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STATE AND PROSPECTS OF RENEWABLE ENERGY SOURCES USE IN CROATIA

Abstract: Natural resources in Croatia are substantial for the use of renewable energy sources: hydropower, biomass, wind and solar energy. Presently only significant use of large hydropower is realized, so called “old renewable”. Other renewable energy sources use is still in its infancy regardless of long history of preparation with research and complete legislation. Early phases of development are visible mainly related to the wind power use, and somehow less related to the biomass and photovoltaic energy utilization.

This paper is reviewing renewable energy resources in Croatia. Current level of renewable energy sources utilization in Croatia is presented in details. Attractive level of incentives for the support of new renewable energy sources construction is gaining significant interest from prospective investors. Difficulties related to the realization of this interest are mainly related to the administrative barriers and lack of experience.

Support for further development of expensive renewable energy sources use in Croatia is mainly based on sustainability and CO₂ reductions. Elements of positive effects to the national economy are so far negligible.

Most important issues for significant development of renewable energy usage in Croatia are related to the lack of comprehensive strategy for both, integration of renewable energy sources in to the national power system and national economy. Without this strategy Croatia will end up using too expensive energy without achieving sustainable goals.

Key Words: *Renewable energy sources, Croatia, state, perspective*

Sažetak: Prirodni resursi u Hrvatskoj su značajni za korištenje obnovljivih izvora energije: hidroenergija, biomasa, vjetar i solarna energije. Trenutno je ostvarena samo značajna uporaba velikih hidroelektrana, tzv. “starih obnovljivih izvora”. Korištenje ostalih obnovljivih izvora energije je još uvijek u povojima, unatoč duge povijesti istraživanja i priprema te kompletiranog zakonodavstva. Korištenje energije vjetra je u svojim ranim fazama razvoja, a nešto slabiji pomaci su vidljivi vezano za korištenje energije biomase i fotonaponsko korištenje energije Sunca.

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Ovaj rad prikazuje pregled obnovljivih izvora energije u Hrvatskoj. Trenutna razina korištenja obnovljivih izvora energije u Hrvatskoj prikazana je detaljno. Atraktivna visina poticaja za podršku novih obnovljivih izvora energije je dokazana značajnim interesom potencijalnih ulagača. Poteškoće u svezi s realizacijom tog interesa također su istaknute u radu.

Podrška za daljnji razvoj korištenja skupih obnovljivih izvora energije u Hrvatskoj uglavnom se temelji na održivosti vezano za smanjenje emisija CO₂. Elementi pozitivnog učinka na nacionalno gospodarstvo su zasad zanemarivi.

Najvažnija pitanja za značajniji razvoj korištenja obnovljivih izvora energije u Hrvatskoj se odnose na nedostatak sveobuhvatne strategije za integraciju obnovljivih izvora energije kako u nacionalni elektroenergetski sustav tako i u nacionalnu ekonomije. Bez sveobuhvatne strategije Hrvatska će završiti korištenjem preskupe energije bez postizanja ciljeva održivosti.

Ključne riječi: *Obnovljivi izvori energije, Hrvatska, stanje, perspektive*

INTRODUCTION

Major visible motivation and justification for the rapid introduction of renewable energy sources (RES) despite their intermittency, immaturity, and higher cost, lies in the hope that they present important part of the solution for the CO₂ emissions reduction. There is no doubt that the future belongs to the renewable sources but it is not quit clear when is that future starting nor how much I worth to spend in order to speed up that transformation.

Certainly other reasons are of similar importance, and they could be used to complement cost disadvantages. This is mainly related to the potential that new so called “green jobs” might be drive for the recovery from current global economical crises.

Finally energy security also presents important potential complementary contribution from increased use of renewable energy sources.

Having this entire in mind it is easy to imagine why major introduction of renewable energy sources would present significant challenge. It is the goal of this paper to present in short most important information related to the renewable energy sources potential, use, and perspective in Croatia.

RENEWABLE ENERGY RESOURCES POTENTIAL IN CROATIA

In Croatia significant renewable resources are available from solar, wind, hydro, and biomass energy sources. Technical potential for each source is presented here because economically they are all not viable at present.

Solar energy resource in Croatia is above the European average (1300–1900 kWh/m²). Figure 1 is showing how significantly southern parts of Croatia are sunnier. Technical potential is depending on assumptions (i. e., stand alone vs. mounted etc.), and for simplicity if 1% of continental surface is utilized that gives above the about 750 PJ of useful energy (i. e., heat and electricity – 14% share for ~30 TWh).

Wind power resources in Croatia are not as good as at the Atlantic coastal regions, but available potential is significant to Croatia. Figure 1 is showing how sig-

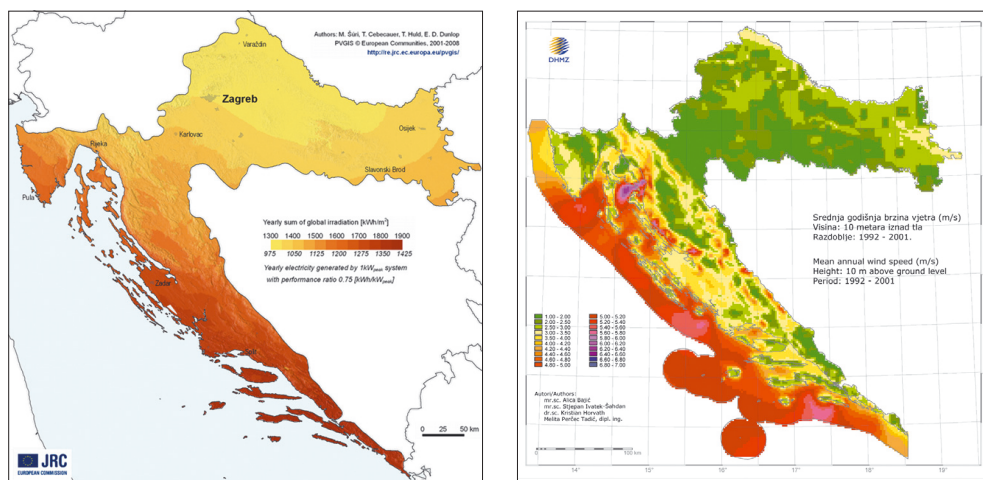


Figure 1. Solar [10] and wind [11] energy resources in Croatia

nificantly southern parts of Croatia are windier. Less than half of the potential is on the continental area, and it is estimated technically as 10 TWh (36 PJ).

Hydro power technical potential is already significantly utilized in big hydro electric power plants (21 PJ). Further potential exists with both big and small hydro electric power plants across whole Croatian territory with technical estimate at 12 TWh (43 PJ), with 10% for small units (<10 MW).

Geothermal energy is also available in northern parts of Croatia where is average geothermal temperature gradient of 49 °C/1 km (63% higher than European average). These are mainly low temperature sources (i. e., bellow 50 °C, and bellow 120 °C) Technical estimate is at about 63 PJ with potential for about 50 MW of electricity generation (few sites with >120 °C).

With almost 50% of land covered with woods, and even more as agricultural land Croatia has significant biomass resources. Total technical potential for all uses (i. e., heat, biofuel, and biogas) is estimated at 93 PJ.

STATE OF RENEWABLE ENERGY USE IN CROATIA

Most recent complete data about energy from²⁰⁰⁸ ([9]) are clearly showing that only significant renewable source in use are hydro power and biomass.

In total primary energy production (197 PJ) hydro power is contributing with 25% and biomass is contributing with 9%. This hydro power is coming almost completely (98%) from large hydro power plants. Biomass is also dominantly from wood and wood residues.

When electrical energy supply is analyzed picture is not any better. Figure 2 is presenting share of sources for electrical energy supply of 19 TWh in Croatia in 2008. Only large hydro power is significant renewable source with 28%. Wind pow-

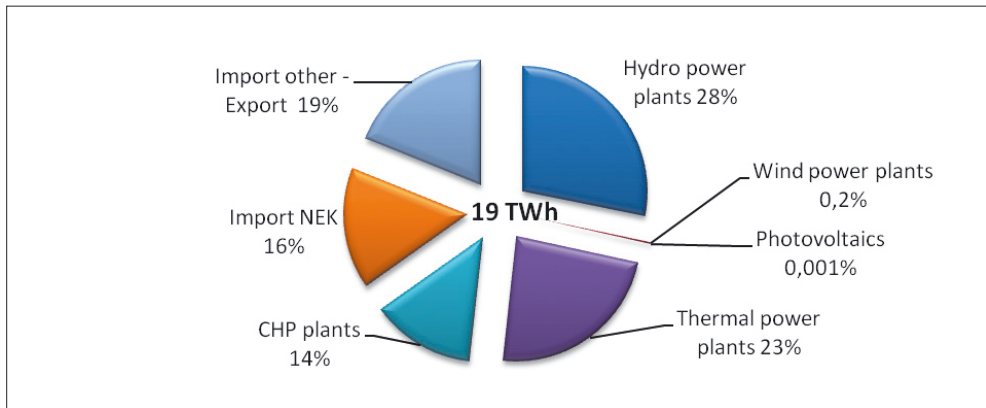


Figure 2. Electrical energy supply share in Croatia 2008, [9]

er plant produced 0,2%, and photovoltaic power plants produced only 0,0001% of electricity in 2008.

This situation has not improved till 2010 when total installed capacity is as presented in Table 1. Current use of new renewable energy sources is waiting for better days.

Table 1. Cumulative installed supported renewable energy sources in Croatia 3rd quarter 2010, [7]

Capacity MW	Wind	PV	Small HP	Biomass CHP	Biogas
Installed	28	0,053	0,030	0	2
In construction	96	0,080	0	6	3

PROSPECTS OF RENEWABLE ENERGY USE IN CROATIA

In order to support introduction of costly renewable energy sources Croatia has established feed-tariff from July 2007 (table 2). How attractive these incentives are it is best visible from the extra ordinary interest shown from the registered projects with government (Table 2). This interest is even bigger then officially stated in energy strategy goals till 2020 ([8], Table 2). Goals for 2020 are to use 20% of RES in final energy consumption with 35% share for electricity, 10% share for transportation, and 20% for heating/cooling.

All this will be excellent for the renewable development if the fact is that very little, almost nothing is realized so far (Table 1). Current goal for achieving 5,8% share of supported renewable sources for electricity production in 2010 will not be achieved. The question is how things will develop further till 2020 with existing economical situation and other difficulties related to the renewable sources introduction in Croatia.

Feed-in tariff funds are collected from the customers originally with 0,123 c€/kWh (0,89 lp), and from 2010 this is reduced to 0,069 c€/kWh (0,50 lp). With this level of incentives and consumption of 19 TWh it is possible to support for exam-

ple about 0,141 TWh of wind power (which is about 60 MW installed capacity depending on the capacity factor). This means that collected money would have to be increased when installed capacity of supported RES increases.

Major problems related to this huge contrast between high incentives, huge developer interest and very modest installed supported RES capacity is related with lack of experience and administrative barriers. Experience is slowly gained, but administrative barriers have yet to be removed. Whole process is not just unnecessarily complicated, but also very costly, time consuming and same for small integrated kW size and bigger MW size installations. Work in progress is on the way to solve some of experienced problems, but it is not clear how to organize this because numerous administrative institutions are involved. Ideally each investor should deal smallest possible number of offices (i. e., they should communicate between each other).

However, solving this experience and administrative issues will not mean open road for major introduction of RES in Croatia because problems related to power system integration and related expenses coverage are already starting to face early investors. For long term future of increased RES usage Croatian power system has certain advantage with existing and potential for new hydro power energy storage. This again raises total cost.

One way to justify this increased cost could be to add other incentives like increasing additional benefit for RES introduction for national economy and priorities RES introduction by sources and locations. Like in some other countries significant incentives are missing almost completely for thermal solar applications regardless of almost economical maturity and potential for economical benefits.

Table 2. Feed-in Tariff, registered RES projects ([7]) and Croatian energy strategy for 2020, [8]

Capacity FIT	Wind	PV	Small HP	Biomass + waste	Geothermal
Feed-in tariff e€/kWh*	9,0	29–47,0	9,5	14,0	17,0
Registered MW	5640	48	200	157	5
2020 goals MW	1200	45	100	140 + 40	20

* 1€ = 7,25 kn, incentives are varied based on installed capacity and other parameters

CONCLUSION

This paper has presented that natural resources in Croatia are substantial for the use of renewable energy sources (RES). However, presently only significant use of large hydropower, so called “old renewable”, is realized. With all other renewable energy sources use is still in its infancy regardless of long history of preparation with research and complete legislation. Only early phases of development are visible mainly related to the wind power use, and significantly less to the biomass and photovoltaic energy utilization.

This state of RES utilization in Croatia is in sharp contrast with the current trends in the rest of the world. Significant results are missing regardless of existing

attractive level of incentives for the support of new RES construction and significant interest from investors. Difficulties related to the realization of this are mainly related to the administrative barriers, and lack of experience.

Part of the problem is also the fact that support for further development of expensive RES use in Croatia is mainly based on sustainability and CO₂ reductions. Important elements of positive effects to the national economy are missing.

Finally, most important issues for further significant development of renewable energy usage in Croatia are related to the lack of comprehensive strategy for both, integration of renewable energy sources in to the national power system and national economy. Without this strategy Croatia will end up using too expensive energy without achieving sustainable goals.

LITERATURE

- [1] B. Hrastnik and B. Franković: "Solar energy demonstration zones in the Dalmatia region" *Renewable Energy* 24 (2001) 501–515
- [2] M. Božičević Vrhovčak, Ž. Tomšić, N. Debrecin: "Potential and use of renewable energy sources in Croatia" *Renewable Energy* 31 (2006) 1867–1872
- [3] D. R. Schnider, N. Duić, Ž. Bogdan: "Mapping the potential for decentralized energy generation based on renewable energy sources in the Republic of Croatia" *Energy* 32 (2007) 1731–1744
- [4] D. Lončar, N. Duić, Ž. Bogdan: "An analysis of the legal and market framework for the cogeneration sector in Croatia" *Energy* 32 (2009) 134–143
- [5] Z. Glasnović and J. Margeta: "The features of sustainable Solar Hydroelectric Power Plant" *Renewable Energy* 34 (2009) 1742–1751
- [6] Z. Guzović, D. Lončar, N. Ferdelji: "Possibilities of electricity generation in the Republic of Croatia by means of geothermal energy" *Energy* 35(2010) 3429–3440
- [7] Dubravka Škrlec: *Personal correspondence* 21 Oct. 2010
- [8] Croatian energy development strategy, in Croatian: *Strategija energetskeg razvoja republike Hrvatske*, October 16, 2009. http://narodne-novine.nn.hr/clanci/sluzbeni/2009_10_130_3192.html
- [9] Energy Institute Hrvoje Prožar: "Energy in Croatia from 1945–2008", http://www.eihp.hr/english/e_sustavi.htm
- [10] Photovoltaic Geographical Information System (PVGIS), Geographical Assessment of Solar Resource and Performance of Photovoltaic Technology, <http://re.jrc.ec.europa.eu/pvgis/>
- [11] Croatian Meteorological and Hydrological Service: "Croatian wind speed map" http://klima.hr/klima_e.php?id=karta_vjetra_e¶m=