



# National energy scenario of Pakistan – Current status, future alternatives, and institutional infrastructure: An overview



M. Mujahid Rafique<sup>a,\*</sup>, S. Rehman<sup>b</sup>

<sup>a</sup> Department of Mechanical Engineering, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia

<sup>b</sup> Center for Engineering Research, Research Institute, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia

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## ABSTRACT

In this article, the current energy consumption of Pakistan is presented and the issue of security of electrical energy supply is discussed. The power sector has been looked from variety of aspects such as, demand and supply gap, diminishing energy sources, energy security, and increasing energy costs. Furthermore, the status of energy and potential of renewable sources of energy has been discussed as sustainable alternative. In addition, the roles of different sectors in the promotion and development of renewable energy technologies have been discussed. The renewable energy future prospects are encouraging in Pakistan with a total renewable energy potential of about 167.7 GW which is more than enough to meet the total electricity demand of the country. This vast potential of renewable sources of energy could be utilized to overcome the energy shortage which has not been utilized properly due to lack of policies and infrastructure. The diversification of existing energy resources and exploration of new sources is an important aspect to be considered in order to have a sustainable power development and its implementation in the country.

## 1. Introduction

Energy consumption is an index of industrial economy and prosperity of the people in a country because energy is an important factor for almost all human activities and developments. Due to increasing global population and materialistic lifestyles of the people, the energy resources are depleting rapidly. Furthermore, the increasing consumption of energy across the globe has adverse effect and implication on the environment and ecosystem of the earth. The usage of fossil fuels for energy generation is the major causes of environmental degradation. The increasing consumption and demand for energy shows that energy will be one of the major future problems of the world [1]. Alternative, clean and renewable resources of energy are required to meet this demand and at the same time to combat the adverse environmental problems. Renewable energy sources such as solar and wind have the potential to fulfill the energy gaps without emitting the greenhouse gases and affecting the ecosystem.

Pakistan is facing a severe energy deficiency and most of the northern areas are still not connected with the grid. Energy supply and demand gap is large and is widening with time. The country has limited fossil fuel resources and need to import to fill this gap [2,3]. Due to this energy shortfall, urban areas are facing 10–12 h load shedding while in rural areas electricity remains unavailable for 16–

18 h [4]. To overcome the energy shortfall in the country it is necessary to diversify the energy resources like hydropower, solar, biogas and wind.

Pakistan is situated in the high solar isolation area on the Earth [5]. The potential of solar energy resources can be used to generate electricity in off-grid areas in the western deserts and northern regions. Additionally, solar energy can also be used in some other applications such as solar cookers, solar water heaters, etc. [6].

The solar power system is considered expensive while comparing with a power system operating on a conventional energy source. These comparisons often do not give a clear and true picture of cost analysis because the cost of a single unit of photovoltaic is compared with the power available at the doorstep of the house. The solar systems will be much more cost effective while comparing fixed and running cost of some mega solar projects in the national policy.

Globally renewable energies such as: solar, wind, and biomass can meet the rapid demand of the consumer and it can fulfill the increasing power shortages of Pakistan. The purpose of the present work is to evaluate the facts behind the current energy shortages in the country and potential of renewable energy as a viable alternative to overcome the gap between supply and demand. The recent developments on alternative energy technologies and their applications in the country to overcome the energy shortage problem have been discussed. In

\* Corresponding author.

E-mail address: [g201303750@kfupm.edu.sa](mailto:g201303750@kfupm.edu.sa) (M.M. Rafique).

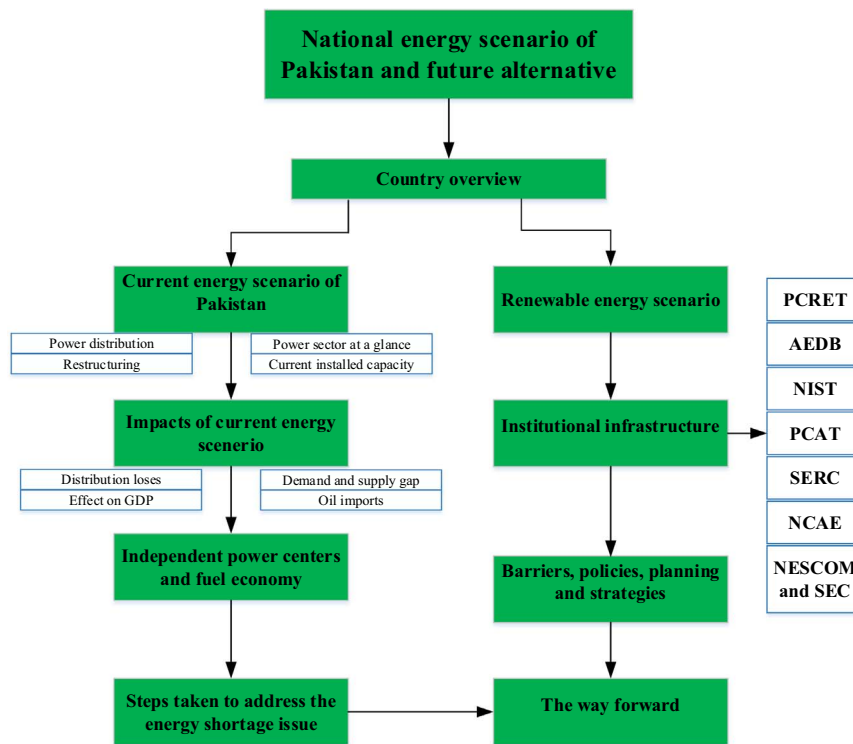


Fig. 1. Flow diagram of the article.

addition, this study also describes the role of the research and development (R & D) organizations and institutions in the country related to the promotion of renewable energy technologies.

The present research paper has been divided into different sections. The scope of the present work and need of alternative energy resources are introduced in Introduction Section 1 while Section 2 presents an overview of the country for better understating of available resources. Section 3, provides technical details about the current energy scenario of the country with respect to power sector, increasing energy cost, and new capacity addition plan. The effects of power shortfall on fuel economy and GDP have been discussed in Section 4 and different steps taken to overcome the energy shortage problem are presented in Section 5. The potential of renewable energy resources from variety of aspects has been discussed in Section 6. Role of different institutions and organizations working in Pakistan for the promotion of renewable energy is described in Section 7. Sections 8 and 9 discuss barriers and suggestions to overcome these hurdles for the development of alternative energy resources. Finally, a summary is presented in Section 10 for quick understanding. A graphical representation of the structure of article flow is presented in Fig. 1.

## 2. Country overview

Geographically, Pakistan enjoys an interesting strategic location. The country lies between latitudes 24° and 27°N and longitudes 61° and 76°E. It is comprised of five provinces namely Khyber Pukhtoon kha (KPK), Punjab, Baluchistan, Sind and Gilgit Baltistan. On the east border of the country is India, on the west is Iran, China is in the north, Afghanistan in the northwest and the Arabian Sea in the south. The total area of Pakistan including Federally Administered Tribal and Northern Areas (FATA and FANA) is about is 8,03,950 km<sup>2</sup>, Mirza et al. [7]. Pakistan has about 1,046 km long coastline which is extending from Indian border in the east to the Iranian border in the west, NIO [8].

Pakistan is blessed with numerous natural resources including one of the world's highest mountain range, flow of fresh water, fertile lands,

deep sea ports and rich reserves of natural gas, copper, coal and iron ores. Moreover, enormous potential of renewable energy sources is found across the country. The country inherited one of the world's best irrigation networks which have helped improve agriculture productivity and achieve associated gains in terms of poverty reduction in rural areas.

Unfortunately, limited work has been done in the past to explore naturally existing renewable energy sources. The effective utilization of existing or locally developed renewable energy technologies can play a vital role to meet the current energy deficit of the country.

## 3. Current energy scenario of Pakistan

The energy consumption per capita is an index to measure the prosperity of any society. An overview of the energy scenario indicates that Pakistan is an energy deficient country. The power sector growth, energy sources, cost of energy, etc. issues are discussed in details in the forthcoming subsections.

### 3.1. Power sector at a glance

In energy infrastructure a strong and complex relationship exists among different segments of the network from production to consumption. Lack of compatibilities between infrastructure and institutions has resulted in severe failure of functioning of the technical systems. Power sector infrastructure in Pakistan has passed through several stages since independence in 1947. The production capacity has increased significantly but not relative to the shooting demand in residential, industrial, commercial and agriculture sectors. Transmission and distribution sectors lagged behind equally.

The power sector of Pakistan is mainly under direct or indirect control of either government departments or private organizations. The energy infrastructure of the country is poorly managed, insufficient, inefficient, and under-developed. The major energy consuming sectors include domestic, industrial, agricultural, transport, commercial and government. The increase in energy consumption rate in domestic

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