria have committed to the fulfillment of obligation which follows from the Kyoto Protocol. "This is a package of measures that aim is to reduce by 2020 greenhouse gas emissions by 20% compared to 1990 levels, increase the share of renewable energies in overall EU consumption to 20% and increase energy efficiency in Europe by 20%" (Evropský parlament, 2008).

### 2.1. FOSSIL FUELS

The situation among fossil fuels is for all of them similar. In this part oil, gas and coal will be discussed. It is obvious that fossil fuels are not ecological sources and for this reason they should be used as little as possible. Nevertheless, they dispose of better calorific property and power in comparison with for example renewable energy. Another benefit is that they are serviceable in every moment and we do not have to wait for sun or wind. That is their main advantage. However, people should not forget the fact that fossil fuels have a big share on global warming. Professor František Janouch points out that "fossil fuels were generated in the bowels of the planet hundreds of millions of years to absorb atmospheric carbon dioxide. Now, when they are burning, the greenhouse gas releases into the atmosphere at a rate of nearly one million times faster than was once absorbed" (Janouch, 2011).

The danger of oil is not only by burning when carbon dioxide is released to the atmosphere and causes greenhouse effect but it is on the beginning of whole cycle. Firstly, the mining of oil is a huge disruption to the face of a landscape. Secondly, there is a problem with transportation. Although every new tanker according to law from 1990 must have a double lining that prevents the outpouring of oil into the sea during an accident, they are still happening (Habjanec, 2008). It has negative impact on flora and fauna in the part of affected area of the sea. That was only a brief overview of adverse effects of oil.

The next fossil fuel refers to coal. We differentiate two types of coal. Between brown and black coal are from ecological point of view quite distinctions. Brown coal is used in Czech households the most often because it is the cheapest source. On the other hand brown coal burdens the environment the most and in addition to that has the lowest calorific property. Black coal is more expensive however more environmentally friendly. By both of them the biggest problem is the mining. For example the opencast mining in the north of Bohemia in Most's coalfield is devastating the landscape which cannot be reclaimed again. Other problem is dust particles and their negative impact on local pollution. Although coal has lots of cons, its biggest pros are very low costs in comparison with other energy sources and also the fact that coal is a native fuel in the Czech Republic (Kos, 2012).

The last one of the fossil fuels is natural gas. Although it also belongs to fossil fuels, in comparison with them it has significant advantages. By combustion it does not release so

much harmful substances like in the instance of coal or oil. For example for the released unit of heat is generated by burning natural gas by 50% less of carbon dioxide in comparison to solid fuels and by 35% to liquid fuels. Another important advantage is that gas lines are put under ground and therefore do not violate the landscape. Easily say that gas is the most environmental friendly source from fossil fuels. (Zemní plyn, 2010).

## **2.2. RENEWABLE ENERGY**

Among renewable energy there are counted primarily solar, wind and hydro energy and also biomass. Alternative sources are really important from an ecological aspect. The support of renewable energy will lead to the reduction of greenhouse gas emissions and thereby to the mitigation of global warming. That is their significant advantage.

Nevertheless, renewable energy is not as environmentally friendly as they may appear. For instance, solar energy occupies fertile ground, which could be used for growing foodstuffs. With wind energy is connected the same issue. In addition to that, wind power plants are quite noisy and they disturb people who live nearby and also animals. Water power plants are also not completely ecological but they have one substantive benefit. We are not able to accumulate and store solar or wind energy. However, pumped storage plant disposes of this ability.

## **2.3. NUCLEAR ENERGY**

Nuclear energy and ecology is an often discussed topic. Supporters claim that this source of energy is environmental, because it does not produce carbon dioxide. Reduction of CO<sub>2</sub> is nowadays the main goal. Opponents point out mining of uranium, storage of spent fuel, radioactivity and the biggest problem the possibility of nuclear disaster. Both groups are particularly right.

As mentioned above, nuclear power plants do not produce greenhouse gases and do not consume primary resources that could be used for other purposes. Of course, by construction of the power plant the air is polluted and even the intervention to the soil is not negligible. However, in comparison with other sources it is doing very well. Quite a significant benefit is that a small area provides great performance.

One of the main problems of nuclear energy is the waste. Radioactive decay takes a long time, which may scare many people and the issue of final repository of nuclear waste is still not resolved. The waste is firstly stored in the spent fuel pools near the reactor and then to 60 years in dry storage overhead. After this time it is taken to deep underground repositories, in highly secure containers that are designed to withstand extreme conditions. For several years we may not use this procedure because there are technologies for the reprocessing of spent fuel to new one. But the process is still not economically profitable.

There is no doubt that nuclear accidents have a strongly negative impact on the environment. Certainly a lot of us think of the Chernobyl nuclear plant disaster in April 1986, Three Mile Island accident in the United States or the recent explosion in Fukušima. The crash may occur by the interplay of different factors, but the likelihood is very slim. High security, advanced technology and high-trained staff are a guarantee of safe operation.

To conclude nuclear power plants have both positive and negative impacts on the environment. The negative counts extraction and subsequent refining of uranium. This represents an intervention into the landscape. In addition, storage of spent fuel is still an unresolved question. If we compare coal mining with uranium mining, it is an intervention into nature in both cases. Nuclear accidents disrupt the ecosystem. Affect agricultural land, afterward produced food and animals. Effects on human beings are obvious. Plus points will earn nuclear energy that does not cause greenhouse effect. This is its main strength (Burket, 2007).

### 3. ECONOMIC ASPECTS OF ENERGY SOURCES

To analyze the economic aspects of different sources of energy, we focused on the costs for production of electricity in power plants in which they are used. In this process several costs were accumulated to total costs of production in €/MWh, which include costs for capital, operating costs as well as fuel costs. External costs of pollution cannot be completely included as they are very difficult to measure in an accurate way. Although, to contribute to these negative externalities on the one hand a price for CO<sub>2</sub>-emissions is included and on the other hand the negative aspects of different sources of energy were discussed in the chapter above. The capital costs account of course for the plant itself but also for overnight investment costs, the parcel of land and interest. As costs are accumulated, which arise at different moments in time, there has to be on the one hand a certain discount rate, and on the other hand a forecast for the development of fuel prices.

In Table 2 the costs for energy production are shown for some of the most relevant, currently operating power plants in the Czech Republic and Austria. These are clustered by source and therefore the costs are shown in min-max range, as they depend on the exact type and size of the power plant as well as on the assumed discount rate.

Further in Table 3 the total costs per unit of energy for possible new energy-production sights are also displayed in a min-max range. This is argued by the fact that beside the parameters of discount rate and forecasts for energy prices, also the average utilization and the interest rate for capital affects the outcome of total costs.

**Table 2: Total costs of current production of electricity, 2010**

	€/MWh	Coal	Natural gas	CHP*	Hydro	Geothermal	PV	Nuclear
CZ	min	57	63	29	106	112	267	47
	max	104	80	272	312	184	416	78
AUT	min	0	0	35	33	0	0	0
	max	0	0	38	63	0	0	0

\*combined heat and power

Source: IEA (2010)

**Table 3: Total costs of possible new production of electricity**

€/MWh	Brown coal	Black coal	Natural gas	Biomass	Wind	PV	Nuclear
min	49	56	73	107	102	228	41
max	63	67	84	122	137	380	66

Source: Wissel (2010)

For the current production in the Czech Republic, nuclear power turns out to be one of the sources with relative low costs. Only some combined heat and power stations account for lower costs of electricity, what also strongly depends on the type of combination. Natural gas and coal also seem to be on the lower end of costs, where again coal has a bigger range as it is not split up in brown and black coal. Considering renewable sources, geothermal and hydropower are somehow close to coal and natural gas under certain



conditions, although range up to 312 €/MWh. Photovoltaic clearly causes the highest costs, although in the last few years, these constantly declined and might will do in the future.

For Austria the main sources for production of electricity, hydro and combined heat and power plants, are quite close, depending on the assumptions. Due to favorable geographic conditions, the Austrian costs for hydro power are even lower than nuclear power in the Czech Republic. Also CHP is on a low level, with a small range, compared to the Czech.

As in Table 3 the possible costs for electricity of some new power plants with state of the art technology are shown, economic suggestions could be made. Fossil fuels as well as nuclear power clearly show an advantage in costs, compared to renewable sources of energy. Although, two points can be pointed out in this case. Firstly, that technological innovations in the sector of renewable energy lead to big reductions in production costs in the last years, whereas the efficiency in the production by fossil fuels seems to be already mature. Secondly, as shortly mentioned above, the calculation of this costs accounts only for a very small part of external costs, as there is no recognition for the risks of accidents or for the total costs of emissions of greenhouse gases.

## 4. SUGGESTIONS

The Czech Republic and Austria have a limited amount of raw materials for energy production. This fact is alarming, because the consumption is increasing and population demands are rising. Besides, the governments have to respect the Kyoto Agreement.

In the situation of Austria the biggest imports are caused by oil and natural gas, which should be transformed into other domestic and preferably renewable sources. For the Czech Republic it follows, that coal power plants should be changed with more ecological sources. The problem is that coal power plants nowadays are providing about 60% of the Czech supply of electricity. It will be difficult to find the source which would meet strict environmental requirements and be high-performing. There are only two other possibilities which can be considered. Those are renewable and nuclear energy.

Renewable energy is doubtless environmental friendly. Another positive fact is that with the production of energy from alternative sources the country will be less dependent on external supplies, thus will be less affected by volatile oil and gas prices, while it will reduce emissions. Nevertheless, it would be difficult to rely only on this source. The example from Danish island Samsø will document this statement. This island, which is situated in the middle of Denmark, produces more energy than it is able to consume and furthermore 100% of this energy comes from renewable energy. For all that Samsø is not completely energy self-sufficient. The reason is that there are moments when the consumption is higher than production (CZREA, 2011). This truth is the strongest disadvantage for alternative energy. They are unreliable. The exceptions create pumped storage plants. They can change their power almost immediately.

However, in the Czech Republic they are able to provide only a few percentages from whole consumption. More to that this island has perfect conditions for using renewable energy. This same cannot be said about the Czech Republic. Pumped storage plants in Austria do already account for about 20% of the domestic electricity production. As the geographic conditions are promotive, this share still should be increased. Also combustible renewables have already a share of about 13% of total consumption, while energy production of wind, solar and photovoltaic contributes only slightly. Although, this share also could be increased, the total contribution is not expected to have a decisive influence.

Last source which should be considered is nuclear energy. A lot of people are against nuclear power. They are afraid of nuclear accident. These ideas again enhanced recent accident in Fukušima. Nevertheless, in terms of energy security and independence for the Czech Republic nuclear power plants are the most reliable source of energy with which it should be counted to the future. Today nuclear energy is only one of single low-emission technologies capable of producing large amounts of electricity.

For Austria, nuclear power creates no possibility, as the societal conditions refuse this source of production. But for the Czech Republic our suggestion is to set up whole energy mix on nuclear energy. It should create the biggest share. Then follow coal power plants. Their operation is strategic, because of quite large reserves of black and brown coal. Of

course, it is important to focus on cleaner running of power plants. Finally, the renewable energy should have also its place in energy mix but only as additional source of energy. It would not be reasonable to build up the Czech energy system only on alternative sources.

Two further issues appear for both countries. These are the dependency on oil in the sector of mobility and the need for a reduction of energy demand. Beside incentives for a general reduction of energy consumption, especially in the sector of mobility, a more aware way of consumption should be encouraged. This is the only way to decrease the dependence on oil in this sector, while changing the technology of transport from oil to electricity driven vehicles.

Another aspect to decrease the risk of uncertain imports of oil and also natural gas in the short run is to construct storages for those resources. These measures are already taken to some extent in Austria and the Czech Republic and are an effective way to reduce dependency.

## 5. CONCLUSION

One of the main points of the EU energy policy and as well the National Energy Policy of the Czech Republic and Austria is to reduce dependency. The aim of this paper was to find a solution how the energy system in the Czech Republic and Austria could be more independent. This was shown on the basis of previously explained data for both countries in the chapter above. The analysis of the current situation as well as the target independency displayed by a certain share of imports in relation to total consumption could be further specified. This could be achieved for example by an economic analysis, which accounts for the costs of dependency and shows a market equilibrium with the result of this comprehensive target share of imports. However, ecological and economical aspects were taken into account, although some further examination of the future development of both costs of especially renewable technologies and also fuel costs of fossil fuels should be examined. Also the technical potentials of sources like nuclear power have to be constantly observed, to consult for new developments. Generally an increase in independency has to be grounded on a change in energy supply, an expansion in storage facilities as well as in consumer behavior.

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