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Integration of renewable energy sources in southeast Europe: A review of incentive mechanisms and feasibility of investments

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ABSTRACT

Incentivizing development and deployment of renewable energy sources (RES), but also other low carbon technologies (LCT), has been a successful way of promoting new technologies by creating a feasible investment case and making them competitive with traditional energy sources. Although different incentive mechanisms exist, feed-in tariffs have shown to be the best model for accelerating LCT development guaranteeing producers preferential prices for the produced electricity over a period of time and enabling them access to the power network to sell/inject produced electricity. Due to these benefits, feed-in tariff models are the most common model for stimulating RES integration in southeast Europe.

The paper reviews the current state of preferential tariffs for RES in countries of southeast Europe. While some countries already have significant installed RES capacity, others are still in the planning stage. The review shows that the amount of installed capacity of a specific technology has a strong impact on the support for the future projects for same technology. This comprehensive review of legislative development supporting RES, as well as technologies preferred in different countries of the region, is supported with feasibility assessment of investing in RES using the example of two different technology projects, wind and photovoltaic, analysing the impact of the current tariffs on the return on investment for each country of the region.

1. Introduction

1.1. Technical aspects of RES

In times of constant fluctuations of fossil fuel prices, increase of energy demand and awareness of reducing CO_2 emissions, there is a need for new sources of electricity. Supported by regulatory decisions and goals for reducing the environmental impact of the electricity generation [1], RES are the fastest growing technologies in the previous years [2,3]. The characteristics of RES, such as spatial distribution, low or zero CO_2 emissions, are also characterized by, in lesser or greater extent, volatility and variability in production and lower power density than those of conventional power plants. The basic operational principle of the energy sector is stable and secure supply of a specific energy vector (electricity, heat, gas etc.) procured through various market services and delivered at different time horizons. In order to provide these services, energy systems need to be flexible to maintain the supply-demand balance, responding to uncertainties and variability in both production and consumption. The increasing share of RES in the generation mix redefines requirements on the flexibility of energy systems. Although the uncertainty and variability have always been present in these systems, the integration of RES has increased them, setting new technical and economical requirements. The share of RES in most countries of the world is still relatively small and these systems have sufficient flexibility to cope with them. However, several systems have already experienced problems with large share of RES in overall electricity production [4]. These problems resulted in an increased awareness of advanced planning tools and strategies to avoid potential problems. To address the challenge, multiple studies have been conducted analysing different aspects, issues and challenges ranging from low and high voltage ride-through capabilities, active and reactive power responses during and after faults, extended range of voltage–frequency variations, active power (frequency) control facility, and reactive power (voltage) regulation support [5]. In [6], the authors provide an insight into grid code requirements for power factor in large scale wind power plants connected to the system, discussing the increased voltage regulation issues as a consequence of RES integration [7]. Summarizing many RES integration studies, the authors of [8] emphasize that “Grid codes help to ensure that the needs of all connected parties to the grid can be met in the most efficient and

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optimal way". In line with that, they discuss experiences of several European countries with respect to the RES integration, ranging from dynamic stability issues, short-circuits, electromagnetic transients, to transmission network expansion and operational reserve requirements. While some countries, such as Germany and Spain, have been constantly upgrading the technical requirements for newly installed generation to cope with the changes [9], others, such as Ireland, introduced additional new services (negative reserve) to maintain the stability of the system. Special focus in the report is put on the RES output forecasting challenges, as these have a crucial role in successful transition to a sustainable electric system. Due to lack of experience in developing tools, as well as practical knowledge, the errors in forecasting could be high for a single unit (up to 40% daily in terms of the forecasted electricity produced), while the error significantly reduces with shortening the forecast period or for spatially dispersed RES production [10]. These inputs lead to new concepts in power system dispatch, through different unit commitment models, recognizing benefits of stochastic and rolling unit commitment approaches, emphasizing the value of load and RES forecasting [11], as well as interconnecting multiple balancing areas [12]. Multiple studies show that, with the increase of RES penetration, the need for balancing services increases in order to mitigate the stochastic nature of wind and solar production [13]. The authors of [14,15] conclude that the balancing requirements increase by 2–9%, similar to the conclusions of a Germany market study in [16], estimating the increasing needs to 4%. It is interesting to note that the type of service to be increased, due to RES, differs depending on the source, especially when discussing the increasing needs for the fastest contingency reserve (or primary response) [17]. Several papers have proposed solutions to new operational practices to cope with higher primary response requirements, either by adjusting the existing operational principles [18] or by engaging the providers of flexibility services [19,20]. As the share of the RES in power systems increases, it will be necessary to adjust the current market rules [21,22] enabling them to become balancing service providers [23]. In addition to balancing services, RES integration can have an impact on technical grid constraints [24] (voltage, congestion etc) both at the transmission level [25,26] and at the distribution level [27].

Prospects and integration issues in South Eastern Europe have been addressed in multiple studies. In the following sections, multiple technical aspects are elaborated for each country individually. A summary of barriers and potentials for wind integration in Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Montenegro, Romania and Serbia is given in [28]. While all these European countries have common issues and challenges in order to integrate the desired levels of RES, e.g. available reserve levels, specifics, such as low spatial distribution of wind projects in Croatia, require customized approaches and solutions.

The solution to technical aspects of RES integration is rather complex and requires significant changes both in operational and planning approaches as well as technical grid code requirements. As the market rules are changing [29], it is important to understand what financial instruments were and are implemented and how they encouraged or hindered integration of a specific RES technology.

1.2. Financial aspects of RES

Uncertain and variable characteristics of RES also impact risk assessment of making an investment [30]. These obstacles can be overcome in two ways: the first is through political measures and the second by introducing financial incentives. The main initiative for promoting renewable energy at the European Union level was set back in 1997 when the European Council and the European Parliament adopted the "White Paper for a Community Strategy and Action Plan", aiming to increase the share of renewable energy which was at the time only 6% of gross energy consumption [31]. The Directive of the European Parliament and of the Council of 23 April 2009, sets the targets for final energy consumption and CO_2 emission reductions by 20%. It also defines national targets for the share of RES in total energy production for every member state for target year 2020 [32]. The RES group comprises of wind power plants, solar power plants, plants using biomass and biofuel, cogeneration plants, geothermal and small hydro power plants. Political measures do not directly affect investors and RES producers; this is the assignment of member states and regional governments who independently establish support mechanisms for stimulating investors and producers [33].

There are several different classifications of incentive models. One of those is the object of the research by Del Rio and Mir-Artigues [34], who differentiate primary and secondary models. Primary, or main incentive models, are the basis of the RES integration. They shift the costs of purchasing the electricity from RES producers to end consumers. Almost every country in Europe, has implemented one of the models [35–37]. Mainly, it is either a feed-in tariff model or Renewable Portfolio Standard model (RPS) [38–41]. Jenner et al. in [42] divide incentive models in two categories. One criterion is the object of the regulation, and the other is the object of the support. The incentive model can regulate either price of the energy from RES or the amount of the produced energy. On the other side, the object of the support can be the RES investment or the production itself. In that respect, primary incentive models are those which support the production, and by the object of regulation they are divided into feed-in tariffs, which regulate the price of electricity, and RPS which regulates the amount of produced energy [43]. Models that support the investment are characterized in [34] as secondary incentive models. These are capital incentives, tax incentives, credit enhancement, soft loans and public funds.

Feed-in tariffs are an incentive model defined by Feed-in laws, usually on a national level. Its primary goal is to reduce the investor's risk by contracting three key elements between a producer and the market operator: fixed long-term period of support, preferential price for purchased electricity and prioritized access to the grid. RPS or incentive model through green certificates is a form of a market in which eligible producers sell certificates to retailers. Green certificates are a guarantee that a certain amount of electricity, usually 1 MW h, sold by retailers is produced by RES. Depending on the technology, 1 MW h can generate more than one certificate, and thus different RES technologies can get different support levels. Retailers then shift the cost of electricity produced by RES to the end consumers. The principle is the same as in the tariff system, with the exception that in the tariff system the regulatory body determines the cost to be transferred to the end consumers, not the retailers [44].

Strengths and weaknesses of feed-in tariffs and RPS are the topic of many papers [43,45–47]. Sun et al. [43] and Couture et al. [45] came to conclusion that feed-in tariffs are more effective in the promotion of RES development. Their research has shown that with the rise of subsidy, the amount of energy delivered from RES increases more than when applying certificates. Another result was that feed-in tariffs perform better at decreasing market prices [43,48–51]. In the case of RPS, after a certain amount of subsidy, further increase of subsidy starts increasing market price [52,53].

As the most common incentive policy in the European market, feed-in tariffs are also studied with an objective to define the optimal model, not only from the perspective of the RES share in total production portfolio, but also considering economic sustainability of such system and the impact on market prices and on end consumers [54–57]. Couture et al. [45] define seven different types of feed-in tariff models, divided into two groups with respect to their market dependency. Market-independent models offer a fixed price for the whole duration of the contract. Beside the basic model, market-independent models are also *fixed price with inflation adjustment tariff model*, *front-end loaded tariff model* and *spot market gap model*. Front-end loaded model is especially interesting since, in the case of equal total cash flow during the lifetime of the project, it provides investors a shorter

Table 1
Overview of the installed generation capacity in SEE countries (GW) in 2012.

	Greece	Bulgaria	Slovenia	Croatia	Serbia	B & H	Macedonia
Total capacity	22.303	13.475	3.009	4.564	8.827	4.312	1.828
Fossil fuels	15.694	6.731	1.206	1.893	5.524	2.156	1.290
Hydropower	2.537	2.265	1.074	1.848	2.221	2.156	0.538
Nuclear	0	1.906	0.344	0.344	0	0	0
PHPP	0.699	0.864	0.180	0.293	0.614	0	0
RES	3.373	1.709	0.205	0.186	0.468	0	0

payback period. This is achieved by setting a higher feed-in tariff at the beginning of the support period and gradually reducing the remuneration in the later stages. On the other hand, in case of spot market gap model, producers sell their electricity in the market and the market operator pays them the balance to the remaining agreed amount. Market dependent feed-in tariff models are called models with premium. Instead of agreeing on a fixed tariff, the total amount producers receive is equal to the market price plus a fix or variable premium. In the premium model the producers accept part of the risk as their payments depend on electricity market prices. This model is usually more acceptable for larger producers and, accordingly, in some countries that offer a choice between fixed tariff and premium, producers with installed power exceeding a specified limit are only eligible for the premium model [43].

Papers that analyze RES incentive mechanisms are mostly focused on the development of different policy mechanisms [33], such as the ones in Germany and Spain as one of the pioneers in Europe to adopt incentivizing RES [58], on the development of a specific technology, such as photovoltaic (PV) [59–63], comparing the effect of the current policies [50,64,65] or on analysing future policy development in order to improve the uptake of an RES technology [66–68]. Only few reports focus on the southeast European (SEE) region. However, these provide only an overview of RES share in the SEE countries [69], general discussion on RES goal and share requirements in those countries [70,71] and guidelines on how can SEE countries adjust their legislation to achieve those goals [72,73]. In this light, an interesting economic analysis of PV feasibility in Bulgaria, Czech, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia can be found in [74]. The authors report that the feed-in tariff impact is very limited in Estonia, Hungary, Latvia, Lithuania, Poland and Romania.

To the best of our knowledge, there are no reports or papers that comprehensively capture the development and incentive policies of all RES technologies within a specific region, particularly SEE, and their development as a result of those incentives policies. In addition, this paper critically assesses the impact of remuneration programs on the development of each technology. In particular, we analyze how the uptake of one RES technology can have a positive or negative impact on other RES technologies. In addition to the detailed review of existing RES policies in the entire south-eastern Europe region, this paper provides insight into economic aspect of investing into PV and wind technologies.

The paper is organized in two main parts. Section 2 provides an overview of the current state of feed-in tariff systems in SEE countries. In general these countries can be divided into three groups; Greece, Bulgaria and Slovenia as EU members, Croatia that recently joined EU and Serbia, Bosnia and Herzegovina and Macedonia as countries with intentions to join the EU in years to come. Common to all these countries is that they have defined national targets for the share of RES in total electricity generation by 2020 and committed themselves to fulfil them in accordance with the Directive from 2009 [32]. Also, all of these countries have implemented a form of feed-in tariff system. Data required for analyses is gathered from RES legal database [75], Macro Economy Meter Database [76], Independent Statistics and Analysis [77] and World Bank database [78]. Available data for other countries of the SEE region, namely Albania, Montenegro and Kosovo, are insufficient for analyses, while Romania is the only country in region that has adopted the RPS incentive model and therefore is not comparable to the analysed countries. In Section 3, an investment analysis for two RES systems, a 50 kW PV system and a 9.9 MW wind power plant, is performed using RETScreen International software [79]. Countries of the SEE region are analysed considering their current RES policies. A similar concept is shown in the work of Papadopoulos and Karteris, however only for the example of PV systems in Greece [17]. The final Section offers a discussion and conclusions.

2. Feed-in tariffs in Southeast Europe

The amount of feed-in tariff varies depending on the technology and is influenced by many factors. Countries with high installed RES capacity generally offer less support for the future projects. A similar conclusion can be drawn when considering RES technologies, e.g., countries with large installed solar capacity offer lower incentives than countries with low installed solar plants capacity. Along with the fixed purchase price, producers are guaranteed the duration of the preferential tariff. Longer duration of the preferential tariff allows producers to estimate their cash flows for a longer period. Often, longer and stable revenues are more important to producers than higher but short-term ones.

To better understand conditions and potential for future RES development, data on installed capacity and annual production for each country is provided from Independent Statistics & Analysis database [77]. The data represents the capacity and production in 2012 and for the purpose of this paper is considered relevant since that data was the driver of the last legislative changes and current state of feed-in tariffs in most of the analysed countries. In Table 1 the data on installed generation capacity is shown (in GW) and in Table 2 total electricity produced in TWh. It should be noted that the negative values

Table 2
Breakdown of electricity produced in SEE countries (TWh) in 2012.

	Greece	Bulgaria	Slovenia	Croatia	Serbia	B & H	Macedonia
Total	57.552	43.734	12.187	12.604	31.773	13.448	5.939
Fossil fuels	47.526	23.925	5.345	5.033	22.819	9.275	4.905
Hydropower	4.359	3.194	3.853	4.593	9.193	4.173	1.031
Nuclear	0	14.861	2.622	2.622	0	0	0
PHPP	−0.081	−0.347	−0.063	−0.069	−0.246	0	0
RES	5.748	2.101	0.430	0.425	0.007	0	0.003

Table 3
Feed-in tariff for PV systems installed between 2014 and 2019.

Connection date	2/2014	2/2015	2/2016	2/2017	8/2017	2/2018	8/2018	2/2019	8/2019
Feed-in tariff [€ct/kWh]	12.0	11.5	11.0	10.5	10.0	9.5	9.0	8.5	8.0

for Pumping Hydro Power Plants (PHPP) come from their capability to act as a consumer. RES Legal database [75] is used to extract the information on the amount, duration and other characteristics of the feed-in tariffs in each country. In addition, RES legal database contains updated data on regulative framework for each European country. The following subsections elaborate in details the RES legislative in Greece, Bulgaria, Slovenia, Croatia, Serbia, Bosnia and Herzegovina and Macedonia.

2.1. Greece

The main barriers for the deployment of wind power in Greece are the strong public opposition to wind turbines, and complicated administrative licensing procedures [80]. From the technical point of view, wind power integration in Greece is restricted mainly by the limited transmission capacity in the mainland and the penetration limitations in the islands. The Hellenic Transmission System Operator adopted the concept of "interruptible contracts" in order to increase the wind power penetration in northeastern part of the country. Continuous monitoring and control of the power flow through the congested corridors is performed in order to issue set points to each wind power plant to reduce its output if the system security is endangered [81].

Development of RES in Greece is subject of a number of studies, mostly focused on PV systems [82–85] as the most developed RES sector in Greece. Greece owes this development to the fact that it has the highest solar potential in the region and a legislative framework which provided generous support to the investors in the period after 2010. Success of the framework is the object of the work by Karteris and Papadopoulos [84]. They stated that the previous low tariff combined with short support period, long process for obtaining the required licenses and regulatory and technical obstacles associated with the grid access were the main reasons for slow and insufficient development of PV systems at the early stage of the adoption of feed-in tariff system. Until 2006, when the Law 3468/2006 [86] was enforced, the interest of the investors was insignificant. However, in the following two years more than 7940 applications were submitted for PV incentives. As a consequence, all further applications were postponed. At the time, the feed-in tariff for grid-connected plants varied between 40 and 50 €ct/kW h, while for the off-grid plants between 50 and 55 €ct/kW h. Guaranteed remuneration period was 10 years with additional 10 years under another tariff, determined after the expiration of the initial period. Two additional feed-in tariff system changes followed, in 2009 and 2010 [87,88]. Law 3851/2010 assigned different priorities to the applicants. Thus, the residential systems with installed capacity up to 10 kW were given the highest priority, and certain amount of preference was given to the oldest submitted applications and professional farmers.

With 22.303 GW of total installed capacity in the 2012, Greek electric power system is the largest of all the analysed power systems. Out of the total installed capacity, 15.12% are RES units. The system contains 1.54 GW of solar and 1.75 GW of wind power plants, while biomass contributes slightly less than 100 MW. In 2013, another 1.1 GW of solar systems was put in operation, followed by only 16 MW in 2014 due to reduction in tariff remuneration.

The feed-in tariffs for various technologies are set according to the Law 3486/2006 [86]. Wind power plants connected to grid receive 10.5 €ct/kWh. However, if the producer is already receiving other form of support, which exceeds 20% of the total cost, the amount of feed-in tariff is reduced. In that case, plants up to 5 MW capacity receive 8.5 €ct/kW h, and plants over 5 MW 8.2 €ct/kW h. Since the beginning of 2015, the feed-in tariff for PV systems has been determined according to the Eq. (1). *MASPv* in the equation represents the average marginal system price for the previous year.

$$1,\ 2{*}MASPv{-}1 \quad [\text{€/MWh}] \tag{1}$$

For the rooftop PV systems up to 10 kW, the tariff amount is determined in a different way; tariffs for these systems, installed between 2014 and 2019, are reduced according to the Table 3.

The feed-in tariff for geothermal plants depends on the process temperature. For generation process temperature up to 90 °C the tariff is set to 14.3 €ct/kW h in case the producer does not receive any another source of support; in case it does, the tariff is app. 20% lower and is set to 13 €ct/kW h. For plants operating at process temperatures above 90 °C the tariff is 11 €ct/kW h with no additional subsidies, or 10 €ct/kW h in case producer receives other forms of incentive. For biogas the tariff logic is similar to the above, they are slightly lower if another incentive is received. The base tariff for landfill gas is 13.1 €ct/kW h, or 10.8 €ct/kW h if the installed capacity exceeds 2 MW. For gas produced from biomass the tariff is 23 €ct/kW h, or 20.9 €ct/kW h for plants over 3 MW. Hydro power plants with capacity up to 15 MW installed receive between 10 and 10.5 €ct/kW h. If a producer receives another form of incentive, the tariff decreases to 8.0–8.5 €ct/kW h.

Duration of the preferential tariff is 20 years, but it can be prolonged with a new contract. Deadline for the prolongation is three months before the first contract expires. For the rooftop PV systems up to 10 kW, the contract is signed for 25 years.

2.2. Bulgaria

Bulgarian electric power system is more than sufficient to supply national consumption. In fact 28.7% of total electricity generated in 2012 was exported. With 13.475 GW of installed capacity and 43.734 TW h of electricity produced in 2012, technologies shares were as follows: thermal power plants produced almost 55%, nuclear plants 34%, hydro power plants 7% and RES produced around 4.8% of the total generation. An overview of Bulgaria RES potential is presented in [89], while in [90] the authors list Bulgaria as an example of positive correlation between economic growth and increased share of RES. From the technical point of view, according to [91], an effective integration of wind power in Bulgaria is limited by relatively low system reserve and network absorption capability in windy areas.

Feed-in tariffs are defined once a year, on June 30, and current amounts are defined in Energy from Renewable Sources Act [92].

According to the tariff system, wind power plants are incentivized from 7 €ct/kW h, for wind power plants up to 30 kW of installed capacity, to 4.9 €ct/kW h for plants over 1 MW. The tariff for residential solar systems varies from 7.4 to 10.8 €ct/kW h. Non-residential solar systems are eligible for incentives between 6.7 and 7.8 €ct/kW h. Hydro power plants, depending on their size, are entitled to the tariff ranging from 4.8 to 12.14 €ct/kW h. A similar principle is valid for biogas. However, besides the installed capacity, the technology of the plant is an important factor in defining the amount of incentives. It can range from 4.6 €ct/kW h for large units fuelled by biogas from household wastewater to 23.3 €ct/kW h for smaller units fuelled by biogas from plants and animal waste. Similarly, tariffs for units fuelled by wood waste range from 11.4 to 12.8 €ct/kW h, for agricultural waste they are 9.1 €ct/kW h, and for energy crops 8.4 €ct/kW h.

Bulgarian tariff system is adjusted annually. However, this usually results in a lower tariff, which is not regulated by law and can be drastic. The contracted period of the tariff is 20 years for geothermal power plants, biomass and solar power plants. Biogas and hydro power plants are entitled to 15 years contracts, and wind power plants up to 12 years.

2.3. Slovenia

Among the countries analysed in this paper, Slovenia stands out as the only country that offers two feed-in models. The first one is the market-independent model, the *front-end loaded model* [45]. According to this model, the tariff is higher during the first five years, after which it decreases by 5%. Finally, after another five years it stops at 90% of the initial amount. The other model deployed is the market-dependent *premium price* model. Within this model, the RES producers sell electricity in the market and receive a contracted amount of premium on top of that. Producers with installed capacity less than 1 MW can choose between the two incentive options. Producers with installed capacity between 1 and 10 MW (20 MW in case of CHP and 50 MW in case of wind power plants) are entitled only to the premium model. Producers above these limits are not entitled to any incentive.

In 2012, according to data in Table 1, installed capacity in Slovenia was just above 3 GW with annual electricity production of 12.187 TW h. In the generation mix, 40% of installed capacity and 44% of production belongs to fossil fuels. Nuclear energy participates with 11.4% of capacity and 21.5% of the electricity production. Hydropower is the second dominant technology with 35.7% of installed capacity and 31.62% of electricity produced. Interestingly, almost half of the installed hydropower in Slovenia are small, privately owned, hydro power plants [93]. The initial goal of Slovenia was to have 12% of RES installed by 2010 and 25% by 2020 [94]. However the goal for 2010 was not achieved [95]. In 2012, RES contributed with 205 MW of installed capacity and represented 6.5% of the installed capacity, but produced only 3.5% of the total annual output. The largest share of RES belonged to the solar systems (163 GWh) and biomass (267 GWh) [96]. Only 2 MW of wind systems were installed in 2012 [97].

2.3.1. Feed-in tariff model

The distribution of the installed capacity by source reflects on the feed-in tariffs for different technologies [98,99] and, due to the low capacity of installed wind power plants, feed-in law in Slovenia favours wind over solar systems. The unique price for energy produced in wind power plants is 9.538 €ct/kW h. Solar systems, on the other hand, do not receive a unique tariff. In addition, a monthly reduction of the reference cost by 2% was introduced in 2014. In November 2014, rooftop and other solar systems below 50 kW were entitled to a tariff between 9.427 and 8.857 €ct/kW h, respectively. Plants of up to 1 MW received 8.620 €ct/kWh for rooftops and 8.159 €ct/kW h for other installations. These tariffs were then reduced by 2% in each following month. Additionally, rooftop systems below 5 kW connected behind the customers' meters are entitled to another 5% of the reference cost, stimulating the onsite consumption. Feed-in tariff for geothermal plants, regardless of the installed capacity, is 15.247 €ct/kW h. Plants using biogas, depending on the technology, receive a tariff between 6.609 and 12.555 €ct/kW h. In Slovenia one of the highest tariffs is awarded for generation from biomass. Plants below 50 kW receive incentives from 19.053 to 25.210 €ct/kW h, which resulted in the largest share of biomass in total RES generation [97]. Tariffs for small hydropower plants range from 9.261 to 10.547 €ct/kW h, depending on the capacity. Duration of the fixed feed-in tariff for all RES technologies is 15 years.

2.3.2. Premium model

The amount of fixed premium for all technologies is determined by Eq. (2), where RC represents the reference cost and MP market price for electricity [98,99]. Factor B is a number between 0 and 1 and, as well as RC, is defined for each particular group. In 2014, the reference market price was 4.331 €ct/kW h.

$$Premium = RC - MP*B \, [\text{€ct/kWh}] \tag{2}$$

For wind power plants below 10 MW, the RC is 9.538 €ct/kW h and for plants larger than 10 MW is 8.657 €ct/kW h. The corresponding B factors are 0.80 and 0.86. In the case of solar systems, in November 2014, the RC varied from 1.776 €ct/kW h, for systems larger than 125 MW, up to 9.427 €ct/kW h for rooftop solar systems below 50 kW. In addition, B factors varied from 1 to 0.88. This means that units below 50 kW, which signed their contract in November 2014, receive a premium in the amount of 5.616 €ct/kW h which, with reference to the market price, makes 9.947 €ct/kW h.

The RC for geothermal plants was 15.427 €ct/kW h and B factor was 0.92. For biogas RC varied from 6.747 €ct/kW h up to 16.555 €ct/kW h, while B factor varied from 0.88 up to 0.92. As for the biomass, RC was between 12.504 €ct/kW h and 24.629 €ct/kW h and B factor was between 0.88 and 0.92. The RC for the hydropower plants was between 10.547 €ct/kW h, for plants with installed capacity up to 50 kW, and 7.657 €ct/kW h for plants larger than 125 MW. Corresponding factors B were 0.86 and 0.90. Just as in the case of the feed-in tariff model, the duration of the preferential premium is 15 years.

2.4. Croatia

Croatian electric power system is characterized by a high share of hydropower. In 2012, over 50% of total installed capacity, or 2.141 GW, were hydro power plants, while thermal power plants contributed to the overall generation mix with 1.893 GW. Third place belonged to nuclear power with 344 MW, as Croatia and Slovenia jointly own a nuclear power plant located in Slovenia. Almost the entire installed capacity of RES comes from wind power. Until 2012, a total of 180 MW was installed, while by 2015 that number was doubled to almost 400 MW. It should be noted that this capacity could have been larger. However, the Croatian Transmission System Operator set a limit on installed wind power due to security of the power system operation [100]. A number of analyses have been made concerning technical challenges of integrating RES into Croatian Power system emphasizing both positive and negative aspects [101]. The geographical aspects of Croatia resulted in most of large wind projects being located in the same area as large hydro power plants. At the same time, consumption wise, this area has very distinct seasonal demand due to touristic season resulting in overvoltage and regulation issues [102]. However, Croatian TSO is gained more experience and recently "the bar was raised" for wind integration to 800 MW by 2020 [103]. This advancement should be attributed to both development of forecasting methods and experiences in RES operation [104,105] as well as introduction of day ahead market in Croatia [106] which should increase the liquidity and availability of flexibility services needed.

In 2012, the 180 MW of wind power capacity produced 329 GWh of electricity, or slightly less than 2.61% of the total electricity generated. Additionally, 94 GWh of electricity was produced in biomass plants and only 2 GWh in solar plants. These two technologies have been recognized as high potential RES for achieving goals set for 2020 [107]. The issue of slow deployment of PV in Croatia has been a topic of a number of papers and reports [108–110], particularly since Croatia has high potential for solar integration [111,112]. It should be noted that Croatia has one of the highest feed-in tariffs for solar systems in the region and, at the same time, one of the lowest for wind power plants. Geothermal energy is still not being utilized, although a number of reports recognized benefits of installing geothermal facilities at multiple locations in Croatia [113].

Methods for calculating the tariffs for different technologies and capacities are defined in document *Tariff System for the Electricity*

Production from Renewable Energy Sources and CHP [114]. For solar systems up to 10 kW, the tariff in 2013 was 24.9 €ct/kW h, for systems up to 30 kW it was 22.1 €ct/kW h and for systems up to 300 kW 20.0 €ct/kW h. In the case of the building-integrated installations, where solar energy is used for heating or/and domestic hot water, the final tariff is calculated using the correction factors. Taking that into account, the tariff for systems below 10 kW rises to 29.9 €ct/kW h, for systems up to 30 kW rises to 24.3 €ct/kW h, and for systems up to 300 kW final tariff is 20.7 €ct/kW h. For solar power plants whose capacity is larger than 300 kW, the tariff is equal to the reference price RC, which is the unique daily price for electricity supply of 6.9 €ct/kW h.

For geothermal plants, the tariff is 15.6 €ct/kW h. Tariff for biogas, depending on the installed capacity, ranges between 15.3 and 17.4 €ct/kW h, while for biomass it depends on the annual plant efficiency and varies from 14.0 to 20.3 €ct/kW h. As for the hydro power plants, the plants with capacity up to 300 kW are entitled to 13.9 €ct/kW h, plants between 300 kW and 2 MW are entitled to 12.1 €ct/kW h and larger plants, up to 5 MW, receive 11.8 €ct/kW h. Hydro power plants, biomass and biogas plants larger than 5 MW, as well as wind power plants regardless of the installed capacity, are entitled to the tariff determined by the reference price 6.9 €ct/kW h. All RES technology contracts guarantee 14 years of preferential price. In January 2016 Croatia adopted a new legislation package, shifting the remuneration of RES from Feed in Tariff system to premium system [115].

2.5. Serbia

Driven by the ambition to join the EU, the Serbian government defined a national target of 20% share of RES in the total annual electricity production by year 2020. Data on installed capacity in 2012 shows that out of 8.827 GW installed, 63% was in thermal power plants, 32% in hydro power plants, while RES contributed with only 5%. In order to increase the share of RES, Serbia conducted a detailed analysis of the RES potential [116,117], financing opportunities [118], and tariff systems [119,120].

The document which defines tariffs for certain technologies is *Decree on incentive measures for privileged power producers* [121], which has been enforced since February 1, 2012. Other than the tariffs, it includes a correction factor due to inflation. According to the Decree, wind power plants receive 9.20 €ct/kW h and rooftop solar systems up to 30 kW are incentivized with 20.66 €ct/kWh. For rooftop systems up to 500 kW, the feed-in tariff is calculated according to the Eq. (3):

$$20,941 - 9,383*P \quad \left[\frac{€ct}{kWh}\right] \tag{3}$$

where P is the installed capacity of the system. Ground-mounted PV units receive a tariff of 16.25 €ct/kW h. Due to decrease of investment costs of solar systems [122], the tariff is adjusted once a year according to Article 14 of the Decree [123]:

$$C1 = C0*\left(1 + \frac{pinf}{100}\right) \tag{4}$$

Geothermal power plants, depending on the capacity, receive a tariff between 6.92 and 9.67 €ct/kW h. Tariff for small hydro power plants varies from 7.38 up to 12.40 €ct/kW h and only units smaller than 30 MW are entitled to incentives. In the case of the existing hydro power plants, producers are entitled to a feed-in tariff in the amount of 5.9 €ct/kW h for units up to 30 MW [124].

For biogas, the tariff varies between 12.31 €ct/kW h and 15.66 €ct/kW h and for biomass plants from 8.22 up to 13.26 €ct/kW h, depending on the size of the unit. Biomass and biogas units are expected to be the driver and prevailing technologies in achieving the goal of generating 27% of electricity from RES by 2020 [125], particularly in rural areas [126].

Caps for installed capacity of specific technology are defined in the tariff system. These are as follows: 300 MW of the total installed capacity in wind power plants by the end of 2015 and 500 MW by the end of 2020 [127], while 10 MW should come from the solar systems. Cap for rooftop solar systems with capacity up to 30 kW is 2 MW; as well as for the systems with installed capacity between 30 and 500 kW. The remaining 6 MW of the cap for the total installed PV capacity should come from the ground-mounted installations. Duration of the preferential tariff is set to 12 years. It should be mentioned that hydro power plants older than 40 years are entitled to an incentive through the feed-in tariff system for 12 years after conducting a reconstruction.

2.6. Bosnia and Herzegovina

Electric power system of Bosnia and Herzegovina (B & H) is an example of a homogeneous power system. Out of 4.312 GW of the installed capacity, half is installed in thermal and half in hydro power plants. Production is not that evenly distributed. In 2012, 69% or 9.275 TW h, was produced in thermal power plants, while only 31% in hydro power plants. Since B & H has not had significant investments in RES, in attempt to fulfil national target for share of RES, B & H should become an attractive environment for RES investments [128,129]. More precisely, biomass is expected to play a significant role in the sustainable energy development of B & H [130] and, similar to Serbia, the rural areas are expected to be the leaders in deploying this technology, particularly for heating purposes [131].

Bosnia and Herzegovina is a federation consisting of two administrative-territorial units: Federation of B & H (FB & H) and Republic of Serbia (RS). Along with two administrative units, two feed-in tariff systems are effective.

Tariff system of FB & H was enacted in 2014 [132]. It is the first form of a tariff system in B & H and offers relatively high tariffs. It was necessary since there were no previous RES investments and the goal was to attract the first investors giving them large support and reducing their investments risks. For wind power plants, depending on installed capacity, tariff varies from 7.54 €ct/kW h, for plants larger than 10 MW, up to 18.97 €ct/kW h for plants under 23 kW. Tariff for solar systems also depends on the installed capacity and varies between 20.10 €ct/kW h and 31.60 €ct/kW h. Biomass plants are entitled a tariff between 11.60 and 15.99 €ct/kW h, while biogas plants receive from 14.25 to 46.83 €ct/kW h. This tariff system provides no support to geothermal power plants. Article 22 of Decree [133] defines certain caps. Those caps include maximum total installed capacity for each technology until 2020. Total installed capacity of hydro power plants under 1 MW is limited to 25 MW, total capacity for plants between 1 and 10 MW is limited to 55 MW and total capacity of plants larger than 10 MW by the end of 2020 is limited to 85 MW. The cap for solar systems below 1 MW is set to 1 MW and for wind power plants to 230 MW. For all technologies, guaranteed incentive period is 12 years.

Although RS is a territorial part of the same country as FB & H and passed the feed-in laws in the same year [134–136], the amounts of feed-in tariffs in RS are significantly different. For example, in the case of wind power plants only units with installed capacity of up to 10 MW are entitled to a feed-in tariff, which is 8.45 €ct/kW h. Compared to the tariff in FB & H, this incentive is higher in RS for the plants between 1 and 10 MW. Solar systems in RS are eligible for tariff only if capacities are below 1 MW. The support varies between 11.11 and 13.98 €ct/kW h for ground-mounted plants and between 12.05 and 17.37 €ct/kWh for rooftop installations on residential objects. Although residential rooftop installation show high prospect for potential investors, they are not expected to contribute significantly to the RES production in the overall energy mix [137]. Small hydro power plants are entitled to a tariff in the range 6.36–7.87 €ct/kW h. This tariff is about the same as in FB & H, except in the case of mini and micro hydro power plants (< 23 kW). The tariff for micro hydro power plants in FB & H is almost double as compared to RS. Tariff for biogas plants up to 1 MW capacity is 12.28 €ct/kW h. Tariff for biomass plants under 1 MW is 21.53 €ct/kW h and for plants up to 10 MW is 11.55 €ct/kW h. For plants up to 1 MW this incentive is significantly higher than in FB & H. In addition, the duration of the contract is 15 years. One common characteristic of these two feed-in tariff systems is they do not provide any support to geothermal plants.

From the regulatory side, document [138] identifies complex development procedures and lack of legislative framework as the main obstacles to higher integration of wind power in the B & H grid. Technically, the biggest issues are limited system reserve capacity and limited network absorption capabilities in wind-rich areas of the country. For the network security reasons, document *Estimates of marginal power of wind farms integration for connection to the transmission grid* limits the amount of wind power installed capacity up to 350 MW by 2019. An analysis of wind turbine connection to the distribution network in B & H [139] emphasized the issues with poor control of active and reactive power that wind turbines incur. The impact of various reactive power control policies on network power losses and voltage profile is investigated. The authors conclude that in the case of asynchronous generators, it is important to properly design the accompanying compensating device in order not to consume excessive reactive power from the system.

2.7. Macedonia

In 2012, Macedonia had the installed generation capacity of 1.828 GW, out of which 70% in thermal power plants. Out of 5.939 TWh of electricity produced, hydro power plants provided only 17%, while most of the remaining electricity production came from thermal units. RES contributed with 3 GW h or 0.05% of the total annual production [140]. Dynamic characteristics of a wind farm connected to the Macedonian transmission power system are analysed in [141]. A nearby short-circuit fault simulation indicates that wind turbines should operate in voltage regulation, instead of VAR regulation mode.

Macedonian feed-in tariff system from in 2012 provides support for wind, solar and hydro power plants. Wind power plants receive a unique tariff of 8.9 €ct/kW h. Solar systems with installed capacity below 50 kW receive a tariff of 16 €ct/kW h, and systems over 50 kW 12 €ct/kW h. Feed-in tariff for hydro power plants depends on the delivered electricity and varies from 4.5 up to 12.0 €ct/kW h. Guaranteed purchase period is 15 years for solar systems and 20 years for wind and hydro power plants [142,143]. Despite the fact that the share of RES in Macedonia is very low, plans for increased utilization of RES in Macedonia are ambitious. The authors of [143] suggest that introducing feed-in tariff, in particularly for small hydro units, biogas and biomass which should be the drivers RES dependent future Macedonian system [144], could reflect as only 1.6–3.8% increase of the final consumers electricity bill [145].

Macedonian system has defined limits on the total installed capacity by the year 2025. Total capacity for RES is limited to 150 MW. For solar systems below 50 kW the limit is 4 MW and for systems between 50 kW and 1 MW the total installed capacity until 2025 is limited to 14 MW. For hydro and wind power plants there are no specific limits, beside the one for the total capacity of all RES.

3. Comparison of investments in PV and wind power plant

RETScreen International software tool [79] is used to perform calculations for a 50 kW PV system and a 9.9 MW wind power plant for each country analysed in this paper. The analyses provide insight to the potential investors on payback periods for investments in RES with support from the tariff system of each country. Similar analysis can be found in [146] with the difference of analysing SEE countries and specific technologies under the feed-in tariff scheme. Table 4 shows the values of discount rate, debt ratio, interest rate and repayment period used in the analyses, as well as the inflation rates. Inflation rates, unlike other data, differs from country to country but is considered constant during the entire RES project. Mean interest rate during the last 10 years is selected as input [76].

Table 4
Economic data for the RES investment analyses in SEE countries.

	Inflation	Discount rate (%)	Debt ratio (%)	Interest rate (%)	Repayment period (%)
Greece	2,74	6	35	6	8
Bulgaria	5,17	6	35	6	8
Slovenia	2,95	6	35	6	8
Croatia	2,94	6	35	6	8
Serbia	7,03	6	35	6	8
Federation B & H	2,94	6	35	6	8
Republic of Serbia	2,94	6	35	6	8
Macedonia	2,43	6	35	6	8

The PV system consists of 200 PV panels with 250 W capacity. The most favourable location in each country is chosen among the locations available in RETScreen database. Annual production is calculated based on this data and the installed capacity of the unit. After that, using the economic data from Table 4 and feed-in tariff specifics, payback period is calculated for both projects in all of the analysed SEE countries.

Wind power plant project simulation is based on six wind turbines with overall installed capacity of 1.65 MW. Again most favourable locations, based on highest average wind speeds from RETScreen database, are used. Location data is limited only to average annual wind speed. Opposed to the PV system simulation, where average annual irradiation is sufficient to calculate the production, this is not the case for wind power plant. In order to obtain the distribution of wind speed on a certain location, a simplified form of a Weibull's probability density function with two parameters, Rayleigh's probability density function with average speed as a parameter [147] is used. Based on the calculated wind distributions and power characteristics of the selected wind turbines, we obtain a load factor that RETScreen uses to calculate the annual electricity production. As well as for the PV plant, annual production is used along with the economic data from Table 4 and feed-in tariff specifics to calculate the payback period.

Payback period is not the only relevant factor for the assessment of project profitability, nor is the only measure of the successful implementation of a tariff system. However, in this paper it is used as an indicator of the attractiveness of the current feed-in systems in the SEE region. Additionally, the presented simulations do not consider other forms of support offered by some countries, such as soft loans and tax incentives.

3.1. PV plant calculation results

Table 5 provides information on location, annual irradiation, produced electricity and feed-in tariff for the PV installation. The most important result, the investment payback period, is shown in the last column.

In case of Slovenia, we used the feed-in tariff data in effect since May 2015. This should be kept in mind since, as it was explained in Section 2.3, for each following month the tariff is reduced by 2%. The value in brackets for Serbia represents an annual adjustment of feed-in tariff due to the inflation in Eurozone.

Usually, countries with more existing solar capacity offer lower tariffs and, mostly due to that, in those countries the investment payback time is longer. Croatia, Serbia, Bosnia and Herzegovina and Macedonia have very similar annual irradiation, so the differences in the payback period are mostly related to the feed-in tariffs. The shortest

Table 5
PV plant simulation results.

	Location	Annual irradiation (kW h/m^2/d)	Produced electricity (MW h)	Duration of privileged tariff (years)	Feed-in Tariff (€ct/kW h)	Payback (years)
Greece	Methoni	5.22	76.661	25	11.50	6.5
Bulgaria	Svilengrad	3.91	58.980	20	8.60	13.6
Slovenia	Portoroz	3.95	59.619	15	8.35	13.5
Croatia	Blato	4.65	69.234	14	20.00	3.3
Serbia	Sjenica	4.06	63.129	12	16.25 (+2%/year)	4.7
FB & H	Mostar	3.93	59.024	12	24.19	3.2
RS	Mostar	3.93	59.024	15	17.37	5.1
Macedonia	Bitola	4.36	66.088	15	16.00	4.9

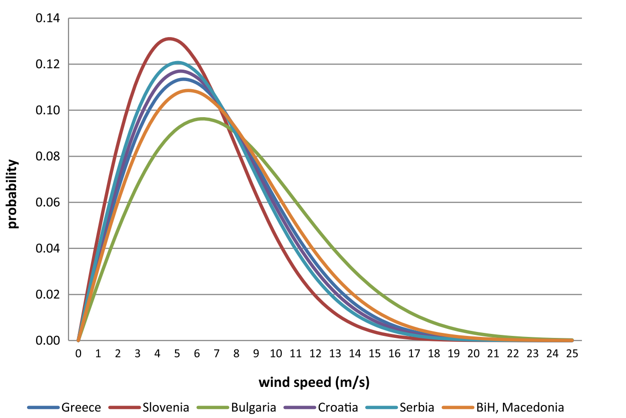

Fig. 1. Wind speed distribution. (For interpretation of the references to color in this figure, the reader is referred to the web version of this article.)

payback times are in Croatia and FB & H, as they offer higher tariffs for PV. It is interesting to notice a significant difference in payback periods for two administrative territories of the Bosnia and Herzegovina; RS has almost 60% longer payback period, again only due to the difference in incentive amounts for PV. The longest payback times are in Slovenia and Bulgaria, as these are the countries with significant existing solar installations. With many existing privileged producers, a sizeable amount of the support coming from end consumers is already allocated.

3.2. Wind power plant simulation results

Calculation of the investment payback period for wind power plants is more complex than for PV systems. The biggest difference is in estimating the annual wind power plant electricity production. Although the average annual wind speed data at analysed locations is available, this data cannot be directly used in calculation due to the power characteristics of wind turbines. Turbine power output function is presented in the Eq. (5).

$$P_T(v) = \frac{1}{2} \bullet \rho \bullet A \bullet v^3 \bullet c_p \tag{5}$$

Variables in the equation are as follows:
$P_T(v)$ – turbine power output (W),
ρ – air density (kg/m^3),
A – rotor swept area (m^2),
v – wind speed (m/s),
c_p – power coefficient (non-dimensional).

Eq. (5) shows the cube relation between the power output of wind turbines and the wind speed. Optimally one would have the data on wind speed distribution hour by hour (or more frequent), however such information is often missing. Using the average wind speed at a location to get the average annual power output results in incorrect estimations as shown by the relation in Eq. (6).

$$P_{avg}(v) = \left(\frac{1}{2} \bullet \rho \bullet A \bullet v^3 \bullet c_p\right)_{avg} = \frac{1}{2} \bullet \rho \bullet A \bullet c_p \bullet (v^3)_{avg} \neq \frac{1}{2} \bullet \rho \bullet A \bullet c_p \bullet v_{avg}^3 \tag{6}$$

Variables in the equation are as follows:
$P_{avg}(v)$ – Average annual turbine power output (W),
v_{avg} – Average annual wind speed (m/s),

I instead of average wind speed one needs the average of cube of speed and, to get that data, it is necessary to express wind duration data with probability density function (PDF).

The average value of the cube velocity equals to the integral in Eq. (7):

$$(v^3)_{avg} = \int_0^\infty v^3 \bullet f(v) dv \tag{7}$$

In a discrete version the integral becomes a sum shown in Eq. (8):

$$(v^3)_{avg} = \sum_i^n v_i^3 \bullet probability(v = v_i) \tag{8}$$

The next step is creating a wind distribution using a probability density function. Depending on the nature, type and number of factors used in the probability function, the distributions can be more or less complex and accurate. Most commonly used PDF for wind production is the two-parameter Weibull's PDF, especially when location data is limited to average annual wind speed on the location. Dependence of the wind speed distribution on the average wind speed in Weibull's PDF is shown in Eq. (9).

Table 6
Wind power plant simulation results.

	Average wind speed (m/s)	Load factor (%)	Annual production (GW h)	Duration of privileged tariff (years)	Feed-in Tariff (€ct/kW h)	Simple payback (years)
Greece	6.7	23.84	20.675	20	10.50	3.5
Bulgaria	7.9	33.41	28.974	12	4.90	6.6
Slovenia	5.8	16.74	14.518	15	4.33+6.07 (premium)	6.7
Croatia	6.5	22.24	19.287	14	6.90	8.3
Serbia	6.3	20.64	17.900	12	9.2 (+2% a year)	5.7
FB & H	7.0	26.26	22.774	12	8.19	4.7
RS	7.0	26.26	22.774	15	8.45	4.5
Macedonia	7.0	26.26	22.774	20	8.90	3.9

$$f(v)=\frac{k}{c}\bullet\left(\frac{v}{c}\right)^{k-1}\bullet e^{[-(\frac{v}{c})^k]} \quad (9)$$

Variables in the equation are as follows:
$f(v)$ – probability of the wind speed v,
v – wind speed (m/s),
k – shape parameter,
c – scale parameter.

When there is limited data about the wind regime at the wind farm site, shape parameter is assumed to be equal to 2. Another approximation commonly used is expression of the scale parameter with the average speed. Relation between those two is derived from the Eq. (10), where average speed is drawn from Rayleigh distribution:

$$v_{avg}=\int_0^\infty v\bullet f(v)dv=\int_0^\infty \frac{2v^2}{c^2}e\left[-\left(\frac{v}{c}\right)^2\right]=\frac{\sqrt{\pi}}{2}c \quad (10)$$

Expressing the scale parameter c through average speed $\bar{v}$, Rayleigh PDF takes its simplified form which depends only on average speed parameter as shown in Eq. (11):

$$f(v_i)=\Delta v\bullet\frac{\pi}{2}\bullet\frac{v_i}{v_{avg}}\bullet e^{\left[-\frac{\pi}{4}\bullet\left(\frac{v_i}{v_{avg}}\right)^2\right]} \quad (11)$$

Variables in the equation are as follows:
$f(v)$ – probability of the wind speed v,
v_i – discrete value of wind speed (m/s),
Δv – speed differential (m/s),
$\bar{v}$ – average wind speed (m/s).

For each of the seven countries, average annual wind speed was used to create wind distribution using simplified Rayleigh's PDF from Eq. (11), with speed differential Δv set to 1 m/s. Fig. 1 shows the resulting wind speed distributions for each of the seven countries. Average wind speeds at the proposed locations are shown in Table 6. When comparing graphs of the distributions and average speeds, it can be observed that lower average wind speed increases the graph maximum and shifts it to lower speeds. Therefore, locations with higher average speed have wider distribution but lower maximum. The largest average speed, 7.9 m/s, is the one for the selected location in Bulgaria and is shown with green line in Fig. 1. Location with the lowest average speed is the one in Slovenia (red line in Fig. 1). These distributions are used to calculate power characteristics of wind turbine load factors and their annual production.

In Table 6, for selected project and locations, the shortest investment payback period of 3.5 years the location in Greece. Although Greece does not have the largest load factor in the table, it has the highest tariff. Greece is followed by B & H (similar payback period for both RS and FB & H) and Macedonia. With the same load factor, Macedonia, due to a higher tariff, has shorter payback period. Additionally, duration of the preferential tariff in Macedonia is longer which lowers the investment risks. The results in Table 6 indicate that, although Bulgaria has a higher load factor by a factor of two, the premium model in Slovenia provides double the amount of support, 10.4 €ct/kW h while in Bulgaria the tariff is only 4.90 €ct/kW h. This is very good example of the importance that tariff system plays in creating conditions for successful integration of RES.

The longest payback period, according to the results, is in Croatia. The main reason is relatively large share of wind power, in particularly compared to other RES technologies, which resulted in lower support for future wind power projects.

4. Conclusion

The amount and the duration of the preferential tariff are the most relevant factors for profitability of investments in RES. Since wind and solar are dependent on the environmental factors, their feed-in tariffs need to be developed taking into account solar irradiation and wind speeds, but also the network characteristics, which plays a major role in the cost of connecting an RES to the power system. The same RES technology in countries with lower feed-in tariffs can perform better than in countries with the higher tariff. For example, countries with higher annual irradiation such as Greece and Croatia need less support than, e.g., Slovenia, for deployment of solar systems. A similar logic can be applied for wind power plants. Due to lack of suitable locations in Slovenia, investors need to be offered higher subsidies. In addition to the natural resource availability, total project profitability is also affected by economic data, like inflation, interest rate and discount rate.

On top of this, countries with more existing RES plants lower their tariff for future projects, primarily to reduce the cost of RES for end consumers. RES represent a sustainable future, but they are not worth threatening the stability of electricity prices.

The question is how to continue the development of RES in the future and achieve the desired shares of RES in total production? The main obstacles to development of RES are high investment costs and low utilization factor. Already, by supporting investments, we also support technology development, which leads to an improvement in technology efficiency and cost reductions.

Feed-in tariffs have shown to be a great supporting mechanism for RES development, but the era of high incentives slowly ends because a new, more sustainable and long-term model is necessary. Such model could be found in feed-in premium model for market performance. In that way, producers would be encouraged to invest in efficiency of their RES plants and lower their costs. Feed-in premium model for market performance would be, in a way, a rewarding mechanism for efficient production of renewable energy.

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