

PRICING ELECTRIC POWER IN THE CZECH REPUBLIC AND IN SELECTED COUNTRIES

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Abstract

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This paper focuses on state intervention in the pricing of electricity from renewable power sources in the Czech Republic when compared with the pricing in the Slovak Republic, Germany, France and Italy. In these countries the state intervention is implemented in different forms, but the critical part of the price is regulated everywhere by the state. The price of electricity is determined by its production costs, which depend on the source from which electricity is produced. The highest cost of electricity is required to generate renewable energy, particularly solar power, while the lowest costs of power are associated with its production by coal-fired and natural gas-fired thermal power plants. However, hydroelectric power plants attain clearly the lowest cost for generating electricity. State intervention includes supporting power generation from renewable power sources by guaranteeing purchase prices.

Keywords: the price of electricity, power generation from renewable power sources, the cost-effectiveness of power generation, state intervention in the electricity market

INTRODUCTION

The ever-increasing need for electricity for industry, transport and households can only be met by power plants with sufficient output. Electricity is converted from heat, from the energy of flowing water, from nuclear energy (the fission of uranium nuclei), from wind or sunlight (Goňo, Král, 2008). The available resources for generating electricity in the Czech Republic include in particular thermal, nuclear, hydroelectric and solar power plants. As far as renewable power sources are concerned, apart from hydroelectric plants, it is mainly solar and wind power which has the greatest importance and prospects. Due to its geographical conditions, the Czech Republic has a relatively limited use of wind and solar energy (Mastný *et al.*, 2011). However, the use of solar energy for generating electricity from solar photovoltaic panels received a high level of state support, which unfortunately was not effectively monitored and regulated in the Czech Republic, unlike in Germany, France or Italy, and it experienced a sharp uncontrollable growth (Pavelková, 2013).

A substantial factor that has an impact on the decisions of politicians and national governments on which resources of power generation will be supported, is its cost effectiveness, which significantly affects the subsequent price of electricity. The price of electricity in the Czech Republic is currently relatively high in comparison with other countries (Federal Network Agency, 2012).

The main aim of this contribution is the analysis of the system of electrical prices paid by households in the Czech Republic in comparison with prices in Slovakia, France and Italy and assessment of impact of state intervention on this commodity price.

MATERIAL AND METHODS

The price of electricity is affected not only by the cost of its production, but also by state intervention, whose share on the final price varies in different countries. The paper first looks at the structure of power generation from different media segmented into thermal and nuclear power plants, and plants

generating electricity from renewable energy sources, which include hydroelectric, wind, solar and bio-gas power plants. Each of the production media determines to a large extent the cost of production, where the performance is measured by an indicator of the power density in kWh/m², which is defined for different types of plants. The production costs are shown in EUR per 1 MWh, again according to the type of power plant. In selected countries (the Czech Republic, the Slovak Republic, Germany, Italy and France) the structure of electricity prices for households is compared, including various items, some of which are regulated by state intervention. The level of regulation varies in different countries. The structure of prices for electricity is assessed in the Czech and Slovak Republics in the years 2009 to 2012, in Germany – due to the availability of data – in the years 2010 and 2011, and in France and Italy for similar reasons in 2011 and 2012. The reference data were drawn from available resources and were subsequently processed into graphs shown in the article.

To confirm results obtained by comparison the Delphi method has been used which belongs to a group of intuitive prognostic methods. It involves the gradual discovery and sequential comparisons of experts' opinion on the future development of chosen area while a mutual anonymity, feedback control of information and statistical identification consensus of expert group are guaranteed. The method is implemented through the sophisticated system of chosen questions in the field of the study which are asked a selected group of experts in the form of questionnaires or personal interviews of survey organizer with individual experts to identify individual opinion. The survey participant

does not come to contact with other respondents interviewed. The optimal group size for the Delphi method varies between ten and twenty participants-experts.

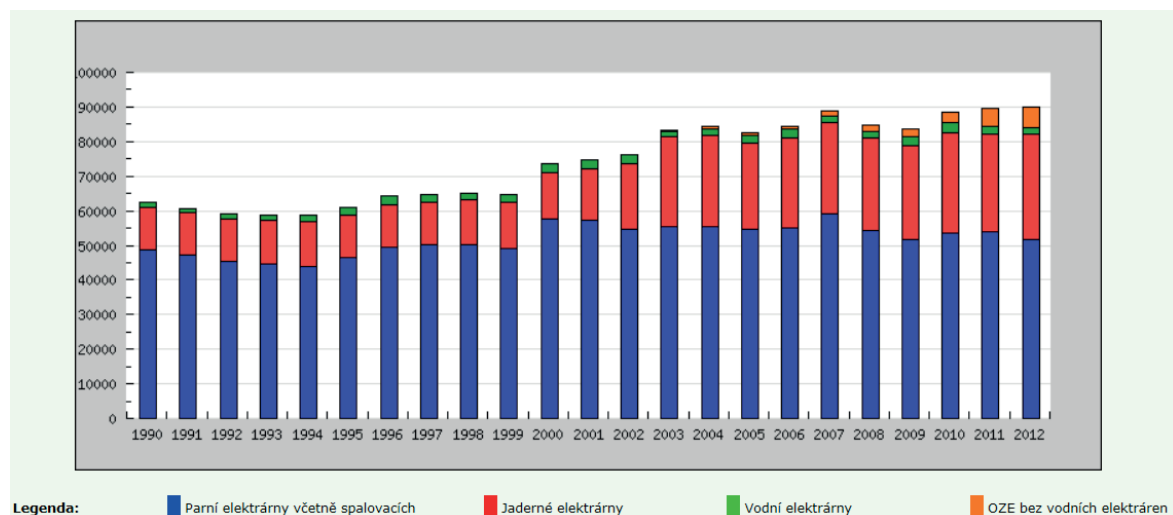
The study uses the responses received by questionnaires (see Pavelková, 2013). With the help of a questionnaire interview was conducted with ten experts from the field of energy sector from the Czech Republic, Slovakia, Germany, France and Italy. Part of the issues asked also included questions like "What are the key factors influencing the price of energy in your state?" and "What are the key factors in your opinion, affect the price of production of energy from photovoltaic power plants?" From each country two experts were approached.

RESULTS AND DISCUSSION

Comparison of the Structure of Power Generation According to Sources in the Czech Republic and Selected Countries

The cost of electricity generation depends on the source from which it is produced. The structure of electricity generation in the Czech Republic according to sources is evident from Fig. 1.

The diagram above shows the increasing share of power generation from renewable sources. Until 2000, the primary source of renewable power in the Czech Republic was hydroelectric power. Since 2000 other sources have been used to generate electricity – bio-gas and waste heat. Since 2009, electricity has been produced in solar power plants. In 2012, out of a total amount of 87,947 GW, 5,927 GWh of electricity was produced from renewable sources, representing 6.7% of the total amount of



1: The structure of electricity generation in the Czech Republic from 2012 data (GWh)

Explanation:

Parní elektrárny včetně spalovacích = Steam power plants (including combustion)

Jaderné elektrárny = Nuclear power plants

Vodní elektrárny = Hydroelectric plants

OZE bez vodních elektráren = Renewable sources (except for hydroelectric)

Source: <http://issar.cenia.cz/issar/page.php?id=1560>

electricity produced in the Czech Republic, while, for example in 2009 this portion was only 2.8%.

The question is what impact the planned expansion of nuclear power production will have on the price of electricity, and also how it will be taken by other European countries, some of which (e.g. Austria, Germany, Italy, etc..) seek the maximum elimination of nuclear energy in the future. It is likely that the price of electricity will also reflect the new costs linked to ensuring adequate safety of nuclear power plants operation.

The above-mentioned increasing share of renewable sources in generating electricity in the Czech Republic corresponds with the expected development outlined by the provisions of the European Parliament and Council Directive 2009/28 / EC on promoting power generated from renewable sources and amending and subsequently repealing Directives 2001/77 / EC and 2003/30 / EC. The Directive divided among the EU Member States the common goal of achieving a 20% share of power from renewable sources in final power consumption by 2020. The target for the Czech Republic was set at 13% of power from these sources in final energy consumption by 2020.

In *Slovakia* generation of electricity from nuclear power plants currently dominates, which makes up 53% of total production. The amount of power generated in thermal power stations is decreasing, and the renewable sources are mainly represented by electricity generated from hydroelectric power stations; since 2000, the share of electricity generated from biogas and waste heat has been gradually increasing, currently making up around 2%. Power generation from other renewable sources such as wind and the sun is still negligible in this country.

In *Germany* generation of electricity from thermal power plants prevails, but power generation from other sources is represented as well and it constitutes an interesting production mix. The significant share taken up by nuclear power plants has been decreasing since 2008 and it is being replaced by a higher volume of production from renewable power sources. In response to the situation following the nuclear accident in Japan in 2011, the German government decided to move completely away from nuclear energy, which will be eliminated and replaced by the production of renewable energy. Germany will build new power plants for renewable energy sources (wind, water, sun, etc..) under an approved program of development for the next 50 years.

The main sources of electricity in *France* are nuclear power plants, which has been the case since 1990 up to the present. Regarding renewable energy resources, they are represented mainly by hydroelectric plants, which constitute about 12% of the total power generation, and since 2008 it has also been wind, attaining about 2% of total production. To a small extent, there is also the production from

bio-gas and waste heat, which represents 1% of the total. Power generation in solar power plants is very low in this country, representing less than one percent of total production. France can be labelled unequivocally as the nuclear superpower of the European Union. However, in the future they must take into account the high costs to retrofit existing nuclear reactors to meet the international safety standards set by the International Atomic Energy Agency (IAEA).

In *Italy* generation of electricity from thermal power plants has dominated since 1990. Regarding renewable power resources, due to its geographical location and natural conditions, this country quite understandably uses hydroelectric and wind power plants. Since 2008 up to the present, the share of thermal power in the country has been decreasing and the generation of electricity from renewable resources has been increasing. In 2010, the production of renewable energy in this country attained 41% of the total amount of electricity produced. Power generation in nuclear power plants in Italy is minimal. The country has also expressed its intentions, along with Germany, to turn away from nuclear energy produced in its territory in the future. For this reason, a substantial portion of electricity is imported from France and Switzerland, in addition to increasing the production from renewable resources. It is also important to note that an Italian energy group ENEL has bought a share in Slovak power plants and therefore it is expected that a significant portion of electricity from Slovak nuclear power plants will be exported from Slovakia to Italy.

It is clear from the above-stated data that the structure of power generation varies considerably in the surveyed countries. In the Czech Republic the production of thermal power (mainly coal-fired plants) still dominates, but in the future it is imperative that it be replaced by another source, due to the limited resources of coal and its CO₂ emissions. A common trend in all the surveyed countries is the fact that since 2000, a gradual elimination of power generation by thermal power plants (coal, oil, and natural gas-fired) has been going on, together with their replacement by other sources.

Before the nuclear accident in Japan's plant in Fukushima occurred, it was nuclear energy that offered itself as a perfect solution. However, this path has proved to carry a significant risk due to the possible consequences for the environment and human lives, which are hard to quantify financially due to the risk of accidents, not to mention the issue of safe storage of nuclear waste. Another possible solution is to follow the path of making greater use of renewable resources, e.g. the sun, by more efficient conversion of light rays using nanotechnology. Generating electricity from waste heat is an option, too, as it can lead to increasing the efficiency of the existing processes.

Cost Effectiveness of Electricity Generation in the Czech Republic

As already noted, the source from which electricity is generated is one of the main factors affecting the cost of producing electricity. Prior to evaluating the cost of electricity generation from a single type of source, it is necessary to determine the power density of each type of production, which has a direct impact on the costs.

The power density determines the size that the technical equipment must have (the medium from which electricity is produced) to provide for the production of a fixed amount of energy. The power density of individual power plants (based on the media) in the Czech Republic is listed in Tab. I.

The data clearly indicates that the production media vary considerably. In the Czech Republic, it is the nuclear power plants that have the highest power density, whereas wind and solar power plants

I: The power density of plants in the Czech Republic (in kWh/m²)

Wind plant	0.13
Solar plant	0.25
Hydro plant	108.0
Coal plant	500.0
Nuclear plant	650.0

Source: <http://www.cez.cz/edee/content/microsites/elektrina/3-3.htm>

have the smallest. The efficiency of individual types is reflected in the cost effectiveness of power generation from the appropriate media (see data in Tab. II).

Based on Tab. II it can be said that the most expensive electricity is produced by renewable resources, especially the energy from solar power, and the lowest cost for 1 MWh of electricity is connected with coal-fired and natural gas-fired power plants. However, should the costs reflect the emissions in thermal power plants and the costs of storage of nuclear waste as well as possible risk of accidents in nuclear power plants (natural disasters, terrorism, etc.), we find that the current nuclear power plants along with natural gas and coal are

both a costly resource, and also less safe from an environmental standpoint.

Breakdown of the Price of Electricity in the Czech Republic Compared to Selected Countries

The final price of electricity in each country is formed by a regulated and an unregulated part. In the Czech Republic the price of electricity for households is composed of the distribution price and the price of the commodity, i.e. electricity. The distribution price is regulated by the state and consists of the following parts:

- network services,
- EU ETS (allowances),
- promotion of renewable energy sources (RES),
- environmental taxes.

The price breakdown does not include VAT to help compare like with like with other countries. The commodity price (electricity) is an unregulated part of the total price and depends on the commercial policy of the company in the market offering energy.

Changes in the structure of electricity prices in the years 2009 to 2012 are shown in Figs. 2 to 5.

It is clear from Fig. 2 that 60% of the structure of the electricity price in 2009 is the commodity price alone, 19% is the distribution price and the remaining 21.57% includes the 1% environmental tax, 2% support of renewable resources and 18% is the EU ETS. In 2010, the overall market price for electricity changed its structure, see Fig. 3. There was a significant increase in support for renewable resources, to the detriment of the price of electricity itself as the commodity.

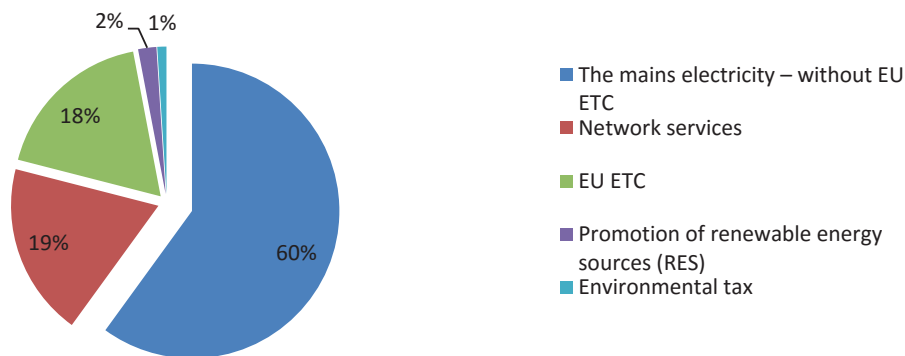
Figs. 4 and 5 show the structure of electricity price in 2011. Fig. 4 shows the structure of electricity price after the introduction of additional income taxes from solar power plants commissioned in 2009 and 2010. Fig. 5 shows the structure of market prices without the introduction of this additional tax.

It is evident from the comparison of Fig. 4 and 5 that the introduction of an additional tax on profits from solar power plants decreased the amount of support for renewable energy by 7%. It also increased the price for network services by 2% and 4% for mains electricity. There was an interesting trend from 2009 to 2011, as the price structure for the households changed

II: Production of 1 MWh in CZ (in EUR)

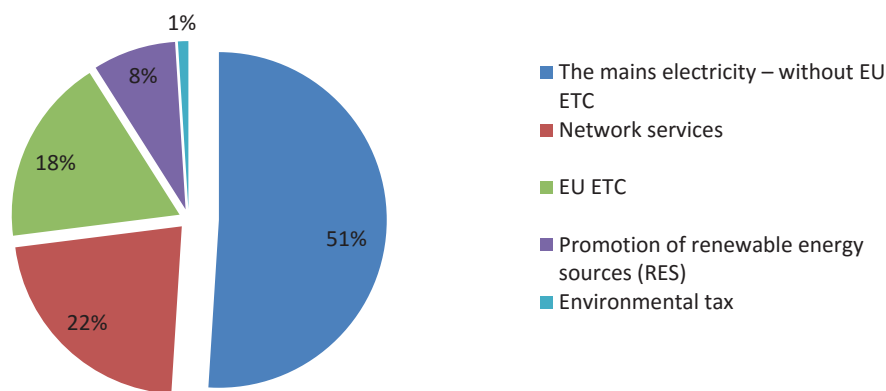
The type of power plant	Production costs per 1 MWh
Natural gas-fired power plant	34–50
Bituminous coal-fired power plant	43–48
Brown coal-fired power plant	43–48
Nuclear power plant	100–140
Hydroelectric power plant	24–77
Wind power plant	40–60
Biogas-fired power plant	70–90
Solar power plant	250–500

Source: Ecoconsulting Energy Environment, adapted by the author



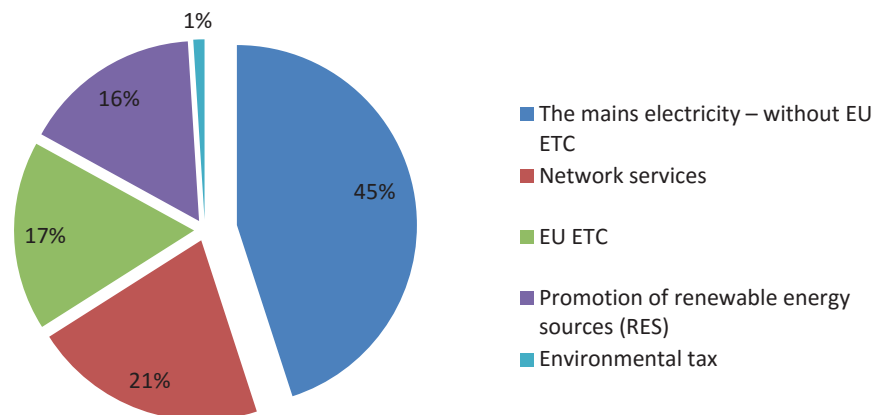
2: The structure of electricity price for households in the Czech Republic in 2009 (GWh)

Source: adapted by the author from the document „The consequences of subsidy and environmental policy on energy prices, Praha 2011



3: The structure of electricity price for households in the Czech Republic in 2010 (GWh)

Source: adapted by the author from the document „The consequences of subsidy and environmental policy on energy prices, Praha 2011



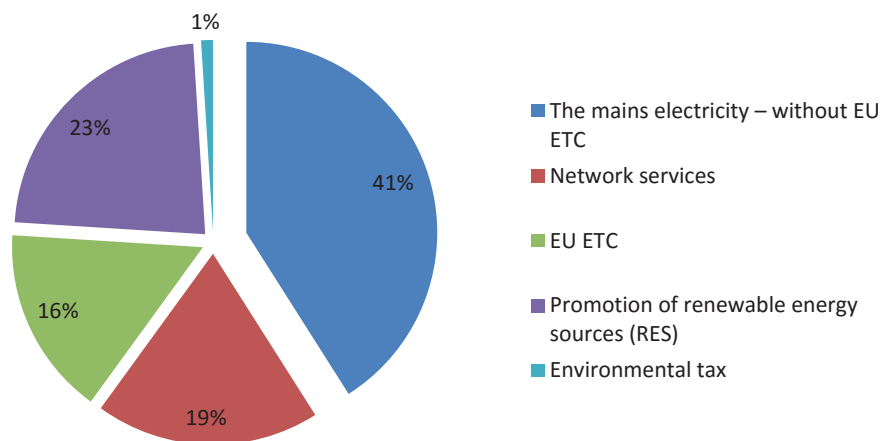
4: The structure of electricity price for the households in the Czech Republic in 2011 with the tax (GWh)

Source: adapted by the author from the document „The consequences of subsidy and environmental policy on energy prices, Praha 2011

with an increase in the proportion of government regulation in the total price. In 2011, the state-regulated price constituted more than 50% of the total.

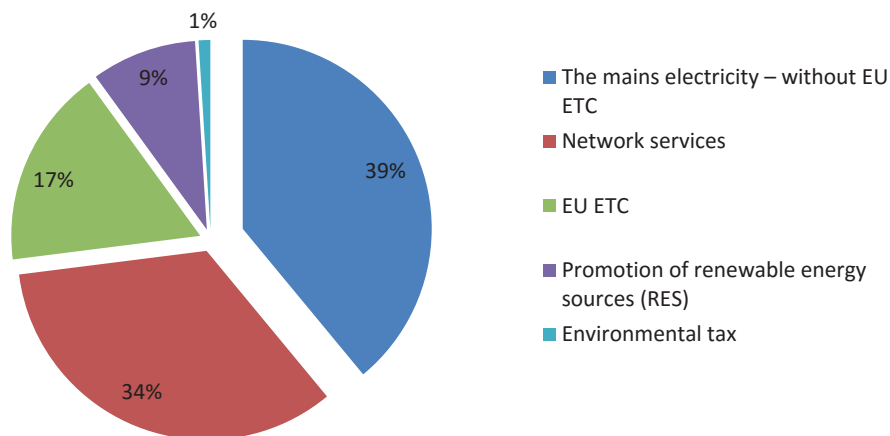
The breakdown of electricity prices in the Czech Republic in 2012 shown in Fig. 6 does not include the EU ETS (the allowances). However, VAT is included. The pie chart also confirms another trend

from previous years: the part of the price regulated by the state clearly exceeds the unregulated part. Further, it is clear that from 2009 up to the present the share of national grid services has been growing, and in 2012 it peaked at 34% of the total. The part of the price unregulated by the state (the mains electricity) forms only 40% this year.



5: The structure of electricity price for households in the Czech Republic in 2011 without a tax

Source: adapted by the author from the document „The consequences of subsidy and environmental policy on energy prices, Praha 2011



6: The structure of electricity price for households in the Czech Republic in 2012 with the tax

Source: Adapted by the author according to: <http://www.ceskatelevize.cz/ct24/ekonomika/227471-cena-elektřiny-jak-se-dělá-draha-skladanka/>

The above-mentioned facts clearly confirm that government intervention has had a critical impact on the final price of electricity for households in the Czech Republic (i. e. more than 50%).

In the *Slovak Republic*, the price of electricity also consists of two parts. The first one is the price of electricity itself (i.e. energy as a commodity). This part of the price is determined by the price offered on the European Energy Exchange. It is therefore an unregulated part of the price of electricity. Other components form the regulated part of the price and include:

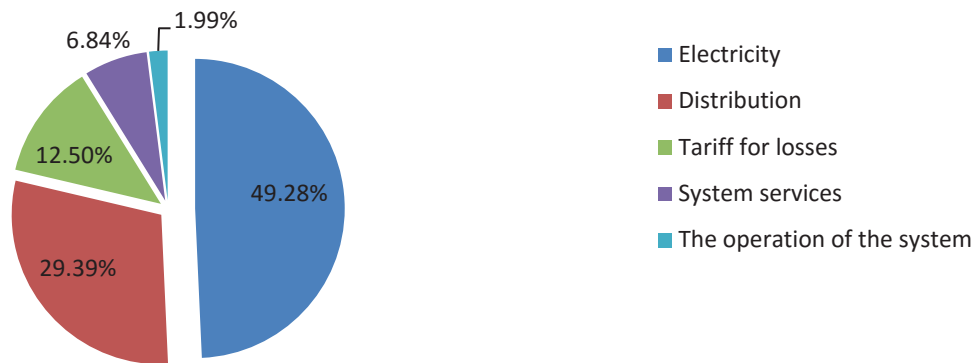
- distribution,
- tariff for losses,
- system services,
- the operation of the system,
- payment to the nuclear fund.

The distribution price consists of the price for access to the grid and the cost of the actual distribution of electricity. The tariff for losses means the part of the price that reflects the cost of electricity losses during its distribution. System services form

a part of the price reflecting the costs related to the regulation of the power system necessary to ensure its stability and reliability. The operation of the system is the part of the price that contributes to the generation of electricity from renewable sources. The payment to the nuclear fund means the fee covering the costs of decommissioning nuclear power plants and the disposal of spent nuclear and radioactive waste. This price component was newly introduced by the Slovak government in 2011 as a response to the disaster in Fukushima, Japan.

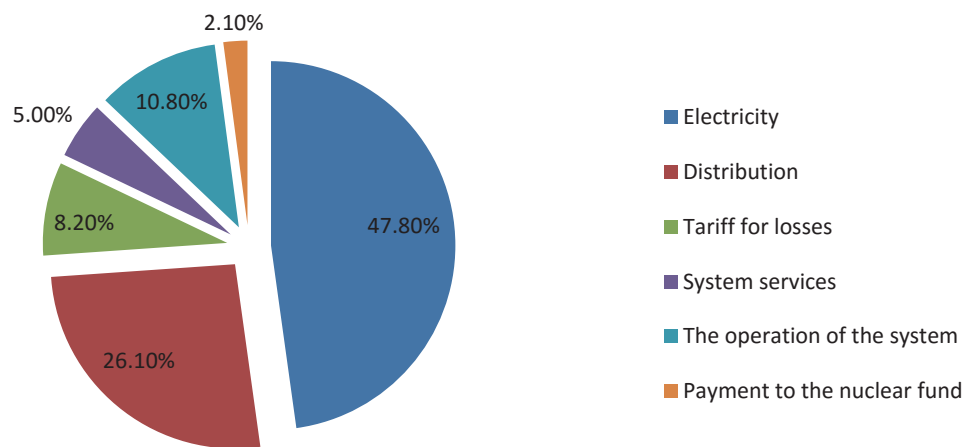
Fig. 7 shows the structure of prices in 2009. That year the price of electricity itself (the unregulated part of the price for households) accounted for about half of the total price. Just like in the case of the Czech Republic, the distribution charge represents a significant percentage of the total price, i.e. almost 30%.

In 2010, in comparison with 2009, the share of the non-regulated part of the price dropped in favour of the regulated part. Also the distribution share increased to almost 35% of the total cost. In



7: The structure of electricity price for households in the Slovak Republic in 2009

Source: Adapted by the author according to material from the Regulatory Office for Network Industries – Annual Report 2011



8: The structure of electricity price for households in the Slovak Republic in 2012

Source: adapted by the author from the documents on www.zse.sk

2011, in contrast to 2010, the share of electricity itself increased and the distribution share in the total cost decreased. It is worth mentioning that the share of the support for the operation of the system increased significantly and also that it was in 2011 when the payment to the Nuclear Fund first appeared.

The price of electricity on the Slovak market is governed by the prices at the European energy exchanges, especially the European Energy Exchange AG (EEX). The economic crisis caused a drop in the price of the commodity between 2008 and 2009 and a sharp increase between 2010 and 2011.

As shown in Fig. 8, in 2012 there was again a growth in the share of the unregulated parts of electricity. The share of the distribution in the total price decreased slightly in favor of the system operation and the tariff for losses. Other shares in comparison with 2011 remained at the same level.

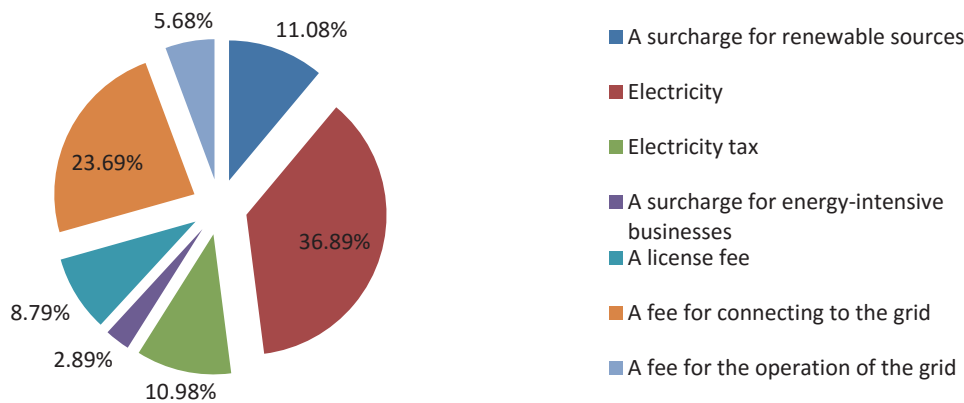
In 2012 there was again a growth in the share of the unregulated part – the electricity. The share of distribution in the total price fell slightly in favour of system services. Other parts in comparison with 2011 remained at the same level.

Based on the above-mentioned data, it can be said that more than 50% of the electricity price in the Slovak Republic is regulated by government provisions in all the monitored periods. It is important to note that the price of electricity for households in this diagram does not include VAT.

In *Germany*, the price of electricity is made up of the unregulated part – the price of the commodity (electricity), which is determined by the price offered on the energy exchange and subsequently by the regulated parts. The items regulated by the state by laws are as follows:

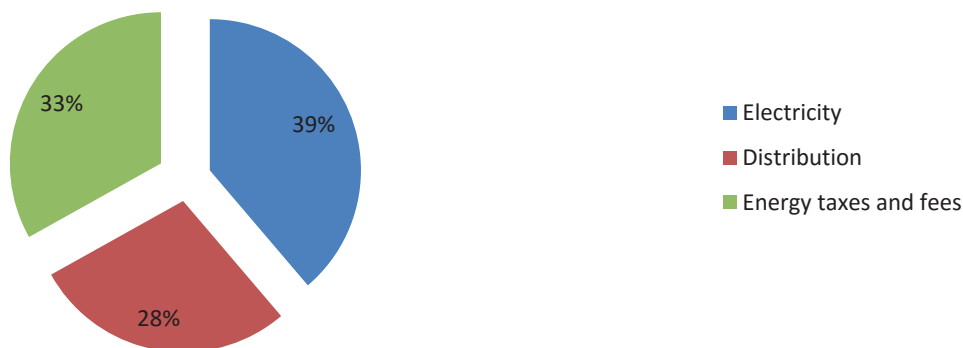
- a surcharge for renewable sources,
- a tax on electricity,
- a surcharge for energy-intensive businesses,
- a license fee,
- a fee for connecting to the network.

In comparison with the Czech or Slovak Republics, some parts of the price of electricity which are regulated by the state are not paid directly to the state. For example the amount of the surcharge for renewable power sources is set by the law and the fee is paid directly to the producers of energy. The same principle is applied in the surcharge



9: The structure of electricity price for households in Germany in 2010

Source: adapted by the author from the documents in Monitoringbericht 2010, DIW Berlin 2011



10: The structure of electricity price for households in Germany in 2012

Source: adapted by the author from the documents in <http://www.vaasaett.com/>

designated for energy-intensive companies; according to law, it is also paid directly to the energy producers. The electricity tax is paid to the pension fund. The license fee is determined by a government decree and is paid to the individual municipalities. The fees for connecting to the grid and the cost of its operation (referred to as distribution) are paid – just like the price for electricity – directly to the companies (providers) who own the distribution network that transfers electricity to the final consumers.

The following Fig. 9 shows the structure of electricity prices for households in Germany in 2010. The regulated part of the electricity price in Germany constitutes more than 50% of the total price, as is the case with the Czech Republic and Slovakia. The unregulated part is only 36.89%.

Fig. 10 shows the structure of prices in Germany in 2012. As no detailed information for the years 2011 and 2012 is available, the price structure is divided only into three categories: electricity, distribution and energy taxes and fees. Again, as was the case in 2010, the regulated part of the price constituted more than 50% of the total price in 2011, thus having a critical impact. In 2012, the share of energy taxes and fees increased to 33%, e.g. by 4%. The ratio of the distribution in the total cost then decreased by 2% and the share of electricity was also reduced by 2%.

Again the regulated part of the price prevailed in its structure, with a share of more than 50%.

The data in Figs. 9 and 10 show that the structure of electricity prices in Germany are more than 50% controlled by the state, as is the case with the Czech and Slovak Republics. The two countries clearly differ only in the system of redistribution of taxes and fees to individual recipients.

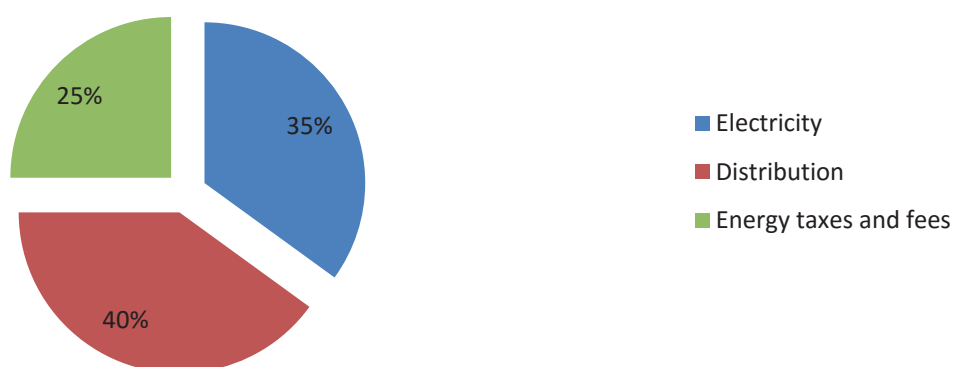
In France the price of electricity is composed of the following items:

- a) the price of electricity itself – the part not regulated by the state,
- b) the price of distribution (connecting to the grid and the cost of its operation),
- c) the fee for public use of electricity,
- d) the fee for the distribution of electricity.

Only the price of electricity itself is not regulated by the state and its amount depends on the price of this commodity offered in the exchange. The other parts of the price are regulated by the state.

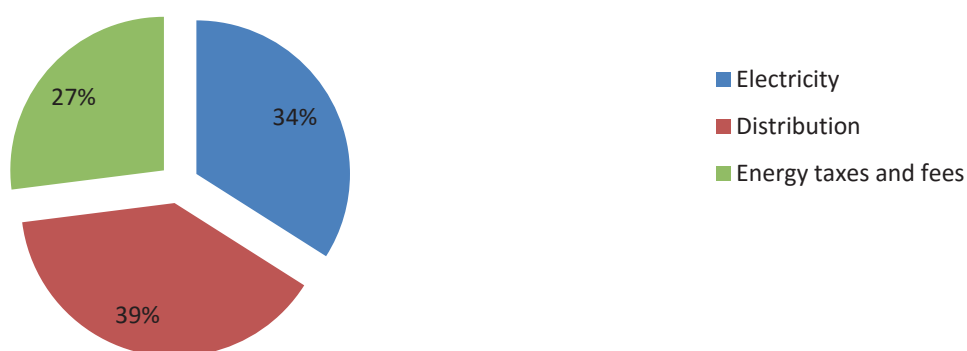
The following Fig. 11 shows the structure of electricity prices for households in France in 2011.

Looking at Fig. 11, one can clearly see that the largest component of the total price is the distribution. The state-unregulated part of the price makes up only 35% of the total. The taxes and fees make up 25%. The low price of electricity in the



11: *The structure of electricity price for households in France in 2011*

Source: adapted by the author from Energie Control Austria and Vaasa ETT, Energy Price Report 2012



12: *The structure of electricity price for households in France in 2012*

Source: adapted by the author from <http://www.vaasaett.com/>



13: *The structure of electricity price for households in Italy in 2011*

Source: adapted by the author from Energie Control Austria and Vaasa ETT, Energy Price Report 2012



14: *The structure of electricity price for households in Italy in 2012*

Source: adapted by the author from <http://www.vaasaett.com/>

country is probably due to the prevailing power generation in nuclear power plants.

Fig. 12 shows the structure of *electricity price for the households* in 2012. The share of the unregulated price decreased by one percent in 2012 in comparison with 2011. Furthermore, the share of the distribution also decreased by one percent, while the share of taxes and fees increased by 2%.

The structure of electricity prices for households in France in those years shows that the share of the commodity price – the electricity – in this country is only around 34–35%, which is the smallest share of this items in all the monitored countries. The distribution (connection costs, operation and monitoring of the distribution system) costs of around 40% are a significant component of the total cost. Comparable to the Czech Republic, the Slovak Republic and Germany, the critical portion (more than 50%) of the total price is regulated by the state.

Italy has the following structure of electricity prices:

- a) the price of electricity itself – unregulated by the state,
- b) a fee for the decommissioning of nuclear power plants,
- c) a compensation fee for locations hosting the nuclear power plants,
- d) a fee for the renewable power sources,
- e) a fee for the funding of specific areas,
- f) a fee for the funding of science and research in the field of power generation,

- g) a fee for the funding of customers in a difficult financial situation,
- h) a surcharge for the operation and maintenance of the distribution network,
- i) a surcharge for small power producers,
- j) a surcharge for improving services in the field of power generation,
- k) a surcharge for the improvement of energy efficiency standards and regulations.

Fig. 13 shows the structure of electricity prices for households in Italy in 2011. For this country, it is clear that the largest share of the total price is the part unregulated by the state, i.e. the price of electricity itself, which constituted 62% of the total price. The distribution then represents 30% and taxes only 8%. Italy is the only monitored country where the part of price unregulated by the state (electricity) constitutes the crucial part (over 50%) of the total price.

Fig. 14 shows the structure of electricity price for households in 2012. Just as in 2011, the crucial part of the price is the item unregulated by the state, which attained 61%. The taxes and charges are 7% and the distribution is 32%, which increased by 2% in comparison with 2011.

It is important to mention that in Italy, despite a series of government measures to regulate the price of electricity (a total of 10 measures), the electricity itself occupies a critical share of the total, which is not the case in any other of the countries compared.

CONCLUSION

When comparing the pricing of electricity in the countries under study, it is clear that state intervention in the prices of energy occurs in each of them. However, the method of regulation is different in each country. Different methods of state intervention are related to the purpose and effect to be achieved by the government's intervention. When comparing state intervention in the selected states, we must not forget that the cost of disposing of nuclear waste and the subsequent disposal of nuclear power plants are included in the structure of electricity prices in all the selected countries except for the Czech Republic. Therefore, we can assume that such a fee will also be introduced in the future. One of the other reasons is also to increase the safety of nuclear power plants according to the standards set by the EU in response to the nuclear accident in Japan. What also cannot be omitted is the fact that the planned construction of two new nuclear reactors in the Czech Republic was stopped due to its economic inefficiency (Pavelková, 2012).

Apart from the above-mentioned methods of state intervention in the pricing of electricity, the state intervenes in yet another way, in the form of price subsidies topping up the revenue, by setting the guaranteed purchase prices for renewable sources, etc. The situation in the Slovak Republic, Germany, France and Italy has been similar since 2013.

Decisive impact of state intervention on electricity prices was also confirmed by the aforementioned questionnaire, in which ninety percent agreed that the key factor influencing energy prices are state interventions. In the case of solar energy produced by solar power plants one hundred percent of experts confirmed that government interventions have a key influence on the price of electricity.

The amount of promotion in those countries varies, according to the policies of the particular country and its decision on the optimal structure of production media on the national territory. State intervention determines what the production mix in the country will be like, how the costly production technologies will be utilized, which is then reflected in the production price of electricity as such. The effective setting of state intervention is therefore very important and it is subsequently reflected in the functioning of the entire economy of each state.

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