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SMALL HYDROPOWER PLANTS IN SLOVENIA

MALE HIDROELEKTRARNE V SLOVENIJI

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Keywords: small hydropower plants, hydrological potential, renewable sources

Abstract

In this article, an overview of the small hydropower (SHP) sector in Slovenia and the EU is given. Data were collected from publically accessible statistics (SURS and EUROSTAT) and public documents available on the internet. The gross production of electric energy from small hydropower plants, its share in production from renewable sources, available hydrological potential, trends in SHP sector and strategic development for the future are all considered. EU experts optimistically predict increasing SHP capacities while the statistical data for the previous decade show the opposite.

Povzetek

V članku je podan pregled stanja v sektorju malih hidroelektrarn v Sloveniji in EU. Podatke smo pridobili iz javno dostopnih statistik (SURS and EUROSTAT) in iz javno dostopnih dokumentov objavljenih na spletu. Obravnavamo bruto proizvodnjo električne energije malih hidroelektrarn, njihov delež v proizvodnji iz obnovljivih virov, razpoložljiv hidrološki potencial, trende v sektorju malih hidroelektrarn in njihov strateški razvoj v prihodnosti. Napovedi evropskih strokovnjakov optimistično napovedujejo rast kapacitet malih hidroelektrarn, vendar statistični podatki kažejo ravno nasprotno sliko.

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1 INTRODUCTION

Throughout the world and also in Slovenia, electric energy consumption is rising every year. To ensure a quality supply for the future and to decrease Slovenia's dependency on energy imports, production capabilities must be increased, or the trend of rising consumption must be reversed. The latter option requires significant changes in behaviour, thinking and lifestyle. In accordance with sustainable development, reduced consumption and increased production must be pursued, accompanied by an increased share of renewable sources of energy (RSE). Hydropower has a significant role in reaching the 2020 renewable energy targets as well as the greenhouse gas reduction targets. The target for Slovenia is to attain a 25% share of renewable sources in final energy consumption and a minimum share of renewable electricity consumption of 34%, [1].

With regard to water resources, Slovenia is one of the richest EU countries; with significant hydrological potential to exploit for the generation of electricity. This potential can be harnessed without significant impact on the environment, with minimal pollution and at relatively low cost with the use of technology of small hydropower plants (SHP), which is very well known and efficient.

The definition of SHP differs from country to country. Slovenia has defined it as hydropower plants whose maximum installed capacity does not exceed 10 MW. This definition is also approved by the European Small Hydropower Association (ESHA).

An SHP is not simply a reduced version of a large hydropower plant, but requires special equipment that ensures high efficiency, maintaining simplicity for non-experts, environmental measures and maximum reliability [2].

SHPs can be divided into two groups according to their ecological impact, [3]. The first group consists of run-of-river power plants, which can be subdivided to: diversion hydroelectric plants (plants involving a partial diversion of water of the water of the river) and through-flow power plants (plants with no diversion but run-through regimes). The second group is infrastructure-related power plants, also called multipurpose plants, which exploit water that has already been used for other purposes. They produce only small amounts of electricity and are usually integrated into the network of the drinking water supply, wastewater disposal infrastructure or irrigation infrastructure. They can also exploit the excess of water of larger plants and can aid in the creation of flows to aid fish migration.

2 OVERVIEW OF THE CURRENT SITUATION

This research is mainly based on publically accessible statistical data (SURS and EUROSTAT) and public documents available on the internet.

Electricity consumption in Slovenia rose continually from the year 2000 to 2012 (Figure 1). The only exception was 2009 when there was a significant drop of consumption (to the level of 2001) due to beginning of the economic crisis. Since then, consumption has again risen.

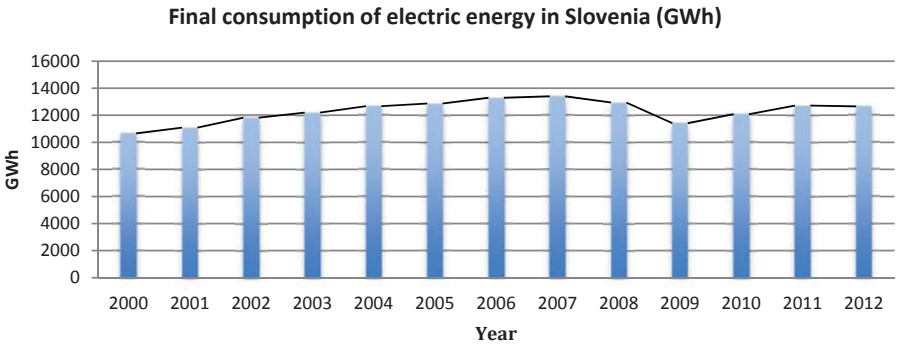


Figure 1: *Electric energy consumption from year 2000 to 2012 [5]*

In 2012, electricity was mainly produced from nuclear fuel (Figure 2). Renewable sources had a 29% share if hydropower and other sources (photovoltaic, biomass and biogas) are taken into account.

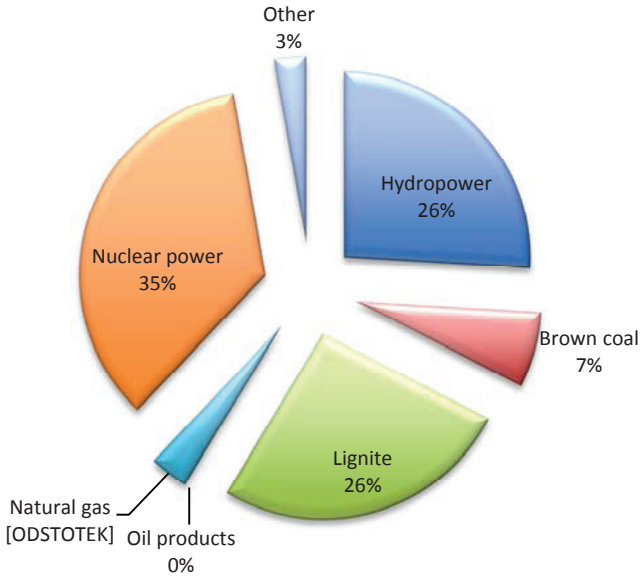


Figure 2: *Electric energy production by source in 2012, [5]*

The largest share (80%) of electricity production from renewable sources in 2012 was held by large hydropower plants. The second largest share was held by SHP at 7% (Figure 3). The SHP share and gross production was even bigger from 2000 to 2012. (Figure 4).

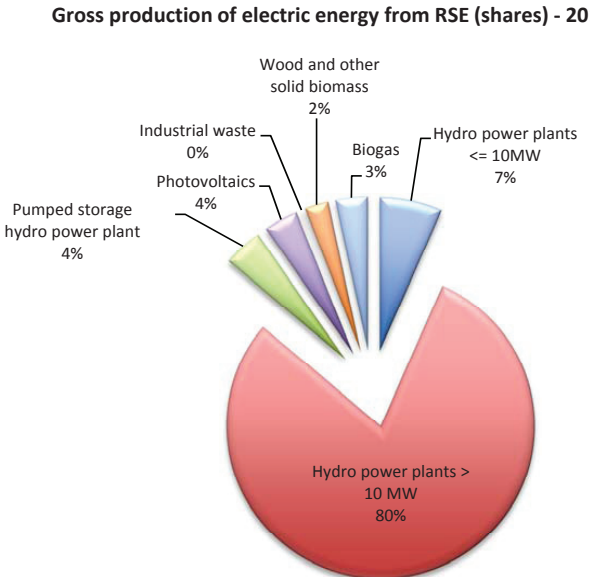


Figure 3: *Gross production of electric energy from RSE [5]*

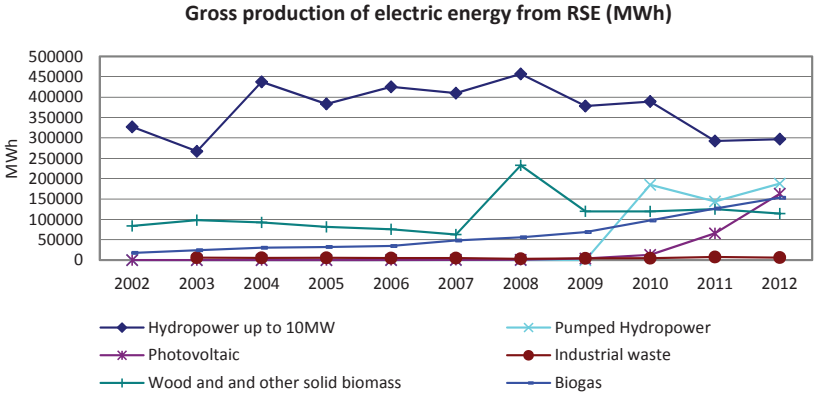


Figure 4: *Gross production of electric energy from RSE over past 10 years – large Hydropower plants not included, [5]*

The hydro-electric gross potential of Slovenian rivers is estimated to 19440 GWh/year, of which 9145 GWh/year is technically feasible and between 7000 and 8500 GWh/year is economically feasible, [4].

In 2013, 4080 GWh of electric energy was produced, which represents 45% of the entire technically feasible potential; 297 GWh of that production was produced by SHP, which is 7% of all electric-

ity produced by hydropower, [5]. The hydrological potential suitable for SHP is estimated at 1114 GWh/year (not including the Kolpa and Mura rivers). Currently, approximately 25% of that potential is harnessed, [4], which leaves 835GWh/year to exploit.

In Slovenia, 407 SHPs with an average installed capacity of 234 kW are currently active, [6]. These are the SHPs that have concessions for water exploitation; the authority for granting such concessions is the Slovenian Environment Agency.

SHP are situated mostly in the Alpine region, in the north and north-west of the country (Figure 5). These regions have the most of SHP exploitable potential, because Alpine rivers are water abundant with high water heads.

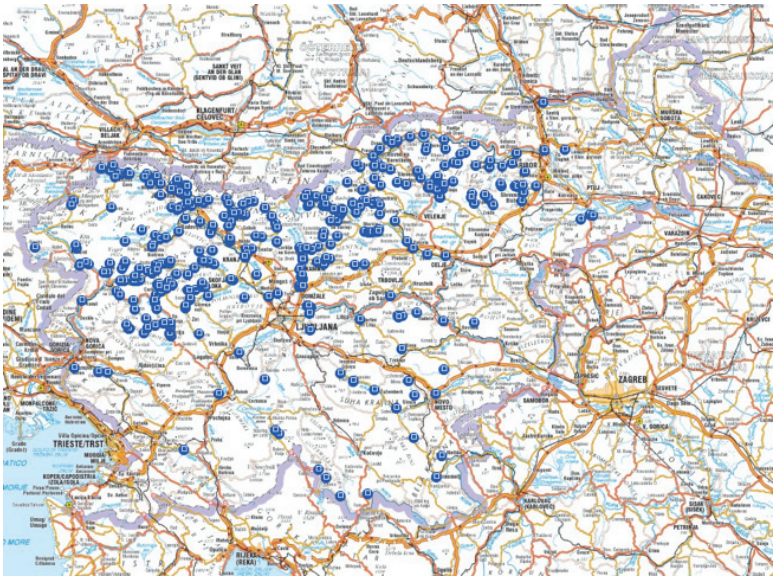


Figure 5: *SHP on the map (source: http://www.geopedia.si/)*

3 SHP TRENDS IN SLOVENIA AND THE EU

Most of the SHPs in Slovenia were built before its declaration of independence in 1990. The real boom of new SHP was in the 1980s; this was caused by energy legislation that allowed building SHPs in non-electric power industrial facilities, [7]. More than 80% of operating SHPs originate from that time. Since then, new legislation has almost halted the building new SHPs. The situation in the rest of EU is similar, [8].

If the installed power of SHP from 2002 to 2011 in the EU is considered, it rose approximately 2% per year. Installed SHP power in Slovenia has also risen, but a drop of 8% was recorded 2003 and 2004. After 2006, it continued to rise again at average of 2% per year (Figure 6). Although the installed power of SHP is rising, the gross production of electricity has been dropping since 2008 (Figure 4).

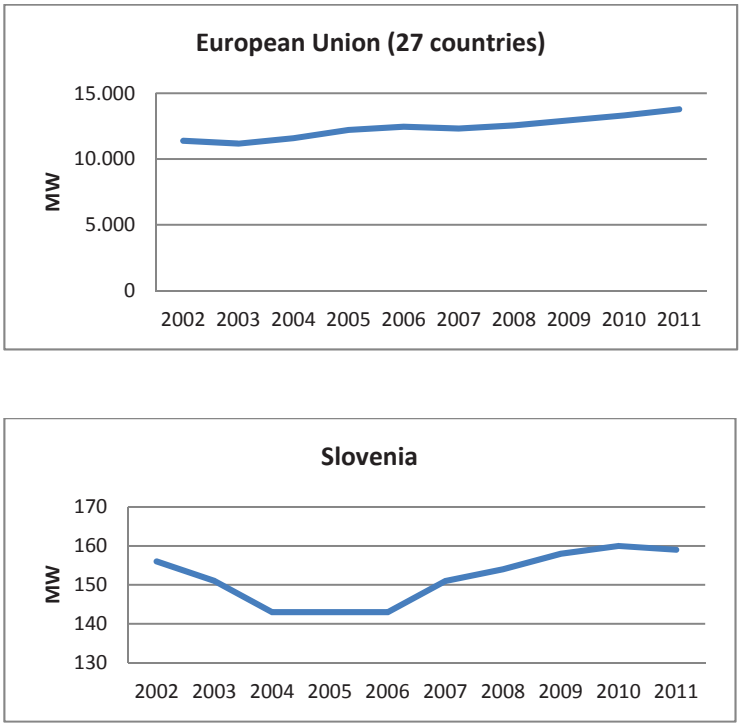
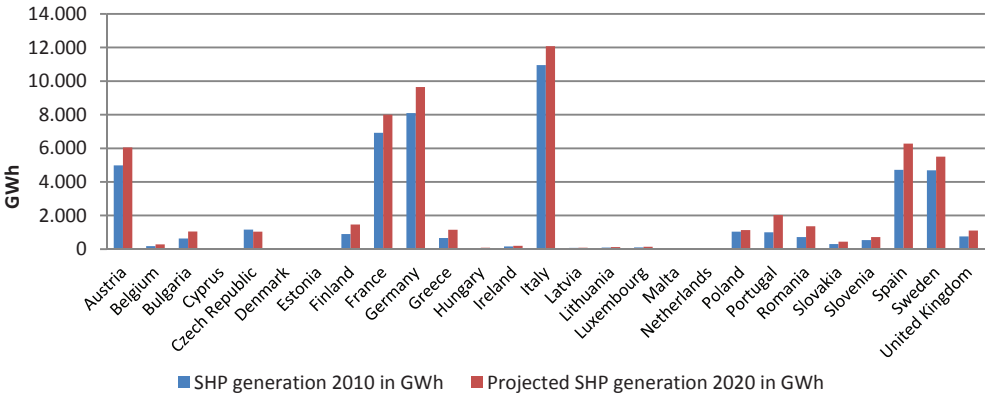


Figure 6: *Installed capacity of SHP in EU-27 and Slovenia [9]*

In 2010, approximately 21,800 active SHPs in the EU-27 generated 49,000 GWh of electricity and accounted to over 13,000 MW of installed capacity, which is enough to supply over 13 million households. This contributes to an annual reduction of CO_2 of 29 million tonnes, [10].

The ESHA (European Small Hydropower Association) made projections of generation of electricity by SHP from 2010 to 2020. They predict a 23% increase of total production in the EU-27 (Figure 7). The largest increase of production is predicted for Netherlands and Portugal (over 100%). Only for the Czech Republic is a decrease predicted (10%). The forecast for Slovenia is a 35% increase.



Member State	SHP electricity capacity in MW	SHP generation in GWh	Projected SHP generation 2020 in GWh
Austria	1.109	4.983	6.050
Belgium	64	178	285
Bulgaria	285	630	1.050
Cyprus	-	-	2
Czech Republic	297	1.159	1.040
Denmark	9	21	31
Estonia	8	30	33
Finland	302	900	1.460
France	2.110	6.920	8.000
Germany	1.723	8.098	9.650
Greece	183	657	1.150
Hungary	14	67	80
Ireland	45	160	200
Italy	2.735	10.958	12.077
Latvia	26	69	85
Lithuania	29	93	120
Luxembourg	34	100	137
Malta	-	-	-
Netherlands	2	8	18
Poland	275	1.035	1.136
Portugal	360	997	2.032
Romania	387	719	1.360
Slovakia	80	303	443
Slovenia	117	535	720
Spain	1.926	4.719	6.280
Sweden	1.134	4.694	5.500
United Kingdom	230	750	1.100
TOTAL	**13.485**	**48.783**	**60.039**

Figure 7 and 8: *EU-27 SHP Generation 2010 and 2020 Forecasts (source: http://dev02.semaforce.eu/index.php?id=263)*

4 STRATEGIC DEVELOPMENT OF SHP

Because most of the SHPs are situated in the Alpine region, which is environmentally highly fragile, and because sustainable development must be planned, SHP development guidelines and recommendations of Alpine Convention should be adopted, [2]; these were approved by the 11th Alpine Conference held in Brdo pri Kranju, Slovenia in 2011. These guidelines and recommendations are oriented towards the usage of renewable resources and decentralized plants.

The SHP sector continues to face significant obstacles, especially with increasing environmental demands and administrative barriers. Therefore, far-reaching increases in the development of new SHPs cannot be expected. The gross production of electric energy from SHP has even been dropping since 2008 (Figure 4).

For the future development of the SHP sector, two possible scenarios are predicted, [11]. The first scenario is the development of SHP if the conditions will remain as they are currently, while the second scenario predicts that the condition will improve.

The first scenario predicts that the development of new SHPs will expand more slowly because the most suitable places already have been used. Furthermore, the refurbishment of old abandoned SHPs will be questionable because of new stricter environmental regulations. For the EU-27, this scenario estimates that one-third of the potential can be developed with existing conditions by 2020.

The second scenario estimates the growth will be the same until the year 2020, which means that two thirds of the EU-27 potential can be developed, i.e. a total SHP capacity of 20 GW. That is 3.3GW more than estimates of the first scenario or 13,000 GWh per year. Because Slovenia is a member state of the EU-27, two similar scenarios can be expected.

Slovenia's plan for increasing its share of renewable sources is to provide a wide range of technology to harness them. The priority for electric production is to promote the sectors with significant economic potential, i.e. hydropower, biomass and biogas, [12]. When the trend in decentralized power plants and the fact that SHPs demonstrate the best performance with regard to emissions measured on a lifecycle basis are taken into account, the SHP sector is one that should be more present in national and regional financial and planning incentives.

If the target of a 25% share of renewable sources is to be attained, all available potentials must be used. Therefore, it is necessary that government and policy makers consider the SHP sector to be an equally important component of the renewable energy mix and as a technology that supports water management policies. More consensus and cooperation between the energy and environmental policies and actors is also needed, [13].

The development of SHPs is also a major challenge for Slovenia's SHP industry, which has a significant role in the EU and further abroad. The SHP industry must obtain a competitive role and has to invest in developing new technologies and knowledge in automation, frequency conversion, permanent magneto-generators, efficient, low head turbines, fish-friendly turbines and new materials, [11]. Throughout the world, there is a considerable amount of un-used hydrological potential, and this represents an excellent opportunity.

Refurbishing old existing SHPs or renovating old mills into SHPs are more appropriate courses of action than building new plants, because there is a smaller impact on the environment as well as

added value in the sense of preserving a technical legacy and promoting tourism. All of this contributes to the development of rural regions and job creation.

5 CONCLUSION

In this article, a quick overview of the situation in the small hydropower sector in Slovenia and the EU has been made. Slovenia has significant hydrological potential, of which 25% is currently harnessed by SHPs. The production share of electric energy from SHP in Slovenia is currently 7% but is decreasing due to the increased usage of other renewable sources, as well as EU and state policies. The European Small Hydropower Association has predicted an increase of installed SHP capacity by one third by 2020 for Slovenia, but the current trends indicate the opposite.

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