Renewable and Sustainable Energy Reviews 16 (2012) 5260–5267

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Potential of the renewable energy development in Jammu and Kashmir, India

Arsalan Nisar*, Carlos Rodríguez Monroy

Department of Industrial Organisation, Business Administration and Statistics, School of Industrial Engineering (ETSII), Universidad Politecnica de Madrid (UPM), c/ José Gutiérrez Abascal, 2, 28006 Madrid, Spain

ARTICLE INFO

Article history:
Received 21 July 2011
Received in revised form
28 March 2012
Accepted 31 March 2012
Available online 29 June 2012

Keywords:
Economic development
Renewable energies
Electricity supply
Financial instruments
India

ABSTRACT

The future economic growth for India is likely to result in rapid and accelerated surge in energy demand, with expected shortages in terms of supply. Many of its current policies and strategies are aimed at the improvement and possible maximization of energy production from the renewable sector. It is also clear that while energy conservation and energy efficiency can make an important contribution, renewable energies will be essential to the solution and are likely to play an increasingly important role for providing enhanced energy access, reducing consumption of fossil fuels, and helping India pursue its low-carbon progressive pathway. However, most of the states in India, like the northernmost state of Jammu and Kashmir, have experienced an energy crisis over a sustained period of time and the government both at center and state level has to embark upon with these pressing issues in a more sustainable manner and accordingly initiate various renewable energy projects within these states. This paper will provide a broad-spectrum view about the energy situation within Jammu and Kashmir and will highlight the current policies along with future strategies for the optimal utilization of renewable energy resources.

Contents

* Corresponding author. Tel.: +34 91 3363022.
E-mail address: arsalan.nisar@alumnos.upm.es (A. Nisar).

1364-0321/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.rser.2012.03.060

1. Introduction

India is currently experiencing the much-needed low-carbon transition and with the second highest population in the world combined with a positive Gross Domestic Growth (GDP) growth rate of around 8%, the demand for energy is ever increasing. There is a need to address the future energy security of supply of India in a sustainable manner and this requires greater need to develop and harness the vast renewable energy potential. Renewable energy (RE) will be an important part of India's plan to add new capacity and also increase energy security, address environmental concerns, and lead the massive market for RE.

However, renewable energy development has been underused and lacks an integrated national economic perspective. This has largely been driven by uncoordinated state policies and programs. Many of the states with the richest RE resources like the state of Jammu and Kashmir (J&K) lag far behind in the utilization and development of renewable sources. India needs to address this uneven development across states and within the renewable energy sector. Moreover, this paper provides a framework that will help to understand the problems and limitations involved with the implementation of renewable energy policies in J&K.

The paper is structured as: the next section will provide a brief introduction to J&K along with the current energy situation and the potential for renewable energy sources. Section 3 provides an overview of the hydro potential in J&K.

2. Background: The state of Jammu and Kashmir

J&K is the northernmost state of the Union of India, lying between six mountain ranges and covering an area of 222,236 square kilometers. J&K commonly known as Kashmir, shares a border with the Indian states of Himachal Pradesh and Punjab to the south and internationally with the People's Republic of China to the north and east and with the Pakistan-administered territories of Azad Kashmir and Gilgit–Baltistan, to the west and northwest, respectively. The state accounts for 3.2% of the total geographic area of India and1% of its total population. J&K consists of three territorial divisions: Jammu, Kashmir valley and Ladakh, and is further divided into 22 administrative districts (Fig. 1) [1].

2.1. Current energy situation

J&K is one of the energy-starved states within India and the inadequacy of the existing power capacity power has been affecting the pace of development in all sectors of the economy. The state has a unique position in the power generation and power market within northern India. Historically the principal energy source in J&K has been hydroelectricity and still constitutes around 68% of the total energy mix. Its rivers, which are the main source of power generation, have the maximum flow during the summer season (April–October) and thus have a potential to meet the pressing energy demands. However, during the rest of the year, i.e., in the winter season, the water level drops to one third of the annual average and the demand increases due to the extra usage of electricity for heating and lighting purpose and thus resulting in purchase of large quantities of power from adjacent states. This has placed the state finances in a deficit situation. During the fiscal year 2008–2009 alone, only 29% of the power was produced within the state, while the rest was purchased, thus creating large differences in revenue and income. The figures for the last ten years indicate that energy poverty has created a lot of pressure on the limited forest reserves and the state government has been forced to buy energy resources to meet the demand during the winter season, when the gap between demand and supply is highest.

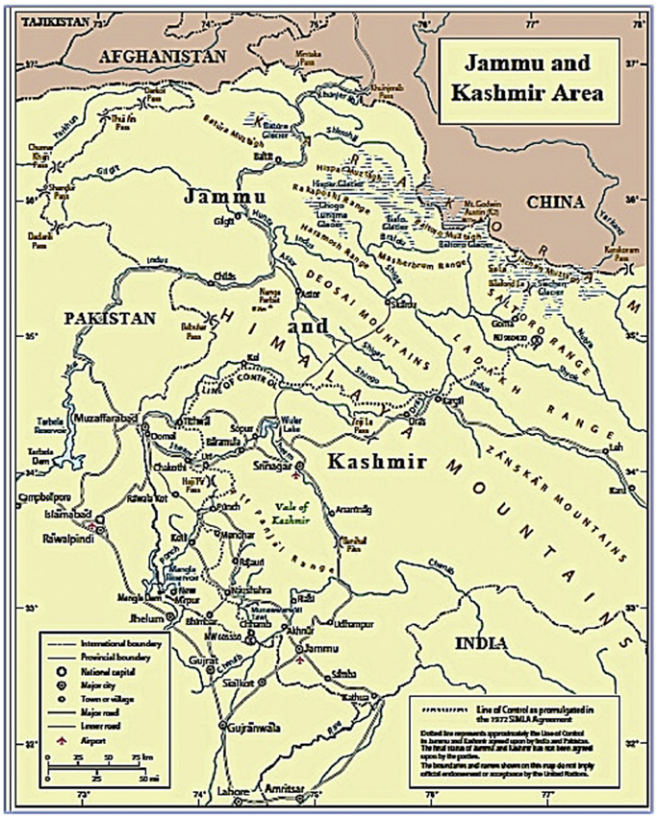

Fig. 1. Map of Jammu and Kashmir according to the United Nations (UN). *Source*: United Nations, 2011 [14] The Economist Intelligence Unit; CEIC; national statistics [15].

Table 1
Installed power capacity in Jammu and Kashmir by the end of 2009. *Source*: Ministry of Power, Govt. of India [7].

Nuclear (MW)	Hydro (MW)	Other Renewables (MW)	Diesel (MW)	Gas (MW)	Coal (MW)	**Total (MW)**
68	1469	113	302	9	198	**2158**

From the year 1990 to 2005, the energy demand in J&K grew by 3.5% per year, but the state recorded a deficit of more than 20% in the availability of power during peak hours. This deficit is expected to increase in the future if major steps towards the development and exploitation of renewable resources are not taken. Hence, a strong need exists to design renewable energy models that can contribute towards solving the persistent energy problems in J&K (see Tables 1 and 2) [1]. The next section will measure the persistent energy problems and highlight the need for renewable sources.

2.2. The problem and the need for renewable energy sources

J&K has the legacy of state-owned vertically integrated electricity supply industries, often with lobbying of tariff setting that