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Sustainability assessment of increasing renewable energy sources penetration – JP Elektroprivreda B&H case study

Zinaida Dimitrijevic, Iris Salihbegovic*

JP Elektroprivreda BiH d.d. – Sarajevo, Vilsonovo setaliste 15, 71000 Sarajevo, Bosnia and Herzegovina

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ABSTRACT

After the recent war (1992–1995) the country B&H includes the two entities and given these two entities the country is politically divided. Also the country is in transition process with neglected economic circumstances and the energy sector is supported via high subsidies. There are some pollution taxes but not enough to stimulating the more sustainable energy sector development. Under those circumstances the management of JP Elektroprivreda B&H (one of three state owned public enterprises for generation and distribution electricity in B&H) is committed to investing in renewable energy but still there is no final decision on the percentage share of RES or the state BH has prescribed obligated share of RES. So the main objective of this paper is to investigate optimal share of renewable sources to be introduced into power system of EP B&H. Analysis, which takes into account three different scenarios defined according to the percentage share of new renewable sources, Low (5% of RES), Medium (10% of RES), and High (20% of RES), was made. According to the evaluated indicators and the analysis, it can be concluded that scenario of introducing 10% of new renewable sources by year 2025 will bring the best effects to the sustainability.

1. Introduction

1.1. Goals in Europe

Europe has enjoyed many decades of growth in wealth and well-being, based on intensive use of resources. But today it faces the dual challenge of stimulating the growth needed to provide jobs and well-being to its citizens, and of ensuring that the quality of this growth leads to sustainable future. To tackle these challenges and turn them into opportunities economy will require a fundamental transformation within a generation – in energy, industry, agriculture, fisheries and transport system, and in producer and consumer behaviour. In energy sector this means among the others reduce fossil fuel use via: increased energy efficiency (20% by 2020), substituting for renewable sources (20% by 2020) and 20% reduction of GHG (greenhouse gas) emissions below 1990 by 2020 (30% if conditions is are right) and long-term objective is 80–95% GHG reduction by 2050 [1]. On 4 February 2011, European Council, at special energy and innovation summit, repeat its commitment to achieve the long-term targets of 80–95% domestic GHG reductions and recognize that this means nothing less than "a revolution in energy systems, which must start now" [2]. The analysis confirms the central role that electricity plays in the decarbonisation of other sectors such as transport, industry and buildings, and indicates that power itself can almost totally eliminate CO_2 emissions by 2050 with power sector reduction in 2030 −54% to −68% and in 2050 −93 to −99%. Electricity will play central role in low carbon economy. The share of low carbon technologies in the electricity mix is estimated to increase from around 45% today to around 60% in 2020, including through meeting the renewable energy target, to 75%–80% in 2030, and nearly 100% in 2050 [3].

1.2. Current state-of-art in BH

The EU (European Union) and Member states should strive to remove barriers that hold back resource efficiency and so create the right set of incentives for production and consumption decisions. This will require for EU Member States (see Table 1).

Economic instruments provide economic incentives to reach the desired level of renewable energy. Pollution charges in FB&H are not high enough yet to stimulate investment in emission reduction but on-going process of market liberalisation and feed-in tariffs create favourable conditions for the development of renewable energy (see Table 1). B&H's electricity sector still faces the common problems as is the case for power utilities in most developing countries including poor financial performance and inappropriate

* Corresponding author. Tel.: +387 33751718; fax: +387 33751707.
E-mail addresses: z.dimitrijevic@elektroprivreda.ba (Z. Dimitrijevic), i.salihbegovic@elektroprivreda.ba (I. Salihbegovic).

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Nomenclature

A	avoided damages
B&H	Bosnia and Herzegovina
D	specific damage
EI	environment indicator, kg/MWh
EcI	economic indicator
E_{CO_2}	indicator of CO_2
E_{SO_2}	indicator of SO_2
E_{NO_x}	indicator of NO_x
e_{CO_2}	specific emission CO_2
e_{SO_2}	specific emission SO_2
e_{NO_x}	specific emission NO_x
EU	European Union
EP B&H	public enterprise Elektroprivreda B&H
FB&H	Federation of B&H
GDP	gross domestic product
GHG	greenhouse gas
HPP	hydro power plant
LCP	large combustion plant
RES	renewable energy source
TPP K	Thermal Power Plant Kakanj
TPP T	Thermal Power Plant Tuzla
U	unit

investment policies. Also B&H has no national policy or reform plans in power sector. The structure of the energy administration in B&H reflects the country's politically divided situation so the institutional energy structure of B&H remains fragmented, weak and incomplete. The institutions for energy policy making, enforcement and statistics are understaffed and lack financial resources [5]. Regulatory agencies have been established for the electricity sector; although they have adequate resources, the authority remains weak, notably over price setting. In the electricity sector, the overall institutional fragmentation adds complex problems for B&H and this is in addition to the normal technical, economic, regulatory difficulties and barriers which are common to a process of unbundling and liberalisation. The country's large power plants (see Fig. 1) are owned and operated by three state owned electricity companies (reflecting the country's current political situation-after war the country still remains politically divided):

- Elektroprivreda Bosne i Hercegovine (EP BH) located in Sarajevo,
- Elektroprivreda Hrvatske zajednice Herceg Bosna (EPHZHB) located in Mostar, and
- Elektroprivreda Republike Srpske (EPRS) located in Trebinje [6].

EP B&H and EPHZHB are located in FB&H. The power system of B&H is a part of the Union for the Coordination of Transmission of Electricity (UCTE), which is the association of transmission system operators in continental Europe. Among three public utilities EP B&H is the major with over 53% share in total electricity generation in B&H and approx. 688,000 consumers. EP B&H is engaged in the production and distribution of electricity, electricity supply, trading, export and import of electricity and power system control. As can be seen from Fig. 1 EP B&H has the least favourable ratio of thermal and hydro installed capacity.

Carbon intensity for the power system of B&H is 726 kg/MWh for 2010 which is rather high due to old facilities for electricity generation from coal fired power plants [7]. Also, the emissions of SO_2 and NO_x, are high and amount 22 kg/MWh and 1 kg/MWh, respectively [8]. It must be mentioned that none of coal fired unit in B&H has technology for desulphurization and denitrification.

1.3. EP B&H

B&H (and so EP B&H) took over obligations to implement EU Directives on energy environment, competitiveness and implementation of RES. Along with the acceptance and signing of

Table 1
Barriers in the EU and in FB&H[a] regarding "revolution in energy systems".

EU	FB&H's electricity sector
Addressing markets and prices, taxes and subsidies that do not reflect the real costs of resource use and lock the economy into an sustainable path	• In FB&H air pollution charges are imposed: for SO_2 18.4 EUR/t, for NO_x 19.4 EUR/t and for particles 86.8 EUR/t (since 2011) • There is no electricity taxation • There is feed-in tariff (as guaranteed price-G_P) for RES in amount of: - $G_P = R_P \times C$ (R_P is approx. 24 Eurocent/kWh[b]; C – vary from type of technology and capacity) - funds collected from consumers range 0.050 ÷ 0.025 Eurocent/kWh depending of voltage level
Encouraging more long-term innovative thinking in business, finance and politics that leads to the uptake of new sustainable practices and stimulates breakthroughs in innovation, and develops forward thinking, cost effective regulation	• Long-term innovative thinking is not encouraged on any level or any sector • Sustainable development is still unknown for the majority of managers in companies as well as in the electricity sector • Cost efficiency is not applied in making new regulations because of decision maker knowledge lack • Policy makers are giving week initial impulse to get started with sustainable development of state mainly due to lack of knowledge and needed skills
Carrying out the research to fill the gaps in knowledge and skills and provide the right information and training	• For research and development B&H spends less than 0.1% of GDP [4] • Education and training are the first in cutting costs in all B&H's companies as well as in the electricity sector • Expanding knowledge and skills is not supported
Dealing with international competitiveness concerns, and seeking to get a consensus with international patterns to move in similar direction	Electricity sector is still dealing with: • low fuel quality (coal with low calorific value and high sulphur content) • inadequately designed furnaces and boilers • poor facility maintenance • outdated technology • inefficient energy use • poor operating performance

[a] The country B&H includes two entities, FB&H and the Republic Srpska (RS).
[b] Prescribed for 2010, 2011, and 2012.