ENERGETSKI SEKTOR CRNE GORE – STANJE I PERSPEKTIVE
THE CURRENT SITUATION AND FUTURE POTENTIAL OF THE MONTENEGRIN ENERGY SECTOR

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U članku se daje sažeti pregled energetskog sektora Crne Gore, razvoj u prošlosti, sadašnje stanje i mogući prostor događanja u budućnosti. Predstavljeni pregled je svojim najvećim dijelom zasnovan na projektu Stručne osnove strategije razvoja energetike Republike Crne Gore do 2025. godine, koji je rezultat zajedničkog rada stručnjaka iz Energetskog instituta Hrvoje Požar (Zagreb) i IREET instituta (Ljubljana). Projekt je započet krajem 2005. godine, a završen je sredinom 2006. godine. Naručen je i izrađen s ciljem da posluži kao osnova za izradu energetske strategije Crne Gore.

Uvažavajući činjenicu da je udjel električne energije u potrošnji finalnih oblika energije vrlo značajan, odnosno da je važnost elektroenergetike za gospodarski, a i svekoliki razvoj Crne Gore ključna, opis budućeg razvoja energetskog sektora je primarno fokusiran na elektroenergetski sektor. Sektor ugljena je razmatran samo u onoj mjeri u kojoj je ugljen u funkciji elektroenergetskog sektora.

The article provides an overview of the past development, current situation and future potential of the energy sector of Montenegro. This overview is primarily based upon a project entitled Basis for the Energy Development Strategy of the Republic of Montenegro till 2025, which is the result of a joint project by the Energy Institute Hrvoje Požar, Zagreb, Croatia, and the IREET Institute, Ljubljana, Slovenia. The project began in late 2005 and ended in mid 2006. It was commissioned and implemented with the goal of providing a foundation for the development of the energy strategy for Montenegro.

Since the percentage of electrical energy in the consumption of the final forms of energy is highly significant, i.e. the importance of electrical energy for the economic and overall development of Montenegro is crucial, the description of the future development of the energy sector is primarily focused upon the electrical energy sector. The coal sector is considered only to the extent that domestic coal serves as a potential energy base for the production of electrical energy.

Ključne riječi: električna energija, energetski sektor, investicije, izgradnja elektrana, privatizacija

Key words: construction of electrical power plants, electrical energy, energy sector, investments, privatization

https://doi.org/10.37798/2007563358

1 UVOD

Energetski sektor Crne Gore je specifičan u odnosu na nekoliko aspekata. Kao prvo, Crna Gora je brojem stanovnika i površinom, relativno mala zemlja. Ukupna energetska potrošnja, a i potrošnja pojedinih energenata je također mala. S te strane je energetski sektor znatno osjetljiviji na neke poremećaje, bilo u samoj Crnoj Gori, bilo u okruženju. Kao što će se vidjeti kasnije, uvoz energije je u 2004. godini bio 31 % od ukupnih potreba.

S druge strane, udjel električne energije u potrošnji finalne energije je prilično visok i u 2004. godini je iznosio oko 45 %. Elektroenergetski sektor je u proizvodnom dijelu vrlo ranjiv. Jedan od glavnih razloga je dominantan udjel hidroelektrana pa sušna hidrologija predstavlja vrlo velik problem. Drugi razlog je da postoje svega tri velike elektrane (dvije hidroelektrane i jedna termoelektrana ložena ugljenom). Ispadom iz pogona samo jedne elektrane nastaju velike poteškoće u elektroenergetskom sustavu (EES-u) u smislu sigurnosti opskrbe.

Sljedeća specifičnost EES-a Crne Gore su veliki (direktni) potrošači. Potrošnja samo jednog od njih (Kombinat aluminija Podgorica – KAP) je veća nego ukupna neto potrošnja na distribucijskoj mreži.

Kao i ostale republike bivše Jugoslavije, tako je i Crna Gora skrbila za svoju energetiku, dakako u okolnostima i okvirima kako je to u to vrijeme bilo moguće. Nakon raspada bivše države Crna Gora je, u državnoj zajednici sa Srbijom, i dalje samostalno planirala svoj energetski sektor.

Nakon opredjeljenja za samostalnost i konačnog proglašenja samostalne države (2006. godine) ta potreba, a i nužnost za organizacijom, planiranjem i izgradnjom vlastitog energetskog sektora je još izraženija. Pri tome se mora voditi računa o povezanosti i međusobnim utjecajima energetskog sektora Crne Gore s energetskim sektorima zemalja okruženja. Uz to, postoji i jedan već definirani, relativno čvrsti međunarodni okvir koji je uspostavljen potpisivanjem Povelje o energetskoj zajednici. Potpisivanjem spomenutog dokumenta države regije obvezale su se na usvajanje i primjenu pravne regulative EU iz područja energetike, zaštite okoliša te tržišnog nadmetanja. Drugim riječima, države regije obvezale su se na provođenje procesa koji će omogućiti stvaranje usklađenih nacionalnih tržišta energije, međusobno povezivanje sustava i tržišta te stvaranje mogućnosti trgovine energijom, podizanje razine zaštite okoliša u skladu s jednakim standardima

1 INTRODUCTION

The energy sector of Montenegro is specific in several aspects. First, Montenegro is a relatively small country in terms of area and the number of inhabitants. Total energy consumption and the consumption of individual energy sources is low. From this aspect, the energy sector could be significantly affected by certain disturbances in Montenegro or the surrounding countries. As will be seen later, imported energy covered 31 % of the total energy needs in the year 2004.

On the other side, the percentage of electrical energy in the final energy requirements was also fairly high in the year 2004, when it amounted to approximately 45 %. The electrical energy sector is highly vulnerable regarding production. One of the main reasons is the predominant share of hydroelectric power plants, so that drought hydrology represents a very great problem. A second reason is that there are only three large power plants (two hydroelectric power plants and one coal-burning thermoelectric power plant). When only one power plant is not operating, great difficulties occur in the electrical energy system (EES) regarding supply.

The next specific quality of the EES of Montenegro is that it has large direct consumers. The consumption of only one of them (the Aluminum Plant of Podgorica – KAP) is greater than the total net consumption on the distribution network.

In the former Federal Republic of Yugoslavia, Montenegro obtained its energy supply in the same manner as the other republics, under the circumstances and within frameworks that were possible at the time. Following the disintegration of the former state, Montenegro, as a state united with Serbia, continued to plan its energy supply sector independently.

After Montenegro decided upon independence and declared itself to be an independent state in 2006, the need to organize, plan and construct its own energy sector became even more apparent. Furthermore, it was necessary to take the connections and mutual influences of the energy sector of Montenegro and the energy sectors of the surrounding countries into consideration. Moreover, there is also an already defined, relatively firm international framework that was established with the signing of the Energy Community Treaty. By signing this document, the states of the region assumed the obligation to adopt and implement the legal regulations of the EU in the areas of energy, environmental protection and market competition. In other words, the states of the region pledged that they would implement the process that will facilitate the creation of coordinated national energy markets, the za sve države, poticanje razvoja obnovljivih izvora energije, uklanjanje barijera za slobodno tržišno natjecanje i međusobnu pomoć u slučajevima poremećene opskrbe energijom.

Kronološki redoslijed važnih događaja za energetski sektor:

- Zakon o energetici prihvaćen u lipnju 2003. godine [1],
- formirana Energetska regulatorna agencija u siječnju 2004. godine,
- dokument Energetska politika usvojen u veljači 2005. godine [2],
- Strategija o energetskoj učinkovitosti usvojena u listopadu 2005. godine,
- Strategija razvoja malih hidroelektrana u Crnoj Gori usvojena u travnju 2006. godine,
- Ugovor o energetskoj zajednici potpisan u listopadu 2006. godine,
- Kyoto protokol ratificiran u ožujku 2007 godine,
- Analiza potencijala obnovljivih izvora (vjetar, sunce, biomasa), završena u travnju 2007. godine,
- u tijeku je pravno razdvajanje funkcionalnih cjelina Elektroprivrede Crne Gore (EPCG).

Ključni dokument koji će identificirati mogućnosti ulaganja u energetski sektor je Energetska strategija koja je u završnoj fazi. Izrada podloga je započela krajem 2005. i završena je u 2006. godini. Nacrt strategije je već izrađen, a završetak se očekuje sredinom 2007. godine.

Jedan od najvažnijih dokumenata koji je Vlada Republike Crne Gore pripremila i usvojila 2005. godine, a koji se tiče energetskog sektora, je Energetska politika Republike Crne Gore [2]. Taj dokument iskazuje ciljeve i instrumente kojima Vlada Republike Crne Gore nastoji razvijati energetski sektor u smislu: sigurne i pouzdane opskrbe energijom, zaštite okoliša, vlasništva, tržišnog poslovanja, investicija, energetske učinkovitosti, novih obnovljivih izvora, povezivanja s regijom i šire, mjera socijalne zaštite i dr. U skladu s gospodarskim razvojem Crne Gore i s energetskom praksom i standardima za zemlje-kandidate za pristupanje EU, ovom energetskom politikom posebno se naglašava potreba za uspostavljanjem odgovarajućeg pravnog, institucionalnog, financijskog i regulatornog okvira, potrebnog za održivi razvoj energetskog sektora. Zajedno s dokumentom o nacionalnoj energetskoj strategiji (Strategija razvoja energetike RCG), Energetska politika ukazuje energetskim subjektima na njihovu ulogu u reformi energetskog sektora i potiče domaće i strane investitore na ulaganja u nove energetske objekte.

mutual connection of the systems and markets, and the creation of possibilities for energy trade in the implementation of the process, raising the level of environmental protection pursuant to uniform standards for all the states, promoting the development of renewable energy sources, and removing barriers for free market competition and mutual assistance in the event of disruptions in the energy supply.

The following is a chronological list of significant events for the energy sector:

- Energy Act, adopted in June 2003 [1],
- formation of the Energy Regulatory Agency in January 2004,
- Energy Policy Document, adopted in February 2005 [2],
- Energy Efficiency Strategy, adopted in October 2005,
- Strategy for the Construction of Small Hydro Power Plants in Montenegro, adopted in April 2006,
- Energy Community Treaty, signed in October 2006,
- Kyoto Protocol, ratified in March 2007,
- Analysis of renewable sources potential (wind, sun, biomass), completed in April 2007, and
- the legal unbundling of the Electric Power Company of Montenegro (EPCG), in progress.

The key document that will identify the investment possibilities in the energy sector is the Energy Strategy, which is in the final stage of preparation. The preliminary work began in late 2005 and was completed in the year 2006. A draft of the Strategy has already been prepared and completion is anticipated in 2007.

One of the most important documents that the Government of the Republic of Montenegro prepared and adopted in 2005 regarding the energy sector is the Energy Policy of the Republic of Montenegro [2]. This document presents the goals and instruments with which the Government of the Republic of Montenegro is attempting to develop the energy sector in the sense of a secure and reliable energy supply, environmental protection, ownership, market operations, investment, energy efficiency, new renewable sources, links with the region and beyond, social welfare measures etc. In coordination with the economic development of Montenegro and the energy practices and standards for candidate countries for accession to the European Union, there is particular emphasis in this energy policy upon the establishment of the suitable legal, institutional, financial and regulatory framework necessary for the sustainable development of the energy sector. Together with the document on the national energy strategy (Energy Development Strategy of the Republic of Montenegro), the Energy Policy emphasizes the role of energy subjects in the reform of the energy sector and provides incentives for domestic and foreign investors to invest in new energy facilities.

Identifikacija postojećeg stanja u energetskom sektoru u vrijeme izrade spomenutog dokumenta može se sažeti u sljedećem :

– početne aktivnosti reformi u energetskom sektoru (donesen je Zakon o energetici, otpočelo uključenje u Atenski proces, osnovana Regulatorna agencija za energetiku, Elektroprivreda Crne Gore funkcionalno razdvojena, donesena odluka o osnivanju Jedinice za energetsku učinkovitost, urađena Strategija energetske učinkovitosti u Crnoj Gori, s Akcijskim planom 2005. – 2006. i dr.),
– ustavno opredjeljenje Crne Gore kao ekološke države,
– nepostojanje nacionalne energetske strategije, kojom bi se odredili srednjoročni i dugoročni ciljevi, prioriteti i uvjeti razvoja energetskog sektora Crne Gore,
– izrazito visoka uvozna ovisnost (cjelokupne potrebe tekućih i plinovitih goriva i oko 1/3 električne energije), zbog dugogodišnjeg zastoja u gradnji vlastitih energetskih izvora,
– veliki neiskorišteni i energetski kvalitetan potencijal, naročito hidropotencijal,
– znatne mogućnosti za korištenje obnovljivih energetskih izvora,
– dominacija električne energije u energetskoj bilanci,
– naslijeđena energetski intenzivna industrija i koncentracija potrošnje kod dva velika potrošača obojene i crne metalurgije i kod kućanstava,
– energetska neučinkovitost u sektoru potrošnje (naročito u pogledu uporabe električne energije za grijanje) i visoka energetska intenzivnost,
– nedovoljna istraženost nafte i plina, kao i energije obnovljivih izvora,
– visoka amortiziranost energetske infrastrukture i potreba njene ubrzane revitalizacije i tehnološke modernizacije,
– odsustvo fondova za istraživanje i tehnološki razvoj u energetici,
– nepotpuna zakonska regulativa za energetski sektor,
– dijelom dereguliran energetski sektor i privatiziran u segmentu nabave i trgovine naftnim derivatima.

Na temelju identifikacije postojećeg stanja postavljeni su ciljevi energetske politike, koji su u svojim osnovnim odrednicama vrlo slični (gotovo jednaki) onima koji se proklamiraju na razini EU:

– sigurna, kvalitetna, pouzdana i diverzificirana opskrba energijom radi uravnoteženja opskrbe s potražnjom svih oblika energije,
– održavanje, revitalizacija i modernizacija postojeće i izgradnja nove pouzdane infrastrukture za potrebe proizvodnje i korištenja energije,

The situation in the energy sector while this document was being prepared may be summarized as follows:

– initial activities in the reform of the energy sector (the adoption of the Energy Act, the beginning of inclusion in the Athens Process, the establishment of the Energy Regulatory Agency, the functional unbundling of the Electric Power Company of Montenegro, the adoption of a ruling on the establishment of the Energy Efficiency Unit, the preparation of the Energy Efficiency Strategy of Montenegro with the Plan of Action for 2005 – 2006 etc.),
– the constitutional orientation of Montenegro as an ecological state,
– the absence of a national energy strategy, according to which medium-range and long-range goals, priorities and the conditions for the development of the energy sector of Montenegro would be determined,
– markedly high dependence upon imports (the total requirements for liquid and gas fuels and approximately 1/3 of electrical energy), due to many years of stagnation in the construction of the country's own energy sources,
– considerable unused and high quality energy potential, particularly hydroenergy potential,
– significant possibilities for using renewable energy sources,
– domination of electrical energy in the energy balance,
– inherited energy-intensive industry and concentrated consumption by two large consumers engaged in non-ferrous and ferrous metallurgy and households,
– lack of energy efficiency in the consumption sector (particularly regarding the use of electrical energy for heating) and high energy intensity,
– insufficient exploration of oil and gas, as well as renewable energy sources,
– high depreciation of the energy infrastructure and the need for its rapid revitalization and technological modernization,
– lack of funds for research and technological development in energetics,
– incomplete legal regulations for the energy sector, and
– partially deregulated energy sector and privatization in the segment of the purchasing and trading of petroleum derivatives.

Based upon identification of the existing situation, energy policy goals were established that have very similar (nearly identical) frames of reference to those proclaimed at the level of the European Union:

- smanjenje uvozne energetske ovisnosti, u prvom redu stvaranjem stabilnih uvjeta za ulaganja u istraživanje i gradnju novih energetskih izvora (naročito na istraženim objektima neiskorištenog hidro potencijala) i ulaganja u ostalu energetsku infrastrukturu,
- stvaranje odgovarajućeg zakonodavnog, institucionalnog, financijskog i regulatornog okvira za poticanje udjela privatnog sektora i ulaganja u sve dijelove energetske infrastrukture,
- stvaranje uvjeta za veće korištenje obnovljivih izvora energije, zajedničke proizvodnje električne i toplinske energije i korištenje fosilnih goriva s čistim tehnologijama,
- uspostavljanje konkurentnog tržišta za osiguranje energije u djelatnostima u kojima za to postoji mogućnost (proizvodnja i opskrba) u skladu s konceptom regionalnog tržišta energije, uz reguliranje monopolskih mrežnih djelatnosti,
- osiguranje institucionalnih i financijskih poticaja za unaprjeđenje energetske učinkovitosti i smanjenje energetske intenzivnosti u svim sektorima, od proizvodnje do potrošnje energije,
- održiva proizvodnja i korištenje energije u odnosu na zaštitu okoliša i međunarodna suradnja u toj sferi, naročito oko smanjenja emisije stakleničkih plinova,
- potpora istraživanjima, razvoju i promociji novih, čistih i učinkovitih energetskih tehnologija i vođenju energetske politike na stručnim i znanstvenim osnovama.

Da bi se uopće moglo očekivati, barem djelomično, a osobito cjelokupno, ostvarenje navedenih ciljeva, nužno je bilo osmisliti konzistentan skup mjera koje bi usklađenim djelovanjem stvorile pogodnu klimu, odnosno okruženje kao potreban preduvjet. Te mjere su kako slijedi:

sustavne:

- izrada Strategije razvoja energetike RCG za razdoblje do 2025. godine (sa sektorskim studijama),
- uspostavljanje i implementacija sustava za praćenje podataka, suglasno EUROSTAT metodologiji prikaza nacionalnih energetskih podataka,
- donošenje poticajnih mjera za znanstveno-tehnološki razvoj u energetici i suradnju na međunarodnim programima u području energetike,
- uspostavljanje i primjena jednostavnih i transparentnih procedura u funkcioniranju svih segmenata energetskog sektora, radi sprječavanja korupcije,

- a secure, high quality, reliable and diversified power supply, with the goal of balancing the supply and demand of all forms of energy,
- maintenance, revitalization and modernization of the existing infrastructure and building a reliable new infrastructure for the production and use of energy,
- reduction of dependence on imported energy, primarily through the creation of stable conditions for investment in the research and construction of new energy sources (particularly facilities with unused hydro potential that have been previously studied) and investment in the rest of the energy infrastructure,
- creation of the suitable legislative, institutional, financial and regulatory framework for promoting involvement by the private sector and investment in all the aspects of the energy infrastructure,
- creation of the prerequisites for the greater utilization of renewable energy sources, combined heat and power generation and the use of fossil fuels based upon clean technologies,
- establishment of a competitive market for securing energy in fields where there is a possibility to do so (generation and supply), pursuant to the concept of the regional energy market, together with regulated monopoly network activities,
- providing institutional and financial incentives for improving energy efficiency and reducing energy intensity in all sectors, from energy generation to consumption,
- sustainable generation and energy use in relation to environmental protection and international cooperation in this sphere, particularly regarding reduced greenhouse gas emissions, and
- supporting research, development and the promotion of new, clean and efficient energy technologies, and conducting energy policies upon professional and scientific foundations.

In order to be able to achieve the cited goals, either partially or completely, it would be necessary to devise a consistent group of coordinated measures to create a favorable climate, i.e. a suitable environment as an essential prerequisite. These measures are as follows:

systematic:

- the preparation of the Energy Development Strategy of the Republic of Montenegro till 2025 (with sector studies),
- the establishment and implementation of a system for monitoring data, pursuant to the EUROSTAT methodology for presenting national energy data,
- the adoption of incentive measures for scientific and technological development in energetics and cooperation with international programs in the area of energetics,

– osiguranje poticajnih mjera za implementaciju programa energetske učinkovitosti, novih obnovljivih izvora i čistih tehnologija, uključujući i uporabu energetski učinkovitih uređaja prihvatljivih za okoliš,
– osiguranje uvjeta za izgradnju objekata kontinuiteta za proizvodnju električne energije,
– diverzifikacija izvora i energenata, vodeći računa o regionalnim specifičnostima,
– promoviranje tehnoloških dostignuća i razvoja infrastrukture radi smanjenja učinka stakleničkih plinova.

zakonodavne:

– donošenje podzakonskih akata za implementaciju Zakona o energetici i Strategije razvoja energetike RCG, kao i usuglašavanje domaće s međunarodnom legislativom u tom području, uključujući UN deklaracije, EU direktive, Kyoto protokol i dr.,
– preispitivanje postojećih i donošenje novih zakonskih akata, tehničkih standarda i propisa u području gradnje energetskih objekata, a posebno radi povećanja energetske učinkovitosti,
– donošenje propisa s pojednostavljenim postupcima za dobivanje koncesija i dozvola za izgradnju malih elektrana i drugih postrojenja za proizvodnju iz obnovljivih izvora energije, dozvola za pristup mreži i dozvola za obavljanje djelatnosti proizvodnje i prodaje energije.

institucionalne i organizacijske:

– osposobljavanje Vladine administracije za praćenje ostvarivanja Strategije razvoja energetike RCG i pripremu energetskih bilanci,
– osposobljavanje Jedinice za energetsku učinkovitost za uspješno promoviranje i provođenje Vladinog Programa energetske učinkovitosti, uključujući i predlaganje odgovarajuće regulative za njegovo poticanje,
– reorganizacija EPCG i drugih energetskih subjekata u financijski održive kompanije, sposobne za poslovanje na konkurentnom tržištu i financiranje razvoja,
– unaprjeđenje inspekcijskog nadzora.

gospodarsko-socijalne:

– utvrđivanje tarifne i cjenovne politike energenata kojima se, na tržišnim osnovama, uvažavaju troškovi (uključujući troškove zaštite okoliša) i profit, potiče racionalna uporaba energije i štite interesi potrošača u pogledu sigurnosti i kvalitete energetskih usluga, kao i mogućnosti plaćanja računa za energiju,

– the establishment and application of simple and transparent procedures in the functioning of all the segments of the energy sector, with the goal of preventing corruption,
– the securing of incentive measures for the implementation of energy efficiency programs, new renewable energy sources and clean technologies, including the use of environmentally acceptable energy efficient equipment,
– the securing of conditions for the construction of continuation facilities for the production of electrical energy,
– the diversification of sources and energy-generating products, taking specific regional characteristics into consideration, and
– the promotion of technological achievements and the development of the infrastructure in order to reduce the effect of greenhouse gases.

legislation:

– the adoption of regulations for the implementation of the Energy Act and the Energy Development Strategy of the Republic of Montenegro, as well as the coordination of domestic and international legislation in this area, including UN declarations, EU directives, the Kyoto Protocol etc.,
– the reexamination of existing legal acts and the adoption of new acts, technical standards and regulations in the area of the construction of energy facilities, particularly with the goal of increasing energy efficiency, and
– the adoption of regulations with simplified procedures for obtaining concessions and permits for the construction of small power plants and other facilities for the production of renewable energy, permits for network access and permits for the generation and sale of energy.

institutional and organizational:

– enabling the Government Administration to monitor the implementation of the Energy Development Strategy of the Republic of Montenegro and prepare energy balances,
– enabling the Energy Efficiency Unit to promote and implement the Government's Energy Efficiency Program successfully, including the proposal of suitable regulations for incentives,
– restructuring of the Electric Power Company of Montenegro (Elektroprivreda Crne Gore – EPCG) and other energy enterprises into financially sustainable companies capable of operating in a competitive market and the financing of development, and
– improving inspection supervision.

– donošenje programa subvencioniranja socijalno najugroženijih grupa građana s ciljem zadovoljavanja minimalnih potreba u električnoj i toplinskoj energiji.

2 POTROŠNJA ENERGIJE U CRNOJ GORI

2.1 Ukupna potrošnja energije

Tablica 1 pokazuje ukupnu potrošnju energije u prošlosti. Ono što je bitno za energetsku situaciju u Crnoj Gori je da je npr. u 2004. godini (posljednja dostupna godina) pokrivenost ukupnih energetskih potreba iz domaćih izvora bila 69 % a uvoz 31 %.

socioeconomic:

– determining tariff and pricing policies for energy-generating products, taking into account market-based costs (including expenditures for environmental protection) and profit, in order to encourage rational energy use and protect consumer interests regarding the security and quality of energy services, as well as consumers' ability to pay energy bills,
– adopting a subsidy program for the socially most vulnerable groups of citizens, with the goal of meeting their minimum requirements for electricity and heating.

2 ENERGY CONSUMPTION IN MONTENEGRO

2.1 Total energy consumption

Table 1 presents total energy consumption in the past. Of significance regarding the energy situation in Montenegro is, for example, that in the year 2004 (the last available year), the coverage of total energy requirements from domestic sources was 69 % and imports amounted to approximately 31 %.

Tablica 1 – Ukupna potrošnja energije [3]
Table 1 – Total energy consumption [3]

Godina / Year	1990.	1997.	1998.	1999.	2000.	2001.	2002.	2003.	2004.
					(PJ)				
Proizvodnja / Production	28,23	29,33	37,74	34,51	34,90	35,21	31,83	34,55	43,34
Saldo uvoz-izvoz / Import-export balance	17,62	13,82	15,33	16,57	18,90	19,11	19,52	19,91	19,29
Saldo skladišta / Stock change	– 0,13	0	– 0,20	– 0,74	– 0,01	0,09	0,12	0,66	0,05
Bunker brodova / Marine bunkers						0,1	0,1	0,1	0,1
UKUPNA POTROŠNJA / TOTAL CONSUMPTION	45,72	43,15	52,87	50,34	53,79	54,51	51,52	55,16	62,72
					(%)				
Proizvodnja / Production	61,7	68,0	71,4	68,6	64,9	64,6	61,8	62,6	69,0
Saldo uvoz-izvoz / Import-export balance	38,5	32,0	29,0	32,9	35,1	35,1	37,9	36,1	30,8
Saldo skladišta / Stock change	– 0,2	0,0	– 0,4	– 1,5	0,0	0,2	0,2	1,2	0,1
Bunker brodova / Marine bunkers						0,1	0,1	0,1	0,1
UKUPNA POTROŠNJA / TOTAL CONSUMPTION	100	100	100	100	100	100	100	100	100

Tablica 2 prikazuje strukturu ukupne potrošnje energije (apsolutne vrijednosti i udjeli), gdje je finalna potrošnja u 2004. godini nešto manja od 50 %.

Table 2 presents the structure of total energy consumption (absolute values and percentages), where final consumption in the year 2004 is somewhat less than 50 %.

Tablica 2 – Struktura ukupne potrošnje energije [3]
Table 2 – Structure of total energy consumption [3]

Godina / Year	1990.	1997.	1998.	1999.	2000.	2001.	2002.	2003.	2004.
					(PJ)				
UKUPNA POTROŠNJA / TOTAL CONSUMPTION	45,72	43,15	52,87	50,34	53,79	54,51	51,52	55,16	62,72
Gubici transformacije / Transformation losses	14,23	17,05	24,83	21,70	23,07	23,73	20,25	22,02	28,63
Energija za pogon / Energy for operations	0,60	0,48	0,62	0,72	0,76	0,52	0,79	0,79	0,67
Gubici / Losses	1,06	1,66	1,81	2,04	1,70	1,81	1,83	2,23	2,50
Neenergetska potrošnja / Non-energy consumption	0,50	0,30	0,39	0,18	0,63	0,45	0,35	0,30	0,35
Finalna potrošnja / Final consumption	29,33	23,67	25,22	25,71	27,63	28,01	28,30	29,82	30,58
– Industrija / Industry	16,90	11,01	10,93	10,54	11,43	12,36	13,54	14,07	14,31
– Promet / Transport	5,48	4,31	6,18	7,20	7,74	6,86	5,57	5,73	6,36
– Opća potrošnja / General consumption	6,95	8,34	8,11	7,97	8,46	8,79	9,19	10,03	9,91
					(%)				
UKUPNA POTROŠNJA / TOTAL CONSUMPTION	100	100	100	100	100	100	100	100	100
Gubici transformacije / Transformation losses	31,1	39,5	47,0	43,1	42,9	43,5	39,3	39,9	45,6
Energija za pogon / Energy for operations	1,3	1,1	1,2	1,4	1,4	1,0	1,5	1,4	1,1
Gubici / Losses	2,3	3,8	3,4	4,1	3,2	3,3	3,6	4,0	4,0
Neenergetska potrošnja / Non-energy consumption	1,1	0,7	0,7	0,4	1,2	0,8	0,7	0,5	0,6
Finalna potrošnja / Final consumption	64,2	54,9	47,7	51,1	51,4	51,4	54,9	54,1	48,8
– Industrija / Industry	37,0	25,5	20,7	20,9	21,1	22,7	26,3	25,5	22,8
– Promet / Transport	12,0	10,0	11,7	14,3	14,4	12,6	10,8	10,4	10,1
– Opća potrošnja / General consumption	15,2	19,3	15,3	15,8	15,7	16,1	17,8	18,2	15,8

Struktura potrošnje finalne energije (apsolutne vrijednosti i udjeli) je prikazana u tablici 3. Udjel električne energije u finalnoj potrošnji u 2004. godini je bio oko 45 %. To je vrlo visok udjel električne energije. Za usporedbu, u istoj godini je udjel električne energije u potrošnji finalne energije u Hrvatskoj bio nešto manje od 20 %. Svakako da je elektroenergetski sektor od iznimne važnosti, ne samo za energetiku, za svaku zemlju, ali na osnovi ovako visokog udjela električne energije u potrošnji finalne energije se može konstatirati da je za Crnu Goru elektroenergetski sektor izrazito važan. Zato će se u nastavku ovog članka pridati posebna važnost baš elektroenergetskom sektoru.

The structure of the consumption of final energy (absolute values and percentages) is presented in Table 3. The percentage of electrical energy in final consumption in the year 2004 was approximately 45 %. This is a very high percentage of electrical energy. In comparison, the percentage of electrical energy in final energy consumption was somewhat less than 20 % during the same year in Croatia. Certainly the electrical energy sector is of exceptional importance, not only for energetics, for every country. However, on the basis of such a high percentage of electrical energy in final energy consumption, it can be concluded that the electrical energy sector is exceptionally important for Montenegro. Therefore, this article will afford particular importance to the electrical energy sector.

Tablica 3 – Struktura potrošnje finalne energije [3]
Table 3 – The structure of final energy consumption [3]

Godina / Year	1990.	1997.	1998.	1999.	2000.	2001.	2002.	2003.	2004.
					(PJ)				
Mrki ugljen / Brown coal		0,01		0,03		0,04	0,40	0,04	0,03
Lignit / Lignite	0,61	0,74	0,78	0,88	0,51	0,52	0,63	0,60	0,52
Ogrjevno drvo / Wood fuel	1,58	1,55	1,17	1,18	1,13	1,23	1,43	1,98	2,07
Tekući naftni plin / Liquid petroleum gas	0,56	0,13	0,16	0,08	0,06	0,08	0,12	0,15	0,23
Motorni benzin / Gasoline	3,06	2,58	3,54	4,10	3,50	2,95	2,26	2,75	2,76
Mlazno gorivo / Jet fuel	0,55	0,02	0,22	0,02	0,58	0,70	0,65	0,57	0,32
Dizel gorivo / Diesel fuel	2,51	2,28	3,04	3,67	4,35	3,78	3,32	3,04	3,81
Ekstralako loživo ulje / Extra-light heating oil	0,52	0,26	0,29	0,32	0,36	0,40	0,44	0,48	0,53
Loživo ulje / Heating oil	2,84	1,51	1,44	1,35	1,65	1,76	1,76	1,68	1,90
Petrolkoks / Petroleum coke	2,23	0,58	1,07	0,67	0,67	0,67	1,61	2,23	1,79
Derivati nafte ukupno / Total petroleum derivatives	12,28	7,37	9,76	10,22	11,17	10,34	10,15	10,90	11,33
Električna energija / Electrical energy	11,10	11,13	10,92	10,50	12,01	12,88	13,20	13,46	13,62
Toplinska energija / Thermal energy	3,75	2,88	2,59	2,91	2,80	2,99	2,84	2,84	3,01
UKUPNO / TOTAL	29,33	23,67	25,22	25,71	27,63	28,01	38,30	29,82	30,58
					(%)				
Mrki ugljen / Brown coal		0,0		0,1		0,2	0,1	0,1	0,1
Lignit / Lignite	2,1	3,1	3,1	3,4	1,9	1,9	2,2	2,0	1,7
Ogrjevno drvo / Wood fuel	5,4	6,5	4,6	4,6	4,1	4,4	5,1	6,6	6,8
Tekući naftni plin / Liquid petroleum gas	1,9	0,6	0,6	0,3	0,2	0,3	0,4	0,5	0,7
Motorni benzin / Gasoline	10,4	10,9	14,0	15,9	12,7	10,5	8,0	9,2	9,0
Mlazno gorivo / Jet fuel	1,9	0,1	0,9	0,1	2,1	2,5	2,3	1,9	1,0
Dizel gorivo / Diesel fuel	8,6	9,6	12,0	14,3	15,7	13,5	11,7	10,2	12,4
Ekstralako loživo ulje / Extra-light heating oil	1,8	1,1	1,2	1,3	1,3	1,4	1,5	1,6	1,7
Loživo ulje / Heating oil	9,7	6,4	5,7	5,3	6,0	6,3	6,2	5,6	6,2
Petrolkoks / Petroleum coke	7,6	2,4	4,2	2,6	2,4	2,4	5,7	7,5	5,9
Derivati nafte ukupno / Total petroleum derivatives	41,9	31,1	38,7	39,7	40,4	36,9	35,9	36,5	37,1
Električna energija / Electrical energy	37,9	47,0	43,3	40,8	43,5	46,0	46,7	45,2	44,5
Toplinska energija / Thermal energy	12,8	12,2	10,3	11,3	10,2	10,7	10,0	9,5	9,8
UKUPNO / TOTAL	100	100	100	100	100	100	100	100	100

2.2 Potrošnja električne energije

Struktura izvora i potrošnje električne energije prikazana je u tablici 4. Kada se pogleda struktura potrošnje električne energije vidljivo je da je potrošnja velikih (tzv. direktnih) potrošača oko 47 % ukupne potrošnje. To je bitno više nego što je neto potrošnja na distribucijskoj mreži. Analizom strukture izvora ili pokrivanja potreba za električnom energijom uočava se da je uvoz u 2004. godini bio na razini od gotovo 30 %. Uzme li se u obzir činjenica da je proizvodnja hidroelektrana u istoj godini bila oko 50 % (a radilo se o vrlo vlažnoj godini) može se zaključiti koliko je osjetljiva situacija u opskrbi električnom energijom u Crnoj Gori.

2.2 Electrical energy consumption

Electrical energy structure of sources and consumption is presented in Table 4. When the structure of electrical energy consumption is reviewed, it is evident that consumption by large (so-called direct) consumers comprises approximately 47 % of total consumption. This is significantly more than the net consumption on the distribution network. Through analysis of the structure of sources or the coverage of electricity requirements, it is evident that import was at the level of nearly 30 % in the year 2004. If the fact is taken into account that the production of hydroelectric power plants in the same year was approximately 50 % (and this was a very rainy year), it can be seen how sensitive the electricity supply situation is in Montenegro.

Tablica 4 – Struktura izvora i potrošnje električne energije [3]
Table 4 – Electrical energy structure of sources and consumption [3]

Godina / Year	1994.	1995.	1996.	1997.	1998.	1999.	2000.	2001.	2002.	2003.	2004.
						(GWh)					
Proizvodnja na pragu / Production at the threshold	1 993,0	1 497,4	3 004,7	2 182,9	2 564,3	2 616,6	2 530,2	2 414,4	2 195,4	2 606,2	3 185,7
Proizvodnja HE / Hydroelectric power plant generation	1 469,7	1 497,4	2 255,8	1 436,1	1 709,4	1 692,4	1 579,1	1 767,6	1 095,8	1 532,4	2 231,2
HE / HPP Perućica	722,1	908,4	1 356,2	741,3	919,9	864,0	882,2	998,8	671,3	814,0	1 210,4
HE / HPP Piva	736,1	571,7	879,2	679,4	769,4	810,4	678,8	753,6	408,4	701,6	997,0
Distributivne HE/ Small HPP	11,5	17,3	20,4	15,4	20,1	18,0	18,1	15,2	16,1	16,8	23,8
Proizvodnja TE / Thermoelectric power plant generation	523,3	0,0	748,9	746,8	854,9	924,2	951,1	646,8	1099,6	1 073,8	954,5
TE / TPP Pljevlja	523,3	0,0	748,9	746,8	854,9	942,2	951,1	646,8	1099,6	1 073,8	954,5
Saldo uvoz – izvoz / Import-export balance	151,3	1 009,4	126,3	1 384,3	990,4	906,3	1 298,0	1 688,3	2 035,3	1 787,1	1 324,1
Raspoloživo za potrošnju / Available for consumption	2 144,3	2 506,8	3 131,0	3 567,2	3 554,7	3 522,9	3 828,2	4 102,7	4 230,7	4 393,3	4 509,8
Direktni potrošači / Direct consumers	505,4	763,0	1 233,9	1 629,9	1 580,6	1 511,0	1 711,3	1 885,4	1 998,6	2 024,7	2 104,7
KAP / Aluminum Plant of Podgorica	329,3	599,9	1 029,0	1 420,2	1 362,4	1 365,6	1 568,0	1 719,8	1 855,0	1 903,8	1 898,0
Željezara / Steelworks	154,1	139,3	174,5	180,4	186,8	130,4	123,8	144,5	122,5	99,9	184,4
Željeznica / Railways	22,0	23,8	30,4	29,3	31,4	15,0	19,5	21,1	21,1	21,0	22,3
Distribucija bruto / Gross distribution	1 531,0	1 641,7	1 747,9	1 794,9	1 847,2	1 863,2	1 967,0	2 062,6	2 077,0	2 196,7	2 212,1
Neto potrošnja distribucije / Net energy consumption of distribution	1 218,0	1 329,1	1 434,6	1 475,7	1 472,6	1 446,6	1 645,8	1 715,7	1 722,5	1 750,2	1 710,6
Gubici u distributivnoj mreži / Losses in the distribution network	313,0	312,6	313,3	319,2	374,6	416,6	321,2	346,9	354,5	446,5	501,5
Gubici u prijenosnoj mreži / Losses in the transmission network	108,1	98,8	149,2	142,3	127,0	148,7	149,8	154,7	155,1	171,9	193,0

U Crnoj Gori su tijekom 70-tih i 80-tih godina 20. stoljeća izgrađeni značajni industrijski kapaciteti u energetski intenzivnim industrijskim granama (industrija obojenih metala, crna metalurgija). Među takvim postrojenjima posebno se ističu Kombinat aluminija Podgorica (KAP) i Željezara Nikšić. Samo pogoni KAP-a godišnje potroše oko 45 % ukupne potrošnje električne energije u Crnoj Gori. Osim u crnoj metalurgiji i industriji obojenih metala, relativno manji dio električne energije se troši u drvnoj, papirnoj, tekstilnoj, prehrambenoj i drugoj industriji. Budući da je dinamika potrošnje električne energije u industriji bitno drugačija nego u sektorima kućanstva i usluga, od interesa je analizirati karakteristike potrošnje u toj kategoriji.

In Montenegro, significant industrial facilities were constructed in energy intensive industrial branches (non-ferrous metals, ferrous metallurgy) during the 1970s and 1980s. Among such plants, the Aluminum Plant of Podgorica (KAP) and the Nikšić Steelworks stand out. The KAP plant alone uses approximately 45 % of the total energy consumed in Montenegro annually. Besides the ferrous metallurgy and the non-ferrous metal industries, a relatively small percentage of electrical energy is consumed in the wood, paper, textile, food and other industries. Since the dynamics of the consumption of electrical energy in industry is significantly different than in the sectors of households and services, it is of interest to analyze the characteristics of consumption in this category.

Potrošnja električne energije u industrijskom sektoru Crne Gore iznosila je u 2004. godini 2 151 GWh, od čega oko 97 % potrošnje otpada na KAP i Željezaru.

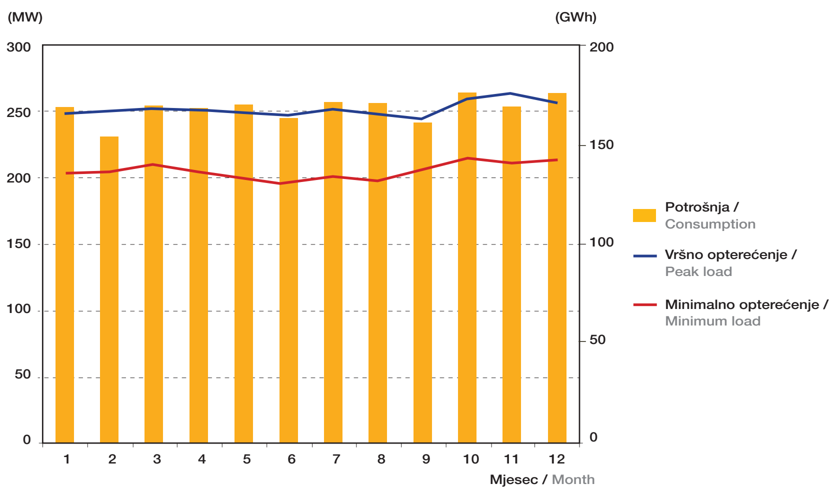
Slika 1 prikazuje mjesečne promjene u potrošnji električne energije, te kretanje maksimalnog i minimalnog opterećenja u sektoru industrije.

Sa slike se može vidjeti kako potrošnja električne energije u industriji vrlo malo oscilira po mjesecima. Uglavnom se kreće oko 170 GWh, uz odstupanja do nekoliko GWh. Maksimalno i minimalno opterećenje pokazuju puno manje varijacije nego kod sustava u cjelini i kreće se oko razine od maksimalno 250 MW, a minimalno 200 MW.

The consumption of electrical energy in the industrial sector of Montenegro was 2 151 GWh in the year 2004, of which approximately 97 % of the consumption was by KAP and the Nikšić Steelworks.

Figure 1 presents the monthly changes in the consumption of electrical energy and the maximum and minimum load trends in the industrial sector.

From the figure, it can be seen how the consumption of electrical energy in industry oscillates very little over the months. It is generally approximately 170 GWh, with deviations of up to several GWh. The maximum and minimum loads show much less variation than in the system as a whole, and range from approximately a maximum level of 250 MW to a minimum level of approximately 200 MW.



Slika 1
Mjesečne potrošnje, maksimalna i minimalna opterećenja u industrijskom sektoru [3]
Figure 1
Monthly consumption, maximum and minimum loads in the industrial sector [3]

3 PROGNOZA POTROŠNJE ELEKTRIČNE ENRGIJE ZA RAZDOBLJE 2005. – 2025.

Scenariji buduće potrošnje električne energije detaljno su obrađeni po sektorima potrošnje u [3]. Stoga se ovdje daje samo sumarni prikaz porasta potrošnje i vršnog opterećenja, i to radi jednostavnosti samo za srednji scenarij, budući da su razlike u razinama potrošnje među scenarijima male. Kretanje prognozirane potrošnje električne energije, vršnog i minimalnog opterećenja u sustavu, te faktora opterećenja prikazano je tablicom 5 i slikom 2. Navedeni iznosi sadrže i gubitke u prijenosnoj i distribucijskoj mreži, dakle predstavljaju ukupnu potrebnu električnu energiju na ulazu u prijenosnu mrežu, koju trebaju pokriti proizvodnja elektrana i/ili uvoz električne energije.

3 FORECAST OF ELECTRICAL ENERGY CONSUMPTION FOR THE 2005 – 2025 PERIOD

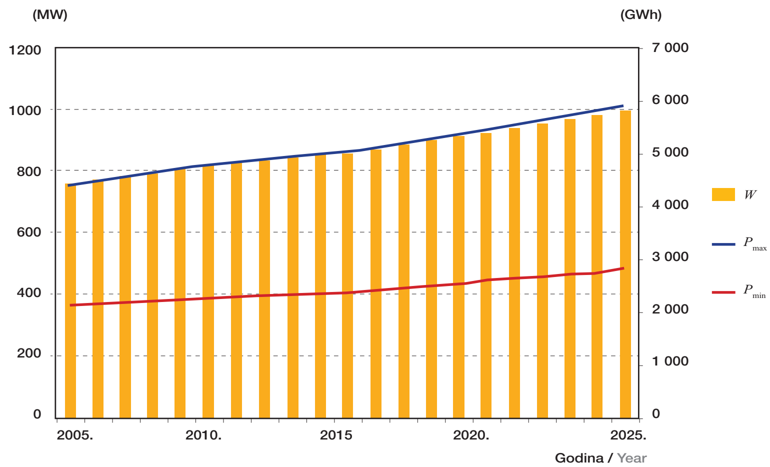
Scenarios for the future consumption of electrical energy have been worked out in detail according to sectors in [3]. Therefore, only a summary is provided here of the growth of consumption and peak load. For purposes of simplicity, only the medium scenario is presented because the differences in the levels of consumption among the scenarios are small. Trends in the predicted consumption of electrical energy, peak and minimum loads in the system, and the load factor are presented in Table 5 and Figure 2. The stated amounts contain losses in the transmission and distribution networks, i.e. they present the total required electrical energy input to the transmission network, which is supposed to be covered by power plant production and/or imported electrical energy.

Pretpostavljeni prosječni godišnji porast potrošnje električne energije u razdoblju do 2025. godine iznosi 1,33 %, dok je prosječni godišnji porast vršnog opterećenja u sustavu 1,51 %. Iako se ne radi o posebno visokim stopama porasta, rast vršnog opterećenja nešto je brži od porasta potrošnje, što ukazuje na to da se kroz plansko razdoblje (2005. – 2025.) smanjuje faktor opterećenja. Ovakav je trend u skladu s pretpostavkom o bržem porastu potrošnje električne energije u sektoru kućanstva i usluge (s više promjenljivom potrošnjom) nego u sektoru industrije (čija potrošnja ima male oscilacije), za koji se smatra da je već dostigao određeno zasićenje.

The anticipated average annual growth in the consumption of electrical energy during the period up to the year 2025 amounts to 1,33 %, while the average annual increase in peak load in the system is 1,51 %. Although these are not particularly high rates of growth, the growth in the peak load is somewhat more rapid than growth in consumption, which indicates that during the planning period (2005 – 2025) there will be a reduction in the load factor. Such a trend is in accordance with the assumption of the more rapid growth in the consumption of electrical energy in the household and services sectors (with more changeable consumption) than in the industrial sector (with minor oscillations), in which a certain saturation is considered to have already been reached.

Tablica 5 – Predviđena potrošnja električne energije, vršnog i minimalnog opterećenja tijekom razdoblja planiranja (2005. –2025.) [3]
Table 5 – Anticipated electrical energy consumption, peak and minimum loads during the planning period (2005 – 2025) [3]

Godina / Year	P_{max} (MW)	P_{min} (MW)	W (GWh)	Faktor opterećenja / Load factor (%)
2005.	752,1	361,3	4 443	67,43
2006.	764,8	367,4	4 518	
2007.	777,8	373,6	4 594	
2008.	791,0	380,0	4 672	
2009.	804,4	386,4	4 751	
2010.	818,0	391,1	4 765	66,49
2011.	826,9	395,4	4 817	
2012.	836,0	399,7	4 870	
2013.	845,1	404,1	4 923	
2014.	854,3	408,5	4 976	
2015.	863,6	407,9	4 982	65,86
2016.	878,0	414,7	5 065	
2017.	892,6	421,6	5 150	
2018.	907,4	428,6	5 235	
2019.	922,6	435,8	5 323	
2020.	937,9	447,4	5 372	65,38
2021.	953,0	454,6	5 458	
2022.	968,3	461,9	5 546	
2023.	983,9	469,3	5 635	
2024.	999,7	476,9	5 726	
2025.	1 015,8	491,1	5 791	65,08



Slika 2
Predviđena potrošnja električne energije, vršnog i minimalnog opterećenja tijekom razdoblja planiranja (2005. – 2025.) [3]

Figure 2
Anticipated electrical energy consumption, peak and minimum loads during the planning period (2005 – 2025) [3]

4 POSTOJEĆI PROIZVODNI KAPACITETI

U EES-u Crne Gore nalaze se u pogonu tri veće proizvodne jedinice: hidroelektrane Perućica (307 MW) i Piva (342 MW), te termoelektrana Pljevlja (210 MW) [4]. Uz njih, u sustavu postoji sedam malih hidroelektrana, ali je njihov doprinos u snazi i proizvodnji relativno mali. Dakle, ukupna instalirana snaga elektrana iznosi 868 MW, dok je snaga na pragu 849 MW. Udio hidroelektrana u instaliranoj snazi je 76 %, dok u proizvedenoj energiji sudjeluju sa oko 60 %, dakako uz očekivane oscilacije ovisno o hidrološkim prilikama.

4.1 HE Perućica

HE Perućica koristi vode sliva Gornje Zete koje dotječu u Nikšićko polje, s bruto padom od oko 550 metara. Za sada su realizirane tri faze izgradnje elektrane. U prvoj fazi (1960. godina) izgrađene su sve akumulacije i dovodni organi, prvi cjevovod, rasklopno postrojenje 110 kV, odvodni kanal te strojarnica s agregatima I. i II. snage po 38 MW, odnosno 40 MVA, i instaliranog protoka od 8,5 m³/s. U drugoj fazi (1962. godina) izgrađeni su drugi cjevovod i agregati III., IV. i V., također svaki snage 38 MW (40 MVA) i instaliranog protoka od 8,5 m³/s. U trećoj fazi (1977/78. godina) izgrađeni su treći cjevovod i agregati VI. i VII. snage 58,5 MW (65 MVA) i instaliranog protoka od 12,75 m³/s svaki. Nakon realizacije treće faze ukupna instalirana snaga svih agregata iznosi 307 MW, s ukupnim instaliranim protokom od 68 m³/s.

4 EXISTING GENERATING CAPACITIES

In the electrical energy system in Montenegro, three large generating units are in operation: the Perućica Hydroelectric Power Plant (307 MW), the Piva Hydroelectric Power Plant (342 MW) and the Pljevlja Thermoelectric Power Plant (210 MW) [4]. In addition, the system also includes seven small hydroelectric power plants but their contribution to power and generation is relatively small. The total installed capacity of the plants amounts to 868 MW, while power at the threshold is 849 MW. The percentage of hydroelectric power plants in the installed capacity is 76 %, while its percentage in generated energy amounts to approximately 60 %, with anticipated oscillations, depending upon hydrological conditions.

4.1 Perućica Hydroelectric Power Plant

The Perućica Hydroelectric Power Plant uses water from the Gornja Zeta basin that flows into the Nikšić plain, with a gross head of approximately 550 meters. For now, three phases in the construction of the power plant have been achieved. In the first phase (the year 1960), construction was completed of all the storage reservoirs and intake, the first pipeline, 110 kV switchgear, discharge canal and power station with Generators I and II, each with a 38 MW power rating or 40 MVA, and an installed flow of 8,5 m³/s. In the second phase (the year 1962) a second pipeline and Generators III, IV and V were constructed, each again with a 38 MW power rating (40 MVA) and an installed flow of 8,5 m³/s. In the third phase (1977/78) a third pipeline and Generators VI and VII were constructed, with a 58,5 MW power rating (65 MVA) and an installed flow of 12,75 m³/s each. After the completion of the third phase, the total installed capacity of all the generators amounted to 307 MW, with a total installed flow of 68 m³/s.

4.2 HE Piva

HE Piva je akumulacijsko-pribransko postrojenje na rijeci Pivi, smješteno između planinskih masiva Pive, Komarnice i Vrbnice. Dovršenje izgradnje i puštanje agregata u pogon obavljeno je 1976. godine. Zbog specifičnih topografskih karakteristika terena kompletno postrojenje smješteno je ispod površine zemlje. U elektrani se nalaze tri agregata, svaki snage 114 MW (ukupno 342 MW), i instaliranog protoka 80 m^3/s. Ukupni volumen akumulacije iznosi 880 milijuna kubnih metara, a projektirana godišnja proizvodnja 860 GWh. Prosječna je ostvarena proizvodnja manja od projektirane za 14 %, ponajprije zbog manjih dotoka u akumulaciju od očekivanih, ali i stoga što režim rada elektrane nije uvijek bio optimalan (korištenje optimalne kote jezera za postizanje maksimalne snage agregata), a u pojedinim godinama su i preljevi bili nešto veći nego što je to bilo nužno.

Specifičnost HE Piva je da od svog puštanja u pogon 1976. godine radi kao vršna elektrana za elektroenergetski sustav Srbije, na osnovi razmjene energije u skladu sa ugovorom o dugoročnoj poslovno-tehničkoj suradnji, zaključenim između Elektroprivrede Crne Gore i Elektroprivrede Srbije (EPS). Na račun dobivanja električne energije iz HE Piva prema zahtjevima i potrebama EPS-a, Elektroprivreda Srbije zauzvrat isporučuje EES-u Crne Gore baznu električnu energiju sa snagom od 105 MW tijekom cijele godine, te dodatno 105 MW, u trajanju od 58 dana, za vrijeme remonta TE Pljevlja.

U Crnoj Gori je izgrađeno sedam malih hidroelektrana, koje se danas nalaze u vlasništvu Elektroprivrede Crne Gore. To su hidroelektrane: Glava Zete, Slap Zete, Rijeka Mušovića, Šavnik, Rijeka Crnojevića, Podgor i Lijeva Rijeka. Njihova ukupna instalirana snaga iznosi 9,025 MW, a očekivana godišnja proizvodnja 21 GWh.

4.3 TE Pljevlja

TE Pljevlja je prva crnogorska kondenzacijska termoelektrana, inicijalno projektirana s dva bloka od 210 MW svaki. Akumulacija vode, kao i svi pomoćni, tehnički i upravno-administrativni objekti (osim dekarbonizacije i recirkulacijskog rashladnog sustava) izvedeni su za dva bloka, no do sada je izgrađen samo jedan blok. Izgradnja prvog bloka TE Pljevlja trajala je od 1976. do 1982. godine. Opskrba TE Pljevlja vodom za hlađenje i za druge potrebe vrši se iz akumulacije Otilovići, volumena 18 milijuna m^3, koja se nalazi na rijeci Ćehotini, oko 8 km udaljena od termoelektrane. TE Pljevlja radi kao bazna elektrana u sustavu, a projektirana je za rad od oko 6 000 sati godišnje, što uz

4.2 Piva Hydroelectric Power Plant

The Piva Hydroelectric Power Plant is located near a dam on the Piva River, located among the mountains of Piva, Komarnica and Vrbnica. The completion of construction and commencement of operations occurred in the year 1976. Due to the specific topographic characteristics of the terrain, the whole plant is located below the earth's surface. The power plant has three generating units, each with a power rating of 114 MW (a total of 342 MW), and an installed flow 80 m^3/s. The total reservoir storage volume is 880 million m^3 and the plant was designed for an annual production of 860 GWh. The average production achieved is 14 % lower than planned, primarily due to lower inflows into the storage reservoir than anticipated, but also because the operational regime of the power plant was not always optimal (the use of the optimal lake elevation in order to achieve the maximum power rating of the generating units), and in individual years overflow was somewhat greater than necessary.

A specific characteristic of the Piva Hydroelectric Power Plant is that since it went into operation in the year 1976, it has operated as a peak-load plant for the electrical energy system of Serbia, based upon energy exchange pursuant to a contract on long-term business-technical cooperation, concluded between the Electric Power Company of Montenegro (EPCG) and the Electric Power Company of Serbia (EPS). In repayment for the electrical energy obtained from the Piva Hydroelectric Power Plant, the Electrical Power Company of Serbia delivers base electrical energy with a power rating of 105 MW to the Electric Power Company of Montenegro throughout the year, and an additional 105 MW for a period of 58 days during the servicing of the Pljevlja Thermoelectric Power Plant.

Seven small hydroelectric power plants have been built in Montenegro that are today under the ownership of the Electric Power Company of Montenegro, as follows: Glava Zete, Slap Zete, Rijeka Mušovića, Šavnik, Rijeka Crnojevića, Podgor and Lijeva Rijeka. Their total installed capacity amounts to 9,025 MW, and the expected annual production is 21 GWh.

4.3 The Pljevlja Thermoelectric Power Plant

The Pljevlja Thermoelectric Power Plant is the first Montenegrin condensing thermoelectric power plant, initially designed with two blocks of 210 MW each. The reservoir, as well as all auxiliary, technical and administrative/managerial facilities (except the decarbonization and recirculation cooling system) were built for the two blocks. However, up to the present, only one block has been built. The construction of the first block of the Pljevlja Thermoelectric Power Plant lasted from 1976 to 1982. The supply of water to the Pljevlja Thermoelectric Power Plant for maksimalnu snagu na pragu od 191 MW daje projektiranu maksimalnu godišnju proizvodnju od 1 146 GWh. Od 1992. godine elektrana je radila sa smanjenom prosječnom snagom. Na to su utjecali nepovoljan sastav ugljena iz površinskog kopa Potrlica i amortiziranost postrojenja, u prvom redu zbog abrazije cijevnog sustava kotla.

5 MOGUĆI SCENARIJI IZGRADNJE ELEKTRANA

5.1 Teoretski hidroenergetski potencijal

Na osnovi dosadašnjih istraživanja površinskih vodotoka u Crnoj Gori, može se govoriti o vrlo izraženoj vodnosti u odnosu na relativno malu površinu teritorija Crne Gore, a time i o načelnoj raspoloživosti značajnog hidro potencijala za energetsko korištenje. Ukupni hidro potencijal na području Crne Gore se kroz dimenziju godišnjeg otjecanja unutarnjih voda na teritoriju Crne Gore procjenjuje na 18,75 milijardi kubnih metara, odnosno 595 m^3/s, a s aspekta hidro energetskog korištenja procjena je na 13,34 milijardi kubnih metara, odnosno 423 m^3/s.

Vodoprivrednom osnovom Crne Gore [5] iz 2001. godine izračunat je ukupan teoretski hidroenergetski potencijal u iznosu od 9 846 GWh, s tim da je dio ovog potencijala već u eksploataciji u postrojenjima HE Perućica i HE Piva. Raspodjela ovog potencijala prema glavnim vodotocima dana je u tablici 6.

cooling and other purposes comes from the Otilovići Storage Reservoir, with a volume of 18 million m^3, located on the Ćehotina River, approximately 8 km from the thermooelectric power plant. The Pljevlja Thermoelectric Power Plant operates as a base power plant in the system, and was designed to operate for approximately 6 000 hours per year, which provides the planned maximum annual production of 1 146 GWh with maximum power at the threshold of 191 MW. Since the year 1992, the power plant has operated at a reduced average capacity. This was influenced by the unfavorable coal composition from the Potrlica Surface Mine and the depreciation of the plant, primarily due to abrasion of the boiler pipes.

5 POTENTIAL SCENARIOS FOR THE CONSTRUCTION OF POWER PLANTS

5.1 Theoretical hydroenergy potential

Based upon investigations to date of the surface waterways in Montenegro, it is possible to speak about the extensive water resources in relation to the relatively small territory of Montenegro, and therefore about the availability of significant hydro potential for energy use in principle. The total hydro potential in the territory of Montenegro, in terms of the dimension of the annual inflow on the territory of Montenegro, is estimated at 18,75 billion m^3 or 595 m^3/s. From the aspect of hydro energy use, the estimate is 13,34 billion m^3 or 423 m^3/s.

According to the Water Management Master Plan of Montenegro [5], dated 2001, the total theoretical hydro energy potential is calculated in the amount of 9 846 GWh. A part of this potential is already being exploited by the Perućica Hydroelectric Power Plant and the Piva Hydroelectric Power Plant. The distribution of this potential according to the main waterways is presented in Table 6.

Tablica 6 –Teoretski hidro potencijal Crne Gore na glavnim vodotocima [3]
Table 6 – The theoretical hydro potential of Montenegro according to the main waterways [3]

Rijeka / River	Teoretski hidroenergetski potencijal / Theoretical hydroenergy potential (GWh)
Piva	1 361
Tara	2 255
Ćehotina	463
Lim	1 438
Ibar	118
Morača (do Zete) / (to Zeta)	1 469
Zeta	2 007
Mala rijeka	452
Cijevna	283
Ukupno / Total	9 846

Za proračun energetskog potencijala dužinom glavnih riječnih tokova u Crnoj Gori u okviru Vodoprivredne osnove usvojen je korak od 5 km. Na osnovi ovih podataka, energetski najmoćnija rijeka je Tara, nakon koje slijede Zeta, Morača, Lim, Piva i ostale.

5.2 Tehnički iskoristivi hidroenergetski potencijal

Uz pretpostavku da se na bilo kojem mjestu može podići brana ili neki drugi objekt, tehnički iskoristivi hidro potencijal jednak je teoretskom hidro potencijalu umanjenom za gubitke na padu (u dovodno-odvodnim organima i oscilacijama razine u akumulaciji) i gubitke u strojevima (turbine, generatori, transformatori itd.). Gubici na padu se trebaju računati za svako postrojenje posebno, dok se gubici na strojevima, za današnji stupanj razvoja, generalno mogu procijeniti na oko 13 %.

Današnje tehničke mogućnosti dopuštaju izgradnju u gotovo svim uvjetima. Međutim, ekonomski iskoristivi hidro potencijal je vezan uz promjenu ekonomskih kriterija rentabilnosti tijekom vremena korištenja. Promjenom raznih čimbenika koji utječu na izgradnju objekata i proizvodnju električne energije mijenjaju se i ekonomski kriteriji rentabilnosti korištenja vodnih snaga.

Ekonomično iskoristive vodne snage mogu se utvrditi za određeno vrijeme tako da se odrede najveće prihvatljive investicije po kW, i o tome ovisni trošak proizvodnje po kWh, i pribroje sve vodne snage koje daju energiju jeftiniju od utvrđene. Pri ovakvoj procjeni jedan veliki dio hidro potencijala ući će u kategoriju ekonomski nepovoljnog, iako bi u jednoj kompleksnijoj analizi, uključujući neke dodatne pozitivne učinke (odbrana od poplava, navodnjavanje, opskrba vodom i dr.) mogao postati ekonomski prihvatljiv. Kako je bez osnovnih vodoprivrednih studija, vodoprivrednih osnova čitavih riječnih slivova i studija utjecaja na okoliš teško dati procjenu o investicijama, tek se izradom takve dokumentacije može pouzdanije razgraničiti ekonomski povoljan od ekonomski nepovoljnog hidro potencijala. Apsolutno točno utvrđivanje granice između te dvije kategorije nije moguće, jer vrijednost električne energije nije stalna, nego je to dinamička veličina.

5.2.1 Tehnički iskoristivi potencijal glavnih riječnih tokova

Prethodnim istraživanjima definiran je i tehnički iskoristiv potencijal vodotoka u Crnoj Gori, kao dio teoretskog potencijala za koji je izrađenom projektnom dokumentacijom dokazano da je u

For the estimate of the energy potential along the main rivers in Montenegro within the framework of the Water Management Master Plan, a span of 5 km has been adopted. On the basis of these data, the most powerful river in terms of energy is the Tara, followed by the Zeta, Morača, Lim, Piva and the others.

5.2 Technically exploitable hydroenergy potential

Assuming that a dam or some other facility can be built in any place, the technically exploitable hydro potential is equal to the theoretical hydro potential minus head losses (in intake or discharge waterways and oscillations in the reservoir water levels) and losses in machinery (turbines, generators, transformers etc.). Head losses should be calculated for each plant separately, while losses in machinery, at today's level of development, can generally be estimated at approximately 13 %.

Today's technical possibilities permit construction under nearly all conditions. However, economically exploitable hydro potential is linked to change in the economic criteria of profitability during the period of use. With changes in various factors that affect the construction of facilities and the generation of electrical energy, there are changes in the economic criteria of the profitability of using water power.

Economically exploitable water power can be determined for a specific period in order to establish the highest acceptable investment per kW and, accordingly, the production cost per kWh, to which should be added all the water power that provides energy that is less expensive than that determined. In such an estimate, a large part of the hydro potential is categorized as unsuitable, although it could become economically acceptable in a more complex analysis, including some additional positive factors (flood protection, irrigation, water supply etc.). Since it is difficult to provide an estimate for investments without basic water management studies, water management studies of entire river basins and ecological impact studies, it will only be possible to differentiate economically favorable from economically unfavorable hydro potentials reliably after such documentation has been prepared. An absolutely precise determination of the boundary between these two categories is not possible because the value of electrical energy is not constant but dynamic.

5.2.1 The technically exploitable potential of the main rivers

In previous investigations, the technically exploitable potential of the waterways in Montenegro has been defined as part of the theoretical potential tehničkom smislu moguća eksploatacija, odnosno za koji se pouzdano može odrediti prosječna moguća godišnja proizvodnja. Procjena iznosa tehnički iskoristivog potencijala glavnih vodotoka u prirodnom pravcu otjecanja kreće se u rasponu 5,4 do 6,3 TWh (ovisno o varijanti korištenja voda), s tim da je oko 1,7 TWh već u eksploataciji u do sada izgrađenim hidroelektranama. Osim energetskog korištenja vodotoka u njihovom prirodnom pravcu toka, razmatrana je i mogućnost kojom se predviđa prevođenje dijela vode rijeke Tare u rijeku Moraču (22,2 m³/s). U tom slučaju procijenjeni iznos tehnički iskoristivog potencijala kreće se od 6,3 do 6,9 TWh.

Analiza preostalog tehnički iskoristivog hidro potencijala rijeka u Crnoj Gori načinjena je na osnovi planiranih tehničkih rješenja hidroenergetskih objekata u dvije globalne varijante. Varijanta 1 postoji u mnogobrojnim razvojnim programima, planovima i projektnoj dokumentaciji hidroenergetskih objekata Elektroprivrede Crne Gore. Varijanta 2 dana je u službeno usvojenoj Vodoprivrednoj osnovi Crne Gore [5] (usporedo s Varijantom 1). Varijante 1 i 2 razmatraju korištenje hidroenergetskog potencijala na prirodnom pravcu toka i s prevođenjem dijela vode rijeke Tare u rijeku Moraču (Q = 15,2 m³/s ili Q = 22,2 m³/s).

Varijanta 1, koja je usvojena od strane Elektroprivrede Crne Gore i obuhvaćena Programom razvoja i izgradnje novih elektroenergetskih objekata s prioritetima gradnje Elektroprivrede Crne Gore [6], predviđa izgradnju novih akumulacija i elektrana kako slijedi:

- Tara: akumulacija i HE Ljutica (bez akumulacije HE Tepca) i akumulacije i HE Visoki Žuti Krš, Opasanica, Bakovića Klisura i Trebaljevo,
- Morača: RHE Koštanica, akumulacija i HE Visoko Andrijevo i nizvodne akumulacije i HE Raslovići, Milunovići i Zlatica,
- Lim: akumulacije i HE na glavnom toku Andrijevica, Lukin Vir i Plavsko jezero,
- Ćehotina: akumulacija i HE Mekote (bez akumulacije i HE Milovci),
- Piva: akumulacija i HE Komarnica i dvije manje derivacijske HE Pošćenje i Bukovica Šavnik.

Varijanta 2, koja je kao alternativa obuhvaćena Vodoprivrednom osnovom Crne Gore, 2001. godina, predviđa izgradnju novih akumulacija i elektrana kako slijedi:

- Tara: akumulacije i HE Tepca, Mojkovac, Niski Žuti Krš, Mateševo i Opasanica,

for which it has been shown through the preparation of project documentation that exploitation is possible in the technical sense, or for which it is possible to determine potential average annual production reliably. The estimates of the amounts of the technically exploitable potential of the main waterways in their natural course range from 5,4 to 6,3 TWh (depending on the variants of water use), so that approximately 1,7 TWh are being exploited by hydroelectric power plants that have already been built. Besides the use of waterways for energy in their natural course, the possibility has also be considered of redirecting part of the water of the Tara River into the Morača River (22,2 m³/s). In this case, the estimated amount of technically exploitable potential would range from 6,3 to 6,9 TWh.

Analysis of the remaining technically exploitable hydro potential of the rivers in Montenegro has been performed on the basis of the planned technical solutions of the hydro energy facilities in two global variants. Variant 1 exists in many development programs, plans and project documentation for the hydro energy objects of the Electric Power Company of Montenegro. Variant 2 was provided in the officially adopted Water Management Master Plan of Montenegro [5] (comparable to Variant 1). Variants 1 and 2 consider using the hydro energy potential of the natural course of the flow together with the redirected part of the water from the Tara River into the Morača River (Q = 15,2 m³/s or Q = 22,2 m³/s).

Variant 1, which was adopted by the Electric Power Company of Montenegro and includes the Program for the Development and Construction of New Electrical Energy Facilities with Priority Building of the Electric Power Company of Montenegro [6], anticipates the construction of new storage reservoirs and electrical power plants, as follows:

- Tara: the Ljutica Storage Reservoir and Hydroelectric Power Plant (without the storage reservoir of the Tepca Hydroelectric Power Plant), and the storage reservoirs and hydroelectric power plants of Visoki Žuti Krš, Opasanica, Bakovića Klisura and Trebaljevo,
- Morača: the Koštanica Reversible Hydroelectric Power Plant, the Visoko Andrijevo Storage Reservoir and Hydroelectric Power Plant, and the downriver storage reservoirs and hydroelectric power plants of Raslovići, Milunovići and Zlatica,
- Lim: on the main course, storage reservoirs and hydroelectric power plants of Andrijevica, Lukin Vir and Plavsko jezero,
- Ćehotina: the Mekote Storage Reservoir and Hydroelectric Power Plant (without the Milovci Storage Reservoir and Hydroelectric Power Plant),
- Piva: the Komarnica Storage Reservoir and Hydroelectric Power Plant, and two smaller derivation hydroelectric power plants Pošćenje and Bukovica Šavnik.

– Morača: akumulacija i HE Nisko Andrijevo, uzvodna akumulacija i HE Dubravica, akumulacija i HE Grla, te nizvodne akumulacije i HE Raslovići, Milunovići i Zlatica (kao u Varijanti 1),
– Lim: višenamjenske akumulacije i HE na pritocima, a na glavnom toku samo kanalske protočne HE,
– Ćehotina: akumulacija Milovci i derivacijska HE u rijeku Taru,
– Piva: akumulacije (kao u Varijanti 1), HE Šavnik s derivacijom iz akumulacije na rijeci Bijela i HE Timar s akumulacijom na rijeci Bukovici.

U obje varijante ista su rješenja za Ibar sa HE Bać i za HES Buk Bijela na rijeci Drini. Obje varijante su uvjetne, a moguće je i kombiniranje varijantnih rješenja na pojedinim rijekama (onih koja su međusobno neovisna).

U tablici 7 dan je pregled preostalog tehnički iskoristivog potencijala glavnih vodotoka za varijantu 1 i 2, i to u prirodnom pravcu toka, te za slučaj prevođenja dijela voda Tare u Moraču, prema podacima iz Vodoprivredne osnove Crne Gore [5].

Variant 2, which as an alternative includes the Water Management Master Plan of Montenegro, 2001, predicts the construction of new reservoirs and power plants, as follows:

– Tara: the storage reservoirs and hydroelectric power plants of Tepca, Mojkovac, Niski Žuti Krš, Mateševo and Opasanica,
– Morača: the Nisko Andrijevo Storage Reservoir and Hydroelectric Power Plant, the upriver Dubravica Storage Reservoir and Hydroelectric Power Plant, the Grla Storage Reservoir and Hydroelectric Power Plant, and the downriver storage reservoirs and hydroelectric power plants of Raslovići, Milunovići and Zlatica (as in Variant 1),
– Lim: multipurpose storage reservoirs and hydroelectric power plants on the tributaries, and on the main course only channel run-off-river hydroelectric power plants,
– Ćehotina: the Milovci Storage Reservoir and derivation Hydroelectric Power Plant to the Tara River,
– Piva: storage reservoirs (as in Variant 1), the Šavnik Hydroelectric Power Plant with a derivation from the storage reservoir on the Bijela River and the Timar Hydroelectric Power Plant with a storage reservoir on the Bukovica River.

In both variants, the solutions are the same for Ibar with the Bać Hydroelectric Power Plant and for the Buk Bijela Hydroenergy System on the Drina River. Both variants are conditional and it is possible to combine variant solutions on individual rivers (those which are mutually independent).

Table 7 presents the remaining technically exploitable potential of the main waterways for Variants 1 and 2, in the natural direction of flow and for the case of the diverted part of the water of the Tara River into the Morača River, according to data from the Water Management Master Plan of Montenegro [5].

Tablica 7 – Preostali tehnički iskoristivi hidroenergetski potencijal glavnih vodotoka za varijantu 1 i 2, u prirodnom pravcu toka i uz prevođenje voda Tare u Moraču [3]
Table 7 – Remaining technically exploitable hydroenergy potential of the main waterways for Variants 1 and 2, in the natural direction of flow and the redirected water of the Tara River into the Morača River [3]

Rijeka / River	Pravac prirodnog oticanja / Natural river course		Prevođenje voda / Diverted water			
	Varijanta 1 / Variant 1	Varijanta 2 / Variant 2	Varijanta 1 / Variant 1		Varijanta 2 / Variant 2	
			22,2 m³/s	15,2 m³/s	22,2 m³/s	15,2 m³/s
	(GWh)	(GWh)	(GWh)	(GWh)	(GWh)	(GWh)
Tara	803	1 326	1 420	1 169	1 650	1 453
Morača	1 198	1 332	1 564	1 448	1 708	1 590
Lim	826	933	826	826	933	933
Ćehotina	136	218	136	136	218	218
Piva	316	365	316	316	365	365
Ibar	48	48	48	48	48	48
Buk Bijela (1/3)	380	380	330	345	330	345
Ukupno / Total	3 707	4 602	4 639	4 288	5 252	4 952

Iz tablice 7 je vidljivo da se prevođenjem dijela vode rijeke Tare u rijeku Moraču potencijal povećava u odnosu na zamišljeno stanje s prirodnim pravcem toka, a isto se može reći i za Varijantu 2, kojom se postiže bolja energetska iskorištenost vodotoka.

From Table 7, it is evident that the diverted part of the Tara River into the Morača River has a potential for increase in comparison to the envisioned situation with the natural direction of flow, and the same can also be said for Variant 2, according to which better energy exploitation of the waterways can be achieved.

5.2.2 Tehnički iskoristivi potencijal u malim hidroelektranama

U dosadašnjim planskim dokumentima bruto hidro potencijal na manjim vodotocima je procjenjivan na oko 800 – 1 000 GWh, od čega se ocjenjuje da je realno iskoristiv potencijal malih hidroelektrana oko 400 GWh. Ta procjena je dana na osnovi ocjene dosta oštrih ekoloških i prostornih ograničenja koja se postavljaju na nizu malih vodotoka.

Ovdje je, radi cjelovitosti, bitno naglasiti da na iznos procijenjenog tehnički iskoristivog potencijala malih hidroelektrana (oko 400 GWh) ne utječu režimi korištenja vodotoka, kao ni dvije spomenute varijante pa se, radi dobivanja informacije o ukupnom tehnički iskoristivom potencijalu svih vodotoka u Crnoj Gori, potencijal malih hidroelektrana kao takav može jednostavno dodati potencijalu za bilo koju varijantu, iz čega slijedi tablica 8.

5.2.2 Technically exploitable potential in small hydroelectric power plants

In the planning documents up to now, the gross hydro potential for minor waterways has been estimated at approximately 800 – 1 000 GWh, of which it is estimated that the real exploitable potential of the small hydroelectric power plants is approximately 400 GWh. This estimate has been prepared on the basis of the evaluation of the fairly rigid ecological and physical limitations on the series of small waterways.

Here, for purposes of comprehensiveness, it is necessary to point out that the amount of estimated technically exploitable potential of the small hydroelectric power plants (approximately 400 GWh) is not affected by the regime of exploiting the waterways or the two previously mentioned variants so that, with the goal of obtaining information on the total technically exploitable potential of all the waterways in Montenegro, the potential of the small hydroelectric power plants as such can simply provide potential for any variant whatsoever, as seen in Table 8.

Tablica 8 – Preostali tehnički iskoristivi hidroenergetski potencijal svih vodotoka (u ovisnosti o varijanti) [3]
Table 8 – Remaining technically exploitable hydroenergy potential of all the waterways (depending on the variant) [3]

Preostali tehnički iskoristivi potencijal svih vodotoka / Remaining technically exploitable potential of all the waterways	U prirodnom pravcu toka / In the natural river course	S prevođenjem dijela vode rijeke Tare u rijeku Moraču / With the diverted part of the water from the Tara River into the Morača River 22,2 m³/s
	(GWh)	(GWh)
Varijanta 1 / Variant 1	4 107	5 039
Varijanta 2 / Variant 2	5 002	5 652

5.2.3 Tehnički iskoristivi potencijal izvan granica Crne Gore

Hidroenergetski sustav Buk Bijela najmanje je sporan s aspekta usuglašenosti raspodjele potencijala, budući da je dogovorom između Republike Crne Gore i Republike Srpske određeno da Crnoj Gori pripada oko 1/3 potencijala (odnosno oko 450 GWh) koji se realizira u HE Buk Bijela, budući da bi se uspor njezine akumulacije prenosio više kilometara na teritoriju Crne. Odgovarajući dio potencijala koji bi se realizirao u toj elektrani

5.2.3 Technically exploitable potential outside the borders of Montenegro

The Buk Bijela Hydroenergy System is the least controversial regarding agreement on the allocation of potentials, since pursuant to a contract between the Republic of Montenegro and the Republika Srpska it has been stipulated that Montenegro is entitled to approximately 1/3 of the potential (i.e. approximately 450 GWh) that is generated in the Buk Bijela Hydroelectric Power Plant, since backwater could extend several kilometers on the territory of Montenegro. The corresponding part of the potential that would be achieved in this power uračunat je u procjene tehnički iskoristivog potencijala prikazanog u tablici 7. Problem kod realizacije tog objekta je u stavu crnogorske javnosti kako je takav zahvat u kanjonu Tare neprihvatljiv s ekološkog aspekta. Takav je stav formuliran i kroz Deklaraciju o zaštiti rijeke Tare, usvojenu u Skupštini Republike Crne Gore 2004. godine, radi koje su daljnje aktivnosti na realizaciji projekta morale biti zaustavljene.

Kod planiranih objekata na rijeci Ćehotini spominju se dva objekta u graničnom području s Bosnom i Hercegovinom, a koji se međusobno isključuju: HE Vikoč i HE Milovci. Nizvodni objekt HE Vikoč (na teritoriju Bosne i Hercegovine) u novije vrijeme se ne spominje, pa se tako ne nalazi niti u jednoj od dvije varijante iz Vodoprivredne osnove Crne Gore [5]. Za HE Milovci (koja je sastavni dio Varijante 2) za sada još ne postoji sporazum o podjeli hidroenergetskog potencijala, pa se za taj potencijal ovdje pretpostavlja da u potpunosti pripada Crnoj Gori (uračunato u tablici 7).

U planskoj i ostaloj dokumentaciji [7] spominje se i objekt HE Brodarevo u smislu realizacije potencijala u pograničnom području. Riječ je o hidroenergetskom objektu na rijeci Lim, koji bi bio izgrađen u Republici Srbiji, a uspor akumulacije se proteže na teritorij Crne Gore.

Projektni parametri elektrane su sljedeći: kota uspora 540 m.n.m., snaga 50,4 MW, očekivana godišnja proizvodnja 200,4 GWh. Što se tiče kote akumulacije i njenog pružanja na teritoriju Crne Gore, kota 540 m.n.m. pruža se u kanjonskom području i doseže do nizvodnog dijela Bjelopoljske doline (oko 1 km uzvodno od ušća rijeke Bistrice u Lim čija je kota 537 m.n.m.). Tu je dokumentaciju EPS pokušao aktualizirati 2002. godine, međutim do realizacije nije došlo. Prema informacijama iz EPCG, kod te hidroelektrane još ne postoji sporazum o podjeli hidroenergetskog potencijala, pa se do postizanja takvog sporazuma može smatrati da u planovima EPS-a ovaj objekt ostaje kako je projektiran, uz potrebu dogovora s Crnom Gorom oko njegove realizacije.

5.2.4 Zaključno o hidroenergetskom potencijalu

Ovim poglavljem obrađen je pregled postojećeg hidro potencijala Crne Gore s planiranim hidroelektranama. Korišteni podaci (kao kombinacija korištenja različitih podloga) uglavnom se baziraju na podacima iz Vodoprivredne osnove Crne Gore, osim u dijelu procijenjenog potencijala malih hidroelektrana i potencijala izvan granica Crne Gore.

plant is calculated in the estimate of the technically exploitable potential presented in Table 7. The problem in the construction of this facility is in the attitude of the Montenegrin public that this undertaking in the Tara Canyon is unacceptable from the ecological aspect. This position has also been formulated through the Declaration on the Protection of the Tara River, adopted by the Parliament of the Republic of Montenegro in the year 2004, due to which further activities on the realization of the project had to be stopped.

For the planned facilities on the Ćehotina River, two facilities are mentioned in the border region with Bosnia and Herzegovina, which are mutually exclusive: the Vikoč Hydroelectric Power Pant and the Milovci Hydroelectric Power Plant. The downriver facility of the Vikoč Hydroelectric Power Plant (on the territory of Bosnia and Herzegovina) has not been mentioned recently, so it does not occur in either of the two variants from the Water Management Master Plan of Montenegro [5]. For the Milovci Hydroelectric Power Plant (which is an integral part of Variant 2), for now there is no agreement on the division of the hydro energy potential. Therefore, this potential is assumed here to belong completely to Montenegro (as calculated in Table 7).

In planning and other documentation [7], there is also mention of the facility of the Brodarevo Hydroelectric Power Plant in the sense of the realization of the potential in the border region. This concerns a hydro energy facility on the Lim River, which would be built in the Republic of Serbia, backwater would extend to the territory of Montenegro.

The project parameters of the power plant are as follows: the elevation of 540 meters above sea level, power rating of 50,4 MW and anticipated annual production of 200,4 GWh. Regarding the elevation of the reservoir and its extension onto the territory of Montenegro, the elevation of 540 meters above sea level extends into the canyon and reaches the downriver part of Bjelopoljska Valley (approximately 1 km upriver from the mouth of the Bistrica River in Lim, the elevation of which is 537 meters above sea level). The Electric Power Company of Serbia attempted to implement this documentation in the year 2002. However, it was not implemented. According to information from the Electric Power Company of Montenegro, regarding this hydroelectric power plant there is still no agreement on the division of the hydro energy potential, so that until such an agreement is reached, it can be assumed that the plans of the Electric Power Company of Serbia for this facility remain as designed, together with the necessity of reaching an agreement with Montenegro regarding their implementation.

5.2.4 Conclusion regarding hydroenergy potential

This chapter is a review of the existing hydro potential of Montenegro and the planned hydroelectric power

Može se reći da je postojeća dokumentacija koja obrađuje hidro potencijal Crne Gore (studije i projekti za pojedine objekte koji su različite razine obrade) zastarjela. U tom smislu, u ovom trenutku manje je bitna određena nekonzistentnost u grupiranju potencijala s obzirom na vodotoke, odnosno pritoke. Veću težinu treba dati ažuriranju tehničkih rješenja s obzirom na nove okolnosti. U proteklom vremenu došlo je do značajnijih promjena duž vodotoka koje uvjetuju mogućnost izgradnje, o čemu treba voditi računa prilikom izbora kandidata za izgradnju. Postojeće koncepcije iskorištenja vodotoka su suočene s raznim ograničenjima i teško se mogu realizirati, što uvjetuje potrebu za novom analizom tehnički iskoristivog hidro potencijala i što skorije započinjanje radova na tim poslovima. Ipak, kao glavni imperativ postavlja se definiranje realno iskoristivog potencijala, imajući u vidu sve glasnije zahtjeve ekologa o upitnosti realizacije nekih projekata, tako da sama vrijednost tehnički iskoristivog potencijala može dati lažnu sliku o stvarnim mogućnostima realizacije. Imajući u vidu opredjeljenje Crne Gore kao ekološke države, tek definiranjem ekološki prihvatljivog potencijala (što je zahtjevan i dugotrajan posao) moći će se s prihvatljivom sigurnošću izvršiti valorizacija realnih mogućnosti gradnje hidroelektrana u Crnoj Gori.

5.3 TE na ugljen

Dosadašnja istraživanja i postojeći status korištenja ukazuju na to da ugljen predstavlja najznačajniji neobnovljivi energetski resurs u Crnoj Gori, a po svemu sudeći takvu će ulogu zadržati i u budućim desetljećima. Rezerve ugljena u Crnoj Gori zahvaćaju mrko-lignitni ugljen u širem području Pljevalja, te mrki ugljen na prostoru općine Berane. Rezerve ugljena potpuno su definirane u pljevaljskom području, a nedovoljno u beranskom.

Eksploatacijske rezerve ugljena na pljevaljskom području iznose oko 200 milijuna tona. Prosječna ogrjevna vrijednost ugljena pljevaljskih bazena je oko 10,4 MJ/kg, a u maočkom bazenu 12,3 MJ/ kg. Ukupne pretpostavljene eksploatacijske rezerve beranskog bazena iznose oko 18,5 milijuna tona, uz višestruko veće izvanbilančne rezerve. Prosječna ogrjevna vrijednost ugljena u beranskom bazenu je 13,68 MJ/kg.

Očekuje se da dominantna uporaba ugljena u Crnoj Gori bude potrošnja u termoenergetskim postrojenjima za proizvodnju električne i eventualno toplinske energije. Proizvodnja električne energije na bazi ugljena za sada predstavlja najbolji način valorizacije ovog energetskog resursa.

plants. The data used (as a combination of various databases) are chiefly based upon information from the Water Management Master Plan of Montenegro, except the section on the estimated potential of small hydroelectric power plants and potential outside the borders of Montenegro.

It can be said that the existing documentation that discusses the hydro potential of Montenegro (studies and projects for individual facilities at various levels) is obsolete. In this sense, a certain lack of consistency in the grouping of potentials is less important at this moment regarding the waterways or tributaries. More weight should be afforded to bringing the technical solutions up to date, according to the new circumstances. In recent times, there have been significant changes along the waterways that affect construction possibilities, which must be taken into account when choosing a candidate for construction. The existing concepts of exploiting waterways are subject to various limitations and it is difficult to implement them, necessitating new analysis of the technically exploitable hydro potential and the beginning of work on these projects as soon as possible. Nonetheless, the principal imperative is the definition of the actual exploitable potential, bearing in mind the ever louder demands of ecologists regarding the controversial nature of the implementation of some projects, so that only the value of the technologically exploitable potential could provide a false picture of the actual possibilities for implementation. Bearing in mind Montenegro's orientation as an ecological state, with the definition of the ecologically acceptable potential (which is a demanding and long task), it will be possible to perform the valorization of the actual possibilities for the construction of hydroelectric power plants in Montenegro with acceptable certainty.

5.3 Coal-burning thermoelectric power plants

Investigations to date and the existing status of exploitation show that coal represents the most significant non-renewable energy resource in Montenegro, and by all indications it will maintain this role in the coming decades. Coal reserves in Montenegro include lignite (brown coal) in the general area of Pljevlja, and brown coal in the area of the municipality of Berane. The coal reserves have been completely defined in the Plevlja area and insufficiently defined in the Berane area.

The exploitable coal reserves in the Pljevlja area amount to approximately 200 million tons. The average calorific value of the coal from the Pljevlja basin is approximately 10,4 MJ/kg, and in the Maočka basin 12,3 MJ/kg. The total assumed exploitable reserves of the Berane basin amount to approximately 18,5 million tons, with several times higher contingent reserves. The average calorific value of coal in the Berane basin is 13,68 MJ/kg.

It is expected that the dominant use of coal in Montenegro will be consumption in thermal energy

Rezerve ugljena u pljevaljskom području mogu zadovoljiti potrebe termoenergetskih postrojenja za proizvodnju električne i toplinske energije, kao i za široku i industrijsku potrošnju u Crnoj Gori u idućih 70 do 80 godina. Geološke rezerve ugljena u beranskom bazenu zahtijevaju dodatne istražne radove radi povećanja eksploatacijskih rezervi.

Trenutačno stanje poduzeća za eksploataciju ugljena je problematično, kao posljedica restrukturiranja gospodarstva i nestanka velikih potrošača ugljena. Stoga se ulažu napori da se kroz procese privatizacije rudnika osigura njihovo dugoročno stabilno poslovanje. Rudnik ugljena Pljevlja raspolaže proizvodnim kapacitetom od 1,5 milijuna tona godišnje, od čega 1,35 milijuna tona koristi TE Pljevlja, a 150 tisuća tona široka potrošnja. Rudnik ugljena Ivangrad – Berane u novije vrijeme radio je s kapacitetom od oko 65 tisuća tona godišnje, s tim da je posljednjih nekoliko godina proizvodnja u zastoju zbog velikih poslovnih problema.

Energetski potencijal ugljena u Crnoj Gori moguće je u budućnosti kvalitetno realizirati proizvodnjom električne i toplinske energije, što će najviše ovisiti o strategiji razvoja elektroenergetskog sustava, točnije njegovog proizvodnog dijela. Zbog realnih okolnosti, proširenje kapaciteta očekuje se u pljevaljskom bazenu, a to za sobom povlači i odgovarajuće povećanje kapaciteta postrojenja za eksploataciju ugljena. U beranskom bazenu preduvjeti za izgradnju elektrane su nepovoljniji, zbog neistraženosti rezervi i nepostojanja osnovne infrastrukture kao u slučaju TE Pljevlja. U slučaju izgradnje novog izvora na pljevaljskom području, očekuje se povećanje kapaciteta proizvodnje ugljena za 1 – 1,5 milijun tona godišnje kroz razdoblje od 4 – 5 godina. U slučaju gradnje elektrane na beranskom području potrebni kapacitet tamošnjeg rudnika bi bio oko 600 tisuća tona, što bi se moglo dostići kroz razdoblje od 3 – 4 godine.

5.3.1 TE Pljevlja 2

Kao što je već spomenuto, prilikom izgradnje i puštanja u pogon prvog bloka TE Pljevlja 1982. godine, velik dio izgrađene infrastrukture dimenzioniran je za zajednički pogon oba bloka. Osim toga, na području Pljevalja postoje značajne i dobro istražene zalihe ugljena potrebnog za pogon oba bloka termoelektrane. Iz ova dva razloga lokacija TE Pljevlja je svakako prvi kandidat za izgradnju novog termoenergetskog bloka u Crnoj Gori [8].

plants for the production of electricity and eventually heat energy. The production of electrical energy based on coal represents the best manner of evaluating this energy resource. Coal reserves in the Plevlja area can meet the requirements of thermal energy plants for the production of electrical and heat energy, as well as for general and industrial consumption in Montenegro for the next 70 to 80 years. The geological reserves of coal in the Berane basin require additional exploration for increasing the exploitable reserves.

The current state of the enterprises for the exploitation of coal is problematic, as a consequence of the restructuring of the economy and the disappearance of large consumers of coal. Therefore, efforts are being invested so that the mines will be assured long-term stable operations through the process of privatization. The Pljevlja Coal Mine has an available production capacity of 1,5 million tons annually, of which 1,35 million tons are used by the Pljevlja Thermoelectric Power Plant and 150 000 tons are for general consumption. The Ivangrad – Berane Coal Mine in recent times has operated at a capacity of approximately 65 000 tons annually, with production stagnating in the past several years due to major operational problems.

The energy potential of coal in Montenegro can be realized in the future through the production of electrical and heat energy, which mostly depends upon the development strategy for the electrical energy system, more precisely its production aspect. Due to the actual circumstances, expansion of capacities is anticipated in the Pljevlja basin, which brings with it the corresponding increased capacity of plants for the exploitation of coal. In the Berane basin, the prerequisites for the construction of a power plant are unfavorable, due to the unexplored reserves and the lack of basic infrastructure, as in the case of the Pljevlja Thermoelectric Power Plant. In the event of the construction of a new source in the Pljevlja area, an increase in the production capacity of coal by 1 –1,5 million tons annually over a period of 4 –5 years is anticipated. In the event of the construction of a power plant in the Berane area, the necessary capacity of the mine there would be approximately 600 000 tons, which could be achieved in a period of 3 – 4 years.

5.3.1 The Pljevlja 2 Thermoelectric Power Plant

As previously mentioned, during the building and placing into operation of the first block of the Pljevlja Thermoelectric Power Plant in the year 1982, a large part of the constructed infrastructure was dimensioned according to the joint operation of both blocks. Moreover, in the Pljevlja area there are significant and well explored coal reserves necessary for the operations of both blocks of the thermoelectric power plant. For these two reasons, the location of the Pljevlja Thermoelectric Power Plant is certainly the first candidate for the construction of a new thermal energy block in Montenegro [8].

Izgradnjom prvog bloka TE Pljevlja izvedeni su radovi na sljedećim objektima zajedničkim za oba bloka:

- lučno-betonska brana Otilovići visine 59 m, koja osigurava potrebnu količinu vode za rad blokova 1 i 2,
- dovodni cjevovod od brane do termoelektrane duljine 8 km,
- dimnjak visine 250 m,
- doprema ugljena,
- mazutna stanica,
- pomoćna kotlovnica,
- kemijska priprema vode,
- bager stanica (građevinski dio),
- skladišta i radionice,
- upravna zgrada i laboratoriji,
- regulacija rijeke Vezišnice,
- podstanica za kiselinsko pranje,
- transformator 32 MVA,
- mosna dizalica 100/20 u strojarnici,
- postrojenje za pročišćavanje otpadnih voda,
- rasklopno postrojenje.

Lokacija drugog bloka predviđena je na odobrenoj lokaciji bloka 1 i dispozicijom idejnog projekta TE 2 x 210 MW. Na osnovi predračuna investicijskih ulaganja za izgradnju bloka 2 iz 1978. godine i stvarno izvedenih radova tijekom izgradnje bloka 1 TE Pljevlja, procjena vrijednosti zajedničkih objekata iznosi 66,6 milijuna USD.

Za pogon prvog bloka TE Pljevlja snage 210 MW (225 MW nakon rekonstrukcije) koristi se ugljen iz pljevaljskog bazena. Godišnja potrošnja ugljena zajamčene kvalitete od 9 211 kJ/kg za 6 000 sati rada godišnje iznosi oko 1,35 milijuna tona. S obzirom da se od 2007. planira potpuni prelazak na korištenje ugljena iz PK Potrlica, ogrjevne vrijednosti od oko 10,7 MJ/kg, a i s obzirom na planirano povećanje učinkovitosti kotla u termoelektrani, za godišnji rad termoelektrane (proizvodnja oko 1 000 GWh) trebat će nešto manje, odnosno oko 1,1 milijun tona ugljena. Za preostali životni vijek prvog bloka potrebno je stoga osigurati ukupno još oko 20 milijuna tona ugljena. Za pogon drugog bloka sličnih karakteristika, uz pretpostavljeni životni vijek od 40 godina, trebalo bi oko 45 milijuna tona ugljena navedenih parametara.

Kako pljevaljski bazen raspolaže s oko 65 milijuna tona eksploatacijskih rezervi, od čega će jedan dio biti usmjeren za široku potrošnju, količine ugljena pljevaljskog bazena nisu dovoljne za potpunu opskrbu dva bloka sličnih karakteristika za vrijeme trajanja njihovog životnog vijeka.

With the construction of the first block of the Pljevlja Thermoelectric Power Plant, work was performed on the following facilities for both blocks:

- the Otilovići concrete arch dam, 59 m in height, that secures the necessary amount of water for the operations of Blocks 1 and 2,
- pipeline from the dam to the thermoelectric power plant, 8 km in length,
- a chimney, 250 m tall,
- coal transport,
- mazut station,
- auxiliary boiler room,
- chemical preparation of water,
- excavator station (construction part),
- warehouse and workshops,
- administrative building and laboratories,
- regulation of the Vezišnica River,
- substation for acid washing,
- 32 MVA transformer,
- 100/20 crane in the engine room,
- plant for the cleaning of waste waters, and
- switchgear.

The location of the second block is anticipated at the approved location for Block 1 and according to the Preliminary Design for the Thermoelectric Power Plant, 2 x 210 MW. On the basis of the estimated investments in the construction of Block 2 from the year 1978 and the actual work performed during the construction of Block 1 of the Pljevlja Thermoelectric Power Plant, the estimated value of facilities for both blocks amounts to 66,6 million USD.

For the operation of the first block of the Pljevlja Thermoelectric Power Plant, with a 210 MW power rating (225 MW after reconstruction), coal from the Pljevlja basin is used. The annual consumption of coal of guaranteed quality of 9 211 kJ/kg for 6 000 hours of operations annually amounts to approximately 1,35 million tons. Taking into account that starting in 2007 a full transition is planned to the use of coal from Potrlica Coal Mine of a calorific value of approximately 10,7 MJ/kg, and taking account the planned increased efficiency of the boiler in the thermoelectric power plant, for the annual operation of the thermoelectric power plant (generation of approximately 1 000 GWh) somewhat less will be required, i.e. approximately 1,1 million tons of coal. For the remaining lifetime of the first block, it will therefore be necessary to secure a total of approximately 20 million tons of coal. For the operation of the second block of similar characteristics, assuming a lifetime of 40 years, approximately 45 million tons of coal of the stated parameters will be required.

Since the Pljevlja basin has approximately 65 million tons of exploitable reserves available, of which one part will be oriented toward general consumption, the quantities of coal from the Plevlja basin are not sufficient for the complete supply of the two blocks of similar characteristics for the duration of their lifetimes.

Eksploatacijske rezerve u obližnjem bazenu Maoče, s druge strane, iznose oko 113 milijuna tona ugljena ogrjevne vrijednosti od 12,3 MJ/kg. Tako bi za proizvodnju električne energije za jedan blok (snage 225 MW) bilo potrebno oko milijun tona ugljena iz maočkog bazena godišnje. Pretpostavi li se životni vijek bloka od 40 godina (u što je uračunato i produljenje nakon revitalizacije), može se zaključiti kako je za pogon drugog bloka potrebno osigurati ukupno oko 40 milijuna tona ugljena iz maočkog bazena. No, maočki je ugljen dislociran u odnosu na već postojeći kompleks TE Pljevlja (udaljenost iznosi oko 25 km), pa bi za njegovo korištenje bilo potrebno ili osigurati transport do postojeće lokacije TE Pljevlja, uz nešto veću cijenu ugljena na ulazu u elektranu, ili izgraditi elektranu na maočkom području, što bi bila skuplja varijanta s obzirom na investicije.

Prema raspoloživim informacijama, uvjeti eksploatacije u ležištu Maoče takvi su da se smatra da je ekonomična eksploatacija u tom ležištu ostvariva tek uz relativno visoku razinu godišnje proizvodnje (oko 2 – 3 milijuna tona). Te količine ugljena bile bi dovoljne za opskrbu jednog velikog termoenergetskog bloka, npr. snage 300 MW do 500 MW, koju bi u tom slučaju bilo najisplativije izgraditi na samoj lokaciji Maoče. Eksploatacijske rezerve ugljena u ležištu Maoče dovoljne su za opskrbu ugljenom termoelektrane te veličine.

Zbog raspoloživih količina ugljena u pojedinim ležištima pljevaljske regije, prema do sada usvojenim planskim dokumentima vezanim uz izgradnju drugog bloka TE Pljevlja pretpostavlja se da će budući drugi blok koristiti ugljen s ležišta Maoče. Prema Programu dugoročne stabilizacije EPCG, potrebne investicije za otvaranje rudnika ugljena Maoče iznose 106,9 milijuna eura. Uz pretpostavljenu proizvodnju od oko 1 milijun tona ugljena godišnje, cijena ugljena iznosila bi 28,8 EUR/t. Predviđeni rok izgradnje ovog rudnika je 7 godina. Pritom nije do kraja riješeno pitanje transporta ugljena od ležišta do elektrane, a još je donekle otvoreno i pitanje lokacije (Maoče ili pri postojećem bloku TE Pljevlja 1).

Za definiranje nužnih tehničko-ekonomskih parametara koji utječu na odluku o izgradnji, potrebno je uraditi dodatnu dokumentaciju vezanu uz definiranje kapaciteta i tehnologije eksploatacije ugljena u maočkom bazenu, iz koje će proizaći i cijena ugljena iz ovog bazena, te se definirati trajanje i potrebna sredstva za otvaranje kopa.

Uzevši u obzir spremnost lokacije, postojeću investicijsko-tehničku dokumentaciju, izgrađenost zajedničkih objekta i iskustva kadrova koji

The exploitable reserves in the nearby Maoča basin, on the other hand, amount to approximately 113 million tons of coal, with a calorific value of 12,3 MJ/kg. For the production of electrical energy for one block (power rating of 225 MW), approximately one million tons of coal from the Maoča basin would be needed annually. If the lifetime of a block is assumed to be 40 years (including prolongation following revitalization), it can be concluded that for the operation of the second block it would be necessary to secure a total of approximately 40 million tons of coal from the Maoča basin. However, Maoča coal is at a distance of approximately 25 km from the already existing complex of the Pljevlja Thermoelectric Power Plant. In order to use it, transport would have to be secured to the existing location of the Pljevlja Thermoelectric Power Plant, with a somewhat higher price for coal at the entrance to the power plant, or a power plant would have to be built in the Maoča area, which would be a more expensive variant, taking investments into account.

According to available information, the conditions for exploitation in the Maoča deposit are such that it is believed that the economical exploitation of this deposit is only possible with a relatively high level of annual production (approximately 2 – 3 million tons). These quantities of coal would be sufficient for the supply of one large thermal energy block, for example with a power rating of 300 to 500 MW, which in this case would be the most economical to build at the Maoča location. The exploitable reserves of coal in the Maoča deposit are sufficient to supply coal for a thermoelectric power plant of this size.

Due to the available quantities of coal in the individual deposits of the Pljevlja region, according to the planning documentation adopted thus far in connection with the construction of the second block of the Pljevlja Thermoelectric Power Plant, it is assumed that the future second block will use coal from the Maoča deposit. According to the Program for the Long-Term Stabilization of the Electric Power Company of Montenegro, the necessary investments for opening the Maoča Coal Mine would amount to 106,9 million euros. Assuming production of approximately 1 million tons of coal annually, the price of coal would amount to 28,8 EUR/t. The anticipated period for the construction of this mine is 7 years. Furthermore, the question regarding the transport of coal from the deposit to the power plant has not been finally resolved and the question of location is still somewhat open (Maoča or at the existing block of the Pljevlja Thermoelectric Power Plant 1).

For defining the necessary technical-economic parameters that affect the construction decision, it is necessary to prepare additional documentation connected with defining the capacities and technology for the exploitation of coal in the Maoča basin, from which the price of coal from this basin will be derived, and to define the duration and funds needed for opening the mine.

su gradili blok 1, trajanje izgradnje bloka 2 procjenjuje se na 4 godine, računajući i pripremne radove. Na osnovi vrijednosti izgrađenih objekata, preliminarnih ponuda za izgradnju bloka 2, potrebnih ulaganja za rješavanje ekoloških pitanja tog prostora i iskustva u gradnji bloka 1 procjenjuje se da su ukupna potrebna ulaganja u blok 2 TE Pljevlja oko 120 milijuna eura. No, na osnovi iskustva, činjenice da su postojeće analize pomalo zastarjele (a i provedene su za blok snage 210 MW), ocijenjeno je realnijim računati s nešto većim investicijama, pa su proračuni rađeni i s investicijama u visini 135 milijuna eura, što, međutim, nije utjecalo na rezultate proračuna, u smislu redoslijeda izgradnje ove elektrane. Ove investicije obuhvaćaju samo sredstva za izgradnju bloka elektrane, bez sredstava za otvaranje rudnika.

Cijena ugljena iz ležišta Maoče za rad bloka 2 pretpostavljena je u iznosu od 28,77 EUR/t, ili 2,3 EUR/GJ [9].

5.3.2 TE Berane

Kako bi se kvalitetno iskoristio energetski potencijal ugljena u beranskom bazenu, kao kandidat za buduću izgradnju u obzir je uzeta i termoelektrana Berane. Pritom treba naglasiti kako je budućnost termoelektrane na beranski ugljen uvjetovana poboljšanjem stanja istraženosti bilančnih rezervi ugljena. Uz tu pretpostavku, termoelektrana Berane može figurirati kao kandidat za buduću izgradnju.

Lokacija TE Berane predviđa se na periferiji grada Berana, u industrijskoj zoni, gdje su već locirani drugi industrijski objekti. Plato predviđen za smještaj termoelektrane nalazi se između tvornice celuloze i ciglane, udaljen oko 800 – 1 000 m od rijeke Lim, u neposrednoj blizini puta Berane – Rožaje. Samo područje nalazi se na 630 m nadmorske visine. Izvor vode za potrebe tehnološkog procesa proizvodnje električne i/ili toplinske energije može se osigurati iz rijeke Lim, za što je potrebno još provesti istraživanja vodnog režima rijeke na tom profilu.

Na prostoru općine Berane utvrđeno je postojanje mrkog ugljena i to u dva bazena: beranskom (ležišta Petnjik, Berane, Zagorje i Budimlje, u kome je završena eksploatacija) i poličkom (ležište Polica). Ukupne geološke rezerve procjenjuju se na oko 158 milijuna tona, od čega se zbog nedovoljne istraženosti samo 33,5 milijuna tona prikazuju kao bilančne, a 18,5 milijuna tona kao eksploatacijske rezerve.

Taking into account the preparedness of the location, the existing investment-technical documentation, the previously constructed joint facilities and the experience of the personnel who built Block 1, the duration of the construction of Block 2 is estimated at 4 years, including preparatory work. On the basis of the value of the constructed facilities, the preliminary bid for the construction of Block 2, the necessary investments for resolving the ecological questions of that area and the experience in the construction of Block 1, it is estimated that the total necessary investment in Block 2 of the Pljevlja Thermoelectric Power Plant would be 120 million euros. However, on the basis of experience and the fact that the existing analyses are somewhat out of date (they were also performed for the a block with a power rating of 210 MW), it was considered more realistic to count on somewhat larger investments, so that estimates were made with investments in the amount of 135 million euros, which, however, did not affect the results of the estimates in the sense of the sequence of the construction of this power plant. These investments only cover funds for the construction of a block of the power plant, not including funds for opening the mine.

The price of coal from the Maoča deposit for the operation of Block 2 is assumed to amount to 28,77 EUR/t or 2,3 EUR/GJ [9].

5.3.2 The Berane Thermoelectric Power Plant

In order to exploit the energy potential of the coal in the Berane basin, the Berane Thermoelectric Power Plant was taken into consideration as a candidate for future construction. It should be emphasized that the future thermoelectric power plant using Berane coal would be conditional upon the improvement in the situation regarding the exploration of the reserve coal balances. With this assumption, the Berane Thermoelectric Power Plant could figure as a candidate for future construction.

The location of the Berane Thermoelectric Power Plant would be at the periphery of the city of Berane, in the industrial zone, where other industrial facilities are already located. The plateau foreseen for the location of the thermoelectric power plant is located between a cellulose factory and a brickworks, at a distance of approximately 800 – 1000 m from the Lim River, in the immediate vicinity of the Berane – Rožaje route. The area is located at 630 m above sea level. The source of water necessary for the technological process of the generation of electrical and/or thermal energy could be secured from the Lim River, for which it would be still necessary to conduct an investigation of the water regime of the river at this profile.

In the territory of the municipality of Berane, the existence of brown coal has been determined in two basins: Berane (the deposits of Petnjik, Berane, Zagorje and Budimlje, in which exploitation has been

Pretpostavljeni su sljedeći parametri buduće TE Berane:

- instalirana snaga: 125 MW,
- snaga na pragu: 110 MW,
- specifična potrošnja topline: 11 540 kJ/kWh (η = 31,2 %),
- srednja ogrjevna vrijednost ugljena: 13 970 kJ/kg,
- specifična potrošnja ugljena: 0,83 kg/kWh,
- investicije u izgradnju elektrane: 109,5 milijuna eura,
- cijena ugljena: 26,03 EUR/t,
- životni vijek elektrane: 30 godina,
- trajanje izgradnje: 4 godine.

Prema gornjim podacima, uz pretpostavku rada od 6 000 sati godišnje, se može procijeniti da su trenutačno poznate eksploatacijske rezerve uglja u beranskoj općini dovoljne za 34 godine rada elektrane.

U jednoj, ranije provedenoj analizi se procjenjuje da potrebne investicije u rudnik ugljena za osposobljavanje za rad s kapacitetom od 600 tisuća tona godišnje iznose oko 31 milijun eura. Vrijeme izgradnje rudnika procjenjuje se na 3 – 4 godine, što bi se odvijalo paralelno s izgradnjom elektrane. Naravno, potrebno je intenzivirati aktivnosti na verifikaciji postojećih rezervi, kako bi se poboljšalo stanje istraženosti.

5.4 Prirodni plin

Proizvodnja električne energije u termoelektranama na plin ne predviđa se u razdoblju do 2025. godine zbog nedovoljne istraženosti domaćih nalazišta prirodnog plina, nepostojanja plinske mreže kojom bi se mogao uvesti prirodni plin, zbog značajnog hidropotencijala kao i domaćih rezervi ugljena.

5.5 Mogući scenariji izgradnje

Tijekom izrade studije [3] prepoznata je potreba definiranja i obrade nekoliko scenarija izgradnje novih elektrana koji su ocijenjeni kao realniji s aspekta ostvarenja. U studiji je analiziran veći broj scenarija od kojih se ovdje prikazuju samo 3 koja su ocijenjena kao najrealnija. Detaljne karakteristike pojedinih scenarija su kako slijedi:

completed) and Polica (the Polica deposit). The total geological reserves are estimated at approximately 158 million tons, of which only 33,5 million tons are shown as balance, due to insufficient exploration, and 18,5 million tons as exploitation reserves.

The assumed parameters for the future Berane Thermoelectric Power Plant are as follows:

- installed capacity: 125 MW,
- power at the threshold: 110 MW,
- specific heat consumption: 11 540 kJ/kWh (η = 31,2 %),
- average calorific value of the coal: 13 970 kJ/kg,
- specific coal consumption: 0,83 kg/kWh,
- investment in the construction of the power plant: 109,5 million euros,
- price of coal: 26,03 EUR/t,
- lifetime of power plant: 30 years, and
- construction time: 4 years.

According to the above data, assuming 6 000 hours of operation annually, it could be estimated that the currently known exploitable reserves of coal in the municipality of Berane are sufficient for 34 years of power plant operation.

In an earlier analysis, it was estimated that the necessary investment in the coal mine in order for it to operate with a capacity of 600 000 tons annually would amount to approximately 31 million euros. The time required for the construction of the mine is estimated at 3 – 4 years, which would occur parallel to the construction of the power plant. Naturally, it is necessary to intensify activities on the verification of the existing reserves in order to improve the level of exploration.

5.4 Natural gas

The production of electrical energy in thermoelectric power plants using gas is not anticipated during the period up to the year 2025, due to insufficient exploration of the domestic natural gas fields and the lack of a gas network for the import of natural gas, owing to the significant hydro potential and the domestic coal reserves.

5.5 Potential scenarios for the construction

During the study [3], the need was recognized for defining and processing several scenarios for the construction of new power plants that are considered realistically attainable. In the study, a large number of scenarios were analyzed, of which only the three considered to be the most realistic are presented here. The detailed characteristics of the individual scenarios are as follows:

Scenarij N-1 Scenarij ograničene izgradnje, u kojem se do kraja planskog razdoblja (2025.) predviđa ulazak u pogon drugog bloka TE Pljevlja, te određenog broja malih elektrana koje koriste obnovljive izvore energije (male HE, vjetroelektrane, TE na otpad),

Scenarij N-2 Scenarij umjerene izgradnje, u kojem se do 2025. godine, pored izgradnje objekata iz scenarija N-1, predviđa i izgradnja HE na Morači, te HE Komarnica,

Scenarij N-3 Scenarij intenzivne izgradnje, u kojem se osim elektrana iz scenarija N-2, grade i HE Koštanica (uz prevođenje dijela voda Tare u Moraču), HE Ljutica i HES Buk Bijela.

Definiranjem ulazaka elektrana u pogon prema tim scenarijima, tamo gdje je izgradnja intenzivnija može se očekivati pojava određenog viška električne energije u bilanci. Zbog dobre povezanosti crnogorskog EES-a s okolnim sustavima, kao i zbog procesa stvaranja regionalnog tržišta električne energije u jugoistočnoj Europi, u tim je scenarijima pretpostavljeno da će se ti viškovi plasirati na okolnom tržištu. Radi ravnopravnosti tretmana, cijene po kojima se izvozi električna energija pretpostavljene su na jednakim razinama kao i cijene uvoza električne energije, odnosno vezane su uz cijene terminskih ugovora (futures) na burzi EEX. Kad je riječ o konkretnim elektranama, višak proizvodnje termoelektrana pretpostavljen je kao izvoz bazne energije, dok je za hidroelektrane višak proizvodnje pretpostavljen kao izvoz vršne energije.

Dakako da je vrlo teško točno predvidjeti kretanje cijena na tržištu električne energije za razdoblje od 20 godina u budućnosti. U posljednjim godinama doživjeli smo prilično dramatične promjene u energetici na globalnom planu i posljedično porast cijena svih oblika energije. Daljnji porast ili eventualna stabilizacija cijena ovisit će o brojnim političkim i geostrateškim čimbenicima koje nije jednostavno predvidjeti na dugi rok.

U nastavku su pokazani osnovni rezultati proračuna za naprijed spomenute scenarije, dinamika ulazaka u pogon novih elektrana te struktura izvora u pokrivanju potrošnje.

Scenario N-1 This is a scenario of limited construction, in which the entry into operations of the second block of the Pljevlja Thermoelectric Power Plant and a certain number of small power plants that use renewable energy sources (small hydroelectric power plants, wind power plants, waste-fueled thermoelectric power plants) is anticipated by the end of the planning period (2025).

Scenario N-2 This scenario is oriented to moderate construction, in which in addition to the construction of the facilities from Scenario N-1, the construction of a hydroelectric power plant on the Morača River and the Komarnica Hydroelectric Power Plant is anticipated by the year 2025.

Scenario N-3 This is a scenario of intensive construction, in which in addition to the power plants from Scenario N-2, there would also be construction of the Koštanica Hydroelectric Power Plant (with the rerouting of part of the water from the Tara River into the Morača River), the Ljutica Hydroelectric Power Plant and the Buk Bijela Hydroenergy System (HES).

According to the definition of the placing of power plants into operation as provided by these scenarios, a certain energy surplus in the balance may be expected where construction is more intensive. Due to the good connections of the Montenegro Electrical Energy System with the surrounding systems, as well as the process of creating a regional electrical energy market in Southeastern Europe, with such scenarios it is assumed that the surpluses would be sold on the surrounding markets. For the purpose of equal treatment, the prices at which electrical energy would be exported are assumed to be at the same levels as the prices of imported electrical energy, i.e. linked to the prices of futures contracts on the European Energy Exchange (EEX). When speaking about specific power plants, surplus production of thermoelectric power plants is assumed to be the export of base energy, while for hydroelectric power plants the surplus production is assumed to be the export of peak energy.

It is certainly very difficult to anticipate the price trends on the electrical energy market for a period of 20 years into the future. In past years, we have experienced fairly dramatic changes in energetics on the global level and the consequent increase in the cost of all forms of energy. Continued growth or eventual stabilization of prices will depend on numerous political and geostrategic factors that are not simple to forecast over a long period.

In the next sections, the basic results of estimates for the aforementioned scenarios, the dynamics of the entry into operations of the new power plants and the structure of the sources in covering consumption are presented.

5.5.1 Scenarij N-1

Scenarij N-1 definiran je tako da su zadani objekti koji ulaze u pogon tijekom planskog razdoblja, a u ovom slučaju to su TE Pljevlja 2 (drugi blok u termoelektrani Pljevlja), te obnovljivi izvori energije – male hidroelektrane, vjetroelektrane i TE na komunalni otpad. Vremenski slijed ulazaka u pogon prikazan je u tablici 9. Ukupno izgrađeni novi proizvodni kapaciteti, tj. njihova instalirana snaga iznosi 285 MW.

5.5.1 Scenario N-1

Scenario N-1 is defined in such a manner that the last facilities to enter operation in this case during the planning period would be the Pljevlja 2 Thermoelectric Power Plant (the second block in the Pljevlja Thermoelectric Power Plant), and renewable energy sources – small hydroelectric power plants, wind power plants and waste-fueled thermoelectric power plants. The schedule for entry into operation is presented in Table 9. The total construction of new production facilities, i.e. new installed capacity, amounts to 285 MW.

Tablica 9 – Ulazak u pogon novih elektrana prema scenariju N-1
Table 9 – Entry into operation of new electric power plants according to Scenario N-1

Godina / Year	Elektrana / Power plant	Snaga / Power (MW)
2005.		
2006.		
2007.		
2008.		
2009.		
2010.	Vjetroelektrane, male HE / Wind power plants, small HPP	15
2011.	TE / TPP Pljevlja 2	225
2012.		
2013.		
2014.		
2015.	Vjetroelektrane, male HE, TE na komunalni otpad / Wind power plants, small HPP, waste-fueled TPP	35
2016.		
2017.		
2018.		
2019.		
2020.	Vjetroelektrane / Wind power plants	5
2021.		
2022.		
2023.		
2024.		
2025.	Vjetroelektrane / Wind power plants	5
Ukupno / Total		285

Od većih izvora, u ovom scenariju u pogon ulazi jedino TE Pljevlja 2 i to 2011. godine, dok manji objekti koji koriste obnovljive izvore ulaze postupno tijekom planskog razdoblja. S obzirom da očekivana proizvodnja TE Pljevlja 2 nije dovoljna za eliminiranje deficita u Crnoj Gori, dio električne energije i dalje će se nabavljati iz uvoza.

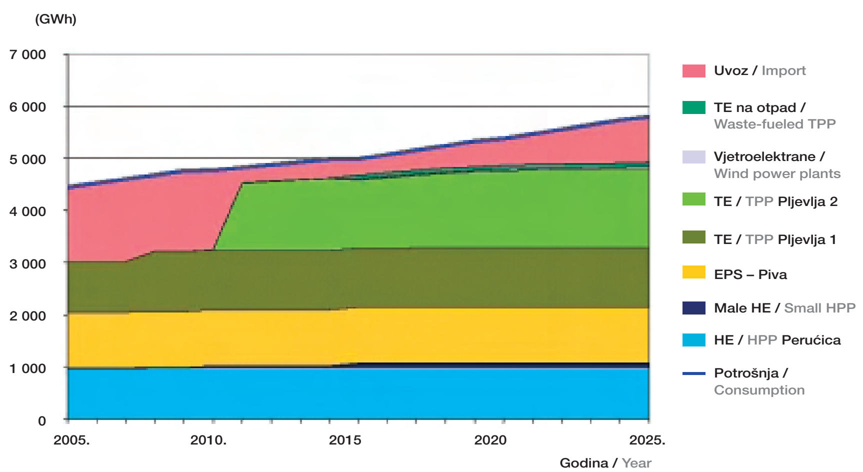
Among the large sources, only the Pljevlja 2 Thermoelectric Power Plant, and this up to 2011, enters in this scenario, while the smaller facilities that use renewable energy sources would enter gradually during the planning period. Since the anticipated production of the Pljevlja 2 Thermoelectric Power Plant would not be sufficient to eliminate the deficit in Montenegro, part of

Elektroenergetska bilanca za razdoblje od 2005. – 2025. prikazana je u tablici 10, a struktura izvora, u smislu proizvodnje, dana je na slici 3.

the energy would still be purchased from imports. The electrical energy balance for the 2005 – 2025 period is presented in Table 10, and the structure of the sources, in the sense of production, is provided in Figure 3.

Tablica 10 – Elektroenergetska bilanca za razdoblje od 2005 – 2025 prema scenariju N-1
Table 10 – The electrical energy balance for the 2005 – 2025 period, according to Scenario N-1

Godina / Year	HE / HPP Perućica	Male HE / Small HPP	Valorizacija HE Piva / Equivalent for the HPP Piva (EPS – Piva)	TE / TPP Pljevlja 1	TE / TPP Pljevlja 2	Vjetroelektrane / Wind power plants	TE na otpad / Waste-fueled TPP	Uvoz / Import	Ukupno / Total
	(GWh)	(GWh)	(GWh)	(GWh)	(GWh)	(GWh)	(GWh)	(GWh)	(GWh)
2005.	957,5	21,0	1 065,4	976,0	0	0	0	1 422,5	4 442,4
2006.	957,5	21,0	1 065,4	976,0	0	0	0	1 497,5	4 517,4
2007.	957,5	21,0	1 065,4	976,0	0	0	0	1 574,3	4 594,2
2008.	971,0	21,0	1 065,4	1 152,3	0	0	0	1 462,5	4 672,2
2009.	971,0	21,0	1 065,4	1 152,3	0	0	0	1 541,7	4 751,4
2010.	971,0	49,0	1 065,4	1 152,3	0	11,1	0	1 515,8	4 764,6
2011.	971,0	49,0	1 065,4	1 138,6	1 292,8	10,9	0	288,8	4 816,5
2012.	971,0	49,0	1 065,4	1 141,8	1 320,3	10,9	0	311,1	4 869,5
2013.	971,0	49,0	1 065,4	1 144,5	1 347,7	10,9	0	334,0	4 922,5
2014.	971,0	49,0	1 065,4	1 146,4	1 375,4	10,9	0	357,9	4 976,0
2015.	971,0	99,2	1 065,4	1 137,5	1 303,5	21,6	76,3	307,6	4 982,1
2016.	971,0	99,2	1 065,4	1 142,2	1 346,0	21,6	76,3	343,5	5 065,2
2017.	971,0	99,2	1 065,4	1 145,7	1 389,2	21,6	76,3	381,0	5 149,4
2018.	971,0	99,2	1 065,4	1 148,5	1 424,3	21,9	76,6	428,0	5 234,9
2019.	971,0	99,2	1 065,4	1 151,2	1 450,6	21,9	76,6	486,6	5 322,5
2020.	971,0	99,2	1 065,4	1 151,5	1 466,3	32,9	76,6	508,9	5 371,8
2021.	971,0	99,2	1 065,4	1 152,3	1 480,1	32,9	76,6	580,7	5 458,2
2022.	971,0	99,2	1 065,4	1 152,3	1 489,7	32,9	76,6	658,7	5 545,8
2023.	971,0	99,2	1 065,4	1 152,3	1 498,3	32,9	76,6	739,5	5 635,2
2024.	971,0	99,2	1 065,4	1 152,3	1 506,2	32,9	76,6	822,1	5 725,7
2025.	971,0	99,2	1 065,4	1 152,3	1 510,5	44,1	76,7	871,5	5 790,7



Slika 3
Struktura izvora u pokrivanju potrošnje prema scenariju N-1
Figure 3
Structure of the sources for covering consumption according to Scenario N-1

Udio uvoza u pokrivanju potrošnje prema ovom scenariju dosegao bi maksimalnu vrijednost u 2010. godini (32 %), da bi ulaskom u pogon TE Pljevlja 2 pao na samo 6 %, uz postupni porast do kraja razdoblja planiranja na oko 15 %. Udio obnovljivih izvora (male HE, vjetroelektrane i TE na otpad) nakon 2015. godine, zbog izgradnje novih objekata, kretao bi se nešto ispod 4 %.

5.5.2 Scenarij N-2

U scenariju N-2 kao objekti – kandidati za izgradnju su, pored objekata iz scenarija N-1, i sljedeće elektrane: HE na Morači (HE Andrijevo, HE Raslovići, HE Milunovići i HE Zlatica), i to u varijanti bez prevođenja voda Tare u Moraču, te HE Komarnica. Raspored ulazaka u pogon za ovaj scenarij prikazan je tablicom 11. Ukupna snaga svih izgrađenih elektrana iznosi 691,4 MW.

The percentage of imports in covering consumption according to this scenario would reach a maximum value in the year 2010 (32 %). When the Pljevlja 2 Thermoelectric Power Plant went into operation it would drop to only 6 %, with a gradual increase until the end of the planning period to approximately 15 %. The percentage of renewable energy sources (small hydroelectric power plants, wind power plants and waste-fueled thermoelectric power plants) after the year 2015, due to the construction of new facilities, would range somewhat below 4 %.

5.5.2 Scenario N-2

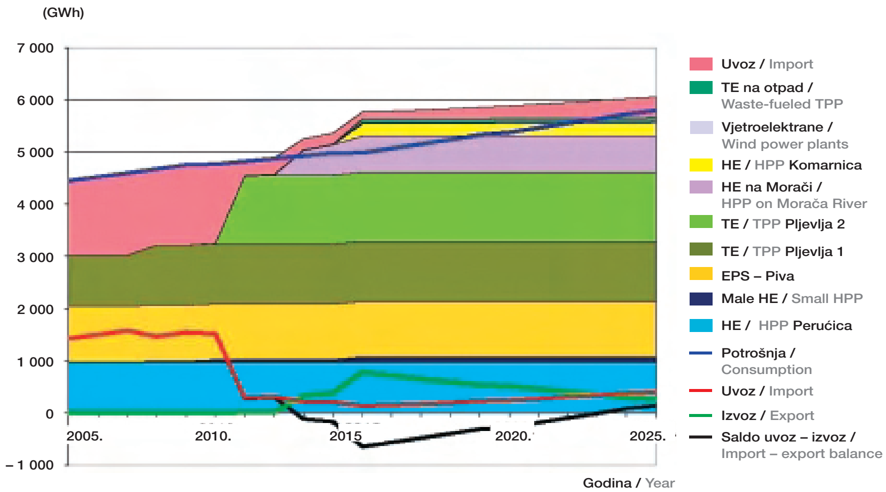
In Scenario N-2, in addition to the facilities from Scenario N-1, the following power plants are also candidate facilities for construction: the hydroelectric power plants on the Morača River (the hydroelectric power plants of Andrijevo, Raslovići, Milunovići and Zlatica), in a variant without the rerouting of water from the Tara River into the Morača River, and the Komarnica Hydroelectric Power Plant. The schedule for going into operation for this scenario is presented in Table 11. The total power of all the constructed electric power plants would amount to 691,4 MW.

Tablica 11 – Ulazak u pogon novih elektrana prema scenariju N-2
Table 11 – Entry into operation of new electric power plants according to Scenario N-2

Godina / Year	Elektrana / Power plant	Snaga / Power (MW)
2005.		
2006.		
2007.		
2008.		
2009.		
2010.	Vjetroelektrane, male HE / Wind power plants, small HPP	15
2011.	TE / TPP Pljevlja 2	225
2012.		
2013.	HE / HPP Andrijevo, HE / HPP Zlatica	164,4
2014.	HE / HPP Raslovići	37
2015.	HE Komarnica, HE Milunovići, vjetroelektrane, male HE, TE na komunalni otpad / HPP Komarnica, HPP Milunovići, wind power plants, small HPP, waste-fueled TPP	240
2016.		
2017.		
2018.		
2019.		
2020.	Vjetroelektrane / Wind power plants	5
2021.		
2022.		
2023.		
2024.		
2025.	Vjetroelektrane / Wind power plants	5
Ukupno / Total		691,4

U scenariju N-2, osim TE Pljevlja 2, koja i ovdje ulazi u pogon 2011. godine, i obnovljivih izvora, u pogon ulaze i HE na Morači (između 2013. i 2015. godine) te HE Komarnica (2015.). Struktura izvora za ovaj scenarij prikazana je slikom 4.

In Scenario N-2, in addition to the Pljevlja 2 Thermoelectric Power Plant, which would go into operation here in the year 2011, and renewable energy sources, the hydroelectric plants on the Morača River would also commence operations between 2013 and 2015, as well as the Komarnica Hydroelectric Power Plant in 2015. The structure of the sources for this scenario is presented in Figure 4.



Slika 4
Struktura izvora u pokrivanju potrošnje prema scenariju N-2
Figure 4
Structure of the sources for covering consumption according to Scenario N-2

U ovom se scenariju u razdoblju od 2013. – 2015. zbog ulaska u pogon nekoliko novih hidroelektrana u određenim godinama javlja višak električne energije, za koju se pretpostavlja da će se izvoziti. Radi se uglavnom o vršnoj proizvodnji hidroelektrana, koja bi prema svim očekivanjima trebala imati kupce na tržištu u okruženju.

Zbog ulaska u pogon nekoliko hidroelektrana u razdoblju od 2013. – 2015. već od 2008. godine bi trebao početi značajan investicijski ciklus, u kojem potrebna investicijska sredstva u nekim godinama dostižu vrijednost od oko 160 milijuna eura godišnje, odnosno oko 180 milijuna eura godišnje uključujući i interkalarne kamate. Ukupne investicije potrebne za ostvarenje ovog scenarija iznose oko 800 milijuna eura.

In this scenario during the 2013 to 2015 period, there would be a surplus of electrical energy, which is assumed would be exported, because several new hydroelectric power plants would be going into operation. This mainly concerns the peak production of the hydroelectric power plants, which according to all expectations should have customers in a neighboring market.

Because several hydroelectric power plants are going into operation during the 2013 to 2015 period, a significant investment cycle should already have begun in the year 2008, in which the necessary investment funds in some years would reach a value of approximately 160 million euros annually, i.e. approximately 180 million euros annually including compounded interest. The total investment needed for achieving this scenario amounts to approximately 800 million euros.

5.5.3 Scenarij N-3

U scenariju N-3 se, pored izgradnje TE Pljevlja 2 i obnovljivih izvora, predviđa i izgradnja HE Koštanica, prevođenje dijela voda Tare u Moraču, izgradnja četiri HE na Morači, izgradnja HE Komarnica, te izgradnja hidroelektrana na srednjem i donjem toku Tare – HE Ljutica i HES Buk Bijela. Predložena dinamika izgradnje navedenih objekata prikazana je u tablici 12. U ovom scenariju izgradnja elektrana je intenzivna, pa ukupna instalirana snaga novih izgrađenih proizvodnih objekata iznosi 1 781,1 MW, što

5.5.3 Scenario N-3

In Scenario N-3, in addition to the construction of the Pljevlja 2 Thermoelectric Power Plant and renewable energy sources, the construction of the Koštanica Hydroelectric Power Plant, the rerouting of part of the water of the Tara River into the Morača River, the construction of four hydroelectric power plants on the Morača River, the construction of the Komarnica Hydroelectric Power Plant, and the construction of hydroelectric power plants on the middle and lower parts of the Tara River – the Ljutica Hydroelectric Power Plant and the Buk Bijela Hydroenergy System – are also anticipated. The proposed dynamics of the construction of these facilities is presented in Table 12.

je više nego dvostruko u odnosu na trenutačnu instaliranu snagu elektrana u Crnoj Gori.

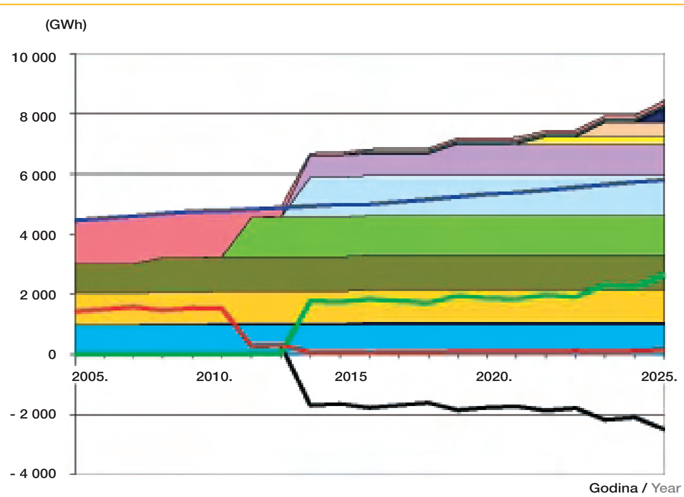
In this scenario, the construction of power plants is intensive and the total installed capacity of the newly constructed production facilities would amount to 1 781,1 MW, which is more than twice the current installed capacity of the power plants in Montenegro.

Tablica 12 – Ulazak u pogon novih elektrana prema scenariju N-3
Table 12 – Entry into operation of new electric power plants according to Scenario N-3

Godina / Year	Elektrana / Power plant	Snaga / Power (MW)
2006.		
2007.		
2008.		
2009.		
2010.	Vjetroelektrane, male HE / Wind power plants, small HPP	15
2011.	TE / TPP Pljevlja 2	225
2012.		
2013.	HE / HPP Koštanica, HE / HPP Andrijevo, HE / HPP Zlatica	798,6
2014.		
2015.	Vjetroelektrane, male HE, TE na komunalni otpad / Wind power plants, small HPP, waste-fueled TPP	35
2016.		
2017.		
2018.	HE / HPP Raslovići, HE / HPP Milunovići	111
2019.		
2020.	Vjetroelektrane / Wind power plants	5
2021.	HE / HPP Komarnica	168
2022.		
2023.	HE / HPP Ljutica	250
2024.		
2025.	HES / HES Buk Bijela (1/3), vjetroelektrane / Wind power plants	173,5
Ukupno / Total		1781,1

Struktura izvora za pokrivanje potrošnje prikazana je slikom 5.

The structure of the sources for covering consumption is presented in Figure 5.



Slika 5
Struktura izvora u pokrivanju potrošnje prema scenariju N-3
Figure 5
Structure of the sources for covering consumption according to Scenario N-3

U ovom scenariju, zbog intenzivne izgradnje hidroelektrana, u sustavu postoji priličan višak električne energije, za koji je pretpostavljeno da će se plasirati na regionalnom tržištu. Najveći neto izvoz ostvaruje se u posljednjoj, 2025. godini, u iznosu od oko 2 500 GWh, što iznosi 43% od predviđene potrošnje u Crnoj Gori u toj godini.

Nakon 2013. godine, odnosno nakon ulaska u pogon triju hidroelektrana, uvoz električne energije postaje vrlo mali. Zbog izgradnje većeg broja proizvodnih objekata tokom planskog razdoblja investicijska ulaganja su potrebna praktički u svim godinama između 2007. i 2025. Najintenzivnije investiranje očekuje se u razdoblju od 2008. – 2012., zbog ulaska u pogon nekoliko velikih objekata (TE Pljevlja 2, HE Koštanica, HE Andrijevo, HE Zlatica), tako da npr. u 2010. godini potrebne investicije iznose 257 milijuna eura (s interkalarnim kamatama 287 milijuna eura). Ukupne potrebne investicije kroz čitavo plansko razdoblje iznose oko 1,6 milijardi eura.

6 ZAKLJUČAK

Kao i većina zemalja u okruženju, tako i Crna Gora, nova država na zemljovidima, postaje sve više ovisna o uvozu energije. Tako je u 2004. godini uvoz pokrivao oko 30 % energetskih potreba. Jedna specifičnost Crne Gore, u odnosu na većinu zemalja je relativno velik udjel električne energije u strukturi potrošnje finalne energije. Kao sektor s najvećim udjelom u strukturi potrošnje finalne energije, elektroenergetski sektor je svakako najvažniji sektor u energetici Crne Gore. Uvoz električne energije u posljednjih nekoliko godina (ovisno o hidrologiji) se kretao od 30 % do čak 48 % (u 2002. godini). To je i od strane vodećih ljudi EPCG a i od političkih struktura prepoznato kao goruće pitanje. Nažalost, takav problem se ne može riješiti u kratkom roku.

Za rješenje, ili barem za ublažavanje tog relativno velikog manjka električne energije, potrebno je i do deset godina. Osim relativno dugog vremena, rješenje takvog problema traži istodobno ispunjenje nekoliko preduvjeta. Jedan od njih je promišljen akcijski plan zasnovan na strateškim energetskim dokumentima. Sljedeće je priprema javnosti kako bi se iz svijesti građana potisnulo razmišljanje da je moguće imati dovoljno energije, a da se ne rade značajniji zahvati u prostoru. Uz to je jedna od velikih poteškoća i očekivanje ljudi da energija treba biti jeftina, bez obzira na troškove koje proizvodnja ili kupnja takve energije iziskuje. Naime, u Crnoj Gori, slično kao i u nekim drugim

In this scenario, due to the intensive construction of hydroelectric power plants, there is a considerable surplus of electrical energy, which is anticipated for sale in the regional market. The greatest net export would be achieved in the last year, 2025, in the amount of approximately 2 500 GWh, which amounts to 43 % of the forecast consumption in Montenegro during that year.

After the year 2013, i.e. after three hydroelectric power plants would go into operation, imports of electrical energy would become very low. Due to the construction of a large number of generating objects during the planning period, investments would be necessary during practically all the years between 2007 and 2025. The most intensive investment is expected during the 2008 – 2012 period, when several large objects would be going into operation (the Pljevlja 2 Thermoelectric Power Plant, the Koštanica Hydroelectric Power Plant, the Andrijevo Hydroelectric Power Plant and the Zlatica Hydroelectric Power Plant), so that, for example, in the year 2010 the necessary investments would amount to 257 million euros (287 million euros with compounded interest). The total investments required throughout the entire planning period would amount to approximately 1,6 billion euros.

6 CONCLUSION

Like the majority of the countries in the environs, Montenegro, a new country on the map, is becoming increasingly dependent on the import of energy. Thus, imports covered approximately 30 percent of the energy requirements in the year 2004. A specific characteristic of Montenegro, in comparison to the majority of countries, is the relatively high percentage of electrical energy in the structure of the consumption of final energy. As the sector with the largest percentage in the structure of the consumption of final energy, the electrical energy sector is certainly the most important sector in the energetics of Montenegro. The import of electrical energy in the past several years (depending upon hydrology) has ranged from approximately 30 percent to as much as 48 percent (in the year 2002). This has been recognized as an urgent question by both the leadership of the Electric Power Company of Montenegro and the political structures. Unfortunately, such a problem cannot be resolved in a short period of time.

Up to ten years will be needed in order to solve or at least mitigate this relatively great shortage of electrical energy. In addition to the relatively long period of time, the solution to such a problem also requires the meeting of several prerequisites. One of these is to devise a plan of action based upon strategic enzemljama iz regije, socijalni problemi se prelamaju i pokušavaju riješiti kroz elektroprivredu.

Poznato je da se Crna Gora deklarirala kao ekološka država i velik dio javnosti je to vrlo kruto shvatio. Bilo kakav tip elektrane koji bi se pokušavao izgraditi u Crnoj Gori, za sada, bi nailazio na vrlo snažno protivljenje raznih pokreta, udruga, a i općenito jednog značajnog dijela javnosti. Za sada je vrlo jasno deklarirano, od strane najviših državnih institucija, da se u kanjonu Tare i na još nekim zaštićenim lokalitetima neće moći graditi hidroelektrane. Time se neki objekt iz scenarija N-2 i N-3 eliminiraju kao potencijalni kandidati za izgradnju.

Iako je teritorijalno mala država, Crna Gora raspolaže sa značajnim primarnim energetskim resursima, od ugljena do hidro potencijala. Što se tiče nafte i plina, potrebna su daljnja istraživanja podmorja da bi se s većom sigurnošću moglo zaključivati o potencijalnim zalihama.

S druge strane, iako je tek od 2006. samostalna država, Crna Gora je napravila vidan napredak u restrukturiranju, ali i u pripremama te konačno i u realizaciji privatizacije energetskog sektora. EPCG je u državnom vlasništvu nešto iznad 67 %. Fizičke osobe imaju gotovo 12 % dionica, dok je ostatak u rukama raznih investicijskih fondova i jedan vrlo mali dio (oko 0,35 %) drži tvrtka M&V Company. U vrijeme pisanja ovog materijala u tijeku su pregovori s najpovoljnijim ponuđačem za kupnju TE Pljevlja i 31 % dionica Rudnika ugljena Pljevlja. Partner s kojim se pregovara je i vlasnik KAP-a, najvećeg potrošača električne energije u Crnoj Gori.

Kad se radi o tržištu nafte i naftnih derivata, dio koji se bavi maloprodajom je već privatiziran a u tijeku je i natječaj za prodaju tvrtke koja se bavi skladištenjem nafte i derivata [10].

Sve ovo pokazuje da je interes ulagača, kako domaćih tako i stranih, za investiranje u energetski sektor dosta velik. Stranim ulagačima se pruža visoki standard zaštite njihovih prava te jamči puna ravnopravnost s domaćim pravnim i fizičkim osobama. Zakon koji regulira strana ulaganja pruža jamstva potpuno otvorenog poduzetničkog tržišta i kao takav ne predstavlja ni u jednom svom segmentu branu stranim ulaganjima, naprotiv, predstavlja više nego dobar okvir za razvoj stranog poduzetništva odnosno privlačenje inozemnih investicija.

Analizirajući moguće scenarije izgradnje elektrana u Crnoj Gori, naročito scenarije N-2 i N-3, koji bi rezultirali u konačnici, ne samo s dovoljnom

ergy documents. The next is preparing the public to comprehend that it is not possible to have sufficient energy without conducting significant undertakings in this area. In addition, one of the great difficulties is the public perception that energy should be inexpensive, regardless of the costs of the generation or procurement of this energy. In Montenegro, as in some other countries in the region, there are attempts to resolve social problems through the electrical power supply.

It is known that Montenegro has declared itself to be an ecological state and that a large portion of the public comprehends this in a very rigid manner. The attempt to construct any type of power plant in Montenegro would at present encounter very strong opposition from various movements, associations and generally a large portion of the public. For now, it has been very clearly declared by the highest state institutions that it will not be possible to build hydroelectric power plants in the Tara Canyon and several other protected locations. Thus, several facilities from Scenarios N-2 and N-3 are eliminated as potential candidates for construction.

Although Montenegro is a small country territorially, it has significant primary energy resources, from coal to hydro potential. Regarding oil and gas, further offshore exploration would be required in order to reach more definitive conclusions regarding potential reserves.

On the other side, although Montenegro has only been an independent country since 2006, it has made evident progress in restructuring, but also in preparations and finally in the privatization of the energy sector. The Energy Company of Montenegro is somewhat more than 67 % under government ownership. Natural persons have a share of nearly 12 %, while the remainder is in the hands of various investment funds and a very small part (approximately 0,35 %) is held by the M&V Company. At the time of this writing, negotiations are in progress with the most suitable bidders for the purchase of the Pljevlja Thermoelectric Power Plant and 31 % of the shares of the Pljevlja Coal Mine. The partner with whom negotiations are being conducted is also the owner of the Aluminum Plant of Podgorica – KAP, the biggest consumer of electrical energy in Montenegro.

Regarding the oil and petroleum derivatives market, the part that is engaged in retail has already been privatized and bidding competition is in progress for the sale of a company engaged in the storage of oil and derivatives [10].

All of this shows that there is considerable interest in investment in the energy sector by both domestic and foreign investors. Foreign investors are afforded proizvodnjom električne energije za potrebe Crne Gore, nego bi bilo i raspoložive energije za izvoz, jasno je da država Crna Gora ne može sama to financirati, nego da će se tu trebati uključiti privatni, vjerojatno dominantno strani, kapital. Budući da su neke hidroelektrane prema svojim energetskim mogućnostima i prema potrebnim investicijama prilično atraktivne, izvjesno je da će biti dosta interesa mnogih tvrtki iz bližeg i daljeg okruženja. Ono što je nužno prije bilo kakvog konkretnijeg razgovora o ulasku u neku od tih investicija je vrlo jasno određenje i politike i javnosti općenito u Crnoj Gori, o tome koje lokacije nisu sporne s ekološkog, međugraničnog ili nekog drugog aspekta.

a high standard of protection for their rights and guaranteed full equality to domestic legal and natural persons. The law that regulates foreign investment guarantees a completely open entrepreneurial market and as such does not present an obstacle to investors in any segment. On the contrary, it provides a better than adequate framework for the development of foreign entrepreneurship, i.e. attracting foreign investments.

Analyzing possible scenarios for the construction of power plants in Montenegro, particularly Scenarios N-2 and N-3, which would ultimately result not only in the sufficient production of electrical energy for the requirements of Montenegro but also energy available for export, it is clear that the state of Montenegro cannot finance this alone. It would be necessary to include private, probably dominant foreign, capital. Since several hydroelectric power plants in terms of their energy possibilities and investment requirements are fairly attractive, it is certain that there will be considerable interest from many companies from the immediate and more distant surroundings. Prior to any concrete discussion on entering into any of these investments, the very clear determination of policy and general public consensus in Montenegro would be necessary regarding the locations that would not be considered problematic from the ecological, border or other aspects.

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Uredništvo primilo rukopis:
2007-05-23

Prihvaćeno:
2007-06-04

Manuscript received on:
2007-05-23

Accepted on:
2007-06-04