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United Nations Development Account project on promoting renewable energy investments for climate change mitigation and sustainable development

Case Study on Policy Reforms to Promote Renewable Energy in Serbia

Economic and Social Commission for Western Asia E/ESCWA/SDPD/2017/CP.12

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Beirut

United Nations publication issued by ESCWA, United Nations House,
Riad El Solh Square, P.O. Box: 11-8575, Beirut, Lebanon.

Website: www.unescwa.org.

Preface

This case-study report was prepared for the Sustainable Energy Division, United Nations Economic Commission for Europe (UNECE) within the framework of the United Nations Development Account (UNDA) project Promoting Renewable Energy Investments for Climate Change Mitigation and Sustainable Development. The project focused on capacity-building for policymakers and project developers in order to promote investments in renewable projects. The project was led by UN ESCWA and implemented in partnership with the UNECE.

The UNDA project included case studies of the experience of renewable energy policy reforms in selected countries from each of the two regional commissions. Four countries were selected from each regional commission: Jordan, Lebanon, Morocco and the United Arab Emirates from UN ESCWA Member States; and Georgia, Kazakhstan, Serbia and Ukraine from UN-ECE Member States.

The present report covers the case study for Serbia, and was prepared by Mr Milan Ristanovic (PhD), an Associate Professor of the Faculty of Mechanical Engineering at the University of Belgrade; currently is involved in the development of national policies on energy in Serbia. Mr. Viktor Badaker, Regional Adviser, Sustainable Energy Division (UNECE), helped review and finalize the document.

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List of abbreviations

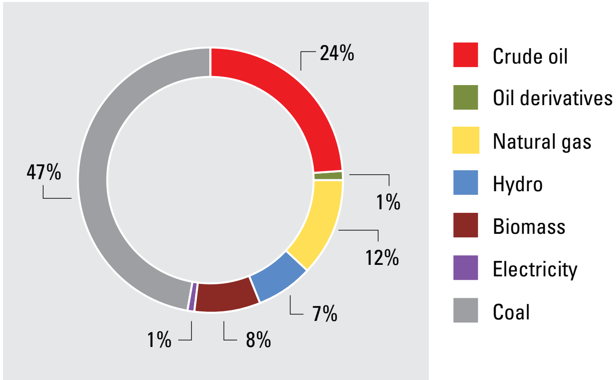
BAU	business as usual
BFPE	
BM	build margin
CDM	Clean Development Mechanism (Kyoto Protocol, UNFCCC)
CHP	combined heat and power
CM	combined margin
CO_2	carbon dioxide
EnC	Energy Community
ENTSO-E	
ETS	Emissions Trading System or Scheme (EU)
EU	European Union
FIP	feed-in premiums
FIT	feed-in tariffs
GHG	greenhouse gas
GWth	
HPP	hydrower plant
IED	Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)
IPA	
ITC	Inter-Transmission System Operator Compensation (EU)
JP EPS	
ktoe	thousand tons of oil equivalent
LCP directive	Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants
LSU	local self-government units
MFI	
Mtoe	million tons of oil equivalent
MW	megawatt
MWel	
NHSS	National Hydrometeorological Service of Serbia
NERP	National Emission Reduction Plan
NREAP	National Renewable Energy Action Plan
OIE	
OM	operating margin
PE	
PFS	
PSHP	pumped storage hydropower plant
PPA	power purchase agreement
PPP	privileged power producer
PU EMS	Public utility Elektromreže Srbije, independent transmission system and market operator
PU EPS	Public utility Elektroprivreda Srbije, vertically integrated public utility
PV	photovoltaic
RED	
RES	renewable energy sources
RES Directive	Directive 2009/28/EC — promoting the use of energy from renewable sources
SHPP	small hydropower plant
SPP	solar power plant
TEEnC	Treaty establishing the Energy Community
TJ	terajoule
TPP	thermal power plant
TPPP	temporary privileged power producer
UNFCCC	United Nations Framework Convention on Climate Change
WPP	wind power plant

I. Sector characteristics

1.1. Serbian energy sector

Serbia has diverse energy supplies. Energy generation relies largely on lignite reserves, which are estimated at 3.1 billion tons (excluding reserves in Kosovo and Metohija). Serbia produces a small amount of natural gas domestically (387 million m³ in 2010), which covers about 16% of its total gas demand, while the rest is imported, mainly from the Russian Federation through Hungary (1,967m m³ in 2010). Serbia also produces oil from domestic sources, covering about 31.5% of the total oil supply (2.7 million tons in 2010).

Figure 1: Share of particular energy sources in gross inland consumption for Serbia in 2014



Total installed power generation capacity was 7,124 MW in 2010. This comprised 3,936 MW lignite-fired thermal power plants, 353 MW combined heat and power (CHP) plants and 2,835 MW hydropower plants (HPPs).

The electricity sector of Serbia was unbundled in 2005, when the public utility Elektromreže Srbije (PU EMS), independent transmission system and market operator, was established by separating it from the vertically integrated public utility Elektroprivreda Srbije (PU EPS). Both EMS and EPS are fully State-owned companies. The electricity market of Serbia is formally open for all non-household customers, who can choose their electricity suppliers freely. In practical terms, this remains a theoretical possibility, since low regulated tariffs for electricity supplied by EPS restrict new market entrants. According to the Energy Law adopted in August 2011, households and small customers were entitled to choose suppliers from January 2015.

Some 76% of households in Serbia use coal, wood and electrical energy for individual household heating. District heating systems serve 24% of households; district heating systems with total installed capacity of 6.6 GWth are located in 58 cities and municipalities. Most district heating plants have heat-only boilers fuelled by natural gas with the ability to switch to heavy fuel oil, lignite and brown coal.

Figure 2: Share of various energy sources in electricity production

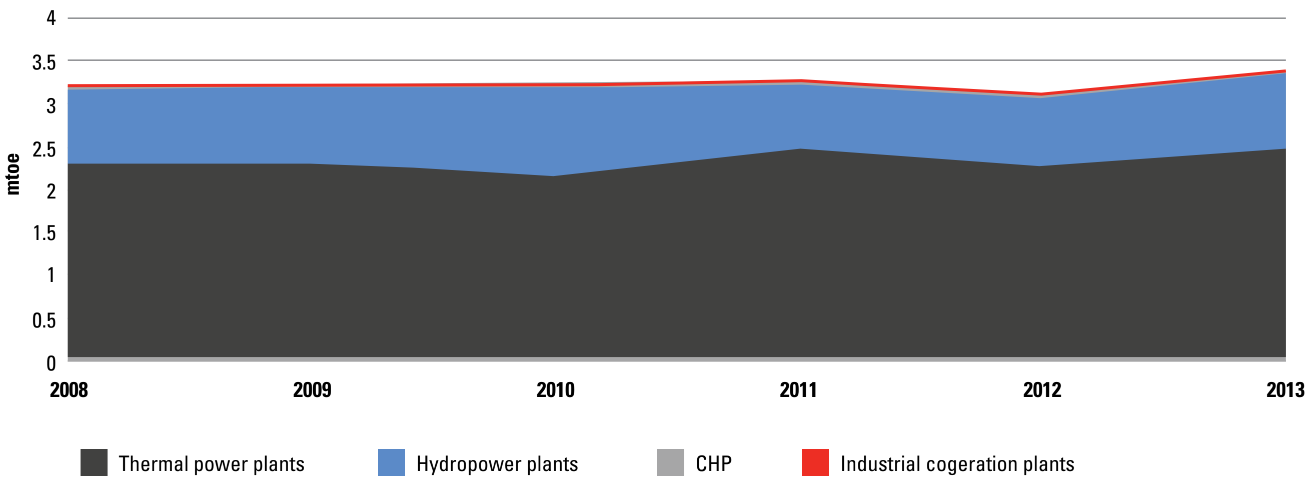
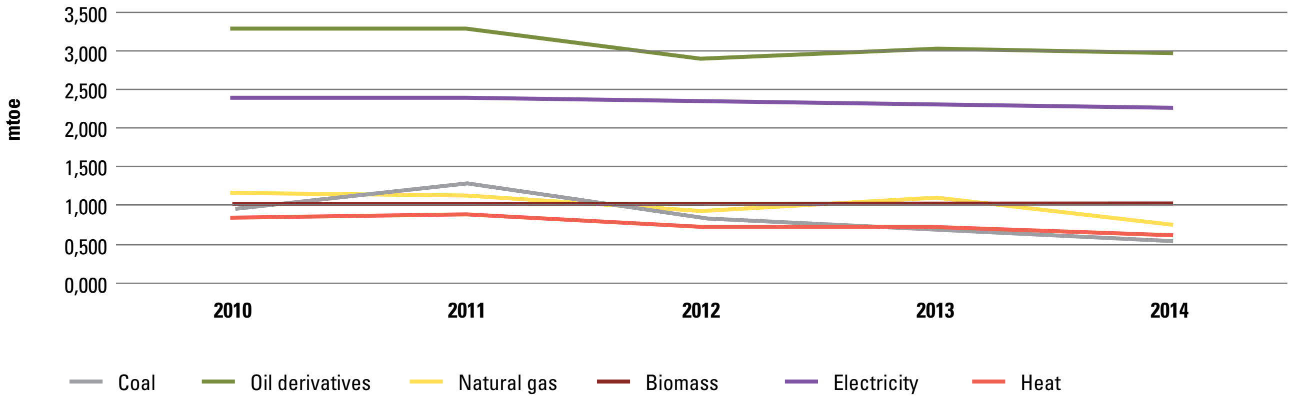
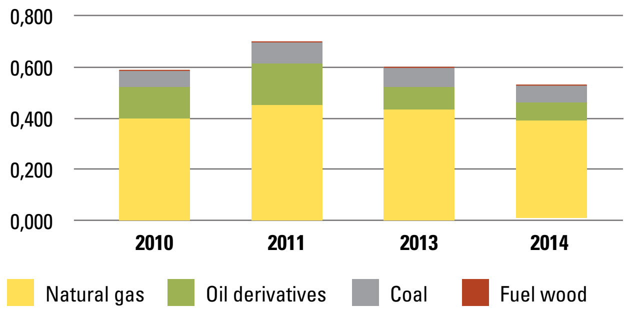


Figure 3: Share of different energy sources in total final energy consumption



Installed heat capacity in industry is estimated to be 6.3 GWth comprising approximately 1,800 steam and hot water boilers. Currently, the main fuel source for district heating is natural gas (50.4%), followed by heavy fuel oil (26.5%) and coal (23%), while biomass use is negligible (0.1%). Thermal plants in industrial companies in Serbia are ageing – it is estimated that 74% are more than 20 years old.

Figure 4: Share of different energy sources in energy consumption of district heating systems



1.2. Commitment of Serbia to reduce greenhouse-gas emissions

Serbia has ratified the Kyoto Protocol as a non-Annex 1 country and as such is eligible only for the Clean Development Mechanism (CDM) of the Kyoto Protocol (United Nations Framework Convention on Climate Change, UNFCCC), but not for emission trading. Serbia did not accept any liabilities for greenhouse-gas (GHG) emissions reduction under the Copenhagen Accord, but only indicated that potential for emission reductions could be between 18% and 29% below 1990 levels. Hitherto, Serbia has not adopted targets for carbon emission reductions.

According to the Initial National Communication submitted to the UNFCCC in November 2010, total carbon dioxide (CO_2)emissions in 1990 amounted to 62,970 kton (of which 94.1% were the emissions from the energy sector). In 1998, total emissions of CO_2 were 50,605 kton, of which 47,430 kton CO_2 or 93.73% had originated from the energy sector.

Table 1 presents GHG emission scenarios in Serbia up to 2020:

- Business-as-usual (BAU) scenario with 2020 projections;
- Low scenario (lower application of emission reduction measures) – with achieved 2.0% emissions reduction;
- High scenario (higher application of emission reduction measures) – with achieved 4.4% of emissions reduction.

Table 1: Greenhouse-gas emission scenarios in Serbia up to 2020[1]

				GHG emissions projections (kt CO_2)			
Sectors					BAU	Alternative scenario 2020	
	1990	1998	2007	2015	2020	High	Low
Energy	48,177	41,434	44,684	52,863	61,042	59,634	58,263
Industry	4,271	3,620	4,682	6,046	7,410	7,249	7,032
Buildings	8,889	5,243	8,245	8,979	9,713	9,579	9,354
Transport	5,710	3,872	5,296	8,026	10,756	10,528	9,9237
Agriculture	11,827	9,500	9,306	9,720	10,135	10,114	10,063
Waste	1,930	2,678	3,122	3,651	4,180	4,116	4,034
Forestry	-6,665	-8,661	-11,188	-11,956	-12,725	-12,900	-13,075
Total with Forestry	74,138	57,685	64,146	77,328	90,510	88,320	85,594
Total without Forestry	80,803	66,346	75,334	89,284	103,235	101,220	98,669

[1] Efficient ways for GHG emissions reductions within the Post-Kyoto Framework in Serbia, Final report, Study for MEMSP, Garrigues. August 2011.

Source: Thermal power plant, v_sot - fotolia.com

1.3. Renewable energy sources

The renewable energy sources (RES) sector, apart from hydro-energy, is in its early phase of development. Estimated total RES potential, which is technically available in Serbia, amounts to 5.65 million tons of oil equivalent (Mtoe) per year; 1.054 Mtoe of biomass and 909 thousand tons of oil equivalent (ktoe) of hydro-energy of this potential are already in use (Table 2 and Figure 6).

Table 2: Overview of technically usable potential of renewable energy sources

RES type	Available technical potential in use (Mtoe/year)	Unused available technical potential (Mtoe/year)	Total available technical potential (Mtoe/year)
BIOMASS	1.054	2.394	3.448
Agricultural biomass	0.033	1.637	1.67
Parts of agricultural species	0.033	0.99	1.023
Parts in fruit-growing, viniculture and fruit-processing	-	0.605	0.605
Liquid manure	-	0.042	0.042
Wood (forest) biomass	1.021	0.509	1.53
Biodegradable waste	0	0.248	0.248
• Municipal waste	0	0.205	0.205
• Other	0	0.043	0.043
HYDRO ENERGY	0.909	0.770	1.679
• Up to 10 MW	0.004	0.151	0.155
• From 10 MW to 30 MW	0.020	0.102	0.122
• Over 30 MW	0.885	0.517	1.402
WIND ENERGY	≈ 0	0.103	0.103
SOLAR ENERGY	≈ 0	0.240	0.240
• For electricity	≈ 0	0.046	0.046
• For heating	≈ 0	0.194	0.194
GEOTHERMAL	≈ 0	0.1	0.180
For electricity generation	≈ 0	≈ 0	≈ 0
For heating	0.005	0.175	0.180
Total from all RES	**1.968**	**3.682**	**5.65**

II. Current policy: a summary of relevant policies for renewable energy investments in place before the introduction of reforms

Serbia is not yet a European Union (EU) Member State. Due to its geographical position, however, and above all because of its clear political goals to use renewable energy, mitigate the effects of climate change and achieve sustainable development, **Serbia became a member of the Energy Community (EnC) in 2006.** This was achieved through adoption of the Law ratifying the Treaty establishing the Energy Community between the European Community and Albania, Bulgaria, Bosnia and Herzegovina, Croatia, the Former Yugoslav Republic of Macedonia, Montenegro, Romania, Serbia and the United Nations Interim Administration Mission in Kosovo, in line with United Nations Security Council Resolution 1244 (Official Gazette of the Republic of Serbia, No. 62/06).

Pursuant to the provision set forth in Article 20 of the Treaty establishing the Energy Community, **Serbia has undertaken to implement European directives in the field of renewable energy sources (Directive 2001/77/EC** on the promotion of electricity produced from renewable energy sources and Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport). As of 2009, the aforementioned directives were gradually superseded and eventually repealed in January 2012 with the new Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC CELEX No. 32009L0028.

In line with Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources, Serbia introduced in 2009 the so called “feed-in tariffs (FIT) incentive”. The regulations on FIT, established in 2009, were renewed in 2013 with four new decrees. Recently, in June 2016, new secondary legislation was adopted which is expected to create more favourable investment conditions for renewable energy and bring the Serbian legal framework in line with the EU Third Energy Package.

Figure 5: Total available technical potential (Mtoe/year)

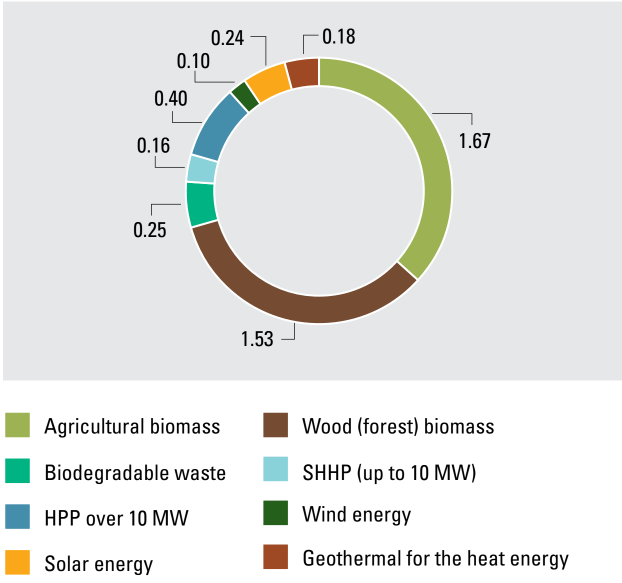
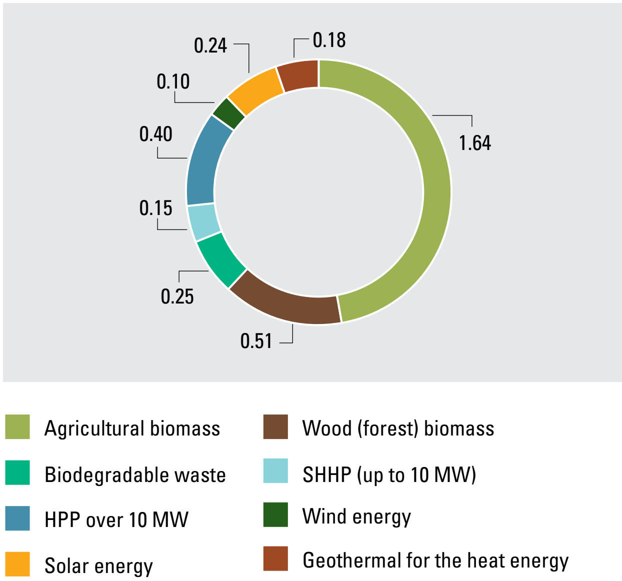


Figure 6: Total unused available technical potential (Mtoe/year)



By the **Ministerial Council Decision of 18 October 2012 (D/2012/04/MC-EnC)**, a demanding and binding goal **of achieving a 27% share of renewable energy sources in the gross final energy consumption (GFEC) in 2020** was set for Serbia.

National Renewable Energy Action Plan.
In accordance with **Directive 2009/28/EC** and the **Energy Community, the same decision required preparation of the National Renewable Energy Action Plan** of Serbia in line with the approved template for the preparation of this document (Decision 2009/548/EC) and its submission to the Energy Community Secretariat. The National Renewable Energy Action Plan (NREAP) was adopted by Serbia in June 2013 (Official Gazette of the Republic of Serbia, No. 53/13). It sets the targets for the use of RES until 2020, as well as the manner of their achievement. The Action Plan was prepared as per EU methodology and standards, on the basis of all relevant data in the field of energy and RES in Serbia. For the preparation of NREAP, two scenarios were developed for defining GFEC until 2020, as well as scenarios of energy consumption per sector (electricity sector, heating and cooling sector and transport sector):

- Reference (baseline) scenario (REFSC);
- Scenario with applied energy efficiency measures (EESC).

The reference scenario does not take energy-saving measures into account, but is based on the increase of GFEC in compliance with envisaged economic growth in the given period. The scenario with applied energy efficiency measures takes into account the saving on primary energy in the households and public and commercial sectors and the industry and transport sectors, defined within the National Action Plan for Energy Efficiency of 2010.

Table 3 shows expected trajectories (indicative paths) of the share of energy from RES in the electricity, heating and cooling, and transport sectors. These trajectories were developed for all three sectors on the basis of available data on expected energy consumption in each of them and projects planned to be implemented in that period, in compliance with the goals defined in the Energy Sector Development Strategy until 2015 and other planning documents.

Serbia is bound to prepare an annual progress report on the implementation of NREAP and submit it to the Secretariat of EnC. Until now, Serbia has submitted four progress reports.

Energy Law. As a member of EnC, and in line with the same Ministerial Council Decision of 18 October 2012, Serbia undertook to transpose Directive 2009/28/EC on the promotion of the use of RES into its legal framework by 1 January 2014. By the same Energy Community Ministerial Council Decision, the Directive was amended and adapted for application within the EnC framework.

The Energy Law, adopted on 29 December 2014, transposed suggestions of Directive 2009/28/EC and chose “support schemes” to encourage greater utilization of RES. Article 2 of the Directive defines support scheme as any instrument, scheme or mechanism applied by a Member State or a group of Member States, that promotes the use of energy from RES by reducing the cost of that energy, increasing the price at which it can be sold, or increasing, by means of a renewable energy obligation or otherwise, the volume of such energy purchased. This includes, but is not restricted to, investment aid, tax exemptions or reductions, tax refunds, renewable energy obligation support schemes, including those using green certificates, and direct price-support schemes including FIT and premium payments. Serbia decided, on the basis of Article 2 of the Directive, which promotes the possibility for each State to freely choose a support scheme that it considers the most suitable, to continue with applying the FIT model for two reasons: firstly, because of the lack of rapid development of projects and progress in this field; and secondly, in order to more easily implement the policy in the field of RES through the incentive mechanism whose effects it was possible to analyse and forecast, since it had been applied for almost four years. The Law did not define the possibility of applying other mechanisms of support schemes.

Source: Wind farm in a green field, jorisvo - fotolia.com

Table 3: Expected gross final energy consumption in Serbia in the areas of heating and cooling, electricity and transport until 2020, taking into account the impact of energy efficiency and energy-saving measures 2010–2020 (ktoe)

	2009	2010		2011		2012		2013		2014	
	Base year	Reference scenario	Additional energy efficiency	Referwence scenario	Additional energy efficiency	Reference scenario	Additional energy efficiency	Reference scenario	Additional energy efficiency	Reference scenario	Additional energy efficiency
Heating and cooling	4.144	4.608	4.608	4.890	4.890	5.023	5.023	4.923	4.881	4.823	4.739
Electricity	3.079	3.191	3.191	3.237	3.237	3.237	3.237	3.260	3.226	3.284	3.215
Transport	1.926	2.005	2.005	2.073	2.073	2.140	2.140	2.208	2.180	2.275	2.220
GFEC	9.150	9.804	9.804	10.200	10.200	10.400	10.400	10.391	10.287	10.383	10.174

	2015		2016		2017		2018		2019		2020	
	Reference scenario	Additional energy efficiency	Reference scenario	Additional energy efficiency	Reference scenario	Additional energy efficiency	Reference scenario	Additional energy efficiency	Reference scenario	Additional energy efficiency	Reference scenario	Additional energy efficiency
Heating and cooling	4.724	4.597	4.625	4.456	4.527	4.314	4.428	4.172	4.329	4.030	4.231	3.888
Electricity	3.307	3.203	3.331	3.192	3.354	3.181	3.378	3.170	3.401	3.159	3.425	3.148
Transport	2.343	2.260	2.409	2.299	2.476	2.339	2.542	2.379	2.609	2.419	2.675	2.458
GFEC	10.374	10.060	10.365	9.947	10.357	9.834	10.348	9.721	10.339	9.608	10.331	9.495

Guarantee of origin. The Energy Law stipulates that the guarantee of origin is a document with the sole purpose of proving to the final customer that the given share or quantity of energy was produced from renewable energy sources, as well as from combined heat and power (CHP) production with a high degree of primary energy utilization. The Energy Law established the legal basis for enactment of the regulation of the guarantee of origin and the rulebook on the method of calculation, showing all shares of energy sources in electricity sold. This regulation and the rulebook specify the contents of the guarantee of origin of electricity produced from RES, the procedure of issuing guarantees, transfer and termination of validity of guarantees, manner of maintaining the register of issued guarantees of origin, as well as the manner of submitting data on electricity produced, measured at the point of delivery to the transmission or distribution system. The Energy Law stipulates that the operator of the distribution system issues guarantees of origin. Since the operator of the distribution system has ensured technical conditions for maintaining the register, the application of the system of guarantees of origin will start when bylaw regulations enter into force. In December 2016, the process of adoption of these bylaws began, and the beginning of full implementation of the system is planned for 2017.

New set of bylaws and power purchase agreement. A package of bylaws governing the system of incentives in the sector of producing electricity from renewable sources was adopted on 15 June 2016. The package includes three regulations:

- The Decree on the Conditions and Procedure of the Acquisition, Duration and Termination of the Status of a Privileged Power Producer (PPP), Temporary Privileged Power Producer (TPPP) and Power Producer from Renewable Energy Sources (Decree on PPP Status);

- The Decree on Incentive Measures for Electricity Generation from Renewable Energy Sources and from High-Efficiency Cogeneration of Heat and Power (Incentives Decree); and

- The Decree on Power Purchase with a Standard Model Power Purchase Agreement (PPA) and Appendix to a Model Agreement.

Since the introduction of an FIT system in 2009, this had been the third update of the system of incentives, which introduced significant improvements in comparison to the previous regulation.

Table 4: Feed-in tariffs for electricity production (2016)

No.	Type of power plant of the privileged producer of electricity	Installed power – P (in Mw)	Incentive purchase price (¢€/kWh)	Maximum effective operating time (hours)
1.	Hydropower plant			5,000 in a year of the incentive period
1.1		Up to 0.2	12.60	
1.2		0.2–0.5	13.933 – 6.667* P	
1.3		0.5–1	10.60	
1.4		1–10	10.944 – 0.344* P	
1.5		10–30	7.50	
1.6	On the existing infrastruc-ture	Up to 30	6.00	5,000 in a year of the incentive period
2.	Biomass power plant			8,600 in a year of the incentive period
2.1		Up to 1	13.26	
2.2		1–10	13.82 – 0.56*P	
2.3		Up to 10	8.22	
3.	Biogas power plant			8,600 in a year of the incentive period
3.1		0–2	18.333 – 1.111*P	
3.2		2–5	16.85 – 0.370*P	
3.3		Over 5	15	

4.	Landfill gas power plant and gas from municipal wastewater treatment facilities		8.44	8,600 in a year of the incentive period
5.	Wind power plant		9.2	9,000 in a three-year quarter of the incentive period
6.	Solar power plant			
6.1		On a facility of up to 0-03	14.60–80*P	1,400 in a year of the incentive period
6.2		On a facility of 0.03 – 0.5	12.404–6.809*P	
6.3		Out of facility	9	
7.	Geothermal power plant		8.2	8,600 in a year of the incentive period
8.	High-efficiency cogeneration natural gas power plant			8,600 in a year of the incentive period
8.1		Up to 0.5	8.20	
8.2		0.5–2	8.447–0.493*P	
8.3		2–10	7.46	
9	Waste power plant		8.57	8,600 in a year of the incentive period

Law on Planning and Construction. The umbrella law for the construction of power plants which use RES is the Law on Planning and Construction, whose amendments were adopted on 29 December 2014 (Official Gazette of the Republic of Serbia, No. 145/14).

The amendments of the Law brought a number of specific obligations for administrative bodies and accelerated procedures for the construction of energy facilities. From 1 January 2016, the building permit is issued as an electronic document. The Ministry of Construction, Transport and Infrastructure provides a support for informing citizens through a special website dedicated to instructions for using a unified procedure for issuing permits and approvals in the process of constructing facilities: http://gradjevinskedozvole.rs/pitanja-i-odgovori.php?IDOblast=678.

In 2015, the Serbian Assebly adopted the new Energy Sector Development Strategy of the Republic of Serbia until 2025 with projections until 2030. This Strategy is based on the EU Energy Road Map, i.e. the Serbian comitemnt to EnC (EU) in connection with fulfilling obligations to increase the share of RES and energy efficiency and in connection with reducing emissions of GHGs, environmental protection and mitigation of climate change.

With respect to climate change, Serbia is commited to implementing two EU directives: Directive 2010/75/EU on industrial emissions and Directive 2001/80/EC on large combustion plants (LCP). Activities in implementing these directives are closely connected with the activities of the Ministry of Agriculture and Environmental Protection, as well as with the national Electric Power Industry (EPS). The activities of the Ministry of Agriculture and Environmental Protection encompass to a much more significant extent communication with the United Nations and concern about the implementation of commitments under the Kyoto Protocol.

By the end of 2015 JP EPS prepared the National Emissions Reduction Plan (NERP) and defined which JP EPS plants will be included in the so-called “opt-out programme”, as the first phase of introduction to the European Union Emissions Trading System or Scheme (EU ETS).

Due to its restrictive character, which first limits the number of work hours of the thermal power plants (TPPs) and large coal- and heavy-oil-fuelled district heating plants in the next eight years, and then imposes full withdrawal of unadjusted plants from operation, implementation of NERP will lead to reduced production of electricity and heat from these two energy carriers. Consequently, for Serbia to meet its own needs it can be logically assumed that emphasis on the production of these energies will fall basically on the exploitation of existing, but so far not used, renewable energy sources. Due to that indirect effect, the energy sector of Serbia has been carefully planning (Table 5).

Table 5: Preliminary list of old large combustion plants from "network-energy" sector in Serbia envisaged for "opt-out" mechanism

No.	Plant name (operator)	Total rated thermal input (MW)
1	EPS, TPP Morava	420
2	EPS, TPP Kostolac A1	358
3	EPS, TPP Kostolac A2	689
4	EPS, TPP Kolubara A A3 (boiler 1)	147
	EPS, TPP Kolubara A A3 (boilers 3,4,5)	441
5	EPS, TPP Kolubara A5	382
6	NIS a.d., Energana Novi Sad	98.9
7	NIS a.d., Energana Pančevo	67.3

III. Renewable energy potential: an assessment of CO_2 emissions

Unfortunately, no ministry or government organization in Serbia performs permanent monitoring and reporting on CO_2 and GHG emissions. The only existing data, published by the Ministry of Agriculture and Environmental Protection, are the result of efforts by certain foreign experts during their work on the relevant projects. Thus, for the purposes of this study, and on the basis of available data, it was necessary to make an independent estimate of potential for the reduction of CO_2 emissions through the use of RES. Three models were used and are described in detail in Chapter 4. The model for the calculation of emission reductions resulting from the substitution of electricity by that potentially generated from RES was based on the so-called network factor that is the UNFCCC tool for the calculation of the emission factor for an electricity system, CDM. In calculations of the electricity for heating, the model is based on the reduction of actual CO_2 emission occurring in the existing energy mix for the generation of energy for heating from conventional energy sources (coal, heavy fuel oil, gas, electricity) for the share that might be achieved through the use of RES. In calculations of the emission reduction for biofuels, the methodology recommended by the Directive on RES (Directive 2009/28/EC) was used.

Table 6 shows the estimated net reduction of CO_2 in the case of substituting electricity produced by existing TPP with maximum technically possible production of electricity from RES calculated for the carbon emission factor of the Serbian national power grid . Data used for unused available technical potential of RES are taken from the Energy Sector Development Strategy of Serbia until 2025 with projections until 2030.

Source: Multiple Coal Fossil Fuel Power Plant, jzehnder - fotolia.com

Table 6: Net reduction of CO_2 in the case of substitution from electricity produced by existing TPP with maximum technically possible production of electricity from RES

Electricity from	Total available technical potential (MWh/year)	Total available technical potential (Mtoe/year)	Total estimated net CO_2 emission reduction ($ktCO_2$/ year)
Hydro-energy	8,955,100	0.770	8,463
Wind energy	1,200,000	0.103	1,134
Solar energy	540,000	0.046	510
Liquid manure	488,460	0.042	462
Biodegradable waste, municipal waste	2,384,150	0.205	2,253
Parts of agricultural species	240,000	0.021	227
TOTAL		**1.187**	**13,049 $ktCO_2$/year**

According to this calculation, the substitution of electricity generation with a theoretically feasible electricity generation from RES might result in a CO_2 emission reduction of 13,049 $ktCO_2$ per year.
If this CO_2 reduction potential is expressed as a percentage and referred to the emission of CO_2 and GHG in 1998, i.e.

$$CO_2 \text{ saving potential [\%]} = \frac{\text{Total estimated net } CO_2 \text{ emission saving}}{\text{Total } CO_2 \text{ emissions produced in 1998}}$$

it would lead to the indication that in this way the emission of CO_2 in Serbia can be reduced by 25.78% (without negative forest emissions) or the emission of all GHGs for 22.62%.

Considering that the Energy Sector Development Strategy of Serbia until 2025 with projections until 2030, a technically usable potential of wind energy of 500 MW and 2,400 working hours per year determined based on the existing technical possibilities of the electric power system to accept this energy and not on the real natural technically usable potential of 1,300 MW and 3,000 working hours per year, the above calculation can be remarkably different. A similar situation can be applied to solar energy, estimated in the Strategy as 450 MW and 1,200 working hours per year, while its real technically usable potential is much larger. In a case of using only 10 km^2 with the average value of global radiation energy for the territory of Serbia, which is 1,400 kWh/m^2/year, and efficiency of photovoltaic (PV) panels of 0.16, it is possible to obtain 2.240 TWh or 0.193 Mtoe of electricity. In that case, the net reduction of CO_2 in the case of substituting electricity produced by existing TPPs with the maximum technically possible production of electricity from RES would be 17,206 $ktCO_2$. Expressed through CO_2 reduction potential, it would indicate that CO_2 emissions in Serbia might be reduced by 34% (without negative forest emissions), i.e. an emission of all GHGs of 29.83% .

As indicated in the introduction, the calculation of reduction of CO_2 emissions, which can be achieved in the generation of energy for heating by replacing conventional sources with RES, differed from the calculation of reduced CO_2 emission used in the case of electricity generation. It was necessary both due to different mixes of fuels (energy carriers) participating in electricity generation and to a different degree of conversion in the transformation of gas, heavy fuel oil and coal into electrical or thermal energy. In addition, due to the fact that, in Serbia, electricity is used for heating to a large extent, in the calculation of the so-called carbon emission factor for heating , in proportion with the share of such use of electricity, the carbon emission factor of the Serbian national power grid was also used. The detailed procedure of determining the carbon emission factor for heating which was determined for Serbia as is described in chapter 4.

Table 7 shows the estimated net reduction of CO_2 in the case of substituting heating energy produced in the existing district heating system and households that used conventional energy sources for heating (coal, heavy fuel oil, gas, electricity) by the maximum technically possible capacity of RES producing heating energy, calculated for the carbon emission factor for heating . Data used for the unused available technical potential of RES are taken from the Energy Sector Development Strategy of Serbia until 2025 with projections until 2030.

It follows from this calculation that the substitution of heat energy produced from conventional sources by RES energy might result, in the theoretical case of maximum use of all RES, in the reduction of CO_2 emissions by **20,117 ktCO$_2$** per year.

If this CO_2 reduction potential is expressed as the percentage relation and compared with the CO_2 emissons of 1998, it would result in the possibility of a reduction of CO_2 emissions in Serbia of 39.75% (without negative forest emissions), i.e. a reduction of all GHG emissions of 34.87%.

For estimating the reduction of CO_2 emissions in the case of substituting diesel and petrol by biodiesel and bioethanol, the methodology recommended by the Directive on RES (Directive 2009/28/EC) was used. The data for unused available technical potential of RES were taken from Energy Sector Development Strategy of Serbia until 2025 with projections until 2030. The assumptions, calculation model and rules for calculating the greenhouse gas impact of biofuels, bioliquids and their fossil fuel comparators used are described in detail in Chapter 4. Calculation results are shown in Table 8.

Table 7: Net reduction of CO_2 in the case of substituting heating energy in existing conditions with the maximum technically possible production of heat energy from renewable energy sources

Heat energy from	Total available technical potential (Mtoe/year)	Total available technical potential (TJ/year)	Total estimated net CO_2 emission reduction ($ktCO_2$/year)
Agricultural biomass	1.09	45,825	6,208
Parts of agricultural species	0.97	40,585	5,498
Parts in fruit-growing, viniculture and fruit-processing	0.61	25,330	3,431
Wood (forest) biomass	0.51	21,311	2,887
Geothermal for heating	0.18	7,327	993
Solar for heating	0.19	8,122	1,100
TOTAL	**3.51**		**20,117 ktCO$_2$/year**

Table 8: Net reduction of CO_2 in the case of fossil-fuel substitution in the transport sector (diesel and petrol) with maximum technically possible production of biodiesel and bioethanol

Bioliquids	Total available technical potential (t/year)	Total available technical potential (toe/ year)	Typical greenhouse gas emission saving for biofuels if produced with no net carbon emissions from land-use change [%]	Total estimated net CO_2 emission reduction ($ktCO_2$/year)
Biodisel	230,000	197,800	49.0	595
Bioethanol	30,000	19,200	61.0	60
Total		**197,928**		**654 ktCO$_2$/year**

It follows from this calculation that the substitution of diesel and petrol by the technically feasible production of biodiesel and bioethanol might reduce CO_2 emissions by 593.5 ktCO_2 per year.

If we compare this CO_2 potential reduction with the emission of CO_2 and GHG in 1996 or express it as a percentage, it would indicate that the emissions of CO_2 in Serbia might be reduced by 1.29% (without negative forest emissions), i.e. emissions of all GHGs might be reduced by 1.13%.

IV. Assessment methodology: a description of the analytical tool or models used to assess potential energy production and CO_2 reductions

The last detailed assessment of the energy potential of RES in Serbia was made in 2013 for the needs of the Energy Sector Development Strategy of Serbia for the period until 2025 with projections until 2030. It is important to note that, to assess the potential of RES, this Strategy has taken some data and results that were published in the previous official Government document – Programme of Implementation of the Energy Development Strategy Serbia until 2015 for the period from 2007 to 2012. Despite many subsequent studies on the subject, the official data for Serbia did not change. Therefore, this segment shows the methods and approaches used in developing this document, in order to correspond to the data on estimated potential given in Chapter 1.

The calculation of potential for CO_2 reduction by substituting existing sources with RES, for the case of electricity and heat production, uses the methodology recommended by the UNFCCC tool to calculate the emission factor for an electricity system (CDM). Although this method requires a recalculation of the emission factor for an electricity system every three years, the last available data on fuel consumption and net electricity generation of each power plant/unit were from 2013, so they are used in this calculation

For estimating the reduction of CO_2 emissions in the case of substituting diesel and petrol by biodiesel and bioethanol, the methodology recommended by the Directive on RES (Directive 2009/28/EC) was used.

4.1. Models used to assess potential energy production

Biomass. The assessment of the energy potential of biomass was made depending on its origin, separately for biomass of agricultural, forest or animal origin. In all three cases, the theoretical energy potential was determined first, followed by the technical one. Assessments of the real available energy potential for agricultural biomass and economically feasible potential were not produced.

The calculation for determining the theoretical energy potential of agricultural biomass was based on the formula:

$$\boxed{E_{th.agric} = \sum_j \sum_i w_i \cdot m_{i,j} \cdot H_{d,i}}$$

where:

w_i= mass ratio of plant residue and yield of i-th agricultural culture (-),

m_i= annual yield of i-th agricultural culture on j-th parcel (t)

$H_{d,i}$= lower calorific value of the residues of i-th agricultural culture (kJ/t)

The technical energy potential of agricultural biomass – taking into consideration that a part of the entire mass of produced biomass residue is ploughed under, some is used as cattle feed and some in the industry of construction materials, paper, packaging, cosmetic products – is usually estimated at 25% to 30% of the theoretical energy potential of biomass. For the sake of caution, therefore, it was determined as one fourth of the theoretical potential, i.e.:

$$\boxed{E_{tech.agric} = 0{,}25 . E_{theo.agri}}$$

To determine this potential, data were used from the Statistical Office of Serbia on average surfaces under certain agricultural cultures during the last 10 years, including the impact of their rotation, followed by data on average annual yields per hectare for each of the identified agricultural cultures and the ratio between the mass of the main product and plant residue in the region for each culture.

The value of the theoretical energy potential of forest biomass was determined as the sum of all individual theoretical energy growths for all types of forests from all parcels in Serbia, i.e.:

$$\boxed{E_{theo.fores} = \sum_j \sum_i \Delta m_{i,j} \cdot H_{d,i}}$$

where:

Δm_i = annual natural growth of the i-th type of forest on j-th parcel (t);

$H_{d,i}$ = lower calorific value of the i-th forest mass on j-th parcel (kJ/t).

To determine the forest fund, forestation and natural growth of certain types of forests, data were used from the National Hydrometeorological Service of Serbia (NHSS), the Ministry of Agriculture and Environmental Protection, the Faculty of Forestry of the University of Belgrade and PE Srbijašume and PE Vojvodina šume.

Since the ratio between the volume of felled wood and volumetric growth of wood in the forests of Serbia is around 50%, this value was used as relevant to assess the technical potential of the forest biomass in Serbia.

The theoretical energy potential of biomass from animal origin was determined as:

$$\boxed{E_{theo,anim} = \sum_j \sum_i z_{i,j} \cdot m_i \cdot Y_i \cdot H_{d,i}}$$

where:

$z_{i,j}$ = number of i-th species of animals at j -th farm,

m_i = mass of liquid manure produced by a single animal of the i-th species [t],

Y_i = amount of biogas obtained from one ton of liquid manure of an animal of i-th species [m^3/t],

$H_{d,i}$ = lower calorific value of biogas produced from liquid manure from animals of the i-th species [kJ/ m^3].

Once again, the data sources were the NHSS, the Ministry of Agriculture and Environmental Protection, as well as the Faculty of Agriculture of the University of Belgrade, Novi Sad and several other relevant State institutes. According to these assessments, biomass represented a significant energy potential of Serbia. Biomass potential was estimated at 3.448 Mt and its share in the total potential of renewable energy amounted to 61%. The largest part of this potential iswood biomass – 1.53 Mtoe and agricultural biomass potential – 1.67 Mtoe (in crop-farming, cattle-breeding, food-growing, viniculture and primary fruit-processing), while the potential of biodegradable municipal waste was estimated at 205 ktoe. Biodegradable waste (except municipal waste) includes also waste cooking oils and animal waste (slaughterhouse waste) to the total amount of 0.043 Mtoe/year.

Biomass potential is available across the whole territory of Serbia. Wood biomass is located mostly in central Serbia and agricultural biomass in the area of Vojvodina. Nevertheless, while the level of use of wood (forest) biomass potential is relatively high (66.7%), agricultural biomass potential is used very little (about 2%) and biodegradable municipal waste potential is not used at all. It is possible to produce both bioethanol and biodiesel in Serbia. Growing oilseed for the production of biodiesel could be performed over 350,000 ha, from which 220,000 t of biodiesel and about 30,000 t of ethanol per year could be produced. It is estimated that it is possible to collect about 10,000 t of waste cooking oil per year, which could be used for the production of biodiesel.

Wind. Official Serbian data on the assessment of energy potential of wind originate from the study drafted in 2002 for the needs of PE Elektroprivreda Srbije (EPS), a company 100% State-owned. The assessment was implemented based on data from the NHSS collected by measurements from meteorological pylons up to 10 m high, prescribed by IEC 61400-12 standard for 26 locations, as well as data obtained from several other locations with measurements at heights of 50 m. Data on the mean wind velocity and direction were measured and recorded every 10 min. Additional measurements were required, for even though NHSS held data records for several decades, they were related to data on wind at a height of 10 m. Statistical processing of both groups of data and their extrapolation for heights of 100 m, with a 3% to 4%

error led to the estimate that the energy potential of wind in Serbia is **1,300 MW**, with a potential annual production of electricity from wind of 2.3 TWh. Several subsequent studies, taking into consideration technological advancements and the potential for using wind with pylon heights of up to 130 m, showed the potential to be considerably higher.

On the other hand, technically usable potential is, in the case of wind energy and solar energy, determined according to the existing technical possibilities of the electric power system to accept this energy. Additional assumptions in determining the potential are that maximum variations of electricity generation from wind energy will not coincide with the maximum variations of electricity generation from solar power plants and that the maximum variation will not exceed 90% of the total installed capacities. This means that, in the installed capacities, it is possible to have **500 MW** with the current size of tertiary reserves. Bearing in mind the maximum generation possibilities of WWPs with such installed capacity, their maximum technically usable potential would be 1,200 GWh/ year, i.e. 0.103 Mtoe/year.

Solar energy in Serbia represents energy potential that can be used for the generation of heating energy or electricity. Over the greater part of the territory, the number of hours of solar radiation is significantly higher than in most European countries (between 1,500 and 2,200 hours per year). The average intensity of solar radiation ranges from 1.1 kWh/m^2 day in the north to 1.7 kWh/m^2/day in the south during January and from 5.9 to 6.6 kWh/m^2/day in July. The annual average value of radiation energy is from 1,200 kWh/m^2/year in the north-west to 1,550 kWh/m^2/year in the south-east, while, in the central area, it is about 1,400 kWh/m^2/year.

Technically usable energy potential for the conversion of solar energy into heating energy (for the preparation of hot water and other purposes) is estimated at 0.194 Mtoe/year, assuming the application of solar thermal collectors at 50% of the available facilities in the country. Regarding electricity generation, the basic technical limitation is the possibility of the electric power system to accept this energy in the summer months due to variable generation. Based on the currently available capacities of the electric power system for the provision of tertiary reserves, the maximum technically usable capacity of solar power plants (SPPs) adopted is **450 MW**, i.e. their technically usable potential is 540 GWh/ year (0.046 Mtoe year).

Hydro potential. This potential was calculated based on multiannual measurements and monitoring of the values of flow at all 83 NHSS input-output hydrological stations for surface water, as well as local and regional water balances, encompassing balances of precipitation, evaporation, monitoring the groundwater regime, including hydrogeological properties of the terrain, total spring capacities, etc. These calculations were used to produce the study Water Management Basis of the Republic of Serbia (1996/2001). This study shows that the total gross potential from waters flowing along waterways in Serbia is around 27,200 TWh/year. Individual studies at locations assessed as favourable for the construction of HPPs set the technically usable hydropotential in Serbia at around 19.5 TWh/year, with some 17.7 TWh/year in facilities above 10 MW. The energy potential of waterways and locations for the construction of small hydropower plants (SHPPs) was established by the document Cadastre of Small Hydro Power Plants within the Territory of SR Serbia outside of SAP in 1987 and the cadastre of SHPPs in the autonomous province of Vojvodina.

The remaining part of hydro potential and the possibility to use it will also be determined in accordance with the non-energy sector criteria, which are related to multipurpose water use and based on the political agreements as to the division of hydro potential with neighbouring countries. Also, bearing in mind that the estimated potential of SHPPs is based on the cadastre of SHPPs from 1987, a detailed revision of locations will be carried out in the following period in order to make a more precise list of feasible locations and create a better planning basis for the use of this renewable source. Also, for the overall hydroenergy sector, it is necessary to consider the impacts of climate change and the possibility of using water flows for electricity generation. This is important both for the consideration of the expected electricity generation from the existing HPPs and for the possible potential of hydroenergy for the construction of new HPPs.

Geothermal energy. For the assessment of geothermal energy potential, several decades of data collected by the Ministry of Mining and Energy, NHSS and the Faculty of Mining and Geology of the University of

Belgrade were used. The hydrogeothermal potential was determined through the procedure of direct measurements of the yield of identified natural and artificial sources of thermal waters within the territory of over 60 municipalities. The period for identifying the yield of certain springs lasted at least one calendar year. The measured amounts were temperatures, and flows of water at the exit from the borehole and its chemical composition. In case of exploitation, the measured reserves were regularly checked. The greatest number of deep boreholes were drilled in the period from 1969 to 1996 (73 hydrothermal boreholes with a total depth of 62,678.60 m), whereas 45 boreholes with a total depth of 34,840 m were drilled during the 1980s, as part of the search for oil reserves by the former State company for the exploitation and processing of oil. All of the data acquired were used in 2011 to produce the Geothermal Map and Hydrogeological Map of Serbia (http://geoliss.rgf.rs/?page=atlas, Dimitrijević, 2011).

Total heat capacity that could be made by using all existing sources of thermal water is about 216 MWt, with generation of heat energy from 180 ktoe. Significant but not considered geothermal potential is in the use of watered oil and gas boreholes in Vojvodina, where the exploitation is completed.

4.2. Models used to assess potential CO_2 reductions in energy production

Electricity. In the case of electricity, the following formula was used for the calculation of the CO_2 reduction potential (for unused technical hydroenergy potential, wind energy, solar energy, liquid manure, biodegradable waste potential):

$$CO_2 \text{ saving potential } [tCO_2] = EG_{RES}\ [MWh] \times EF_{grid,CM,y}\ [t\ CO_2/MWh]$$

where:

EG_{RES} = potential electricity generated from new RES plants;

$EF_{grid,CM,y}$ = carbon emission factor of Serbian national power grid.

The carbon emission factor of the power grid in Serbia was calulated with the methodological tool to calculate the emission factor for an electricity system developed by the UNFCCC.

The grid carbon emission factor is the amount of CO_2 emissions associated with each unit of electricity in an electricity grid ($tC0_2$/MWh).

The tool determines the grid carbon emission factor for the displacement of electricity generated by power plants in an electric power system, by calculating the „operating margin" (OM) and the "build margin" (BM), as well as the "combined margin" (CM) for grid-connected power generation in the year y. The operating margin refers to a group of power plants that reflect the existing power plants whose electricity generation would be affected by the proposed CDM project activity. The build margin refers to a group of power units that reflect the type of power units whose construction would be affected by the proposed CDM project activity.

Calculation of the OM emission factor. The simple OM emission factor that is based on the net electricity generation of each power unit and an emission factor for each power unit, is:

$$EF_{grid,OMsimple,y} = \frac{\sum_{i,m} EG_{m,y} \cdot EF_{EL,m,y}}{\sum_{m} EG_{m,y}}$$

where:

$EF_{grid,OMsimple,y}$ = simple operating margin $C0_2$ emission factor in the year y ($tC0_2$/MWh);

$EG_{m,y}$ = net quantity of electricity generated and delivered to the grid by power unit m in the year y (MWh);

$EF_{EL,m,y}$ = $C0_2$ emission factor of each power unit m in the year y ($tC0_2$/MWh);

m = all power units serving the grid in the year except low-cost/must-run power units;

y = the relevant year according to the ex-ante option.

$EF_{EL,m,y}$ = is calculated based on data on fuel consumption and net electricity generation of each power plant/unit:

$$EF_{grid,OMsimple,y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO_2,i,y}}{\sum_m EG_{m,y}}$$

where:

$EF_{EL,m,y}$ = CO_2 emission factor of each power unit m in the year y (tCO_2/MWh);

$FC_{i,m,y}$ = amount of fossil fuel type i consumed by power plant m in the year y (mass or volume unit);

$NCV_{i,y}$ = net calorific value (energy content) of fossil fuel type i in the year y (GJ/mass or volume unit);

$EF_{CO_2,i,y}$ = CO_2 emission factor of fossil fuel type i in the year y (tCO_2/GJ);

$EG_{m,y}$ = net quantity of electricity generated and delivered to the grid by power unit m in the year y (MWh);

m = all power plants/units serving the grid in the year y except low-cost/must-run power plants/units;

i = all fossil fuel types combusted in a power plant/unit m in the year ;

y = the relevant year according to the ex-ante option.

The following data for the emission factor of fuel, derived from the Intergovernmental Panel on Climate Change (IPCC), 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) were used for the calculation:

$EF_{CO_2,lignite,y}$ = 101,000 $kgCO_2/TJ$;

$EF_{CO_2,heavy\ fuel\ oil,y}$ = 77,400 $kgCO_2/TJ$;

$EF_{CO_2,oil,y}$ = 74,100 $kgCO_2/TJ$;

$EF_{CO_2,natural\ gas,y}$ = 56,100 $kgCO_2/TJ$;

The simple OMs calculated for 2008, 2009 and 2010 are:

2008: simple OM $EF_{grid.OM,2008}$ = 0.940 t CO_2/MWh;

2009: simple OM $EF_{grid.OM,2009}$ = 0.905 t CO_2/MWh;

2010: simple OM $EF_{grid.OM,2010}$ = 1.119 t CO_2/MWh.

The weighted average OM grid emission factor is

$EF_{grid.OM,y}$ = 984.81 t CO_2/GWh.

The BM emission factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units m during the most recent year y for which power-generation data are available. It includes data about the set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently. BM has been calculated as:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

where:

$EF_{grid,BM,y}$ = BM CO_2 emission factor in the year y (tCO_2/MWh);

$EG_{m,y}$ = net quantity of electricity generated and delivered to the grid by power unit m in the year y (MWh);

$EF_{EL,m,y}$ = CO_2 emission factor of power unit in the year y (tCO_2/MWh);

m = power units included in the build margin;

y = most recent year for which power-generation data are available.

The CO_2 emission factor of each power unit m is determined as in the OM calculation. Table 9 shows the information on the power plants recently built in Serbia to be included in the sample group for BM calculation.

Table 9: Recently built power plants

Power plant	Commissioning date	Capacity (MW)	Average	Fuel consumption (Kt)
TPP Nikola Tesla B2	1985	620	3,900	5,530
TPP Kostolac B1/B2	1987,1991	680	3,306	4,530
TPP-HP Zrenjanin A1/A2	1989	110	41	6
HPP Djerdap II	1985–1987, 1998, 2001	270	1,520	-
HPP Pirot	1990	80	138	-
Total		**1,760**	**8,905**	**10,066**

The BMs calculated for 2008, 2009 and 2010 are:

2008: $EF_{grid.BM,2008} = 0.889\ tCO_2/MWh$;

2009: $EF_{grid.BM,2009} = 0.932\ tCO_2/MWh$;

2010: $EF_{grid.BM,2010} = 0.894\ tCO_2/MWh$;

The weighted average BM emission factor is

$EF_{grid.BM,y} = 0.9052\ tCO_2/MWh$

The CM emission factor is calculated as follows:

$$\boxed{EF_{grid,CM,y} = EF_{grid,BM,y} \cdot w_{BM} + EF_{grid,OM,y} \cdot w_{OM}}$$

where:

$EF_{grid,BM,y}$ = BM CO_2, emission factor in the year y (tCO_2/MWh);

$EF_{grid,OM,y}$ = OM CO_2 emission factor in the year y (tCO_2/MWh);

w_{OM} = weighting of OM emission factor (%);

w_{BM} = weighting of BM emission factor (%).

The following data were used for the calculation:

$EF_{grid.BM,y} = 0.905\ tCO_2/MWh$: the calculated value from the BM section;

$EF_{grid.OM,y} = 0.985\ tCO_2/MWh$: the calculated value from the OM section;

$w_{OM} = 0{,}5$: the default value in accordance with the methodology tool;

$w_{BM} = 0{,}5$: the default value in accordance with the methodology tool.

According to the tool and to the above-mentioned assumptions, the carbon emission factor of the Serbian national power grid, therefore, is:

$$\boxed{EF_{power.grid} = EF_{grid,CM,y} = 0{,}945\ tCO_2/MWh}$$

Heat energy. In the case of heat energy, the following formula was used to calculate the CO_2 reduction potential (for unused technical hydroenergy potential, wind energy, solar energy, liquid manure, biodegradable waste potential):

$$\boxed{CO_2 \text{ saving potential } (tCO_2) = EG_{RES}\ (TJ) \times EF_{heat,CM}\ (tCO_2/TJ)}$$

where:

EG_{RES} = heating potential from unused RES;

$EF_{heat,CM}$ = carbon emission factor of the Serbian heat sector.

According to the energy balance of Serbia for 2013, heating requirements used 23% of energy from the district heating systems: 21.20% electricity; 9.3% natural gas; and 9.5% coal (37% wood biomass). The consumption of energy carriers in the district heating systems therefore had the following shares: 50.5% natural gas; 26.50% heavy fuel oil; 23 % lignite. The main fuel source for the district heating was natural gas (50.4%), followed by heavy fuel oil (26.5%) and coal (23%), and the carbon emission factor of the Serbian heat sector was calulated as:

$$EF_{heat,CM} = \sum_i EF_{CO_2,fuel,i} \cdot w_{fuel,i} + w_{dist.heat.} \sum_j EF_{CO_2,fuel,j} \cdot w_{dist.heat.fuel,j}$$

where:

$w_{fuel,i}$= energy share of each energy carrier;

$EF_{CO_2,fuel,i}$ = CO_2 emission factor of fossil fuel type I;

The following data for the CO_2 emission factor of fuel (IPCC, 2006), were used for the calculation:

$EF_{CO_2,lignite,y}$ = 101,000 $kgCO_2/TJ$;

$EF_{CO_2,heavy fuel oil,y}$ = 77,400 $kgCO_2/TJ$;

$EF_{CO_2,oil,y}$ = 74,100 $kgCO_2/TJ$;

$EF_{CO_2,natural gas,y}$ = 56,100 $kgCO_2/TJ$.

V. Economic, environmental and policy analysis: an appraisal of the overall impact of the policy measures introduced

5.1. Electricity sector

In addition to data on the energy sector of Serbia and the current energy policy, elaborated in previous sections of this study, the implementation of a correct and comprehensive analysis of the impact of renewable energy investments on the economic development and state of the environment in Serbia and the assessment of future trends requires reverting to the reasons for the current state of the energy sector.

During the second half of the 20th century, when the energy sector was expanding, Serbia was not an independent State, did not have an independent energy policy and did not develop its energy sector independently. Being one of the republics comprising Yugoslavia (PRY, SFRY) during this period and in accordance with its energy resources, it subjected the development of its energy sector to common interests and the energy policy of the State of Yugoslavia. The energy policy of Yugoslavia at the time was primarily directed towards the development of plants for its own use, as well as cost-effective energy sources. Serbia was one of the former Yugoslav republics with significant amounts of lignite and relatively significant hydropotential, leading, during the period 1956–1987, to the construction of eight TPPs in Serbia, employing 25 thermal-energy blocks with a total power of 3,963 MW, using lignite as a fuel; six HPPs with 50 hydro-aggregates with an installed power of 2,835 MW; and three gas thermal power and heating plants, with an installed power of 353 MW (Tables 10 and 11).

At the time, these capacities were significantly in excess of the power needs of Serbia. It is interesting to note that, although no particular attention was given to the increased use of renewable resources at the time, 16 large and medium-sized HPPs were built solely for their cost-effectiveness, comprising nearly 34% of the total electrical power capacity of Serbia to date. Likewise, considering the centralized communist, followed by the socialist, approach to doing business at the time, all these facilities were built within a single company that was, naturally, State-owned. Although Serbia has initiated processes of transition and privatization (the sale of State-owned property to private owners) since 1990, the electricity sector remains non-privatized, thus the sector continues to operate within PE Elektroprivreda Srbije (PE EPS), still 100% owned by the Government of Serbia.

The sole significant change of ownership occurred in 2005, when the segment for high-voltage transmission of electricity – the so-called transmission system – was separated from EPS, with the founding of a separate company PE Elektomreže Srbije (PE EMS). Both companies are 100% State-owned. It is also worth noting that coal production for the needs of PE EPS has been, and still is, being carried out by the same company, fully meeting its needs. Open pits are located in the immediate vicinity of the relevant TPPs and the confirmed reserves of lignite within these deposits are assessed as sufficient to meet the electricity needs of Serbia for the next 50 years. At the same time, in accordance with the existing Law on Mining and Geological Research, the ore rent for lignite and for water is only 3%, meaning that PE EPS is obtaining the required lignite and hydroenergy at an extremely low price.

Table 10: Thermal power plants and combined heat and power plants in Serbia

Generator	Fuel	Commissioning	Pnet (MW)	Fuel Consumption PMAX (MJ/MWh) (Net, LHV)
TENT A1 – CHP	Lignite	1970	191	11.300
TENT A2 – CHP	Lignite	1970	191	11.300
TENT A3****	Lignite	1976	305	10.900
TENT A4****	Lignite	1978	305	10.900
TENT A5****	Lignite	1979	320	10.500
TENT A6****	Lignite	1979	320	10.500
TENT B1	Lignite	1983	610	9.800
TENT B2	Lignite	1985	610	9.800
TPP Kostolac A1 - CHP	Lignite	1967	90	13.000
TPP Kostolac A2 - CHP	Lignite	1980	191	11.900
TPP Kostolac B1	Lignite	1987	320	10.500
TPP Kostolac B2	Lignite	1991	320	10.500
TPP Morava	Lignite	1969	108	12.100
TPP Kolubara A1 - CHP	Lignite	1956	29	16.500
TPP Kolubara A2 - CHP	Lignite	1957	29	16.500
TPP Kolubara A3 - CHP	Lignite	1961	58	16.500
TPP Kolubara A4	Lignite	1961		
TPP Kolubara A5	Lignite	1979	100	12.300
CHP Novi Sad - CHP	Gas	1984	210	12.547
CHP Zrenjanin - CHP	Gas	1989	111	13.824
CHP S. Mitrovica - CHP	Gas	1979	25	15.296

Table 11 : Hydropower plants and PSHPP in Serbia

Generator	Technology	Commissioning	Pnet (MW)
HPP Bajina Bašta	RoR	1966–1968	410
HPP Đerdap 1	RoR	1970–1972	1122
HPP Đerdap 2	RoR	1985–1987, 1998	270
HPP Zvornik	RoR	1955–1958	96
HPP Potpeć	RoR	1967–1970	51
HPP Elektromorava	RoR	1954–1957	17,8
HPP Bistrica i HPP Kokin Brod	Storage	1960–1967	126
Vlasinske HPPs	Storage	1954–1978	129
HPP Uvac	Storage	1979	36
HPP Pirot	Storage	1990	80
PSHPP Bajina Bašta	Pumped storage	1982	614
Small HPPs	RoR		20

The electric power plants built 30 years ago were economically already paid-off, with the direct use of almost free energy carriers, lignite and hydroenergy due to the very low ore rent, as well as social-political reasons, the maintenance of social peace by way of low electricity prices, this PE proved to be able to operate in a financially positive manner and produce and sell very cheap electricity. The market price of this electricity, placed on the market by PE EPS during the last decade, was frequently the lowest in Europe for households amounting, during the second half of 2015, to €cent 6.45/kWh (4.99 + 1.46 VAT), whereas for industry it amounted to €cent 8.13/kWh (6.30 + 1.83 VAT). All of this, despite the completely open market in accordance with the Energy Law of 2015, still positions PE EPS as a form of monopoly under the direct control of the Government of Serbia, representing one of the obstacles to strengthening the private electricity sector in general and the RES segment in particular.

At the same time, due to the large number of employees of PE EPS, with nearly 35,000 directly employed and several times more in various dependent companies, the importance for the Serbian economy of this, the largest Serbian enterprise, as well as the social peace brought about by the stable operation of this company, the Government is expected to protect this company as much as possible for a considerable period, ensuring its market domination. All of this is indirectly placing the management of EPS in a position where they do not have to be in a particular hurry in turning towards the construction and use of new RES.

Still, under pressure of the commitments of Serbia towards the EnC, as well as recognizing the strategic importance of RES, PE EPS acted upon the request of the Ministry of Mining and Energy in 2011, founding the company EPS RES PLC as a component part tasked with the development of new power plants using RES. As a result of their work and in addition to 18 projects for the revitalization of SHPP, EPS is on track to implement two large RES projects by 2020: the Kostolac Wind Park with an installed power of 60 MW and an estimated annual production of 144 GWh, and a solar power plant with 10 MW of power. A solar power plant with 100 MW of power will also be built during the second phase.

It is precisely this concept that could represent a recommendation for the model, showing how the Government, i.e. the Ministry of Mining and Energy, in cooperation with EnC and the power company controlled by the Government, can prepare large RES projects. This model can be expected to produce good results, because each of the above parties is directly interested in project implementation. The EU and the EnC as a signatory of the Energy Community Treaty, managed to implement its obligations, increase RES capacities and reduce CO_2 emissions. The Government of Serbia i.e. the Ministry of Mining and Energy, motivated with the desire to meet the preconditions for EU accession, and PE EPS because, in addition to making a certain profit, is continuing to strengthen its dominance in electricity production on the national market. Additionally, due to all of the above, the Government has a clear motive to further empower its company so that, even in the case of privatization, it would have the greatest economic rating possible, modernizing it and therefore making it more attractive for sale.

Even if privatization does not occur, strengthening PE EPS is strategically strengthening the energy stability and independence of Serbia. Using domestic energy sources leads to reduced import dependency, and thus a higher level of energy security. The use of new technologies also increases the level and quality of know-how in PE EPS and modernizes obsolete plants. In particular, the living conditions for all citizens are improved. In addition to the reduction of GHG emissions, the emissions of other harmful matter and solid particles are also being reduced. Likewise, due to reduced consumption, there is a decrease in the number of devastated areas, ash-holes and open pit mines. This is particularly important, because nearly all open pits in Serbia are situated on high-quality first and second category land, already used for agricultural purposes.

PE EPS also has advantage in technical terms in comparison with the other investors in renewable energy. Namely, the entire power distribution system, up to 35 kV, is owned by this company. Since the majority of connections, other than larger wind parks, are connected to networks at this voltage, there is not even the possibility of misunderstandings when developing contracts for power plant connections to the network. They are particularly economically feasible in the case of building solar plants on large ash-holes, in the immediate vicinity of existing TPPs due to the close proximity of connections to high-voltage 110 kV lines.

Finally, an issue becoming ever more important with the construction of new RES power plants, is that PE EPS and the Government, i.e. the Ministry of Mining and Energy, can say with pride that their companies are socially responsible, taking care not only of their own interests, but also of general social interests, and pay attention to the creation of a cleaner and healthier environment.

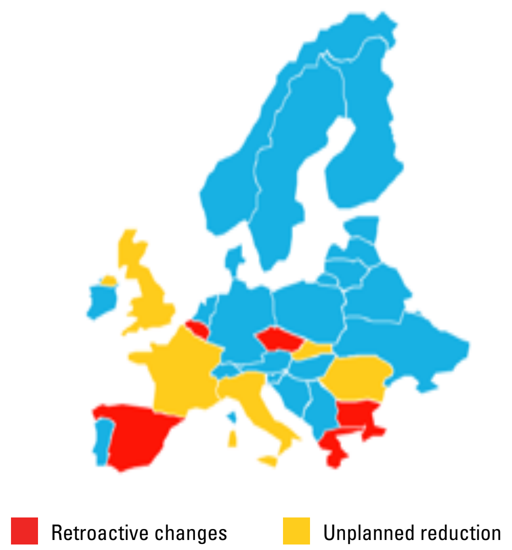
On the other hand, precisely through accession to EnC and commitments for adapting the operation of the energy sector, Serbia is becoming harmonized with the rules and method of operation of all its energy sectors with those in the EU. Serbia has therefore indirectly accepted that, with the opening of the electricity market, as well as the RES electricity market, it will treat public and private companies on an equal footing. **Considering the greater flexibility and greater rate of adoption of new technologies and higher operational capabilities, as well as higher motivation due to a direct link between profits and earnings in all countries, including Serbia, the logical solution for the envisaged bearers of the future development of this sector is for them to be private investors.** This also happened in Serbia in the segment of relatively small investments of up to several million euros, i.e. power plants with outputs up to several MW. Over 100 SHPPs, solar plants and bio-gas plants have been built in this segment (see next chapter for more details). However, under the segment of large investments, large and medium-sized HPPs, and particularly wind parks, requiring multi-million euro investments, the construction of new power plants has been lacking.

Despite the efforts made by the Government and the fact that, since 2009, through relevant bylaws, Serbia has introduced the very attractive FIT system for subsidizing producers of electricity from RES. The legal framework was also improved several times and the Energy Law of 2014 is fully harmonized with all EU rules and the RES Directive, nothing significant happened regarding the construction of large RES power plants.

The main reasons for this were identified as a significant lack of trust among investors, as well as international financial institutions (IFI) in the legal system of Serbia, a relatively modest financial rating for Serbia and, especially, very poor experiences that investors, and particularly IFIs, had in EU Member States. These poor experiences related primarily to retroactive changes of laws, the so-called political force majeure and insurance of investments.
During the last decade, nine EU Member States made retroactive changes to laws and retroactive renewable energy market rules. During the same period, unplanned reduction of electricity accepted on the grid from the system operators has often occurred. This has introduced additional uncertainty for lenders and investors.

Figure 7 shows which EU Member States made retroactive changes to laws and unplanned reductions of the acceptance of electricity produced from RES.

Figure 7: EU Member States implementing retroactive changes to laws and unplanned reductions in the acceptance of electricity produced from renewable energy sources



Source: Bloomberg New Energy Finance

At the same time, the already mentioned insufficient credit rating of Serbia (2016, Moody's, B1, positive, Fitch, BB-, stable), i.e. modest macroeconomic performance, political stability, banking sector stability (speculative grade – capacity to meet financial commitments, risk of changes in business environment and economic conditions, significant credit risk) have created a situation where investments in large projects are entirely absent.

To resolve this stalemate, the Ministry of Mining and Energy decided in 2015 to prepare a new set of bylaws, to be fully harmonized with IFI requirements, while simultaneously protecting the interests of Serbia. In other words, the requirements of lenders had to be met to protect the security of their investment (lenders insist on State guarantees for their investment), while, on the other hand, no concessions were to be made that would slow down Serbia's process of financial consolidation (Serbia is in the process of financial consolidation. The World Bank does not allow State guarantees (increasing the debt).

The solution that led to a way to overcome these problems was the adoption of **a new model of a power purchase agreement.**

The basic idea of this document was that it would include almost every disputed situation that could arise, with a prescribed method of settling such disputes, such as:

- **Force majeure** – political and natural – and effects thereof;
- **Change in law** – the coming-into-force of new regulations after the date of coming-into-force of the PPA;
- **Payment security instruments** – maintenance and enforcement of payment security instruments;
- **Contract termination** – defining all possible circumstances when a privileged producer can terminate a PPA and charge their entire losses;
- **Risk of electricity not received by the system operator, etc.**

Moreover, the competence for the resolution of any disputes arising from, or in connection with, the PPA is not held by national, but by international courts, such as the international courts of arbitration of the International Chamber of Commerce (ICC) in Paris and the International Arbitral Centre of the Austrian Federal Economic Chamber in Vienna (VIAC).

This move by the Ministry of Mining and Energy turned out to be very good. A total of 13 requests were submitted in 2015 only, for acquiring preliminary privileged power producer status for wind farms with a total installed power of 920.3 MW, significantly above the maximum capacities planned through strategic and planning documents and bylaws to the amount of 500 MW by 2020.

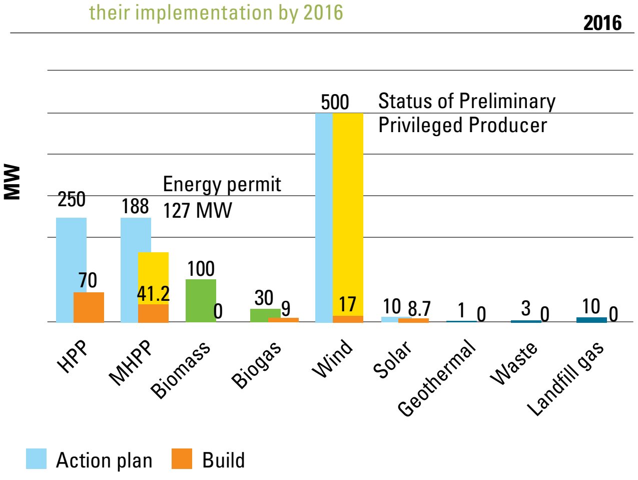
Temporary status was issued for approximately 500 MW in new wind farms, representing an investment of around €700 million (investors have applied for, and received, the status of temporary privileged producer for the rest of the available capacity for wind farms of 483 MW, Figure 7). These capacities are significant for Serbia for two very important reasons: the first is a contribution to the gradual achievement of the goal of 27% share of RES in the BFPE by 2020, the other is assuring other investors that Serbia is developing a stable climate for investments, and is a reliable partner for anyone wanting to invest in the field of RES.

One of the conditions for acquiring the temporary privileged power-producer status was the submission of financial securities (bank guarantee or deposit) to the amount of 2% of the investment value of the project. This condition was introduced to eliminate investors not having a serious intention to implement their projects. The Ministry of Mining and Energy received bank guarantees to some €16 million, as financial securities guaranteeing the construction of 500 MW of new wind farms. The Ministry is authorized to collect the guarantees if the plants are not built by the set deadline. The collected funds would be used to pay privileged producers of electricity from RES, as envisaged by the regulation on reimbursements for stimulating privileged power producers.

All of this gives hope, and may also be a recommended model for how to overcome similar problems in other countries.

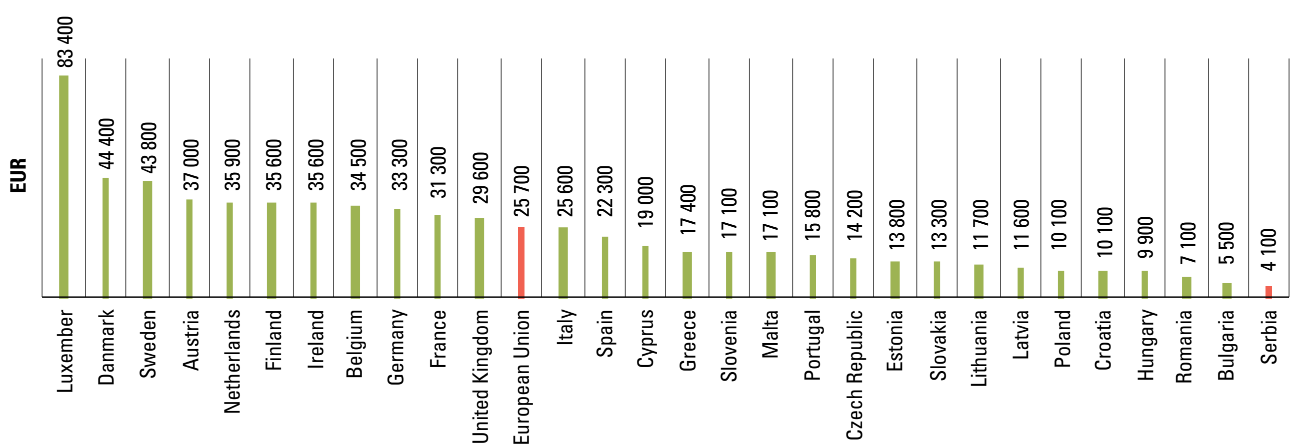
This analysis should not leave out another important factor, related to the overall awareness of citizens, typical only for former socialist and communist countries. Namely, the society and citizens of these countries have, as a rule, undergone or are still undergoing the transition from social property to private property. In most countries of the former Eastern Bloc, the transition process was rather unfair and led to a significant stratification of the population, where the owners of certain private companies gained enormous richess, while the majority of the population, in addition to the loss of certain social benefits, became poor. Likewise, in this process, society moved suddenly from a more or less socially safe socialist system into the early phase of capitalism, with a rather harsh situation in the labour market, producing an additional lack of trust in the new system, i.e. lack of faith in its justness. Since all of this happened in a relatively short period, awareness and memory of socially responsible State companies from the era of socialism, taking care of their workers, and new experiences of the completely opposite behaviour in private companies, caused citizens to view the intentions of private investors with distrust, without a kindly opinion of their expansion, particularly when they are given natural resources to use, even when they are renewable.

Figure 8: Review of the goals of the renewable energy sources action plan for Serbia for 2020 under the section of electricity and their implementation by 2016



This part of the analysis should also stress that during the end of the last century, in addition to going through transition, Serbia was involved in a 10-year civil war. The consequences of these events in the economic sense were a drastic depletion of the wealth of its citizens – one Serbia still has not recovered from. Gross domestic product of 1986, amounting to some US$ 6,460.70, has still not been achieved. In 2015, it amounted to US$ 5,235.10 (World Bank), i.e. just over 80%. At the same time, since modern use of RES for electricity production still represents a more expensive method of producing this energy compared to classical sources, it is clear that richer countries will be able to afford significantly greater investments, resolving energy problems in a long-term and comprehensive manner, ensuring a cleaner environment, better struggle against global warming and better care of their citizens' health. On the other hand, this automatically places developing countries in an inferior position. Figure 8 shows the comparison of GDP per capita for EU Member States and Serbia. This already clearly shows that Serbia and other developing countries, with GDPs several times lower than those of developed countries, have a significantly poorer economic basis, and can transition to a modern way of using RES only with proportionately greater economic effort.

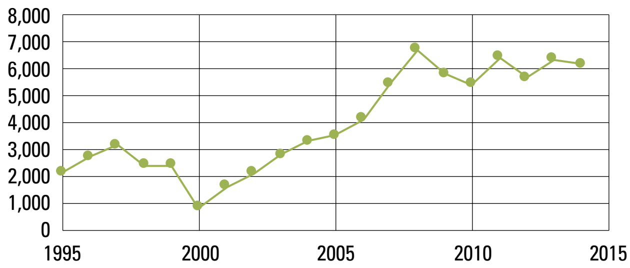
Figure 9: Gross domestic product per capita in euros (2013)



Additionally, speaking of the economic aspects of the use of RES, it is particularly important to comprehend the total economic profit this field can bring a society and State. In this phase, Serbia – **but also the vast majority of developing countries – represents only users of modern technologies for the use of RES.** To one who is only a user of this equipment, it is clear that the **number of employees in this field is, in fact decreasing**, regardless of widespread talk of the large number of new jobs in this field. Modern technologies for the use of wind, SHPPs and solar energy hardly require employees. At the same time, considering that electricity generated from RES will replace electricity generated from fossil fuels, it is clear that this will, in practice, lead to a reduction of the number of employees. Serbia does not have a developed industry, the technological processes for the manufacture of devices and equipment for the use of RES are unknown and have not been adopted. Unfortunately, due to the Yugoslave wars, and subsequent international sanctions, Serbia was barred from international affairs and trends for an entire decade and its industrial production virtually stopped. Due to the relatively long duration of the civil war and international sanctions, in addition to technological delays, the country faced migrations and the departure of the technically best educated segment of the population abroad. The overall level of education and technical know-how in Serbia was thus significantly reduced, along with the capacities to quickly take over the technological processes for the production of devices and equipment for the use of renewable energy sources.

It is important to note that developed countries started the development of long-term programmes to contribute to the use of RES more than three decades ago. These started as scientific projects, followed by projects for technological development and the construction of the first pilot plants for the use of RES and, finally, the development of technological processes and raising the production of equipment and devices for the use of RES to an industrial level. In each of these segments, through investing funds, these countries strengthened their scientific, technological, and industrial potential, producing a difference compared to developing countries: a visionary policy that produced results after a number of years. Through the development of technologies for the mass production of equipment and devices for

Figure 10: Variation of gross domestic product per capita in Serbia since 1995



the use of RES, such as wind turbines, PV systems, bio-gas technologies and gas turbines, developed countries have become leaders in the field. The unattainable differences in knowledge and familiarity with the technologies for small and developing countries (an exception being China), enable the developed ones to regain and multiply all the invested funds through high prices. By purchasing finished products, developing countries continue to strengthen the economies of developed countries. Only in rare cases do large companies invest in factories for the production of certain parts of the equipment and devices for the use of RES in developing countries. In such cases, however, the host countries are only providers of the service of renting the labour force, while the investor companies retain the indisputably existing profits.

Due to all of the above, in the financial sense, and observed in the short-term, as usual for developing countries, the use of these technologies is considered an extra expense in the generation of electricity. In the case of Serbia, where one of the conditions for EU accession is an increase in the share of RES in the final consumption, the construction of expensive wind farms, bio-gas plants and the still expensive solar power plants and/or the purchase of expensive electricity, are all considered primarily as the price to pay for EU membership. Although Serbia has the comparatively large advantage of having significant lignite reserves – its own large energy source – the wars brought Serbia into a situation where it is a buyer and not an exporter of knowledge and technologies. Unfortunately, Serbia did not begin working on the development of RES technologies in time, so in this phase it cannot expect this to be its economic development area.

5.2. Heating-energy sector

A situation similar to the electricity sector, regarding its development, occurred in Serbia in the field of district heating systems. A total of 55 of them with an installed power of 6,548 MW were built over 30 years ago. All were designed to be fuelled by oil derivatives that were cheap at the time – heavy fuel oil, fuel oil and coal. Later, due to the energy crisis, most heating plants that were reached by the gas pipeline network transitioned to the use of natural gas, which was cheaper at the time. During 2015, the use of natural gas in heating plants was 558,790 million m3, coal 180,920 tons, oil derivatives 92,822 tons, and biomass 3,559 tons [2]. The share of these fuels in the total consumption of heating plants for natural gas was 74%, oil derivatives 15%, coal 11% and biomass less than 0.1%.

It is important to note that all district heating systems in Serbia are still owned by local self-government units (LSUs), under so-called public ownership, i.e. neither privatization nor the development of the heating energy market has occurred in this field. In other words, the heating plants had – and retained – a free form of monopoly position at the level of towns and/or municipalities. The price of heating is still determined by LSUs. At the same time, in accordance with the Energy Law and the Law on communal activities, district heating systems are under the auspices of local authorities, i.e. LSUs. This also applies to stimulating the use of RES for heating purposes, since, according to the Energy Law, LSUs prescribe incentive measures for heating-energy producers using renewable sources in the production of heating energy. This was shown to be the greatest obstacle to the more intensive introduction of RES as a fuel – primarily biomass –for heating purposes.

The excessive indebtedness of nearly all LSUs located in the south of Serbia, rich with forest biomass, prevents these municipalities from undertaking any large interventions and changes in their district heating systems. Likewise, in addition to the continued trend of depopulation (the population increase coefficient is negative, amounting to –4.9 per mille annually), a significant problem is the decades-long migration of the population from smaller towns to the capital. This reduction in population numbers aggravates the difficulty for LSU management to justify investments in the development of local energy infrastructure. If we add to this the usual lack of experts in such small and underdeveloped communities, capable of working with this contemporary approach to energy, it is clear that, without significant intervention by the central State authorities, this process will be fully blocked. This, of course, does not represent a desirable and EU-mandated, sustainable, market-oriented approach to the use of RES. However, considering the overall situation and the fact that these are publicly owned enterprises, it represents the only currently acceptable model.

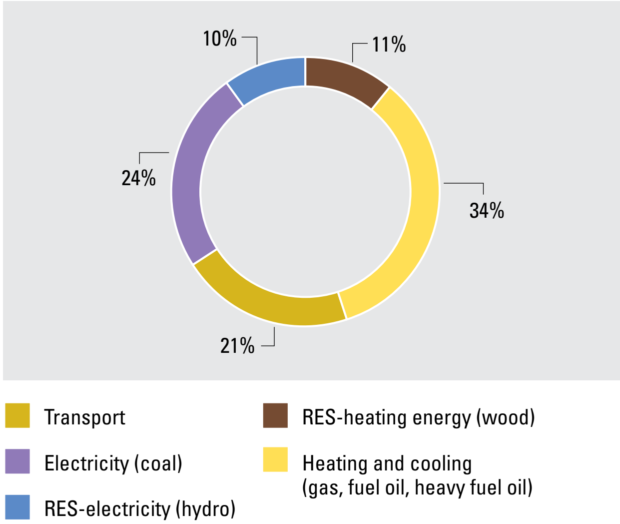
With the recognized need for involving central authorities, the Ministry of Mining and Energy started the project "Stimulating the use of renewable energy sources – development of the biomass market" in 2012. The project, implemented in cooperation between Germany, Serbia and the German Development Bank (Kreditanstalt für Wiederaufbau (KfW)), aims for the use of biomass in heating plants in Serbia. Biomass would be used to produce heating energy or the cogeneration of heating and electricity. The approximate budget is €100 million, and the first phase would use €20 million of loans and €7 million in grants. The project of transitioning boilers in heating plants to biomass involves the substitution of fossil-fuel boilers to wood-chaff boilers; additional fossil-fuel boilers would be used as auxiliary systems during periods of peak heating loads.

At the same time, due to the need for educating the population and the importance of increased awareness of the advantages of the use of biomass, the Ministry of Mining and Energy, in cooperation with the United Nations Development Programme (UNDP), initiated another project entitled "Development of the biomass market for energy production (2014–2018)", financed from the funds of the Global Environmental Fund (GEF) and UNDP, to the amount of US$ 3.15 million. The goal of the project is to increase the share of renewable energy in the energy balance of Serbia, i.e. the share of biomass in energy production. In addition to direct incentives to investors for building facilities that would use biomass, this project provides support for the improvement of the institutional and regulatory framework and serves as support to the technical preparation of similar projects by drafting feasibility studies and technical documentation. It will also develop instruments for ensuring security and continuity of supply for the plants for producing energy from biomass and a reduction in the business risk of producing and selling biomass, such as contracts on the long-term supply of biomass and detailed technical specifications for biomass products.

Regarding heating energy, it is important to note that, within the household sector in Serbia, forest biomass is traditionally used for heating. This fuel for households is used in non-urban environments, as well as peripheral sections of urban environments, lacking both a district heating network and gas pipelines. Unfortunately, although this fuel comprises half the total RES energy used in Serbia (Figure 10), it is used in a very inefficient manner. The low efficiency rate of stoves used in households for heating and the relatively high moisture content of this wood leads to a significantly higher use of this fuel than necessary. Likewise, despite multiple attempts to identify the exact level of use of this fuel, due to the high rate of illegal felling and a developed black market, they did not provide entirely reliable results. Assessments indicate that Serbia is currently using around 1.03 Mtoe, i.e. 10% of total energy consumption, although some surveys indicate that the felling rate is significantly higher, greater even than natural growth (20% of the total energy consumption in Serbia).

An important opportunity in the development of this sector lies in the fact that currently nearly all forests in Serbia are of a relatively poor quality, so-called coppice forests, which should be cleared; high-quality forests should be planted and maintained in their place. This would contribute to an increased growth of biomass, higher CO_2 absorption, as well as the development of new jobs and the potential development of the wood-processing industry. Additionally, significant results could be achieved through the forestation of the northern parts of Serbia and the autonomous province of Vojvodina, which, although once rich in forests, currently represents the least forested region in Europe with a rate of 6.37% of afforestation.

Figure 11: Gross final energy consumption (2012)



VI. Policy design considerations: implications for promoting this successful policy more widely on a national basis

6.1. Beginnings and obstacles

Renewable energy sources were introduced in the legal framework of Serbia for the first time in 1986, by the Law on Electricity (Official Gazette of the Socialist Republic of Serbia, No. 13/86), but at that time there were no subsidies for producing electricity using RES. This law has been changed many times in the past and was eventually replaced in 2004 by the Energy Law (Official Gazette of the Republic of Serbia, No. 84/04). This law did not predict any subsidies for producing electricity using RES but it was sufficient to introduce the relevant incentives through the FIT system in 2009.

Despite the fact that Serbia introduced incentive measures for using RES, the ministry in charge of energy issues did not have sufficient administrative capacity for renewable energy issues. After Serbia became a member of the EnC in 2006, the need to establish an RES unit was recognized. In 2009, this unit included the assistant Minister for RES and just one energy lawyer. As interest in the use of RES has grown, the number of employees in the RES unit, which is responsible for the transposition and implementation of EU policy regarding RES, has increased; in 2012, it had six employees. Since the restrictive measures of the Government regarding the number of employees in public administration, it comprises just three permanently engaged employees, which represents a large administrative limitation in terms of fulfilling demanding policy goals in this area.

A small number of employees in the government administration, lack of experience and general knowledge in this area, especially in the area of legal and contractual procedures, meant that demanding plans and commitments to improve and develop the field of renewable energy were not met. The engagement of additional capacity was required, i.e. international and bilateral assistance.
In order therefore to strengthen its technical, organizational, legal and managing capacity, raising the level of knowledge, but also in order to cover the construction of concrete plants that use renewable energy, the Ministry of Mining and Energy has started the implementation of several international projects, which are listed below.

Before reviewing the projects, **it is important to emphasize that in addition to their main results – creation of studies, plans, projects, plant construction, etc. – these projects have a special significance in the area of transfer of knowledge, the acquisition of valuable experience and the subsequent implementation thereof. These segments of the projects give them a special quality and contribute to their sustainability.**

6.2. RES projects and programmes of the Ministry of Mining and Energy

COMPLETED PROJECTS

1) Promotion of renewable energy sources and energy efficiency

Performed: EPTISA (Spain) in association with Mannvit (Iceland) and Energy Saving Group (Serbia)
Financial support: 2010 Programme for the Republic of Serbia. (EUROPEAID/129768/C/SER/RS) under the European Union's IPA
Goal: Part A: support Serbian institutions in their effort to increase geothermal utilization and guide the management of the geothermal resource; three PFS for geothermal projects.
Part B: support Serbian institutions in their effort to increase energy efficiency; three PFS for combined produce of heat and electricity
Implementation period: 2010–2012 (18 months)

2) Methodology and calculation of feed-in tariffs for electricity generation

Performed: Economic Consulting Associates and Energy Saving Group
Financial support: European Bank for Reconstruction and Development (EBRD) under the Western Balkans Sustainable Energy Direct Financing Facility
Goal: Institutional capacity-building to support individual countries in the promotion of sustainable energy investments
Prepared an FIT calculation methodology for electricity generation using RES and from CHP) production for Serbia
Implementation period: 2011–2012

3) Incentive measures for heat production

Performed: Economic Consulting Associates and Energy Saving Group
Financial support: European Bank for Reconstruction and Development (EBRD) under the Western Balkans Sustainable Energy Direct Financing Facility
Goal: Institutional capacity-building to support individual countries in the promotion of sustainable energy investments
Recommended financial and non-financial incentive measures for greater use of RES in the heating sector
Implementation period: 2011–2012

4) National renewable action plan development (NREAP)

Performed: Local expert and ECOFYS
Financial support: Government of Netherlands
Goal: Support Serbia to find best possible trajectroy to achieve binding RES share 2020
Developed simplified NREAP and National Renewable Energy Action Plan
Implementation period: 2011–2013

ONGOING PROJECTS

5) Updating the register of small hydropower plants

Projects financed through IPA 2012 EU Instrument for Pre-Accession Assistance
This programme envisages a service agreement for the project “Updating the Register of Small Hydropower Plants” for €1.5 million. The evaluation of bids received for the project is in progress, and the project completion is planned for 2018, when it is expected that an updated cadastre of SHPPs will be completed. Its development will facilitate the implementation of projects relating to SHPP construction through a streamlined search for potential locations and the systematized presentation of main parameters.

6) Preparation of the national scheme for the verification of biofuels

This programme envisages a service agreement for the project to developing a national scheme for the verification of biofuels to the amount of €500,000. Approval of the project is in progress and its completion is planned for 2018, when it is expected that the analysis of possibilities for applying the national scheme for the verification of biofuels is completed. The study will provide a specific insight into the costs and benefits of any national scheme for the verification of biofuels and facilitate the achievement of the targets from the NREAP in the transport sector.

7) Cooperation between Serbia and Germany in the energy sector

This cooperation involves primarily the financial form of cooperation between Germany and Serbia that is being implemented through appropriate projects in the fields of energy efficiency, RES and district heating. The main partners of Serbia are the Ministry for Economic Cooperation and Development of Germany (Bundesministerium für Wirtschaftliche Zusammenarbeit (BMZ)), KfW and the German Agency for International Cooperation (Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)), as part of the German Climate and Technology Initiative (Deutsche Klima- und Technologieinitiative (DKTI)).

8) Promotion of utilization of renewable energy sources – biomass market development

The aim of this project is the utilization of biomass in heating plants for the production of heat energy or combined heat and power production. The budget amounts to around €10 million. In early December 2012, the Ministry of Mining and Energy and KfW signed an agreement on a donation for consultancy services worth €800,000, within which the previous feasibility study for selected TPPs was completed. The feasibility studies were completed in April 2014 and, in line with their results, LSUs in the south-western part of Serbia were invited to take part in the implementation of projects related to the utilization of forest biomass for producing heat energy in local heating plants. The negotiation process for the realization of the first phase of the project in the amount of €20 million, is currently in progress.

9) Reducing barriers to accelerate the development of biomass markets in Serbia

The Ministry of Mining and Energy and UNDP, together with the Ministry of Agriculture and Environmental Protection, are implementing this project. The project funds are provided by GEF (US$ 2.85 million) and UNDP (US$ 0.31 million). The overall objective of the project is sustainable energy utilization through the diversification of energy sources and development of the biomass market for energy purposes in Serbia. The project funds shall be used to provide grants to investors for construction of plants (~1 Wel) for CHP production from biomass. The total amount of funds available for grants for this purpose is US$ 1.6 million.

A public call for tender for interested investors was completed in December 2015 and the agreement of donation was signed for six concrete projects for constructing biogas plants. Four plants were completed in November 2016 and it is expected that the remaining two will be completed in 2017. The total installed capacity of all plants is 6.32 MWel, and the overall investment value of all projects is US$ 23 million. Interactive step-by-step guides for investors were created and translated into English, with the aim of acquainting potential investors with all the necessary procedures awaiting them.

A "Green Energy" internet portal was prepared as the official informative website in the field of RES and the site of the biomass stock exchange. It was created in cooperation with the Chamber of Commerce of Serbia and it was planned to be launched by the end of 2016.

6.3. Market conditions and normative conditions

When Serbia became a member of EnC, a few years before accepting its obligations in the field of renewable energy, Serbia began harmonization of the market and regulatory conditions of the power sector with the rules, market and normative conditions of the EU power sector. That harmonization was significantly more complex, comprehensive and difficult than harmonization solely in the field of renewable energy.

From the institutional point of view, in order to achieve full harmonization and open the electricity market, it was necessary first of all to unbundle the Electrical Power Industry of Serbia – the only State-owned company – and, at the same time, establish an independent regulatory agency for energy - the Energy Agency.

The separation of electricity transmission and distribution, which represent natural monopolies, from generation and supply, which are market operations, is a key element of market reforms.

Electricity transmission and transmission system operation were separated in 2005 as a company PE EMS, thereby unbundling the transmission system operator from the vertically integrated PE EPS. Unbundling the network activities of electricity transmission and distribution, which are natural monopolies, from production and supply, which are market activities, is a key element of market reforms. Electricity transmission and transmission system operation were unbundled into a separate company PE EMS in 2005. Thereby, transmission system operator was unbundled from the vertically integrated PE EPS.

The Energy Agency was established by the Energy Law of 2004. The Agency is a regulatory body functioning independently of State executive authorities, as well as of other State bodies and organizations, legal and natural persons engaged in energy activities.

The Agency is managed by the Agency Council that is appointed by the National Assembly of Serbia. The president and members of the Council are accountable for their work to the National Assembly. The Agency submits annual reports to the National Assembly which also include the report on progress in the energy sector.

The scope of the Agency's work includes regulatory activities related to electricity, natural gas, oil and oil derivatives.

6.4. Liberalization of the electricity market

Liberalization of the electricity market in Serbia began in 2013, when large consumers at high voltage first came out on the market. As of 1 January 2014, the market was opened for consumers at medium voltage and as of 1 January 2015, it will be opened also for small customers and households, if they wish and if they do not opt for supply at regulated prices, to which they will continue to have the right.

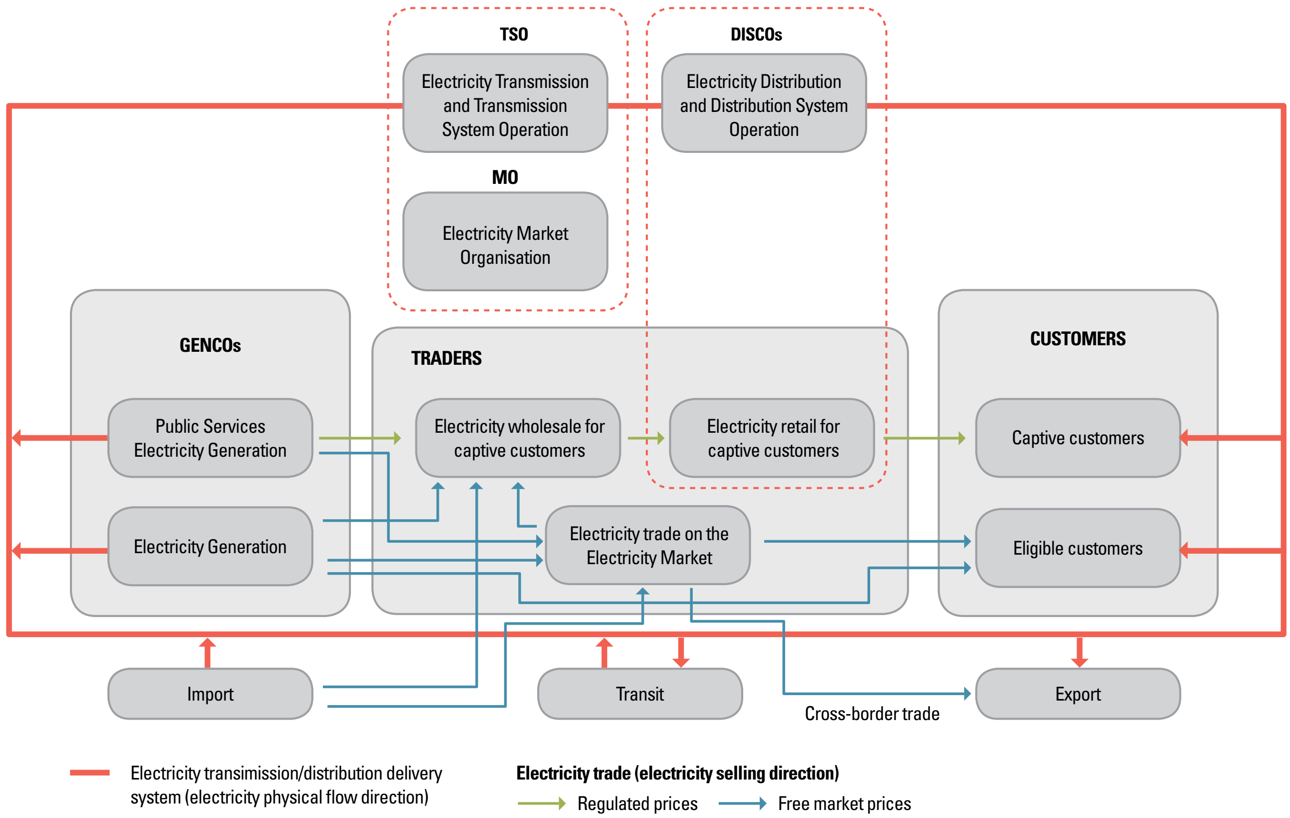
As of 1 January 2014, the second phase of liberalizing the electricity market began, with about 3,200 customers at medium voltage, accounting in total for about 43% of the liberalized electricity market.
After completion of the public tender the Government of Serbia authorized EPS Snabdevanje (EPS Supply) d.o.o. Belgrade for the supplier that will reserve a supply of electricity to final customers that are not eligible for public supply (reserve supplier). This decision is issued pursuant to Article 146 of the Energy Law, as one of the steps towards the opening the electricity market in Serbia.

It should be noted that EMS, acting as the operator of the transmission system and electricity market in Serbia, is a full-fledged member of ENTSO-E association, established in accordance with the provisions of the Third Energy Package, and it also participates in the pan-European Inter-Transmission System Operator Compensation (ITC) mechanism, implemented in accordance with Regulation 838/2010 on guidelines relating to the intertransmission system operator compensation mechanism and a common regulatory approach to transmission charging.

From the perspective of electrical energy, the new Energy Law is in full compliance with the provisions of Directive 2003/54/EC of the European Parliament and of the Council concerning common rules for the internal market in electricity; Directive 2003/54/EC concerning rules for the internal market in electricity; Directive

2005/89/EC on measures to safeguard the security of electricity supply and infrastructure investment; and Regulation 1228/2003 on conditions for access to the network for cross-border exchanges in electricity. The law stipulates deadlines for market opening in Serbia so that the gradual opening should start on 1 January 2013 (for customers connected to the transmission system) and complete with the full market opening on 1 January 2015. Market rules were made by the transmission system operator and approved by the Energy Agency, entering into force on 1 January 2013. The law created the conditions for a safe, high-quality and reliable electricity supply, a well-balanced development of the electricity sector in order to provide the required amount of electricity to meet the needs of customers, encourage competition in the market based on the principles of non-discrimination, develop electricity infrastructure and introduce new technologies and create transparent, attractive and stable conditions for investments in the construction, reconstruction and modernization of power plants, consumer protection and the use of renewable energy.

Figure 12: Electricity market in Serbia



6.5. RES policy design considerations

Based on the Ministerial Council Decision of October 2012, Serbia undertook to implement the recommendations of RES Directive 2009/28/EC, adapted to the context of EnC. The same decision was the basis for accepting the demanding objectives for 2020. In order to ensure the achievement of mandatory objectives, Article 3 of the Directive refers to the introduction of incentive measures for energy production from renewable sources.

Each EU Member State should ensure that the share of energy from renewable sources in the gross final energy consumption in 2020 is at least as the one established under Section A of Annex I of the Directive. Bearing in mind that energy markets are unable to stimulate and secure the investments required to achieve these objectives, Member States may apply the following measures, among others:

- Support schemes;

- Cooperation mechanisms among various Member States and third-party countries to achieve overall national objectives.

A support scheme is any instrument, scheme or mechanism applied by a Member State or groups thereof to promote the use of energy from renewable sources by reducing costs related to this energy, the increase of price at which it can be sold, or increase of the purchase of such energy through obligations (quota system) regarding RES, or by some other means. Support schemes require State intervention, which gives them the character of State aid.
This aid can be provided as:

- **Operational aid** (FIT, feed-in premiums and green certificates);
- **Investment aid** (grants, exemptions from fees, fee refunds, lower interest rates for loans).

Serbia opted for the operational form of aid by introducing a system of incentives through FIT. The legal framework for the use of this form of incentive was introduced in 2009 and amended in 2013 and 2016. It was chosen because it provides investors with the highest degree of investment security and, according to EU Member State experiences, represents the most efficient means of stimulating the construction of new capacities.

The current concept of incentives through FIT in Serbia implies that all the electricity produced by a privileged producer is to be purchased at a defined price within a period of 12 years, with the producer exempt from balancing responsibilities. The status of privileged producer is acquired upon the construction of a facility, i.e. incentive measures may be reserved at the moment an investor holds a valid construction permit (temporary privileged producer status). The status of privileged and temporary privileged producer is acquired as per the order of submitting requests; the capacities for acquiring the status in the field of wind and solar energy are limited to 500 MW for wind plants and 10 MW for solar plants.

A detailed overview of the newly built plants is given in Table 12.

Based on this concept, since 2009, when the legal framework with incentive measures (FIT) was established for the first time in Serbia, until October 2016, the following new plants with the installed capacity of 80.3 MW were constructed for production of electricity from RES:

- 61 SHPPs with total installed capacity of around

Table 12: Overview of the planned (in line with the National Renewable Energy Action Plan) and constructed power plants in the field of renewable energy sources

Power plant type	Planned in NREAP (MW)	Current state, October 2016					
		Energy permits* (number and MW)		Temporary privileged producer status (number and MW)		Privileged producer status (constructed) (number and MW)	
HPP larger than 10 MW	250	2	106**	-	-	0	0
HPP up to 10 MW	188	87	149	2	0.7	61	41.2
Biomass	100	4	17	-	-	0	0
Biogas	30	3	7	1	2	7	9,1
Wind	500	8	70	7	489.6	2	10.4
Solar	10	4	17	2	0.1	105	8.8
Geothermal	1	0	0	-	-	0	0
Waste	3	0	0	-	-	0	0
Landfill gas	10	0	0	-	-	0	0

* Energy permits for facilities up to 10 MW issued in January 2011 and later. The energy permit is a document issued by the Ministry of Mining and Energy in charge of energy activities and is necessary for receiving a building permit when constructing energy facilities of 1 MW and more. The energy permit is issued with a validity period of three years that may be extended for one additional year. The number of issued energy permits can provide indicative information about future projects.

** Reconstruction of existing power plants

41 MW (including two old, reconstructed power plants: Ovcar banja and Medjuvrsje);

- 104 SPPs with a capacity of 8.8 MW;
- 2 WPPs with the capacity of 10.5 MW, while 7 WPPs have gained the temporary privileged producer status with the total capacity of 489 MW,
- 7 biogas power plants with total capacity of around 9 MW.

Since 2010, when the implementation of the FIT system started, there has been a continuous growth of new capacities for producing electricity from RES. The growth is more significant in terms of the number of newly constructed capacities than in the installed capacity, as shown on Figures 11, 12 and 13.

It took a few years for the new system of incentives to come to life, and then to build confidence with investors in the functioning of the system, as well as to prepare appropriate projects, especially for large power plants.

Figure 13: The number of all types of renewable-energy-fuelled power plants from introducing the system of incentives with feed-in tariffs

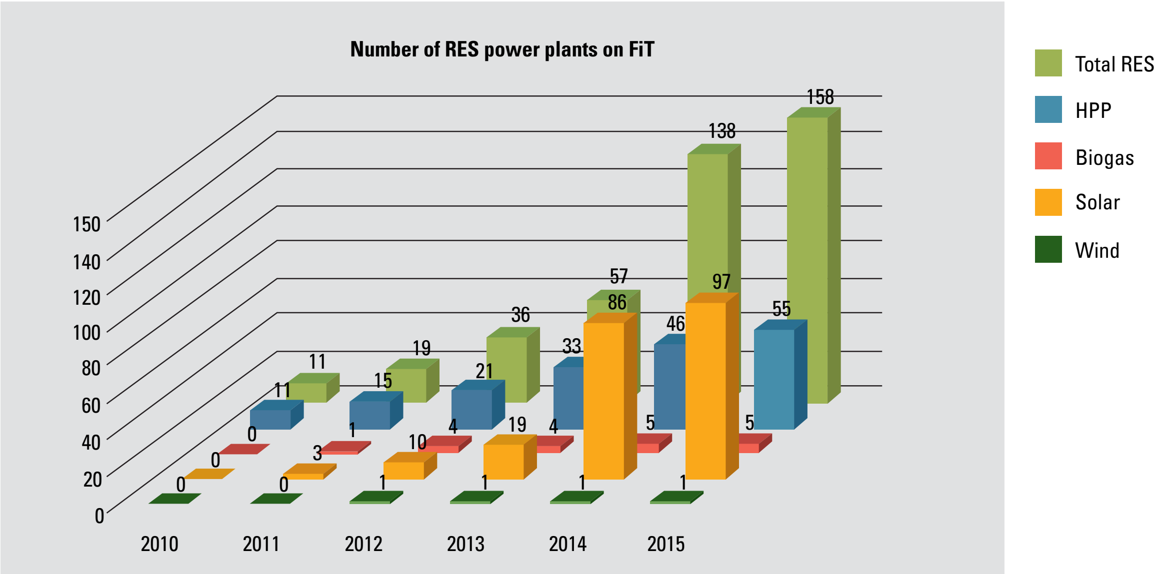


Figure 14: Installed capacities of all types of renewable-energy-fuelled power plants from introducing the system of incentives with feed-in tariffs

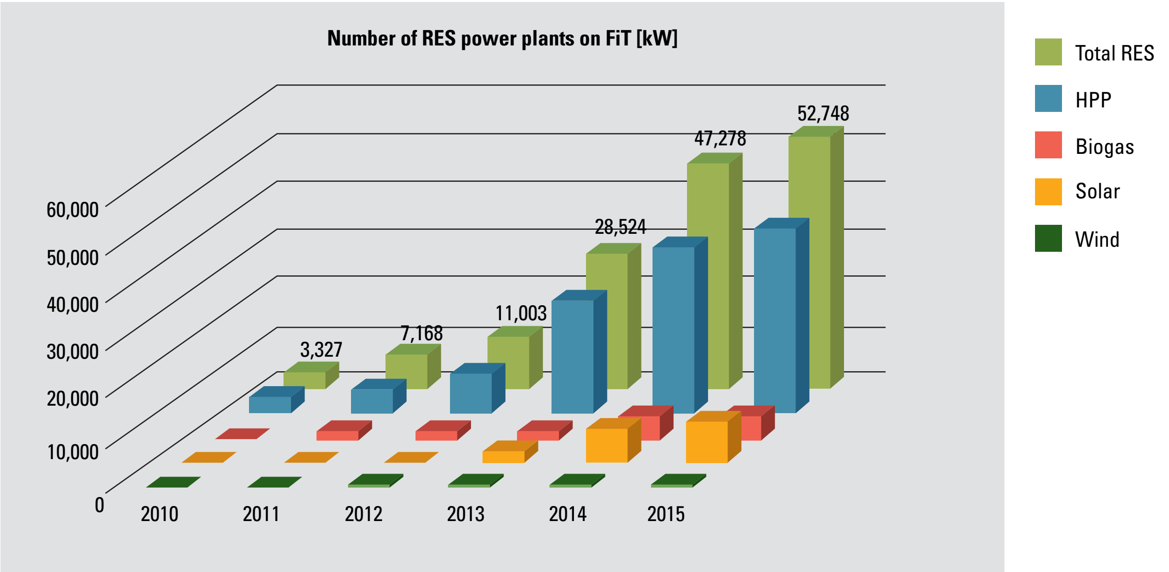
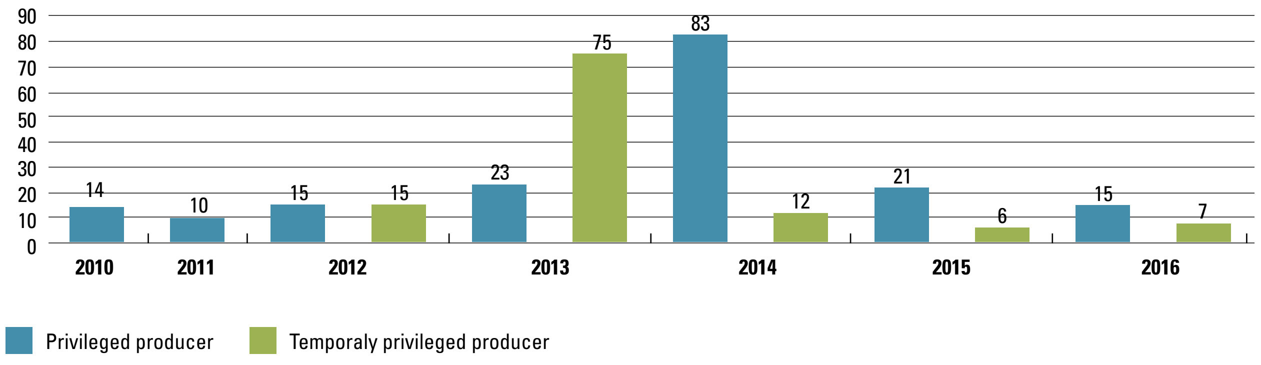


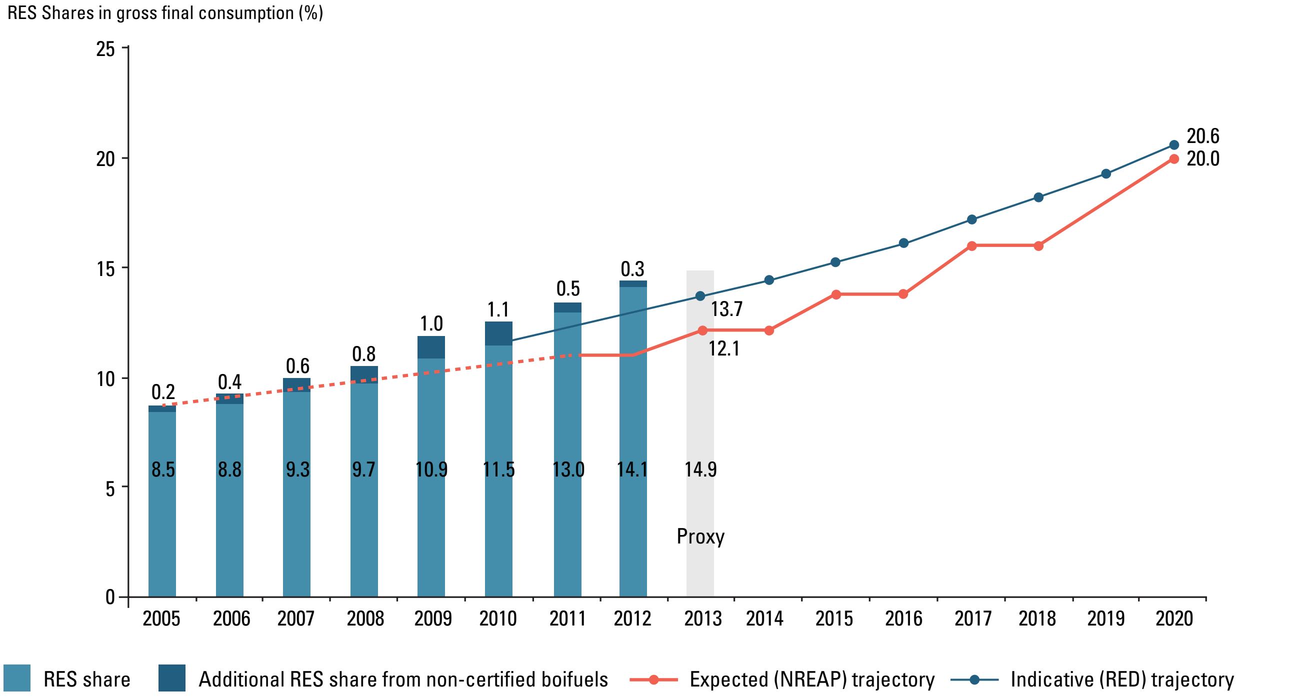
Figure 15: Number of status of temporary and privileged producers issued from introducing the system of incentives with feed-in tariffs



6.6. Further implications

It is worth emphasizing that EU countries introduced the use of RES in their legal frameworks through the Maastricht Treaty from 1992, opting for the promotion of economic development with environmental protection. Since 1997, the EU was dedicated to achieving the goals of 12% of RES in the EU total final energy consumption in 2010. The contribution of Member States to this goal was on a voluntary basis and did not lead to the expected implementation of projects in this field. The adoption of the RES Directive in 2009 introduced mandatory goals for EU Member States and a more intensive development of RES projects.

Figure 16: EU actual and approximated progress to interim and 2020 targets



Note: The EU's indicative National Renewable Energy Action Plan trajectory is calculated from all national indicative RED trajectories. The NREAP trajectory represents cumulative expected realizations according to Member States' NREAPs. For a consistent comparison across years, this figure provides separately the RES shares accounting only for biofuels complying with RED sustainability criteria, and the additional RES shares due to the other biofuels consumed in transport. By contrast, the RES share series reported by Eurostat, 2014 (SHARES Results 2012) takes into account all biofuels consumed in transport for the period from 2005 to 2010, and only biofuels complying with RED sustainability criteria for the years following 2011.

Source: EEA, 2014 (authors' paper based on: Eurostat, 2014; NREAP reports (18) using gross final energy consumption after reduction for aviation in the energy efficiency scenario).

Considering that RES have seen significant expansion in the EU and that incentive schemes lead to an increase in product prices for high energy activity companies which are designated organizations for RES reimbursements, as well as to an increase in the electricity bills of households, the European Commission published a working document in November 2013 on guidance for the design of renewables support schemes, providing recommendations to EU countries for creating incentive policies for the use of RES so as to avoid creating distortions in the electricity market.
This document represents a form of introductory recommendations for the adoption of guidelines on State aid for environmental protection and energy 2014–2020, mandatory for the EU. The document was adopted in July 2014 with deferred application as of 1 January 2016. Chapter 3 refers to the use of RES (operating aid granted to energy from renewable sources (section 3.3.2)) and aid for electricity from renewable energy sources (section 3.3.2.1)).

The key novelty is the introduction of the obligation of coupling incentive measures to the premium (additional fee) for the achieved market value of electricity sold. As of the beginning of 2016, operational aid in the form of FIT is no longer in accordance with the criteria for State aid. The introduction of feed-in premiums (FIP) can replace the current system of FIT. Compared to the existing system, the purchase of produced electricity is no longer guaranteed; instead, the producer, in order to comply with the conditions for the premium, is conditioned by sales on the market (exchange). Within such a system, the producer of electricity from RES is not exempt from balancing responsibilities, as is currently the case. Exemptions from this new rule are:

- Plants of up to 500 kW;
- Demonstration projects;
- Wind plants of up to 3 MW.

Another significant novelty is the obligation for every type of project support (either through operational or investment aid) to be implemented through a competitive procedure based on clear, transparent and non-discriminatory criteria. A technology- and location-neutral tender should enable the selection of the most competitive offer in order to limit the required support to the minimum and thus minimize the burden for end users. However, if diversification is required to overcome network limitations, stability of network costs or system integration, tenders may support specific technologies to correct the results obtained through the initial concept of neutrality.
Exemptions are permitted for projects with installed power up to 1 MW and demonstration projects of wind plants up to 6 MW.

Guided by EU recommendations and the effects of changes to incentive measures in the EU, EnC is insisting on the rigid application of rules in a completely different context of very slow implementation of projects in the field of RES under conditions of underdeveloped electricity markets in EnC member States. In particular, it insists on measures envisaged within the WB6 Sustainability Charter signed by six Western Balkans member States as part of the Berlin process in July 2016, especially the consistent application of the above recommendations for Rules on State Aid for EU Member States and the replacement of FIT with the system of incentives through feed-in premiums.

Incentive measure systems
Feed-In premiums (FIP)

- **Fixed premium**
  - The producer receives a monthly established fixed premium independent of the market price.

- **Cap and floor premium**
  - The producer receives changing premium values against the market price, ranging between the cap and floor values.

- **Sliding premium**
  - The producer receives a variable premium against the monthly established market price up to a fixed value. The amount of the premium depends on the market price.

- **Auctions** represent a form of incentive where selected producers may use incentive measures of FIT or FIP only in an auction and at the lowest bid during the auction process.

Main characteristics of an auction:

- Call to producers for a predefined limited capacity of MW;
- Without specifying technologies or for specific technologies;
- With a disclosed or undisclosed maximum price per kWh;
- Pre-qualification criteria may be defined to eliminate non-serious participants;
- Selection based on lowest price;
- If the capacity and prices are set in an optimum manner, a large number of bidders is provided;
- Transparency of the process of establishing prices.

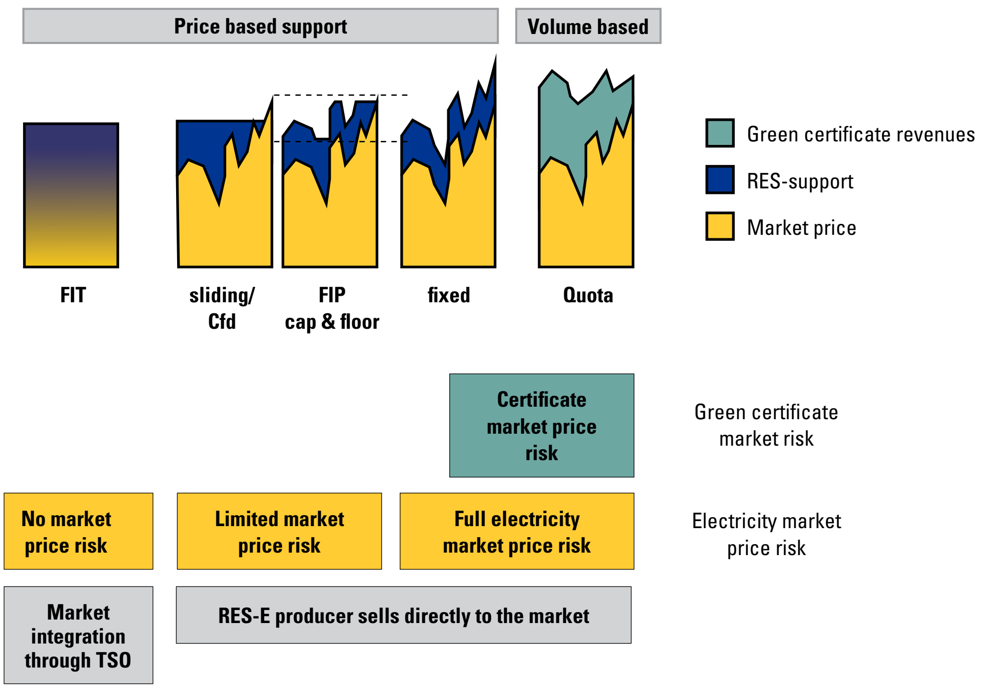
○ **A tender** is a special form of auction with the following specifics:

- Call to bidders for specific locations, capacities and technologies;
- The selection of bidders is based on more precisely defined criteria, including price;
- Usually a small number of bidders.

Taking into account all that has been previously mentioned in relation with considerations of policy design, it is worth emphasizing that, prior to initiating the preparation of a new system of incentives, a comprehensive comparative analysis of the effects of the use of the system of FIT and premiums needs to be made, also taking auctions into consideration and recognizing the level of market development in Serbia. The analyses need to show and express in economic parameters all the advantages and disadvantages of both systems for various technologies and determine the real risks of changing the system.

The Energy Community insists on the transition from FIT to FIP by 2019, explaining: "The premium must be granted based on a technology neutral competitive bidding process to ensure a cost-effective deployment of renewable energy and therefore minimise the impact to end-users consumer prices”.

Figure 17: The main support schemes expose renewable-energy-sourced electrictiy producers to different levels of risk



However, the system of premiums introduces the corresponding risk of investor participation in the market. As this directly reflects on the bid amount for all serious investors during the auction process, the probability is higher that such a system will lead to higher electricity prices for end consumers (contrary to the expectation from the quote) or a reduction in the number of investments, due to the excessive risk for the conditions offered, or bids of unrealistically cheap projects that cannot be successfully implemented due to financial unsustainability. All preliminary rough analyses, therefore, indicate that a hasty introduction of FIP in an underdeveloped electricity market would lead either to increases in electricity prices for end consumers to cover the additional risk of investment through the amount of premium or a full blockade of further investments into RES! Bearing in mind that, despite the currently very attractive legal framework for investments, planned projects are being implemented very slowly (only 80 MW of the expected 1,092 MW), it is more likely that the change of the incentive system would completely halt RES investments at a time when FIT are only starting to show the first significant effects with the trust developed among investors in the legal system of Serbia. Moreover, there seems to be no reason to rush, since FIP cannot provide such rapid results and help achieve the objectives planned for 2020, while the trust developed among investors would, moreover, be shaken.

In other words, small developing countries, with a relatively low credit rating and a just established or still not completely established electricity market, require significantly more stable conditions for attracting investors and for successful implementation of RES projects than the ones which will be achieved in the open RES market. Under such conditions, therefore, it is not possible to skip the first step in this RES development, i.e. the application of conventional support schemes that implies State intervention, giving them the character of State aid (operational aid and/or investment aid). In the initial stage it is also desirable to change the legislation and other conditions affecting the security of investments as rarely as possible. If there is no possibility of protecting the security of investments by state guarantees, it is necessary to do so by means of a corresponding PPA, which will precisely define all contractual obligations and consequences of their non-fulfillment, and set the jurisdiction for settling all conflict situations through international arbitration. It is desirable to apply newer support mechanisms, based on the market and greater competition (limited market-price risk and full electricity market-price risk), only in the second stage of development of RES utilization), when a certain number of RES-fuelled power plants will already have been constructed and when this field of activity generally comes to life. Also, simultaneously with the processes of construction of RES facilities, great efforts should be exerted to raise the general awareness about the necessity of use of RES, so that a general social consensus can be achieved on this issue.

Regarding innovative financing for renewable enegy projects (crowdfunding, energy cooperative schemes, etc.), as previously described, Serbia is currently in the early stage of development in the use of renewable energy sources. Serbia is, moreover, a small country with a relatively small number of rich people and a great lack of trust in the banking system and State institutions, primarily in the protection which should be provided by the judicial system. The banking and economic system of Serbia completely collapsed during the 1990s. During 1992, inflation in Yugoslavia amounted to 19,810.2% and hit a world record. The negative effects of hyperinflation were further encouraged by its duration, with Serbia in third place in the world, after the Russian Federation and Nicaragua. Serbian citizens' trust in the domestic legal system has been very low over the past two decades. According to the official declarations of the anti-corruption agency, the judiciary system was involved in electoral thefts and proceedings conducted against opponents of the regime.

Thus, despite decades of experience in using the crowdfunding model in agriculture during the socialist period, the economic and social environment, citizens' awareness and the situation in general, society is not in favour of using these alternative models. Such measures are applicable first of all in economically and legally stable countries and societies of rich and environmentally aware individuals, with confidence in the State, so it is not to be expected that Serbia and similar countries will be the leaders and head the implementation of these alternative measures.

7. Future national policy development and implications for adoption of a similar approach in neighbouring countries: conclusions and recommendations:

Unequivocally, use of renewable energy contributes to reducing negative environmental impacts, increasing the reliability of energy supply, creating conditions for the establishment of sustainable energy development and improving standards of living. In order to increase the use of renewable energy and to make it more sustainable – apart from necessary strong political will and appropriate financial support – it is necessary to establish a secure legal framework and organizational structure. The legal framework implies the adoption of laws and corresponding secondary legislation that should establish clear regulations, protect investments and provide proper incentives. Organizational changes imply the establishment of appropriate units and bodies within the ministries and agencies that should be able to create and manage, as well as other organizations that will, in the technical-operational meaning, be able to perform the takeover, transmission and distribution of generated renewable energy. An important mechanism within this system that should be established represents a mechanism of collection and allocation of the incentives. Appropriate functioning and operation of each of these elements of the system are necessary. In order to perform a proper operation of the whole system, the role of each part of the system has to be clearly defined.

Due to the complexity and sensitivity of each element and the functioning of the whole system, many hardly predictable circumstances and possible mistakes that can imply serious consequences for the performance of the whole process, it is recommended to follow the practical knowledge of already successfully accomplished countries in this field. One model that has already been successfully implemented, that has been developing over several decades and been repeatedly upgraded, has been applied in EU Member States. The entire legal framework of the EU – including the part related to renewable energy – is based on the use and implementation of all binding EU directives and regulations, proposed by the European Commission and adopted by the European Parliament and the Council of the EU. However, direct adoption and implementation of this model by countries outside the EU is not possible.

In order to make it possible, it is necessary to have a national energy sector which is fully harmonized with that sector of EU countries. Moreover, significant differences in economic power, underdevelopment of the renewable energy industry, general orderliness of the State administration and investment security, the country's credit rating and the level of awareness among EU citizens and citizens of non-EU countries require the additional mechanisms and interventions which should represent a path for other countries. For that reason, EnC was established as an organization that would help all parties to the Treaty and harmonize the entire energy sector regulations within the EU and hence increase the renewable energy share in the final energy consumption.

Although Serbia has been a memeber of EnC since its establishment in 2005, and has almost completely harmonized the operation of its energy companies and sectors with EU rules, including the fully open electricity market, the aforementioned differences do not allow for Serbia to begin earlier use of RES potential.

Based on almost a decade of experience, however, it is posible to provide some recommendations and basic guidelines that have been prepared or are expected to produce an increase of renewable energy use.

First of all, **it is required to systematically strengthen and enhance the capacities of all institutions and government agencies that are responsible for this area**. The corresponding number of highly educated and skilled experts who work in State institutions, ministries, agencies and other bodies, are indispensable for the success of development in this area. They should be able to follow the requirements and instructions of the international community, which, in this case particular case, is the Energy Community.

It is not enough for the sustainable and stable development of this area for only ad hoc projects and activities to be carried out; it is necessary to adapt systematically the whole energy system, especially the electricity sector for the use of renewable energy. It concerns primarily the opening of the electricity market, the abolition of State monopolies and the introduction of unique rules of operation of the whole system. One model that has shown good results that can be used is that of the EU power system.

When speaking of a type of project for developing countries which still have **a State-owned electricity company, it is especially recommended to support the use of renewable energy within those companies. In Chapter 5, the advantages of this concept were described in detail. They include the modernization of those companies**, ensure profits, increase their economic rating and security of supply and enhance knowledge and awareness about renewable energy sources. This applies equally to the power-generation sector and the remote heating system, the latter concerning the use of biomass as a fuel.

Strengthening of the private sector in electricity generation from renewable energy sources also represents one of requirements and targets that have to be achieved in order to increase the use of RES. Due to the distrust of investors and international financial institutions in the legal systems of non-EU countries in this area and their relatively modest financial rating, as well as bad experience in major renewable energy projects investments in other countries, **it is necessary to provide specific guarantees for investors. In the case of small developing countries, which are typically in a process of financial consolidation, where State guarantees are not an acceptable mechanism for protection, it is recommended that these problems are overcome with high-quality, bankable PPAs.** The contract should define precisely all obligations and dispute situations (political and natural force majeure, changes in laws, payment security instruments, risk of electricity not received by the system operator, contract termination, etc.) and the consequences of their failure to comply with them. The rules for resolving disputes should involve the option for international arbitration. To avoid any kind of misunderstanding and provide bankability for the agreement, it is recommended that the **PPA model is prepared in close cooperation between MFI and lenders, the ministry responsible for energy and the ministry in charge of finance.**

It is worth emphasizing that **small developing countries, with a relatively low credit rating** and an electricity market that is recently established or not yet completely established, require significantly more stable **conditions for attracting investors and for the successful implementation of RES projects than those on the open RES market.** Under such conditions, it is not possible to skip the first step in RES development, i.e. the application of conventional support schemes that implies State intervention, giving them the character of State aid (operational aid and/or investment aid). It is desirable to apply newer support mechanisms, based on the market and greater competition (limited market price risk and full electricity market price risk), only in the second stage of development of RES utilization), when a certain number of RES-fuelled power plants will already have been constructed and when this field of activity generally comes to life.

Since small and developing countries have not developed their own renewable energy industry for the production of appropriate equipment, they are in the first stage of its implementation and obliged to use only imported equipment and technology. In order to reduce costs and make more use of renewable energy in these countries, **it is important to strengthen and develop this industry sector.** In the case of Serbia, the main concern is the production experience of biomass boilers, equipment for the preparation and processing of biomass (pellets, briquettes, chips), thermo-solar system, equipment for SHPPs and other less technologically demanding systems that can be directly applicable to projects. To compensate for differences between developing and developed countries, **the State should initiate appropriate scientific and technological projects.** These projects could also be supported by international funds and donor institutions, because it is the only way to catch up with developed countries and to become an equal member of the international community in the field.

Finally, simultaneously with the construction of RES projects, **great efforts should be made to raise general awareness about the necessity of using RES,** so that a general social consensus can be achieved on this issue.

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