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SOLAR VILLAGES FOR SOCIAL DEVELOPMENT AND POVERTY REDUCTION

I M DHARMADASA and LALITH GUNARATNE[1]
Faculty of Arts Computing Engineering & Sciences, Sheffield Hallam University, Sheffield S1 1WB, United Kingdom.
[1]Energy Forum, 247 Polhengoda Road, Colombo 6, Sri Lanka.

Tel: +44 (0)114 225 4067, E-mail: Dharme@shu.ac.uk, Blog:http://www.apsl.org.uk/dharme/default.aspx

Abstract

This presentation describes how solar power could assist in the social and economic development of developing and developed countries, using various applications at different power levels. The largest impact in developing countries, in the short-term will come from drip irrigation and community water pumping systems, combined with "solar village" concepts introduced recently for social development. Solar energy can be used as the first wave of actions to improve agriculture and enhance food production. In the second wave of actions, small industries could be established to benefit from an enhanced food production process. This will lead to an establishment of a healthy export business creating jobs and wealth for economic development. Other large scale solar power applications are also presented and relevant recommendations are made in order for developing countries to move towards energy independent and fully developed countries establishing a low-carbon economy in the future.

1.0 Progress in solar energy applications

The conversion of light energy into electricity was invented by Edmund Becquerel in 1839, but the practical solar cells and their applications did not appear until 1950s. By the beginning of the 1960s, solar power was used in small power applications and to provide remote power requirements. The following list indicates how the solar power levels have grown to produce MW scale large power systems in numerous applications.

- Low power applications in calculators, wristwatches etc. (~mW and W range)
- Remote applications in satellites, tele communication stations etc.
- Applications in solar home systems (~50 W range)
- Applications in small drip irrigation systems (~100 W range)
- Powering computers in remote schools and road signage (500-1000 W range)
- Applications in large scale water pumping systems (~1000-5000 W range)
- Solar power applications on buildings (solar roofs) and solar farms (~3-1000 kW range)
- Large scale solar farms in deserts for electricity generation (larger MW range)

2.0 Energy situation in Sri Lanka

Sri Lanka has a population of ~20 million people of whom, ~75% inhabit rural areas. The total installed capacity is ~3.0 GW and the summary of current energy production methods is given in the following Table.

Conventional production of energy	Approximate figures in MW
Large hydro power stations	1180
Thermal power stations	1682
Non conventional renewable energy	Approximate figures in MW
Mini-hydro	174
Bio-mass	12
Wind	30
Solar	8
Total power generation	~3044 MW = 3.0 GW

About 85% of the country's households are now connected to the national grid. This still leaves about 800,000 households without access to electricity from the grid. A good fraction of these, the more affluent households use an automotive battery, which is periodically re-charged to power a few 12 V lamps and in some cases a DC powered TV and a radio. Solar energy businesses estimate that about 10% of the un-electrified homes can afford to purchase solar home systems if all other barriers were out of the way. The rest of the households will continue to live with kerosene lamps. This population has little chance of coming out of poverty as there are other added barriers to their development. This is the target community that requires assistance to move to a level where they can begin to participate in the economy of the nation. The solar village projects are designed to lift the living standards of these most vulnerable communities, establishing food security, clean environment and sustainable development.

3.0 Solar PV applications in Sri Lanka

Sri Lanka has a rich history in solar PV applications over the last three decades. Over 150,000 solar home systems already exist in a private sector driven market development initiative. The current rate of installation of solar home systems is about 1000 per month. These systems however, are used by the more affluent, off-gird population in rural areas. Most of the customers have paid cash between £200 (Rs. 35,000) and £300 (Rs. 55,000) for these systems. However, the micro-credit facilitations have been established for installing solar home systems in the country.

Solar PV also provides power for water pumping, drip irrigation and telecommunication systems around the country. There are 5000 solar powered drip irrigation systems currently operating in the dry zone. Therefore, the solar PV technology is a proven and well accepted alternative to the fuel based electricity generation in off-grid areas. In promoting solar PV, all these projects have to ensure that proper installation and customer service is part and parcel of the system. These can now be provided by the commercial vendors that operate in the country through Solar Industries Association (SIA). It is good news for the country to notice development of several companies during the past few decades in this sector, creating new jobs for younger generation.

Figure 1. A solar roof (25 kW) on a commercial building in Colombo and one of the two solar farms (500 kW each) installed in Sri Lanka for initial training and promotional purposes.

4.0 Back ground to solar village project

It is good news to see that the grid connected households is reaching ~85% of the population. The extension of the grid to provide 100% electrification will not be economically viable and therefore the solar home systems could serve the remote communities from the national grid. The next stage is to rapidly introduce solar roofs on well-to-do households and feed the national grid during the day time. For example, in April 2010, UK Government introduced solar tariff of 40.3p per kWh unit instead of present grid-electricity cost of 22p. This incentive created over 20,000 solar roofs of the size 2-3 kW round the country in 14 months. This is equivalent to ~(40-60) MW clean power feeding to the national grid during the day time. This also accelerated formation of new companies, job creation and rapid reduction of cost of solar roofs due to a healthy competition in industry. Countries in the sun-belt could do extremely well with such positive policy making opening doors for sustainable development. It is pleasing to see the

recent appearance of domestic solar roofs (2-3 kW each), commercial solar roofs (~25 kW each) and two solar farms (~500 kW each) in Sri Lanka to feed the national grid or local use of the produced clean energy.

The Higher Education-Link (HE-Link) programme funded by the DFID-UK, managed by the British Council and coordinated by the main author, continued during the 1990s. This programme held many rural schools based solar awareness creation activities over a period of 10 years in Sri Lanka. The idea of the solar village community project evolved from the discussions with communities living in the dry zone. The pilot project for Centres for Application of Renewable Energy Sources (CARES) or solar village committee has been formed in a north western province village called Kaduruwewa, centering around the village primary school. These stakeholders unanimously accepted that the CARES concept would help in dealing with some of the acute problems facing people in the surrounding areas. Lack of energy services and clean water supply were said to be the biggest barriers to the development of the area.

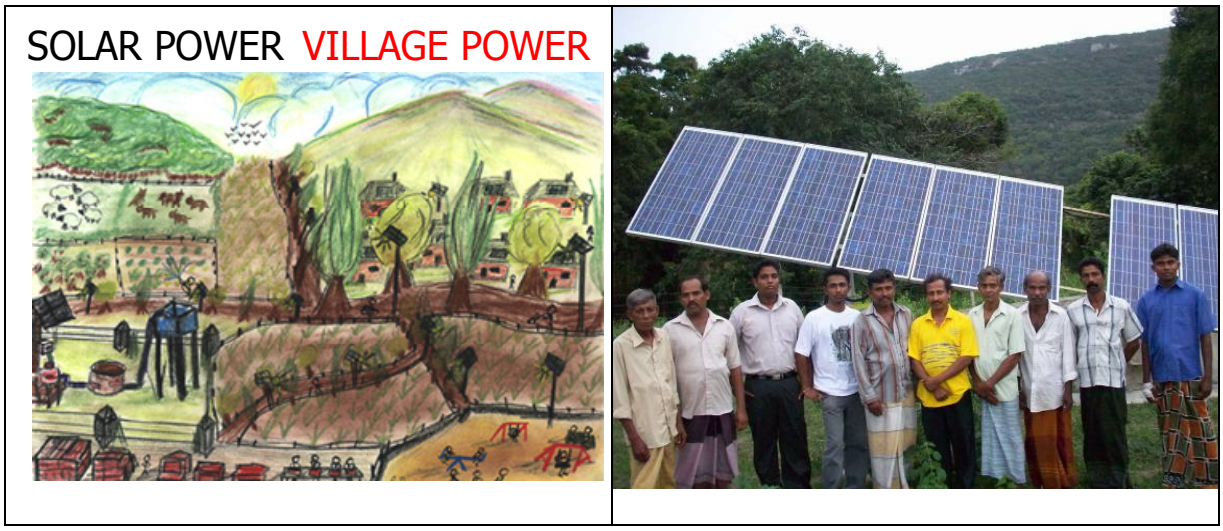

Figure 2. A child artist's impression of a CARES centre or solar village at initial design stage, and a photograph of the solar water pumping station in the pilot solar village established in July 2008.

5.0 The "Solar Village" or "CARES" concept

This concept focuses on the rural communities who are off the national grid or cannot afford currently commercially available alternatives, and trapped in poverty due to various reasons. In such a typical community, lighting comes from kerosene lamps and cooking is done with firewood.

The project is developed so that rural communities will learn to help themselves in meeting their energy needs. The design of the project ensures that credible leaders in the community (led by the educationists) will create the CARES, which will enable target householders to gain access to energy services at an affordable price. The project also aims to begin with a small number of households and to grow the number with their own contributions. A CARES scholarship programme for village children will be established from the growing revolving fund to support the development of people in the area. In addition, various development projects and activities to improve the environment depending on the geography, climate and the livelihood of people will be introduced. The project can be modified according to the requirements of the community and the promoters will act as advisors to the project. One important aspect that is built into the project is regular monitoring, evaluation and wide publicity for encouraging it's replication.

This is a project to assist people to help themselves and to catalyse the eradication of poverty through rural economic development. Currently, these marginalised rural households are condemned to a perpetuation of their poverty. Not having access to basic lighting, information, and entertainment denies them opportunities. Poor lighting makes it difficult for children to study at night, the effects of kerosene fumes and the kerosene lamp fire risks are detrimental for their health and safety, and overall the quality of life is very bleak.

Therefore, the project proposes to install solar powered water pumping systems in a number of selected clusters of villages. The customers are required to do a monthly payment for their water usage, and this creates a useful funding mechanism for them. This revolving credit fund would be administered by the CARES committee of the village in a transparent way so that these small communities will grow minimising corruption. These projects will merely plant the seeds to catalyse sustainable development of the villages through the efforts of the village community. The main aim is to empower them for their own economic development keeping all good values within the society.

This particular project is more attractive to Sri Lanka, since it combines with already completed agro-wells within the dry zone of the country. Most of these 6 metre diameter agro-wells have been built for rural communities to develop themselves by growing food around the well by pumping water using diesel pumps. However, the bottle-neck of pumping water is due to the cost of diesel engine and fuel, and therefore a large fraction of these agro-wells are not fully used today. There are also thousands of clean water pumping systems built round the country, but the main difficulty again the expensive water pumping systems based on imported diesel with their ever increasing costs.

The first stage is to form a small community group close to an unused agro-well, any other water source or established water pumping infra structure. This eventually grows into a CARES or a solar village. After having several meetings to explain the procedures and with the agreement to take part in the project, installation of one solar powered water pumping system can be completed with available funds. In this process, local government, private companies or any other association could help through a competitive bidding process, and train a few people from the group to look after the system. Vegetable growing around the agro-well for example will bring regular and additional income to families involved. The required funds must be raised within the country rather than depending on aid from outside or external loans to the country.

In order to recover the cost of the system and accelerate the development process, a group of 5 people could produce bricks during the dry season. It is possible to produce 100,000 bricks within 4-5 months, and this could cover a good fraction of the cost of the whole system. One way of using this income would be to use half of the income to pay the initial capital and share the rest among the group participants. Continuation of this process within 3 years, will pay back the initial loan, and earn funds locally for a new system within the solar village. Since the new system is virtually earned by the community itself, the rest of the process will show a cascading effect for a rapid development of the country. This scheme will be attractive, since it creates employment opportunities in construction and related areas especially in conflict affected northern and eastern areas for rapid recovery. After a period of few years, the small community fully owns the whole system, but should contribute a small tariff to the country-wide CARES account for sustainable development. This will provide a continuous income to the CARES for various development activities within the community.

The above additional activities are also a good solution to a serious social problem one can find in the farming communities in Sri Lanka. After completion of the work in paddy fields, most of the men are free for about 4-5 months in a year, and waste their valuable time consuming illegal alcohol, smoking, gossiping in coffee shops and gambling. This has been a main cause for their ill health and poverty, and the additional activities in solar villages will gradually take them away from these detrimental social habits. These improvements have already been observed in the pilot solar village.

Since the water in the well is pumped out daily during the day time, using solar energy, it is important to educate the community on water management. In order to keep the soil wet, organized tree plantation round the well-area is essential. This will provide long term income through fruit production and timber required for buildings and carpentry. Organic farming methods and bee keeping projects encouraged within the solar village will produce healthy food while increased pollination double and treble the annual crops from this agriculture related activities. More importantly, while the power is generated with zero emission of CO_2 (by using sunlight), the built-in tree plantation enhances the removal of CO_2 from the atmosphere through photo-synthesis.

The same project could be carried out using a small wind turbine which is another source of renewable energy. However, water pumping depends on the available wind and this could happen any time during the day without overlapping with the working hours of the day. In this respect, solar power is more suited for the project but storage tank could solve this problem to a certain level. To use the limited amount of water available in the dry zone, drip irrigation should be introduced widely to these communities for water management.

A large fraction of the country's electric power is generated using hydropower (~40%), another renewable energy source. In order to maintain this power source, the water management throughout the country is essential to avoid power cuts during droughts. The repairing programme of water reservoirs and tree plantation projects around the country are most important in retaining ground water and hence helping solar water pumping and drip-irrigation. These projects will also rapidly provide the right solution to the slow desertification of the Jaffna peninsula. The sand and palm trees are the main signs of desertification and the solar water pumping, drip irrigation systems and tree planting programmes will convert the country into a "green carpet" avoiding this extremely detrimental desertification process. Organised planting of 1.1 million trees in 11 minutes, involving school children in Sri Lanka last year is a good example for many other countries to exercise, as an effective contribution to the climate change.

6.0 What happens in the pilot solar village ?

Figure 3. The official opening of the pilot solar village in July 2008, with the participation of Geography final year undergraduates from Sri Jayawardanapura University in Colombo.

The first solar power project under the solar village programme was completed at Kaduruwea village in the Kurunegala district. Here the water supply scheme to the village was provided by using solar pumps replacing a diesel pump. The villagers have formed a society to operate the scheme and they are now saving about Rs 100,000 per annum on diesel costs. This enables them to use their saved funds in various development projects to uplift their living standards.

The whole community is directed to work together, to grow more trees around the area, to keep bees for honey production, use organic agriculture methods, etc. to improve the quality of environment. In short "Solar Villages" use clean energy technologies as well as developing their living environment. By developing themselves, contributions are made for the economic development of the country via enhanced food production. As already mentioned in the above section, there are many individual projects one can incorporate in this social development programme. The projects depend more on the nature of the society, climate and the geography. Another key feature of this solar village is that one of the local universities or an established school adopts this cluster of villages to guide the development of that society. For example, the pilot project is adopted by a team led by Prof. Krishan Deheragoda (previous Chairman of the Sri Lanka Sustainable Energy Authority) at the Dept. of Geography, University of Sri Jayawardanapura (USJ). The Geography special students carry out their final year survey in this village cluster feeding new ideas for development. Imagine the impact of fresh ideas from enthusiastic university dons and undergraduate students for rural communities and the use of younger generation to spread out these new ideas round the country for replicating these new projects. In fact, the solar village is a "social science laboratory" for training young graduates with social responsibilities.

The individual projects emanating from this programme are: Tree planting, honey production, brick making, vegetable & animal farming in dry areas, development of cottage businesses, scholarships and micro-finance schemes using saved funds within the community due to use of renewable energy sources. The development of the village temple, pre-school, the local school, library and the environment through Sramadana (voluntary work) activities are organised and encouraged. These individual projects can be selected to suit the community an keep the people away from detrimental habits mentioned above..

7.0 Monitoring progress, gathering information and disseminating knowledge

The pilot projects will have a further benefit to the solar PV technology itself where the installed systems will serve as a demonstration in the area. This will also act as a showcase for the government to provide further support to the dissemination of solar PV technology and rapidly develop the poorest section of the community. To build up and maintain the momentum, identify problems and their solutions during implementation, conferences like “Solar Asia” and "Solar Africa" organized in different regions will stimulate the acceleration and replication of this project.

In the EU-solar energy conference held in Paris in 2003, Sri Lanka was identified and announced as the "Hot Spot of Solar Energy Applications". With these developments and recognitions, the country should move forward towards to become an energy independent "Renewable Energy Island". The Maldive islands are ideal examples to convert into renewable energy islands, and hence to convert into an attractive eco-tourist centre.

Figure 4. Dissemination of new knowledge through public lectures to young people in Sri Lanka and Maldives as the first step of replication of solar villages.

The next phase will be the replication of these projects in other parts of Sri Lanka and outside the country, based on the experience gathered with the pilot project. The South Asia Renewable Energy Programme (SAREP) will disseminate this knowledge worldwide through:
newsletters: http://apsl.org.uk/Newsletter/Forms/Public%20View.aspx
websites: http://apsl.org.uk/dharme/default.aspx and
conferences: (http://www.solarasia2011.ifs.ac.lk) in order to spread this project.

Even though, the technology is proven, the unknown factors lay mostly in the administrative, social, financial and the technology/human interface areas. There will be a structured process of gathering information from these projects to learn about these areas. Taking new technologies from laboratories to the society needs considerable efforts through various dissemination programmes overcoming numerous barriers.

8.0 Benefits of the “Solar Village” projects

- immediate benefit of electric power or clean water to the households; replacing kerosene use resulting in improved health, removal of kerosene lamp induced fire risks, reducing carbon dioxide emissions and extending the productive hours for work and study, access to information and entertainment via TV/radio etc.
- empowerment of the rural community to develop themselves and escape from their poverty traps. This project fulfills three Millenium Development Goals namely; clean water, clean environment and reducing poverty.
- capacity building so the community can manage their own projects minimizing corruption.
- development of the CARES revolving fund to support more renewable energy applications and solar water pumping systems for providing clean water for drinking and drip irrigation.
- revolving fund supporting CARES scholarship programme and the development of the school by purchasing library books for example.
- installed systems will act as a demonstration to the area and will help solar PV business development.
- CARES becoming a part of the wider local, regional and later an international project, contributing to reduction of poverty and creation of a cleaner environment.

- Sri Lanka will gain publicity and reputation through SAREP, on implementation of village power pilot projects well-suited to developing countries with renewable energy applications, while developing rapidly with untapped and freely available solar energy.

9.0 Solar villages as social science laboratories

In Higher Education Institutes, it is a well established practice to build laboratories to teach subjects like physics, chemistry, engineering, agriculture, biology and medicine. In fact “solar village” is a “social science laboratory” suitable for all faculties in these institutes. Establishing a solar village attached to every university or well established secondary school, the opportunities are open for all subjects to contribute. This will not only produce young graduates in their chosen subjects with social responsibilities, but also contribute to develop the most vulnerable section of the society. These ideas have been openly discussed with 108-universities in Nigeria during a recent UK-Nigeria special delegation took place in March 2011. The event was organized by the UKTI, Training gateway, the National Commission of Universities-Nigeria and the British High Commission in Nigeria. The initiation of the conference series "Solar Africa" has been discussed in order to stimulate both solar energy research and applications in the Continent.

Figure 5. Part of the UK-Nigeria delegation took place in March 2011 in order to discuss development projects through Higher Education Institutes. IMD presented the capacity building in solar energy conversion and replication of solar villages in Nigeria via HE sector.

10.0 Replication plans of “Solar Villages”

After a successful pilot project established in July 2008, in Sri Lanka, the work is progressing to replicate solar villages widely in Sri Lanka, neighboring countries (Bangladesh, India and Maldives) and in Nigeria. Nigeria will eventually provide the gateway to other countries in the African continent for this information and knowledge. Raising funding for these projects is an issue but the local governments should take the responsibility in planting seeds (solar powered water pumping systems) of the solar villages in right locations. By applying solar village concepts, the communities will rapidly grow with their own initiations. The teachers, university dons, political leaders and community & religious leaders have an important role to play in this project to develop the society in addition to their main stream duties.

"Solar Energy is a clean and free natural resource, available to the mankind. The effective use of this un-tapped energy resource has huge potential to develop every corner of the globe, and establish a peaceful, safe and pleasant world for our future generations. It is our responsibility to start this onerous but honourable task"

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