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Challenges of Integrating Solar Energy Systems in Remote Areas of Egypt

Lessons learnt from the case of Qarat Um Elsaghir Village

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ABSTRACT

The energy sector in Egypt faces challenges that threaten energy security. This is witnessed in the increase of energy consumption and the wide gap between demand and supply. The reason for this gap could be population growth combined with high subsidy policies for energy, which do not encourage a reduced demand. Furthermore, one of the main reasons is the excessive reliance on energy generated from fossil fuels, which is usually subjected to fluctuating costs. In response to this energy crisis, the Egyptian government plans to increase the renewable energy share to 20% of the overall energy supply by 2020 (NREA, 2013).

Accordingly, The New and Renewable Energy Authority (NREA) is working on providing electricity for 195 remote villages and residential communities using photovoltaic (P.V.) technology. Such plans are expected to cause significant alterations in landscape and affect the cultural and visual perception of these communities. Such alternations have been explored by authors in previous research in Qarat Um Elsaghir village; The NREA already provided electricity for villages in the Western Desert. Throughout the research related to the NREA's last project, one can read that the residents pinpointed various deficiencies in the introduced P.V. system including concerns related to: sense of ownership toward the introduced P.V. system, maintenance of the system, and P.V. performance and efficiency with respect to their needs.

This paper highlights the importance of considering the socio-cultural, financial, maintenance and managerial aspects when planning sustainable solar energy systems in remote areas by observing deficiencies in the previously introduced system in "Qarat Um Elsaghir." The paper additionally attempts to propose a preliminary model that incorporates the aforementioned aspects in order to sustain and integrate the P.V. solar technology within the remote communities, based on lessons learnt from Qarat Um Elsaghir project, local and international case studies.

1. BACKGROUND

The frequent electricity cuts in Egypt in the past three years demonstrate the energy sector's challenges. On the one hand, industrial development, population growth, energy subsidy policies and lack of diverse energy resources were pinpointed as the main reasons for the gap between demand and supply (Economic Research Portal, 2013). On the other hand, the U.S. Energy Information Administration stated that the remoteness of various areas in Egypt left 300,000 residents with no electricity (2013). As a result, many remote villages are dependent on diesel generators, which provide limited electricity for a few hours a day. Focusing on this issue, the NREA paid special attention to provide energy in the remote areas through P.V. solar panels. Accordingly, a partnership between the Ministry of Electricity and United Arab of Emirates was established aiming at providing electricity in 195 remote villages by P.V. technology in Matrouh governorate and Upper Egypt (NREA, 2013). This large scale project requires appropriate planning to sustain the introduced technology in the remote area. For that matter, this paper attempts to develop a preliminary model for sustainable renewable energy systems in remote areas deduced from scanning the international and local sustainable experiences. Additionally, one of the two already implemented electricity generation projects carried out by the NREA in the remote village of Qarat Um Elsaghi in Siwa oasis, Egypt is reviewed.

2. REVIEWING CONCEPTUAL FRAMEWORK FOR PLANNING SUSTAINABLE ENERGY PROJECT

In an attempt to advance a conceptual framework for the design of sustainable energy landscape, Stremke emphasized the importance of utilizing renewable energy in a sustainable manner (2013). He differentiated between renewable and sustainable energy whereby sustainable energy is renewable, but not all renewable energy is sustainable. By this rationale, he understands sustainable energy as a quality that characterizes how renewable energy source function in a dynamic physical state. Based on this, a conceptual framework for a sustainable energy landscape was developed pinpointing four main criteria: technical, environmental, economic and socio-cultural, shown in Figure 1, where the core of minimum technical criteria in any project occurs in the center. In this regard, he mentioned that this framework is conceptual, because the size, number and type of the criteria are dependent on the nature of the project.

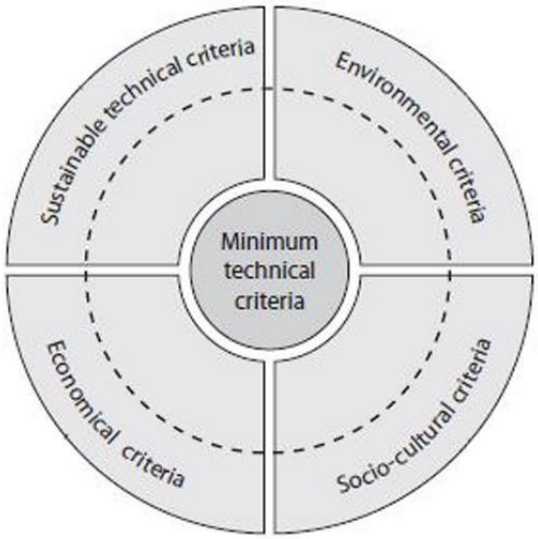

Figure 1: Schematic representation of relations between groups of criteria for sustainable energy landscape planning (Stremke, 2013).

Reviewing the international and local context of P.V. electricity generation projects, two case studies were found to be of significant relevance to community-based sustainable electricity generation projects. The first case study explored, "Powering West Africa," funded by the UN Development Program (UNDP) (Assogba, 2014), discussed providing electricity for 14 villages across the West Africa region. This project succeeded in considering the aforementioned criteria by Stremke (2013). In terms of economic aspects, the inhabitants' financial contributions were considered, even if at minimal percentages. Additionally, the residents are currently paying a monthly fee of 10 US dollars for maintenance and spare parts. In terms of technical aspects, a partnership between UNDP and the hosting governments provided technical trainings in colleges for community-selected inhabitants to be able to perform installations, maintenance and network expansion. During six months, they became solar engineers responsible for maintaining the solar-powered systems in their villages. They received a salary from the monthly fees paid by each family. Moreover, they trained other residents to be their assistants. Meanwhile, spare parts stores were provided, which secured an immediate accessibility to them.

The local case study explored is called Tanweer El Heiz Village in Bahariya Oasis, Egypt. In an interview in 2014, Eng. Omar Hosny, the project manager and initiator, described the project as a community-based sustainable project. Hosny and four other volunteers raised funds from the Rotaract club to provide electricity for 60 people (Rotaract Club, 2013). Hosny also stated the community-based planning process of this project took one year of community involvement. Accordingly, the project team held various community meeting where they introduced the types of P.V. solar cells and helped the residents to decide their energy needs and preferable system. In terms of economic aspects the residents agreed to pay 1 EGP daily per house to secure money for the maintenance and spare parts. In terms of technical aspects, the initiators selected four volunteers from the village and trained them for one month on the system

installation, troubleshooting and equipment renewal. Through this training, they became the key persons for the installation and maintenance process.

The two case studies emphasize economic and technical aspects within a community-based planning process. These facets are consistent with the Stremke framework of sustainable energy planning. The next part will reflect on Qarat Um Elsaghir's NREA electricity generation project and will evaluate the sustainability planning considerations.

Providing Electricity for Qarat Um Elsaghir as a Governmental Approach

The Context

Qarat Um Elsaghir, is a village in the Western desert of Egypt, located south west of the Qattara Depression. The distance measures around 270 Km away from both Matrouh and Siwa, as shown in Figure 2. From 1983 until now, the government has been providing the residents with new modern houses, a paved road, a clinic, a school and a mosque (El-Wagieh, 2014).

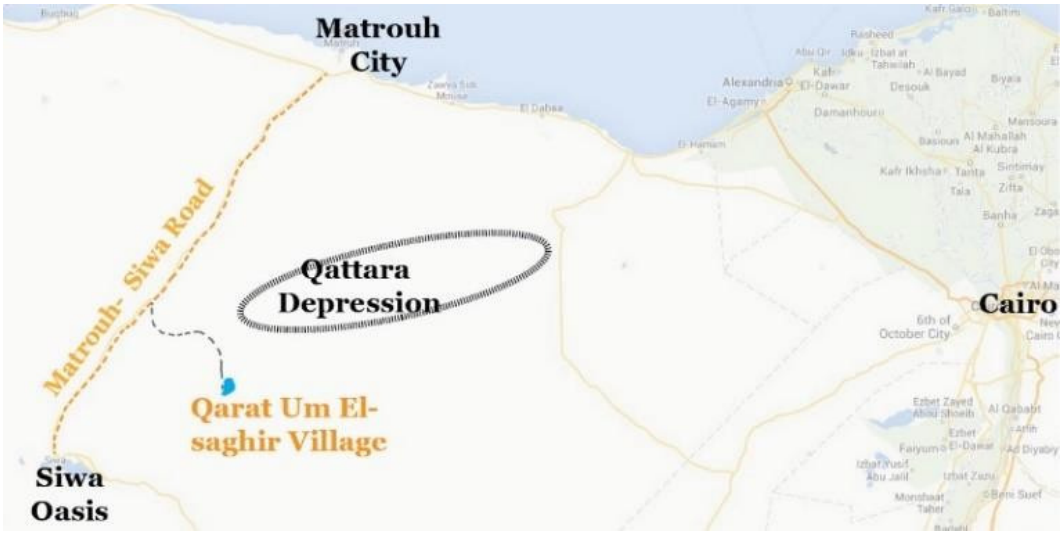

Figure 2: Accessibility of the Village (El-Wagieh, 2014).

Table 1 provides some technical information about the P.V. panels that were provided to the households in Qarat Um Elsaghir.

Table 1: Information about the PV panels provided to the village (El-Wagieh, 2014)

	Loads	Number / house	Hours/day / house	Panels/ house	Total WP/ house
75 Houses	Saving Lamps	5	5		
	T.V	1	4	2	344
	Saving Lamps	4	3		
	Sterilizer	1	1	4	688
	vaccine	1	7		
	Computer	6	3		
	Printe	1	1		
	Saving Lamps	2	3		
	T.V	1	3		
	VR	1	3		
Mosque	Saving Lamps	5	5	2	322
	Loud Speaker	1	4		
30 Lighting Poles				1	120

The energy sector has been rapidly developing in the village within the past 30 years. For instance, the residents shifted from burning wood and farming wastes to diesel generators provided by the state in the middle of 1980s for limited hours a day (Bakr, 2014). By 2010, the NREA implemented a P.V. solar energy electricity generation project for the houses, service buildings and inner roads. As mentioned by the NREA in 2010, the project was funded in cooperation with the Italian Ministry of Environment, Land and Sea. It covered the 75 houses existing at that time as follows:

Community-Based Evaluation to the Introduced P.V. System

In a previous research conducted by the authors aiming at evaluating the impact of the introduced P.V. systems, one can read that the resident's perception towards their landscape. The residents mentioned various deficiencies and drawbacks in the introduced systems, which consequently affected their opinions. In terms of technical aspects, the residents raised concerns related to the efficiency and performance of the produced system. They stressed on the need for more P.V. panels to operate the other appliances, such as washing machines, fans and refrigerators. Additionally, there were neither local committees nor external technicians in the village monitoring and maintaining the P.V. systems. Furthermore, no response was received from NREA towards the frequent municipality reports, which led to the accumulation of the broken down systems (Bakr, 2014). Accordingly, nine houses' systems and 13 lighting poles broke down (Bakr, 2015). This was consistent with the absence of plans concerning the future expansion and maintenance of the introduced P.V. system in the provided NREA documents.
In terms of economic aspects, the costs and means of funding the maintenance of the system are unclear. On the one hand, the P.V. system was introduced to the residents for free without any

past or future financial obligations. Accordingly, the residents were neither aware of the system components nor the cost of the spare parts. On the other hand, the fund was dedicated for the initial costs of purchasing and installing the system (NREA, 2012), while the running costs for monitoring and maintenance were not included. Eventually, the residents' trust towards the decentralized P.V. system decreased significantly where the majority of the participants in the community meetings chose the centralized P.V. solar farms (El-Wagieh, 2014). For them, the centralized P.V. system is perceived as a complicated system, which will require the presence of permanent technical team to maintain it immediately. Concerning the public awareness and participation, it is worth mentioning that the community was included in introductory meetings to get acquainted with the introduced P.V. system and were consulted in the lighting poles allocation process (Bakr, 2014). However, the residents did not receive any training to know how to be responsible for their own systems. They were trained to know how to clean the P.V. panels only.

Based on these concerns, the introduced system in general appears to lack appropriate planning that enables sustaining it. In fact, this deficiency threatens the integration of the P.V. technology within the community. It demonstrates that it should be a community choice instead of an external intervention.

3. PROPOSED PRELIMINARY MODEL

Reflecting on the previous three case studies, the different deficiencies that were found in Qarat Um Elsaghir existed due to neglecting the sustainable energy planning criteria. Meanwhile, the success of other two case studies could be significantly related to the developed sustainable energy planning that took place. On the one hand, the economic criteria are taken into account in the due care taken to plan a financial mechanism. This secures energy equality for all the users and provides an affordable energy solution for the residents. On the other hand, the importance of the technical criteria was pinpointed in securing a technical support team and the accessibility of spare parts.

By contextualizing the conceptual framework of Stremke, community inclusion criteria that includes participation and ownership, was significant in driving the sustainability of the P.V. systems in the different case studies. This is due to the remoteness of the villages. This remoteness strengthens the bond between the residents and affects their perception. Additionally, a managerial criteria in the context of remote areas appeared as an important aspect. As shown in the case of Qarat Um Elsaghir, the absence of local or state managerial committee responsible for running, monitoring and communicating the problems led to a failure in running the P.V. system long-term. Meanwhile, the presence of local key persons tasked with monitoring and maintaining the system in West Africa and El Heiz projects led to a sustainable running process for the P.V. systems. Accordingly, the urgency of that managerial aspect is clear from the remoteness of the villages, which requires a thorough planning and responsibilities distribution prior to the implementation. For that matter, Figure 3 represents a modified relation between the group criteria for a preliminary proposed model for a sustainable energy landscape contextualized in the realm of remote areas where a fifth criteria for managerial aspect is added to it. Moreover, the nature of the remote areas emphasizes on assigning a community inclusion core circle in the middle containing the aspects of community participation and ownership.

Figure 3: Schematic representation of relations between groups of criteria for sustainable energy landscape in remote area planning. Source: Authors

4. CONCLUSION

This preliminary model is an attempt to incorporate the different aspects that would achieve a sustainable energy landscape in the remote areas. These aspects are highly important due to the nature of the remote areas, which require introducing simple technology that can be managed independently and be integrated within the community. It is worth mentioning that the environmental criteria were not considered during analyzing the case studies. Accordingly, their appropriate size in the model is questionable and requires further research specifically in the case of P.V. solar panels in remote areas.

REFERENCES

Assogba, C., 2014: *A Solar Revolution in West Africa's Villages*. SciDev.Net. Accessed from http://www.scidev.net/global/energy/feature/solar-revolution-west-africa-villages.html (29 August 2015).

Bakr, M., 2014: *Personal Communication*. Qarat Um Elsaghir Municipality Official, Interviewed by Aya El-Wagieh (24 February 2014).

Bakr, M., 2015: *Personal Communication.* Siwa Municipality Official, Interviewed by Aya El-Wagieh (10 August 2015).

Economic Research Portal, 2013: *Egypt Crisis in the Energy Sector*. Eco Emerging. BNP Paribas, October, 20–21. Accessed from http://economic-research.bnpparibas.com/Views/DisplayPublication.aspx?type=document&IdPdf=23025 (29 August 2015).

El-Wagieh, A., 2014: *Landscape* Aesthetics *and the Introduction of Solar Energy Farms in the Western Desert of Egypt Elsaghir.* Village Landscape Aesthetics and the Introduction of Solar Energy Farms in the Western Desert of Egypt, Visual Public Preference Evaluation in Stuttgart University and Ain Shams University.

Hosny, O., 2014: *Personal Communication*. El Heiz Electrification Project's Team Manager. Interviewed by Aya El-Wagieh (19 March 2014).

NREA, 2010: *Final Report for Photovoltaic- Powered Lighting Systems for Two Villages.* Matrouh Governorate/Cairo.

NREA, 2012: *New and Renewable Energy Authority Annual Report 2011/2012*. Cairo.

NREA, 2013: *New and Renewable Energy Authority Annual Report Annual Report 2012/2013*. Cairo.

Rotaract Club, 2013: Tanweer el Heiz. *Rotaract Club of Cairo Royal*. Accessed from http://www.rotaractcairoroyal.org/Tanweer elHeiz.htm (10 May 2014).

Stremke, S., 2013: Energy-Landscape Nexus : Advancing a Conceptual Framework for the Design of Sustainable Energy Landscapes, *Proceedings of the ECLAS Conference 2013*, 1–5.

U.S. Energy Information Administration, 2013: *Egypt*. Accessed from: http://www.eia.gov/countries/cab.cfm?fips=EG#note (10 May, 2014).