MADRAS MMA MANAGEMENT ASSOCIATION Trichy Chapter

MADRAS MANAGEMENT ASSOCIATION

PRAGYAHAM

21st Regional Conclave

on

Go Green - Go Solar

For a Better India Tomorrow

Monday, 29 July 2013

Hotel Sangam, Collector's Office Road, Trichy-1

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Editor's Message

Welcome, Dear Readers!

Pragyānambrahma - Knowledge is God – declares the **Aitereya** Upanishad of Rig Veda. The Trichy Chapter of Madras Management Association has prepared ***Pragyānam*** – the booklet to be released during its 21st Regional Conclave titled **'GO GREEN GO SOLAR - FOR A BETTER INDIA TOMORROW'**, with the same reverence. Apart from several articles on the subject by various experts in the field, the booklet also contains a comprehensive list of numerous manufacturers of Solar Power based systems and components. The objective is to provide a concise view of the state of art in this area to the readers that should help them to choose appropriate products and technology, to satisfy their requirements.

At this juncture, I wish to thank my team members for their sincere efforts and excellent co-operation in bringing out Pragyānam in the short duration of 10 days.

I hope that Pragyānam serves as an informative handbook both for the beginners and the experts in this field.

Warm Regards,

Dr. V. Gopalakrishnan,
Editor / Pragyānam,
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MMA Trichy Chapter Chairman's Message

Dear friends,

India has been facing electric power shortages ever since it got Independence. Due to depletion of fossil energy resources coupled with global warming and climate change, we are forced to find alternative solutions through unlimited renewable energy options. In this segment, SOLAR ENERGY offers an excellent choice amidst several other existing options. Research & development is underprogress throughout the world and is likely to yield unimaginable results in finding newer routes of meeting global energy needs.

Since SOLAR POWER occupies a prime position in our search for energy alternatives, Madras Management Association – TRICHY CHAPTER thought it fits to organize a Regional Conclave on **'GO GREEN GO SOLAR- FOR A BETTER INDIA TOMORROW'** with distinguished stalwarts from Industry, Business, Entrepreneurs, Research Scholars and Prospective Customers, putting their thoughts together to evolve what suits best for the growth and development for this part of India.

On this great occasion, ***Pragyānam,*** the e-Book released by us, is intended to serve the general public, consumers and investors with informative articles on Solar Energy with excerpts from the Speakers and Consultants of various Solar Power Equipment manufacturing companies in India.

With immense pleasure, I congratulate and thank our team for their efforts in shaping up ***Pragyānam*** within a short span of time.

Happy reading!

Best Regards,

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Impact of Solar Power on Growth

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"We all know that our country is the Sun's most favoured nation, blessed with over 5000 TWh of annual solar insolation"

For the human race, as we know, all energy is solar. Here on our mother earth organic life depends on light and radiation energy from the sun and the same is converted into pretty much everything else – from plants that feed cows to fossil fuels. This is elementary science. But, as responsible and accountable citizens it is imperative that we go a little beyond this.Solar energy has played a crucial role in society's technological and economic progress.

Let us mull over and explore the main areas…

History:

We must study and understand history of solar energy – to know the cause of global warming and the importance of use of alternative energy sources. Sun worshipped as central source of energy for sustenance of life is not only common in ancient civilization but also to date and is here to stay as long as the Universe is alive. For without the sun's core nothing is possible for human race.

Over 170 years ago, in 1830s Edmund Becquerel observed that "electric current arose from light-induced chemical reactions" and Auguste Mouchout was the first man to patent a design for a motor running on solar energy in 19th century. In history, there are books on "A substitute for fuel in tropical countries". There have been many authentic and well recognized experiments on the use of selenium solar cells for electricity power generation. The ever first selenium solar cell by Charles Fritz enabled conversion of sunlight into usable electrical energy – with a rate of one to two per cent considered as a big milestone in solar cell invention.

Fuller were the principle discoverers of the silicon. Gerald Pearson, Daryl Chapin and Calvin solar cell – the first material to directly convert enough sunlight into electricity to run electrical devices. Then came the satellite instrumentation in late 1950s. Solar cells success played major role in powering American and Soviet satellites. The advent of huge oil tankers in 1960s crippled the solar energy field, particularly the water heater business. The price of oil has a greater role and direct impact on the growth and slump of solar power industry. This again is something which is here to stay and is certainly a challenge to be addressed diplomatically by the administration.

Second simple basic reason to focus on growth perspective of solar energy creation is because it will reduce dependence on fossil fuel. This leads us logically to appreciate the fact that its environmental advantages are aplenty. And the other major factor is its scalability and modularity.

More advantages are that solar energy can effectively supplement electricity supply from

transmission grid during peak demand in summer. This will address the local electricity consumption and user friendly pricing by policy makers.

Then, we have the flexibility of installation. Production facilities could be installed at consumer's sites. This means saving of investment in production and transmission infrastructure. The most effective form of solar energy – photovoltaic systems can be more cost effective than extending power grids. They are especially appropriate for remote, environmentally sensitive areas, such as parks, cabins and remote homes.

As we all know, our country's electricity consumption has been increasing at one of the fastest rate in the world. India's economy faces increasing challenges because energy supply is struggling to keep pace with demand. Nearly everywhere in our country, there are energy shortages. Such chronic lack of energy and unreliable supplies threaten India's economic growth.

In the context of Trichy, power shortage has been incorrigible. Many of us have witnessed small scale industries perishing pathetically primarily due to poor power supplies. (The local industrialists would be better sources of sharing their woes in this context)

Solar Energy – Cost Effective Option:

Well, we all know that our country is the sun's most favoured nation, blessed with over 5000 TWh of annual solar insolation. We must take full advantage of this golden opportunity. Solar is the prime free source of inexhaustible energy available to all. We have tremendous energy needs and increasing difficulty in meeting these needs through traditional means of power generation. Even today, nearly 300 million people in remote and rural India, do not have access to reliable sources of energy. Solar energy is the most cost effective option for us to reduce 'energy poverty' without having to extend national grid services to provide power for individual homes and buildings. It is high time that we shift to non-polluting renewable sources of energy to meet future demand for electricity. For long term economic growth of our country the answer is renewable energy. Innovative and favourable policies on renewable sources of energy could create millions of new jobs and an economic stimulus.

Solar and renewable energy distribution could be decentralized for meeting rural energy needs. This empowers people at grassroots level. Solar electricity could also shift about 90 percentage of daily trip mileage from petroleum to electricity by encouraging increased use of plug-in hybrid cars. In today's increasing oil prices, this could mean reduction in cost per mile for drivers in our country.

To talk on macro levels, our Indian present business models needs must change from centralized to a decentralized structure that helps all stakeholders, including capital investment coming from state owned investors, pension funds and overseas. My reading knowledge gives me a background that India has developed a cluster of energy business models and policies that have not been productive. Hence, the need for distributed energy. This will lighten the load on the main grid. It is cost effective smart grid

solution that could make the system more reliable. We have a unique position to introduce clean energy solutions on an enormous scale to provide affordable energy for all – especially the poor.

It is possible that 70 percent of India's electricity and 35 percent of its total energy could be powered by renewable resources by 2030, provided we massively switch from coal, oil, natural gas and nuclear power plants. Also experts share their confidence that there are no technological or economic barriers to supplying almost 100 percent of India's energy demand through the use of clean renewable energy from Solar, wind, hydro and biogas by 2050.

As we have been witnessing and experiencing, newly built solar plants are already considerably cheaper. Solar energy will compete head on with conventional energy generation to attain Grid Parity.

I would like to conclude by emphasizing that this forum would drive home the thought that India needs a radical transformation of its energy system to the use of renewable energy –especially Solar and Wind to end the “India's Addiction to Oil”. With this we will pave way to lift massive population out of poverty and combat climate change.

“India cannot afford to delay renewable energy deployment to meet its future energy needs”.

This is the precise message that experts must keep crying to the best of their energy, from the roof top

HARNESSING SOLAR ENERGY

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Solar Energy is available to everybody in plenty and is the ultimate sustainable source of renewable energy available to mankind. But, different consumers have different requirements. Some want to use the solar energy during the day and some want to use during the night. Since solar energy is available only during the day, it needs to be stored for utilization during the night. It is very important to understand the most efficient way of capturing and using solar energy.

Every consumer is a unique consumer. Solar energy solutions should be provided after thorough analysis of the energy consumption pattern.

There are different system configurations that are available to suit various needs. These configurations can be broadly classified as battery based and non-battery based systems.

Normally, for residential and night load applications, battery based systems are ideal. But, for commercial and Industrial consumers, non battery based systems are the most efficient system configuration. Issue of energy management is also an important point to be considered while designing solar systems. What will happen if an industry that has set up a solar power system does not operate on a Sunday? What will happen to the energy generated on a Sunday? Can this energy be fed to the grid or what options are available to consume it internally? Obviously, these questions necessitate the deployment of “Back-to-Grid” systems to effectively manage the generated power.

Sustainable Carbonless Development

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Director, Horizon SolSolar Pvt. Ltd., (Suntech,Australia)
Founder and Secretary,
Global Green Growth Group (4GTulsi)

"Scientifically, plantation of more trees will bring more rain to earth, but will not solve exponential increase in CO_2 levels"

1.Carbonless Economy - Agricultural Era

Right from the origin of civilisation till the mid eighteenth century, world has witnessed carbonless, sustainable development during Agricultural Era.

2.Carbon Intensive Economy - Industrial Era

Due to advancements in science, James Watt invented Steam Engine.Over the last 262 years,as a part of industrial development and technology advancement, gradually industrial world developed carbon intensive – power plants, using fossil fuel such as coal and automobile industry, using petroleum products.

3.Mother Earth in Intensive Care Unit (ICU)

Due to large scale automobile and power production all over the world, Greenhouse gas such as carbon dioxide (CO_2) in atmosphere has reached 400 PPM (Parts per Million), which is highest in the last three million years of civilisation. Sustainable or palatable level of CO_2 in earth's atmosphere is 350 PPM. Our earth has crossed such a threshold limit during November 1988.

Since early 1990's, by way of 1992 Rio Summit and "Rio+20" Climate Change Conference in 2012, discussions between various country heads have been going on; but little actions takes place to save mother earth from ICU.

Mother earth is in ICU, nobody cares. No one is serious.

Looks like a good old joke about "Everybody..Somebody..Nobody..Anybody"..... What a pity?

4.If today's trend of exponential addition of CO_2 and Greenhouse gases to atmosphere continues for next 20 years, then, in 2033 all over the world people should carry Oxygen cylinder at the back to have normal breathing.

5. What is the solution to solve this Global Warming Green House emission?

Solution I

One of the major solutions is available in our back yard, that too for the past 1000 years in India - Tulsi or Holy Basil cultivation. Let us reinvent the glory of this queen of herb by understanding the multiple benefits.

Tulsi is the only plant in the world which emits 20 hours Oxygen and 4 hours ozone. We should grow Tulsi plant in every house, which would be helpful to an extent of reversing 400 PPM CO_2 to 350 PPM CO_2.

Solution II

Settle for Renewable Energy (RE) based Power production using Roof Top Solar as well as large scale Solar and Wind Power plant to power your Car / Truck and home to avoid further CO_2 production.

Solution III

Save Electrical Power by using Energy Efficient

Products. Shifting to DC based gadgets instead of AC based existing gadgets as a part of creating Carbonless economy.

The combination of solutions one to three as mentioned above shall bring down CO_2 levels to 350 PPM in the next 15 to 20 years.

6. Change of Individual's Life Style to save Mother Earth

6.1 Need Vs Greed

As Mahatma Gandhi rightly said that in this world, we have enough things to meet out the need of every individual; but, not the greed of every individual. Hence, justified utilisation and consumption of energy is the responsibility of every human being.

Our style of living should be in line with Gandhiji's saying: "Simple in Living,High in Thinking"

6.2 Paradigm shift - Urgent Need Small contributions made by few people in various parts of the world will dramatically alter the course in mitigating Global Warming and to achieve sustainable development, in spite of population explosion and fast track world GDP growth.

6.3 Carbon Intensive development to Carbon Less development

This is high time for individual citizens of the world to make paradigm shifts from Greed-based carbon intensive development to Need-based carbonless sustainable development, to save mother earth. It is a situation of NOW or NEVER.

7.All environmentalists are promoting large scale tree plantation to absorb CO_2, which is 100% wrong. All plants and trees absorb CO_2 during day time [as a part of Photosynthesis] and release CO_2 during night time. Scientifically, plantation of more trees will bring more rain to earth,but will not solve exponential increase in CO_2 levels.

8. 24 Hours Oxygen producing plants

There are 3 exceptional plants, which produce oxygen, day and night, irrespective of availability of Sun. They are:

I. Pipal (Tamil Name – ArasaMaram)

2. Bamboo (Tamil Name - Mungil)

3. Holy Basil (Tamil Name - Thulasi)

Growing Tulasi is relatively easy [within two months], as plantation of Pipal tree takes ten years and Bamboo needs two to five years.

Mission –"***Tulsieverywhere***"www.tulsi4g.org.

Our Concrete Jungles need to have a Tulsi Jungle through Pot Culture. Space Limitations in urban area may be solved by Roof top Tulsi plantation.

9. Future Car - IC Engineless & Gearless Car

In USA, by 2020, one out of four new cars is going to be Electric Car and by 2030, 90 per cent of new cars will be Electric Cars energised with ROOF TOP SUN / WIND POWER. Globally, by 2030, nearly One Billion cars shall phase out from our roads and will undergo radical shift by giving way towards Electric Cars. All electric cars will be charged by Heaven Power (Wind, Water & Solar) and by not using Hell Power (Coal, Natural Gas, Diesel etc.,)

It is going to be India's Era with Holy Basil (Tulsi) and Sun Power. Let us understand and grab the emerging opportunity to take on the world.

Challenges in Grid Connected Solar Power Plant

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"A comprehensive Grid Behavioural study, future developments, Load centres and VAR Compensation are also mandatory for development of a successful Solar Power Plant"

India is in a power strived state and scarcity of power is an impediment on the overall growth of the country. Our country does not have great reserve of primary energy resources like Oil, Gas, Coal and Uranium. Unavailability of primary energy resources affects the availability of secondary energy resources like electricity. In fact, always there remains 10-12 per cent deficit in demand and supply of electricity across the country for last two decades. This can be quite oblivious from the forecast data of the Planning Commission of India and actual achievements.

Particulars	2006	2012	2017	2022	2027
Forecasted Per Capita Consumption (kWh)	631	1000	1300	1900	2800
Required Installed Capacity (GW)	124	225	333	512	790
Actual Installed Capacity (GW)	85	180	..	..	..

In states like Andhra Pradesh, Tamilnadu, Karnataka and Kerala which are located far away from Indian coal reserve, the demand supply gap is even more than the national average. This leads to frequent, unpredictable load shedding and shortage of power in these states even affecting so called dedicated supplies to industries, hospitals, education institutions and other commercial facilities.

Solar Power has been evolved as a promising solution to this chronic problem as the cost of solar power has come down significantly in the last two years. Today, the levelized cost of electricity (LCOE) from solar power is very competitive to the electricity tariff to High Tension (HT) consumers like HT IA, HT IIA, HT IIB and HT III. But, the competitive LCOE can only be achieved when every challenge to the utility scale solar power project development shall be addressed in holistic and diligent ways.

In India, major developments in Grid connected solar power plant has started in last three years and the development is not uniform across the country. Many commissioned solar power projects which were initially believed to deliver very competitive LCOE, come out to be major failures because of early and premature refurbishment activities, forced Capital Expenditure (CAPEX) investment and poor energy yield.

The major challenges in a Solar Power Project from the concept to commissioning in Indian context can be identified as follows

1.Project Model Conceptualisation and Financial Viability:

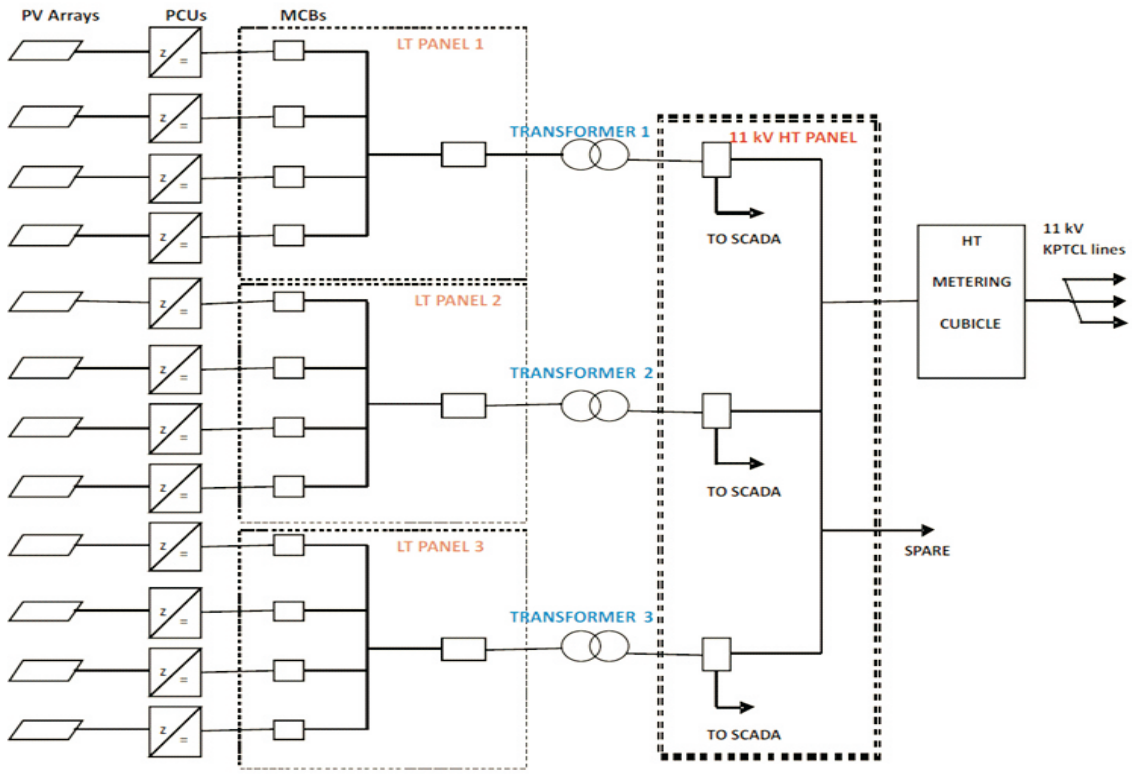
During concept stage, the choice of the project model and financial viability is pivotal for long term success of a Solar Power Project. The Project Developer has to choose the particular model depending on his convenience, suitability to his existing business and risk appetite. Expected returns and payback in various existing project model of Solar Power Plants can be -

Project Model	Expected Project Return	Expected Payback
Reverse Bidding/Competitive Tariff Bidding	15% to 17%	6 to 7 years
APPC +REC	16% to 18%	5 to 6 years
Captive Consumption	20% to 25%	4 to 5 years
Group Captive	15% to 17%	6 to 7 years

APPC: Average Pooled Purchase Cost; REC: Renewable Energy Certificate

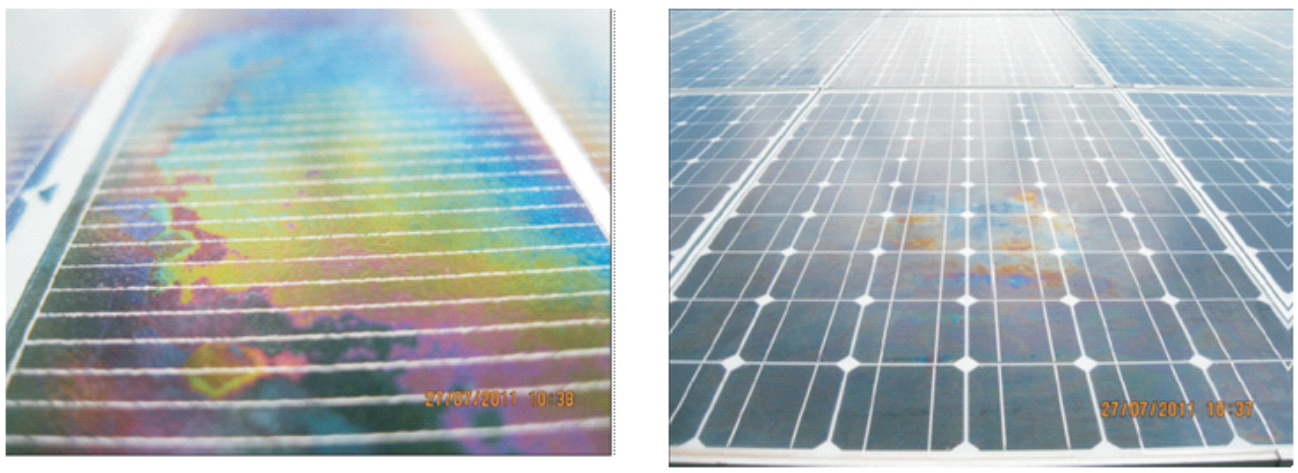
2.Design & Engineering:

Solar Power Project without expert design and engineering is a risky investment. The adoption of energy efficiency, agility, quality, proven track record in design and engineering are must for success in a large scale solar power project.



Simple Block Diagram of PV Plant (evacuation @11kV)

Poor design and engineering leads to many irreversible problems like *Potential Induced Degradation* (PID), Accelerated Degradation, Higher Energy Loss and Poor Energy Yield, High Harmonic Distortion, Module Delamination and Colour Changes in Module.



Visual Colour Change in Photovoltaic Module

3.Regulatory Constraints:

Like any other power project, solar power project requires various regulatory clearances, approvals from different local, state and central government authorities. These authorities are *Ministry of New and Renewable Energy* (MNRE), State Nodal Agencies, Ministry of Civil Aviation, Ministry of Defence, District Advisory Committee, Planning Department, Ministry of Environment and Forest, Pollution Control Board, Local Panchayat and Electrical Inspectorate. These regulatory clearances depend on state and central policies.

4.Site Selection and Land Acquisition:

Plain land nearby substations with adequate evacuation capacity and excellent grid availability is ideal for solar power plant. But, there are several other criteria which have to be taken into consideration while selecting site for solar power plant like availability of water, soil bearing capacity, seismic zone and contour map. The land acquisition and conversion are real challenges in India which are to be addressed in suitable way. The land has to be converted for commercial uses for development of Solar Power Plant.

5. Power Evacuation and Grid Connectivity:

Power evacuation and Grid connectivity are essential for Solar Power Plant. Most of the rural sub-stations, transmission Lines at 11kV or 33kV in India do not have enough power evacuation capacity. Further, for determination of point of interconnection, only load flow study and evacuation approval are not sufficient. A comprehensive Grid Behavioural study, future developments, Load centres and VAR Compensation are also mandatory for development of a successful Solar Power Plant.

6. Solar Insolation Direct Normal Irradiance (DNI) Data: The primary sources of DNI data are NASA and METEONORM. But, there are differences in the DNI data experienced in the field and the data from these sources. DNI database is also available from MNRE. Only a few experienced Solar Companies with long term legacy in India has developed their own database which is proven to

Financing

Statutory Requirement

1. Debt: Equity: 70:30 in case of JNNSM & State Policy Projects
2. Equity Lock–in period of 3 years for JNNSM & StatePolicy Projects

Equity Financing

1. Own Fund
2. Venture Capital
3. NRI Funds
4. Green Funds

Debt Financing

Project Financing	Balance sheet Financing	Equipment Financing	Access to Public Fund
1 Non-recourse financing 2 Financing institutions finance the project based on the off-take agreement like PPA 3 Rate of PPA plays a major role in terms of project merit 4 Good PPA projects is helpful for getting project financing	1. Recourse Financing 2. Financing institutions finance the project based on the merit of the project developers financial strength 3. Poor PPA projects are normally financed in Balance Sheet Financing	1. Buyer's Credit 2. Bridge Finance 3. ECB against imported equipment 4. Lease Finance	1. Debenture 2. Green Infra Bond 3. IPO

In the whole financing process, the debt financing is very important as its share in the total project capital is 70 per cent or more. The hustle free access to debt financing depends on the financial institution's evaluation of the project. It does not only depend on the Debt Service Coverage Ratio (DSCR) of the project but largely to the factors like reputation and bankability of the Engineering, Procurement and Construction (EPC) contractor, meaningful warranties and guarantees and performance track record of the projects commissioned by the EPC contractors.

7.Project Execution without Cost and Time over run: The overall project execution without any Cost and Time overrun is the major challenge to the developers. Since the development of solar Power Project has very little history (just 2-3 years) in India, there are chances for Developers getting disguised by the false promises of the EPC contractors. A typical execution period for 1-5 MW solar power plant is about 4-6 months and 5-10 MW or more than 10 MW Solar Power plant is 8-9 months. But, there are exceptions created by good EPC contractors and Project Proponents. Recently, TATA Power Solar has executed a 2 MW Solar Power project for Chennai Silks Group in Kangeyam, Tirupur in just 90 days period. This has become a record time execution in India without any cost overrun and without compromising to project workmanship.

2 MW Solar Power Plant of Chennai Silks Group located at Kangeyam, Tirupur (EPC:TATA Power Solar)

8.Commitments from Suppliers, EPC Contractors: The commitments from Suppliers and EPC contractors are very pivotal for long term success of the Solar Power Project. The bankability of the Supplier and EPC contractor to fulfil the commitment is mandatory. Solar Industry has experienced a lot of turbulence in last few years. Many companies got into very tragic financial health or even bankrupted and could not stand to its commitment just in few years from the execution of the project for the developers. It becomes an onus to the developer to judge the right and proper Suppliers, EPC Contractors who can deliver the good project with meaningful commitments, warranties and guaranties.

9. Operation & Maintenance: The operation and maintenance of solar power plant is another challenging area in long term aspect. Being a long term contract in nature, it is always prudent to give the operation and maintenance responsibility to the same EPC contractor who developed the Solar Power Plant, since he can coordinate and liaison with OEMs in better terms. Only a good and reputed EPC service provider can get better terms from OEMs in terms of after sale services, long term tie-up, service level guaranties etc. Today, once again, there is no track record available for O and M service performance of most of the EPC contractors. A reliable EPC contractor with strong O and M team and service offerings can make huge difference in ensuring competitive LCOE from the Solar Power Plant and hence ensuring quick payback period to the developer.

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Solar Power Plants on Land and Roof Top Solar

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"Availability of 'low cost' financing and offer of 'pay and use' models by the manufacturers can further accelerate this business."

Solar Energy

India lies in the sunny regions of the world. Most parts of India receive 4–7 KWh (kilowatt-hour) of solar radiation per square meter per day with 250–300 sunny days in a year. The highest annual radiation energy is received in western Rajasthan while the north-eastern region of the country receives the lowest annual radiation.

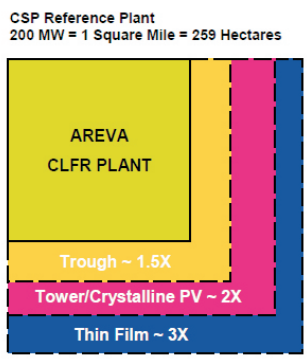
Solar Electricity

Solar energy, experienced by us as heat and light, can be used to generate electricity through two routes: the thermal route uses the heat for power generation and other applications; the photovoltaic (PV) route converts the light in solar energy into electricity, which can then be used for a number of purposes such as lighting, pumping, communications and also power supply to the Grid.

Solar Power Plants on Land

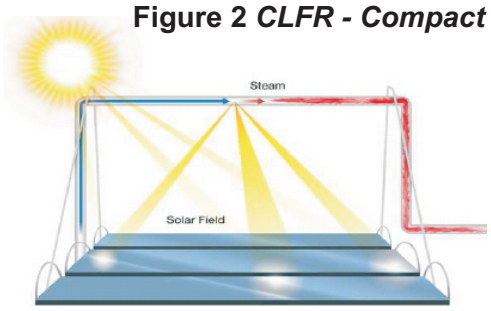
Large Megawatt scale power plants in large areas / stretches of land are installed and being installed in our country and all over the world. The technologies are again solar PV or solar thermal. The figure 1 is indication of Land requirement and a comparison of areas required for different technologies.

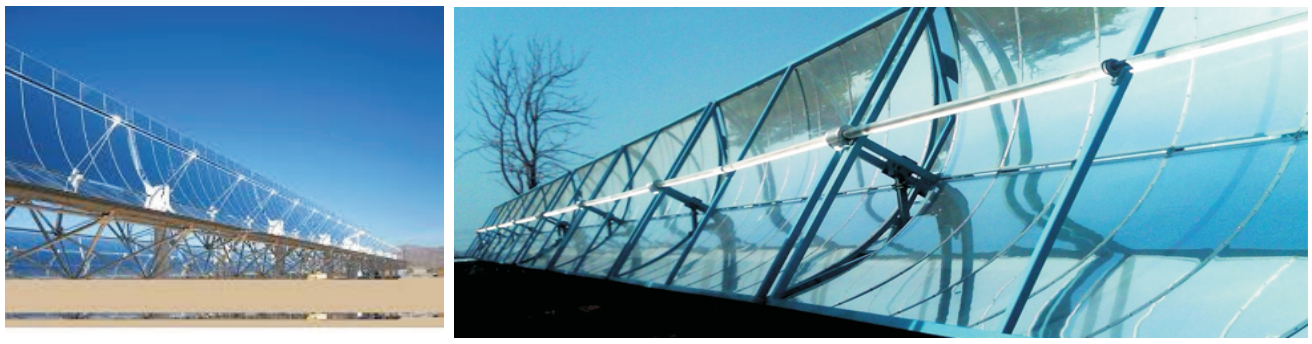
Figure 1 Land requirement



The extent of Land required per MW could be around five to seven acres, depending on the technology adopted and the efficiency of the system in converting solar energy to electricity.

Figure 2 ***CLFR - Compact Linear Fresnel Reflector***





Courtesy: THERMAX www.thermaxindia.com

There is a tremendous pressure on availability of large extents of land due to various other requirements such as Industries, Software parks, SEZs & Infrastructure, Real Estate prices are also sky rocketing. For solar power generation, it is found feasible to use land areas which are found barren and unfit for other uses.

Roof Top Solar

This is an important area which deserves closer attention and exploitation. Roof Tops of Homes and Flats, Commercial Buildings and Industrial Buildings and Sheds including Warehouses and Hangers in airports provide very large scope for installations to generate solar electricity mainly through solar PV route.

Courtersy: HHV Solar Technologies Pvt. Ltd www.hhvsolar.com

The area required per KW can be taken as 10 Square meter per kW and the capacity planned can be matched with the area available. Domestic installations from about 1.5 kW to 10 kW, Commercial Building installations from about 50 kW to 100kW and Industrial Installations from 100 kW to a few MW capacities are being installed in many places.

There is a tremendous scope for large scale and large number of Roof Top installations of Solar Power in Industries where the power can be inverted and used directly when ever available through local Low Tension Grid cutting down on Grid Power use. Availability of 'low cost' financing and offer of 'pay and use' models by the manufacturers can further accelerate this business.

OVERVIEW ON CURRENT ENERGY SCENARIO IN TAMILNADU - NECESSITY OF SOLAR ENERGY

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"The availability of land and technology is abundant in our country but the Grid availability is limited."

Electricity Generation Statistics

As on January 31, 2013, the installed electricity generation capacity in Tamilnadu is 18,382 MW. The Private sector share is 47 per cent which shows that there is a healthy investment environment. The power share from Renewable Energy sources contributes about 52 per cent of the total generation capacity, including small hydroelectricity.

Demand and Supply Position

The peak demand deficit is one per cent in the Financial Year (FY) 2005-06 and 18 per cent in 2011-12. The Peak electricity demand grew at a Compounded Annual Growth Rate (CAGR) of eight per cent from FY 2005-06 to FY 2011-12. The Peak demand met at CAGR of 5 per cent.

Position of Renewable energy

The installed renewable energy capacity is 7,979 MW by September 2012, out of which Wind Energy capacity is 7,134 MW.

Energy problems and fall outs in Tamil Nadu

The major problem Tamil Nadu is facing is inefficiencies in generation of electricity. Few months ago, power cuts lasted over six hours. The energy and peak shortage of power were 17.4 per cent and 12.3 per cent respectively of the demand between April 2012 and February 2013.

Future Energy Requirement in India

'Integrated Energy Policy Report' of the Planning Commission projected that by 2031-32 India would require a generation capacity of about 9,00,000 MW to 12,00,000 MW. This implies that the country requires additional generation capacity of about 7,00,000 to 10,00,000 MW by 2032. Our country needs to add four times the existing capacity in the next 20 years or so.

Solution to Energy Problems in Tamil Nadu

The electricity problem can be overcome by using various methods as given below:

- Solar Energy (Above average irradiation)
- Wind Energy (Existing)
- Bio-mass (Dependency on 20 per cent coal)
- Tidal Energy (Yet to get reliable technology)
- Geo-thermal (unexplored so far in the country)

Adaption to Solar

The irradiation is around 5.5 KWh/m^2/day. The availability of land and technology is abundant in our country but the Grid availability is limited.

Solar generation cost

Current Capital Cost: 7.50 to 7.80 per unit (PU)
Expected Cost in next 2/3 yrs: 5.50 to 6.00 PU

Solar Policy in Tamil Nadu

There is an ever increasing demand for energy irrespective of the escalating prices and depletion of fossil fuels. Energy demand, in particular, electricity production has resulted in creation of fossil fuel-based power plants that let out substantial greenhouse gas / carbon emission into the atmosphere causing climate change and global warming.

The Government of Tamil Nadu is committed to mitigate the climate change effects by bringing out policies conducive to promote renewable energy generation in the State. The Government intends to make renewable energy a people's movement just like rain water harvesting.

The state is blessed with various forms of renewable energy sources like Wind, Solar, Biomass, Biogas and Small Hydro Power Plants. Municipal and Industrial wastes could also be useful sources of energy while ensuring safe disposal.

Renewable Energy (RE) sources provide a viable option for on/off grid electrification and wide industrial applications.

Establishment of TEDA

The Government of Tamil Nadu realized the importance and need for renewable energy and set up a separate Agency, as registered society, called the Tamil Nadu Energy Development Agency (TEDA) as early as 1985,as per G.O.Ms.No.163, P. & D. (EC) Department, dated 29.11.1984 with the following specific objectives:-

1.To promote the use of new and renewable sources of energy (NRSE) and to implement projects therefore.

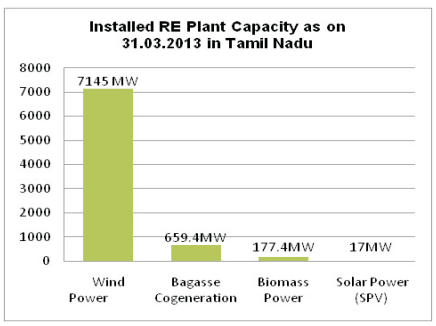
2.To promote energy conservation activities.

3. To encourage research and development on renewable sources of energy.

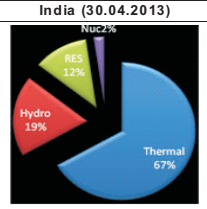
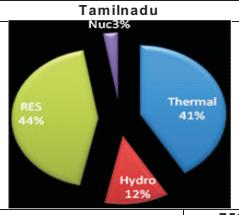
Renewable Energy Installations

Achievements of TEDA as on 31.03.2013

Renewable Energy Programme/ Systems	Cumulative achievement up to 31.03.2013(MW)
Wind Power	7145.00
Bagasse Cogeneration	659.40
Biomass Power	177.40
Solar Power (SPV)	17.00
Total Capacity (MW)	**7998.80**



Power Sector at a Glance

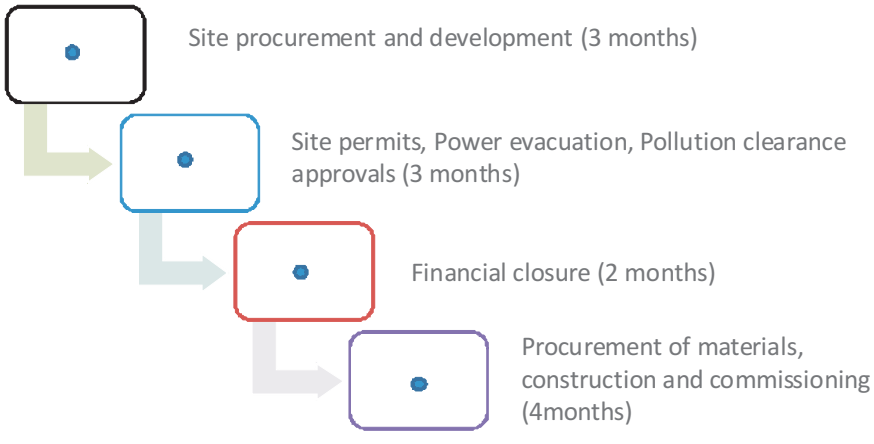
India (30.04.2013)		Tamilnadu	
			
Thermal	**1,51,680.49 MW**	**Thermal**	**7527 MW**
Hydro	**39,623.40 MW**	**Hydro**	**2186 MW**
Renewable (12%)	**27,541.71 MW**	**Renewable**	**7979 MW**
Nuclear	**4,780.00 MW**	**Nuclear**	**501 MW**
TOTAL	**2,23,625.60 MW**	**TOTAL**	**18193 MW**

By Tamil Nadu Solar Policy 2012

- 3000 MW of Solar Power by 2015
- 3% (in 2013) and 6% SPO to HT Consumers from 2014

Year	Utility Scale (MW)	Solar Roof Tops (MW)	REC (MW)	Total (MW)
	(A)	(B)	(C)	**(A)+(B)+(C)**
2013	750	100	150	**1000**
2014	550	125	325	**1000**
2015	200	125	675	**1000**
Total	**1500**	**350**	**1150**	**3000**

Typical Solar Power Plant Development Timeline for a 25 MW Plant



Economics for low cost Installation of Solar Photo Voltaic systems

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"Any off-the-shelf installation without considering the usage profile adds only cost and not value to the end user."

The solar Photo Voltaic (PV) system has been in use for the past 50 years. But there has been a drastic reduction in the cost of the PV system in the last 2 to 3 years. In a way, this can be attributed to the widespread use of PV systems.

In this discussion, the present scenario of solar PV system and the consumer awareness required to achieve economic installation is outlined.

The overall cost of the solar PV system can be divided into three major categories.

1. Cost of the panels
2. Cost of balance of systems
3. Cost of Installation

The cost of solar panels can be compared by end users, since the technologies are commercially stabilized and the costs are available. Presently, consumers are able to identify the *International Electrotechnical Commission* (IEC) certification standards for panels and the warranty period along with price tag attached to the panels.

Performance limitations in the solar PV system mostly come from the balance of systems. The problem with balance of system is the lack of awareness with the consumers regarding the specifications and performance of components like Batteries, Inverters and structures. This is especially true with the terminologies such as Inverter battery, Solar battery, Sine wave Inverters, Solar Hybrid U*ninterruptible Power Supply* (UPS),Solar Power Conditioning Units and Solar Inverters with *Maximum Power Point Tracking (*MPPT) controllers.

An economical solar PV system installation depends on selection criteria with respect to the usage profile. Any off-the-shelf installation without considering the usage profile adds only cost and not value to the end user.

For example, a one kilo Watt (kW) solar PV system can be installed with two batteries rated at 150Ah capacity or two batteries rated at 200 Ampere hour (Ah) capacity. Some of the installers may even go for four batteries rated at 150Ah capacity. End user should be aware that there can be performance and cost difference among the three systems, even though all the three can be advertised as 1 kW solar PV system.

From the performance point of view, for a house where both husband and wife are employed, providing a system for day time usage profile may not be economical. But, in a residence with homemakers and offices, system with maximum day time use will be economical.Hence, it has become important to educate the consumer with respect to the points to be considered while choosing a solar PV system, which may lead to further reduction in the costs of solar PV system because of wider acceptance.

The following points can be considered as important for the economical and effective installation of solar PV systems.

1.Type of panels

- Roof and 'shadow-free' space availability
- Cost of panels
- Orientation of panels

2.Capacity of batteries based on the usage or load profile

- C_{10} rated and C_{20} rated batteries
- Compatibility with Power Conditioning Unit (PCU) and panels

3.Selection of the capacity/ Type of inverter or Power Conditioning Unit based on the maximum load to be connected to the solar PV system

- Solar Panels are modular and can be added at a later date. But, we need to replace the inverter beyond certain capacity. Hence, due consideration for future upgrades is required before selecting Power Conditioning Unit.

4.Type of structure required based on the roof type available

- For cutting down the cost of installation and transportation, some of the installers and customers use powder coated rack angles which -angles which can reduce the cost of non-value added parts of system.

5. Usage of correct size of wires

- Any wrong selection of wire size may lead to reduced performance of the system. It is better to shift to 24/48 V systems for addition of loads like Fridge, Washing machines or kitchen equipment.

Another important aspect of achieving economy is through maintenance that is required for the systems to function effectively. Most of the users are unaware of the problems like hotspot due to dirt, bulging batteries and loss of battery life, which can be avoided by proper care of the system.

To summarize, we can say that more awareness in understanding the specifications, design and maintenance of solar PV system, can further help in reduction of overall installation cost of the PV system. This situation can lead to more penetration of the system and wider acceptance by common people.

RENEWABLE ENERGY – ELIXIR OF INDIAN ENERGY AND ECONOMY SYSTEMS

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"The solar thermal technology when fully exploited in industrial process heat sector holds the potential to save up to 6 to 10 percent of India's oil import"

India is a developing country and energy consumption is predicted to increase with time. The Table 1 indicates the amount of energy needed for eight per cent and nine per cent GDP.

Table 1

Energy Requirement (Billion kWh)			Peak Demand (GW)		Installed Capacity Required (GW)	
GDP growth at	8.0%	9.0%	8.0%	9.0%	8.0%	9.0%
2003-04	633	633	89	89	131	131
2006-07	761	774	107	109	153	155
2011-12	1,097	1,167	158	168	220	233
2016-17	1,524	1,687	226	250	306	337
2021-22	2,118	2,438	323	372	425	488
2026-27	2,866	3,423	437	522	575	685
2031-32	3,880	4,806	592	733	778	960

Source: IMaCS Research

The inferences from the above Table 1 are

1. For 1 per cent increase in GDP 2.845 per cent of increase in energy is required.
2. For the same GDP the energy requirement increases 140.7 per cent (for 8 per cent GDP growth rate) with time.

Although, GDP is monetary value of all the finished goods and services produced within a country's borders in a specific time period, GDP per capita takes a country's production, as measured by GDP and divides it by the country's total population. Due to rapid increase in India's population over time, energy demand also increases with time.

Table 2

FY	Energy (MU)				Peak Demand (MW)			
	Demand	Availability	Shortage	%	Demand	Met	Shortage	%
2002-03	545,983	497,890	48,093	8.8	81,492	71,547	9,945	12.2
2003-04	559,264	519,398	39,866	7.1	84,574	75,066	9,508	11.2
2004-05	591,373	548,115	43,258	7.3	87,906	77,652	10,254	11.7
2005-06	631,024	578,511	52,513	8.3	93,214	81,792	11,422	12.3
2006-07	693,057	624,716	68,341	9.9	100,715	86,818	13,897	13.8
2007-08	737,052	664,660	72,392	9.8	108,866	90,793	18,073	16.6
2008-09	777,039	691,038	86,001	11.1	109,809	96,785	13,024	11.9
2009-10	830,594	746,644	83,950	10.1	118,472	102,725	15,747	13.3

Source: http://www.spartastrategy.com

Whereas for the fiscal year 2011-12 Energy requirement is 853324MU and energy availability is 782124 MU, Energy deficit is 71200MU and deficit per cent is 8.3.

The inference from the Table 2 is

1. Supply keeps increasing with time.
2. Demand keeps increasing with time.
3. Gap between demand and supply also increases with time constantly.

For the fiscal year 2011-2013, deficit per cent has come down to 8.3 which indicates the increasing contribution of renewable energy in the fiscal year 2011-2012 from the Table 3.

Table 3

Growth of Installed Capacity & Percentage share of RES in the Total Installed			
	Total Installed Generating capacity India (MW)	Total Installed RES Generating capacity (MW)	% of Total Capacity
As on 31.03.1990	63636	18	0.03
As on 31.03.1992	69065	32	0.05
As on 31.03.1997	85795	902	1.05
As on 31.03.2002	105046	1658	1.58
As on 31.03.2007	132329	7761	5.86
As on 31.03.2008	143061	11125	7.78
As on 31.03.2009	147965	13242	8.95
As on 31.03.2010	159398	15521	9.74
As on 31.03.2011	173626	18455	10.63
As on 31.03.2012	199877	24503	12.26
As on 31.03.2017	318414*	54503**	17.12

Source: http://www.cea.nic.in

To reduce the gap between demand and supply for energy, demand has to be reduced by switching over to energy efficient or increasing supply through renewable energy sources.

With reference to India, the potential and generation of Renewable energy sources are listed in the Table 4.

Renewable Energy sources	Potential (MW) Table 4	Generation (MW)
Wind	49130	19,564.95
Solar	50000	1891.3
Biomass	25245	4190.04

Sources:www.mospi.gov.in and http://www.mnre.gov.in/

In fact, still there is a difference existing between the installed capacity and generation capacity. The reasons are to be analyzed and solved. The Table 4 shows that only 25646.29 MW of biomass, wind and solar are utilized. This reduction in actual energy produced is because of the varying Plant Load Factor (PLF) values for each type of renewable energy generation sources.

The utilization of full renewable energy sources will become marginally high, if there is a change in

1. Technology.
2. Policy.
3. Marketing.
4. After-sales services.

Unfortunately, anyone of the above four aspects is only to the level of satisfaction for any renewable energy system. For example, although in solar cookers, technology is well developed due to insufficient marketing and after-sales services, contribution of solar cookers to the renewable energy system is very low. Similarly, power generation by solar thermal route doesn't have significant impact due to under-developed technology. The capital cost of power generation by solar thermal route will have less than half the cost of the solar photovoltaic system available currently. It has a potential to save about 25 to 100 per cent of process heat in industrial units.

The solar thermal technology when fully exploited in industrial process heat sector holds the potential to save up to six to ten percent of India's oil import.

If efforts would be applied with reference to improve all the four aspects, as a whole, the cost of renewable energy system will come down, facilitating more demand for renewable energy system which will further lead to huge commercial production providing ecofriendly atmosphere.

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MADRAS MANAGEMENT ASSOCIATION Trichy Chapter

The Subsidy Buzz – What are we eligible for?

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"If a manufacturer claims that they can provide subsidy without availing proper documentations, then, the cost subsidy offered by the manufacturer may be untrue and it will have direct consequences on the quality of the components and safety of the end-user."

Being responsible citizens, we intend to switch over to Renewable Energy. But, at the time of our purchase, the following are our questions after conversing with the product seller or manufacturer:

1) How much is the subsidy?
2) Is it applicable for the Total Cost of the Renewable Energy system?
3) Should I pay the retail price upfront and claim the amount later? Or do the manufacturer or reseller claim on my behalf?

The subsidy is worth few thousand rupees for domestic installations to lakhs of rupees for commercial installations.

1) What is the subsidy for?

The Ministry of New and Renewable Energy (MNRE) promotes the wide spread of renewable energy devices and installations through Financial Assistance for the end users.

MNRE Subsidy Formula

a) Capital Subsidy – 30 per cent on the cost of Solar Energy Trapping Devices. This can be claimed from the MNRE for Solar Panels in Power generation systems and Flat Plate Collectors in Solar Water heaters.
b) Balance of Systems such as Power conditioning units, Panel mounting structures, batteries and installation fee in the Power Generation systems and Storage water tank, pipe lines and plumbing fee in the Solar Water Heaters shall be borne by the end users. MNRE is encouraging banks to provide soft loans at an interest of five per cent per annum.

Subsidy for Solar Power Generation Devices

The following Table 1 shows the boundary conditions based on which an end user is eligible for claiming subsidy from the MNRE.

Table 1 BOUNDARY CONDITION FOR SUPPORT TO OFF-GRID SOLAR PV APPLICATIONS

1.	**Individuals**	**Solar Panel Capacity**	Capital subsidy and interest subsidy
A.	All application except 1B	1 kWp	
B.	Pumps for irrigation and community drinking water	5 kWp	
2.	Non- commercial entities		Capital subsidy and interest subsidy
A.	All application except 2B	100 kWp per site	
B.	Mini-grids for rural electrification	250 kWp per site	
3.	Industrial /commercial entities		Capital subsidy or interest subsidy
A.	All application except 3B	100 kWp per site	
B.	Mini-grids for rural electrification	250 kWp per site	

If an end user is eligible under one of the boundary conditions given in Table 1, the 30 per cent Capital subsidy shall be provided based on a benchmark value as shown in Table 2 which shall be revised by the MNRE based on the market conditions.

TABLE 2

Scale of Capital Subsidy		
Based on benchmarking annually	Rs. 90/Wp	With Battery Storage
	Rs. 70/Wp	Without Battery Storage
Scale of Interest Subsidy		
	Soft loan @ 5% p.a	Eligible Loan Amount = Total Project Cost – Capital Subsidy Amount – Promoter/End User Contribution

Use of the best/competitive and innovative technologies available globally would be allowed, subject to standard and technical parameters, laid down by MNRE.

For Rural Electrification Projects and stand alone rural SPV power plants with battery storage in a micro grid mode/ local distribution network, a Capital Subsidy of Rs.150/Wp and a soft loan at five per cent shall be applicable.

Subsidy for Solar Heating Devices

For Solar heating devices, the subsidy shall be calculated based on the sunlight trapping surface area of the Collectors. In a typical Solar Water Heating product, the Sun's rays are collected using a Flat Plate Collector or an Evacuated Tube collector. In either case, Capital subsidy is calculated based on the active surface area utilised for absorbing sunlight for heating the water.

The Table 3 lists the boundary conditions for Solar Thermal Devices based on which an end user is eligible for claiming subsidy from the MNRE.

Table 3 BOUNDARY CONDITION FOR SUPPORT TO OFF-GRID SOLAR THERMAL APPLICATIONS

S.NO.	SOLAR COLLECTOR TYPE	CAPITAL SUBSIDY/COLLECTOR AREA (Rs. /Sq.m.)
1	Evacuated tube collectors (ETCs)	3000
2	Flat plate collectors (FPCs) with liquid as the working fluid	3300
3	Flat plate collectors with air as the working fluid	2400
4	Solar collector system for direct heating applications	3600
5	Concentrator with manual tracking	2100
6	Non imaging concentrators	3600
7	Concentrator with single axis tracking	5400
8	Concentrator with double axis tracking	6000

Based on the applicable type of Collectors, Capital subsidy would be computed based on the collector area involved in a given solar thermal application/ project.

Besides the capital subsidy as proposed above, the pattern of support also includes a soft loan at five per cent, for balance of systems cost which may comprise installation charges, cost of civil work for large systems and costs of accessories (viz. insulating pipeline, electric pump, controllers and valves, additional water tanks, blower for air heating systems, drying trays for solar dryers, steam system).

For standalone / co-generation mode of thermal energy projects in un-electrified rural areas, a capital subsidy of 60 per cent and a soft loan at interest rate five per cent per annum shall be claimed by the project developer.

1) Eligibility for Subsidy on Technical Grounds for Solar PV Modules

In order to claim the Capital Subsidy from MNRE, it is equally important that the end user is aware of the minimum technical requirements that the installed energy trapping devices need to meet. Failing to meet these technical compliances may result in rejection of subsidy claim.

Technical Compliances for Solar PV Power Generation Devices.

The MNRE has listed the minimum technical standards (refer Table 4,5,6) for each and every module used to build up a Solar PV Power Generation System.

These requirements and standards recommended by the MNRE ensure that

i) the end user installs a system which is technically superior to deliver maximum return on investment

ii) creating a real value to the eco-system to offset/reduce the emissions as intended

iii) maximum safety to the end user during

Table 4 IEC / equivalent BIS Standards for PV module design qualification and type approval

Crystalline silicon terrestrial PV modules	IEC 61215 / IS14286
Thin Film terrestrial PV modules	IEC 61646
Concentrator PV modules and Assemblies	IEC 62108

Table 5 IEC Standards for PV module for construction, testing and safety qualification

Crystalline silicon terrestrial PV modules	IEC 61730 part 1 [Construction] & IEC 61730 part 2 [Testing / Safety]
Thin Film terrestrial PV modules	
Concentrator PV modules & Assemblies	

Table 6 IEC Standards for PV module for Salt Mist Corrosion Testing

Crystalline silicon terrestrial PV modules	IEC 61701
Thin Film terrestrial PV modules	
Concentrator PV modules & Assemblies	

Balance of System (BOS) Items / Components

The Balance of Systems items / components of the SPV power plants/ systems deployed must conform to the latest edition of IEC / equivalent BIS standards as in Table 7.

Table 7

BoS item/ Component	Applicable IEC/equivalent BIS Standard	
	Standard Description	**Standard Number**
Power Conditioners/ Inverters*	Efficiency measurements Environmental Testing	IEC 61683 IEC 60068 2(6,21,27,30,75,78)
Charge Controller /MPPT Units*	Design Qualification Environment Testing	IEC62093 IEC 60068 2(6,21,27,30,75,78)
Storage Batteries	Generation Requirements &Methods of Test	IEC 61427
	Tubular Lead Acid	IS 1651/IS 13369
	Valve Regulated Lead Acid (VRLA)**	IS 15549
Cables*	General test and measuring methods PVC insulated cables for working Voltages up to and including 1100V- Do-, UV resistant for outdoor installation	IEC 60189 IS 694/IS 1554 IS/IEC 69947
Switches/ CircuitBreakers/ Connectors	General Requirements Connectors-Safety	IS/IEC 60947 Part I, II, III EN 50521
Junction Boxes/Enclosures	General Requirements	IP 65 (for outdoor) IP 21 (for indoor) IEC 62208
SPV System Design	PV Stand-alone System design verification	IEC 62124
Installation Practices	Electrical installation of building Requirements for SPV power supply system	IEC 60364-7-712

*Must additionally conform to the relevant national / international Electrical Safety Standards.

Reference MNRE addendum No. 32/49/2010-11-PVSE dated 19.08.2010.

1. Warranty

i) The mechanical structures and BoS electrical components and works must be warranted against any manufacturing /design/ installation defects for a minimum period of 5 years.

ii) PV modules used in solar power plants must be warranted for their peak performance, which should not be less than 90 per cent at the end of 10 years and 80 per cent at the end of 25 years.

Identification and Traceability

Each PV module used in any solar power project must use an RF identification tag (RFID), which must contain the following information.

(i) Name of the manufacturer of PV Module
(ii) Name of the manufacturer of solar cells
(iii) Month and year of the manufacture (separately for solar cells and module)
(iv) Country of origin (separately for solar cells and module)
(v) I-V curve for the module
(vi) Peak wattage, Im, Vm and FF for the module
(vii) Unique serial No and model No of the module
(viii) Date and year of obtaining IEC PV module qualification certificate
(ix) Name of the test lab issuing IEC certificate
(x) Other relevance information on traceability of solar cells and module as per ISO 9000 series.

Technical Compliances for Solar Thermal Devices

The MNRE has listed the following minimum technical specification as in Table 8 for a Solar Thermal System.

Table 8

Solar Flat Plate Collectors	Requirements	IS 12933 (Part-1):2003
	Components	IS 12933 (Part-2):2003
	Measuring Instruments	IS 12933 (Part-3):2003
	Test Methods	IS 12933 (Part-5):2003
Box-Type Solar Cookers	Requirements	IS 13429 (Part-1):2000
	Components	IS 13429 (Part-2):2000
	Test Methods	IS 13429 (Part-3):2000

Note : These standards do not apply for Concentrated Solar Power [CSP] Collectors.

General Requirement

i) The PV modules and Thermal Collectors must be tested and approved by one of the IEC authorized test centres, NABL/ BIS Accredited Testing / Calibration Laboratories.

ii) Test certificates for the BoS items/ components can be from any of the NABL/ BIS Accredited Testing Calibration Laboratories /MNRE approved test centres.

Now, the final checklist to the prospective end user / developer is that

1) Check if your supplier provides copies of all relevant test certificates for the products / components.
2) Without being compliant to any of the above technical specifications, a product manufacturer cannot claim 30 per cent subsidy from the MNRE, either directly or on your behalf.
3) If a manufacturer claims that they can provide subsidy without availing proper documentation, then, the cost subsidy offered by the manufacturer may be untrue and it will have direct consequences on the quality of the components and safety of the end-user.

And that's where the buzz word stops!

Source: http://www.mnre.gov.in/

RELEVANCE OF ROOFTOP SOLAR POWER

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The need forelectricity is increasing throughout India and Solar Power is one of the best Renewable Energy Sources. Rooftop Solar System can provide great opportunities for residences, offices, institutions, hospitals, industries, irrigation and other commercial segments. We can easily adopt Solar Power Systems for the buildings who have already installed Inverter and Battery systems. Solar Power has a very good Return on Investment (ROI). A typical office using 50computers, 50Tube Lights and 50Fans with Diesel Generator backup and with an average expense of Rs.20,000/- per month as diesel bill,will have the payback period of less than 3years, by migrating to Solar Power from the existing UPS and battery back-up.

Solar Power is expensive with bulkbase load power. However, it provides electricity where ever power is limited and expensive. Offices, Residences and Industries having enough Roof Top space can show their green credentials, while solving the Energy crisis problem for their consumption. Since, land prices are drastically being increased day by day; Roof Top is the best way to put up Solar Power Plants which may not be used for any other purpose.

The main obstacle to install Solar Power Plants is its economicviability. TheGovernment helps to tackle this problem by providing subsidies to either the developers or end users to offset huge upfront cost to install Rooftop Solar Power Plant. Apart from subsidy, there are indirect benefits that developers or end users can avail such aslow bank interests andaccelerated depreciation benefits.

Appendix 1: Solar Electricity Generation Equipment Manufacturers List

S.No	Manufacturer	Products Offered			Market Segments Served / Targeted			Website / Contact Details	MNRE Approved	TEDA Approved
		Solar Photo-voltaicPanels	Solar Inverters &Energy Conversion Devices	Battery & Energy Storage Devices	Domestic	Commercial [Up to 100kW]	Megawatt Projects			
1	Solesa Solar Engg.Pvt.Ltd	v	v		v	v	v	www.solesa.in		
2	PACE	v	v	v	v	v		www.pacesolartek.com		
3	Sun Edison	v	v			v	v	www.sunedison.in		v
4	Kaizen Green Technology(P)Ltd	v	v	v	v	v	v	www.kaizengreentech.com		v
5	Chemtrols Solar Pvt.Ltd	v	v		v	v	v	info@chemtrolssolar.com		
6	SunTechEnergreen Industries	v	v	v	v			www.sunenergreen.com		
7	MindaNexGen Tech Ltd	v	v	v	v	v	v	www.mindanexgentech.com		v
8	Grundfos Pumps India Pvt.Ltd	v	v		v	v		salesindia@grundfos.com		
9	IKRA energiPvt.Ltd	v	v	v	v	v	v	www.ikraenergi.com		
10	KCP Solar Industry	v	v	v	v	v	v	www.kcpsolar.com	v	v

(Source: http://www.teda.in/ and http://mnre.gov.in/)

Appendix 1: Solar Electricity Generation Equipment Manufacturers List

S.No	Manufacturer	Products Offered			Market Segments Served / Targeted			Website / Contact Details	MNRE Approved	TEDA Approved
		Solar Photo-voltaicPanels	Solar Inverters &Energy Conversion Devices	Battery & Energy Storage Devices	Domestic	Commercial [Up to 100kW]	Megawatt Projects			
11	INDU Solar EPC Division	v	v	v		v	v	solar@induprojects.com		
12	Metsol Energy India Pvt.Ltd	v	v	v	v	v	v	www.metsolenergy.com		
13	SPM Energy Pvt.Ltd	v	v			v	v	www.spmenergy.com		
14	EMMVEE Photovoltaics	v			v	v		www.emmvee.com	v	v
15	KBP Solar Pvt.Ltd	v	v		v	v	v	www.kbpgroup.in		
16	E Star Engineers.Pvt.Ltd	v	v	v	v	v	v	www.estar.in		
17	USL.Ltd	v	v		v	v		www.uslsolar.com		v
18	KB Electronics	v	v		v					
19	HHV Solar Technologies Pvt.Ltd	v			v			www.hhvsolar.com		
20	NEPC India.Ltd	v	v		v	v	v	solar@nepcindia.co.in		

(Source: http://www.teda.in/ and http://mnre.gov.in/)

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		Solar Photo-voltaicPanels	Solar Inverters &Energy Conversion Devices	Battery & Energy Storage Devices	Domestic	Commercial [Up to 100kW]	Megawatt Projects			
21	IND-Aussie Solar(P)Ltd	v	v	v	v			www.indaussiesolar.com		
22	SS System		v		v			www.ssups.com		
23	JC Batteries	v	v		v			www.jcbattery.net		
24	Vispra Power Controls	v	v		v			www.vispra.com		
25	Aeon Renewable		v		v			www.aeonenergy.biz		
26	Nuevsol	v			v		v	www.nueosol.co.in		
27	KACO Newenergy		v	v	v			www.kaco-newenergy.de		
28	Gamesa Electric	v	v		v	v		gamesaelectric@gamesacorp.com		
29	Ready Solar & LED Pvt.Ltd			v	v	v		www.readysolararandled.com		
30	Hegemon Technology			v	v	v		www.advantagemep.com		

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S.No	Manufacturer	Products Offered			Market Segments Served / Targeted			Website / Contact Details	MNRE Approved	TEDA Approved
		Solar Photo-voltaicPanels	Solar Inverters &Energy Conversion Devices	Battery & Energy Storage Devices	Domestic	Commercial [Up to 100kW]	Megawatt Projects			
31	Glazer Pvt.Ltd			v	v			Marketing@glazerindia.com		v
32	SHAN Solar	v			v	v		www.shansolar.com		
33	Scorpius Trackers	v			v	v		www.scorpiustrackers.com		
34	Juwi India Pvt.Ltd	v				v			v	
35	Duron Solar		v		v			www.duronsolar.com		
36	Bonfiglioli Photovoltaic	v	v		v					
37	Evergreen Solar System India	v	v		v	v		md@evergreensolar.in		v
38	Powerone Micro Systems.P.Ltd	v	v		v	v		bsgowda@poweroneups.com		v
39	Nordiac India	v			v	v		www.nordiacindia.com		v
40	MAS Solar System.Pvt.Ltd	v	v	v	v	v		marketing@massolarsystems.com		v

(Source: http://www.teda.in/ and http://mnre.gov.in/)

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S.No	Manufacturer	Products Offered			Market Segments Served / Targeted			Website / Contact Details	MNRE Approved	TEDA Approved
		Solar Photo-voltaicPanels	Solar Inverters &Energy Conversion Devices	Battery & Energy Storage Devices	Domestic	Commercial [Up to 100kW]	Megawatt Projects			
41	Jain Irrigation Systems Ltd	v	v	v	v	v		solar@jains.com	v	v
42	Olive Exports Pvt.Ltd			v	v	v		www.oliveled.in		
42	Novus Green Pvt.Ltd		v		v	v		www.novusgreen.in		
43	Prosun Energy Pvt Ltd	v	v	v	v	v		info@prosunindia.com		v
44	Nova Energy Corp.,			v	v	v		sales@novaenergycorp.in		v
45	AargeeEquipmentsPvt.Ltd			v	v	v		ups@aargee.net		v
46	KL Solar Company Pvt Ltd			v	v	v		info@klsolar.com		v
47	Bharat Electronics.Ltd			v	v	v		rochn@bel.co.in		v
48	JagathJothi Solar Energy (P)Ltd			v	v	v		jagathjothi@airtelmail.in		v
49	Kripa Telecom			v	v	v		vm@mic.co.in		v
50	Green Wind and Solar Pvt.Ltd			v	v	v		ceo@kripatelecom.org		v

(Source: http://www.teda.in/ and http://mnre.gov.in/)

Appendix 2: Solar Heating Equipment Manufacturers List

S.No	Manufacturer	Products Offered		Market Segments Served / Targeted		Website / Contact Details	MNRE Approved	TEDA Approved
		Solar Water Heaters	Concentrated Heat Collectors	Domestic	Commercial			
1	V-Guard Industries Limited	v		v	v	chennai@vguard.in	v	v
2	Racold Thermo Ltd.,	v		v	v	www.racold.com	v	v
3	Jain Irrigation Systems Ltd.,	v				solar@jains.com	v	v
4	SoltechEquipments	v		v	v	www.soltechindia.com		v
5	Venus Home Appliances (P) Ltd	v		v	v	contact@venusappliances.com		v
6	Sun Max Energy SystemsPvt. Ltd	v		v	v	sunmax_solar@rediffmail.com		v
7	Vesat Solar Products	v	v	v	v	info@vesatsolar.com	v	v
8	MINDA Industries Ltd	v	v	v	v	pgeoffrey@mindagroup.com		v
9	Glazer Pvt.Ltd	v	v	v	v	Marketing@glazerindia.com		v
10	Agni Solar Systems	v		v		agnigreen@gmail.com		v
11	Prosun Energy Pvt Ltd	v	v	v	v	info@prosunindia.com		v
12	Cascade HelioThermics Ltd	v	v	v	v	info@visitcascade.com		v

(Source: http://www.teda.in/ and http://mnre.gov.in/)

About Madras Management Association

Madras Management Association (MMA) was established in 1956 with the prime objective of promoting management education, training and development activities in this part of the country. The vision of MMA is "To be the Fountainhead of Worldclass Management Excellence in India".

Over the past 5 decades, MMA has striven for development and nurturing management expertise, combining Indian ethos with International Management thoughts and practices.

Madras Management Association is the largest affiliate association of All India Management Association (AIMA) in the country and has been awarded “National Excellence Award” for the year 2007-08 for winning the Best Local Management Association in India for five consecutive years. MMA has also been adjudged as the Best Local Management Association by AIMA for the year 2009-10, 2010-11 & 2011-12.

Apart from corporate leaders, MMA has, in its Managing Committee, the Vice Chancellors of Madras University & Anna University, the Directors of IIT Madras and IFMR and the Chief Secretary, Government of Tamilnadu, as members.

About Konrad-Adenauer-Stiftung

The Konrad-Adenauer-Stiftung (KAS) is a political foundation. German political foundations are unique throughout the world. No other institutions provide the same expertise in the field of democracy building. The Konrad-Adenauer-Stiftung is committed to fostering democracy and the rule of law, to implementing social and market-economic structures and to promoting human rights. With its worldwide networks of political and social leaderships and with its long-term partner structures, it participates in shaping policy in developing and emerging countries. The foundation's headquarters are situated in Sankt Augustin near Bonn and in Berlin/Germany. Currently the KAS hosts more than 200 projects in around 120 countries on four continents with 81 field offices.

India was one of the first countries in Asia in which the Konrad-Adenauer-Stiftung started its activities. In more than 40 years of cooperation, a wide range of activities were covered. Specifically, the KAS offers to contribute towards

- assisting India in its process of social, structural and political transformation based on democracy, the rule of law and secularism
- strengthening economic reforms, the small and medium business sector and an effective market economy
- supporting the integration of India into the global economy and the process of globalization
- promoting local self-governance in rural areas and fostering grass root democracy
- intensifying the dialogue between Germany, Europe and India as well as other major powers
- promoting the development of the media