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# A REALISTIC EU VISION OF A LIGNITE-BASED ENERGY SYSTEM IN TRANSITION: CASE STUDY OF SERBIA

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## Summary

*Several Contracting Parties to the Treaty establishing the Energy Community of the South East Europe, currently in energy transition, have electricity production dominantly based on lignite which contrasts their new reality. Planning approach to designing a new feasible energy policy is presented in this paper. This novel approach in using EnergyPLAN tool stems from analysis of market operation of lignite thermal power plants on hourly basis, and quantification of the feasibility of the energy policy and its alignment with EU vision, and is presented in few scenarios. It was found out that the Serbian energy system is highly sensitive to the electricity market and CO<sub>2</sub> tax increase, because the marginal costs for lignite generation will increase to more than 50 €/MWh. Shifting in the merit order will be observed even at lower CO<sub>2</sub> tax levels, because of the intensity of the emission of the electricity sector (calculated to be higher than 700 gCO<sub>2</sub>/kWhel, according to current energy policy). Based on the increased use of renewable energy sources and more efficient energy conversion technologies, socio-economic and energy policy feasibility would be increased, while long-term marginal costs would be improved by 2 €/MWh and emission intensity by 258 gCO<sub>2</sub>/kWhel, compared to the current energy policy. These contributions, shown in the Serbian case, are of general importance for other lignite dominated Contracting Parties to Treaty establishing the Energy Community.*

**Keywords:** *lignite, national energy system, energy transition, Europe 2020 goals, simulation model, CO<sub>2</sub> tax*

## 1. Introduction

This research was performed to assist the lignite-based Contracting Parties (CPs) to the Treaty establishing the Energy Community (ECT) from the South East Europe (Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Montenegro and Kosovo<sup>1</sup>) among other CPs (Albania, Croatia, Moldavia and Ukraine) to enhance the feasibility of their current energy policies and to align them with the European Union policies (EU vision). The energy development of Serbia [1] and other

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<sup>1</sup> This designation is without prejudice to positions on status and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.

CPs to the ECT, which are undergoing energy transition, will probably continue to use of lignite for the next few decades, since they don't have another source and this source could be highly competitive in the electricity market conditions [1] with tax subsidies [2] and without external costs consideration. Under the ECT [3], CPs have been constrained to implement the core parts of the EU *acquis communautaire* and to adopt development plans with a view to bringing their energy systems in line with generally applicable standards of the EU. Therefore, for these CPs, the EU 2020 energy vision, creates a new reality constrained with: sustainability, competitiveness and security of supply [4]. Furthermore, three key goals, namely, the increased share of renewable energy sources (RES) in gross final energy consumption (GFEC), CO<sub>2</sub> emissions reduction and reductions in total primary energy supply (TPES), as statistical indicators, are provided by the European Commission (EC) and allow the quantification of the performance of the CPs during their EU accession process. For the mentioned CPs special focus should be given to the CO<sub>2</sub> goal and to the electricity sector because of its higher CO<sub>2</sub> intensity and year round operation.

The methodology for planning energy transition in those CPs should be focused on efficiency of the large lignite combustion plants and on limitations of its operation through, e.g., emission limitation directives. A study [5], based on the cost benefit analysis of the investment costs (640-704 M€) and operation and maintenance costs (67-69 M€/year) for the implementation of Large Combustion Plant Directive (LCPD) and the Industrial Emissions Directive (IED) in Serbia show very high benefit to cost ratio (27-29), in particular for the society as a whole, including local external costs [6], without the global externalities. As an alternative to upgrading thermal power plants (TPPs) to meet emission limit values of the LCPD/IED, so called "opted-out" has been preferred option in the case of ageing TPPs [7], among other alternatives such as refurbishment e.g. boiler replacement [8], conversion and reuse of the site [9]. According to this option, a retirement plan has been mentioned in [10], but national emission reduction plan still need to be developed by the operator until 31.12.2015. and approved [11]. The future market reality of the CPs will be establishing a mechanism for operation of network energy markets and the creation of a single energy market of the Energy Community coupled with EU markets [12]. The financial reality for the CPs include CO<sub>2</sub> emission taxes and the lack of investments. Contrary to most EU member states, CPs depend on foreign factors for realising capital-intensive projects [13]. The regulation of new investments do not recommend the building and financing of new lignite TPPs with specific emission levels higher than 500 gCO<sub>2</sub>/kWh [14, 15], except in the case of "no feasible alternatives" [16] which is still higher than average EU27 of 400 gCO<sub>2</sub>/kWh<sub>el</sub>, [17].

The purpose of this research is to develop a planning methodology for a feasible energy policy in the lignite based CPs to the ECT. To be feasible, this energy policy should be realistic and in line with the EU vision, it should meet all the new policies and market and financing constraints.

Lignite has been viewed as being critical to the security of supply [10, 18], however lignite combustion is highly CO<sub>2</sub> emission intensive and it accounts for most of direct CO<sub>2</sub> emissions inventory of the CPs (so called life cycle emissions are not evaluated within this article). The damage attributable to climate change caused by greenhouse gases emissions represents an external cost associated with energy generating technologies, should be included in the total socio-economic cost of energy planning model [19]. By imposing the price on such emissions, an incentive is created to switch to technologies with lower emissions [20] resulting in shifting of the base load units to the margin [21], with less operating hours. A study [20] indicated that coal is competitive with a CO<sub>2</sub> tax

of less than 30 \$/tCO<sub>2</sub>, but in the case of the mentioned CPs (lignite and low efficient technologies) this competitiveness point can occur at the lower CO<sub>2</sub> tax. Increasing the CO<sub>2</sub> tax to 30 €/tCO<sub>2</sub> causes marginal electricity generation costs increased to 70 €/MWh, in German case [22], and to 62.19 and 71.38 €/MWh in the case of new build plants in Bosnia and Herzegovina and Croatia, respectfully [23]. In order to become realistic, the energy system of each of the CPs should be planned and operated based on different planning methodology preferably based on open source tools, [24]. Using the EnergyPLAN tool, a study [19] demonstrated that implementation of a policy on renewable energy and more efficient energy conversion technologies can have positive socio-economic effects under the market conditions, as in the case of Denmark, especially if the external costs are included. Under market conditions, in the absence of CO<sub>2</sub> tax, the lignite TPPs operation hours would likely increase. The high share of lignite consumption and its significant impact on CO<sub>2</sub> emission enables the planning methodology based on the limitation of the operation of the TPPs using EnergyPLAN tool to be highly accurate and applicable in the CPs to the ECT, even for a lower, CO<sub>2</sub> tax.

In this paper three scenarios are created and analysed: the base scenario for year 2009, the scenario in accordance with the current Serbian energy policy documents and one more feasible future scenario with a realistic EU 2020 vision. In this scenario, the faster implementation of renewable energy and efficient energy conversion technologies will be employed. The feasibility of energy policy in Serbia will be quantified based on EU 2020 goals and total annual socio-economic costs for three scenarios. Afterwards, the EU vision alignment will be quantified through sustainability, competitiveness and security of supply indicators for these scenarios.

## 2. Methodology

The EnergyPLAN simulation tool was chosen for the national energy system modelling because it is a user friendly, free, bottom-up model, with an hourly time-step [25] and the ability to accept input data. The EnergyPLAN tool may be used to assist the planning of the national energy systems by simulations of the electricity, heat and transport sectors with scenarios for renewable energy penetrations in EU members [26-29], and CPs [30-33] and its socio-economic costs [34]. In this paper, the national system was described by energy demands, generation capacities and efficiencies, types of energy sources, annual energy balances, fuel consumptions, costs and CO<sub>2</sub> emissions. As a result from the EnergyPLAN tool, three indicators were used to quantify a national energy system:

- 1) The annual generation costs required to supply the required energy demand, including socio-economic consequences of the generation: presented directly, consisted of: total fuel costs, marginal operation costs, annual investment costs, fixed operational costs, electricity exchange costs and benefits, total natural gas exchange costs and CO<sub>2</sub> tax payments.
- 2) Amount of CO<sub>2</sub> emissions resulting from energy consumption and generation: presented directly,
- 3) Total primary energy supply (TPES) by fuel type: presented directly.

The share of renewable energy sources and the energy savings are calculated outside of EnergyPLAN because the EnergyPLAN tool calculates the RES share in TPES instead of GFEC, which is used as the EU 2020 goals.

In the analysis, both EnergyPLAN operation optimisation strategies of *technical* (seeking to meet the national demand) and *market* (plant operators seek to optimise their profits at electricity market) were performed, and each were used in both modes of *island* and *connected* [34]. For the market

conditions, electricity costs were obtained from the European Energy Exchange historic curve for the German-Austrian border [35].

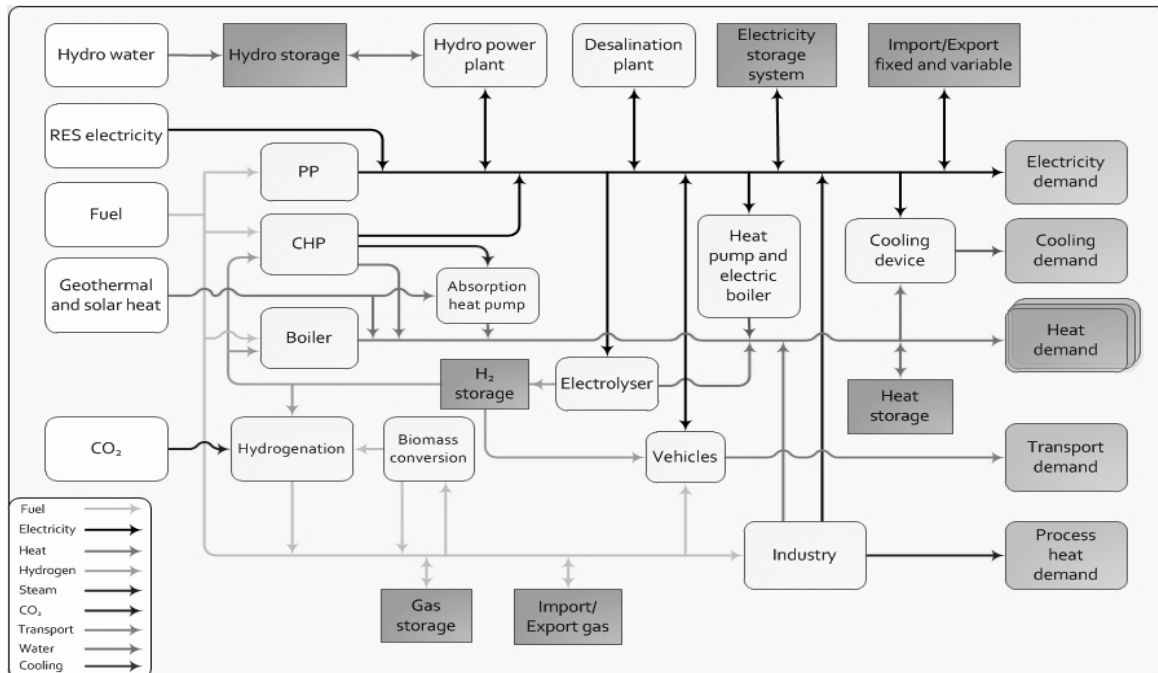


Figure 1 EnergyPLAN System Diagram-Version 11.2 - 6 November 2013

### 3. Case study: Serbian energy transition

Serbia is an energy transition country, i.e., a CP to the ECT, with around 2/3 of the electricity production coming from lignite and the rest from hydro (with biomass for heating 21.2% of RES in GFEC). Specific target of 27% has been set for its RES goal. The other two goals of CO<sub>2</sub> reductions and reductions in TPES, specific targets were not declared, and therefore they will be assumed to be 20%, as the Serbian energy policy will be aligned to the EU energy policy after 2020. The emissions reduction was focused on the electric utility sector, controlled by the CO<sub>2</sub> tax. Taking into account that emission allowances currently at 6.17 €/t<sub>CO2</sub> [35], assumption is 10 €/t<sub>CO2</sub> until 2020.

The Energy Strategy of the Republic of Serbia (Strategy) [10], with an aim to be in line with goals of the energy strategy of the CPs to the ECT, [36] and to comply with the EU *acquis communautaire*, has been drafted. The Strategy covers the topics and accounts for the contents of the following documents:

- Draft National Renewable Energy Action Plan (NREAP), [37],
- National Energy Efficiency Action Plan (NEEAP), [38],
- Summarised list of projects, [39],

This Strategy continues the policy of least-cost end-user energy prices for electricity and heat without taking into account the total socio-economic costs of energy production (external costs of carbon dioxide and import/export payments are not covered).

The energy strategy of the CPs to the ECT [36] was criticised in [40], especially for the huge fossil fuel investments, which could move the region further from reaching the EU 20:20:20 goals and increase socio-economic cost. In accordance with the LCPD [41], Serbia is planning to close some (874 MW) of existing lignite-, gas- and oil-fired plants[36]. The emissions intensity from the

electricity sector in Serbia is approximately 850 gCO<sub>2</sub>/kWh<sub>el</sub> [42], with a goal to be at 600 gCO<sub>2</sub>/kWh<sub>el</sub> in 2020 [10]. In the Serbian case, this biomass is limited to 10%:90% of the energy composition between biomass and lignite. Among other policies e.g. [30], the increase of variable renewable energy production with flexibility options on the demand side (smart grid, storage applications, etc.), a feasible policy for CO<sub>2</sub> reduction could be the “build big-close small” approach and cogeneration [43], along with further shifting to natural gas also bearing in mind its socio-economic costs, especially local externalities, since they are huge barrier for economic growth in Serbia, [44]. A feasible future scenario should be based on the following assumptions:

- 1) a part of the TPPs is closed, while another part is upgraded according to LCPD,
- 2) proposed new lignite TPPs are not commissioned, according to the new investment policy of the European Investment Bank, World Bank and similar EU, U.S. based investment institutions,
- 3) a regional energy market is functional, according to the Energy Law [45], the emissions trading scheme or equivalent CO<sub>2</sub> tax mechanism used to include all socio-economic costs exists.

### 3.1. Scenario development

The EnergyPLAN tool was utilised to assess three different scenarios of the Serbian energy policy, that were chosen among many other scenarios, as being the most representative:

1. **Base scenario (BS)**, for the year 2009, in *island* mode *technical* operation optimisation along with an average market price of 40 €/MWh and no emissions-associated payments.
2. **Strategy energy efficiency scenario (SEES)**, based on the Strategy [10], NEEAP [38] and NREAP [37] for the year 2020. The *connected* mode *market* operation optimisation was used with an average of 50 €/MWh and a tax of 10 €/tCO<sub>2</sub>.
3. **Future scenario (FS)**, based on the assumptions for the year 2020. The *connected* mode *market* operation optimisation was used, with an average of 50 €/MWh and a tax of 10 €/tCO<sub>2</sub>.

External electricity market response to import/export has been modelled for the basic price of 50 €/MWh and price elasticity of 0.1 €/MWh.

#### 3.1.1. Base scenario (BS)

The BS scenario is modeled from the bottom using *island* mode system in the EnergyPLAN tool as in [30] with detailed scenario assumptions related to TPPs shown in tab. 1.

**Table 1 Scenario assumptions relating to TPPs and CHP plant size and average efficiency [46]**

	<i>TPPs max</i>	<i>TPPs min</i>	<i>TPPs max with CHP</i>	<i>TPPs η</i>
	[MW]			[%]
BS	3,936	2,786	4,289	0.317515
SEES	4,011	2,260	4,401	0.328826
FS	2,920	1,380	4,170	0.326338

#### 3.1.2. Strategy - energy efficiency scenario (SEES)

The SEES scenario has been created based on Strategy [10], renewable energy policy from NREAP [37] and on energy efficiency measures proposed in NEEAP for the year 2020 [38]. Currently 22.8 TWh have been already utilised (from large hydro and from biomass for heating). Based on the tertiary reserve study, the integration of only 1.2 TWh with power limited to 500 MW of wind. The photovoltaic (PV)

production technical potential was constrained based on the half-half placement of PV and solar water heating systems on the available rooftops to 450 MW or 540 GWh. A gross final energy consumption of 113 TWh in 2020 was projected. The projected CO<sub>2</sub> emissions are 48.08 Mt CO<sub>2</sub>. According to LCPD, some TPPs will be upgraded with investment costs (498 M€) and yearly operational costs (53 M€), some opted-out. Based on retirement plan, Kolubara will be shut down before 2020 (2017-2019), while others operated under "opt-out" until 2024: Morava (2020), TENT A1-2 (2020-2022), Kostolac A (2020-2024).

The SEES assumptions were created for the year 2020, in which, according to the Strategy [10]:

- existing TPPs have been upgraded according to LCPD, and operated under retirement plan, new Kostolac B3 has been built, details given in table 1.,
- instead of the existing, the new combined heat and power (CHP) plant in Novi Sad of 340 MWeI, with combined electric efficiency (gas and steam) of 40%, and with total fuel utilization of 85%, has been built, [47],
- Bistrica pumped storage hydro power plant has been built (680 MW, 60 GWh),
- consumption of lignite for district heating has been increased to 3.59 TWh/a, oil to 2.5 TWh/a, natural gas to 6.75 TWh/a and biomass to 1.63 TWh/a,

according to renewable energy policy and electricity demand from NREAP, [37]:

- demand for electricity has been increased to 41.1 TWh/a of which 1.8 TWh/a for cooling, and 2.9 TWh/a for heating,
- wind capacity has been increased to 500 MW and PV capacity has been increased to 10 MW,
- solar thermal generation for individual household has been increased to 1.95 TWh/a, according to the procedure in [48], resulting in 0.64 TWh/a of utilized heat demand,
- demand in transport sector has been increased to 28.56 TWh/a equally among available fuels
- waste to energy incineration plant of 3 MW has been modeled with 8,000 hours of work adding 0.024 TWh/a (0.015 TWh/a heat and 0.009 TWh/a electricity) to the group III district heating,
- biodiesel plants production will be increased to 2.9 TWh/a to substitute diesel in transport sector,
- biomass supply in district heating has been increased to 1.279 TWh/a and fixed for a group III CHP plant,
- biogas plant yearly output has been increased to 0.8 TWh/a of biogas,
- 0.8 TWh/a of biomass has been used to produce 0.29 TWh/a of bio petrol,
- small run-of hydro plants capacity has been increased to 471 MW producing additional 1.262 TWh/a,
- landfill gas has been used as CHP plant fuel in district heating group III to replace 0.08 TWh/a of natural gas,

and according to energy efficiency measures proposed in NEEAP, [38].

### **3.1.3.Future scenario (FS)**

The FS scenario was created based on the energy demand from the SEES scenario, but with different investment assumptions:

- instead of Bistrica, 600 MW of run-of-hydro power plants, according to [39], have been built,
- 700 MW of wind, 200 MW of PV plants and 200 MW of geothermal power plants have been built,
- co-firing of biomass with lignite has been fully increased in the existing TPPs,
- 0.5 TWh/a of electric heating has been replaced with heat pumps with same heat demand [49],

- lignite and fuel oil consumption in large CHP plants connected to district heating (group III) has been replaced with natural gas and biomass,
- the CHP plant from district heating group III size has been increased for 860 MWel [39], with efficiencies assumed as in SEES scenario,
- solar thermal yearly production has been doubled in comparison to the SEES ,
- new TPPs units are not being built along with further closure of existing ones below 300 MW, Kostolac A1 and TENT A3-4 opted-out and with other units upgraded (see tab. 1) with investment (326 M€) and operation cost of 39 M€ [5].

For the assumed scenarios, simulations using the EnergyPLAN tool, policy and socio-economic feasibility, followed with a policy alignment with the EU vision, according to chosen indicators, were quantified.

### 3.2. Quantification of the Serbian energy policy feasibility

Table 2 presents the calculations quantifying the feasibility of reaching of the EU 2020 goals and their specific targets followed with socio-economic feasibility for Serbia .

<i>EU 2020 Goals</i>		<i>BS</i>	<i>SEES</i>	<i>FS</i>	<i>EU 2020 targets</i>
RES in GFEC	%	21.6	31	42.7	27
CO <sub>2</sub> reduction	%	0.0	-0.6	23.1	20
TPES reduction	%	0.0	-7.6	2.2	20

In the SEES, the RES penetration is 31%, and in the FS the RES penetration is 42.7% (due to the increased RES in electricity and heat, co-firing in TPPs and bio fuels usage). Therefore, the goal of 27% of RES in GFEC in 2020 was achieved.

The total CO<sub>2</sub> emission reductions compared to the BS are obtained as negative once for 0.6% in the SEES (tab. 3) because of the projected increase in demand for heating, cooling and the transportation sector, and, consequently, the higher fossil fuel generation. Reductions in emissions are achieved in the FS in the amount of 23.1%, according to the target level of 20%.

In tab. 2, the results indicate that in the SEES, the usage of primary energy is higher by 7.6% compared to the BS, and in the FS case, reductions of 2.2% in comparison to the BS are achieved. This increased usage of primary energy is the result of the increased generation of fossil fuel power plants in SEES scenario, reductions are result of different technology and fuel mix.

To discuss the socio-economic feasibility, the total annual costs for all three scenarios are shown in fig. 2. In comparison to the BS, the total system costs are shown in fig. 2 (the total height of the bars). The total system costs are higher in both the SEES (8,412 M€) and FS (8,263 M€) in comparison to the BS (6,869 M€). These higher costs are the consequence of higher investment and emission costs but also of the projected increased consumption. The total socio-economic costs in the FS are lower than in the SEES, due to lower investment, fixed and marginal operation, fuel and emission costs.

### 3.3. Serbia-EU vision alignment according to the indicators

For the quantification of the alignment of the Serbian plans with the EU energy policy vision, three indicators were used: sustainability, competitiveness and security of supply. In the BS, the operation of generators was technically optimised during simulation in the EnergyPLAN tool to meet the



national demand with no additional operations for export. New market conditions in 2020, according to the SEES, are positive for the operation of TPPs (with no or low CO<sub>2</sub> taxes) and, therefore, from the results of the simulation, an increase in the total energy generation can be observed in comparison to the BS in fig. 2.

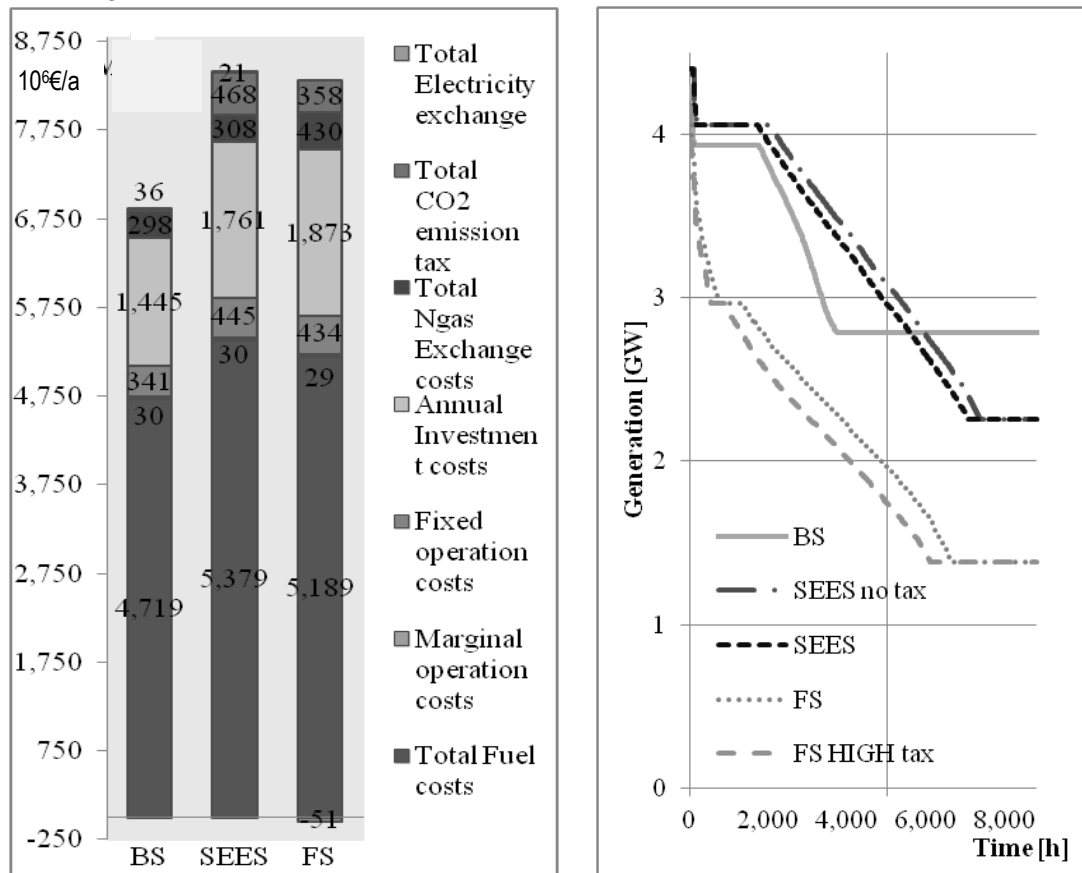


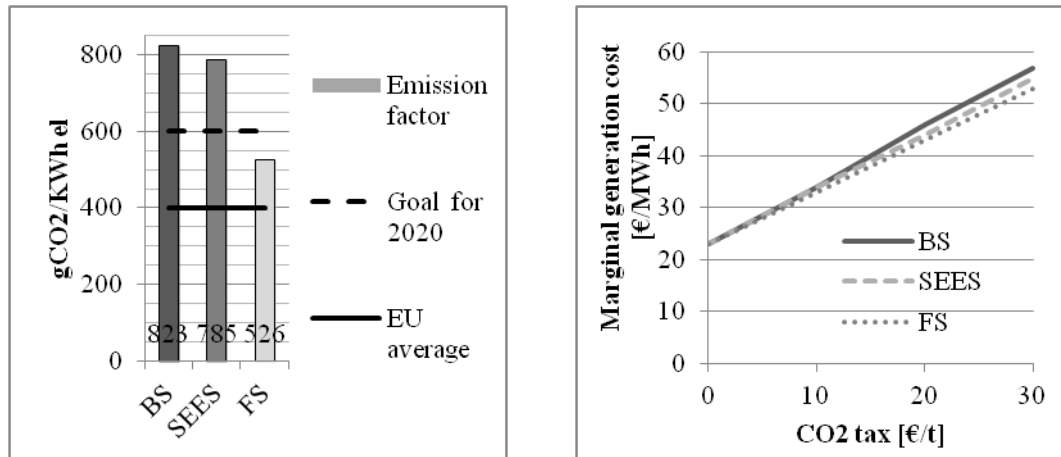
Figure 2 Socio-economic feasibility of energy system (left), load duration hours of TPPs caused by CO<sub>2</sub> tax, market price and increased RES penetration (right).

The TPPs yearly average energy generation of 3,156 MW in the BS (27.7 TWh/a) is increased to 3,240 MW in the SEES without a CO<sub>2</sub> tax ("SEES no tax"). Due to favourable market conditions for export production of TPPs was increased to 28.5 TWh/a. In the "SEES" scenario, the average operation in TPPs was limited to 3,167 MW (27.8 TWh/a), where their market competitiveness and operation were decreased due to the 10 €/tCO<sub>2</sub> tax. Further limitations in the average operation in TPPs to 2,162 MW (19 TWh/a) is achieved in the FS. With an increased CO<sub>2</sub> tax to 30 €/tCO<sub>2</sub> in the FS ("FS HIGH tax"), the average operation of TPPs is even further decreased to 2,026 MW (17.8 TWh/a). This further decrease indicates the high sensitivity of lignite based energy systems to the market conditions in the presence of CO<sub>2</sub> tax.

The emission intensity of the Serbian electricity system in different scenarios compared with the average EU emission intensity and the national emission intensity reduction goal for 2020 is shown in fig. 3. In the SEES, the emission intensity is decreased to 785 gCO<sub>2</sub>/kWh<sub>el</sub>, but it remains higher than the national emission intensity reduction goal for 2020 (600 gCO<sub>2</sub>/kWh<sub>el</sub>). The further emission intensity reduction to 526 gCO<sub>2</sub>/kWh<sub>el</sub> was achieved in the FS, reaching the national intensity reduction goal for 2020, but is still significantly higher than the EU average (400 gCO<sub>2</sub>/kWh<sub>el</sub>). The

emissions intensity could be used as a competitiveness indicator, which shows how difficult it will be for the lignite based transition countries to compete in market conditions with emissions trading and a higher CO<sub>2</sub> tax.

The decrease in competitiveness of the Serbian electricity sector due to increased marginal generation costs in TPPs because of higher CO<sub>2</sub> tax are shown in fig. 3.



**Figure 3** Emission intensity of Serbian electricity sector in comparison to EU (left), sensitivity analysis of TPPs marginal generation costs under CO<sub>2</sub> prices change (right).

The relative competitiveness increase in the SEES in comparison to the BS was achieved based on the efficiency increase of the average TPPs. The further competitiveness increase in the FS is achieved through further average efficiency increases of the TPPs and from the use of biomass used for co-firing with lignite. One should bear in mind that these costs should be increased for the average externalities from the dust, NO<sub>x</sub> and SO<sub>2</sub> calculated to be 13.5 €/MWh [5] for Serbia.

The long term security of supply, measured as the imported energy share in TPES during one year, has decreased from 48.8%, in the BS, to 46.8% in the SEES because TPES increased and the usage of locally available lignite increased. In the FS, the security of supply decreased because the imported energy share increased to 51.5%, mainly as a result of the increased natural gas imports.

#### 4. Conclusion and policy implications

In this paper, it has been shown that the tailoring of a realistic energy policy in the market condition to align with the EU vision is not an easy task for the lignite based CPs to the ECT. Reaching all of the three key statistical Europe 20:20:20 goals simultaneously (tab. 2) is a challenge in their specific conditions. Lignite based energy systems are highly sensitive to the market conditions and CO<sub>2</sub> tax. Thus, it is not socio-economically feasible to produce electricity for export in the case with the external costs included in the CO<sub>2</sub> tax. Therefore, it is recommended that a more sustainable policy be tailored that aligns with the EU energy policy vision and will not create socio-economic drawbacks for the CPs to the ECT. This situation was illustrated for the Serbian case in the future scenario, where the total socio-economic costs are reduced in comparison to the SEES (fig. 2). The TPPs operation decrease can be observed only with the implementation of CO<sub>2</sub> taxes. TPES and CO<sub>2</sub> reductions plans should be modified to enable the further decrease in the socio-economic costs of the energy policy in the new EU reality.

A novel approach for the tailoring of energy policy for lignite based energy transition countries towards Europe 2020 energy vision (sustainability, competitiveness and security of supply) was proposed, based on several results in this paper, and particularly on the load duration curves of TPPs (fig. 2). From these results, a more *sustainable* energy system could be proposed, based on the limitations and control of the operation hours of their TPPs with an imposed CO<sub>2</sub> tax and with the further closure. Realistic CO<sub>2</sub> taxes in lignite based energy transition countries reduce the *competitiveness* of high emission technologies in the electricity market. An emissions intensity that is higher than the EU average, (fig. 4), together with an increased marginal generation cost with a CO<sub>2</sub> tax (fig. 5) and with a high share of fuel costs in total socio-economic costs, leads to the reduced long term market *competitiveness*. The decrease in the emissions intensity can be achieved by the increased RES generation and the efficient conversion technologies that compete with the generation from TPPs and decrease the number of their operation hours. The vision of sustainability and minimal socio-economic costs decreases the *security of supply* in the CPs by increasing the import of natural gas. Reconciliation of the visions of sustainability and of security of supply is possible through the implementation of renewable energy.

Based on this approach, using EnergyPLAN, a more feasible energy policy and national emission reduction plan could be proposed for Serbia (or lignite based CPs to the ECT).

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