Indian Journal of Economics & Business, Vol. 18, No. 2, (2019) : 571-582

MANAGEMENT AND TECHNOLOGY REFORM FOR GRAMIN SAUR URJA

SHAILJA SINHA*, SUMEET SINGH JASIAL AND GOPAL P SINHA*****

Abstract

In this civilized world, even today 1.3 billion people do not have access to electricity and 2.7 billion are deprived of education, good health and standard living. Most of them living in remote rural village areas, and until they have access to energy services, little progress can be made to develop and improve their lives. As United Nations Secretary-General Ban Ki-moon has stated, "energy is the golden thread that connects economic growth, increased social equity, and an environment that allows the planet to thrive". The world energy consumption is 16TW. The sun gives 23,000 TW every year. Thus the solar energy is capable of meeting the world's energy requirement for anytime to come. On a hot, sunny day at room the sun sends down roughly 1KW (the power of a toaster) for every square meter of the ground. The biggest challenge is to make it cost effective so that it can be easily marketed to individual households and organizations. The need is to efficiently manage this initiative so that the awareness and importance is transferred to the remotest locations. To make it cost-effective, the technology needs to be enhanced in order to produce higher benefits with lower cost. The maintenance and installation needs to be educated to more and more population, so that the one-time cost and recurring cost can be controlled. In this paper, the author has re-engineered the current setup circuitry, identified load and capacity, prepared circuit diagram and produced a proposal integrating the management and technology aspects of harnessing solar energy in a rural Indian school of Ayodhya.

Key Words: *Solar, Smart Village, Renewable Energy*

INTRODUCTION

Worldwide fossil fuels are reducing at a very high rate (Powering the Future, 2011) and if we do not switch to other form of energy at this stage, we will leave nothing for our coming generations. Fossil fuel on the earth is finite, these are the fuels produced by natural resources like anaerobic decomposition of buried dead organisms. It takes 1000 of years for fossil fuel preparation. People won't be able to

* PhD Scholar Amity University, Noida, *E-mail: shailja.sinha@student.amity.edu*

** Assistant Professor, Amity Business School, Amity University, Noida, *E-mail: ssjasial@amity.edu*

*** Director (Retired)-CMERI, *E-mail: gopalpsinha@gmail.com*

burn and derive energy any more beyond the lasting periods which is as close as the following for some of the fuels:

(i) Coal ... 120 years

(ii) Oil .... 250 years

(iii) Nuclear fuel … 200 years

Moreover how far is it justifiable for the energy packs, which have taken millions of years to form to consume in the next few generations. Just because the future generation is not present to bid today we are claiming our stake on the entire coal blocks and the oilfields.

The fact that fossil fuels reservoirs are being depleted is not the only reason why scientists are looking for other means to generate energy. Other important factor is the impact caused to the environment and the derived pollution, product from fossil fuels combustion, which raises the presence of greenhouse gases in the atmosphere leading to the acceleration of global warming and subsequent climate change. This situation affects inhabitants all over the world.

We see the growing public concern about environmental problem and air pollution. Air becomes polluted when notorious gases and black carbon particles are released into the air. These are mainly sulphur di-oxide, carbon mono oxide and nitrous oxide. Sulphur di-oxide occurs mainly when coal and oil are burnt in power plants. Carbon mono-oxide and carbon do-oxide are another harmful greenhouse gases caused due to burning of fossil fuels. Nitrous oxide only occurs at high temperatures, it facilitates and causes acid rain, it is known to cause a trifurcation which is caused again by power plants.

RENEWABLE ENERGY

Contrary to popular belief, renewable energies are not new. For thousands of years, human beings have been using water mills, wind mills, hot springs, and combusting wood, charcoal and crops to generate benefits for the society. Just around 200 years ago humans started to exploit fossil resources such as coal, oil, natural gas at a mass scale without knowledge of the great environmental impact this excessive use could cause.

Later, the discovery and development of nuclear energy production brought a new source of energy that, as we all know, had catastrophic consequences for the environment. The latest example of this is Fukushima nuclear disaster, when a Tsunami and an earthquake affected the plant’s reactor number 4 causing a meltdown in its core, leaking thousands of liters of radioactive waste into the sea.

In the past 20 years, the potential of solar energy, wind, water, biomass and geothermal has been rediscovered. With help from modern technologies, this energy sources are converted to electricity, heat and fuel. However, their full potential has not yet been achieved.

Solar energy being abundant in nature is a suitable alternative at this stage, since we now have the technology to channelize this solar energy for power generation. Half of the earth is always receiving incessant energy in the form of solar radiation. On a hot, sunny day at room the sun sends down roughly 1KW (the power of a toaster) for every square meter of the ground. This amounts to almost 23000 tera-watts every year against our total requirement of 16 tera-watts. Thus solar energy is not only free but abundant almost 1000 times more as compared to our requirement. Solar energy also manifests itself in many of the known renewable forms like –

Hydropower	3-4 TW per year
Biomass	2-6 TW per year
Wind	25-70 TW per year
Tidal (harnessible)	2-3 TW per year

With the much of the abundantly available energy from the sun, why is it that our villages and remote cities are suffering for lack of energy for their night life and education? Why do we depend on fossil sources which do not belong to us? Moreover it won't last for more than 100 years.

Solar energy has a special place among potential future energy sources, being extra ordinarily abundant wherever the population exists.

REVIEW OF LITERATURE

The survey of the World energy resources gives an example of Latin America showing that the renewable energy portion of the energy matrix is reduced, and it is mainly distributed in two generation methods: hydropower and biofuels, representing 36% and 62% of the total renewable energy quota (World Energy Council, 2013).

One concern regarding hydropower is that, besides the impact it generates to the environment, such as microclimate changes and flooding of large areas to create the required dams, it is also difficult to ensure energy continuity, as the availability is directly affected by rain seasons and droughts.

Large hydropower is also responsible of social conflicts, especially in sensitive regions like the Amazon jungle. During the construction of the hydroelectric plant "Tucuruí", in the Brazilian rainforest, about 2400 square kilometers of rainforest were flooded, forcing near 30,000 people to leave their territories.

Biofuels are those associated with traditional energy consumption for subsistence (firewood, grass), while the industrial and modern forms relate mainly to the production of biofuels as ethanol.

Both traditional and industrial biofuels have been the criticized for a number of reasons. The most common is that even though biofuels have a reduced impact in the refining and production processes when compared to conventional (United States Environmental Protection Agency, Economics of Biofuels, 2013), they fail to contribute to reduce industrial greenhouse gases and can lead to deforestation and other non-sustainable practices (Greenpeace, Position on Bioenergy, 2008).

Considering the rainfall rates and the rugged topography of many countries, small hydropower plants provide a good alternative for the supply of electricity, particularly in remote places. Energy wave and tidal, together with other forms of energy available in the ocean, represent a huge energy potential for countries in the region.

In 2007 only 12.4% of the total primary energy supply worldwide was produced from renewable energy sources. Other sources of energy represented: 34% for oil, 26.4% for coal, 20.9% natural gas and 5.9% nuclear energy (Intergovernmental Panel on Climate Change, 2007).

The International Energy Agency (IEA) includes renewable fuels and waste (solid biomass, charcoal, renewable municipal waste, gas and biomass, liquid biomass), hydropower, solar, wind and tide as renewable energy sources, while non-renewable industrial and municipal waste sources are not included as renewable energy.

In developing countries, the solid biomass is by far the largest source of renewable energy, representing 9.3% of global total power energy supply (TPES), or 73% of the worldwide renewable energy supply. The second largest source is hydropower, which provides 2.2% of the global TPES, or 17.7% of renewable energy. Geothermal is the third largest renewable source, much lower, representing 0.4% of the global TPES or 3.3% of the renewable energy supply in the world (International Energy Agency, Renewables Information, 2016).

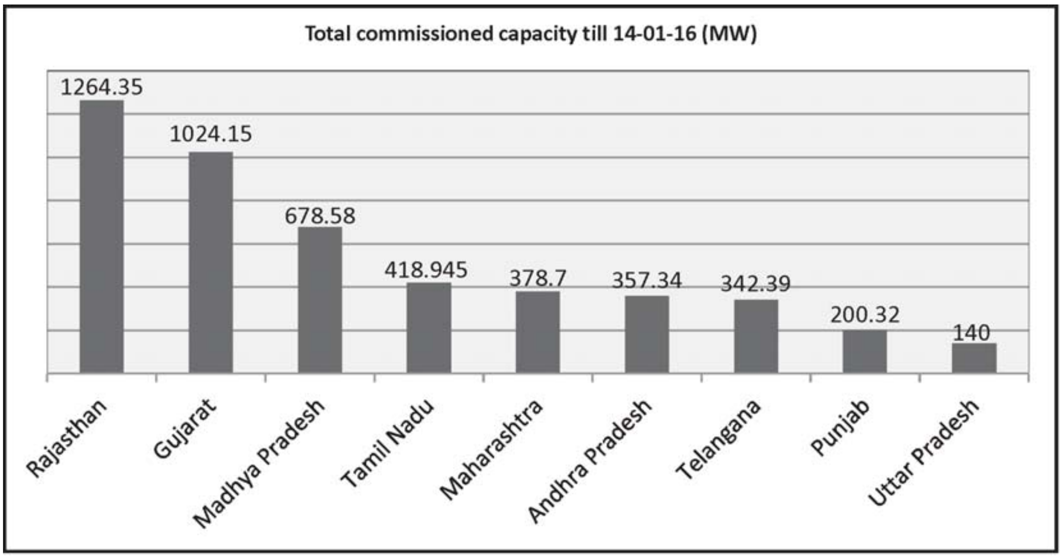
The contribution of the “new” renewable energy sources (solar, wind and tide) for the supply of energy is still very marginal, which represents about 0.2% of global TPES, or the 1.6% of the renewable energy supply. Since 1990, renewable energy sources have grown at an average annual rate of 1.7%. Growth has been particularly high for wind energy, which grew at an average annual rate of 25%. However, this is due to its very low base in 1990, and the production is still small. OECD countries (those belonging to the Organization for Economic Co-operation and Development) account for most of the production and growth of solar and wind energy. Photovoltaic solar energy and thermal solar experienced annual growth rate of 9.8%. The average annual growth rate of hydropower was of 3.7% between 1990 and 2007 in the non-OECD countries and only 0.4% for OECD countries.

Despite this immense potential, it seems that a significant renewable energy industry does not exist, particularly in developing countries, where additional work is needed to identify where these resources are located and how to create high quality maps that would allow their exploitation.

In India, the Government has set the ambitious target of generating 100 GW of solar power by the year 2021-22 under the National Solar Mission (MNRE, 2015). It is envisaged to generate 60 GW ground mounted grid-connected solar power and

40 GW through roof-top grid interactive solar power to fulfill the 100 GW of solar power. The Ministry has also fixed year-wise targets to monitor the solar power generation in the country. The target for the current year is 12,000 MW, the Ministry is putting all efforts through various schemes of Central Government and State Governments to achieve the targets.

To achieve the above stated objective, the Ministry of New & Renewable Energy has initiated several projects like Scheme for Development of Solar Parks and Ultra Mega Solar Power Projects; Scheme for Development of Solar PV Power Plants on Canal Banks/ Canal Tops; Scheme for setting up 300 MW of Grid connected Solar PV Power Projects by Defense Establishments under Ministry of Defense and Para Military Forces with viability Gap Funding; Scheme of setting up 1000 MW of Grid- Connected Solar PV Power Projects by CPSUs with Viability Gap Funding ; Scheme for Setting up of 15000 MW of Grid connected to achieve this target. Solar PV Power Projects by NTPC/NVVN; Setting up of 2000 MW Grid connected solar power with Viability Gap Funding through Solar Energy Corporation of India (SECI). This apart, an ambitious scheme has been launched by the Ministry for roof-top solar installation. Various state governments are coming up with solar power projects under their own policies.



Source: Press information bureau, 2016.

Despite tremendous focus from the government and environmentalists, the access and follow-up difficulties for renewable technologies in rural areas continue to exist which has been highlighted in different studies (Valencia and Caspary, 2008). The closure or halt of many solar projects not only makes the villages de-electrified, but also renders these projects, set up with capital subsidy from the Government, as dead infrastructure (Palit and Chaurey, 2011).

STUDY

Although, the targets are being set from decades to go solar and the technology is also available since 130 years and it is being implemented successfully for 20 years, but still the coverage is not progressing as per the expected targets. Solar implementation is still perceived to be too expensive.

PROBLEMS WITH SOLAR ENERGY - WHY IT IS NOT MORE WIDELY USED?

The typical characteristic of Solar Energy is that it is distributed and based on radiation of photons as against the Fossil Fuel which is based on combustion of carbon and hydrogen and results in emission of Green House Gases (GHG) which is un-desirable.

The sun offers the most abundant, reliable and pollution-free power in the world. However, problems with solar energy, namely the expensive cost and inconsistent availability, have prevented it from becoming a more utilized energy source.

Solar power makes up a tiny fraction of all power produced in Asia, even though there are vast regions of the continent where there is an abundance of sunshine. To harvest more of this free energy, we need to discover new materials, develop new production techniques and solve the problem of storing energy when the sun isn't shining.

What is hampering solar power has everything to do with cost. It is five to eleven times more expensive to produce electricity from the sun than it is from coal, hydro or nuclear sources. The first problem is with the cost of the technology:

- Solar panels use expensive semiconductor material to generate electricity directly from sunlight. Semiconductor factories need 'clean' manufacturing environments and are expensive to build & maintain.
- The efficiency of solar cells currently ranges from around 20% up to a top range of around 40%, although this continues to improve. The rest of the sunlight that strikes the panel is wasted as heat. More efficient photovoltaic cells have been discovered (up to 43% efficient - see How efficient is solar energy? - but these are still in relatively new and are expensive to manufacture).

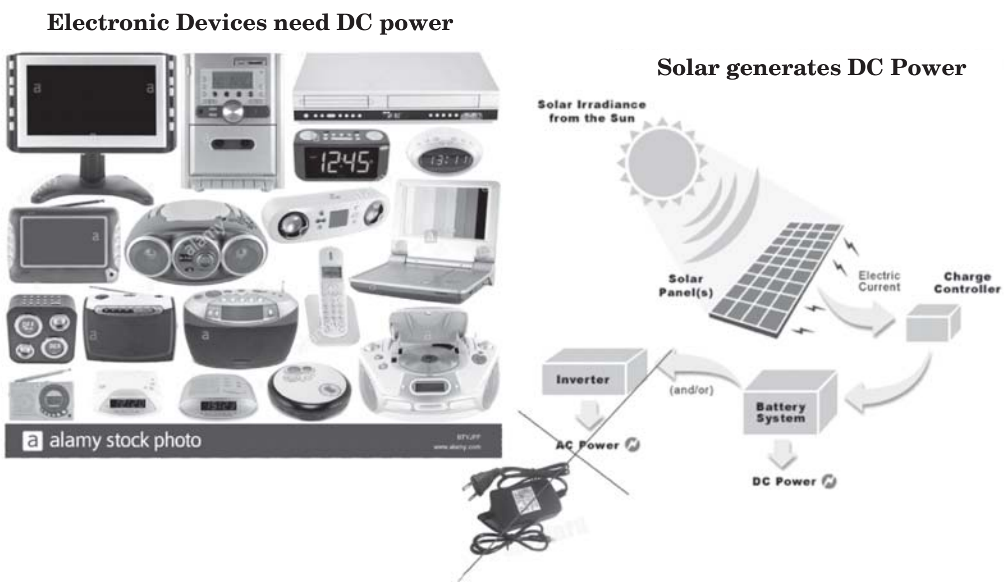
Innovative approaches to generating or storing renewable energy with different levels of complexity keep appearing around the world. While many of them are either simple or aimed to solving very specific needs, others are just the opposite. In most cases, further research is needed to be able to scale them to industrial proportions in an affordable way.

Therefore, the study revolves around integration of the two aspects which consists of firstly the technological changes in the current setup to make it cost-effective and secondly, a strong management to plan, implement and maintain solar setup within the stipulated time, cost and quality.

PROPOSED SOLUTION

The first aspect which is technological changes in the current setup is based on knowledge, re-engineering and re-designing the current setup circuitry eliminating the redundant component.

While the electrical device needs AC power, contrary to it the electronic devices require DC power and Solar generates DC power but in today's scenario we convert this DC to AC as a conventional approach. Thus the new approach proposed is to take DC power from the solar panels to directly charge the electronic devices like computers, laptops, mobiles, microwaves, etc. This would eliminate the need for expensive inverters and AC/DC conversion adapters, and would enable IT education which is which is currently being hampered due to erratic power supply in rural and remote areas.

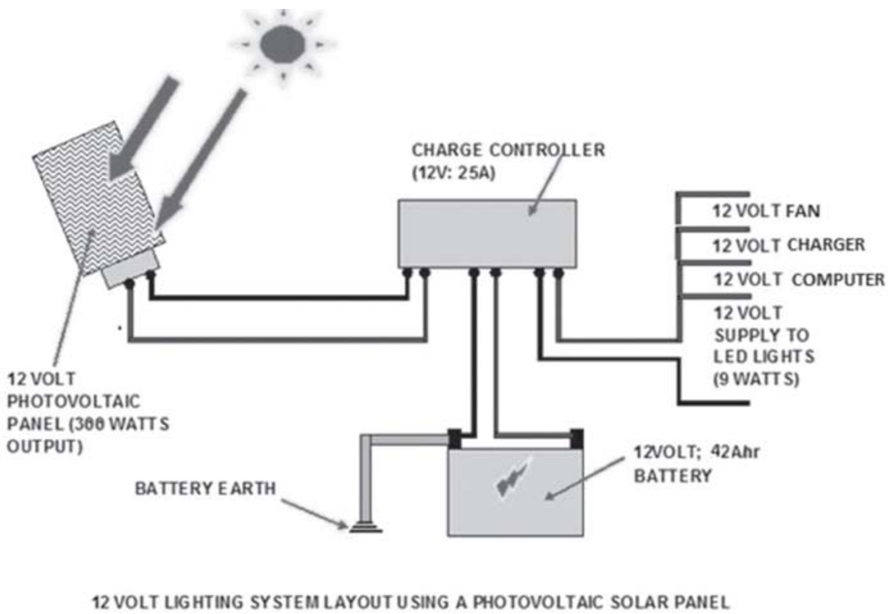


The reason we are using AC power today is that the power generated in power houses needs to be transmitted to individual buildings, which cannot be transmitted as DC because it leads to power wastage (termed as copper-loss). Thus it is converted to AC during transmission from the power houses and hence all our current electrical and electronic equipment are having the input source as AC. But the fact is that all the electronic equipment run on DC, so today although they have input source as AC, they have in-built adapter to convert it to DC before transmitting it to the electronic equipment. Now, if we re-design the current setup, generating DC solar power at the rooftop which doesn't need that long distance transmission, can power the devices as DC, without the need to converting it to AC and without the need for any inverter and adapter. Also, the need for grid is totally eliminated particularly in remote and difficult terrains. Hence it would provide appropriate solution to the problem of excessive cost by eliminating the cost of inverters, adapters and grid in the entire solar implementation.

Study proposes DC circuitry for all the electronic setup like IT organizations, computer laboratories, and electronic shops with the solar panel on their rooftops.

Giving an example of a computer laboratory of a rural Indian school running 10 laptops with basic amenities like light, fan and charger, the consumption comes to less than 300W which can be fulfilled by a 300W photo-voltaic solar panel on their rooftop. The proposed circuitry involves a charge controller that feeds direct current (DC) power to a bank of lead-acid batteries, which connects directly to the electronic appliances without the need of an inverter that outputs alternating current (AC) power (the one used for conventional power supply today) as depicted below:

Circuit diagram



DC Setup - Circuit Diagram for off-grid

The cost and ROI is calculated below assuming sunny days in a year as 300 and full sunshine hours as 5.

ROI calculation

Thus the proposed solution provides a much simpler system which comes out to be less expensive to produce and maintain the required power supply generated by the solar panels at the rooftops. The return on investment (ROI) estimates the

Component	Unit	x	price per unit	Cost
Solar Panel	W	300	35x	10,500
Charge Controller	A	25	750+75x	2,625
Battery	Ah	42	500+80x	3,860
Installation	D	2	500x	1,000
Total				**17,985**

*Cost further goes down if we add the solar incentive and remove the current conventional power incentive

Solar Panel		300	W
Units Produced Yearly		450	KW
Electricity Cost	₹	7	per unit
Return	₹	3,150	
Investment	₹	17,985	
ROI		18%	
Payback Period		5.7	yrs

return in 5-6 years for to power 10 to 25 Classroom PCs, compared to the return of 15-20 years for a conventional AC system. A single inverter alone costs thousands to lakhs of rupees which is totally eliminated in the proposed DC system.

The second aspect, which is the management of solar energy, the author tries to define what solar management is and what the success criteria of a solar project are. Besides managing the project successfully, the project manager needs to have the skill of making the project a success. Even if the project is managed well, the project may fail, which is happening in case of solar projects due to misalignment of nations objectives from top until the ground and poor representation of its benefits across board. The key skills needed to make solar a success are:

1. Strategic planning and management
2. Technical know-how of solar implementation
3. Innovate cost-effective solution
4. Approach and knowledge of government grants and incentives on solar
5. Networking skills
6. Awareness of ground realities
7. Strong monitoring and control
8. Risk & issue identification and handling

The term solar management refers here the management of solar energy production and optimum capacity planning for implementing solar projects to meet the national target of renewable energy within the stipulated time, cost and quality. This notably means improving the efficiency of solar power devices i.e. photo-voltaic cells, solar panels, charge controllers, etc. and bringing the technological changes to make solar implementation cost effective i.e. design DC setup for the solar powered electronic equipment's.

Solar management is the way of channelizing solar energy by integrating the concentration of behavior, awareness, implementation and engineering solution with pollution control. Solar management includes actions and methods that can model the optimal energy generation and consumption and increase the profit or decrease the costs by controlling the products or service qualities.

Solar management analyses solar consumption and implements cost-cutting measures in the entire current setup to minimize energy utilization. The key role of a manager here would be to grasp the opportunities offered by solar management which focuses on both consumption and cost including environmental aspect.

Solar management is the sum of measures planned and carried out to achieve the objective of using the minimum possible energy while the comfort levels (in offices or dwellings) and the production rates (in grids or rooftops) are maintained. Solar management also includes on-grid, off-grid and hybrid setups. The appropriateness is determined in each case. This shows that how much solar energy should be used, what is the ideal consumption and how much solar energy can be saved for the grid.

Besides this, the study proposes that the maintenance and installation education be imparted to 'less-qualified (general)' population, making them self-sufficient for solar setup, so that the one-time cost and recurring cost can be controlled. The implementation needs to be pro-actively planned, executed, monitored and controlled with assessment of all the risks and issues. The above method as a whole is referred here as solar management. Solar management is performed to obtain the following objectives:

1. Power Generation on house rooftop through Solar for charging the batteries, which is available for backup for the rural poor population who lives in darkness due to erratic power supply.
2. Build a DC household with all necessary equipment including DC fans, lights, mobile- charging and other desired electronic / electrical equipment, operated by Solar energy which reduce the cost of power to minimum.
3. Operate Computer Lab on Solar DC setup, which would enhance computer literacy in rural areas which has not been a success so far despite high focus, due to frequent power cuts in rural areas.
4. Develop monitoring techniques to minimize the recurring cost. This will provide true image of solar energy benefits to authorities, consumers and all the stake holders.
5. Provide employment to youth in their local areas by educating them in basics of solar energy harnessing, assembling and installation of solar panels. Also, these rural populations ('less-educated' people) would be trained for long term service providing and capacity expansion, and would serve as local resources.
6. Protect environment by saving fossil fuel, lowering carbon footprint and decreasing pollution created by the conventional power houses as stipulated in Kyoto protocol.

CONCLUSION

In rural areas, Affordability is an important consideration in realizing solar energy access. Even if the installation is provided almost free by the highly ambitious government policies, the finances for solar energy production, operation and maintenance might turn out to be higher than the paying capacity of villagers. It will likely take decades to discover new materials and methods of making solar panels less expensive. How long it takes depends on how much time and money is invested into solar energy research both by government and private industry. Thus, the biggest challenge is to make it cost effective so that these solar panels can be easily marketed to individual households and organizations. Education is also crucial to generate a global sociocultural impact on how energy consumption is perceived and awareness on the cost of energy production as well as depletion of traditional energy sources. The need is to efficiently manage this initiative so that the awareness and importance is transferred to the remotest locations.

To make it sellable and cost-effective, we need to take a different approach in order to produce higher benefits with lower cost i.e. designing an improved way to power electronic devices using solar power directly at DC. Moreover, the maintenance and installation needs to be educated to less-educated local population of rural and remote areas, so that the one-time cost and recurring cost can be controlled.

Author believes that if the given approaches are implemented methodically with efficient solar management and proposed technological reform, it will particularly address the Indian situation around the following:-

1. Common Man's Energy needs;
2. The Education Environment;
3. Industrial and Employment Needs;

And it will be known as the real Infrastructure Settings, in rural areas, which will shape the village as a Smart Village like a Smart City of any State in the country.

References

Assessment Report of the Intergovernmental Panel on Climate Change (2007) [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available Web address at: *https://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter4.pdf*

Balachandra, P. (2013), "Rural energy needs – it's beyond just energy", Workshop on "Solar photovoltaics for off-grid electricity access in rural India", organized by Imperial College London in collaboration with Divecha Centre for Climate Change, Indian Institute of Science, Bangalore, 14th Jan.

Chaurey, A. and Kandpal, T.C. (2010), 'A techno-economic comparison of rural electrification based on solar home systems and PV microgrids', Energy Policy, Vol. 38, No. 6, pp. 3118–3129. Global Advisors (2012) Energy, Monthly News Letter, Sep 30.

<http://www.globaladvisors.in/pdf/2012/energy-september-2012.pdf> (last accessed Feb 12, 2013)

Dr. Hippu Salk Kristle Nathan's (2014), 'Solar PV for Rural Electricity– A Misplaced Emphasis for Mitigating Climate Change'. Available Web address at: *http://paa2014.princeton.edu/papers/143234* e4sv.org (2016), 'Smart Villages: New thinking for off-grid communities worldwide'. Available Web address at: *http://e4sv.org/energy-development-concept*

Economics of Biofuels, United States Environmental Protection Agency (2013). Available Web address at: *https://www.epa.gov/environmental-economics/economics-biofuels*

Excerpt from Renewables Information, International Energy Agency (2016). Available Web address at: *https://www.iea.org/publications/freepublications/publication/KeyRenewablesTrends.pdf*

GLA's (2010), 'The Mayor's Draft Municipal Waste Management Strategy'. Available Web address at: *https://www.london.gov.uk/sites/default/.../draft-mun-waste-strategy-jan2010.pdf*

Intel Corp., 'Solar Power for PC Deployments: Enabling ICT beyond the Grid'. Available Web address at: *http://www.intel.com/Assets/PDF/casestudies/WA-324794.pdf*

Intel Freepress, 'Plugging Laptops into the Sun with a Smart Solar Charger'. Available Web Address at: *http://www.intelfreepress.com/news/solar-powered-laptops/9383/*

MNRE's (2013), 'Solar Power Policy Uttar Pradesh 2013'. Available Web address at: *mnre.gov.in/file-manager/UserFiles/state-power-policies/UP-Solar-Power-Policy.pdf*

Palit, D., Malhotra, R. and Kumar, A. (2011), Sustainable model for financial viabili ty ofdecentralized biomass gasifier based power projects. Energy Policy, Vol. 39, No. 9, pp. 4893–4901.

Palit, D. and Chaurey, A. (2011), Off-grid rural electrification experiences from South Asia: Status and best practices. Energy for Sustainable Development, Vol. 15, No. 3, pp. 266–276.

Planning Commission (2002), Tennth Five-Year Plan, 2002-07, Energy, Chapter 7.3, Sectoral Polices and Programme, Planning Commission, Govt. of India.

Press Information Bureau, GOI, MNRE (2016), Solar Power Capacity Crosses Milestone of 5,000 MW in India. Available Web address at: *http://pib.nic.in/newsite/printrelease.aspx?relid=134497*

Position on Bioenergy, Greenpeace, (2008). Available Web address at: *http://www.greenpeace.org/argentina/Global/argentina/report/2009/6/pol-tica-internacional-sobre-b.pdf*

Powering the Future (2013), Book published by Basic Books (AZ) authored by Nobel laureate Robert B. Laughlin.

Practical Action (2009), Energy poverty: The hidden energy crisis, Practical Action Publishing, London.

Ramamurthy, V. S. and Kumar, S. (2012), 'Pedal Power as the 21st Century Charkha', Mainstream, Vol. L1, No. 1. <http://www.mainstreamweekly.net/article3929.html> (last accessed Feb 06, 2013).

Sameer Jain, 'Integration of Business and Technology Strategy Gramin Saur Urja'. Available Web address at: *https://www.ijsr.net/archive/v1i3/IJSR12120392.pdf*

Savitha C., 'An economic analysis of renewable energy resource management in Karnataka'. Available Web address at: *http://shodhganga.inflibnet.ac.in:8080/jspui/handle/10603/72551*

Singh K. (2009), In India's Sea of Darkness: An Unsustainable Island of Decentralized Energy Production, Consilience, No. 1, Field note.

Valencia, A. and Caspary, G. (2008), Barriers to Successful Implementation of Renewables-based Rural Electrification, Briefing Paper, 7/2008, German Development Institute.

World Energy Resources, World Energy Council, (2013) Survey. Available Web address at: *https://www.worldenergy.org/wp-content/uploads/2013/09/Complete_WER_2013_Survey.pdf*