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## A Study of Socioeconomic Impacts of Renewable Energy Projects in Afghanistan

Ahmad Shoab<sup>a</sup>, Samuel Ariaratnam,<sup>a</sup> Ph.D., P.E., F.ASCE \*<sup>a</sup>Arizona State University, 660 S. College Avenue, Tempe, Arizona 85287, USA

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### Abstract

Energy is the foundation of modern economies and the central need for modern life. It is a prerequisite for economic growth, improving living conditions and alleviating poverty. Therefore, access to energy is considered an important development goal. Obstacles such as high energy costs, unaffordable energy grid infrastructure and disperse population makes providing access to a majority of the world's population in developing countries a daunting task. Meanwhile, renewable energy technologies offer a unique opportunity to provide affordable and sustainable energy to millions of people. Renewable energy technologies, in particular, offer diverse and economically attractive options for rural electrification. This paper evaluates the economic and social impacts of community based renewable energy (CRE) projects on towns and communities. It investigates whether implementing such programs lead to considerable improvements in economic and social conditions of targeted communities and provide a sustainable energy solution. Relevant literature was reviewed and a comprehensive survey was developed to collect data from two towns in Afghanistan where renewable energy based electrification projects were implemented. Initial research findings provide strong indications that renewable energy projects are linked to improvements in economic conditions of the two pilot towns; both at the town and household levels. This research finds that economic impacts of CRE projects are rather modest as they lead to limited improvement in job creation and flourishing of businesses. Finally, CRE projects are found to be responsible for improving on sustainable supply of energy to the targeted communities. Policy makers and planners can use the findings of this paper as a guide to develop alternative sustainable solutions for energy production while using them as a tool for development of the recipient communities.

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\* Corresponding author. Tel.: +1-480-965-7399; fax: +1-480-965-0557  
E-mail address: [ariaratnam@asu.edu](mailto:ariaratnam@asu.edu); [ashoab1@asu.edu](mailto:ashoab1@asu.edu)

## 1. Introduction

Sustainable energy is defined as “energy produced and used in ways that simultaneously support human development over the long-term in all its social, economic, and environmental dimensions” (UNDP 2000). Access to sustainable energy is a prerequisite for social and economic development. Renewable energy sources such as wind and solar is the primary source for sustainable energy production. Renewable energy defined as the “energy obtained from the continuous or repetitive currents of energy recurring in the natural environment”, encompasses a wide variety of energy sources including solar, wind, biomass, geothermal, hydropower, ocean energy, biofuels and hydrogen (Moselle, Padilla and Schmalensee 2010). Technologies developed to harvest these vast resources are diverse, which allows their utilization in different geographical locations. Affordability, sustainability, and adaptability are the main factors justifying the use of renewable energy technologies to produce electricity.

This explains why globally investment in renewable energy sources for energy supply has grown continuously during the past decades and it is expected that these will increase considerably in subsequent decades as global demand for energy increases. In 2011, renewable energy sources supplied 12.4% (or 62.4 Exajoules) of the world’s primary energy supply as shown in Fig. 1 (IEA 2009). This share is estimated to reach 15% in 2040 (EIA, 2016).

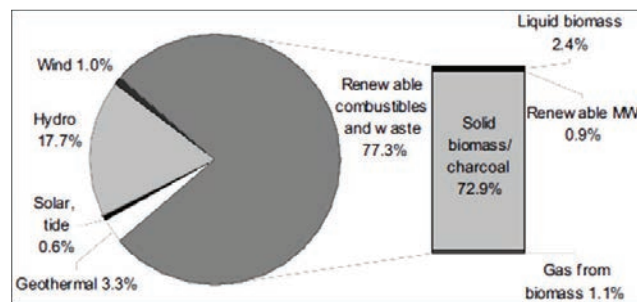


Fig. 1. Product shares in renewable energy supply in 2007

Furthermore, renewable energy sources have the potential to meet many times the existing global demand for energy. Renewable energy sources play an important role in enhancing energy diversity, long-term energy security and environmental protection. Renewable energy, in particular, offer attractive and diverse options for rural areas and developing countries in achieving sustainable energy services. As the technologies mature and the markets expand, it is likely that initial costs will decrease through achieving economies of scale. Today, the major obstacle to extensive use of the renewable technologies is their inability to compete with the conventional fuels except in niche markets (UNDP 2000).

This paper assesses how community based renewable energy electrification projects impact communities both in economic and social terms. It evaluates and identifies: 1) the economic impacts of CREs on communities that previously did not have access to reliable sources of energy; and 2) the social impacts of CREs and the cumulative impact on sustainable development of those communities. The objective of this paper is to investigate whether CREs offer sustainable energy solutions in niche markets such as rural areas, verify if communities benefit from CREs in terms of socioeconomic development and whether, as a result of CREs, recipient communities feel improvements in their standard of living. The data collected in this study is based on one-on-one focus group interviews where the interviewer interacted directly with the respondent, which eliminated the possibility of misunderstanding on the side of interviewee. Since data collected in this study originates from two locations, the results drawn do not claim generality due to the diversity in rural communities. Therefore, this paper does not claim that findings are applicable across all communities. This is since impacts depend on socioeconomic profile of the community, resource endowment and main sources of income. Furthermore, the findings of this research are based on self-reported perception of respondents that might be biased in a sense that they may downplay or exaggerate benefits. However, findings of this paper can be of interest for researchers and policies makers to further investigate whether CREs could become an affordable energy model for rural communities as a component of a comprehensive development program in disadvantaged rural communities.

This paper first reflects on the existing literature on socioeconomic benefits of renewable energies. The methodology of the study is described and the data collected from pilot projects are analyzed and discussed.

## 2. Literature Review

The literature review examined similar studies conducted to evaluate socioeconomic benefits of CRE projects. Unfortunately, prior research in this topic is limited. Opinion-based studies are the primary sources as the literature review is intended to provide a background to introduce the findings of the paper.

Hicks and Ison (2011) investigated the impacts of community-based renewable energies (CRE) in Australia. The study identified four major areas of interest impacting CRE projects: 1) political; 2) social; 3) economic; and 4) environmental. Two case studies combined with formal and informal interviews were used to collect data and draw conclusions. They concluded that CREs lead to social benefits for a community in terms of creating social bonds, strengthening linking among communities, and fostering a sense of ownership and collective response to common problems. This has led to reduced negative opinion towards CRE projects and through a participatory process, enlisted confidence and increased community capacity. The study also found that CREs have brought significant economic benefits to the community by utilizing local labor, business and material; dividends paid to local shareholders and servicing of local banks. Additionally, CREs have increased community resilience through establishing a trust fund that invests the money earned through electricity sales in the local economy. This has enabled some communities to invest in key economic priorities of their own choosing. In terms of environment, CREs have contributed, although modestly, to reducing carbon emissions of the community and increasing community environmental awareness. Hicks and Ison (2011) also concluded that because CREs have greater sensitivity to local environment and conditions, their planning and execution involves more local knowledge compared to projects implemented by organizations external to the community. These in turn result in less severe impacts on wildlife, less negative hydrological impacts and less erosion, noise, and shadow flickers (Hicks and Ison 2011).

Del Rio and Burguillo (2009) researched the socioeconomic benefits of CREs by conducting three case studies in Spain. These cases included biofuel, solar and wind energy projects and used empirical methods to collect data. The aim was to identify the contribution of CREs to local sustainability including: 1) social; 2) economic; and 3) environmental. The objective was to understand the perception of socioeconomic benefits of CREs by the recipient community. It does this by conducting a stakeholder analysis and a perception survey of the communities. In this context, eleven indices were used including: impact on education, employment, income generation, demographic impacts, energy accessibility, social cohesion and human development, tourism and use of indigenous resources.

The paper concluded that the impacts on employment of the CREs are positive. Although direct employment is relatively modest, the indirect contribution to employment creation is large compared to size of the community. While solar power had the lowest number of jobs created, the biofuel projects have created the most number of direct and indirect jobs. In one case, a biofuel project created 200 (i.e. direct and indirect) jobs in a community of ten thousand people. The projects have also led to diversification of employment and income sources as well as creation of temporary jobs (Rio and Burguillo 2009).

The study further found negligible impacts on demographic (i.e. flow of people in the town), educational impacts and cheaper energy supply. It also finds the impacts on tourism to be rather small. However, the study concludes that CREs impact on improving standard of living, human development and social cohesion is significant. CREs have also provided an alternative to farming by providing a source of employment. Significantly, the author finds that environmental benefits from these projects have been rather negative for the local population due to negative externalities. These included noise, occupation of land by projects, replacement of vegetation by crops used for energy production in case of biofuel and visual intrusion. The paper concluded that, although CREs had positive socioeconomic impacts on the communities, they cannot be the only solution to sustainability and had to be treated as a part of the solution rather than the whole.

### 3. Problem Statement

In the age of diminishing economic growth and decreasing public financing for infrastructure projects (often renewable energy projects), researchers have to compete with more pressing government priorities. Moreover, governments across the world face increasing environmental challenges and diminishing traditional fossil fuel resources. The time to promote and invest in sustainable energy solutions has never been better. Therefore, it is critical to have a comprehensive understanding of the benefits of renewable energy technologies and their impacts both economically and socially to make the case for these projects.

The focus of the literature review was on investigating the benefits of CREs for recipient communities. Most similar studies based their findings either on opinion surveys of the recipient communities or empirical data collected from each project.

The literature review illustrates that previous research on benefits of renewable energy projects have focused on environmental and economic benefits where metrics for costs, financial savings and environmental improvements were considered. Some of these studies showed possible improvements in areas such as sustainability and social development. Moreover, renewable energy projects are mostly seen by decision makers as a tool to offset the effect of diminishing energy resources and increasing pollution problems. The combined socioeconomic benefits of these projects are widely ignored. Therefore, this paper identifies and validates the resulting socioeconomic improvements. The aim is to add to the body of existing literature on sustainability and renewable energies while demonstrating how CRE projects can lead to sustainable solutions for immediate social and economic needs.

The methodology used in this paper involved a two-phase approach. Phase I involved assessment of existing literature and technologies as described in the literature review. Phase II included collecting data that involved questionnaire development, pilot project selection, data collection and data analysis. Various indicators were identified that measured the change in each particular dimension.

### 4. Case Studies

#### 4.1. *Sheikh Ali, Afghanistan*

The Sheikh Ali community located in Parwan Province in Northern Kabul has a population of 22,831 inhabitants. The community has dispersed population and is considered an agrarian community relying on farming. The main economic activities are raising livestock, farming, fishery, and gardening. Public services such as health centers, government offices, high schools, and markets are concentrated in the downtown neighborhood. In 2007, a study by the Ministry of Rural Rehabilitation and Development (MRRD) found that 90% of the residents had access to potable water. The same study revealed that main source of revenue for the population was agricultural products (40% of the population work in this sector) followed by animal husbandry, fishery and labor work (MRRD 2007). The community hosts ten micro hydro power plants each with a capacity of 5 Megawatt, two windmills with a capacity of 1 Megawatt as well as numerous individual home based solar power systems. A survey conducted in 2014 found that 80% of the population had access to electricity produced in one of the renewable energy power plants and that electricity in no case was used for industrial purposes (MRRD 2014).

#### 4.2. *Shebar, Afghanistan*

Shebar is one of the seven communities of Bamyan Province. It has a population of 26,100 inhabitants and is located west of Bamyan Province. The community is located at an altitude of 2,600 meters and only 48 km from the Provincial center of Bamyan (UNHCR 2002). There are five micro hydro power stations newly installed in the community each with a capacity of 1 Megawatt. There are also a large number of windmills and solar home systems (SHS) installed. The windmills have a minimum capacity of 100 kwatts while the solar home systems have only 5 kwatts capacity. A study by MRRD showed that around 70% of the population had access to electricity primarily produced in renewable energy power plants (MRRD 2014).

## 5. Preliminary Results

Indicators shown in Table 1 and Table 2 were used in order to measure the socioeconomic impacts of CREs at the household level. Indicators shown in Table 4 were used to measure these impacts at the community level. These indicators were chosen from previous similar studies and adjusted to the socioeconomic profile of the selected communities. A questionnaire was developed to measure these indicators based on the perception of the recipient community.

A representative sample was interviewed in the two communities. The sample in Shebar included 80 respondents, representing 0.3% of the population, while the sample in the Sheik Ali community included 60 respondents accounting for 0.26% of the inhabitants in the community.

### 5.1. Socioeconomic impacts of CREs at household level

In total, 140 residents (80 in Shebar and 60 in Sheikh Ali) were interviewed. Members of all income groups (i.e. rich, middle class and poor), age groups and social classes were included in the sample. The participants expressed satisfaction with the CRE projects; however, when posed specific questions, their answers were mixed. In general, the participants perceived CRE projects as a positive development in their communities. They felt that projects did lead to modest improvements in the social conditions (59% agreed) and economic conditions (40.6% agreed).

In Shebar, 56.5% of the respondents felt that CRE projects have provided them with socio-economic benefits. Out of 12 indicators used to evaluate the socio-economic benefits for households, the indicators that were most significantly improved are: personal security; family interaction; learning conditions for children; and entertainment opportunities. The two indicators that signal the least improvements are: hygiene and health conditions; and working hours for productive purposes (Table 1).

Table 1. Social benefits of renewable energy projects at the household level

Potential Improvement	Percentage of Respondents agreed in Shebar	Percentage of Respondents agreed in Sheikh Ali	Average of Sheikh Ali and Shebar
Personal security for households improved	88%	80%	84%
Entertainment opportunities increased	90%	75%	82.5%
Learning conditions for children improved	88%	71%	79.5%
Access to information increased	90%	62%	76%
Family interaction improved	80%	69%	74%
Time flexibility for domestic and productive tasks	60%	70%	65%
Working hours for undertaking domestic activities increased	43%	80%	61.5%
Efficiency in doing domestic work increased	40%	68%	54%
Time saving for doing domestic work increased	30%	56%	43%
Hygiene and health conditions improved	22%	40%	30%
Efficiency in doing domestic work increased	33%	14%	23.5%
Working hours for doing productive increased	14%	25%	19.5%
<b>Average Rating of Social Indicators</b>	<b>56.5%</b>	<b>61.5%</b>	<b>59%</b>

In Sheikh Ali, 61.5% of the respondents expressed that living conditions had improved since they gained access to electricity. The indicators that showed the highest level of improvement were: working hours for domestic activities; entertainment opportunities; and personal security. The indicators that experienced the least improvements were: efficiency in doing productive work; and increase in time spent for productive purposes (Table 1).

The economic impacts of the CRE projects were rather modest at best (40.6% agreed) as presented in Table 2. In both communities, the respondents felt that CRE projects had little to modest impact on their economic conditions. Of the three indicators, the respondents felt that reduced energy expenses had seen the most improvement (50.5% on average) followed by household income (36.5%) and diversification of income sources (35%).

Table 2. Economic benefits of renewable energy projects at household level

Potential Improvement	Percentage of Respondents agreed in Shebar	Percentage of Respondents agreed in Sheikh Ali	Average of Sheikh Ali and Shebar
Energy Expenses is decreased	58%	43%	50.5%
Household income increased as a result of CRE project	41%	32%	36.5%
Source of income diversified as result of CRE project	33%	37%	35%
<b>Average Rating of Social Indicators</b>	<b>44%</b>	<b>37%</b>	<b>40.6%</b>

### 5.2. Socioeconomic impacts on development of community

In Shebar, 58% of the respondents felt that CRE projects contributed to the development of their community (Table 3). The two economic indicators: 1) job creation and 2) establishment of local enterprises; were perceived to have experienced limited improvement, since only 44% of the respondents believed that jobs were created and only 31% of them indicated that local businesses had flourished as presented in Table 5.

Table 3. Community development as a result of CRE projects

Community Development	Shebar Community	Sheik Ali Community	Average of Sheikh Ali and Shebar
Community improved as a result of CREs	58%	43%	50.5%
Community did not improve as a result of CREs	41%	32%	36.5%

In Sheikh Ali, 43% of the respondents believed that CRE projects did improve their living conditions in their community (Table 3). Among the six indicators used to measure the potential social and economic improvements in the development of the community, the two indicators that showed the most improvements were: education services (67%) and healthcare services (65%). The two economic indicators perceived to have experienced most improvement were: jobs creation (42%) and the improvement of small enterprises (33%) (Table 5).

Table 4. Social benefits of renewable energy projects at the community level

Potential Improvement	Percentage of Respondents agreed in Shebar	Percentage of Respondents agreed in Sheikh Ali	Average of Sheikh Ali and Shebar
Healthcare services were improved	53%	65%	59%
Education services were improved	48%	67%	57.5%
Government services were improved	46%	54%	50%
Veterinary services were improved	38%	36%	37%
<b>Average Rating of Social Indicators</b>	<b>46.25%</b>	<b>55.5%</b>	<b>50.86%</b>

Table 5. Economic benefits of renewable energy projects at the community level

Potential Improvement	Percentage of Respondents agreed in Shebar	Percentage of Respondents agreed in Sheikh Ali	Average of Sheikh Ali and Shebar
Jobs were created as a result of CRE projects	44%	42%	43%
Small enterprises flourished	31%	33%	32%
<b>Average Rating of Social Indicators</b>	<b>37.5%</b>	<b>32.5%</b>	<b>35%</b>

## 6. Discussion

### 6.1. Socioeconomic benefits and community development

To what extent did the renewable energy based rural electrification programs improve social and economic benefits in the recipient communities?

At the community level, CREs led to “modest improvements” in the development of the communities through providing social and economic benefits. On average, 45.5% of the participants of the survey felt that CREs led to development of their community. The most significant improvements were seen in the provision of services such as health services (59% of participants agreed), since the clinics were equipped with backup solar power stations while the rest of the public offices did not have that facility, followed by education services (57.5%) and government services (50%). Economic indicators, that is, job creation (38%) and enterprises (32%) presented the lowest improvement. This is because the energy produced by the renewable energy systems was primarily used for lighting and home appliances. None of the communities used the electricity produced in these plants for industrial purposes. The limited capacity of the electricity production and the high demand in the households were the main reasons hindering the use of electricity for productive purposes. Therefore, one can conclude that CRE projects have led to modest improvement in the social benefits at the community level. Similarly, the projects provided “slight economic improvements” at the community level due to the non-existence of industrial use for power in these communities.

### 6.2. Energy sustainability

To what extent do communities have access to sustainable energy supply as a result of CRE projects?

Sustainability is an important aspect of CRE projects. Although renewable energies are an important element of sustainable development, their use does not necessarily result in a sustainable supply of electricity to the communities.

The United Nations report on environment and development defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (UNDP 2000). Sustainable development has three dimensions: 1) economic; 2) social; and 3) environmental, which together builds the three pillars of sustainable development. Economic sustainability of CRE projects concerns primarily financial sustainability. This includes sustainability in terms of investment, subsidy, financial management and affordability of the electricity service. Secondly, social sustainability concerns equality in access to electricity services, improvement of living conditions and socio-economic benefits. Meanwhile, environmental sustainability requires that the environmental impacts should be minimal to enable preservation of natural resources.

According to the definition, the rural electrification projects in rural Afghanistan are financially sustainable. The initial investments are provided through the country’s development funds. The fund also provides further subsidies for maintenance costs to the community development council (CDC), which is responsible for future financial management of the project. Furthermore, electricity is widely viewed as affordable by consumers. In Shebar and Sheikh Ali communities, 78% and 72% of respondents respectively perceive the electricity services affordable as presented in Table 6.



Table 6. Perceived affordability of electricity produced in CRE power plants

Potential Improvement	Percentage of Respondents agreed in Shebar	Percentage of Respondents agreed in Sheikh Ali	Average of Sheikh Ali and Shebar
Affordable	78%	72%	75%
Not affordable	28%	22%	25%

Secondly, CRE projects in these communities are based on one of the four main technologies: biofuel; solar; wind; and micro hydropower. Due to the small size of the solar, wind and MHP plants; the projects did not produce major environmental hazards. Therefore, CRE projects are also environmentally sustainable.

Thirdly, social sustainability is measured by two indicators: 1) equality of access to electricity and 2) improvement of socio-economic benefits. This study concluded that renewable energy projects are socially sustainable as well. This is due to the fact that energy was distributed equally in the two investigated communities and all members of the community had equal access to the service. Furthermore, the CREs have led to improvements in social and economic benefits as discussed previously.

## 7. Conclusions

It is plausible to argue, based on the indications of the survey, that CRE projects did achieve sustainable energy supply at the pre-determined levels (i.e. energy supply for non-industrial purposes). The average improvement in the living conditions of the recipient communities through provision of socioeconomic benefits at the household and community levels is 46.3% as presented in Table 7. Therefore, one can argue that there are strong indications from the field surveys that community based renewable energy projects in these two communities did lead to “modest improvements” in the living conditions of the recipient communities.

Table 7. Improvement in the living conditions of recipient communities

Type of Improvement (social, economic)	Percentage of Respondents agreed in Shebar	Percentage of Respondents agreed in Sheikh Ali	Average of Sheikh Ali and Shebar
Social benefits improved	59%	50.86%	54.93%
Economic benefits improved	40.6%	35%	37.8%
<b>Average improvement in the living conditions according to respondents' perception</b>			<b>46.3%</b>

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