



Challenges and prospects of electricity production from renewable energy sources in Slovenia



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ABSTRACT

Development of the utilisation of renewable energy sources and energy efficiency represents the main policy for sustainable development. The overall target of the European Union Directive on the promotion of the use of energy from renewables (RES) is to achieve at least a 20% share of energy from renewables in the gross final energy consumption in 2020. The mandatory national target for Slovenia is a 25% share of energy from RES in the gross final consumption. The share of RES in the gross final energy consumption in Slovenia was 18.8% in 2011 and the share of electricity production from RES was 30.8% in the gross electricity consumption. Electricity production from photovoltaics (PV) and biogas plants in agriculture has been growing fast after the adoption of the new supportive decree for electricity from RES in 2009. The very fast growth of PV plants has caused a problem for financing electricity from RES. Similar effects have been also recorded in the biogas sector, which represents a threat to food production. The state of the art, targets and challenges of electricity production from RES in Slovenia are described in the paper.

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1. Introduction

Sustainability is the goal of development strategies in all countries. Energy is an essential factor in overall efforts to achieve sustainable development [1]. Development of the utilisation of renewable energy sources and energy efficiency represents the main policy for sustainable development and the key element in strategies and scenarios to tackle climate change [2–5].

Utilisation of renewable energy sources (RES) is one of the important measures for increased reliability/security of energy supply and to reduce drastically greenhouse gases emissions [6–9]. According to the predominance of policy for sustainable development, the research in the last years was focused on the improvement and development of new technologies for utilisation of renewable energy sources [10–13].

Interesting examples of the investigation and review of renewable energy strategies and perspectives for converting present energy systems into a 100% renewable energy system can be found in Refs. [14] and [15]. According to Ref. [14], a 100% renewable energy system is possible, but large-scale renewable energy implementation plans must include strategies for integrating

renewable sources in coherent energy systems influenced by energy savings and energy efficiency measures. Also, largely renewable energy systems will certainly improve several aspects of security, but they will not automatically lead to the removal of all types of security problems and new problems will most certainly arise [16].

The main objectives of the energy and climate policy of the European Union (EU) are to decrease greenhouse gas emissions, increase energy efficiency and the share of renewable energy sources (RES) in the energy balance and decrease energy dependency. A comprehensive review of the EU energy and climate policy framework together with the instruments to tackle identified gaps can be found in Refs. [17] and [18]. In the past, many countries have defined challenging energy and climate-related long-term objectives, but lack of a clear definition of responsibilities with deadlines for the implementation of the proposed measures was the crucial reason why many goals have not been achieved [19]. Specific measures that have been shown to work well include efficiency targets and standards, benchmarking, energy audits and energy management requirements, complemented by training, capacity-building, information provision and awareness raising campaigns. It is promising that the EU has already demonstrated how much can be done in reducing the energy intensity of manufacturing processes through energy efficiency and sustainable production processes. The twelve largest EU

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member states have achieved a bigger reduction in the relative weight of energy inputs in their exports of manufactured goods than any of their external trade partners since 1995 [19–21]. However, the EU is aware that further improvements are necessary and that is the reason for many policy interventions in recent years. The overall target of the EU Directive on the promotion of the use of energy from renewables (RES) is to achieve at least a 20% share of energy from renewables in the gross final energy consumption in 2020. The targets for individual Member State have been determined as fairly as possible. The Slovenian obligation target as defined in Annex I of the Directive [22] is a 25% share of renewable energy sources in the gross final consumption of energy in 2020. The EU target of a 22.1% share of electricity from RES in total electricity consumption by 2010 was defined in Directive 2001/77/EC on the promotion of electricity from RES (RES-E) [23]. According to this Directive, the obligation for Slovenia was to achieve a 33.6% share of electricity production from RES in total electricity consumption by 2010. However, only 12 Member States had exceeded their planned targets for electricity production from renewable energy sources in 2010, whilst the remaining 15 missed their targets [24]. Barriers to exploiting the full potential of sustainable energy options in the Slovenian energy sector are universal and not much different from in other countries, and are not related to the size of the country or economy. Similar implementation problems can be found in Australia [25] or China [26]. According to Ref. [25], unless additional steps are taken to address barriers to renewable energy development, Australia will miss the opportunity to exploit its abundant renewable resources and enjoy the resulting social, environmental and economic benefits. The portfolio of renewable energy sources available to achieve energy, environmental and economic policy goals for Taiwan can be found in Ref. [27]. Having in mind the current financial and economic crisis, the real challenge of the new renewable energy policy initiatives is hidden within the following question: how many of existing manufacturing jobs can be saved and transformed into clean energy jobs?

The electricity production sector presents one of the most important parts of a country's economy and is a significant source of greenhouse gas emissions [28]. On the EU level the consumption of electricity is growing regardless of its huge impact on the environment. A comprehensive overview of the support schemes for renewable electricity and their relation to the EU emissions trading scheme can be found in Ref. [28]. Recent developments in energy system planning focus on considering various CO₂ reduction scenarios in order to achieve sustainable goals [29–34]. Development of electricity smart grids is recognised as an important element in the process of transformation towards new and low carbon energy systems [35]. However, electricity smart grids must be coordinated with the utilisation of RES being converted into other forms of carriers than electricity, including heat and biofuels, as well as energy conservation and efficiency improvements [36]. Also, interesting research work about future German electricity supply options and possibilities of different bioenergy pathways and conversion technologies suitable for flexible electricity generation can be found in Ref. [37]. The power industry as a whole is subject to comprehensive policy decisions regarding renewable energy production and energy efficiency regulation. Nevertheless, these decisions should be made on the basis of systematic techno-economic analysis using local energy supply chain models and not a-priori favouring any particular development option [38]. Also, as presented in Ref. [39], the local component of policy implementation is mandatory to achieve results on a national level.

This paper presents an overview of the most important targets and challenges for the future development of the RES-E sector in Slovenia. The very important challenge, which lies ahead of future development of the energy sector in Slovenia is how to stimulate

further growth of the renewable energy sector in order to achieve the targets set and to enable a smooth transformation toward a low carbon economy.

2. Structure of the energy supply in Slovenia

The energy dependency of Slovenia in the year 2011 was high (48.4%), but it was a little lower than the average of the EU 27 (53.8%) [40]. The main domestic energy sources are nuclear with a 22.5% share, coal with a 16.7% share, hydroenergy with a 4.3% share, and wood biomass and other renewable energy sources with an 8.8% share in 2011 (Fig. 1). The total primary energy consumption in Slovenia in 2011 was 301.1 PJ (7.0 Mtoe) [41]. Slovenia imported less than half of its primary energy; imports included all petroleum products, almost all natural gas and about 18% coal.

In 2011 Slovenia exported about 4.5 PJ of electricity (the negative value of electricity represents a greater export than import of electricity) as shown in Fig. 1. The share of renewable energy sources was about 13% of the primary energy in 2011.

2.1. Renewable energy sources

The total use of renewable energy sources (RES) in Slovenia was 41 PJ (978 ktoe), which represents a 13.6% share of primary energy consumption in 2011 (Fig. 2). The two main renewable energy sources are hydroenergy with a 4.3% share in primary energy or 17 PJ (306 ktoe), and wood with a 7.2% share in primary energy consumption or 22 PJ (518 ktoe).

Other renewable sources used include biogas (from agriculture and wastes from households, restaurants, food and paper industry, sewage, landfill), biofuels, solar energy (photovoltaic and thermal solar) and geothermal energy (Fig. 2).

2.1.1. Electricity production from RES

The share of RES-E was 26.3% of all net electricity production in 2011 as shown in Fig. 3. Variations in RES-E are dependent on the hydrological situation in the country, since the majority of the electricity comes from hydropower plants as shown in Fig. 4. The share of RES-E (normalised hydrogeneration) was 30.8% of gross electricity consumption (excluding electricity from pumped storage) in the year 2011. Electricity is also produced from wood biomass, biogas, landfill gas, sewage gas and solar energy (photovoltaics – PV) (Fig. 4). The first wind power plant (2 MW) in Slovenia was built in 2012, but up to now no electricity is produced from geothermal sources.

3. Renewable energy policy

The main targets of Slovenian energy policy as defined in all strategic documents adopted in the previous two decades are focused on improvement of energy efficiency and increased utilisation of renewable energy resources [42,43].

The target of the document adopted in 2004 “Resolution on the National Energy Programme (ReNEP)” [43] was to increase the share of RES in the primary energy balance to 12% in 2010 by:

- increasing heat supply from RES from 22% in 2002 to 25% in 2010,
- increasing electricity from RES from 32% in 2002 to 33.6% in 2010,
- achieving a 2% share of biofuels for transport at the end of 2005.

The objectives of the proposal for a new “National Energy Programme to 2030” are to achieve a 30% share of RES in gross final energy consumption by 2030 and a 40% share of electricity from

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