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Eradicating Poverty in India by Sun using Dye Sensitized Photovoltaic Technology

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Abstract

Almost all 1.6 billion people in developing countries have no access to electricity; approximately 85% of the people live in rural areas. Poor people and people in marginal areas, presently depend on natural resources such as wood, charcoal, dung etc. to provide energy for cooking and heating. By 2030, in this category is expected to rise from 2.4 to 2.6 billion people. The result will be greater local competition for traditional energy. So, the rural development can be achieved by promoting locally available renewable energy to meet the basic electricity needs. Decentralised production units are appropriate wherever locally renewable sources of energy are available. Efficient use of traditional and commercial fuels. The main focus of this paper is to present the energy management techniques and different applications of solar energy utilization for the rural people in India to eradicate the poverty in addition to this the role of youth, educationalists, researchers, scientists, politicians and bureaucrats etc. to eradicating poverty in the nation.

1. Introduction

In the next two or three decades in the world population will be expected to, two billion people in the Earth , ninety-five percent of them in developing or underdeveloped countries. This growth will create unprecedented demands for energy, food, land, water, transportation, materials, telecommunications, and infrastructure etc. The role of engineers, academicians and researchers will be critical to fulfil the demands at various scales, ranging from small communities in remote areas up to large urban areas, in the developing world.

Creative research solutions to alleviate poverty can be achieved when the research profession acts to meet the challenges posed by the developing world. Out of all the demands the energy demand is foremost one and if production does not keep the rate of progression with growing demand. It will be a high risk for poor people, particularly in rural areas and also it is more difficult to gain access the electricity. For this severe problem the solution is renewable energy sources which are available in everywhere in the world and it is mainly promoted in different pathways and approaches for eradicate poverty which is going to be discussed in the following subsequence sections in this paper.

1.1. Pathways to Rural Energy Supply

i. Promotion of locally available renewable energy to meet basic electricity needs. Decentralised production units are appropriate wherever locally renewable sources of energy are available and where connection to a central power plant is too costly (while nevertheless retaining the option of subsequent connection to a power grid).
ii. Efficient use of traditional and commercial fuels. Together with promotion of renewable energy, this will contribute to environmental protection at the local, regional and global levels, and also saving costs.
iii. Generation of value added and income for local populations through the productive use of energy. Value added is usually a condition for (economically) sustainable operation of the energy system. Sale of local energy, such as hydropower fed into the national power grid and it can constitute an additional form of income for local people, if the production unit is owned by the community.
iv. Priority in energy supply to the entire population of social infrastructure such as schools, health-care facilities, and community centres etc.
v. Promotion of decentralised organisation and operating models. When planning, operations and management in decentralised energy systems are in local hands as far as possible, greater account is taken of local conditions. This increases the responsibility for maintenance and hence the reliability of energy supply. In addition

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to this pathways the further approaches is useful to the eradicate poverty.

2. Approaches to Eradicate Poverty

2.1. The Participatory Demand-Driven Approach

All local women and men stakeholders makes it possible to assess local demand such as energy needs, type of organisation, financing, etc. in detail. It is an important to distinguish among different needs for households, local production, purposes, and social infrastructure, and to determine short- and long-term demand in each area. At present modern technology must know that what type of energy is needed for cooking, heating, lighting purposes and it will be used depends on time of day and year. For this the information like what type of energy (mechanical, thermal, electric) is required, what purposes (cooking, heating, lighting, etc.), and at what time of day and year it is required. A detailed analysis of energy needs also provides the basis for demand-side management and can improve the use and efficiency of energy production facilities.

2.2. Choosing an Appropriate Technology

Detailed knowledge of ecological conditions and the social environment makes it possible to choose an environmentally friendly technology that is suited to local conditions. Locally available knowledge can be applied, local construction materials used, and existing production capacity developed further. In addition, existing distribution structures can be activated to disseminate such things as energy-saving stoves and solar home systems. Access to credits for start-up investments, method of payment, maintenance costs, etc. must also be taken into account. Use of proven technologies and their continued adaptability to local conditions has been shown to be more sustainable than use of the most innovative technologies. At this point, it is necessary to benefit from the experience of regional and international centres, working groups, and energy programmes.

2.3. Decentralized Projects

Capacity development and motivation of local actors are the agents of technological change of prerequisites for project sustainability. The decentralized project proposed flowchart as shown in Figure 1 which gives an order to enhance institutional financial sustainability.

Figure 1 shows that an importance of rural and often decentralised energy projects are able to provide reliable supplies of energy for the long term. This is more likely to succeed when responsibility is delegated to local decision-makers, sustainable operational and maintenance structures are in place, and ownership as well as rights and responsibilities are clear. Training for local personnel and for management responsibilities is indispensable. This can be overcome by planning a certain organisations have to make transparent from the outset.

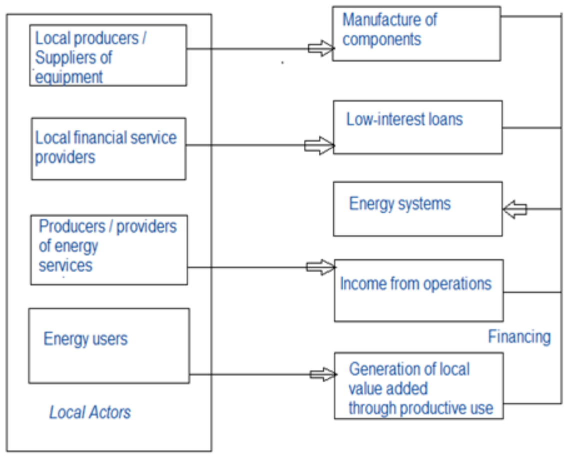

Figure 1: Flow chart of decentralized project.

2.4 National Importance

National poverty-oriented energy programmes should be develop in accordance with the same considerations as local projects. Efforts should also be made to develop synergies with other rural development projects such that, eradicate poverty in national level.

2.5 International Importance

In international level the protocol clearly states that the industrialised countries have the primary responsibility for reducing greenhouse gas emissions. However, the clean development mechanism (CDM) offers an international financing mechanism to support projects concerned with promoting the use of renewable energy in developing countries. But major administrative efforts and high transaction costs make it difficult for small decentralised projects to gain access to this financing option.

The convention to combat desertification (UNCCD) assigns responsibility for sustainable energy primarily to individual countries. Moreover the World Bank and the International Monetary Fund advise developing countries to take account of the linkage between improved national energy policies and poverty reduction in their Poverty Reduction Strategy Papers (PRSP).In addition to the above activities some more activities should be actively carried out by the international organizations to encourage decentralized renewable energy systems.

The above all approaches may or may not happen but every individual person should know and follow strictly to eradicate poverty is energy conservation because ‘A kilowatt of energy saved through conservation should be valued as much a source of energy as a kilowatt obtained from primary resources’.

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3. Involvement of Different Categories

To eradicate poverty in the world the following categories must be involve such as youth, educationalists, politicians, bureaucrats, researchers, industrialists etc. which are briefly describe in the following way.

3.1. Youth

Global youth unemployment has risen during the last decade and now amounts to over 80 million people. Evidence shows that the costs of not investing in youth are beyond belief for our economies. By contrast, if integrated into the development process, we can be a positive force for change. An essential part of applying a youth perspective in poverty reduction is to integrate young people into the shaping, implementation and evaluation of programs and policies.

A youth perspective contributes to better results by relevance, efficiency, legitimacy and democratic development. A youth perspective gives greater relevance to poverty reduction. When taking young people's knowledge and experience into consideration any targets set become more relevant. Young people can reach young people, as they often have the best knowledge of what methods, arenas and approaches will reach other young people. When young people have the right to participation, influence and power development efforts can gain greater legitimacy. Goals and actions gain acceptance among young people when they are included in the implementation of activities. Supporting young people to organise themselves is a way of strengthening the work of democracy and human rights.

3.2. Educationalists

They should motivate the students, society and rural people to use renewable energy sources for their daily needs like solar pumps, solar cookers, solar water heaters etc.

3.3. Politicians

They should help poor people to use alternative energy sources by making and implementing different attractive policies.

3.4. Bureaucrats

They have to implement those policies which made by government without corruption and delay to reach the poor people to eradicate poverty.

3.5. Researchers

They should concentrate and develop the innovative technologies for burning problems in the society.

3.6. Industrialists

They should take the help from researchers for innovative technologies, government for financial help and establish the decentralised units in the rural areas to give employability and solve the problems in rural people. Individually or one group of people can't reach the objectives to eradicate poverty but combinable all together with cooperation and contributing their duties regularly, definitely poverty can easily eradicate within short period. Inspired by the above pathways, approaches and the Involvement of different categories the following technology is well suited to eradicate poverty.

4. Proposed Method of Eradicating Poverty

Among all renewable energy resources, solar energy is the primary and other energies are depends on this energy. This solar energy is the abundant, safety and clean energy. Solar energy captured by solar panels to generate electricity is manufactured by using silicon material and by following very complicated manufacturing process with high cost. But after two decades there may be shortage of silicon to manufacture solar panels so we should be very cautious in finding solution to face this problem. This problem can be solved by dye sensitized solar technology (DSSC) [1] which is naturally available in nature. The operational concepts of DSSC are described elaborately in the subsequent sections of this paper.

4.1 Dye Sensitized Solar Cell Technology

The schematic diagram of DSSC as shown in Figure 2, it consists of semiconducting layers, transparent anode, electrolyte, cathode, [2] to convert light (photons) into electricity.

i. A transparent anode made up of a glass sheet treated with a transparent conductive oxide layer.
ii. A mesoporous oxide layer (typically, TiO_2) deposited on the anode to activate electronic conduction.
iii. A monolayer charge transfer dye covalently bonded to the surface of the mesoporous oxide layer to enhance light absorption.
iv. An electrolyte containing redox mediator to facilitate the regeneration of the dye.
v. A cathode made of a glass sheet coated with a catalyst (typically, platinum) to facilitate electron collection.

When exposed to sunlight, the dye sensitizer absorbs light and gets excited by photons absorption. The exited electron is injected into the conduction band of the mesoporous oxide film. The generated electrons diffuse to the anode and are used at the external load before being collected by the electrolyte at cathode surface to complete the cycle. In order to enhance electrical conductivity and light transmittance, conducting glass is used as the substrate. There are mainly two types of conducting glass; indium-doped tin oxide (ITO) and fluorine doped tin oxide (FTO). The standard to select a proper type is

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sometimes ambiguous because of the variety of cell configurations and materials [3].

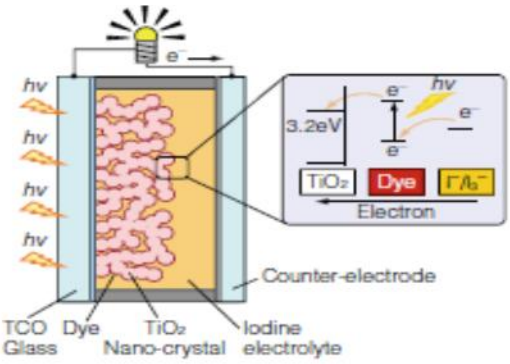

Figure 2: Schematic dye sensitized solar cell.

The semiconductor electrode is usually a layer of monocrystalline titanium dioxide (TiO_2), a thin film deposited on the conducting glass film with the thickness ca. 5-30 mm, which plays an important role in both the exciton acquisition process and transfer. The porosity and roughness of the TiO_2 layer are dominant factors that determine the amount of dye molecules absorbed on its surface. The surface morphology of the TiO_2 provides an enormous area of reaction sites for the monolayer dye molecules to enhance the efficiency of the DSSC solar cell. A large number of artificial dye molecules have been synthesized since the first introduction of dye-sensitized solar cells and some of them have already been successfully commercialized such as N3 and N719 [4].

Desirable dye molecules should meet certain criteria, such as match with the solar spectrum, long-term operational stability, and roughness on the semiconductor surface. In addition, their redox potential should be high enough to facilitate the regeneration reaction with a redox mediator. As such, iodide and tr-iodide (1"/13.) redox couple is most commonly used in the liquid electrolyte, while other solid-state and quasi-solid electrolytes like organic hole-transport material and polymer gel are also applicable. Platinum is generally used as the cathode to catalyse the reduction of the oxidized charge mediator [5]. To make the DSSC is more cost effective, the platinum is usually replaced by other types of metals like ITO or FTO. From the above analysis the semiconductor based solar cells are compared with dye sensitized solar cells gives the simplicity in manufacturing with naturally available materials with low cost which is shown in Table 1.

Table 1: Comparison between semiconductors and the dye sensitized solar cell.

Property	Silicon solar cell	DSSC cell
Transparency	Opaque	Transparent
Pro-environment	Normal	Great
Power generation cost	High	Low
Power generation efficiency	High	Normal
Colour	Limited	Various

From Table 1, it is observed that the comparison of silicon solar cell and DSSC, the dye sensitized solar cell having its simplicity in manufacture with low cost [6-7].

4.2 Fabrication Process

DSSC design involves a set of different layers of components which is shown in Figure 3 stacked in serial, including glass substrate, transparent conducting layer, TiO_2 nano particles, dyes, electrolyte, and counter electrode covered with sealing gasket.

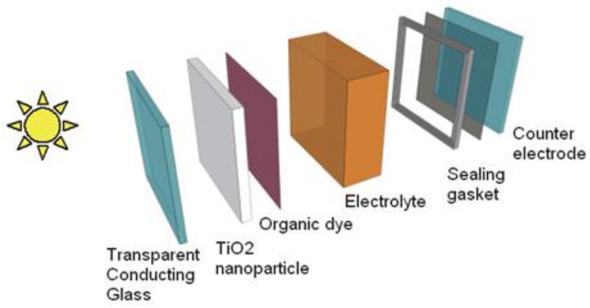

Figure 3: Fabricating process of dye sensitized solar cell.

First TiO_2 coated on TCO substrate using Doppler blade method. Extracted natural dyes and dipped the photo electrode in extracted dyes. Using graphite with a dark pencil on the conducting surface of another transparent conductive oxide glass as a counter electrode prepared. Combine photo electrode with counter electrode; place the electrolyte solution through the syringe. Fix photo electrode and counter electrode with binder clips. From the fabricated process DSSC is tested with digital/analog multimeter which is shown in Figure 4.

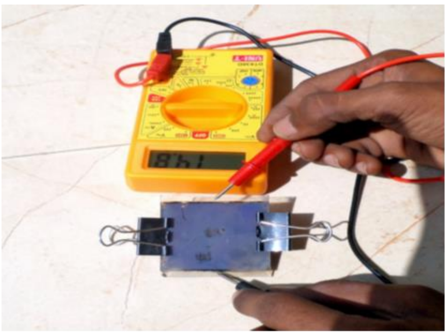

Figure 4: Testing of fabricated dye sensitized solar cell.

In the above stated simple fabricating process TiO_2 used as photo electrode and graphite used as counter electrode and different extracted dyes are used to increase the efficiency and it is achieved which are shown in Table 2 [8].

From Table 2, it is observed that the efficiencies are varying with the dyes used which are available in the nature everywhere. Here the banana is having high efficiency. Different regions are rich enough in different fruits, trees, leaves and flowers which is very much useful in extracting dyes used in DSSC to get better efficiency.

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The proposed DSSC technology can be used in the following applications.

Table 2: Efficiencies of different DSSC cells.

Dyes	Isc	Voc	Im	Vm	F.F	η(efficiency)
Pomegranate	0.9	0.5	0.5	0.3	0.3	0.202
Mango	1.0	0.5	0.6	0.3	0.4	0.269
Apple	2.7	0.6	1.7	0.4	0.4	0.420
Guava	2.1	0.5	1.2	0.4	0.4	0.498
Orange	1.7	0.6	1.1	0.4	0.4	0.517
Banana	1.7	0.5	1.2	0.4	0.4	0.522

5. Applications of Dye Sensitized Solar Cells

The DSSC material is cheap in cost to manufacture with naturally available and rapidly under development, commercializing for different applications such as calculator, bag, buildings, car, windows etc. which are briefly described as.

i. *DSSC calculator*
The calculator requires very less voltage to function for this conventional silicon cell may be high cost but DSSC more cheaply.

ii. *DSSC windows*
DSSC's used in windows for simple household applications.

iii. *DSSC bag*
DSSC bag which is well designed for simple portable DC applications like mobile charger etc.

iv. *DSSC buildings*
DSSC's integrated in buildings for simple DC applications in households.

v. *DSSC car*
DSSC's used in top of the car to utilize it for different DC applications required in car.

6. Conclusion

The proposed method are which is having simple manufacturing process and naturally available dyes one can use this solar panels for generating electricity and different applications. If researchers can innovate the high efficiency DSSC for rural people with their naturally available rich dyes and if government can motivate rural people to establish manufacturing units in their local areas by giving loans and subsidies to some extent this technology is useful to replace the costly conventional silicon solar panels so that this will helps to eradicate poverty successfully by developing different applications by using dye sensitized solar cells.

This paper successfully quoted the role of researchers, educationalists, and politicians etc. to eradicate poverty in the nation.

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