

**Czech University of Life Sciences Prague
Faculty of Economics and Management**

Department of economics



Extended Abstract of Diploma Thesis

Economic evaluation of Czech energy mix

**Author: Bc. Natálie Dubničková
Supervisor: Ing. Petr Procházka, MSc, Ph.D.**

© 2016 CULS in Prague

Summary

The diploma thesis "Economic evaluation of Czech energy mix" focuses on the proportion of individual sources of electric energy in the total energy mix. The main objective is to evaluate current energy mix from an economic and environmental point of view. Based on the available data, the thesis points to the basic problems of the mix, and it is especially huge proportion of coal power plants and the associated enormous amount of emissions released into the air. Diploma thesis optimizes current energy mix by using linear programming and suggests the optimal ratio of selected energy sources both from an economic and from an environmental perspective. The result obtained lowers the total cost of electricity production, taking into account the promotion of renewable resources and thus achieving the specified targets 13% share of renewables in gross electricity consumption in 2020. A greater proportion of renewable energy sources will replace coal power plants, which will serve as an additional energy source, which will result in reduced emissions.

Keywords: energy, emission, energy sources, linear programming, renewable resources, sustainable development, evaluation, electricity, energy mix

Introduction

A stable and balanced energy mix is a prerequisite for the functioning of the economy of every developed country. Recent years have represented a period of dramatic changes for the field of energy. The previously stable industry with relatively long persistence had to cope with several significant factors. One of these factors was gradual subsidy of fossil fuels, whose place began to be taken by renewable energy resources. The main reason for this decline was mainly the reduction of the amount of emissions released into the air during energy production and the subsequent production of electricity. Countries around the world began to struggle with this problem and started to adapt to a new trend in the form of renewable resources.

The Czech Republic, of course, was no exception, and after joining the European Union it has to adapt to the legislative action which sets a certain percentage share to the individual member states that have to be represented by renewables in the gross electricity consumption. The limit for the Czech Republic was established at 8% share by 2010. This goal had been the main driving force for the development of the renewable sector in the Czech Republic that has

triggered a wave of incredible support and setting of high purchase prices from these resources.

The photovoltaic sector was definitely hit the most by the support system, which was then created. Production of electricity from the sun has a high potential and in our conditions can be, especially in the eastern Moravia, effectively used. Since 2009, the purchase prices of electricity produced from photovoltaic panels started to grow year after year, which led to the so-called "solar boom" that occurred in our country by the end of year 2009.

The favourable conditions, which were created, attracted also foreign investors to the Czech Republic who took advantage of these conditions, and therefore, this country had built many photovoltaic power plants currently owned by investors from abroad.

The government intervened in 2013 when it was forced to adopt a law that significantly limited the support of the photovoltaic field, also due to the fact that this strong support of renewable energy sources was negatively reflected in the prices of electricity for the final consumers who had to pay increasing contributions to these resources year after year.

The coal power plants represent over 50% of the current energy mix of the Czech Republic. It produces over 44,000 GWh of electricity in year. This enormous electricity production is also accompanied by an enormous amount of emissions released into the atmosphere during this production, and since the Czech Republic is among the countries, which are mindful of environmental aspects in the energy sector, it is necessary to modify the current energy mix, improve it and make it optimal for the Czech Republic.

The term "optimal energy mix" refers to a model that takes into account not only the environmental aspects, meaning a significant reduction of emission production, but also an optimal solution from an economic standpoint. It shows a mix of electricity sources that takes into account the stability of the production as well as the resultant cost of production.

Goals

The goal of the thesis is to compare energy production of each chosen energy resource in the Czech Republic. After evaluation of the current energy mix, based on the gained data by use of a linear programming tool the main objective is to create an optimal energy mix suitable for the Czech Republic and provide economic evaluation.

Methodology

The methods of induction, synthesis and deduction were used for the creation of the theoretical part.

The analytical part is based on quantitative and qualitative data analysis. The required data was gathered from publicly accessible sites of the Energy Regulatory Office. Linear programming, a publicly available tool, was used for the creation of the optimal energy mix. By using the simplex algorithm and mathematical optimization a set of individual energies that satisfy the conditions of the optimal mix is created. 6 main energy sources used in our country were selected for the optimal energy mix equation – photovoltaics, wind, water, coal power plants, nuclear power plants and biogas. Each source is evaluated in economic terms and in relation to energy legislation.

An optimal energy mix is created based on the analysis of the collected data with a positive economic effect, which will also take into account environmental aspects. At the end, the comparative method is used to compare the current and newly created optimal energy mix.

Results

The aim of the thesis was to analyse the current energy mix from the economic and environment stand point. Based on the analysis it was assumed that the current energy mix may be improved from the economic point of view, and definitely ought to be optimized from the environmental standpoint.

The main problem found from the analysis, was the enormous amount of emissions which are produced into the air from the activity of the energy sector. The energy resource causing this problem are coal power plants. These power plants are largely used in the Czech Republic and are improving energy self-efficiency of the country, therefore their use cannot be stopped. But it certainly can be optimized and decreased on such level it would not cause such a huge problem to the environment and their use would still be economically efficient.

By using the linear programming tool there were proposed two optimized solutions, both of them demonstrates the use of nuclear power plants accompanied with renewable resources. Both scenarios proposed the use of biogas power plants and wind power plants, but the first solution added photovoltaics whereas the second chose water power plants.

The creation of the optimal models of the energy mix answers to the first hypothesis, it means that the current energy mix for the Czech Republic is not optimal and the hypothesis is not confirmed.

Since the recommended model dramatically reduces the production of electricity from coal, thereby significantly reduces emissions and prioritizes ecological resources of electricity that are also economically effective in terms of cost. This fact confirms the second part of the hypothesis of an increase in economic performance of producers of electricity.

The optimal energy mix that emerged from the linear programming method confirms the third hypothesis, because the mix recommends the cheapest energy sources, and the lower cost of producing electricity will be adequately reflected in the final price of electricity, which will also be lower.

The use of the water energy cannot be increased any further in the Czech Republic's conditions, since the capacity of the water resources is almost fully used up.

Based on the natural conditions of the Czech Republic, and also efficiency of the use of each energy resource used in the analysis, it is recommended by the author that the most optimal energy mix for the Czech Republic is represented by the first optimized scenario.

References

MASTNÝ, Petr and coll. *Obnovitelné zdroje elektrické energie*. [online]. CR: České vysoké učení technické v Praze, 2011. ISBN 978-80-01-04937-2. Available from: https://k315.feld.cvut.cz/CD_MPO/CVUT-2-OZE.pdf

MÁSLO, Karel. *Řízení a stabilita elektrizační soustavy*. Asociace energetických manažerů 2013. ISBN 978-80-260-4461-1.

Aktualizace státní energetické koncepce České republiky. [online]. Prague 2014 © Copyright 2005 MPO [Accessed on 11.11.2015]. Available from: <http://www.strukturalni-fondy.cz/getmedia/85476420-5469-46ab-a19f-51a0c97eae8d/AKTUALIZACE-STATNI-ENERGETICKE-KONCEPCE-CR.pdf?ext=.pdf>

Coll. of authors. *Obnovitelné zdroje energie a možnosti jejich uplatnění v České republice*. [online]. CR: ČEZ, a.s., 2007 [Accessed on 10.10.2015]. Available at: <http://www.cez.cz/edee/content/file/energie-a-zivotni-prostredi/oze-cr-all-17-01-obalka-in.pdf>

Coll. of authors. *Obnovitelné zdroje energie – Ekonomika a možnosti podpory*. [online]. CR: Ministerstvo životního prostředí, 2009 [2.1.2016]. ISBN 978-80-7212-519-7 Available at: http://biom.cz/upload/6e01d6d4c4835ec93cda508772f3bf6e/oze_ekonomika.pdf