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

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Abstract: At the end of 2012 and the beginning of 2013, the Serbian Government issued the new national regulations in order to provide an acceptable legislation framework to achieve 2020 targets of 27% increase of total renewable energy sources share in the gross final energy consumption, relative to 2009. The target of a 37% increase relates to participation of renewable energy sources in electricity production. It requires construction of new significant capacities of renewable energy power plants as clearly defined in the National Action Plan for Renewable Energy Sources.

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

According to the new national energy policy identified in 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 concerning the investment security, provision of green electricity market, status of green electricity producer, and significant reduction of time for administrative procedures required to obtain a building permit. Particularly, the real wind potential in Serbia, based on the measured data over the past ten years of measurement campaigns at more than thirty locations, has been used to correct the targeted installed capacity of wind power plants.

Keywords: Serbian National Action Plan for RES, Serbian new regulations for RES, Serbian wind potential.

1. INTRODUCTION

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

Both targeted annual electricity production and new installation capacity, according to the details of RES share set for 2020 are specified in Table 1, 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

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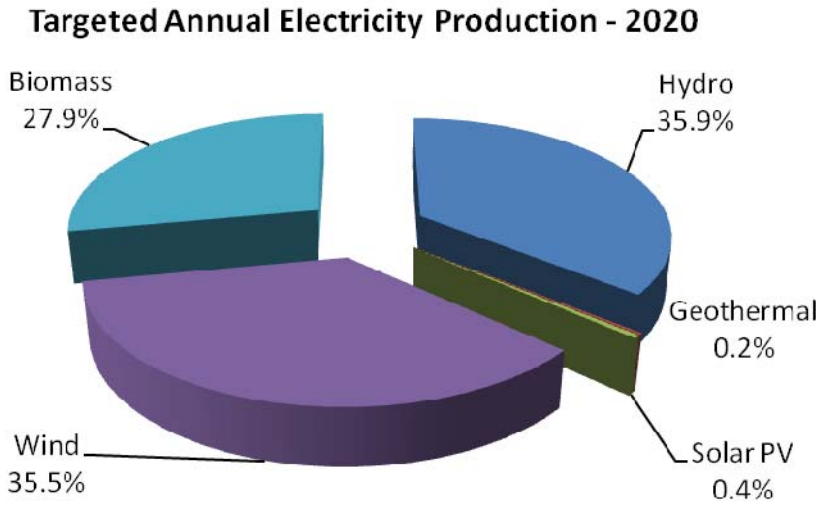

Figure 1. Targeted annual electricity production for 2020 by NAPRES.

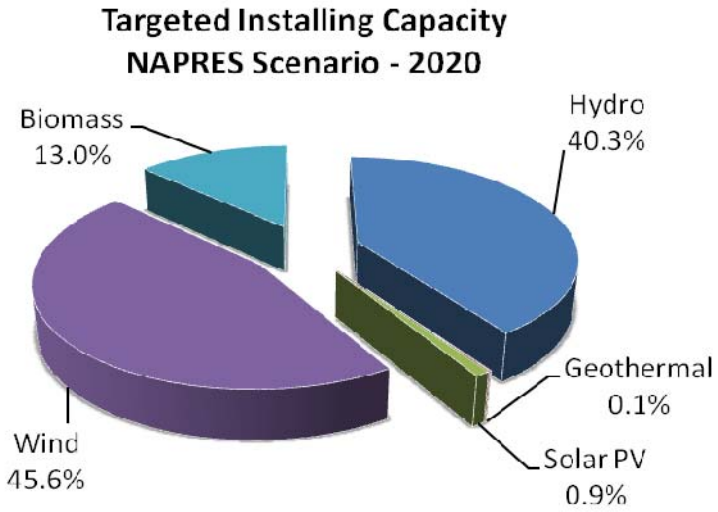

Figure 2. Targeted installing new RES Capacity for 2020 by NAPRES.

2. CURRENT CHARACTERISTICS OF NAPRES

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

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

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

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

For preparation of the National Action Plan for RES, two scenarios were developed to define gross final energy consumption (GFEC) by 2020, as well as scenarios of energy consumption by sectors (electricity, heating and cooling sector and the transport sector). The following scenarios were developed:

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

The reference scenario does not consider energy saving measures, but is based on increasing GFEC in accordance with the forecasted economic growth during the analyzed period. 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 transport sector, as defined in the Action Plan for Energy Efficiency for 2010.

Scenarios were developed based on the approved Energy Balance of Serbia for 2009 and the objectives and obligations defined in negotiations with the Energy Community. A share of renewable energy in GFEC in 2009 was at the level 21.2%, while a specific target set for 2020 is 27.0%.

3. CURRENT CHARACTERISTCS OF SMALL HYDRO POWER PLANTS AND WIND FARMS CONSTRUCTION

3.1. 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, the energy permits and licenses issued for the construction of 191 facilities with a total installed capacity of 387 MW, that is, projected electricity production of 1354.5 GWh / y. Also, the new public call has been completed, and it should provide further 96.3 MW of new installed capacity, which in total amounts to 1681.1 GWh / y at 317 locations.

The main difficulty in the implementation of these projects relates to long processes for procuring necessary technical and legal documentation. Major bottlenecks are to procure building permits and the 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 natural hydro network of Serbia with a potential to cause sludge and coastal erosion.

The Ministry of Energy, Development and Environmental Protection of Serbia is committed to help the investors in the legal process for construction of small hydro power plants from the very start.

Compared to the projected capacity of NAPRES (1262 GWh / y), the activities are taking place in a higher planned capacity. This provides a backup in case that not all planned capacity has been 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**

3.2. Wind farms

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

Based on the available data measurements in 11 locations in Serbia, it can be concluded that the average wind speed of about 6 m / s in 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.

In order to obtain realistic data on annual electricity production, it is necessary to take into account characteristics of the wind turbines installed. As the average wind speed in the category of lower 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 main characteristic of wind turbines which directly affects wind turbine performance is the level of production of electricity power curve. Figure 4 shows the power curve of the wind turbine.

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**

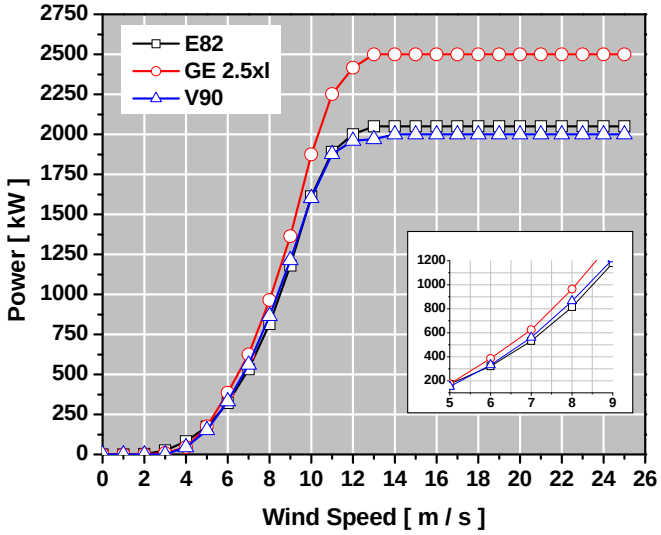

Figure 3. Power curves for three commonly used wind turbines.

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 m/s $U_{POWER\ RATE}$ = 13 m/s, $U_{CUT-OUT}$ = 25 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 5. 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 m/s $U_{POWER\ RATE}$ = 13.5 m/s, $U_{CUT-OUT}$ = 25 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 6. 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 m/s $U_{POWER\ RATE}$ = 13 m/s, $U_{CUT-OUT}$ = 25 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}

4. 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 with the installation of capacity of the order of 1000 MW, which is twice more than planned in NAPRES. Therefore, considering revision of NAPRES, introducing a new scenario for wind power plants is necessary. Details of the new scenarios are presented in Table 7.

Table 7. Target of RES in Serbia for 2020 according to 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

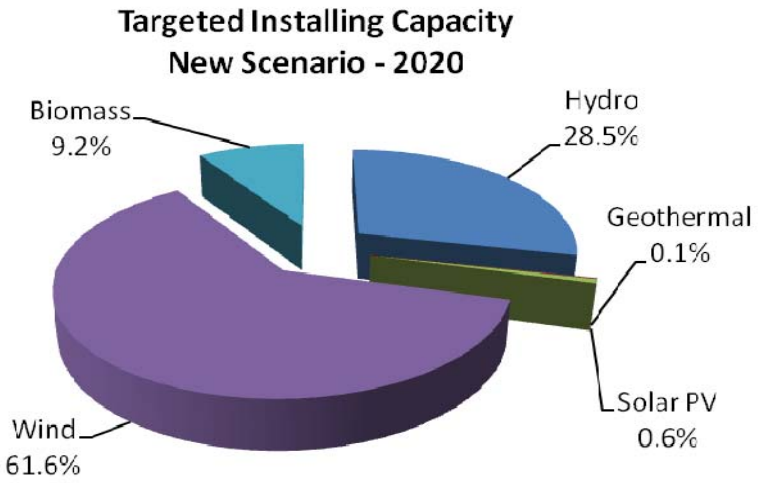

Figure 4. Targeted installing new RES Capacity for 2020 by new scenario of NAPRES

5. CONCLUSION

This paper presents the details of NAPRES for the Republic of Serbia, which includes the objectives construction of new capacity installation of power plants for electricity production from renewable energy sources. As a share of small hydro power plants and wind farm, a separate analysis is presented for these two types of renewable energy sources. A critical review of the planned capacity is presented and it can be concluded that the planned installation capacity for the intended normative annual energy production is significantly small and requires a revision of NAPRES. The most significant revision is related to the installation of wind power capacity. 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 the wind speed and frequency of blowing, it is possible to obtain these data by monitoring these parameters when the first wind power plant is constructed in Serbia.

The construction of the first wind power plant in Serbia has begun recently: "Plandište" (South Banat - Vojvodina), where 32 wind turbines of 3 MW or 102 MW of total installation capacity will be installed. Estimated date of completion is the end of 2014.

6. REFERENCES

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НОВИ ЦИЉЕВИ ЗА 2020. У ПОГЛЕДУ ИЗГРАДЊЕ ЕЛЕКТРАНА
У СРБИЈИ КОЈЕ КОРИСТЕ ОБНОВЉИВЕ ИЗВОРЕ ЕНЕРГИЈЕ

Сажетак: На крају 2012. и почетком 2013. године Влада Србије је донијела нову државну регулативу како би обезбиједила прихватљив законски оквир за постизање постављених циљева повећања удјела укупних извора обновљиве енергије од 27%, у 2020. години, у односу на 2009. Циљ од 37% односи се на удио обновљивих извора енергије у производњи електричне енергије. Да би се овај циљ достигао, потребно је изградити нове значајне капацитете електрана које користе обновљиве изворе енергије, као што је то јасно дефинисано у Националном акционом плану за обновљиве изворе енергије.

Овај рад се бави критичком анализом циљаних нови инсталисаних капацитета централа које користе обновљиве изворе енергије за производњу електричне енергије, са различитих аспеката, као што су: национална енергетска политика, нова национална регулатива, потенцијал обновљивих извора енергије у Србији, ефикасност електрана и инвестициони финансијски модели.

У складу са новом националном енергетском политиком идентификованом у Националном акционом плану за обновљиве изворе енергије, закључено је да је нова регулатива за изградњу нових електрана које користе обновљиве изворе енергије завршена, нарочито кад је у питању инвестициона сигурност, обезбјеђење зеленог електротржишта, статуса зелених произвођача електричне енергије и значајно смањење времена за административну процедуру потребну за добијање грађевинске дозволе. Нарочито је коришћен прави потенцијал вјетра у Србији, на основу података мјерења током посљедњих десет година у којим су спровођене кампање мјерења на више од тридесет локација, како би се кориговао циљани инсталирани капацитет вјетроенергана.

Кључне ријечи: Српски национални акциони план за ОИЕ, Српска нова регулатива за ОИЕ, потенцијал вјетра у Србији.

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