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THE NEW TARGETS OF 2020 FOR CONSTRUCTION OF RENEWABLE ENERGY POWER PLANTS IN SERBIA

Abstract: At the end of 2012 and beginning of 2013, the Serbian Government provided the new national regulations in order to provide acceptable legislation framework to achieve allocated 2020 targets of 27% increasing of total renewable energy sources participation into the gross final energy consumption, comparable to 2009 year. The target of 37% increasing is allocated to participation of renewable energy sources for electricity production. It is required construction of new significant capacity of renewable energy power plants as it is clearly defined in National Action Plan for Renewable Energy Sources.

This paper is dealing with critical analyses for targeted new installing capacity of renewable energy power plants for electricity production from the different point of views, such as: new national energy policy, new national regulations, renewable energy sources potential in Serbia, efficiency of the power plants and investment financial models.

According to the new national energy policy realized through the National Action Plan for Renewable Energy Sources, it is concluded that the new regulations related to the construction of new renewable energy power plants is completed, particularly issuing the investment security, provision of green electricity market, status of green electricity producer, and significantly reduction time of administrative procedures required for obtaining a construction permit.

Particularly, the real wind potential in Serbia, based on measured data through the past ten years of measurement campaigns at more than thirty locations, has been used to correct the targeted installing capacity of wind power plants.

Key words: *Serbian National Action Plan for RES, Serbian new regulations for RES, Serbian wind potential*

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INTRODUCTION

At the end of 2012 and beginning of 2013, the Serbian Government provided the new national regulations in order to provide acceptable legislation framework to achieve allocated 2020 targets of 27% increasing of total renewable energy sources (RES) participation into the gross final energy consumption (GFEC), comparable to 2009 year. The target of 37% increasing is allocated to participation of renewable energy sources for electricity production. It is required construction of new significant capacity of renewable energy power plants as it is clearly defined in National Action Plan for Renewable Energy Sources (NAPRES) [1].

Both targeted annual electricity production and new installation capacity, by details of RES participations allocated to 2020 are specified in Table 1, as well as Figures 1 and 2.

Table 1. Target of RES in Serbia for 2020 by NAPRES.

NAPRES Scenario	2009		2020		NEW CAPACITY			
	MW	GWh/y	MW	GWh/h	MW	%	GWH/h	%
Small Hidro	2224	9892	2666	11154	442	40.3	1262	35.9
Geothermal	0	0	1	7	1	0.1	7	0.2
Solar PV	0	0	10	15	10	0.9	15	0.4
Wind	0	0	500	1250	500	45.6	1250	35.5
Biomass	0	0	143	983	143	13.0	983	27.9
TOTAL	2224	9892	3320	13409	1096	100	3517	100

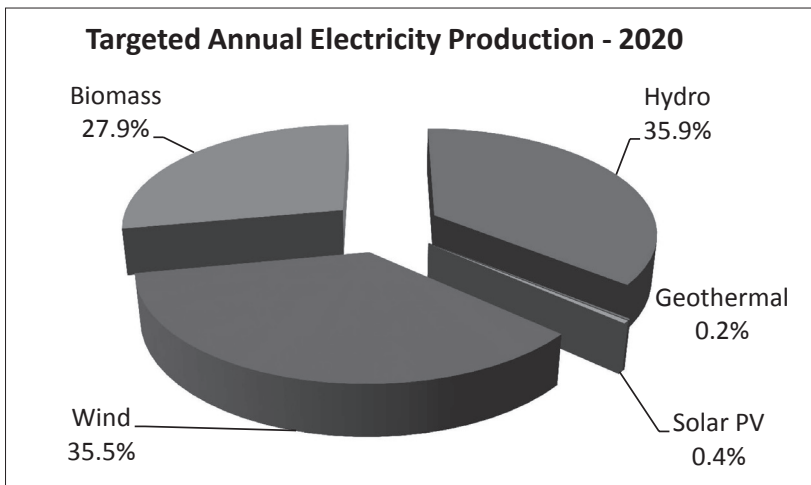


Figure 1. Targeted annual electricity production for 2020 by NAPRES.

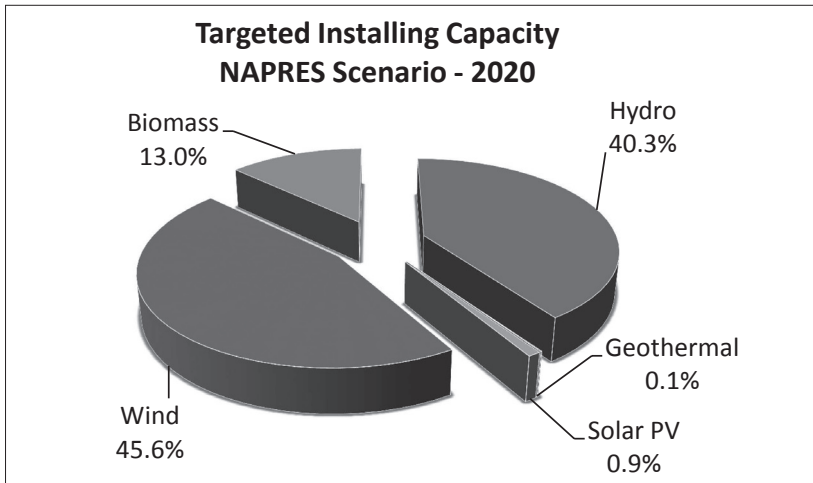


Figure 2. Targeted installing new RES Capacity for 2020 by NAPRES.

1. CURRENT CHARACTERISTICS OF NAPRES

According to the Energy Balance for 2009, the share of RES in GFEC amounted to 21.2% [2, 3]. By the 2020th The Republic of Serbia shall increase the share of RES 27.0%.

In line with the projected GFEC, the amount of renewable energy should be at 2563.6 ktoe in 2020th year, which means that in the period since 2009 to the 2020, the need to increase its renewable energy is 621.0 ktoe, according to the available renewable energy potential and untapped potential in Serbia.

Serbia can achieve the given target set for 2020 year from domestic sources other than regarding the mandatory share of bio-fuels of 10% in the transport sector 2020 year.

Considering the currently available capacity for the production of bio-fuels from biomass of the first generation technology, that does not meet the terms of GHG emissions, as well as the lack of regulations and infrastructure for its implementation in the field of bio-fuels, Serbia will have to plan the importation of bio-fuels until 2018 year.

For preparation of the National Action Plan for RES, it was developed two scenarios for the definition of gross final energy consumption (GFC) to 2020, as well as scenarios of energy consumption by sectors (electricity, heating and cooling sector and the transport sector). It was developed the following scenarios:

- Reference (baseline) scenario (REFSC).
- Scenario with the implementation of measures for energy efficiency (EESC).

Reference scenario does not take energy saving measures, but is based on increasing GFEC in accordance with the forecasted economic growth in the period considered. The scenario with the implementation of measures for energy efficiency takes into account the final energy consumption in the household sector and public and commercial services, industry and the transport sector as defined in the Action Plan for Energy Efficiency from 2010 year.

The scenarios were developed based on the approved Energy Balance of Serbia for 2009 year and the objectives and obligations defined in negotiations with the Energy Community. The share of renewable energy in GFEC in 2009 was amounted to 21.2%, whereas a specific target set for 2020 year was 27.0%.

2. CURRENT CHARACTERISTICS OF SMALL HYDRO POWER PLANTS AND WIND FARMS CONSTRUCTION

2. 1. SMALL HYDRO POWER PLANTS

The focus of this paper is to analyze the current situation in Serbia related to the construction of new capacity of small hydro power plants and wind farms. Table 2 summarizes the activities related to the construction of small hydro power plants.

Until now, energy issued permits and licenses for the construction of 191 facilities with a total installation capacity of 387 MW, that is, projected electricity production of 1354.5 GWh / y. Also, the new public call is completed, should provide another 96.3 MW of new capacity installation, which in total amount secured 1681.1 GWh / y to 317 locations.

The main difficulty in the implementation of these projects are long-term processes provide the necessary technical and legal documentation. The biggest bottlenecks are securing building permits and assessment of environmental impact. Also, a very small number of sites has water permit. In fact, it is estimated that the construction of such a large number of small hydro power plants can significantly compromise the natural hydro network of Serbia with regard to the potential cause sludge and coastal erosion.

Ministry of Energy, Development and Environmental Protection of Serbia is committed to help the investors in the legal process to the construction of small hydro power plants as soon as begun.

Compared with the projected capacity of NAPRES (1262 GWh / y), the activities taking place in a higher capacity. This provides a backup in case it all planned capacity is not realized.

Table 2. Current status of Small Hydro Power Plants

No	SMALL HYDRO POWER PLANTS (SHP)		
	Status	Installing Power MW	Annual Electricity Production, GWh/y
1	SHP (Construction Permit) > 1 MW (63)	285	997.5
2	SHP (Construction Approval) < 1 MW (128)	102	357
3	SHP (Public Call) > 1 MW (18)	29.6	97.6
4	SHP (Public Call) < 1 MW (299)	66.7	229.0
TOTAL		483.3	1681.1

2. 2. WIND FARMS

In the case of wind power plants, planned installation capacity of 500 MW should provide 1250 GWh / y of annual electricity production (AEP). These installation capacity is questionable. The rough estimate, the per one MW capacity installation obtained 2.5 GWh / y is overpriced considering the average wind speed in Serbia. This issue will be further explained.

Based on the available data measurements at 11 locations in Serbia, it can be concluded that the average wind speed of about 6 m / s at the center of the normal amount of today's wind turbine rotor hub height of 100 meters. Table 3 shows the data of the measured values of wind speed for different regions in Serbia.

Table 3. Available average data of wind measurements in Serbia

No	Region	Measurement Height (m)	Measurement Period (years)	Averaged Wind Speed (m/s)	Calculated U_{100} (m/s)
1	East Banat	60	1	5.24	5.59
2	South Banat 1	60	1	5.71	6.09
3	South Banat 2	60	1	6.34	6.77
4	South Banat 3	60	1	6.06	6.47
5	South Banat 4	50	1	7.32	8.00
6	North-East Banat	60	1	5.26	5.61
7	Central Backa	60	1	5.36	5.72
8	Souh-East Serbia	50	3	5.40	5.90
9	East Serbia 1	60	1	4.50	4.80
10	South Serbia	60	1	4.97	5.30
11	East Serbia 2	50	1	5.77	6.31
AVERAGE:					6.05

In order to obtain realistic data on annual electricity production, it is necessary to take into account the characteristics of the wind turbines would be installed. As the average wind speed in the category of lesser intensity, we will consider the so-called low-speed wind turbines. The best representatives of these turbines are ENERCON E82, GENERAL ELECTRIC GE2.5xl and VESTAS V90. The ma-

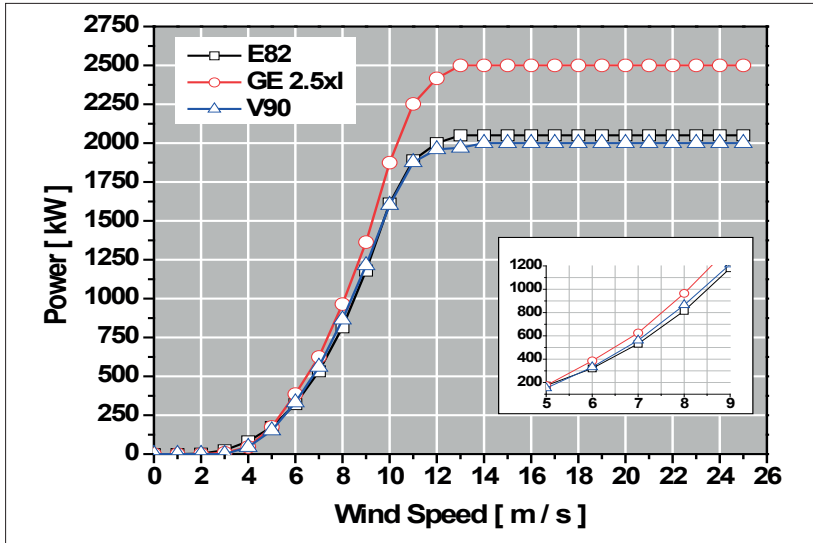


Figure 3. Power curves for three commonly used wind turbines.

in characteristic of wind turbines which directly affects is the level of production of electricity power curve. Figure 4 shows the power curve of the wind turbine.

Based on the average wind speed and wind turbine power curve, it is possible to precisely determine the required installation capacity of wind turbines for a given level of power consumption. This procedure is summarized in Tables 4 – 6.

Table 4. The summary of calculated data for wind turbine ENERCON E82.

	SITE WIND PERFORMANCES							
WIND CLASS (IEC 61400-1)	III	III	II	I	III	III	II	I
U_{ref} (m/s)	30.25	37.50	42.50	50.00	30.25	37.50	42.50	50.00
U_{100} (m/s)	6.05	7.50	8.50	10.00	6.05	7.50	8.50	10.00
	ENERCON E82 (P=2 MW), IIA							
	$U_{CAT-IN} = 2 \text{ m/s}$ $U_{POWER RATE} = 13 \text{ m/s}$, $U_{CUT-OUT} = 25 \text{ m/s}$							
Power Curve (kW)	332	674	998	1612	332	674	998	1612
	Current NAPRES				Target of AEP-New Scenario			
P_{INST} (MW)	500	500	500	500	980	980	980	980
AEWHF (%)	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
RCF (%)	14.6	29.6	43.8	70.8	14.6	29.6	43.8	70.8
RAEP (GWh/y)	638	1295	1918	3100	1250	2538	3760	6076
RATIO (GWh/y)/MW	1.28	2.59	3.84	6.20	1.28	2.59	3.84	6.20

Table 6. The summary of calculated data for wind turbine GENERAL ELECTRIC GE2.5xl.

SITE WIND PERFORMANCES								
WIND CLASS (IEC 61400-1)	III	III	II	I	III	III	II	I
U_{ref} (m/s)	30.25	37.50	42.50	50.00	30.25	37.50	42.50	50.00
U_{100} (m/s)	6.05	7.50	8.50	10.00	6.05	7.50	8.50	10.00
GENERAL ELECTRIC GE2.5xl (P=2.5 MW), IIIA, IIB								
$U_{CAT-IN} = 3.5 \text{ m/s}$ $U_{POWER RATE} = 13.5 \text{ m/s}$, $U_{CUT-OUT} = 25 \text{ m/s}$								
Power Curve (kW)	409	795	1167	1875	332	674	998	1612
Current NAPRES				Target of AEP-New Scenario				
P_{INST} (MW)	500	500	500	500	1030	1030.00	1030	1030
AEWHF (%)	85.0	85.0	85.0	85.0	85.0	85.00	85	85
RCF (%)	13.9	27.0	39.7	63.8	13.9	27.03	39.678	63.75
RAEP (GWh/y)	608	1184	1738	2792	1253	2439	3580	5752
RATIO (GWh/y)/MW	1.22	2.37	3.48	5.58	1.22	2.37	3.48	5.58

Table 7. The summary of calculated data for wind turbine VESTAS V90.

SITE WIND PERFORMANCES								
WIND CLASS (IEC 61400-1)	III	III	II	I	III	III	II	I
U_{ref} (m/s)	30.25	37.50	42.50	50.00	30.25	37.50	42.50	50.00
U_{100} (m/s)	6.05	7.50	8.50	10.00	6.05	7.50	8.50	10.00
VESTAS V90 (P=2 MW), IIIA								
$U_{CAT-IN} = 3.0 \text{ m/s}$ $U_{POWER RATE} = 13 \text{ m/s}$, $U_{CUT-OUT} = 25 \text{ m/s}$								
Power Curve (kW)	352	713	1040	1602	352	713	1040	1602
Current NAPRES				Target of AEP-New Scenario				
P_{INST} (MW)	500	500	500	500	955	955.00	955	955
AEWHF (%)	85.0	85.0	85.0	85.0	85.0	85.00	85	85
RCF (%)	15.0	30.3	44.2	68.1	15.0	30.30	44	68
RAEP (GWh/y)	656	1327	1935	2982	1253	2535	3696	5696
RATIO (GWh/y)/MW	1.31	2.65	3.87	5.96	1.31	2.65	3.87	5.96

LEGEND:

U_{50} (m/s)	Averaged 10 minutes wind speed at 50m height (filtered in the range: $U_{CAT-IN} - U_{CUT-OUT}$)
U_{100} (m/s)	Averaged 10 minutes wind speed at 100m height (turbine hub height = 100m)
U_{ref} (m/s)	Reference wind speed averaged over 10 minutes at hub height (IEC 61400-1): $U_{ref} = 5 * U_{100}$
I_{ref} (-)	Expected value of the turbulence intensity at 15 m/s
P_{INST} (MW)	Targeted total installing power capacity - 2020
AEWHF (%)	Averaged Percentage of Effective Working Hours Factor (estimated)
RCF (%)	Rough Capacity Factor
RAEP (GWh/y)	Rough Annual Electricity Production
RATIO (GWh/y)/MW	Ratio of RAEP / P_{INST}

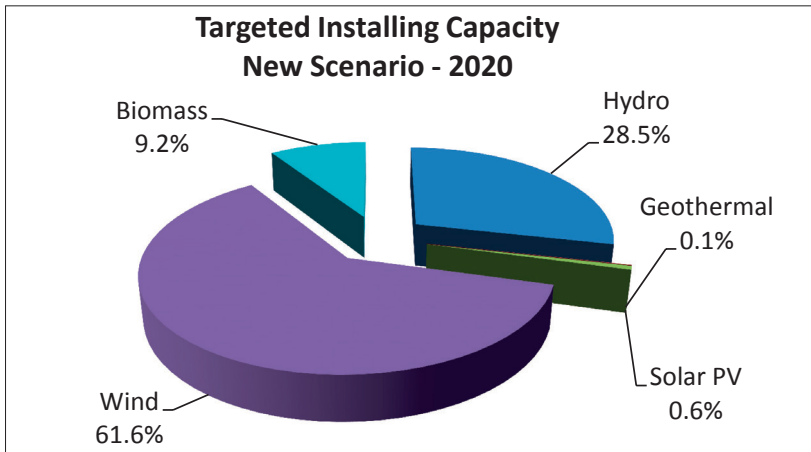
3. POSSIBLE NEW SCENARIO FOR WIND FARMS

Based on the analysis presented above, it can be concluded that the planned annual production of electricity from wind power of 1250 GWh / y can be achieved.

ved with the installation of capacity on the order of 1000 MW, which is twice more than planned in NAPRES. Therefore, considering revision NAPRES, introducing a new scenario for wind power plants. Details of the new scenarios are presented in Table 8:

Table 8. Target of RES in Serbia for 2020 by New Scenario.

New Scenario	2009		2020		NEW CAPACITY			
	MW	GWh/y	MW	GWh/h	MW	%	GWH/h	%
Small Hidro	2224	9892	2666	11154	442	28.5	1262	35.9
Geothermal	0	0	1	7	1	0.1	7	0.2
Solar PV	0	0	10	15	10	0.6	15	0.4
Wind	0	0	955	1253	955	61.6	1253	35.6
Biomass	0	0	143	983	143	9.2	983	27.9
TOTAL	2224	9892	3775	13412	1551	100.0	3520	100.0



CONCLUSION

This paper presents the details of NAPRES Republic of Serbia, which includes the objectives construction of new capacity installation of power plants for electricity production from renewable energy sources. As the share of small hydro power plants and wind farm major, separate analysis is presented for these two types of renewable energy sources. Critical review of the planned capacity is reviewed and it can be concluded that the planned installation capacity for the intended normative annual energy production significantly small and need a revision NAPRES. The most significant revision is related to the installation of wind power capacity, which is especially true in the work.

However, as the real value of the annual production of electric power in the wind power plants can only be obtained by direct measurement of production

correlated with wind speed and frequency of blowing, there is the opportunity to obtain these data by monitoring these parameters when the first wind power plant will be constructed in Serbia.

These days it began construction of the first wind power plant in Serbia „Plandište” (South Banat – Vojvodina), where it will be installed 32 wind turbines of 3 MW or 102 MW total installation capacity. Estimated date of completion is end of 2014.

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NOVI CILJEVI SRBIJE ZA IZGRADNJU ENERGETSKIH OBJEKATA NA OBNOVLJIVE IZVORE ENERGIJE DO 2020 GODINE

Sažetak: Krajem 2012 i početkom 2013, Vlada Republike Srbije donela je nove nacionalne propise u cilju obezbeđenja prihvatljivog zakonodavnog okvira kako bi se postigli predviđeni ciljevi do 2020 godine od 27% povećanja učešća obnovljivih izvora energije u odnosu na 2009 godinu u bruto finalnoj potrošnji energije.

Cilj od 37% povećanja se odnosi na učešće obnovljivih izvora energije za proizvodnju električne energije. Da bi se ovaj cilj ostvario, potrebna je izgradnja novih značajnih kapaciteta elektrana na obnovljive izvore energija, što je jasno definisano u Nacionalnom akcionom planu za obnovljive izvore energije.

U radu je data kritička analiza postavljenih ciljeva izgradnje novih kapaciteta elektrana na obnovljive izvore energije sa različitih aspekata, kao što su: nova nacionalna energetska politika, novi nacionalni propisi, potencijal obnovljivih izvora energije u Srbiji, potencijalna efikasnost ovakvih postrojenja i investicioni finansijski modeli.

Prema novoj nacionalnoj energetskej politici koja treba biti realizovana na osnovu Nacionalnog akcionog plana za obnovljive izvore energije, zaključeno je da su novi propisi koji se odnose na izgradnju novih elektrana na obnovljive izvore energije završeni, što obezbeđuje sigurnost investicija, otvara tržišta zelenom električnom energijom, definiše status povlašćenog proizvođača električne energije i značajno smanjuje vreme administrativnih procedura neophodnih za dobijanje građevinske dozvole.

U radu je posebno analiziran realni potencijal vetra u Srbiji, na osnovu izmerenih podataka kroz proteklih deset godina na više od trideset lokacija i predložena korekcija instalacionih kapaciteta vetroelektrana.

Ključne reči: *Nacionalni akcioni plan za OIE Srbije, novi propisi za OIE u Srbiji, potencijal vetra u Srbiji*

