MOGUĆNOSTI RAZVOJA ELEKTROENERGETSKOG SEKTORA BOSNE I HERCEGOVINE

THE POSSIBILITIES FOR THE DEVELOPMENT OF THE ELECTRIC POWER SECTOR OF BOSNIA AND HERZEGOVINA

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U članku se iznosi pregled stanja i perspektive razvoja elektroenergetskog sektora Bosne i Hercegovine (BiH) do 2020. godine [1]. Uvažavajući postojeću organizacijsku strukturu elektroenergetskog sektora, dan je pregled projekcija potrošnje električne energije po elektroprivredama, entitetima i za BiH kao cjelinu. Zatim su opisani postojeći elektroenergetski (proizvodni) objekti te najizglednije elektrane-kandidati za izgradnju u sljedećem desetljeću. Također je napravljena prosudba mogućnosti izvoza električne energije u zemlje okruženja.

This article overviews the existing condition and the development perspectives for the electric power sector of Bosnia and Herzegovina (BiH) until 2020 [1].

Acknowledging the existing organisational structure of the electric power sector, an overview of electricity consumption projections is given per electric utility company, per entity and for Bosnia and Herzegovina as a whole. It is followed by descriptions of existing electric power (production) facilities, and the power plant candidates for construction in the following decade. An estimate of electricity export possibilities into neighbouring countries has also been made.

Ključne riječi : elektrane-kandidati za izgradnju; izgradnja elektrana; izvoz električne energije; postojeće elektrane; potrošnja električne energije; proizvodnja električne energije

Keywords: candidate power plants; electricity consumption; electricity production; existing power plants; export of electricity; power plant construction

1 UVOD

Slučaj elektroenergetskog sektora BiH je vrlo specifičan s obzirom na ustavno ustrojstvo same države. Postoje tri elektroprivrede: JP Elektroprivreda Bosne i Hercegovine d.d. Sarajevo (EP BiH), JP Elektroprivreda Hrvatske zajednice Herceg Bosne d.d. Mostar (EP HZHB) te Elektroprivreda Republike Srpske a.d. (EP RS)), od kojih je svaka odgovorna za određeni teritorij u smislu podmirivanja potrošnje električne energije. Dodatno situaciju usložnjava Distrikt Brčko, u kojem postoji zasebno tijelo povezano s lokalnom vladom, koje obavlja djelatnost distribucije električne energije.

2 PREDVIĐENA POTROŠNJA ELEKTRIČNE ENERGIJE

U skladu s najboljom praksom (primjenom MAED modela) urađeno je predviđanje svih oblika energije, dakle i električne energije, posebno za svaku elektroprivredu, zatim za svaki entitet i konačno za BiH kao cjelinu. U nastavku su prikazane tablice koje sadrže podatke o potrošnji električne energije, vršnom opterećenju i faktoru opterećenja za sve razine (elektroprivrede, entiteti i država).

U tablicama 1 i 2 prikazana je potrošnja električne energije, vršno opterećenje i faktor opterećenja za tri scenarija potrošnje za pojedine elektroprivrede i entitete. U svim scenarijima pretpostavljeno je da se područje Distrikta Brčko do kraja planskog razdoblja opskrbljuje od strane EP RS (stoga potrošnja EP RS obuhvaća potrošnju Republike Srpske i Distrikta Brčko).

1 INTRODUCTION

The electric power sector is very specific as regards the constitutional structure of Bosnia and Herzegovina. There are three electric utility companies (Public Electric Power Company of Bosnia and Herzegovina d.d. Sarajevo (EP BiH), Public Electric Power Company of the Croatian Community of Herzeg-Bosnia d.d. Mostar (EP HZHB), and the Power Utility of the Republic of Srpska a.d. (EP RS)) and each is responsible for a certain territory in the sense of meeting the needs for electricity consumption. The situation is made more complex by the Brčko District which has an independent body associated with the local government and which performs the electricity distribution services.

2 ESTIMATED ELECTRICITY CONSUMPTION

In accordance with the best practice (the application of the MAED model) an estimate for all energy forms has been made, including electricity, separately for each electric utility company and each entity, and finally for Bosnia and Herzegovina as a whole. The following tables contain data on electricity consumption, peak load and load factor for all levels (electric utility companies, entities, and the state).

Tables 1 and 2 show electricity consumption, peak load and load factor for three consumption scenarios for individual electric utility companies and entities. All scenarios assume that the Brčko District area is supplied by the EP RS until the end of the planning period (therefore, the EP RS consumption encompasses the consumption of the Republic of Srpska and the Brčko District).

Tablica 1 – Ukupna potrošnja električne energije, vršno opterećenje sustava i faktor opterećenja sustava u Bosni i Hercegovini i Federaciji BiH
Table 1 – Total electricity consumption, peak system load and system load factor in Bosnia and Herzegovina and the Federation of Bosnia and Herzegovina (BiH)

	BiH			Federacija BiH / Federation of BiH		
Godina / Year	Energija / Energy, GWh	Snaga / Power, MW	Faktor opterećenja / Load factor,%	Energija / Energy, GWh	Snaga / Power, MW	Faktor opterećenja / Load factor,%
2009.	12 733	2 192	66,3	8 746	1 458	68,5
2010.	13 112	2 235	67,0	9 051	1 496	69,1
2011.	13 550	2 311	66,9	9 333	1 544	69,0
2012.	14 004	2 390	66,9	9 624	1 593	69,0
2013.	14 474	2 471	66,9	9 926	1 644	68,9
2014.	14 962	2 556	66,8	10 238	1 697	68,9
2015.	15 468	2 590	68,2	10 561	1 719	70,2
2016.	15 918	2 667	68,1	10 846	1 766	70,1
2017.	16 384	2 747	68,1	11 141	1 816	70,0
2018.	16 866	2 830	68,0	11 447	1 867	70,0
2019.	17 364	2 915	68,0	11 762	1 920	69,9
2020.	17 880	3 003	68,0	12 089	1 975	69,9

Tablica 2 – Ukupna potrošnja električne energije, vršno opterećenje sustava i faktor opterećenja sustava za pojedinu elektroprivredu
Table 2 – Total electricity consumption, peak system load and system load factor per electric utility company

Godina / Year	EP BiH			EP HZHB			EP RS*		
	Energija / Energy, GWh	Snaga / Power, MW	Faktor opterećenja / Load factor, %	Energija / Energy, GWh	Snaga / Power, MW	Faktor opterećenja / Load factor, %	Energija / Energy, GWh	Snaga / Power, MW	Faktor opterećenja / Load factor, %
2009.	5037	898	64,0	3709	565	75,0	3987	795	57,3
2010.	5275	926	65,0	3776	575	75,0	4061	796	58,3
2011.	5485	963	65,0	3848	586	75,0	4217	826	58,3
2012.	5703	1002	65,0	3921	597	75,0	4379	857	58,3
2013.	5930	1041	65,0	3996	608	75,0	4548	890	58,3
2014.	6166	1083	65,0	4072	620	75,0	4724	924	58,4
2015.	6412	1092	67,0	4150	632	75,0	4907	929	60,3
2016.	6659	1135	67,0	4187	637	75,0	5072	960	60,3
2017.	6916	1178	67,0	4225	643	75,0	5243	992	60,3
2018.	7183	1224	67,0	4264	649	75,0	5419	1025	60,3
2019.	7460	1271	67,0	4302	655	75,0	5602	1060	60,4
2020.	7748	1320	67,0	4341	661	75,0	5791	1095	60,4

*EP RS opskrbljuje i područje Distrikta Brčko, pa je uključena i potrošnja Brčkog / EP RS also supplies the Brčko District, so its consumption was also included

3 POSTOJEĆE ELEKTRANE I IZLASCI IZ POGONA

U nastavku je dan sažeti pregled postojećih elektrana na području BiH.

3.1 Federacija BiH

U tablici 3. prikazani su osnovni podaci o postojećim hidroelektranama na području Federacije BiH (FBiH). Ukupna raspoloživa snaga hidroelektrana u FBiH je 1 256 MW s očekivanom godišnjom proizvodnjom 3 149 GWh. U sastavu EP BiH nalaze se tri velike hidroelektrane i nekoliko malih hidroenergetskih objekata ukupne snage 509 MW i očekivane godišnje proizvodnje 1 580 GWh. Na području EP HZHB nalazi se ukupno šest hidroelektrana ukupne snage 747 MW i očekivane godišnje proizvodnje 1 569 GWh.

3 EXISTING POWER PLANTS AND END OF OPERATIONS

A concise review of the existing power plants in Bosnia and Herzegovina follows.

3.1 Federation of Bosnia and Herzegovina

Table 3 shows the basic data on existing hydroelectric power plants on the territory of the Federation of Bosnia and Herzegovina (FBiH). The total available power of hydroelectric power plants in the Federation of Bosnia and Herzegovina is 1 256 MW with the expected yearly production of 3 149 GWh. EP BiH has three large hydroelectric power plants and several smaller hydropower facilities with the total capacity of 509 MW, and the expected yearly production of 1 580 GWh. EP HZHB territory contains a total of six hydroelectric power plants with the total capacity of 747 MW and the expected yearly production of 1 569 GWh.

Tablica 3 – Postojeće hidroelektrane na području Federacije BiH
Table 3 – Existing hydroelectric power plants on the territory of the Federation of BiH

FBiH – postojeće hidroelektrane / existing power plants			
EP BiH			
Naziv / Name	Snaga na pragu / Net capacity, MW	Očekivana godišnja proizvodnja / Expected yearly production, GWh	Korisni sadržaj akumulacije / Useful reservoir content, GWh
Jablanica	175	771	70
Grabovica	114	334	0,4
Salakovac	207	410	1,7
Male HE EP BiH / Small HE EP BiH	13	65	0
Ukupno / Total EP BiH	509	1 580	72,1

EP HZHB			
Čapljina	400	200	3,4
Rama	159,4	650	303,0
Mostar	71,6	247	0,4
Jajce I	58	233	0,5
Jajce II	28	157	0,2
Peć Mlini	30	82	0,2
Ukupno / Total EP HZHB	747	1 569	307,7
Ukupno / Total FBiH	1 256	3 149	379,8

U tablici 4 prikazani su osnovni podaci o termoelektranama na području Federacije BiH. Sve termoelektrane su u sastavu EP BiH, tj. na području EP HZHB postoje samo hidroelektrane. Ukupna snaga termoelektrana na pragu je **1 015 MW**. Sve elektrane kao gorivo koriste domaći ugljen (mrki i/ili lignit). Navedene cijene goriva odnose se na ostvarene nabavne cijene goriva u 2006. godini. Pri tome treba uzeti u obzir da su cijene ugljena za termoelektrane u Federaciji BiH regulirane od strane Vlade FBiH [1]. Do 2020. godine iz pogona izlaze jedinice Tuzla G3 (2013. godine), Tuzla G4 (2018. godine) i Kakanj G5 (2018. godine). Kakanj G7 je revitaliziran tijekom 2005. godine. Revitalizacija jedinice Tuzla G5 je završena 2008. godine, a predviđena je i revitalizacija blokova Tuzla G6 i Kakanj G6. Nakon revitalizacije očekuje se da će navedene jedinice izaći iz pogona nakon 2020. godine, tj. nakon kraja promatranog planskog razdoblja. Očekivano produljenje radnog vijeka revitaliziranih jedinica je 15 godina.

Table 4 shows the basic data on thermal power plants on the territory of the Federation of Bosnia and Herzegovina. All the thermal power plants belong to EP BiH, i.e. only hydroelectric power plants exist on the EP HZHB territory. The total available net capacity for thermal power plants is **1 015 MW**. All power plants use domestic coal (brown coal and/or lignite) as fuel. The mentioned fuel prices relate to the realised procurement fuel prices in 2006. It should be taken into consideration that the coal prices for thermal power plants in the Federation of Bosnia and Herzegovina are regulated by the Federation of Bosnia and Herzegovina Government [1]. By 2020, the facilities of Tuzla G3 (in 2013), Tuzla G4 (in 2018) and Kakanj G5 (in 2018) will end their operations. Kakanj G7 was revitalised in 2005. Revitalisation of Tuzla G5 was finished in 2008, and the revitalisation of the blocks of Tuzla G6 and Kakanj G6 is planned. Following the revitalisation, it is expected for the said units to end their operations after 2020, i.e. after the end of the monitored planning period. The expected extension of the operation span of revitalised units is 15 years.

Tablica 4 – Postojeće termoelektrane na području Federacije BiH
Table 4 – Existing thermal power plants on the territory of the Federation of BiH

Naziv jedinice / Unit name	Snaga na pragu / Net capacity, MW	Ugljen / Coal	Ogrjevna vrijednost goriva / Heat value of fuel, kJ/kg	Cijena goriva / Fuel price, EUR/GJ	Specifični potrošak topline / Heat rate, kJ/kWh	Izlazak iz pogona / Retirenment, Godina / Year
Tuzla G3	85	lignit/mrki / lignite/brown coal	10407	2,27	14404	2013.
Tuzla G4	175	lignit/mrki / lignite/brown coal	9948	2,27	12150	2018.
Tuzla G5	180	lignit/mrki / lignite/brown coal	10430	2,27	12200	iza/after 2020.
Tuzla G6	190	mrki / brown coal	16062	2,27	11810	iza/after 2020.
Kakanj G5	95	mrki / brown coal	13732	2,01	11700	2018.
Kakanj G6	85	mrki / brown coal	11700	2,01	14433	iza/after 2020.
Kakanj G7	205	mrki / brown coal	11400	1,98	12260	iza/after 2020.
Ukupno / Total FBiH/EP BiH	1015	–	–	–	–	–

U pogledu izlazaka iz pogona i revitalizacije važno je istaknuti da proizvodne jedinice Tuzla G3 i Tuzla G4 proizvode i toplinsku energiju kojom se opskrbljuju industrija i kućanstva na području Tuzle. Zbog toga je potrebno na ovim lokacijama planirati zamjenski proizvodni objekt. Slično stanje je i na lokaciji u Kaknju gdje postojeći blokovi opskrbljuju i toplinski konzum. Postoje i ideje o opsrkbi Sarajeva toplinom iz TE Kakanj.

3.2 Republika Srpska

U tablici 5 prikazani su osnovni podaci o postojećim hidroelektranama u Republici Srpskoj. Pri tome treba uzeti u obzir da se HE Dubrovnik I nalazi u hrvatskom elektroenergetskom sustavu i da se proizvodnja ove elektrane dijeli u omjeru 50:50 između Elektroprivrede RS i Hrvatske elektroprivrede (jedan agregat je povezan na sustav EP RS, a drugi na sustav HEP-a). U skladu s tim u tablici 5 prikazani su podaci o snazi i očekivanoj godišnjoj proizvodnji HE Dubrovnik koji se odnose na dio koji koristi EP RS, tj. pola snage (jedan od ukupno dva agregata) i pola proizvodnje (proizvodnja jednog agregata). Ukupna raspoloživa snaga hidroelektrana u RS je 735 MW uz očekivanu godišnju proizvodnju od 2 661 GWh.

As regards the ends of operations and revitalisation it is important to point out that the production units Tuzla G3 and Tuzla G4 also produce thermal energy which supplies the industry and households in the Tuzla area. Therefore it is necessary to plan an alternative production facility at these locations. The condition is similar at the Kakanj location, where the existing blocks also supply thermal consumption. Furthermore, there are also plans for the thermal supply of Sarajevo from the Kakanj thermal power plant (Kakanj TPP).

3.2 The Republic of Srpska (RS)

Table 5 shows the basic data on existing hydroelectric power plants in the Republic of Srpska. It should be taken into consideration that the Hydroelectric Power Plant Dubrovnik (HE Dubrovnik) I is in the Croatian electric power system, and that the power plant's production is shared in a 50:50 ratio between the Power Utility RS, and Hrvatska elektroprivreda (HEP) (one generator is connected to the EP RS system, and the other to the HEP system). In accordance with that, table 5 shows data on power and the expected yearly production of HPP Dubrovnik which apply to the share used by ERS, i.e. half of total power (one of two generators in total) and half of total production (single generator production). Total available capacity of hydroelectric power plants in the Republic of Srpska is 735 MW with the expected yearly production of 2 661 GWh.

Tablica 5 – Postojeće hidroelektrane na području Republike Srpske
Table 5 – Existing hydroelectric power plants on the territory of the Republic of Srpska

Republika Srpska – postojeće hidroelektrane / The Republic of Srpska – existing hydroelectric power plants			
Naziv / Name	Snaga na pragu / Net capacity, MW	Očekivana godišnja proizvodnja / Expected yearly production, GWh	Korisna veličina akumulacije / Useful reservoir size, GWh
HE Višegrad	315	1038	11,0
HE Bočac	110	307,5	5,5
HE Trebinje I	180	535,4	vidi tekst ispod / see text below
HE Trebinje II	7,6	12,5	0,4
HE Dubrovnik (50 %)*	108	695,6	vidi tekst ispod / see text below
Male i industrijske elektrane / Small and industrial power plants	15,2	72,0	0
Ukupno / Total	735,8	2 660,9	274,7

* – HE Dubrovnik I nalazi se na teritoriju RH. Elektroprivreda RS i Hrvatska elektroprivreda d.dijele proizvodnju iz HE Dubrovnik I u omjeru 50 : 50. / HE Dubrovnik I is on the territory of the Republic of Croatia. The Power Utility of the Republic of Srpska and Hrvatska elektroprivreda d.d. share the HE Dubrovnik I production in the ratio 50 : 50.

Korisni sadržaj akumulacije Trebinje je 9,36 GWh sa stanovišta proizvodnje u HE Dubrovnik. Korisna veličina akumulacije Bileća je 1 010 GWh sa sta-

From the viewpoint of HPP Dubrovnik, the useful content of the Trebinje reservoir is 9,36 GWh. From the total production viewpoint of HPP Trebinje I and

novišta ukupne proizvodnje u HE Trebinje I i HE Dubrovnik, a korisni sadržaj akumulacije Bileća je 200 GWh sa stanovišta proizvodnje u HE Trebinje I.

Podaci o malim i industrijskim elektranama prikupljeni su od strane EP RS. Osim navedenih na području RS postoji još malih i/ili industrijskih elektrana o kojima podaci nisu poznati.

U tablici 6 prikazani su osnovni podaci o postojećim termoelektranama na području Republike Srpske. Navedenim termoelektranama upravlja EP RS. Raspoloživa snaga ovih termoelektrana iznosi 530 MW. Pri tome treba imati u vidu da je projektirana snaga na pragu TE Ugljevik 280 MW, ali je zbog tehničkih problema moguće postići tek 250 MW. Za postizanje projektirane snage potrebna je rekonstrukcija kotla. TE Gacko i TE Ugljevik predviđene su za revitalizaciju čime će se produljiti životni vijek i ispuniti ekološke norme u pogledu emisije onečišćujućih tvari (čestice, sumpor, NO_x). Očekivana godina izlaska iz pogona revitaliziranih jedinica je nakon 2020. godine.

HPP Dubrovnik, the useful size of the Bileća reservoir is 1 010 GWh, and from the production viewpoint of HPP Trebinje I its useful volume is 200 GWh.

The data on small and industrial power plants was gathered by the ERS. Besides the previously mentioned, there are other small and/or industrial power plants on the territory of the Republic of Srpska, but their data are unknown.

Table 6 shows the basic data on existing thermal power plants on the territory of the Republic of Srpska. The mentioned thermal power plants are under the control of EP RS. The available power of these thermal power plants is 530 MW. However, it should be taken into account that the projected power available at threshold of TPP Ugljevik is 280 MW, but due to technical problems it is possible to achieve only 250 MW. To achieve the projected power, a reconstruction of the boiler is necessary. TPP Gacko and TPP Ugljevik have been scheduled for revitalisation, which will prolong their lifespan and fulfil the environmental standards in view of pollutant substances emissions (particles, sulphur, NO_x). The expected year for the end of operations of the revitalised units is after 2020.

Tablica 6 – Postojeće termoelektrane na području Republike Srpske
Table 6 – Existing thermal power plants on the territory of the Republic of Srpska

Naziv jedinice / Unit name	Snaga na pragu elektrane / Plant net capacity, MW	Vrsta goriva (ugljen) / Fuel type (coal)	Ogrjevna vrijednost goriva / Heat value of fuel, kJ/kg [a])	Cijena goriva / Fuel price, EUR/GJ	Specifični potrošak topline / Heat rate, kJ/kWh	Izlazak iz pogona / Retirenment, Godina / Year
Gacko 1	255*	lignit / lignite	8 000	1,45	11 520	iza / after 2017.
Ugljevik 1	235,6	mrki / brown coal	10 200	1,62	11 470	iza / after 2020.
Ukupno / Total ERS	490,6	–	–	–	–	–

* - nominalna snaga na pragu elektrane je 276 MW , a raspoloživa (prije revitalizacije) je 255 MW / nominal power at threshold of the power plant is 276 MW, and available power (before revitalisation) is 255 MW
a) – donja ogrjevna vrijednost / lower heating value

4 ELEKTRANE - KANDIDATI ZA IZGRADNJU

U nastavku je dan sažeti pregled elektrana kandidata na području BiH. S obzirom na relativno veliki ukupni broj kandidata, ovdje se navode podaci za one elektrane čiji se podaci temelje na prethodnim aktivnostima na pojedinom projektu i noveliranim studijama (pred)izvodljivosti i mogućnostima iskorištenja pojedinih vodotoka ili ugljenokopa. Za pojedine termoelektrane, za koje nisu bili poznati podaci o investicijama, ali su uključene u razmatranje, napravljena je procjena usporedbom s podacima o generičkim elektranama kandidatima iz GIS studije [2] i s drugim izvorima o očekivanim visinama investicija u proizvodne objekte.

4 POWER PLANT CANDIDATES FOR CONSTRUCTION

A concise review of candidate power plants in Bosnia and Herzegovina follows. Considering the relatively large total number of candidates, the data given here are only for those power plants whose data are based on previous activities in a certain project, detailed studies of (pre)feasibility and possibilities of exploitation of certain watercourses or coal mines. For certain thermal power plants which investment data was not known, but which have been included in the observation, an assessment has been made comparing the data on generic power plant candidates from the GIS study [2] and from other sources on expected investments in production facilities.

Što se tiče hidroelektrana kandidata za izgradnju postoji nekoliko tzv. zajedničkih objekata koji svojim radom utječu na vodotoke u susjednim državama ili entitetu. Ovi objekti su navedeni u nastavku, ali nisu razmatrani kao ozbiljni kandidati s obzirom na njihov neriješeni i nepoznati položaj koji je potrebno riješiti u izravnim pregovorima i dogovorima zainteresiranih strana.

4.1 Federacija BiH

U tablici 7 prikazani su osnovni podaci o hidroelektranama kandidatima na području Federacije BiH. Prikazana je prosječna moguća neto proizvodnja električne energije, tj. proizvodnja električne energije na pragu elektrane.

Na području EP BiH promatrano je ukupno deset (10) projekata – kandidata za izgradnju. Pri tome su sve male HE promatrane kao jedan projekt. Ukupna snaga kandidata iznosi 732,1 MW s očekivanom godišnjom proizvodnjom od 2 232,2 GWh. Najranija godina ulaska u pogon, za projekt malih HE koji EP BiH izvodi u suradnji s tvrtkom Turboinštitut iz Slovenije je 2009. godina (snaga malih HE u ovom projektu je oko 34 MW, a očekivana proizvodnja 126 GWh). Za ostale projekte pretpostavljeno je da mogu ulaziti u pogon od 2012. godine nadalje. Pri tome treba napomenuti da se radi o optimističnim varijantama najranijeg mogućeg ulaska u pogon s obzirom na stanje aktivnosti na pojedinim projektima.

Na području EP HZHB promatra se ukupno deset (10) kandidata. Pri tome treba imati u vidu da je HE Mostarsko Blato objekt u izgradnji. U svim scenarijima pretpostavljeno je da ova elektrana fiksno ulazi u pogon u 2010. godini. Za projekte malih HE na području EP HZHB pretpostavljeno je da su grupirani po slivovima te se promatraju ukupno tri projekta malih HE. Ukupna snaga svih razmatranih hidroelektrana kandidata iznosi 255 MW s očekivanom godišnjom proizvodnjom 677 GWh. Kao i u slučaju EP BiH i ovdje vrijedi komentar da su prikazane najranije godine ulaska u pogon optimistične.

U tablici 7 prikazani su i objekti koje planira izgraditi tvrtka Intrade Energija d.d. iz Sarajeva te ukupna očekivana snaga malih hidroelektrana na području Federacije BiH.

Ukupno na području Federacije BiH za realizaciju do 2020. godine konkuriraju hidroenergetski projekti snage 1 824,2 MW i očekivane godišnje proizvodnje 4 674,7 GWh. Među kandidatima je i crpna hidroelektrana PHE Bjelimići instalirane snage 2x300 MW s očekivanom godišnjom proizvodnjom 1 029 GWh, ali i potrošnjom od 1 388 GWh u crpnom načinu rada (tj. ova elektrana se u sustavu javlja kao neto potrošač električne energije). Opravdanost rada i izgradnje crpne hi-

Concerning hydroelectric power plant construction candidates, there are several so-called joint facilities which, through their operation, influence watercourses in neighbouring countries or entities. These facilities are mentioned below, but are not considered serious candidates because of their unresolved and unknown position which needs to be settled in direct negotiations and agreements between interested parties.

4.1 Federation of Bosnia and Herzegovina (FBiH)

Table 7 shows the basic data on hydroelectric power plant candidates on the territory of the Federation of Bosnia and Herzegovina. The average possible net electricity production, i.e. electricity production available at threshold, is shown.

A total of ten (10) projects – candidates for construction were monitored on the EP BiH territory. Thereat, all small HPPs were monitored as a single project. The total candidate capacity amounts to 732,1 MW with the expected yearly production of 2 232,2 GWh. The earliest possible year for the start of operations is 2009 for the small HPPs project implemented by the EP BiH in cooperation with the company Turboinštitut from Slovenia (the capacity of the small HPPs from this project is approximately 34 MW, and the expected yearly production is 126 GWh). For other projects it is assumed that they can start operations from 2012 onwards. However, it should be noted that these are optimistic variations of the earliest possible start of operations considering the state of activity on certain projects.

A total of ten (10) candidates were monitored on the EP HZHB territory. However, it should be taken into account that HPP Mostarsko Blato is a facility in construction. All scenarios assume that this power plant will permanently start operations in 2010. For the small HPP projects on EP HZHB territory it is assumed that they are grouped by basins and a total of three small HPP projects was monitored. The total capacity of all hydroelectric power plant candidates considered amounts to 255 MW with the expected yearly production of 677 GWh. As with EP BiH, the comment that the earliest possible years for the start of operations are optimistic applies here as well.

Table 7 also shows the facilities planned for construction by the company Intrade Energija d.d. from Sarajevo, and the total expected power of small hydroelectric power plants on the territory of the Federation of Bosnia and Herzegovina.

The total competition for hydropower projects on the territory of the Federation of Bosnia and Herzegovina to be realised by the year 2020 amounts to 1 824,2 MW of capacity, and 4 674,7 GWh of expec-

droelektrane može se provesti satnom analizom rada i dijagrama opterećenja u sustavu što traži posebnu analizu. Osim toga na području Bosne i Hercegovine već postoji jedna crpna hidroelektrana (CHE Čapljina, 400 MW), a nekoliko elektrana ovog tipa postoji i u susjednim sustavima (Hrvatska, Srbija). Potreba za crpnim hidroelektranama, tj. općenito elektranama koje mogu ponuditi brzu promjenu snage (regulaciju), može se očekivati s povećanom izgradnjom intermitentnih izvora kao što su npr. vjetroelektrane. Pri tome treba na odgovarajući način organizirati tržište električne energije, tj. organizirati tržište energije uravnoteženja.

Projekti HE Vrletna Kosa i HE Ugar Ušće nalaze se na međuentitetskoj crti te su se Vlade Federacije BiH i RS dogovarale o zajedničkoj izgradnji ovih hidroelektrana.

U tablici 8 prikazani su osnovni podaci o termoelektranama kandidatima na području Federacije BiH. Na području EP BiH razmatrano je sedam (7) lokacija termoelektrana. Pri tome tri kandidata (Tuzla G7, Tuzla G8 i Kakanj B) imaju praktično jednake karakteristike s obzirom da su za ove elektrane bile poznate samo očekivane instalirane snage. Podaci o investicijama, drugim troškovima i specifičnom potrošku topline su pretpostavljeni. Osobiti problem prilikom razmatranja termoelektrana kandidata predstavlja različita razina obrade pojedinih lokacija (postojeće, nove) što bitno utječe na nesigurnost cijene ugljena i specifične investicije na novim lokacijama u odnosu na postojeće lokacije. Ova nesigurnost se procjenjuje na 30 %.

Postojeće lokacije Tuzla i Kakanj imaju određene preduvjete i komparativne prednosti u odnosu na nove lokacije kao što su postojanje infrastrukture, osigurane lokacije u prostornim planovima, postojanje stručnog kadra i dr. Na lokacijama u Tuzli i Kaknju iz postojećih blokova se osigurava i toplinska energija za industriju i kućanstva te je potrebno voditi računa o izlasku postojećih blokova iz pogona i izgradnje zamjenskih proizvodnih kapaciteta.

Na području EP HZHB razmatrana je mogućnost izgradnje TE Kongora.

ted yearly production. The pump-storage hydroelectric power plant PHPP Bjelimići is also among the candidates, with its installed capacity of 2x300 MW and an expected yearly production of 1 029 GWh, but also with the consumption of 1 388 GWh during the pump-feeding operation mode (i.e. this power plant appears in the system as a net consumer of electricity).

The justifiability of operation and construction of a pump-storage hydroelectric power plant can be established by an hourly analysis of operations and a system load diagram, but that is not the subject of this study. Moreover, a pump-storage hydroelectric power plant already exists on the territory of Bosnia and Herzegovina (PSPP Čapljina, 400 MW), and there are several power plants of this type in the neighbouring systems (Croatia, Serbia) as well. The need for pump-storage hydroelectric power plants, that is, for power plants which can offer a quick power change (regulation) in general, can be expected with the increased construction of intermittent sources such as, for example, wind farms. The electricity market, i.e. the balance energy market, needs to be organised accordingly.

The projects of HPP Vrletna Kosa and HPP Ugar Ušće are situated at the inter-entity line, so the governments of the Federation of Bosnia and Herzegovina and the Republic of Srpska have agreed on a joint construction of these hydroelectric power plants.

Table 8 shows the basic data on thermal power plant candidates on the territory of the Federation of Bosnia and Herzegovina. Seven (7) thermal power plant locations were considered on the EP BiH territory. Three of the candidates (Tuzla G7, Tuzla G8 and Kakanj B) have virtually identical characteristics since only the expected installed powers were known for these power plants. Data on investments, other expenses and specific heat consumption are assumed. Varying levels of analysis for individual locations (existing, new) are a particular problem in considering thermal power plant candidates, which significantly influences the uncertainty of coal prices and specific investments on new locations in relation to existing locations. The uncertainty is estimated at 30 %.

The existing locations Tuzla and Kakanj have certain preconditions and comparative advantages to new locations, such as the existence of infrastructure, locations secured in physical plans, the existence of expert personnel etc. On Tuzla and Kakanj locations, the existing blocks also ensure thermal energy for industry and households so it is necessary to consider the end of operations of existing blocks and the construction of alternative production capacities.

The possibility for the construction of TPP Kongora has been considered on EP HZHB territory.

Tablica 7 – Hidroelektrane kandidati na području Federacije BiH
Table 7 – Candidate hydroelectric power plants on the territory of the Federation of Bosnia and Herzegovina

Federacija BiH / The Federation of BiH						
EP BiH						
Naziv / Name	Snaga na pragu / Net capacity, MW	Očekivana proizvodnja / Expected production, GWh/god. / GWh/y.	Korisna veličina akumulacije / Useful reservoir size, GWh	Specifična investicija / Specific investment, EUR/kW	Trajanje izgradnje / Duration of construction, Godina / Year	
Male HE EP BiH / Small HE EP BiH	~100	~380	0,0	1 493	2	
Unac	71	250	29,3	963	3	
Ustikolina	59	255	0,1	1 396	4	
Vranduk	22	103,2	0,0	2 111	4	
Glavatičevo[a])	171,8	295	48,3	1 048	5	
Vrhpolje	68	157,4	9,8	1 562	4	
Čaplje	7,7	56,8	0,1	2 845	4	
Goražde	60	234	0,35	1 500	5	
Ključ	49	211	-	1 714	4	
Konjic[b])	121	290	12,1	1 074	5	
Ukupno EP BiH / Total EP BiH	732,1	2 232,2				
EP HZHB						
Mostarsko Blato[c])	60	167	0,4	1 200	4	
CHE Vrilo	52	92	16,3	1 149	5	
CHE Kablić	52	73	20,6	1 437	5	
Han Skela	8,5	36	0,7	1 500	5	
Vrletna Kosa	25	63	34,7	1 500	5	
Jajce II-proširenje (HE Ugar Ušće) / Jajce II-expansion (HE Ugar Ušće)	15	60	0,3	1 500	5	
Male HE HZHB – Sliv T-M-T / Small HE HZHB – T-M-T basin	19,9	127,7	0,0	1 881	2	
Male HE HZHB – Sliv Lištice / Small HE HZHB – Lištica basin	7	27,7	0,0	1 832	2	
Male HE HZHB – Sliv Gornje Cetine / Small HE HZHB – Upper Cetina basin	12,7	30,7	0,0	1 650	2	
Ukupno EP HZHB / Total EP HZHB	252,1	677,1				
Intrade Energija d.o.o., Sarajevo						
PHE Bjelimići[d])	600,0 (–600,0)	1 029 (–1 388)	–	388**	4	
Bjelimići	100,0	306,4	0,0	1 660	5	
Ukupno Intrade / Total Intrade Energija / Energy	700,00	1 335,4 (–1 388)				
Male HE u Federaciji BiH s izdanom koncesijom / Small HE in Federation BiH with granted concession						
Male HE FBiH[e]) / Small HE FBiH[e])	140	430	–	2 000	2	
Ukupno FBiH / Total FBiH	1 824,2	4 674,7 (-1 388)				

a) – postoje različiti podaci o ovom projektu; snaga ovisi i rješenju gornjeg djela sliva, projekt nesiguran / data for this project varies, power also depends on the resolution of the upper basin parts, project uncertain,
b) - projekt upitan s ekološkog stanovišta / project environmentally questionable,
c) - HE Mostarsko Blato u izgradnji. Očekivani ulazak u pogon 2010. godine / HE Mostarsko Blato in construction. Expected start of operations in 2010,
d) – crpna hidroelektrana, bez troškova priključka na mrežu / pump-fed hydroelectric power plant, without network connection costs,
e) – procjena, podaci nisu bili dostavljeni / estimate, data were not delivered.

Tablica 8 – Termoelektrane kandidati na području Federacije BiH
Table 8 – Candidate thermal power plants on the territory of the Federation of BiH

EP BiH					
Naziv jedinice / Unit name	Maksimalna snaga / Maximum power, MW	Vrsta goriva (ugljen) / Fuel type (coal)	Specifični potrošak topline / Heat rate, kJ/kWh	Ogrjevna vrijednost goriva / Heat value of fuel, kJ/kg	Cijena goriva / Fuel price, EUR/GJ
Bugojno 1	350 (320)*	lignit / lignite	10 239	10 600	1,48
Tuzla G7	450 (411)	lignit / lignite	8 511	9 500	2,30
Kakanj G8	250 (230)	mrki / brown coal	9 000	13 600	2,30
Kakanj B	450 (411)	mrki / brown coal	8 511	13 600	2,30
Tuzla B G1	500 (465)**	mrki / brown coal	10 680	10 880	2,30
Kamengrad G1	215 (195)*	mrki / brown coal	9 000	11 700	2,30
Tuzla G8	450 (411)	lignit / lignite	8 511	9 500	2,30
EP HZHB					
Kongora	275 (265)*	lignit / lignite	9 300	7 380	1,53

* – moguća su dva bloka na lokacijama / two blocks are possible at the locations
** – moguća su tri bloka na lokaciji / three blocks are possible at the location

Na području EP HZHB istražen je ili je u fazi istraživanja određeni broj lokacija za vjetroelektrane. S obzirom na specifičnost konfiguracije pojedine vjetroelektrane (veći broj vjetroagregata povezanih u jednu vjetroelektranu), razmatrana je generička vjetroelektrana instalirane snage 50 MW.

A certain number of potential wind farm locations were researched or are being researched on EP HZHB territory. Considering the specific configuration of a single wind farm (a large number of wind powered generators connected into one wind farm), a generic wind farm with 50 MW of installed capacity was considered.

4.2 Republika Srpska

U tablici 9 prikazani su osnovni podaci o hidroelektranama kandidatima na području Republike Srpske. Razmatra se ukupno petnaest (15) projekata ukupne snage 1 167,6 MW i očekivane godišnje proizvodnje 2 945 GWh. Projekti malih HE modelirani su u nekoliko grupa ukupne snage 281,7 MW.

HE Dubrovnik 2 je projekt koji zajednički planiraju EP RS i HEP d.d. (Hrvatska). U tablici je prikazan dio koji bi pripadao EP RS (50 %).

HE Ugar Ušće je zajednički projekt s Federacijom BiH (ukupno planirana snaga je 40 MW, podjela potencijala 50 % : 50 %).

Osim objekata navedenih u tablici 9 u planu je i hidroelektrana na donjoj Sutjesci u sklopu projekta Donja Drina, ali još nije definirano tehničko rješenje.

Hidroelektrane Dabar, Nevesinje i Bileća pripadaju projektu Gornji Horizonti koji je u izgradnji. Do sada je u projekt uloženo oko $80 \cdot 10^6$ EUR (mjerenja, ispitivanja, elaborati, studije, projekti, prikupljanje suglasnosti, izgradnja tunela Fatničko polje – akumulacija Bileća, izgradnja tunela Dabarsko polje – Fatničko polje i drugo). Izgradnjom sustava Gornji Horizonti povećava se

4.2 The Republic of Srpska

Table 9 shows the basic data on hydroelectric power plant candidates on the territory of the Republic of Srpska. Fifteen (15) projects of 1 167,6 MW of total capacity and expected yearly production of 2 945 GWh are considered. The small HPP projects are modelled in several groups with the total power of 281,7 MW.

HPP Dubrovnik 2 is a project jointly planned by EP RS and HEP d.d. (Croatia). The table shows the share which would belong to EP RS (50 %).

HE Ugar Ušće is a joint project with the Federation of Bosnia and Herzegovina (total planned capacity is 40 MW, the share ratio of potentials is 50 % : 50 %).

Besides the facilities listed in table 9, a hydroelectric power plant is also planned on Lower Sutjeska within the Lower Drina project, but a technical solution has still not been defined.

Hydroelectric power plants of Dabar, Nevesinje and Bileća belong to the Upper Horizons project which is in construction. So far, approximately $80 \cdot 10^6$ EUR has been invested in the project (measurements, tests, surveys, studies, projects, obtaining consent, construction of the Fatnik field tunnel – Bileća reservoir, construction of the Dabar field – Fatnik field tunnel, etc). The construction of the Upper Horizons system

proizvodnja električne energije u nizvodnim sustavima.

increases the electricity production in downstream systems.

Tablica 9 – Hidroelektrane kandidati na području Republike Srpske
Table 9 – Candidate hydroelectric power plants on the territory of the Republic of Srpska

Naziv / Name	Maksimalna snaga na pragu / Maximum power at threshold, MW	Očekivana proizvodnja / Expected production, GWh/god. / GWh/y.	Korisna veličina akumulacije / Useful reservoir size, GWh	Specifična investicija / Specific investment, EUR/kW	Trajanje izgradnje / Duration of construction, Godina / Years
Male HE na teritoriju RS / Small HE on RS territory	281,7	740	–	1 750	2
Buk Bijela	132	350	20,0	2 121	4,5
Foča	56	199	0,2	1 512	4
Dabar	160	271	42,7	1 049	4,5
Bileća	36	117	3,9	1 417	3,5
Dubrovnik 2	152	159	6,5	1 153	4
Nevesinje	60	101	54,1	2 027	5
Krupa	49	140	0,3	1 528	5
Banja Luka niska / Banja Luka low	37	187	0,5	2 316	5
Novoselija	16	70	0,1	1 559	2,5
Paunci	42,3	160	–	–	–
Mrsovo	43,8	165	–	–	–
Ulog (Nedavić)	32,8	75	–	–	–
Ugar Ušće – 50%*	20	–	–	–	–
Ključ*	49	211	131,1	2 998	4
Ukupno / Total	1 167,6	2 945			

* – projekti na međuentitetskoj crti razdvajanja / projects on the entity division line

Za izgradnju hidroelektrana na Drini partner EP RS-u je Elektroprivreda Srbije (projekt Gornja Drina koji obuhvaća objekte Buk Bijela, Foča, Paunci i Donja Sutjeska). Ulazak u pogon HE Buk Bijela planiran je do 2015. godine, a ostale elektrane iz projekta očekuju se u pogonu do 2018. godine. Do 2013. godine moguć je ulazak u pogon hidroelektrana Mrsovo i Ulog.

U tablici 10 prikazani su osnovni podaci o termoelektranama kandidatima na području Republike Srpske. Razmatrane su tri lokacije: Stanari, Ugljevik i Gacko.

Na lokaciji Gacko pretpostavljena je mogućnost izgradnje dva bloka (2x330 MW) s najranijim godinama ulaska u pogon 2015. i 2016. Prema dosadašnjim planovima projekt bi zajednički realizirali EP RS i ČEZ (Češka elektroprivredna tvrtka).

Ugljevik 2 je projekt koji EP RS planira graditi u suradnji s američkom tvrtkom AES (udio EP RS 49 %). Za ovaj projekt izrađena je predstudija izvodljivosti. Planirana godina ulaska u pogon je 2014.

For the construction of hydroelectric power plants on Drina, EP RS's partner is the Electric Power Industry of Serbia (the Upper Drina project encompasses the facilities Buk Bijela, Foča, Paunci and Lower Sutjeska). The start of operations for the HPP Buk Bijela is planned for the year 2015, and the other power plants included in the project are expected to start operations by the year 2018. By 2013 it is possible that hydroelectric power plants Mrsovo and Ulog start operations.

Table 10 shows the basic data on thermal power plant candidates on the territory of the Republic of Srpska. Three locations were considered: Stanari, Ugljevik and Gacko.

At the Gacko location, the possibility for the construction of two blocks (2x330 MW) is assumed with the years of the earliest start of operations being 2015 and 2016. According to the plans so far, the project would be jointly realised by EP RS and ČEZ (Czech power utility company).

Ugljevik 2 is a project planned for construction by EP RS in cooperation with the American company AES (EP RS share 49 %). Pre-feasibility study was made for this project. The planned year for the start of operations is 2014.

Tablica 10 – Termoelektrane – kandidati na području Republike Srpske
Table 10 – Thermal power plants – candidates on the territory of Republic of Srpska

ERS						
Naziv / Name	Maksimalna snaga (na pragu) / Maximum power (net capacity), MW	Vrsta goriva (ugljen) / Fuel type (coal)	Specifični potrošak topline / Heat rate, kJ/kWh	Ogrjevna vrijednost goriva / Heat value of fuel, kJ/kg	Cijena goriva / Fuel price, EUR/GJ	Fiksni troškovi pogona i održavanja / Fixed operating and maintenance costs, EUR/k/W/mjesec / EUR/kW/month
Ugljevik 2	400 (380)	mrki / brown coal	9 000	10 200	1,62	3,0
Gacko 2*	330 (300,5)	lignit / lignite	9 000	8 100	1,57	8,8
EFT Grupa / EFT Group						
Stanari	410 (388,7)	lignit / lignite	9 230	9 100	1,32	3,0

* – moguća su dva bloka na lokaciji / two blocks are possible at the location

Na početku 2008. godine položaj projekta TE Stanari je bio takav da je potpisan ugovor o koncesiji za izgradnju s Vladom RS. Prema ovom ugovoru elektrana Stanari je namijenjena za tržište (engl. *Merchant Plant*). Drugim riječima, iako će elektrana biti izgrađena na području BiH moguće je da će sva električna energija iz ove elektrana biti namijenjena stranim tržištima, tj. onome tko ponudi najbolju cijenu. Zbog toga se kod optimizacije izgradnje ova elektrana i njen utjecaj na sustav razmatra na dva načina: elektrana proizvodi za tržište u BiH i elektrana proizvodi isključivo za izvoz. Prema posljednjim informacijama (kolovoz 2009.) pripremni (zemljani) radovi su u tijeku.

In early 2008, the position of the TPP Stanari project was such that a contract for construction concession has been signed with the Government of the Republic of Srpska. According to this contract, the Stanari power plant is a merchant plant. In other words, even though the power plant will be built on the territory of Bosnia and Herzegovina, it is possible that all electricity produced in this power plant will be intended for the foreign markets, i.e. for the highest bidders. That is why this power plant and its influence on the system are considered in two ways concerning construction optimisation: whether the power plant produces for the Bosnia and Herzegovina market, or only for export. According to the latest information (August 2009) the preparatory (ground) work is in progress.

5 ANALIZA UJEDNAČENIH GODIŠNJIH TROŠKOVA – TERMOELEKTRANE

U nastavku je prikazana analiza ujednačenih godišnjih troškova (engl. *Screening Curve Analysis*) za termoelektrane kandidate i termoelektrane predviđene za revitalizaciju na području Bosne i Hercegovine te hidroelektrane i vjetroelektrane.

5.1 Troškovi termoelektrana

Na slici 1 prikazane su krivulje troškova uz pretpostavljene cijene goriva i investicije. Za objekte na području Federacije BiH za koje nije dobivena cijena ugljena od strane elektroprivreda, pretpostavljena je cijena u skladu s odlukom Vlade FBiH o cijenama ugljena za termoelektrane (tj. 2,30 EUR/GJ).

TE Gacko 1 i TE Ugljevik 1 iskazuju znatno veće stalne i promjenljive troškova pogona i održavanja u odnosu na ostale elektrane u sustavu, što

5 SCREENING CURVE ANALYSIS – THERMAL POWER PLANTS

This chapter elaborates on the screening curve analysis for thermal power plant candidates, thermal power plants scheduled for revitalisation on Bosnia and Herzegovina territory, hydroelectric power plants and wind farms.

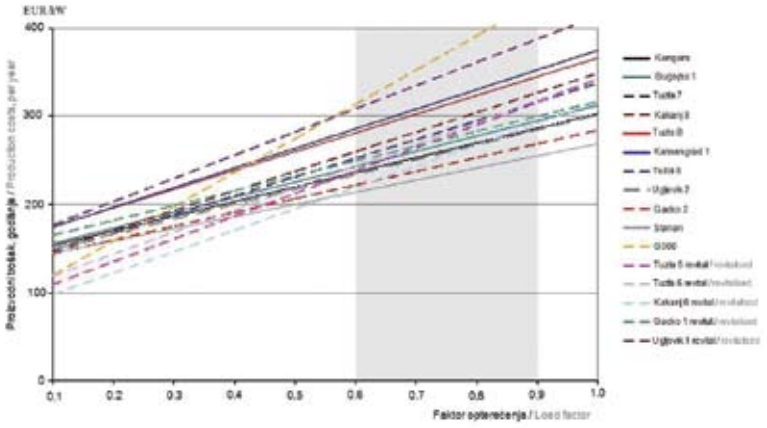
5.1 Thermal power plants costs

Figure 1 shows the screening curves with assumed fuel prices and investments. For facilities on the territory of the Federation of Bosnia and Herzegovina for which the electric utility companies did not disclose coal prices, the prices were assumed in accordance with the decision of the Government of the Federation of Bosnia and Herzegovina on coal prices for thermal power plants (i.e. 2,30 EUR/GJ).

TPP Gacko 1 and TPP Ugljevik 1 show significantly larger constant and variable operations and maintenance costs in relation to other power plants in the system,

bitno utječe na isplativost revitalizacije ovih postrojenja, osobito TE Ugljevik 1. Uz navedene pretpostavke o cijenama ugljena od elektrana kandidata osobito su interesantni projekti TE Stanari i TE Gacko 2. Kao najmanje atraktivna investicija pokazuje se plinska elektrana, zbog visoke cijene plina u odnosu na domaći ugljen. Treba istaknuti da analiza pomoću krivulja troškova ima ograničeni domet u smislu sagledavanja uklapanja pojedine proizvodne jedinice u promatrani elektroenergetski sustav [3] i služi kao okvirna procjena za sužavanje izbora ukupnog broja kandidata.

which significantly influences the cost effectiveness of the revitalisation of these plants, especially of TPP Ugljevik 1. With the given coal price assumptions, the projects TPP Stanari and TPP Gacko 2 are of special interest among power plant candidates. The least attractive investment is a gas power plant, because of high gas prices in comparison with domestic coal. It should be pointed out that the screening analysis has a limited range in the sense of observing the integration of an individual production unit in the monitored electric power system [3], and serves as an approximation for the narrowing down of choices from the total number of candidates.



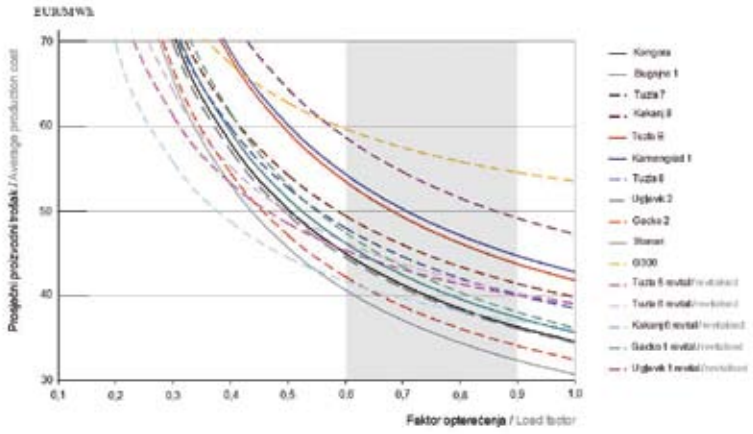
Slika 1 — Krivulje troškova za termoelektrane kandidate i revitalizacije
Figure 1 — Screening curves for thermal power plant candidates and revitalisations

U tablici 11 i na slici 2 prikazani su podaci o prosječnom proizvodnom trošku pojedine termoelektrane (EUR/MWh) tijekom njenog životnog vijeka ovisno o faktoru opterećenja, tj. broju sati iskorištenja maksimalne snage elektrane. Za faktor opterećenja 0,80 što odgovara 7 000 sati rada godišnje, prosječni proizvodni trošak termoelektrana kandidata na ugljen (dakle bez revitaliziranih jedinica za koje se pretpostavlja da će raditi s manjim brojem sati rada – do 6 000) kreće se u rasponu 34,4 EUR/MWh do 47,1 EUR/MWh.

Table 11 and figure 2 show information on average production costs of an individual power plant (EUR/MWh) during its life span depending on the load factor, i.e. the number of hours the maximum power of the power plant was used. For a 0,80 load factor, which corresponds to 7 000 operation hours per year, the average production cost for a coal-powered thermal power plant candidate (therefore without the revitalised units which will approximately operate with a decreased number of operation hours - up to 6 000 hours) is in the range between 34,4 EUR/MWh and 47,1 EUR/MWh.

Tablica 11 – Prosječni proizvodni trošak elektrana kandidata i revitaliziranih jedinica ovisno o faktoru opterećenja
Table 11 – The average production cost of candidate power plants and revitalised units depending on the load factor

Elektrana / Power plant	Faktor opterećenja / Load factor									
	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0
	EUR/MWh									
Kongora	175,2	97,1	71,0	58,0	50,2	45,0	41,3	38,5	36,3	34,6
Bugojno	177,9	98,9	72,5	59,4	51,5	46,2	42,4	39,6	37,4	35,7
Tuzla 7	166,6	95,4	71,7	59,8	52,7	48,0	44,6	42,1	40,1	38,5
Kakanj 8	169,5	97,5	73,4	61,4	54,2	49,4	46,0	43,4	41,4	39,8
Tuzla B	199,6	111,9	82,7	68,1	59,3	53,5	49,3	46,2	43,7	41,8
Kamengrad	199,1	112,3	83,3	68,8	60,1	54,4	50,2	47,1	44,7	42,8
Tuzla 8	166,6	95,4	71,7	59,8	52,7	48,0	44,6	42,1	40,1	38,5
Ugljevik 2	170,8	95,0	69,8	57,2	49,6	44,5	40,9	38,2	36,1	34,4
Gacko 2	164,6	91,2	66,7	54,5	47,1	42,2	38,7	36,1	34,1	32,4
Stanari	165,4	90,6	65,6	53,1	45,7	40,7	37,1	34,4	32,4	30,7
G300	136,9	90,5	75,1	67,4	62,8	59,7	57,5	55,8	54,5	53,5
Tuzla 5 revital. / Tuzla 5 revitalised	124,7	77,1	61,2	53,3	48,5	45,3	43,1	41,4	40,1	39,0
Tuzla 6 revital. / Tuzla 6 revitalised	135,6	82,0	64,2	55,2	49,9	46,3	43,7	41,8	40,3	39,2
Kakanj 6 revital. / Kakanj 6 revitalised	111,8	69,7	55,7	48,7	44,5	41,7	39,7	38,2	37,0	36,1
Gacko 1 revital. / Gacko 1 revitalised	188,4	103,8	75,6	61,5	53,1	47,4	43,4	40,4	38,0	36,2
Ugljevik 1 revital. / Ugljevik 1 revitalised	201,8	115,9	87,3	73,0	64,4	58,7	54,6	51,5	49,1	47,2



Slika 2 — Prosječni proizvodni trošak elektrana kandidata i revitaliziranih jedinica ovisno o faktoru opterećenja
Figure 2 — The average production cost of candidate power plants and revitalised units depending on the load factor

5.2 Troškovi hidroelektrana i vjetroelektrana

U nastavku (tablica 12 i slika 3) je prikazana analiza pomoću krivulje troškova za projekte hidroelektrana i za tipsku vjetroelektranu VE50. Za izračun prosječnog godišnjeg troška po jedinici snage tj. za prosječnu proizvodnu cijenu pretpostavljen je životni vijek za hidroelektrane 50 godina, a za vjetroelektrane 20 godina. Za tipsku vjetroelektranu VE50 prikazane su varijante NISKA (specifična investicija 1 000 EUR/kW, faktor opterećenja 0,34) i VISOKA (specifična investicija 1 500 EUR/kW, faktor opterećenja 0,25).

5.2 Costs of hydroelectric power plants and wind farms

The screening analysis for hydroelectric power plant projects and the typal wind farm VE50 follows (table 12 and figure 3). For the calculations of the average yearly cost per power unit, i.e. for the average production price, the assumed lifespan for hydroelectric power plants is 50 years, and 20 years for wind farms. For the typal wind farm VE50 the versions shown are LOW (specific investment 1 000 EUR/kW, load factor 0,34) and HIGH (specific investment 1 500 EUR/kW, load factor 0,25).

Tablica 12 – Godišnji troškovi po jedinici snage i troškovi proizvodnje hidroelektrana i tipske vjetroelektrane kandidata za izgradnju
Table 12 – The yearly cost per power unit and production costs for hydroelectric power plants and the typal wind farm candidate for construction

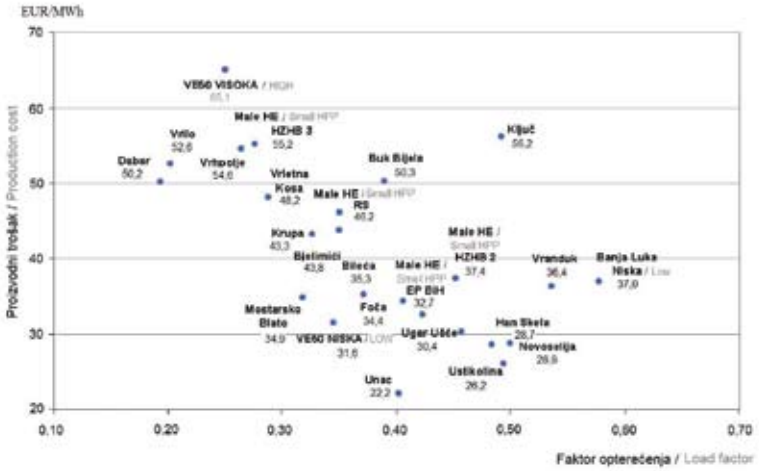
Objekt / Facility	EUR/kW godišnje / per year	Faktor iskoristenja snage / Capacity factor	EUR/MWh
Unac	78,2	0,40	22,2
Male HE HZHB sliv T-M-T / Small HE HZHB T-M-T basin	152,1	0,73	23,7
Ustikolina	113,0	0,49	26,2
Han Skela	121,4	0,48	28,7
Novoselija	126,2	0,50	28,8
Ugar Ušće	121,4	0,46	30,4
Čaplje	229,8	0,84	31,2
Vjetroelektrane NISKA / Wind farms LOW	95,3	0,34	31,6
Male HE EP BiH / Small HE EP BiH	120,9	0,42	32,7
Foča	122,4	0,41	34,4
Mostarsko Blato	97,3	0,32	34,9
Bileća	114,7	0,37	35,3
Vranduk	170,7	0,54	36,4
Banja Luka niska / Banja Luka low	187,2	0,58	37,0
Male HE HZHB sliv Lištice / Small HE HZHB Lištica basin	148,2	0,45	37,4
Krupa	123,7	0,33	43,3
Bjelimići	134,3	0,35	43,8
Male HE ERS / Small HE ERS	141,6	0,35	46,2
Vrletna Kosa	121,4	0,29	48,2
Dabar	85,1	0,19	50,2
Buk Bijela	171,5	0,39	50,3
Vrilo	93,1	0,20	52,6
Vrhpolje	126,4	0,26	54,6
Male HE HZHB sliv Gornje Cetine / Small HE HZHB Upper Cetina basin	133,5	0,28	55,2
Ključ	242,1	0,49	56,2
Vjetroelektrane – VISOKA / Wind farms - HIGH	142,5	0,25	65,1
Kablić	116,4	0,16	82,9
Dubrovnik	93,5	0,12	89,4
Nevesinje	163,9	0,19	97,4

Za hidroelektrane/vjetroelektrane skrining krivulja predstavlja točku na grafičkom prikazu kod koje vertikalna koordinata prikazuje trošak (iskazan u EUR/kW godišnje, tj. ako se prikazuje prosječna proizvodna cijena kao na slici 3 u EUR/MWh), a horizontalna koordinata prikazuje faktor opterećenja za prosječnu godišnju proizvodnju promatrane elektrane.

Osim rangiranja prema prosječnim specifičnim troškovima proizvodnje i prosječnoj proizvodnoj cijeni, za projekte hidroelektrana je važno sagledati najraniju moguću godinu ulaska u pogon i druge moguće probleme u realizaciji projekata (npr. izgradnja tzv. zajedničkih objekata), kao i po-

For hydroelectric power plants / wind farms, the screening curve is a point on the graphic presentation at which the vertical coordinate presents the cost (in EUR/kW per year, i.e. if the average production price is shown as in figure 3 in EUR/MWh), and the horizontal coordinate presents the load factor for the average yearly production of the monitored power plant.

Besides the ranking according to average specific production costs and average production price, for the hydroelectric power plant projects it is important to consider the earliest possible year for the start of operations, other possible problems during project realisation (for example, the construction of the so-



Slika 3 — Prosječna proizvodna cijena tijekom životnog vijeka za hidroelektrane i vjetroelektrane kandidate za izgradnju
Figure 3 — The average production price during the lifespan of a hydroelectric power plant and wind farm candidate for construction.

trebe sustava za energijom i snagom iz hidroelektrana. U tom smislu realne godine ulaska u pogon novih hidroelektrana su od 2014. godine nadalje, osim projekata koji su već u izgradnji (praktično samo male HE i HE Mostarsko Blato).

U pogledu vjetroelektrana stanje je povoljnije što se tiče potrebnog vremena pripreme za izgradnju i izgradnje, ali se problemi mogu očekivati u rokovima isporuke opreme (od narudžbe do isporuke oko 2 godine). Osim toga, tijekom 2007. godine zbog povećane potražnje za vjetroturbinama došlo je do općenitog povećanja razine investicijskog troška za vjetroelektrane (ostvarene narudžbe tijekom 2007. bilježe prosjek od 1 300 EUR/kW). Očekivana cijena vjetroelektrane više nije na razini od 1 000 EUR/kW, već u rasponu od 1 000 EUR/kW do čak 1 500 EUR/kW. U tom smislu je na slici 3 prikazan i utjecaj promjene specifične investicije i očekivanog faktora opterećenja na prosječnu proizvodnju cijenu iz VE.

6 SCENARIJI RAZVOJA EES BIH

Broj mogućih scenarija je vrlo velik. U nastavku su prikazana i komentirana samo dva od njih (S1 i S2), koji daju okvirni pregled mogućih događanja do 2020. godine. Vrlo velik utjecaj na buduća događanja će imati kvaliteta suradnje pojedine elektroprivrede kod izgradnje vlastitih proizvodnih pogona. Isto tako, u mnogome će sve ovisiti o opredjeljenju za podmirivanjem samo vlastite potrošnje ili izvozna orijentacija, kad je električna energija u pitanju. Ova okre-

called joint facilities), and also the system requirements for energy and power from hydroelectric power plants. In that sense, the realistic years for the start of operations of new hydroelectric power plants are from 2014 onwards, except for the projects already in construction (only small HPPs and HPP Mostarsko Blato).

When it comes to wind farms, the condition is more favourable concerning the necessary preparation time for construction and the construction itself, but problems can be expected with deadlines for equipment delivery (from order to delivery, approximately 2 years). Furthermore, during 2007, due to increased demand for wind turbines, there was a general increase in the level of investment costs for wind farms (realised orders during 2007 record an 1 300 EUR/kW average). The expected wind farm price is no longer at the 1 000 EUR/kW level, but in the range from 1 000 EUR/kW up to 1 500 EUR/kW. In that sense, figure 3 also shows the influence of the change of specific investment and the expected load factor on the average wind farm production price.

6 DEVELOPMENT SCENARIOS FOR THE ELECTRIC POWER SECTOR (EPS) OF BIH

There is a very large number of possible scenarios. This chapter elaborates and comments on only two of them (S1 and S2) which give us an approximation of possible events until year 2020. The quality of cooperation an individual electric utility company will give in the process of construction of its production drives will greatly influence future events. Moreover, when electricity is concerned, in many respects everything will depend on the commitment to either the exclusive fulfilment of own consumption or the orientation towards export. The orientation towards export will, of course, be sti-

nutost prema izvozu će, dakako, biti uvjetovana stanjem u ostalim zemljama regije.

pulated by the condition in other countries of the region.

6.1 Scenarij S1

Prema ovom scenariju, sustav BiH je optimiran kao jedna cjelina, uz kriterij podmirivanja potrošnje na području BiH.

6.1 The S1 scenario

In this scenario, the Bosnia and Herzegovina system is optimised as a whole, with the criterion of meeting the consumption needs on the Bosnia and Herzegovina territory.

Tablica 13 – Raspored ulaska u pogon elektrana za EES BiH za scenarij S1
Table 13 – Start of operations schedule for EPS BiH power plants under scenario S1

Snaga na pragu elektrane / Power plant power at threshold				
Godina / Year	HE / HPP	MW	TE / TPP	MW
2010.	Mostarsko Blato	60		
2013.			Stanari	389
2018.			Tuzla 7	411
2020.			Kakanj 8	230
Ukupno / Total	60		1 030	
Ukupno / Total	1 090			

U pogon ulazi ukupno 1 090 MW, od toga 1 030 MW u termoelektranama. U pogon ulaze TE Stanari (2013., 389 MW na pragu), Tuzla 7 (2018., 411 MW na pragu) i Kakanj (2020., 230 MW). Izgradnja blokova u Tuzli i Kaknju omogućit će i kontinuiranu opskrbu toplinom potrošača na tim područjima s obzirom na izlazak iz pogona postojećih proizvodnih jedinica. U tablici 14 prikazana je struktura proizvodnih kapaciteta i rezerva sustava. Rezerva sustava je u svim godinama veća od 40 %. Udio TE u ukupnoj snazi elektrana u sustavu na kraju razdoblja je 53 %. Nakon kraja planskog razdoblja prvi termoenergetski objekt ulazi u pogon 2022. godine.

A total of 1 090 MW will start operations, 1 030 MW of which in thermal power plants. TPP Stanari (year 2013, 389 MW at threshold), Tuzla 7 (year 2018, 411 MW at threshold) and Kakanj (year 2020, 230 MW) will start operations. The construction of blocks in Tuzla and Kakanj will also enable a continuous heating supply for consumers in those areas, considering the end of operations of existing production units. Table 14 shows the structure of production capacities and the system reserve. The system reserve is higher than 40 % in all the years. The share of thermal power plants in the total power of the system power plants is 53 % at the end of the period. After the end of the planning period, the first thermal power facility will start operations in 2022.

Tablica 14 – Struktura proizvodnih kapaciteta, vršno opterećenje i rezerva u sustavu EES BiH za scenarij S1
Table 14 – The structure of production capacities, peak load and system reserve of EPS BiH for the S1 scenario

Godina / Year	HE postojeće / HPP existing	HE nove / HPP new	TE postojeće / TPP existing	TE nove / TPP new	Ukupno / Total	Vršno opterećenje / Peak load	Rezerva sustava / System reserve
	MW						%
2009.	1 991	0	1 087	0	3 078	2 192	40,4
2010.	1 991	60	1 479	0	3 530	2 235	57,9
2011.	1 991	60	1 329	0	3 380	2 311	46,3
2012.	1 991	60	1 609	0	3 660	2 390	53,2
2013.	1 991	60	1 524	389	3 964	2 471	60,4
2014.	1 991	60	1 524	389	3 964	2 556	55,1
2015.	1 991	60	1 524	389	3 964	2 590	53,0
2016.	1 991	60	1 524	389	3 964	2 667	48,6
2017.	1 991	60	1 524	389	3 964	2 747	44,3
2018.	1 991	60	1 254	800	4 105	2 830	45,1
2019.	1 991	60	1 254	800	4 105	2 915	40,8
2020.	1 991	60	1 254	1 030	4 335	3 003	44,3

U tablici 15 prikazana je bilanca podmirenja potrošnje električne energije u BiH i mogućnost izvoza električne energije. U svakoj godini postoji mogućnost izvoza, uz pretpostavku da postojeće revitalizirane termoelektrane imaju vrijeme iskorištenja maksimalne snage od 6 000 h/god, a nove jedinice 7 000 h/god. U tom slučaju prosječno je moguće izvoziti oko 1 850 GWh/god. Na kraju razdoblja udio termoelektrana u ukupnoj proizvodnji je oko 2/3.

Table 15 shows the balance for settling the electricity consumption in Bosnia and Herzegovina and the possibility for the export of electricity. Every year there is the possibility for export, with the assumption that the existing revitalised thermal power plants have the time utilisation of maximum power of 6 000 h/year, and new units 7 000 h/year. When that is the case, it is on average possible to export approximately 1 850 GWh/year. At the end of the period, the thermal power plant share in total production is approximately 2/3.

Tablica 15 – Bilanca proizvodnje električne energije EES BiH za scenarij S1
Table 15 – The electricity production balance in EPS BiH for the S1 scenario

Godina / Year	HE / HPP	TE / TPP	Uvoz / Import	Ukupno raspoloživo / Available total	Potrošnja / Consumption EES BiH	Mogući izvoz / Possible export
	GWh					
2009.	5 808	6 443	481	12 733	12 733	1 956
2010.	5 975	7 118	19	13 112	13 112	1 757
2011.	5 975	7 425	149	13 550	13 550	2 238
2012.	5 975	8 029	0	14 004	14 004	1 628
2013.	5 975	8 499	0	14 474	14 474	1 175
2014.	5 975	8 987	0	14 962	14 962	3 036
2015.	5 975	9 493	0	15 468	15 468	2 531
2016.	5 975	9 943	0	15 918	15 918	2 087
2017.	5 975	10 409	0	16 384	16 384	1 627
2018.	5 975	10 891	0	16 866	16 866	1 141
2019.	5 975	11 389	0	17 364	17 364	2 723
2020.	5 975	11 905	0	17 880	17 880	2 213

U tablici 16 prikazana je ukupna potrošnja ugljena i emisija CO_2 za slučajeve sa i bez izvoza električne energije (za slučaj izvoza pretpostavljeno je iskorištenje maksimalne snage postojećih/revitaliziranih elektrana od 6 000 h/god).

Table 16 shows the total coal consumption and CO_2 emissions for cases with and without the export of electricity (in the case of export the assumed maximum power use of existing/revitalised power plants is 6 000 h/god).

Tablica 16 – Potrošnja ugljena i emisija CO_2 EES BiH za scenarij S1
Table 16 – EPS BiH coal consumption and CO_2 emissions for the S1 scenario

Godina / Year	Potrošnja ugljena / Coal consumption		Emisija / Emissions CO_2	
	milijuni tona / millions of tonnes		milijuni tona / millions of tonnes	
	Bez izvoza / Without export	S izvozom / With export	Bez izvoza / Without export	S izvozom / With export
2009.	7,51	9,66	7,6	9,8
2010.	8,07	10,13	8,0	10,1
2011.	8,31	9,17	8,5	9,3
2012.	8,81	10,71	8,9	10,8
2013.	8,82	12,51	8,7	12,3
2014.	9,36	12,51	9,2	12,3
2015.	9,91	12,51	9,7	12,3
2016.	10,39	12,51	10,2	12,3
2017.	10,87	12,51	10,7	12,3
2018.	11,00	13,32	10,6	12,9
2019.	11,47	13,32	11,0	12,9
2020.	11,59	14,38	11,4	14,2
Ukupno / Total	124,4	150,8	123,1	149,5

6.2 Scenarij S2

U scenariju S2 precizno je definirana realizacija projekata malih hidroelektrana i vjetroelektrana u skladu s najavama i planovima elektroprivrednih tvrtki i dodijeljenim koncesijama. Ostali projekti promatraju se kao ravnopravni kandidati za izgradnju. Ovaj scenarij može se smatrati izrazito ekološki orijentiranim scenarijem. U tablici 17 prikazan je raspored ulazaka u pogon (fiksirani ulasci te rezultati optimizacije).

6.2 Scenario S2

In the S2 scenario, the realisation of the small hydroelectric power plant and wind farm projects is strictly defined in accordance with the announcements and plans of electric utility companies and granted concessions. Other projects are monitored as equal candidates for construction. This scenario can be considered as an especially environmentally oriented one. Table 17 shows the schedule of starts of operations (fixed starts and optimisation results).

Tablica 17 – Raspored ulazaka u pogon za EES BiH za scenarij S2
Table 17 – Start of operations schedule for EES BiH under scenario S2

Snaga na pragu elektrane / Plant net capacity					
Godina / Year	HE / HPP	MW	TE / TPP	MW	VE / Wind farms, MW
2009.	Male HE RS / Small HE RS	42			50
2010.	Mostarsko Blato Male HE EP HZHB / Small HE EP HZHB Male HE EP BiH / Small HE EP BiH	114			50
2011.	Male HE EP HZHB / Small HE EP HZHB Male HE RS / Small HE RS	49			50
2012.					50
2013.	Male HE RS / Small HE RS	42			50
2014.			Gacko 2	300	
2015.	Male HE EP HZHB / Small HE EP HZHB Male HE RS / Small HE RS	55			
2017.	Male HE RS / Small HE RS	42			
2018.			Stanari	389	
Ukupno / Total	345		689		250
Ukupno / Total	1 284				

Do 2020. godine u pogon ulazi ukupno 1 284 MW snage na pragu elektrana, od toga 345 MW hidroelektrana (većinom projekti malih HE), 250 MW vjetroelektrana te dvije termoelektrane, Gacko u 2014. godini i Stanari u 2019. godini.

U ukupnoj proizvodnji električne energije udio hidroelektrana s oko 44 % na početku planskog razdoblja opada na 39 % u 2020. godini. Istovremeno udio termoelektrana ostaje približno stalan (promjena s oko 55% na oko 57 %). Ostatak potrebne električne energije osigurava se iz uvoza (koji prestaje nakon 2011. godine) i iz vjetroelektrana čiji udio u ukupnoj proizvodnji u 2020. godini iznosi oko 4 %.

Zbog povećane izgradnje malih hidroelektrana i vjetroelektrana, emisije ugljikovog dioksida u scenariju S2 iznose deset milijuna tona u 2020. godini što je za 12 % manje u odnosu na scenarij S1.

Uz pretpostavku povećanog iskorištenja maksimalne snage elektrana (5 000 sati do 6 000 sati za postojeće/revitalizirane i 7 000 sati za nove proizvodne jedinice), mogućnosti izvoza u scenariju

By the year 2020 a total of 1 284 MW at power plant threshold will start operations, 345 MW of which from hydroelectric power plants (mostly small HPP projects), 250 MW from wind farms and two thermal power plants – Gacko in 2014 and Stanari in 2019.

In the total electricity production, the share of hydroelectric power plants will fall from 44 % at the beginning of the planning period to 39 % in the year 2020. At the same time, the thermal power plant share will remain nearly constant (change from approximately 55% to approximately 57 %). The remainder of the electricity needed will be ensured from import (which ceases after 2011) and from wind farms whose share in total production in 2020 will be approximately 4 %.

Due to increased construction of small hydroelectric power plants and wind farms, the carbon-dioxide emissions in the scenario amount to ten million tonnes in 2020, which is 12 % less than in the S1 scenario.

With the assumption of increased maximum power utilisation of power plants (from 5 000 hours to 6 000

S2 iznose u prosjeku 1 400 GWh/god., a maksimalno do 2 500 GWh/god.

7 ZAKLJUČAK

Rezimirajući cjelokupnu analizu provedenu za plan izgradnje proizvodnih objekata kroz cijelo plansko razdoblje (2009. do 2020. godine), između svih važnih pitanja izdvaja se nekoliko njih, za koje se može reći da su ključna:

- odnos dva entiteta (Federacije BiH i Republike Srpske), zatim odnos tri elektroprivrede, njihova spremnost na suradnju u elektroenergetskom sektoru i pristup planiranju izgradnje elektrana zasnovan na međusobnim odnosima,
- razina elektroenergetske suverenosti Bosne i Hercegovine kao države, njenih entiteta i elektroprivreda pojedinačno (razina samodostatnosti ili mjera oslanjanja na uvoz električne energije, ili pak izvozna orijentacija),
- stanje u elektroenergetskom sektoru zemalja u regiji i mogući utjecaj na buduću izgradnju elektrana u BiH,
- mogućnost izgradnje novih termoelektrana na ugljen, s obzirom na rezerve ugljena i cijenu ugljena,
- mogućnost izgradnje novih hidroelektrana,
- udio novih obnovljivih izvora električne energije (vjetar, male HE, biomasa i sl.) u podmirivanju ukupne potrošnje,
- utjecaj izgradnje novih izvora na stanje okoliša i mogućnost harmonizacije s domaćom i međunarodnom pravnom regulativom koja tretira problem zaštite okoliša.

Dakako da pored gore navedenih pitanja postoje i druga važna pitanja.

Kad se govori o odnosu entiteta i elektroprivreda misli se na njihov pristup planiranju izgradnje elektrana, s jedne strane, i na vođenje ili eksploataciju EES-a s druge strane. Iz područja planiranja poznato je da veći EES treba manje rezervne snage u postotku. Dakako da to ovisi i o mnogim drugim karakteristikama sustava, kao što je veličina agregata, udjel hidroelektrana, njihov faktor iskorištenja snage, udjel termoelektrana-toplana i sl. Ali uz sličnu strukturu sustava, uz slične veličine agregata, svakako da veći sustav treba relativno manju rezervu. Manja potrebna rezerva posljedica je manje vjerojatnosti neplaniranog ispada iz pogona pojedinog agregata i rezultat neistovremenosti vršnog opterećenja u sustavima koje pokriva pojedina elektroprivreda. Zato je i potrebno razmišljati o mogućoj sinergiji kod izgradnje novih elektrana tri elektroprivrede u

hours for existing/revitalised and 7 000 hours for new production units), the export possibilities in the S2 scenario amount to 1 400 GWh/year on average, and 2 500 GWh/year maximum.

7 CONCLUSION

When summarising the analysis performed for the construction plan of production facilities through the entire planning period (2009 – 2020), among all the important issues, several that arise may be called key issues:

- the relationship between two entities (the Federation of Bosnia and Herzegovina and the Republic of Srpska), the relationship between three electric utility companies, their readiness for cooperation in the electric power sector and the approach to planning the construction of power plants based on their mutual relations,
- the level of electric power sovereignty of Bosnia and Herzegovina as a state, its entities and electric utility companies individually (the level of self-sufficiency, the extent of relying on the import of electricity, or the orientation towards export),
- the state of the electric power sector of other countries in the region and the possible influence on the future construction of power plants in Bosnia and Herzegovina,
- the possibility for the construction of new coal-powered thermal power plants, considering coal reserves and prices,
- the possibility for the construction of new hydroelectric power plants,
- the share of new renewable sources of electricity (wind, small hydroelectric power plants, biomass, etc.) in covering the total consumption,
- the influence of the construction of new sources on the state of the environment and the possibility for harmonisation with the national and international legislation regulating the issue of environment protection.

Naturally, there are other important issues in addition to those listed above.

When discussing the relationships of entities and electric utility companies, their approach to power plant construction planning is referred to on one side, and the running or exploitation of the EPS on the other. It is known from planning that a larger EPS needs a smaller percentage of reserve power. Of course, that depends on many other system characteristics, such as generator size, hydroelectric power plant share, their power utilisation factor, the share of thermal power plants-heating plants etc. However, with a similar system structure, with similar generator sizes, a larger system would absolutely need

BiH. Time se ni u kojem slučaju ne dovodi u pitanje slobodna volja svake elektroprivrede, niti bilo kojeg drugog potencijalnog investitora, da prema svojim procjenama odnosa na trenutnom i budućem tržištu električne energije, u samoj BiH i izvan nje, gradi vlastite elektrane. To je, na koncu, jedno od osnovnih postignuća deregulacije.

Postoje dvije moguće krajnosti – prva da sve elektroprivrede grade elektrane prema svojim strategijama ne vodeći računa o tome što rade ostale dvije elektroprivrede i druga – da se zajednički planira izgradnja na način da se utvrdi redoslijed gradnje elektrana prema optimumu na razini BiH, a da se isto tako koordinira pogon elektrana kako bi se elektrane s nižim troškovima pogona koristile što dulje vremena. U ovom drugom slučaju, računajući na razini cijele BiH uštede bi bile dvojake, manje potrebne investicije u izgradnju novih elektrana i manji pogonski troškovi radi boljeg korištenja elektrana.

Najizgledniji je scenarij negdje između te dvije krajnosti.

Ovdje se daje primjer odnosa potrebne izgradnje novih elektrana i ukupnih troškova u EES-u za razdoblje 2009. do 2020. godine, ako bi se u jednom slučaju planiralo na razini cijele BiH, a u drugom slučaju na razini pojedinih elektroprivreda. Za razinu BiH kao cjelinu dovoljno je do 2020. godine izgraditi oko $1\,090$ MW u novim elektranama, pri čemu su ukupni troškovi (gorivo, održavanje, izgradnja) oko $6\,620 \cdot 10^6$ EUR. U drugom slučaju, kada se planira pojedinačno po elektroprivredama izgradilo bi se oko 2300 MW, a ukupni troškovi u razdoblju 2009. do 2020. godine bili bi oko $8\,150 \cdot 10^6$ EUR. Ovo je dovoljan pokazatelj koje su koristi od suradnje među elektroprivredama u BiH, kada je u pitanju izgradnja novih elektrana a isto tako i kad se radi o pogonu elektrana.

Pitanje razine elektroenergetske suverenosti BiH kao države, zatim njenih entiteta i konačno elektroprivreda pitanje je od iznimne važnosti. Radi se dakle o razini samodovoljnosti svih navedenih subjekata u pogledu podmirivanja potrošnje električne energije. Ili preciznije, koji je to iznos (%) potreba za električnom energijom koji se mora moći podmiriti iz elektrana na vlastitom teritoriju. Treba reći da ima onih koji propagiraju ideju da u uvjetima otvorenog tržišta to pitanje nije toliko bitno. Da se energija, ako je ne možete proizvesti na vlastitom području, može kupiti i dovesti s nekog drugog područja. To je u principu moguće, naravno ako te energije ima uvijek kad je to potrebno i ako su uvjeti u prijenosnoj mreži takvi da je uvijek moguće tu energiju dopremiti. Međutim, vrlo često, barem prema iskustvima u posljednjih nekoliko godina, događa se, da niti jedan od ova

a relatively smaller reserve. The smaller required reserve is a consequence of the decreased probability of an unplanned generator outage and a result of asynchronous peak loads in the systems covered by a certain electric utility company. That is why it is necessary to consider possible synergy in the construction of the new power plants for the three electric utility companies in Bosnia and Herzegovina. That does not in any case call into question the free will of each of the electric utility companies, or any other potential investor, to build their own power plants according to their own estimates of relations on the current and future electricity market in Bosnia and Herzegovina or outside its borders. That is, finally, one of the basic accomplishments of deregulation.

There are two possible extremes – the first is that all electric utility companies build power plants according to their own strategies, not taking into consideration what the other two electric utility companies are doing, and the second – that construction is planned jointly in a way which would determine the order of power plant construction in accordance with the optimum at the level of Bosnia and Herzegovina, and furthermore, that the operations of power plants are coordinated in a manner which would enable the power plants with lower operation costs to be used for longer periods of time. In the second case, when calculating at the level of the entire Bosnia and Herzegovina, the savings would be twofold, the necessary investments for the construction of new power plants would be lower, and so would the operation expenses due to more efficient use of power plants.

The scenario with the best odds is somewhere between these two extremes.

Examples are given of relations between the necessary construction of new power plants and the total EPS costs for the period between 2008 and 2020, if in one case the planning would be at the level of the entire Bosnia and Herzegovina, and in the other, at the level of individual electric utility companies. For the level of Bosnia and Herzegovina as a whole, it would be sufficient to build approximately $1\,090$ MW of new power plants by 2020, which would place the total costs (fuel, maintenance, construction) to approximately $6\,620 \cdot 10^6$ EUR. In the other case, when the planning would cover individual electric utility companies, approximately 2300 MW would be constructed, and the total costs for the period between 2008 and 2020 would be approximately $8\,150 \cdot 10^6$ EUR. This is a sufficient indicator for the benefits of cooperation between electric utility companies in Bosnia and Herzegovina when the construction of new power plants is concerned, and the same applies for power plant operations.
The issue of the level of electric power sovereignty of Bosnia and Herzegovina as a state, of its entities and, finally, of electric utility companies is a pivotal issue. It concerns the level of self-sufficiency of all the gi-

dva uvjeta nije ispunjen. Postoji i jedan dodatni problem, a to je cijena te električne energije koju se mora kupovati. Ona u određenim okolnostima može biti dosta skuplja (ovdje se govori samo o djelatnosti proizvodnje) od proizvodnih troškova nekih potencijalnih elektrana-kandidata za izgradnju u BiH. Radi svega navedenog, i radi energetskih potencijala BiH, zastupa se mišljenje da se u BiH kao cjelini treba ići na potpunu samodovoljnost u proizvodnji električne energije. To znači graditi toliko elektrana koje će biti u stanju podmiriti ukupne potrebe za električnom energijom u BiH.

Jedno od vrlo važnih pitanja jest treba li u BiH graditi elektrane koje će najvećim dijelom proizvoditi električnu energiju za kupce ili potrošače u drugim zemljama. U svakom slučaju to će ovisiti o poslovnim odlukama potencijalnih investitora, međutim u tome treba biti vrlo oprezan ili u najmanju ruku umjeren. Radi se o strateškim odlukama s dugoročnim posljedicama, osobito ako se radi o termoelektranama na ugljen. Ono što je od posebne važnosti za termoelektrane na ugljen jest dovođenje rudnika u stanje koje će osigurati redovitu opskrbu blokova dovoljnim količinama ugljena. Pitanje je koliko je pametno, a i opravdano ići na maksimalnu izgradnju termoelektrana na ugljen čiji bi se najveći dio proizvodnje izvozio. Veliki dio ležišta bi se tako forsiranom izgradnjom termoelektrana potrošio već u radnom vijeku tih elektrana. Što nakon toga? To nije samo stvar potencijalnih investitora nego o tome, u određenom smislu, trebaju odlučivati i političke strukture ili strukture vlasti u BiH, a u konačnici i sami građani BiH. U svakom slučaju, tako forsirana izgradnja termoelektrana na ugljen bi se teško mogla uklopiti u koncept koji se zasniva na održivom razvoju, odnosno koncept u kojem je održivi razvoj temeljna odrednica.

Mogućnost izgradnje novih hidroelektrana zanimljiva je iz više razloga. Prepoznajući problem klimatskih promjena, uzrokovanih velikim dijelom emisijom stakleničkih plinova kao posljedice ljudskog djelovanja, svijet, a posebno EU, stavlja vrlo veliki naglasak na povećanu proizvodnju energije (i električne) iz obnovljivih izvora. Hidroelektrane (i male i velike) dio su mogućeg rješenja. Stoga su u mnogim zemljama, posebice EU, poduzete određene mjere koje čine ulaganje u sektor malih hidroelektrana dosta atraktivnim. Kad se radi o većim hidroelektranama (preko 10 MW) koje ne ulaze u takve mehanizme poticaja situacija je nešto složenija. Preostali hidroenergetski potencijal u mnogim zemljama još je uvijek skup u odnosu na neke termoelektrane. Međutim, kretanje cijena fosilnih goriva u posljednjim godinama ide na ruku i većim hidroelektranama. Tako u BiH ima nekoliko lokacija gdje je izgradnja hidroelektrana vrlo izgledna i treba učiniti sve

ven subjects in view of settling electricity consumption needs. Or, to be more precise, the amount (%) of electricity requirements that need to be settled from power plants on their own territory. It should be noted that there are those who promote the idea that the issue is not very relevant in open market conditions. That energy, if you cannot produce it on your own territory, can be bought and brought from another territory. That is possible in principle, of course, if the energy is available every time it is needed and if the transmission network conditions are such that energy can always be brought. However, it very frequently happens, at least according to experiences gained in recent years, that neither of the two conditions is met. There is also an additional problem, and that is the price of the electricity which needs to be bought. In some circumstances it can be significantly more expensive (only production activity is discussed here) than production costs of some potential power plant candidates for construction in Bosnia and Herzegovina. Because of everything stated above, and because of the Bosnia-Herzegovina energy potentials, the opinion of many is that Bosnia and Herzegovina as a whole needs to strive for complete self-sufficiency in electricity production. That means building a number of power plants which could settle all electricity needs of Bosnia and Herzegovina.

One of very important issues is whether Bosnia and Herzegovina should build power plants which would for the most part produce electricity for buyers or consumers from other countries. In any case, it will depend on business decisions of potential investors. However, extreme caution, or at least moderation, should be exercised in that respect. Those are strategic decisions with long-term effects, especially if coal-powered thermal power plants are concerned. The crucial matter concerning coal-powered thermal power plants is bringing coal mines to a state which would ensure regular supply of sufficient quantities of coal to the blocks. The question arises whether it is smart, or justified, to opt for the maximum construction of coal-powered thermal power plants which largest production share would be exported. A large part of the deposits would, with such a forced thermal power plant construction, be spent in the operation span of those power plants. What would happen afterwards? It is not a matter which should concern only the potential investors. In a certain sense the issue also needs to be decided upon by the political structures or the government structures in Bosnia and Herzegovina, and finally by its citizens themselves. In any case, such a forced construction of coal-powered thermal power plants could hardly fit into the concept founded on the principles of sustainable development, or the concept where sustainable development is the baseline.

The construction possibilities of new hydroelectric power plants are interesting for several reasons. When recognising the climate change issue, caused

da bi se stvorila prihvatljiva poduzetnička klima kako bi se one što prije počele graditi odnosno kako bi se što prije pustile u pogon. Za sada je u gradnji samo HE Mostarsko Blato, ali ima još nekoliko lokacija koje su već sazrele za gradnju. Na ostalim lokacijama koje imaju realne izglede za gradnju treba napraviti potrebne istražne radove i polaznu tehničku dokumentaciju, kako bi se raspolagalo s preciznijim podacima o mogućoj proizvodnji, odnosno instaliranoj snazi i investicijskim troškovima. To je vrlo bitna podloga za odluku potencijalnih investitora: financirati ili ne financirati gradnju pojedine hidroelektrane.

Udio obnovljivih izvora u proizvodnji električne energije pitanje je koje sve više dobiva na težini. Tako se i u zemljama EU donose razni akti (direktive) kojima se nastoji stvoriti prostor za izgradnju što više obnovljivih izvora električne energije. Kao što je poznato u tu kategoriju se ne ubrajaju velike hidroelektrane (veće od 10 MW).

Budući da se proizvodni trošak električne energije iz vjetroelektrana gotovo izravnao s troškom iz do sada tzv. konvencionalnih izvora, u scenariju koji s najviše optimizma tretira korištenje obnovljivih izvora (scenarij S2), očekuje se do 2020. godine izgradnja oko 250 MW u vjetroelektranama (uglavnom EP HZHB). U 2020. godini to bi bilo oko 4 % ukupne proizvodnje električne energije. Za druge obnovljive izvore, kao što su male hidroelektrane, biomasa, sunce i ostali, nije realno očekivati veću penetraciju bez stimulativnih mjera države kojima bi se stvorilo pozitivno okruženje za korištenje obnovljivih izvora. Pretpostavljajući skoro uvođenje takvih mjera, može se uz vrlo veliki optimizam očekivati izgradnja do 280 MW malih hidroelektrana u cijeloj BiH. Udio proizvodnje u malim hidroelektranama u ovakvom scenariju iznosio bi 5 % do 6 % u ukupnoj potrošnji električne energije u BiH. Biomasa i solarna energija nisu razmatrane u nekoj značajnijoj zastupljenosti u proizvodnji električne energije. Rezimirajući sve do sada navedeno u vezi obnovljivih izvora električne energije, može se reći da uz vrlo aktivne mjere države, u smislu konkretne financijske potpore proizvođačima električne energije iz obnovljivih izvora, ne treba očekivati udjel tih izvora veći od 5 % do 10 % do 2020. godine. Iz ovoga su, naravno, isključene velike hidroelektrane.

Utjecaj energetskog sektora na okoliš, gdje posebnu pozornost zaslužuju klimatske promjene kao posljedica efekta staklenika, postalo je pitanje od najviše razine prioriteta u većini zemalja svijeta, a napose u zemljama EU. Kad se govori o elektroenergetskom sektoru, najvažniji su problem elektrane na fosilna goriva, a među njima svakako termoelektrane na ugljen. Dok se za ostale onečišćujuće tvari (NO_x, SO_x, čein the most part by greenhouse gas emissions from human actions, the world, and especially the EU, places great emphasis on the increased energy (and electricity) production from renewable sources. Hydroelectric power plants (small and large ones) are part of the possible solution. Therefore, in many countries, especially of the EU, certain measures have been undertaken which make the investment in the small hydroelectric power plant sector quite attractive. When larger hydroelectric power plants (over 10 MW), ineligible for such incentives, are concerned, the situation is somewhat more complex. The remaining hydropower potential in many countries is still expensive when compared to certain thermal power plants. However, the fluctuations in fossil fuel prices in recent years also benefit the large hydroelectric power plants. There are several locations in Bosnia and Herzegovina where the construction of hydroelectric power plants is highly probable, and all necessary steps must be taken to create an acceptable entrepreneurial climate for their construction or their prompt start of operations. Presently, only HPP Mostarsko Blato is in construction, but there are several other locations ready for construction. Necessary research needs to be undertaken and the initial technical documentation needs to be compiled for other locations with realistic chances of construction, in order to have the use of precise data on possible production, installed power and investment costs. It is a crucial base for the decision of potential investors: to finance or not to finance the construction of a certain hydroelectric power plant.

The share of renewable sources in electricity production is the issue gaining increasing importance. The EU states are enacting various legislations (directives) which try to create space for the construction of renewable electricity sources. That category does not include large hydroelectric power plants (larger than 10 MW).

Since the production cost of electricity from wind farms has nearly equalled the cost from the heretofore so-called conventional sources, the scenario which treats the use of renewable sources with most optimism (scenario S2) expects the construction of approximately 250 MW of wind farms until the year 2020 (predominantly EP HZHB). In 2020 that would amount to approximately 4 % of total electricity production. For other renewable sources, such as small hydroelectric power plants, biomass, the sun and others, a larger penetration is not realistically expected without state incentive measures which would create a positive environment for the use of renewable sources. If we assume an imminent introduction of such measures, the construction of up to 280 MW of small hydroelectric power plants can be expected in the entire Bosnia and Herzegovina with great optimism. The production share of small hydroelectric power plants in such a scenario would be 5 % to 6 % of the total electricity consumption in Bosnia and

stice) može reći da je njihovu emisiju moguće svesti u prihvatljive okvire, za CO_2, kao glavnog predstavnika stakleničkih plinova, za sada nema rješenja. Značajnije komercijalno korištenje CCS (engl. *Carbon Capture and Storage*) tehnologija, prema današnjim sagledavanjima, ne očekuje se prije 2020. godine. Određenje o pitanju emisije CO_2 u BiH u ovom trenutku nije nimalo lako. Naime, BiH nema obveze smanjenja emisije u odnosu na Kyoto protokol. Međutim, postojeći okvir ili obveze Kyoto protokola su na snazi do kraja 2012. godine i još uvijek nije jasno kakav će biti sljedeći korak. Ono što je sigurno je to da je u pripremi novi sporazum koji će uključiti dodatno i zemlje koje nisu obveznice Kyoto protokola, što znači vrlo vjerojatno i BiH. S druge strane BiH nema još izrađen NAP-a (Nacionalni alokacijski plan), koji bi trebao definirati emisijske kvote za sve subjekte koji bi tim planom bili obuhvaćeni. Tim će planom, dakle, biti definirane i emisijske kvote pojedine elektroprivrede u BiH, a to znači da će i svaka termoelektrana na ugljen imati svoju emisijsku kvotu. Svemu ovome relativno skoro treba dodati i mogućnost trgovanja emisijskim dozvolama, kakva je mogućnost u zemljama EU uvedena od početka 2005. godine. Iz navedenog se može zaključiti da postoji još dosta nepoznanica vezanih uz problem emisija CO_2 iz postojećih i budućih termoelektrana u BiH. O tome trebaju voditi računa i budući investitori u termoelektrane na ugljen u BiH. To je jedna od komponenti rizika koja mora biti ukalkulirana u strateške odluke vlasnika postojećih i budućih termoelektrana na ugljen.

Ukupni koncept na kojem je zasnovana izrada ovih scenarija ponajprije vodi računa o pokrivanju vlastitih potreba za električnom energijom, bilo da se radi na razini države, entiteta ili pojedine elektroprivredne tvrtke. Iz te činjenice proizlaze i neka drukčija sagledavanja buduće izgradnje elektrana. Kad se pokušava doslovno slijediti pristup odozdo prema gore, nailazi se na problem uklapanja svih elektrana, koje su u planovima pojedine elektroprivrede, u elektroenergetski sustav BiH. Stoga treba imati na umu da jedan dobar dio potencijalnih kandidata za izgradnju mora naći sebi tržište izvan BiH.

Herzegovina. Biomass and solar power are not considered as having a significant presence in electricity production. Summarising everything stated so far in connection with renewable electricity sources, it can be said that even with very active state measures, in the sense of tangible financial support of renewable source electricity producers, a share of those sources higher than $5\ \%$ to $10\ \%$ before 2020 should not be expected. This, naturally, excludes large hydroelectric power plants.

The influence of the electric power sector on the environment, where climate changes due to the consequences of the greenhouse effect deserve special attention, has become the top priority issue in most countries of the world, and especially in the EU states. When the electric energy sector is concerned, the biggest problem are fossil-fuel-powered power plants, and among them undoubtedly coal-powered thermal power plants. While it can be said that the emissions of other pollutant substances (NO_x, SO_x, particles) can be reduced to acceptable levels, presently there is still no solution for CO_2, the main representative of greenhouse gasses. A more significant commercial usage of CCS (Carbon Capture and Storage) technologies, by today's observations, is not expected before 2020. Tackling the CO_2 emissions issue in Bosnia and Herzegovina at this time is not easy by any means. Namely, Bosnia and Herzegovina is not obligated to reduce emissions in accordance with the Kyoto protocol. However, the existing framework or obligations of the Kyoto protocol are in force until the end of 2012 and it is still not clear what the next step will be. What is certain is that a new agreement is being prepared which will additionally include the countries not committed to the Kyoto protocol, and therefore it will very likely include Bosnia and Herzegovina. On the other hand, Bosnia and Herzegovina has still not composed a NAP (National Allocation Plan), which should define the emission quotas for all subjects encompassed by the plan. The plan will, therefore, also define the emission quotas for individual electric utility companies in Bosnia and Herzegovina, which means that every coal-powered thermal power plant will have its own emission quota. A possibility of emission permits trade which was introduced into EU states in early 2005 will need to be added to all of this relatively soon. From everything stated above it can be concluded that there are still many unknowns tied to the CO_2 emissions problem from the existing and future thermal power plants in Bosnia and Herzegovina. The future investors in coal-powered thermal power plants in Bosnia and Herzegovina will need to take that into consideration. It is one of the risk components which needs to be calculated into the strategy decisions of the owners of existing and future coal-powered thermal power plants.

The overall concept on which the compiling of these scenarios is based firstly takes into account the cove-

ring of electricity needs pertaining to either the state, an entity or an individual electric utility company. Other, different observations of the future power plant construction stem from that fact. When attempts are made to follow the bottom-up approach ad litteram, a problem arises when integrating all power plants contained in individual electric utility company plans, into the electric power system of Bosnia and Herzegovina. Therefore, it should be born in mind that a significant portion of potential candidates for construction will need to find themselves a market outside Bosnia and Herzegovina.

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