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WIND AND SOLAR ELECTRICITY GENERATION PROJECTS DEVELOPMENT IN CROATIA

Abstract: Favourable legislative framework in most EU member countries towards use of renewables has boosted projects in this sector. For many years, wind power plants were leader of this sector, but in previous years there is noticeable growth of installed capacities in solar power. In 2007, Croatia has introduced RES legislative framework which allows development of RES sector in Croatia. This paper will present renewable energy projects for electrical energy production in Croatia with emphasis on wind and solar energy, as well as Croatian electricity sector and introduced RES legislative framework.

Key words: *renewable energy sources, wind energy, solar energy*

INTRODUCTION

European Union directives, as well as the current legislation of the Republic of Croatia encourage the use of renewable energy sources. To make this increase happen, it is necessary to develop the market, which in Croatia, as well as other EU countries started to develop more intensively after the introduction of legislative framework for the production of electricity from renewable sources. The adoption of Update/upgrade of the Energy Strategy of the Republic of Croatia set even more ambitious goals of using energy from renewable sources in the future.

Although the legislative framework and administrative procedures for obtaining the status of eligible producer are defined, there are still present procedure bottlenecks. To facilitate and simplify administrative procedures, it is necessary to analyze the identified obstacles, and joint action of all stakeholders is needed to achieve their removal.

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ELECTRICITY SECTOR OVERVIEW IN CROATIA

Primary energy supply in 2008, totalling 413.24 PJ, decreased by 1.6 % compared to the energy supply in the previous year, making minimum fall of 0.3% over the 5 year average. The total electricity supplied in 2009 (18.9 GWh) decreased by 2.3 % compared to 2008, however, over the longer period it grew by 2.1% annualy. The total production of hydropower plants was higher than in 2008 by 27.9 %. Higher hydro production as well as lower electricity consumption led to decreased production in thermal power plants and public cogeneration plants. The import of electricity decreased for 7.1% in 2009 compared to 2008, but in the longer period (2003-2008), the import of electricity increased for 7.4% p. a. The final energy demand in 2009 decreased by 4.2%. Electricity consumption in households that consume more than 1/2 of the electricity demand was decreased by 3.7% in 2009, compared to the 2008.

Regarding renewables, their use in Croatia remains negligible, except for large hydro and biomass (for heat production). In the electricity sector, some generation was made in small hydro and wind power plants, while biomass and solar PV make the balance. Even target for electricity production from RES (excluding large hydro) was set on share 5.8 % of electricity production, only share of 1% was reached in 2010. Table 1. shows electricity production from RES for 2009.

Table 1 Electricity production from RES in Croatia in 2009.

Renewable energy source	Electricity generation
Solar PV	91.36 MWh
Wind	54.2 GWh
Biomass	24.9 GWh
Small hydro	99.5 MWh
Geothermal	0
TOTAL	178.69 GWh

LEGAL REGULATION OF RENEWABLE ENERGY IN REPUBLIC OF CROATIA

Legal regulation of the RES sector in EU was regulated within the Directive 2001/77/EC [2], and member states have adopted new directive 2009/28 EC on the promotion of the use of energy from renewable sources from June 2009. This directive defines new goals for overall RES production in all energy sectors and transport. The indicative target is now set to 20% share of energy from RES in gross final energy consumption by 2020 [3]. Each member state is to define national targets according to the overall target set for the Community. In general, that will result in an increase in RES goals for all countries. The national sup-

port mechanisms for reaching the targets are still optional and only the principles are defined.

Republic of Croatia has started to adjust its legal regulation in 2001 with the adoption of energy laws stipulating the liberalisation of electricity market and explicitly defining the possibility for RES electricity producers to become eligible producers. The supreme acts were amended in 2004 with more stipulations regarding RES. However, it was only in 2007 with the adoption of five renewable energy and cogeneration (RES&CHP) bylaws that the implementation mechanisms were defined and put in force. The RES&CHP bylaws defined the national targets, the incentive systems and the procedures for acquiring the eligible producer status [4], as the energy undertakings that produce electricity and heat in a single plant or that use waste or renewable energy resources „in an economically viable way and in compliance with environmental protection measures". Eligible producers operate special regime installations, for which system operators (either transmission or distribution) are obliged to ensure the purchase of total produced electricity. Moreover, eligible producers, except large hydro (> 10 MW), can apply for the price (feed-in tariff) defined by the Tariff System for Production of Electricity from RES and CHP. The feed-in price is guaranteed for 12 years from the date of contract effectuation. The existing energy laws lay down the possibility and define the mechanism of establishing a fund managed by the market operator for promotion of renewable energy sources for electric energy generation. The cost of promoting the use of renewable energy sources is borne by all electricity customers, depending on the amount of their total electricity consumption through a special fee, which initial value was 0.0089 kn/kWh and was intent to increase in time, however it stay unchanged in 2008 and 2009, and even decreased to 0.005 kn/kWh in 2010 and 2011. This is a clear warning that now we have funds for feed-in tariffs but we do not have realised projects.

The RES&CHP bylaws are now in force for four years and only a small number of producers have gone through the whole procedure and acquired the eligible producer status. It is evident that the procedures are too complex and that the legislation in other sectors (construction, grid connection, environment protection, spatial planning) is not adequately modified/prepared for efficient RES development. For that reason, and the new obligations according to the new directive, the RES&CHP bylaws are expected to be amended, together with bylaws in new Law on Renewables which is now under preparation. Furthermore, the changes in the legislation are also driven by the national energy targets defined in the national energy strategy. Upgrade of National energy strategy [8] has been adopted in Croatian Parliament. New targets for RES are quite ambitious and it is reasonable to assume that such targets for RES will remain in that order. The targets for PV and wind energy are set out to be 45 MW from PV and 1200 MW from wind energy by 2020.

TRENDS AND DEVELOPMENTS OF WIND FARMS

Croatia has substantial wind resource, notably in coastal region. According to preliminary analyses of wind potentials, it is expected that most of the wind farms in Croatia will operate between 2000 and 2400 full load hours (FLH). Windiest regions in Croatia are mountainous regions between Velebit and Dinara, parts of large planes in the Zadar and Šibenik-Knin Counties, coastal region few tenths of km wide near the north Adriatic Coast. In these areas one could find sites with 2300-2400 FLH on average while the best sites go even up to 2900 FLH. In the coastal part of the country there are many areas with equivalent full load hours in the range of 1900-2300. Continental part of Croatia has generally much lower wind resource and is expected their operation will not exceed 1700 FLH [7]. Also, islands have good wind energy potential but the legal prohibition of wind farm construction on the islands that is currently in power prevents the development of the projects.

The Ravne I wind farm on the island of Pag was the first commissioned wind farm in Croatia (2005), consisting of 7 Vestas wind turbines of 850 kW each, totalling in 5.95 MW. In 2006, wind farm Trtar-Krtolin located few kilometres away from the city of Šibenik was commissioned with 14 wind turbines manufactured by German manufacturer Enercon of 800 kW each totalling in 11.2 MW. Wind farm Trtar-Krtolin, developed by Croatian company Enersys d. o. o. in cooperation with German wpd AG, in the first years of operation performed slightly under the expectations. The reason might be annual variation in available wind resource, but this is still within acceptable range of production. In 2008 Končar Electric Industries, i. e. Končar KET d. o. o. installed their prototype wind turbine of 1 MW rated power on the Pometeno brdo hill in the hinterland of Split. This prototype wind turbine is gearless wind turbine (similar to Enercon) that was completely developed by Končar, with some imported components that are assembled in the design. The testing of the wind turbine is underway. This site is planned to be extended for another 15 units up to the total installed power of 16 MW.

In late 2008 and early 2009 the wind farm Vrataruša located on the south slopes of Velika Kapela Mountain, few kilometres north of Senj, the largest wind farm in Croatia and region so far, was constructed. The site is extremely exposed to the local catabatic wind flow known as Bura. Very high wind resource and extreme wind gusts characterise the site. The wind farm consists of fourteen 3-megawatt Vestas units, totalling 42 MW. Expected average annual production is as high as 125 GWh. After test work of over one year, this project became an Eligible producer in the autumn of 2010. Developer of the wind farm is Valalta d. o. o., Turistic Company from Istria in cooperation with German Wallenborn Projektentwicklung GmbH.

Wind farm Orlice was commissioned in May 2009. near the city of Šibenik with total power of 9.6 MW. Developer of this project is Enersys d. o. o., same as in case of wind farm Trtar Krtolin. Additional wind capacities were installed in 2010, but started with operation in 2011. Wind farm Crno Brdo consist out of 7 wind turbines of 1.5 MW manufactured by Leitwind and is situated near the city of Šibenik together with wind farms Trtar-Krtolin and Orlice. Wind farm ZD 6 (Velika Popina) is situated near city of Gračac and consists of four Siemens wind turbine of 2.3 MW, totalling 9.2 MW. All these mentioned projects totalled wind generation capacity in Croatia on 88.75 MW.

From enforcing of the secondary regulation for RES in Croatia until September 2011, 146 wind projects with 6640 MW capacity has applied to the Ministry of Economy, Labour and Entrepreneurship (MELE) for record in RES&CHP Project Registry. Beside mentioned seven projects, additional four projects with 87.5 MW capacities have signed Power Purchase Contract, but are not commissioned yet.

TRENDS AND DEVELOPMENTS OF PV PROJECTS

Annual global horizontal irradiation for area of the Republic of Croatia, which ranges between 1.20 MW/m^2 for northernmost parts and mountain areas and 1.60 MWh/m^2 for southernmost outer islands, equals productivity of PV systems in range from 950 kWh/kW$_p$ to 1350 kWh/kW$_p$.

Until introduction of RES&CHP legal framework in 2007, photovoltaic installations in Croatia were used primarily to supply isolated locations. Besides the size of solar power plants, feed-in tariffs and the duration of the contract on purchase of electricity, the legal framework has also defined and the cap of the total installed solar power plant to 1 MW. So, at the moment, PV systems will be incentivised until the total installed capacity of PV systems in Croatia reaches 1 MW, which is obviously limiting factor for development of PV market.

Photovoltaic market in Croatia is still undeveloped and dominated by small projects of private developers. Several enthusiastic on-grid PV projects were commissioned even before introduction of RES legislative. In 2007, six PV plants were connected to the grid, with installed power of 55 kW, however, some of them did not obtained status of eligible producer for several years. Introduction of legal framework have driven the interest of developers, thus from2007 there is constant annual growth of installed PV on grid capacities, which totalled 450 kW in 2010, and preliminary results for 2011 show increase of at least new 200 kW. In total, 19 projects were commissioned to the end of 2010, and additional tenths is expected in 2011. Up to date, largest realized project is PV plant on Rijeka Highway Bypass Noise Protection Barrier, with installed capacity of 265 kW, while all the other projects have installed capacity up to 30 kW. High number of projects commis-

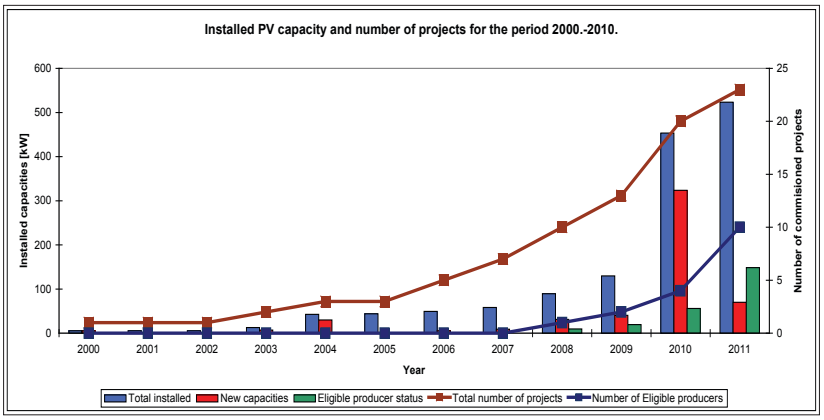

Figure 1. On-grid PV capacities in Croatia

sioned was followed by time delays in obtaining an eligible producer status, thus in September 2011 only 10 projects with installed capacity of 148 kW were incentivized. Additional 30 projects with capacity of 1,426 kW have signed Power purchase contract, but either not yet commissioned either commissioned but waiting for final decision. Figure 1 shows installed capacity and eligible producer status growth in Croatia for the period 2000–2010.

High interest of potential investors is best presented by number of on-going projects in RES&CHP Project Registry in which 116 projects with capacity of 53.5 MW are entered. However, care must be taken when counting projects with 0.9 or 1 MW because some developers apply for several Energy Approvals for PV plant of 1 MW, but they are all physically one larger project. Also, high number of larger projects obtained only a Preliminary Energy Approval, which is basically a first step in administrative procedure, thus not all of them are expected to happen.

CONCLUSION

After the introduction of bylaws which define the use of renewable energy sources, there is a noticeable increase in the interest of investors in this sector. While energy from renewable sources, with the exception of large hydropower plants, is in a small percentage participating in the overall energy balance, there has been a yearly increase of production capacities and their penetration into the market. According to the number of projects registered in the RES&CHP Projects Registry, further increase of energy from renewable sources in total energy balance, especially electricity from wind power is expected. The most significant obstacle to the successful implementation of the RES projects is certainly compli-

cated and in some parts non-transparent administrative procedure, which especially pronounced at smaller projects (such as photovoltaic systems on the roofs of buildings) that had to pass almost the same procedure as well as large wind farms. Simplifying administrative procedures would significantly facilitate the development of small projects using renewable energy sources for electricity production.

It is also very important to define the Action plan for RES for the period from 2010 to 2020 as foreseen by the Croatian energy strategy. Only stable and long-term framework can ensure RES market development.

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RAZVOJ PROJEKATA PROIZVODNJE ELEKTRIČNE ENERGIJE PUTEM VJETRA I SUNCA U HRVATSKOJ

Sažetak: Povoljan zakonodavni okvir za korištenje obnovljivih izvora potaknuo je razvoj projekata u većini država članica EU. Već dugi niz godina, vjetroelektrane bilježe najveći rast instaliranih kapaciteta u ovome sektoru, a posljednjih nekoliko godina je primjetan i rast instaliranih kapaciteta sunčanih elektrana. Hrvatska je 2007. godine uvela zakonodavni okvir za obnovljive izvore koji je omogućio komercijalni razvoj ovoga sektora u Hrvatskoj. Ovaj članak će predstaviti projekte korištenja obnovljivih izvora energije za proizvodnju električne energije, s naglaskom na energiji vjetra i Sunčevoj energiji, elektroenergetskom sektoru i zakonskom okviru za korištenje obnovljivih izvora energije.

Ključne riječi: *obnovljivi izvori energije, energija vjetra, Sunčeva energija*