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How Distortion on the Electric Power Market Can Lead to Stagflation#

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ABSTRACT

At the time of the possible closure of the significant Slovenian classical electricity production in the Šoštanj thermal power plant and related velenje coal mine, as well as the termination of the subsidies of cost-inefficient electric power production in European Union member states, electricity prices in Slovenia for one third of its supply would rise to a level set to cover the cost of its production with a conventional gas-steam turbine. Calculated for the price of electricity produced in the Šoštanj thermal power plant, this means an average price increase of 39 €/MWh. Higher prices of electricity would affect the performance and capacity of the Slovenian economy while bringing a reduction to real household income along with annual drops in Slovenian gross domestic product of 0.4%, Slovenia would stand to lose around 2,700 jobs, and the consumer price level would rise by 0.4%.

Keywords: Electricity Power Market, Electricity Supply and Demand, Energy and the Economy
JEL Classifications: D40, L94, Q3, Q43

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1. INTRODUCTION

Adoption of the directive 2009/28/EC (European Parliament and Council, 2009) that regulates the promotion of the use of energy from renewable sources set institutional conditions for significant subsidies to electricity producers from renewable sources in the EU. These subsidies have reached such a great scale in Germany that it has become a large net exporter of seemingly cheap electricity. As a consequence, the price of this asset has decreased and has started to deteriorate the competitiveness of producers who do not receive subsidies (Križanič and Konovšek, 2017). An example of this kind of electric power producer is Slovenia's thermal power plant "Termoelektrarna Šoštanj" (TEŠ) and the related coal mine "Premogovnik Velenje" (PV), which cover approximately one third of Slovenia's final electricity consumption. After 2012, their electricity sales and revenue started to decline.

For businesses that are dependent on economies of scale, this is a sign of an approaching end. If Slovenia allowed the termination of the operation of TEŠ and the associated PV, the supply of electricity in country would decrease on average by at least 3.7 TWh in the long run (ELEK, 2018). In this analysis we assume that this amount of energy equals what can be provided to the market by the production of the newest and most technological advanced block in thermal power plant TEŠ.

When Slovenia and other countries which import electricity from Germany become strongly dependent on importing this good, it cannot be expected that taxpayers (including electricity purchasers who pay network costs) in Germany will be prepared to continue paying to finance electricity generation intended for export. With the former collapse of most potential competition (classical electric power producers) prices will adjust to market demand and rise to

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the level of the least competitive producer who is still able to cover the cost of electricity generation and ensure its stable supply. We therefore assume that the process of changing the allocation of energy production from Slovenia to Germany, as viewed through the geography of energy (Hamhaber, 2015), is temporary. Market distortions (Srinivasan, 1994) resulting from the large share of state subsidies in covering the costs of electricity generation in Germany will cease, and the consequence will be a changed and less effective structure of electricity generation to cover Slovenian (and other importers') needs for electricity. The Slovenian economy will shift from conditions that explain the growth hypothesis in connection with energy consumption and economic growth (Kraft and Kraft, 1978; Apergis and Paine, 2009), according to which electricity production affects economic growth, prosperity and employment, to the conditions explained by the conservation hypothesis, according to which energy consumption depends on economic growth, which will be slowed in this case.

Increasing prices of electric power in the net imports of this good will cause stagflation pressures and prompt a decrease in the standard of living. The supply curve will shift to the left at a given price level, thus the Slovenian national economy will have less capacity for the production of goods, and the ratio of unemployment to inflation will no longer be explained by the short-term Phillips curve[2] (Friedman, 1968, 1976; Phelps, 1969). Unemployment and prices will rise in parallel.

In this article we show how the electric power market in Slovenia is most likely to respond to changes in the supply of electricity after the eventual termination of operations at TEŠ with PV, and also after the cessation (or substantial limitation) of German subsidies to cost inefficient producers of electricity from renewable sources. We present the impact of these changes on the Slovenian economy.

2. THE EFFECT OF CLOSURE OF THE ŠOŠTANJ THERMAL POWER PLANT AND COAL MINE VELENJE ON THE SLOVENIAN PRICE OF ELECTRICITY

To compare different costs of electricity production from different sources we used the method of levelized cost of electricity (LCOE) (US Energy Information Administration, 2016). The LCOE or levelized cost of new generation resources is in fact the net present value of investment calculated from the cost of the produced electricity unit, which takes into account the lifespan of the production facility. This is designed to be an approximation of the average price that a producer must obtain on the market in order to make the production pay off. It is an assessment of the cost competitiveness of the electricity generation plant. It includes all costs arising from its operation: Initial investment, operation and maintenance, fuel costs and capital costs. Simplification, such as the use of fuel equivalents or the equivalent cost of CO_2 emissions throughout the period of operation, is essential in this regard. The calculation of the LCOE takes into account the lifetime of the production plant, which is usually between 20 and 40 years, and interim technological progress and modernization, yet the actual lifespan of hydroelectric plants is usually significantly longer. The LCOE is subject to different assumptions and can only be approximate. Of particular importance for LCOE calculations are the time of operation of a given plant and the possibility of coordinating demand-driven production, that is, the immediate marginal capability of the plant to balance interruptions and fluctuations to adapt to electric power demand. In doing so, one should not overlook the technological advances in classical coal-based or nuclear power generation. In the case of capital-intensive technologies (wind power plants, solar power plants and nuclear power plants), the LCOE is determined primarily by the cost of capital, while operating costs and fuel costs are more important for other types. LCOE calculations often do not take into account so-called external costs, such as environmental damage, human health, water quality, etc.,

Following the end of the substantial subsidies to cost inefficient producers from renewable sources in EU member states, we can expect electricity producers operating conventional gas turbines to remain or reappear on the market. Their production prices (LCOE) will probably be the same as those rated for Germany in 2015 by VGB Powertech, as presented in Table 1. In the last line we see that their LCOE is between 53 €/MWh and 168 €/MWh, on average 110.5 €/MWh. The upper part of Table 1 shows the uniform cost of electricity generation in various coal power plants (VGB Powertech, 2015) and TEŠ 6 (ELEK, 2017). The newest electricity production block in TEŠ amounts to between 61 €/MWh and 82 €/MWh (on average 71.5 €/MWh) and is in the framework, albeit on the upper side, of the comparable cost in new German thermal power plants fueled on lignite. The LCOE range at the newest production block of electricity in TEŠ depends, in particular, on the cost of CO_2 taxes, while the LCOE in the conventional gas-steam power plant mainly depends on the price of natural gas. This price is expected to vary during the lifetime of the power plant according to economic cycles, changes in the morphology of the market (strengthening or degradation of the monopoly), according to environmental requirements and the like. Therefore, taking into account the average price of LCOE in a conventional gas-steam power plant is quite sensible.

3. METHODOLOGY

In this article we analyze the direct and indirect (through the production chain) impacts of reduced activity of the industry "Electricity, gas and steam supply" and the reduction of personal or investment spending on Slovenian production, value added,

Table 1: Unified electricity costs – LCOE (€/MWH)

Technology	LCOE	Average LCOE
Thermal power stations		
Coal	40–116	78
Lignite	20–84	52
The newest production block of electricity in TEŠ	61–82	71.5
CCGT	53–168	110.5

Source: VGB Powertech, 2015; ELEK, 2017, CCGT: Conventional gas power plants, TEŠ: Termoelektrarna šoštanj, LCOE: Levelized cost of electricity

2 The short-term Phillips curve shows how much unemployment is reduced with a given increase in inflation and vice versa (Phillips, 1958).

general government revenue, employee earnings, covering the depreciation costs, operating surplus, exports and employment. We analyze the data of 63 sectoral input-output matrices of the Slovenian economy for 2014 (Statistical Office of the Republic of Slovenia, a, b). The following expressions estimate the direct and indirect impacts for the given scale and structure of the decrease in personal or investment consumption on these economic variables:

$M=(I-Ad)^{-1}*Y$

$H=(diag\ BDP/X)*(I-Ad)^{-1}*Y$

$G=Au*(I-Ad)^{-1}*Y$

$HW=(diag\ W/X)*(I-Ad)^{-1}*Y$

$HA=(diag\ A/X)*(I-Ad)^{-1}*Y$

$HPR=(diag\ PR/X)*(I-Ad)^{-1}*Y$

$Z=(diag\ F/X)*(I-Ad)^{-1}*Y$

M is the direct and indirect (hereinafter referred to as "global") impact of a possible decline in demand (Y) on production by industry, and the sum shows the impact on the overall economy; Ad is the matrix of technical ratios – the column of domestic input in a given sector divided by its production; I is a unit matrix, $(I-Ad)^{-1}$ is a matrix multiplier.

H is the global impact of a possible drop in demand (Y) on value added where diag BDP/X is a diagonalized direct-value-added matrix GDP. X is the industry's production.

G is the global impact of a possible decline in demand (Y) on imports. Au is the import component of the technological matrix, obtained by dividing imports (Im) by the industries' production (X).

HW is the global impact of a potential decline in demand (Y) on labor income where diag W/X is a diagonalized matrix of direct employee income (W) ratios. X is the industry's production.

HA is the global impact of a possible decline in demand (Y) on depreciation costs coverage where diag A/X is a diagonalized matrix of direct depreciation costs (A). X is the industry's production.HPR is the global impact of a potential decline in demand (Y) on the business surplus where diag PR/X is a diagonalized direct surplus (PR) matrix. X is the industry's production.

HA + HPR is the sum of the impact of the decline in demand (Y) on free cash flow or gross operating surplus.Z is the global impact of a possible decline in demand (Y) on engagement in work.F is the number of employees; diag F/X is a diagonalized matrix of direct labor ratios (F) in branch production (X).

The direct and indirect impact of electricity price increases on the capacity of Slovenian economy reduction was estimated by:

$KAP=ELE*(I-Ad)^{-1}$

KAP is a global impact of a possible reduction in the capacity of the Slovenian economy due to an increase in electricity prices after the market has adapted to the reduced supply of these goods in Slovenia. ELE is a line vector with zeros except in column 24 (place of the industry: "Electricity, gas and steam supply") with the value of the drop in electric power supply caused by the rise of its prices.

The direct and indirect impact of an electricity price increase on Slovenia's inflation was assessed by:

$P = p^d*H + p^i*G$

P is the result of the impact of the change in the prices of the domestic supply of the industry p^d and the supply of this industry from imports, p^i. In this case p^d and p^i are line vectors with value 1 in all places except place 24 with the ratio of the price increase in the industry "Electricity, gas and steam supply". The results of the impact of the increase in the prices are weighted by the share of branches in personal consumption and then summed.

Our estimatess are based on Leontief's production function (Leontief, 1942, 1954) and assume constant returns to scale, elasticity of the production factors substitution equal to 0, and homogeneity of the production within the sectors. The results can be considered as initial tendencies with the indicated direction.

The capacity impact of an electricity price increase for value added, exports and employment related to the reduced capacity of the Slovenian economy was assessed through the effect on production by industry (KAP) and by the ratio of value added, exports and employment in the production levels of branches of the Slovenian economy (GDP/X, E/X, L/X).

The effects on pubic finance are calculated from the estimated impact on GDP and 37.1% of the average share of general government revenue in Slovenia's GDP in 2016 (Statistical Office of the Republic of Slovenia, (a)

4.THE IMPACT OF THE RESULTING INCREASE IN ELECTRICITY PRICES ON THE SLOVENIAN ECONOMY UPON THE CLOSURE OF THERMAL POWER PLANT ŠOŠTANJ AND PREMOGOVNIK VELENJE

What will be the consequences of TEŠ and the related PV withdrawal from Slovenia's electricity supply and its displacement in the form of conventional gas-steam power plants installed in Slovenia or from other grid-tied countries[3] ? First, the price of the 3.7 TWh electric power differential will rise, projected

3 For the sake of simplification, we assume that two older electric power production blocks in TEŠ will operate for a limited time to supply electricity in the case of increased demand for this good and its higher prices. The competitiveness of TEŠ in relation to conventional gas-steam power plants is analyzed for annual averages and according to the capacities and characteristics of the newest and technologically most advanced block of this power plant.

to increase by a total of 144.3 million euros[4]. This cost will be higher for both households and other sectors (the entire economy, including various public services). Because we estimate the effect of more expensive electricity on the Slovenian economy based on input-output matrix data for 2014, we are taking into account the structure of final consumption of electricity in this year (Statistical office of the republic of slovenia, (c) The share consumed by households was 24.9%, while the share among other sectors was 75.1% (value terms). Assuming that the "burden" of more expensive electricity will be distributed proportionally among households and other sectors, the costs of electricity payments for households will increase by 35.9 million euros and by 108.4 million euros for the other sectors.

The increase in electricity prices will affect the Slovenian economy as a capacity constraint, as access to this crucial base asset will be reduced for our economy. At the same time, the price increase will also bring a reduction of real income and thus a similar drop in the population's demand. The capacity impact and the impact on demand will be compounded. With an increase in electricity prices, the volume of supply of this item in the sector "Electricity, gas and water supply" will decrease. It yields a similar effect as rising prices of other energy products, especially characteristic for oil prices.

When assessing the consequence of higher electricity prices as a decline in personal consumption, we take into account the fact that real household income will decrease, and we assume that households will adjust to lower real income by lowering their consumption proportionally according to its structure, that is, they do not reduce only their electricity consumption. In this respect, we take into account the Slovenian population's marginal propensity to save of 4.6% (Statistical Office of the Republic of Slovenia, (a) such that personal consumption decreases by only 95.4% of the real income decline, while the remainder results in a decline in household deposits in banks, investment companies and the like.

We assume that for this 4.6% of the part of the decline in real income of the population, the investment potential of the national economy and, consequently, investment demand is reduced (proportional to the structure of this demand in 2014).

The results in Table 2 show how much Slovenia's production, value added, employee earnings, gross operating surplus, general government revenue, exports of goods and services and employment will decrease in the case where the electric power supply from TEŠ is replaced by more expensive electricity from conventional gas-steam power plants. The following table presents the sum of all three parallel effects: (1) The stagflation pressure of increased costs on the decline in the production potential of the Slovenian economy, (2) the impact of a decrease in the population's demand, and (3) the impact of the decline in investment demand.

4 The average LCOE in the newest electric power production block in TEŠ is 71.5 €/MWh, whereas the conventional steam-power plant is 110.5 €/MWh, with a difference of 39 €/MWh. Considering the 3.7 TWh of average annual electricity supply from the newest electric power production block in TEŠ (ELEK, 2018), we calculate an increase in its cost by: $3.7 * 39 * 10^6 = 144.3$ million euros.

Table 2: Direct and indirect impact on the Slovenian economy of closing TEŠ

Indicators	In millions euros	Share at macroeconomic level (%)
Production	–293	–0.4
Value added	–118	–0.4
Employee earnings	–58	–0.3
Gross operating surplus (depreciation and profits)	–53	–0.4
General government revenue	–44	–0.4
Exports of goods and services	–85	–0.4
Persons in employment (number)	–2,679	–0.3
Inflation	–	0.4

TEŠ: Termoelektrarna šoštanj

Table 2 shows that the 39 €/MWh higher level of electricity prices for the 3.7 TWh electric power differential, the result of replacing the electricity supplied by TEŠ with that from conventional steam-power plants, has a significant negative impact on Slovenian production, value added and its components (employee earnings, gross operating surplus), general government revenue, exports and employment. Naturally, it is assumed that subsidies will be cut off for electricity producers in EU member states and that the market will be balanced in such a way that the price will cover the costs of the marginal producers. At the national level, the higher electricity price will lead to a lower annual value added of 118 million euros, lower employee earnings of 58 million euros, a lower free cash flow (gross operating surplus or total depreciation and profits) of 53 million euros, a reduction in general government revenues of 44 million euros and a decrease in exports goods and services of 85 million euros. Slovenia would lose almost 2,700 jobs. The analysis assumes a very short-term effect in which the economy and the population are not able to adjust. Over time this effect will decrease. At the national level this effect represents a 0.4% worsening of GDP, free cash flow, revenues of the consolidated balance of public financing and exports, and a 0.3% reduction in the number of persons employed as well as their remuneration.

In the analysis of the impact of higher cost electricity on inflation we again take into account the price of electricity (net of network and fiscal costs) at 110.5 €/MWh in the alternative scenario and 71.5 €/MWh under TEŠ operation. In the case of the closure of TEŠ the price of electricity (net of network and fiscal costs) will increase by 55% (a factor of 1.5455) for one third of the Slovenian market's electricity supply. Semi-annual data on electricity prices (sum of the price of energy, network costs and taxes) for the final buyer are published separately for household consumption and the use of electric power in other sectors. We take into account the prices for 2014, that is, the year for which we have the latest input-output matrix of the Slovenian economy. We take into account the physical consumption of this good and we again assume that conventional gas-steam power plants will replace 3.7 TWh of electricity production from TEŠ (29.5% of Slovenia's final consumption in 2014). We take into account that in the input-output matrix of the Slovenian economy the production, transmission and distribution of electricity represents 83.3% of the turnover (production) of the sector "Electricity, gas and steam supply"[5]. So we get a factor of increase in the prices of services of this branch of 1.0791[6]. In the last line of Table 2, we see that the level of consumer prices in Slovenia would increase by 0.4%.

5. CONCLUSIONS

If the electricity supply in Slovenia is going to be reduced by one third of its final consumption, Slovenia will become highly dependent on imports of this good. Because there are no potential competitors, electric power prices will rise to the level of the least competitive producer who is still capable of covering the cost of production. It is expected that this role will fall to the producers of electricity using conventional gas-steam turbines, and their production prices will be higher than those from TEŠ on average by 39 €/MWh. The increase in electric power prices is going to affect the Slovenian economy as a capacity constraint, as access to this important energy source would be reduced to companies and institutions in Slovenia.

At the same time, the price increase would also create a reduction in real income and, consequently, a decline in population demand (for some of the real income that the population would otherwise save, it would continue to have an impact through a reduction in investment demand). In this case, the capacity and impact on demand are compounded.

Upon the end of the operation of TEŠ and the establishment of a balance of electricity prices at a level that allows the operation of conventional steam power plants, the annual value added in the Slovenian economy would drop by 118 million euros (0.4%), employees' income by 58 million euros, the free cash flow (total depreciation and profits) by 53 million euros, general government revenue by 44 million euros and exports of goods and services by 85 million euros. At the same time, the number of jobs would fall by almost 2,700, and the level of retail prices would increase by 0.4%.

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5 Statistical Office of the Republic of Slovenia, 2017, Internal information.

6 Electricity prices will increase by 39 €/MWh, while final prices of this good for households on average amount to 167.5 €/MWh (Statistical Office of the Republic of Slovenia, c); the production of electric power from TEŠ that will be replaced by the supply from conventional steam-power plants represents 29.46% of the Slovenian final electric power consumption, and the share of electricity in the 24th branch of the input-output matrix 2014 is 83.3%. The increase in the price of electricity for household consumption is calculated as: (39 / 167.5) * 0.2946 * 0.833 = 0.0571.