

Promoting renewables in the energy sector of Tajikistan

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ABSTRACT

Energy technology transfer can allow countries to move quickly to environmentally sound and sustainable practices. Integration of Renewable Energy Sources (RES) technologies in the energy sector of these countries can play a key role towards sustainability. The level of penetration of RES technologies remains seriously in arrears in Tajikistan, although the country has great RES potential. The aim of the paper is to look deeply into the most appropriate RES technology, which can be gradually introduced in the energy sector of Tajikistan and supported through demonstrations, business workshops, guides for installers with technical details and design proposals. The multi-dimensional methodology adopted included transparent decision support processes, using linguistic variables, taking into consideration the specific conditions prevailing in Tajikistan, as well as policy and technical proposal for the further development of the local market. Based on the results, the emphasis is laid on decentralized heat production, though the promotion of Solar Water Heaters, which seems to be an attractive energy option, with multiple benefits for the country.

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1. Introduction

Tajikistan is a mountainous country in the middle of Central Asia and borders by Uzbekistan to the northwest and west, Afghanistan to the south, China to the east and Kyrgyzstan to the northeast. The most important resources are mainly water [1]. Indeed, Tajikistan is ranked the ninth in the world for total availability of hydro resources and the second on the volume of hydro resources per capita [2]. The terrain and climate are highly favourable to the development of hydro power [3]. Besides hydropower, there are additional potential opportunities in the field of power generation and heating, such as solar energy, geothermal, biomass and wind power.

Although Tajikistan has vast hydro energy capacity in comparison with other countries of Central Asia, the scarcity of natural resources and the increasingly dependence on imports strangles its development efforts towards Sustainable Development (SD). Furthermore, the unstable economy as well as specific barriers, such as low tariffs for electric power, absence of legislative support, lack of financing for new technologies and lack of awareness of Renewable Energy Sources (RES) has not attracted foreign investment necessary to develop RES projects in the country [4].

Nowadays, the European Union (EU) has strengthened its relationship with Tajikistan and the other countries in Central Asia, namely Kazakhstan, the Kyrgyz Republic, Turkmenistan and Uzbekistan, especially, since the adoption of “The EU and Central Asia: Strategy for a New Partnership” in June 2007 [5]. The EU Strategy seeks to enhance cooperation with these states as regards, among others, economic diversification and energy sector reform. Especially, a Partnership and Cooperation Agreement between the EU and Republic of Tajikistan was signed in October 2004 and entered into force on 1 January 2010 (Decision 2009/989/EC).

In this context, the countries of Central Asia have been fully involved in the TACIS Regional and Inter-State programmes of the EU, such as the TRACECA multilateral agreement on transit and transport, the INOGATE Umbrella Agreement on gas and oil and the EC-supported Environment for Europe Process, incorporating energy networks and policies [6]. Furthermore, relevant studies focus on the promotion of sustainable energy technologies, addressing the related barriers, in EU and Asian countries [7].

An extensive literature is available covering a wide range of aspects related to RES perspectives and market potentials in developing countries and countries with economies in transition [8–11]. The promotion and integration of RES technologies in the energy sector of these countries can play a key role. Indeed, energy technology transfer can allow countries to move quickly to environmentally sound and sustainable practices, institutions and technologies [12,13]. In this context, many decision support

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methods to assess the sustainability of renewable energy options have been developed [14–18].

A number of studies exist in the international literature, which mainly focuses on RES potential in Tajikistan [19,20]. However, there is no paper presenting a transparent methodology RES promotion in the energy sector of Tajikistan. The aim of the paper is to look deeply into the most appropriate RES technology, which can be gradually introduced in the energy sector of Tajikistan and supported through demonstrations, business workshops, guides for installers with technical details and design proposals. The multi-dimensional methodology adopted included transparent decision support processes, using linguistic variables, taking into consideration the specific conditions prevailing in Tajikistan, as well as policy proposals for the further development of the local market, assuring multiple benefits for the country. Based on the results, the emphasis is laid on decentralized heat production, though the promotion of Solar Water Heaters (SWH), which seems to be a very attractive energy option with multiple benefits for the country.

Apart from the introduction, the paper is structured along four sections. In Section 2, the energy status of Tajikistan is thoroughly examined, taking into consideration the country's renewable energy and market potentials. The methodological approach followed for renewable energy technology identification, though multi criteria decision support, using linguistic variables, and integration in the energy sector of Tajikistan is introduced in the third section. The fourth is devoted to the application of the adopted approach in the energy sector of Tajikistan. Finally, the main conclusions drawn up from this paper are summarized in the last section.

2. Energy status in Tajikistan

Tajikistan has no substantial oil or natural gas reserves, while the quantities of proved reserves of crude oil and natural gas are estimated at around 12 million barrels and 200 billion cubic feet (Bcf), respectively [21]. In 2009, the country consumed about 39,000 barrels per day of petroleum and 8 Bcf of natural gas of which 95% were imported [22]. Tajik's total energy production in 2008 was estimated at 1487 ktoe of which 1363 ktoe provided from hydro power plants, while the total energy production was estimated at 1404 ktoe, as illustrated in Table 1 [23].

The overall picture of the Tajikistan's energy consumption per sector is showed in Fig. 1. As it can be seen, the most energy consuming sector is the industry sector with 556 ktoe, followed by agriculture/forestry and residential sector with 374 ktoe and 267 ktoe, respectively [23].

In spite of the very favourable climatic conditions in Republic Tajikistan solar energy utilization is practically absent. Until now the efforts for RES exploitation in the country mainly focused on small and large-scale hydro power projects. It is estimated that the country has a hydroelectric energy potential of over 300 billion kWh per year, though the current utilization is 15 billion kWh (about 5%) [4]. Moreover, Tajikistan and Kyrgyzstan are the major producers of hydro power in the region, possessing an installed capacity of 25,864 MW [24].

Table 1
Energy supply and consumption for Tajikistan [23].

	Coal and Peat	Crude Oil	Oil Products	Natural Gas	Hydro	Electricity	Total
Thousand tonnes of oil equivalent (ktoe) on a net calorific value basis							
Production	86	14	0	24	1363	0	1487
Imports	5	0	524	419	0	456	1404
Exports	1	2	11	0	0	380	394

Energy Consumption per Sector in Tajikistan

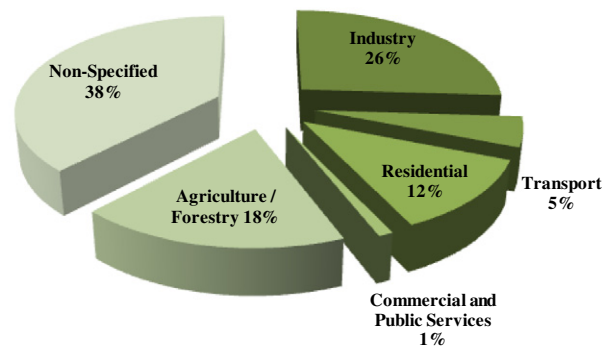


Fig. 1. Energy consumption per sector in Tajikistan 2008 [23].

Tajikistan energy industry development started with the Varzob River resources, where a co-ordinated hydro electrical system of three hydroelectric power stations was constructed. Their aggregate capacity was approximately 25,000 kW and did not meet the demand of the Republic's growing industry. In 1956, a more powerful, having inter-republican importance, Kairakkum GES on the Syrdarya River (126 MW) was put into operation. Later on, a co-ordinated hydroelectric system was constructed on the Vakhsh River, consisting of Perepadnaya, and Golovnaya GES; Golovnaya GES for a long time was the Republic's leader in terms of capacity. In 1979, Nurek GES, the largest in Tajikistan, was put into operation, which in terms of its installed capacity (2700 MW) was one of the most powerful hydroelectric power stations of the world. Besides Nurek GES and Baipaza GES, the Sangtuda GES-1 was built on the Vakhsh River and the construction of Rogun hydroelectric power stations started (estimated capacity of 3600 MW). In addition, another hydroelectric power station, Sangtuda GES-2, is planned to be constructed to further downstream the Vakhsh River with a 220 MW hydroelectric plant. Moreover, a run-of-river power station has been constructed on the Amu Darya in Khorog, with the support from the Aga Khan Foundation, the Asian Development Bank and the International Finance Corporation (Table 2).

The Asian Development Bank, Islamic Development Bank, United Nations Development Program and German Agro Action have funded the construction of several small hydro power stations in Tajikistan [20]. Currently, twenty five small-scale hydroelectric plants are in operation in the Republic of Tajikistan. Construction of ten small-scale hydroplants in the mountainous regions of the country is planned.

On the other hand, RES technologies for electricity production, such as wind, solar, biomass and geothermal technologies are not yet fully competitive, in terms of their integration in the energy sector of Tajikistan, compared to hydro power options.

- *Wind Farm:* In general, the most suitable sites for wind energy utilization are the Faizabad mountain region, Fergana valley, Murgab hollow and some mountain passes as Haburobad, Shahrstan and Anzob [20];

Table 2
Biggest hydroelectric plants in Tajikistan.

Power Station	Configuration	Operation
Baipaza	600 MW	1985
Golovnaya	240 MW	1963
Kairakkum	126 MW	1956
Nurek	2700 MW	1979
Perepadnaya	30 MW	1959
Sangtuda-1	670 MW	2009

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