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Acceptance and willingness to pay for solar home system: Survey evidence from northern area of Pakistan

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ABSTRACT

The importance of solar energy has been accepted worldwide for the generation of electricity, but unfortunately, Pakistan has yet to exert efforts on the development of this source of energy. The purpose of this research is to explore the public acceptance and interest in solar home system (SHS). Moreover, the expectations of the public towards SHS development in Pakistan and the difficulties they face in SHS usage are identified. The result of the survey indicates that about 81% of the respondents show higher interest in SHS. However, many respondents claim that some hindrances obstruct them from using SHS which includes; high cost of solar panels, lack of information and trust on solar panel providers. Almost 60% of the respondents expect that government provision of incentives could be the best way to boost the usage of SHS countrywide. For the successful implementation of new SHS policy, the government of Pakistan needs to establish solar power plants, increase installation of solar panels, provides funding and full information for conducting independent research. In addition, almost 90% of the respondents believe that government should take the lead in developing the SHS sector. Therefore, this study provides some valuable references for SHS promotion in Pakistan.

1. Introduction

Currently, there are 1.317 billion people globally who do not have access to the basic need of electricity and around 99.8% people are living without electricity in developing countries (IEA, 2012). To provide energy services worldwide is indeed a major challenge (WB, 2004). Provision of electricity to all sectors of the economy and for household consumption is a big challenge faced by the developing countries, especially in their rural areas (Rebane and Barham, 2011). Grid electricity can be used for this purpose, but that is accompanied by huge investment such as the construction of power stations, substations, transmission lines etc. Further, it will be dependent on fossil fuels that emit greenhouse gases. Therefore, renewable energy (RE) sources have gained popularity as alternatives to fossil fuels (Ashnani et al., 2014; Kruzner et al., 2013; Moosavian et al., 2013; Rebane and Barham, 2011; Yee et al., 2009).

SHS are frequently depicted as a reliable energy source which can satisfy the basic energy need such as light (Mondal and Klein, 2011), because the lighting is generally considered to be in the top three energy uses in developing countries. Furthermore, solar technology is playing a prominent role in reduction of poverty, providing comfort and improving the quality of life and living convenience, because dwellers will have more time for entertainment, study and family business (Azimoh et al., 2015; Barua, 2001; Biswas et al., 2004; Cherni and Preston, 2007; Cook, 2011; Dahlstrøm et al., 2012; Gustavsson, 2007; Gustavsson and Ellegård, 2004; Javadi et al., 2013; Komatsu et al., 2013, 2011; Kooijman-van Dijk and Clancy, 2010; Laufer and Schäfer, 2011; Millinger et al., 2012; Rahman and Ahmad, 2013; Sharif and Mithila, 2013; Wijayatunga and Attalage, 2005). Moreover, SHS is a viable option for locations with sparsely populated areas and having sufficient sunshine because it is based on photovoltaic technology, which is environment-friendly. The

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Nomenclature

IEA	International Energy Agency
WB	World Bank
RE	Renewable Energy
SHS	Solar Home System
SSA	Sub-Saharan Africa
PV	Photovoltaic
AEDB	Alternative Energy Development Board
MWh	Megawatt hour
w/m^2	watt per square meter
kWh	kilowatt hour
GW	Gigawatts
PWh	Petawatt hour
MW	Megawatt
NREL	National renewable energy laboratory
USA	United States of America
USAID	The United States Agency for International Development
TOE	Tonne of oil equivalent
GOP	Government of Pakistan
NIST	The national institute of silicon technology
PCAT	The Pakistan council for appropriate technology
PCRET	Pakistan council for renewable energy technology
USD	United State. dollar
SPSS	Statistical Package for the Social Sciences
R&D	Research & Development
PPP	Public–private partnership

International Energy Agency (IEA) estimated that in 2050, about 11% of electricity production would be provided by solar energy worldwide (Katinas et al., 2013; Moosavian et al., 2013).

Urpelainen and Yoon (2015) define SHS in an eminent way. They stated, "SHS consists of a solar panel and the ancillary equipment – typically batteries, charge controllers, wiring, and electric appliances – needed to generate electricity for household uses, such as lighting and mobile charging".

Now-a-days it has become a global issue to balance the energy demand and supply relative to consumption. The World Bank report revealed that major challenge is to provide energy services to 1.6 billion people who do not have access to electricity and the other 2.4 billion who use traditional biomass for heating and cooking. About 58% of the total energy is consumed by the world 20% richest population, whereas the poorest 20% consume less than 4%. The majority of the poor reside in Sub-Saharan Africa (SSA) and Asia (WB, 2004). In the developing countries, household energy demand has become an important part of the overall energy demand in rural areas. The choices made by the household about lighting fuels and cooking will have a greater influence to shape the energy system of those countries and hence energy access has become an important topic for both academics and practitioners (Cook, 2011; Javadi et al., 2013). The fall in the price of solar photovoltaic panels has attracted many of the firms to deliver solar panels to rural poor (Economist, 2012). SHS can be used in urban, peri-urban as well as in rural areas. Solar photovoltaic electricity system can be utilized for the electrification of a single home, having a generation capacity of 200 W or less (Nieuwenhout et al., 2000). However, developing countries are confronted with many challenges at the household level regarding the installation of SHS including; immature markets, lack of technical skills needed at the time of mechanical troubles, lack of income to purchase SHS, lack of awareness about PV systems and lack of home appliances suitable for SHS (Alam et al., 2003; Nieuwenhout et al., 2001; Wamukonya, 2007).

The public acceptance and willingness to pay for SHS will be examined to determine the acceptance of SHS technology in Pakistan. Keeping in view the current global energy trend and future energy scenarios in Pakistan, this study reviews the existing utilization of solar energy and aims to investigate the perspective of the general public on the acceptance of SHS. The result of the survey indicates that nearly 20% of the respondents were familiar, 38% were somewhat familiar and almost 42% were not familiar at all with Renewable energy. The level of awareness about RE remains low even among potential consumers of SHS, moreover, the result of the survey cover such things as the importance of solar energy, awareness among respondents, and reliable & correct information about SHS in Pakistan. In a nutshell, this study aims to bridge the gap between the general public, investors and policy makers regarding the understanding of the SHS market.

More specifically the purpose of this study is four-fold. First, this study will inquire about the level of awareness of SHS among rural inhabitants. Second, this study will explore the attitude of public toward SHS utilization. Third, this study will investigate the difficulties faced in SHS usage. Fourth, this study will examine the perspectives of public on the enhancement of SHS dissemination in Pakistan.

2. Review on Pakistan's solar energy situation

Pakistan lies at latitudes 24° and 36° north and longitudes 61° and 76° east covering an area of 796,096 km^2 (AEDB, 2014). Pakistan lies in the sunny belt having a high level of insolation and adequate hours of sunshine. This energy source is distributed widely and available abundantly in the country. Pakistan receives global insolation over more than 95% of its area (AEDB, 2014). The mean of global irradiation which is falling on a horizontal surface is about 200–250 W per day, this results in about 1500–3000 sunshine hours making 1.9–2.3 MWh per m per year (Mirza et al., 2003). The value of solar radiation at sea level is from 900 to 1000 w/m^2. The solar insolation falling on the horizontal surface differs depending on the site of location, but the average ranges from 450–650 W per m^2 per day amounting to about 1500–3000 sunshine hours and 1.9–2.3 M Wh per m^2 per year with an annual mean sunshine duration of 8–8.5 h a day. This amount is sufficient to provide electricity to about 40,000 villages (Mirza and Khalil, 2011). The sunny days in Pakistan ranges from 185 to 290 in a year as evident from historical data (AEDB, 2009). The currently installed photovoltaic has the capacity of about 1600 GW per year, which is almost equal to 3.5 PWh of electricity (this is nearly 41 times greater than the current power generation) (Harijan et al., 2009). In Pakistan, renewable energy accounts for 180 MW in the total energy mix. The potential of solar energy is estimated to be more than 100,000 MW. A study conducted by the national renewable energy laboratory (NREL) of USA in collaboration with USAID regarding solar mapping revealed that Pakistan has a potential of 2.9 million MW (NREL, 2012). The Fig. 1 shows direct normal solar radiation while Fig. 2 shows SUNY solar model for Pakistan.

Energy consumption in Pakistan has enhanced by almost 80% in a preceding couple of decades. In 1994–95, it was 34 million TOE, while it reached to 61 million TOE by 2009–10 (Sheikh, 2010). It is due to increase in population, development of industries and improvement in lifestyles (Farooq and Kumar, 2013). Conventional energy dominates the energy mix. The shares of different sources are Natural gas (45%), imported oil (35%), hydel power generation (12%), coal consumption (6%) and nuclear power (2%) (Sheikh, 2010). Given the limited available resources in the country and increasing prices of fossil fuels, the supply of electricity becomes lower and thus widening the gap between demand and supply. It is imperative for the government to look for alternative and