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Review

Energy management in South Asia

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ABSTRACT

In this era, energy is essential to life and its continuous and ubiquitous supply brings much needed economic growth and prosperity to a region. Energy Management (EnM) contributes to the controlling and monitoring of energy and has recently become the subject of great significance. EnM involves analysis, conservation and imperative actions that leads to the minimization of the system losses for efficient use of available conventional and renewable energy resources of the region. This study evaluates the energy management in South Asia (SA) region, as it houses one-fourth of the world's total population with India, Pakistan and Bangladesh being the most populous countries. The study accesses the regional energy mix, distributed generation strategy plans, and present the trends in EnM over the past few decades. South Asian Countries (SACs), especially Pakistan, India and Bangladesh have a huge potential of coal i.e. 17,550, 90,085 and 884 Million Tonnes, respectively. India has rightly explored nearly 70% of its coal potential, whereas Pakistan and Bangladesh despite having the largest potential of the coal have focused on oil (35.4%) and natural gas (91.5%) exploration respectively. It is important to note that India experiences the highest technical losses of 23.5%, followed by 17% percent and 14.11% losses by Pakistan and Bangladesh respectively. Energy Intensity (EI) values for Afghanistan, Bhutan and Sri Lanka have listed these countries as low EI terrain region. Pakistan, India and Bangladesh have EI values ranging between 10,000 and 20,000 btu per $2000 constant. SACs countries have monopolistic electricity markets, however steps are taken to partially implement competition and monopoly regulation by privatization and ensuring equal conditions for all vendors. Analysis show that the SACs are presently far behind to meet their energy demands. The paper also recommends introduction and implementation of effective EnM policies along with large scale utilization of non-conventional energy resources, which will bring necessary changes and will help SACs to overcome economic challenges. The study also concludes that the inclusion of renewable energy resources and development of competitive electricity markets would overall improve the EnM in SA.

1. Introduction

Exploring, management and sustainability are the dire needs for survival in 21st century. The evolution history of life saw energy on earth taking various forms like chemical, mechanical, and electrical etc. The electrical energy was mainly obtained from Conventional Energy Resources (CERs) before 20th century, however, recently a shift is observed towards gaining Clean and Green Energy (CGE). It is envisioned that the initial shift, which gained pace globally is receiving clear threat of extinction in the near future. This created an alarming situation and forced the stakeholders to not only adopt CGE but to conserve and manage the available energy resources. Over the last decade energy management and conservation has been the focus of research to attain self-sustainability and efficient management of available resources [1].

EnM is all about controlling, monitoring and conservation of the energy resources [2,3]. It aims at optimizing energy generation, distribution and utilization in order to minimize energy cost without affecting quality. EnM also aims to protect environment by restricting the prevailing climate changes resulting from the fossil fuels burning. Therefore, EnM actually involves in identification and assessment of energy saving opportunities along with the controlling and monitoring of the energy consumption [4,5].

Public awareness is very important in energy conservation and sometime the identified opportunities can lead to efficient management of existing resources. However, energy conservation or management is not an easy task without the necessary amendments and reforms in the existing system [6]. The desired changes include but not limited to introduction of home energy management, industrial energy

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management, smart grids, demand side management, smart metering, automatic meter reading, smart communication, integration of information and control technologies. Home energy management makes use of smart appliances and devices that consume energy efficiently and economically. Home Area Network (HAN), which is part of home energy management, is used to communicate between smart appliances/devices, utilities and consumers. It connects devices to the internet server and establishes wireless connection, which build realistic intuition among people to adopt efficient energy usage pattern [7]. In addition, smart home appliances/devices enable auto switching by configuring schedule of devices and operations [8]. In an industrial organization, energy management or conservation is the practice of reducing use of energy for the same quality and quantity of the output in industrial applications. Organizations and industries are direct consumers of energy and they always aim at adopting the efficient energy management techniques to conserve energy, thereby reducing cost of the products and increasing profit margin [9]. Smart Grid establishes bidirectional power flow and communication between the distributors and the consumers. It helps to utilize the best available opportunities for efficient energy utilization with economics as major concern [10].

Various policies have also been devised globally to strengthen the concept of EnM like Energy Wheeling Policy (EWP), Net Metering Policy (NMP), carbon pricing, financial incentives [4]. National Electric Power Regulatory Authority (NEPRA) in Pakistan has also introduced EWP and NMP to encourage energy consumers to be power producers. According to EWP, any Bulk Power Consumer (BPC) can import energy from any Generation Company (GENCO), anywhere within the country. Note that BPCs can use the existing transmission and distribution network of the National Transmission and Dispatch Company (NTDC) and Distribution Companies (DISCOs) under the policy based on mutual agreement [11]. According to NMP, the individuals can produce their own energy and can sell it to the national grid. The net metering policy provides the bidirectional flow of energy between consumers and the DISCOs, thereby offering seamless energy options to consumers [12]. Pakistan is rich in renewable energy sources, thus facilitate individuals to produce their own energy through renewable sources, i.e. solar, wind, which will hugely benefit the overall energy situation.

South Asia is the most diversified area in geological sense with abundant energy resources. The region has enormous sustainable thermal energy resources with over 258,578 MW wind potential, 241,330 MW hydro energy potential and solar potential of 5.1 KWh/m^2/day [13]. Pakistan and India, the most populous countries of SA, have 67.37 trillion cubic feet tapped natural gas reserves, with petroleum deposits of 5.89 billion barrels. The world largest coal deposits are situated in South Asia, with Pakistan and India sharing major portion of 453 billion tons deposits [14]. However, despite these potential energy reserves, the energy mismanagement leads to persistent supply-demand gap, which is worst in this region. A shortfall of 7556 MW is regularly observed in India [15]. Afghanistan has over 200 MW shortfall with 519 MW installed electricity generation capacity. It is important to note that Afghanistan has 720 MW demand, despite the fact that only one-third of the population is linked to the national grid [16]. Pakistan regularly suffers 4000–6000 MW shortfall around the year [1]. In Bangladesh, 50% population has access to electricity with an overall shortfall of 2000–3000 MW [17]. These serious deficiencies and a mismatch between supply and demand with abundant energy resources requires immediate conservation and efficient management of energy resources in SA by introducing all possible short and long term measures.

This paper presents an overview of the energy management in South Asia, covering essentials of the generating capacity, energy intensity, energy markets, exploration of renewable energy resources, regional energy cooperation, energy efficient loads and power system losses minimization for the region.

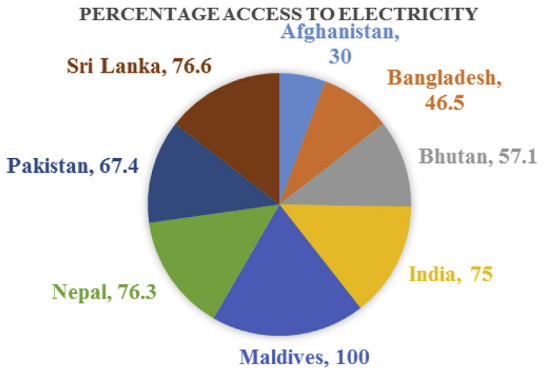

Fig. 1. Access to electricity in SA.

2. Energy management in South Asia

SA has accommodated one-fourth population (24.89%) of the world. India is leading with 1.342 billion residents, followed by Pakistan and Bangladesh with 0.196 and 0.164 billion respectively [18]. The region has a cumulative $2.6 trillion Gross Domestic Product (GDP). Population in SA is expected to increase by 0.4–1.9% [19,20], with 7.4–7.6% annual increase in the energy demand [21,22].

A large proportion of the population in SA is devoid of electricity, with access to electricity data shown in Fig. 1 [23]. According to an estimate by Asian Development Bank, this proportion accounts for more than 700 million people in Asia and Pacific [24]. Among population, who have access to electricity, many face poor quality of electric supply with 5–8 h per day power outages in both urban and rural territories. The regular power blackouts in this region impacts economy and Table 1 shows economic losses occurred due to power outages in different parts of South Asia.

Authors in Ref. [21] state, “Lack of investment in generation, grid extension, problems associated with fuel availability for power plants, and poor financial state of the sector in many South Asian countries continue to hinder the efforts to improve access and availability of electricity”. In addition, authors in Ref. [14] state “limited fuel resources, declining economy, lack of capital investment, external and internal security concerns, aged power system, managerial defects and circular debt” are the factors affecting the power industry in South Asia. Some of the key factors influencing development of energy in SA are poor policy and institutional framework, high energy prices and low affordability of energy wastage and losses, with unpredictable consumption patterns and demand trends [7,10].

Uninterrupted and continuous supply of electricity is the predominant factor, which has led to the socio economic development of the developed countries. SACs are rich enough in their energy resources to meet their immediate energy demand. However, owing to the various factors stated earlier, a continued and uninterrupted power supply is still a vision awaiting its realization. In the region, there is a continuous effort to fulfil this dream as soon as possible in order to improve

Table 1
Economic Losses due to power outages in various SACs [23].

Countries	Economic Loss (%)
Afghanistan	06.49
Bangladesh	10.56
Bhutan	04.33
India	06.62
Maldives	00.00
Nepal	26.95
Pakistan	09.16
Sri Lanka	03.00