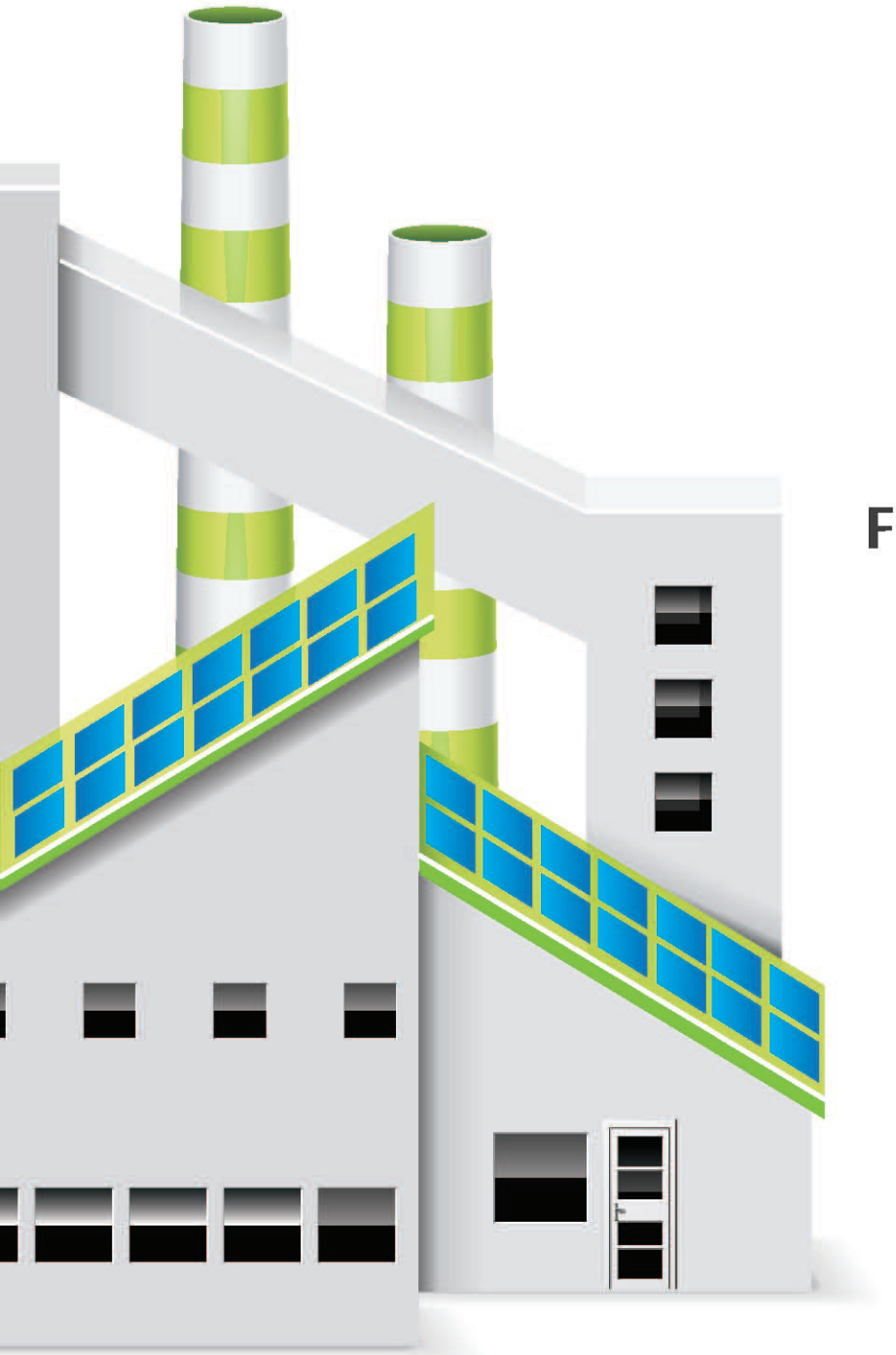
EAI
catalyzing cleantech in India

India Rooftop Solar Guide & Vendor Showcase



SOLAR POWER FROM YOUR ROOFTOP

A STEP BY STEP GUIDE

Cost of Implementing Rooftop Solar

Rooftop Solar Vendor Details

Latest Innovations in Rooftop Solar

Preface

The Indian ground mounted, utility scale solar power industry is growing at a furious pace in the last three years. From almost nil installed capacity prior to 2010, the total installed capacity of solar power is over 2,000 MW pan India. An impressive achievement indeed.

In parallel, the rooftop solar sector has started accelerating too, especially in the last 12 months. The falling solar panel and installation price, coupled with increasing grid tariffs especially for industrial and commercial consumers, has made solar power an attractive option for consumers. Significant load shedding and ceilings on power withdrawals during peak load periods have also made many of these units resort to diesel gensets. The high cost of diesel based power and the decreasing costs of solar are making these units eye rooftop solar as an important solution for energy security and operational cost reductions.

While reliable data is hard to come for the rooftop sector, EAI estimates that total rooftop solar additions in the last 3 years alone could top 150 MW. No mean achievement, given that the average rooftop installation would be in the range of 10 Kw, implying that there have been over 15,000 rooftop solar installations, up from practically nothing before that.

All these augur well for this sector. As a result, we also see a number of companies both small and large providing solutions for the rooftop solar sector. This has motivated EAI to bring forth this comprehensive guide on this sector, the first of its kind for India.

We hope that this guide provides useful insights and data for those keen on having a solar system on their rooftop.

All the best!

Narasimhan Santhanam
Cofounder & Director
Energy Alternatives India - **www.eai.in**

EAI

Solar Mango

Everything about Rooftop Solar

Are you a Commercial or Industrial unit looking to have rooftop solar?

Making mistakes in rooftop solar can be costly. Talk to us first!

TAKE EAI'S **FREE EXPERT ASSISTANCE** BEFORE YOU MAKE YOUR **INVESTMENT**

Solar Assist is a consultation service provided by the rooftop solar experts at EAI's Solar Mango division. At the end of this consultationsession you get the following:

- Clear estimate of the solar power plant capacity you will require
- Realistic estimate of the costs
- Details of technical architecture and latest innovations
- Guidelines to significantly reduce diesel consumption using solar
- Suggestions on suitable vendors

You get all the above inputs at no cost!

Interested?

Send an email to
enquiry@solarmango.com

www.solarmango.com

Gold Sponsors

MITRA MAX™

SOLTECH EQUIPMENTS
Solar Power Solutions

Ganges Internationale
TOWERING EXCELLENCE™

GautamSolar
Formerly Gautam Polymers
pvt limited

InfiniteERCAM®
Harvesting the Sun

Silver Sponsors

SOLAR TOWN

Evervolt
energy that lasts forever

M+ SOLAR

CONTURA SOLAR
Matching the energy needs

Silver Sponsors

Other Advertisers

Contents

Introduction **7**

1. Reasons for Industrial/Commercial sector and Domestics Going for Rooftops **9**

1.1 Unreliable supply of grid power 9
1.2 Cost of Power 10
1.2.1 Industrial/Energy Consumers 10
1.2.2 Residential Consumers 10
1.2.3 Grid Tariffs in Indian Cities for Industrial, Commercial, and Residential consumers 10
1.2.4 Very high cost of diesel power 12
1.3 Issues to be considered 13
1.3.1 For industrial/commercial consumers 13
1.3.2 For residential consumers 13

2. Simple Steps for You to Have Your Own Solar Rooftop **17**

2.1 Lay down the purpose for which the solar plant is desired 17
2.2 Estimate the amount of energy required from the solar plant 17
2.3 Identify the amount of shade-free rooftop area available/required for installation 20
2.3.1 Factors affecting roof area required by rooftop solar PV plants 20
2.3.2 Other considerations 23
2.4 Speak to vendors and obtain quotations for your requirement 23
2.5 Evaluate vendor quotations based on price, warranties, and vendor credentials before finalising the vendor 23
2.5.1 Price 24
2.5.2 Warranties 24

3. Cost Economics of Solar Rooftop **27**

3.1 Component cost of rooftop PV systems 27
3.2 Incentives/Subsidies 28
3.2.1 Accelerated Depreciation (AD) 28
3.2.2 MNRE Subsidy 28
3.3 Final cost of Rooftop PV system factoring in AD and Subsidies 31
3.4 Variations in pricing 32

4. Components of a rooftop solar system **34**

4.1 Basics of rooftop Solar PV 34
4.2 Components of a rooftop solar PV plant 34
4.2.1 PV modules (panels) 35
4.2.2 Inverters 35
4.2.3 Mounting structures 36
4.2.4 Batteries 37
4.2.5 Charge Controllers 39
4.3 Maintenance of rooftop solar PV systems 40
4.4 How long does it take to install a rooftop PV system? 40

5. Best Regions for Solar Rooftops **43**

5.1 Factors affecting rooftop solar plant output 43
5.1.1 Location 43
5.1.2 Orientation 44

5.1.3 Ambient Temperature....45
5.2 Approximation of PV plant output....45
5.2.1 PV plant outputs in different states for different roof areas....46

6. Innovations in Rooftop Solar....48

6.1 Technology innovations....48
6.1.1 Non-penetrating mounting structures....48
6.1.2 Elevated mounting structures....48
6.1.3 East-West layout....48
6.1.4 Diesel substitution....48
6.1.5 Critical load support....48
6.2 Commercial innovations....48
6.2.1 Build Own Operate (Transfer) – BOO(T)....48

7. Warranties and Certifications....51

7.1 Typical Warranties and Certifications....51
7.1.1 Solar Panels....51
7.1.2 Inverters....51
7.1.3 Mounting structures....51
7.1.4 Batteries....51
7.1.5 Charge Controller/MPPT units....52
7.1.6 Cables....52
7.1.7 Junction Boxes/Enclosures for Inverters/Charge Controllers/Luminaries....52
7.2 Expected lifetime of rooftop PV plant components....52
7.2.1 Examples of component failure....52

8. Prominent Solar Rooftops....55

- Alpine Knits (Tirupur, Tamil Nadu)....55
- L&T (Chennai, Tamil Nadu)....55
- Sri Vishnu Educational Society (West Godavari, Andhra Pradesh)....55
- Thermax (Pune, Maharashtra)....55
- J Mitra Associates (New Delhi)....55
- Scope International (Chennai, Tamil Nadu)....55
- TTK Prestige (Coimbatore, Tamil Nadu)....55
- Engineers India Ltd (Gurgaon, Haryana)....56
- Indian Institute of Technology – Madras (Chennai, Tamil Nadu)....56
- Parliament House (New Delhi)....56
- Mahindra World City (Chennai, Tamil Nadu)....56
- Sunderlal Jain Hospital (New Delhi)....56
- Stella Maris College (Chennai, Tamil Nadu)....56
- Indian Institute of Science and Education Research (Mohali, Punjab)....56

Rooftop Vendor Directory....57

About EAI....70

Introduction

Rooftop solar power is being increasingly embraced by commercial, industrial, and residential consumers as a significant contributor to their energy mix because it combines

- On-site generation of power
- Utilising unused rooftop space
- Reasonable cost

Generating power on-site frees the consumer from being at the mercy of grid failures and even load shedding as the solar plant is not dependant on grid infrastructure to deliver its power to the load. In this sense a solar plant is similar to a diesel generator, but without the associated noise and emissions.

Rooftop space is often left unutilised in many establishments; installing a solar plant on the roof is a great way to derive additional value from your building.

Depending on the tariff regime, solar power may be cheaper than even grid power for some consumers.; it is much cheaper than diesel power for all consumers, and offers the added advantage of fixing the cost of power for the next 25 years – a rooftop solar plant that delivers power at a levelised cost of Rs. 7.5/kWh today will deliver power at the very same cost 25 years from now.

In addition, solar plants have no moving parts and are therefore very reliable, requiring minimal maintenance expenditure or downtime.

While the advantages of rooftop solar power are undeniable, some constraints should be considered as well, such as solar power being generated only during daytime, or lack of sufficient rooftop space limiting the size of solar plant that can be installed.

The following chapters of this guide explore both the advantages and constraints of rooftop solar power, and provide the critical inputs that you would require in understanding how rooftop solar can make a difference to your organisation.

Chapter 1

Reasons for Industrial/Commercial sector and Domestics Going for Rooftops

1. Reasons for Industrial/Commercial sector and Domestics Going for Rooftops

The increased interest in rooftop solar power, from the Industrial/Commercial sectors as well as Residential, is primarily driven by two factors.

- **Unreliable supply of grid power (frequent load shedding as well as power quality issues)**
- **Cost of power**
  - **Increasing cost of grid power**
  - **Very high cost of diesel power**

1.1 Unreliable supply of grid power

India suffers from a power deficit of 9-10% of peak demand, which has resulted in poor power quality and productivity losses for businesses. It is estimated that industries in Andhra Pradesh alone have suffered losses of Rs. 30,000 Cr between September 2012 and April 2013 due to the power crisis. The power shortages comprise:

a. Peak power deficit (MWs of capacity)
   i. India's overall peak power deficit in 2012 was 9.4%
   ii. Southern states had the maximum deficit of nearly 18.0%
   iii. Northern regions of the country suffered a deficit of 8.9%

b. Energy deficit (MWhs of energy generated)
   i. India's overall energy deficit in 2012 stood at 8.7%
   ii. Southern states experienced the highest deficit of 15%

The power deficits are caused by

1. Non availability of fossil fuels at acceptable rates
2. Decreasing financial health of the State DISCOMS
3. Delay in commissioning of power projects

The issues surrounding each of these are complex, and are not likely to be resolved immediately. We expect the power deficit to continue in the 8-9% region for the foreseeable future. This shortage of power has significant ramifications for both businesses and residences.

1.2 Cost of Power

Rooftop solar power costs about **Rs. 7.5-8/kWh**[1] and is a cost-effective alternative for energy consumers where

a. The grid tariff is higher than the levelised cost of solar power
b. Diesel generators are frequently used
c. The depreciation on the solar plant (at 80%) can be claimed against taxable profits

Rooftop solar power costs about Rs. 7.5-8/kWh

Based on these parameters, we can classify energy consumers as:

1.2.1 Industrial/Energy Consumers

This category of consumers are likely to be charged higher grid tariff and/or are likely to generate power from diesel, and can claim depreciation against profits.

- **A Commercial Consumer in Mumbai consuming greater than 500 kWh of grid power in a billing cycle will pay Rs. 11.91/kWh which is much more expensive than rooftop solar power**

1.2.2 Residential Consumers

These consumers typically pay a lower tariff for grid power than industrial/commercial consumers, are less likely to consume significant quantities of diesel for power generation, and cannot claim depreciation as they don't generate profits.

- **An LT I Residential Consumer in Mumbai consuming less than 100 kWh in a billing cycle will pay Rs. 3/kWh (drawing from BEST utility) which is cheaper than the cost of rooftop solar power**

Despite the above, it should be noted that some residential consumers may benefit from rooftop solar power depending on the quantum of power consumed.

1.2.3 Grid Tariffs in Indian Cities for Industrial, Commercial, and Residential consumers

The table below gives a comparison of grid tariffs for different categories of consumers across 5 Indian cities.

[1] *Levelised cost calculated as the cost per unit of power generated, taking into account all costs incurred over the lifetime of the plant adjusted for time value of money.*

Sample State-City grid tariff comparison (Rs./kWh)					
	Industrial/Commercial			Residential	
State-City	Category	Industrial Tariff (Rs.)	Commercial Tariff (Rs.)	Consumption	Tariff (Rs.)
Andhra Pradesh – Hyderabad					
	11 kV	7.42	7.42		
	33 kV	6.77	6.77		
	132+ kV	6.51	6.51		
				50 kWh	2.01
				200 kWh	4.33
				400 kWh	5.72
				600 kWh	6.54
Gujarat – Ahmedabad					
	500 kVa	4.67	4.37		
	500-2,500 kVa	5.00	4.70		
	> 2,500 kVa	5.10	4.80		
				50 kWh	4.92
				200 kWh	4.61
				300 kWh	4.89
Karnataka – Bangalore					
	1-1,00,000 kWh	5.62	7.30		
	>1,00,000 kWh	6.04	7.61		
				1-30 kWh	8.40
				31-100 kWh	5.24
				101-200 kWh	5.17
				201+ kWh	5.49
Maharashtra – Mumbai					
	Express feeder	7.32	11.91		
	Non Express feeder	6.58	11.18		
	Seasonal	8.17			
				100 kWh	5.65
				300 kWh	5.44
				500 kWh	7.10
				600 kWh	7.07
Tamil Nadu - Chennai					
		5.98	7.61		
				99 kWh	1.30
				199 kWh	1.70
				499 kWh	2.76
				600 kWh	4.13

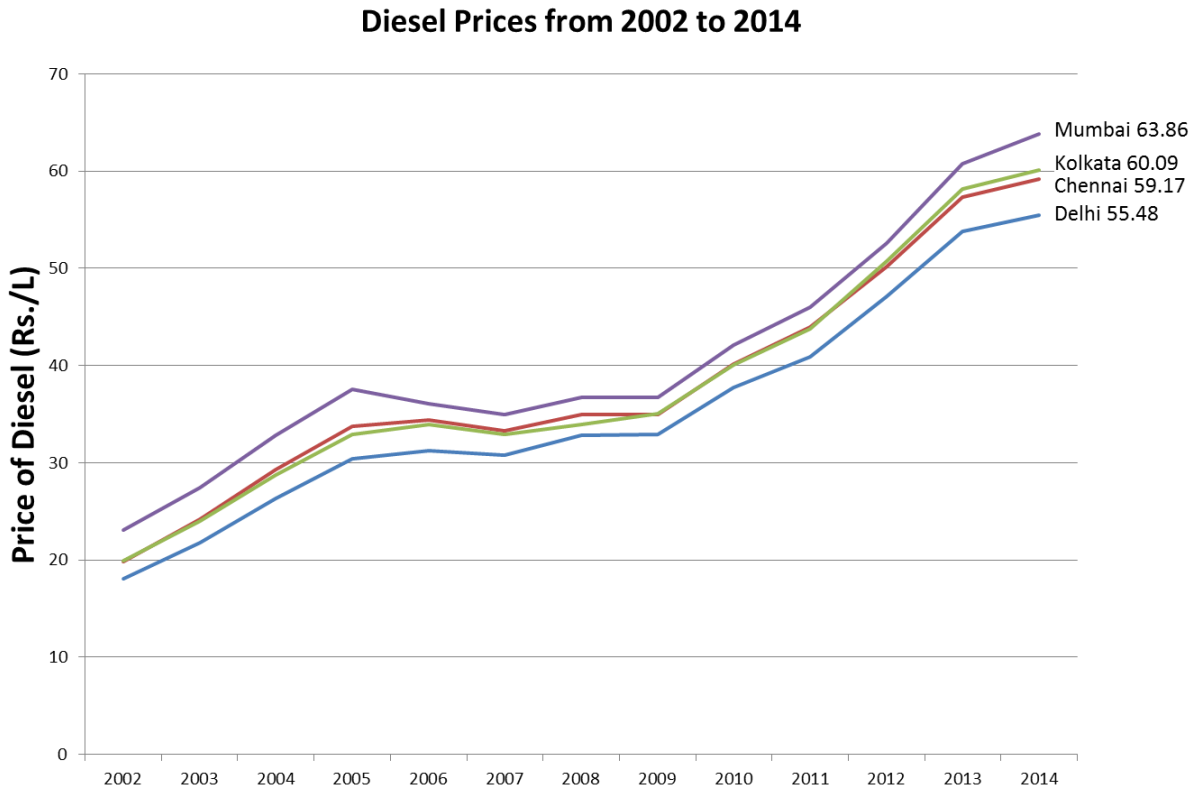
Note: *The above tariffs are only indicative and calculated as an average for each type of consumer. Actual tariffs vary based on several factors such as supplying utility and proportion of variable to fixed charges.*

As can be seen, some consumers at certain locations can save immediately from rooftop solar. It should be noted that the cost of solar power is fixed for the next 25 years while the cost of grid power will continue to increase, thereby increasing the savings from a solar PV plant in the future.

1.2.4 Very high cost of diesel power

Compared to solar power's **Rs. 7-8.50/kWh**, diesel generators generate power at about **Rs. 16/kWh** (a litre of diesel generates around 3-4 kWh). Diesel power can be even more expensive once other losses such as pilferage, evaporation, etc. are considered. In some applications, such as rural telecom towers, diesel power can cost as much as Rs. 40/kWh!

The cost of diesel power has seen a steep increase over the last 12 years, shown in this chart:



A price increase of around 210% since 2002 and 145% since 2010 is serious cause for concern for many businesses and residences that depend on diesel power. If the price were to increase by 10% a year (which has been the trend), **diesel would cost about Rs. 68/litre in 2015 and the cost of power from diesel would be close to Rs. 20/kWh!**

This continuing upward trend in cost of diesel power makes a compelling case for residences and industrial/commercial units that consume a lot of diesel to switch to solar power.

1.3 Issues to be considered

1.3.1 For industrial/commercial consumers

- **Nature of load –** If the load includes equipment that requires heavy starting current (such as manufacturing machinery) a much larger solar installation may be required
    - Alternatively, the solar plant may be balanced against grid power/diesel power to meet part of the load using a hybrid inverter

- **Variations in load –** If the load fluctuates during the day (such as some machinery being turned off during lunch time) and if the solar plant is integrated with a diesel genset, regulation of power output from the solar plant may be required to ensure that solar power doesn't flow into the diesel generator

- **Type of roof –** Industrial and commercial units can have different kind of roofs, some of which may be unsuitable for solar installations
    - Asbestos roofs – These are not suitable for solar installations
    - Metal roofs – Most metal roofs are suitable but some may not permit solar installation
    - Concrete roofs – These are ideal for solar installations, subject to facility specific structural constraints

1.3.2 For residential consumers

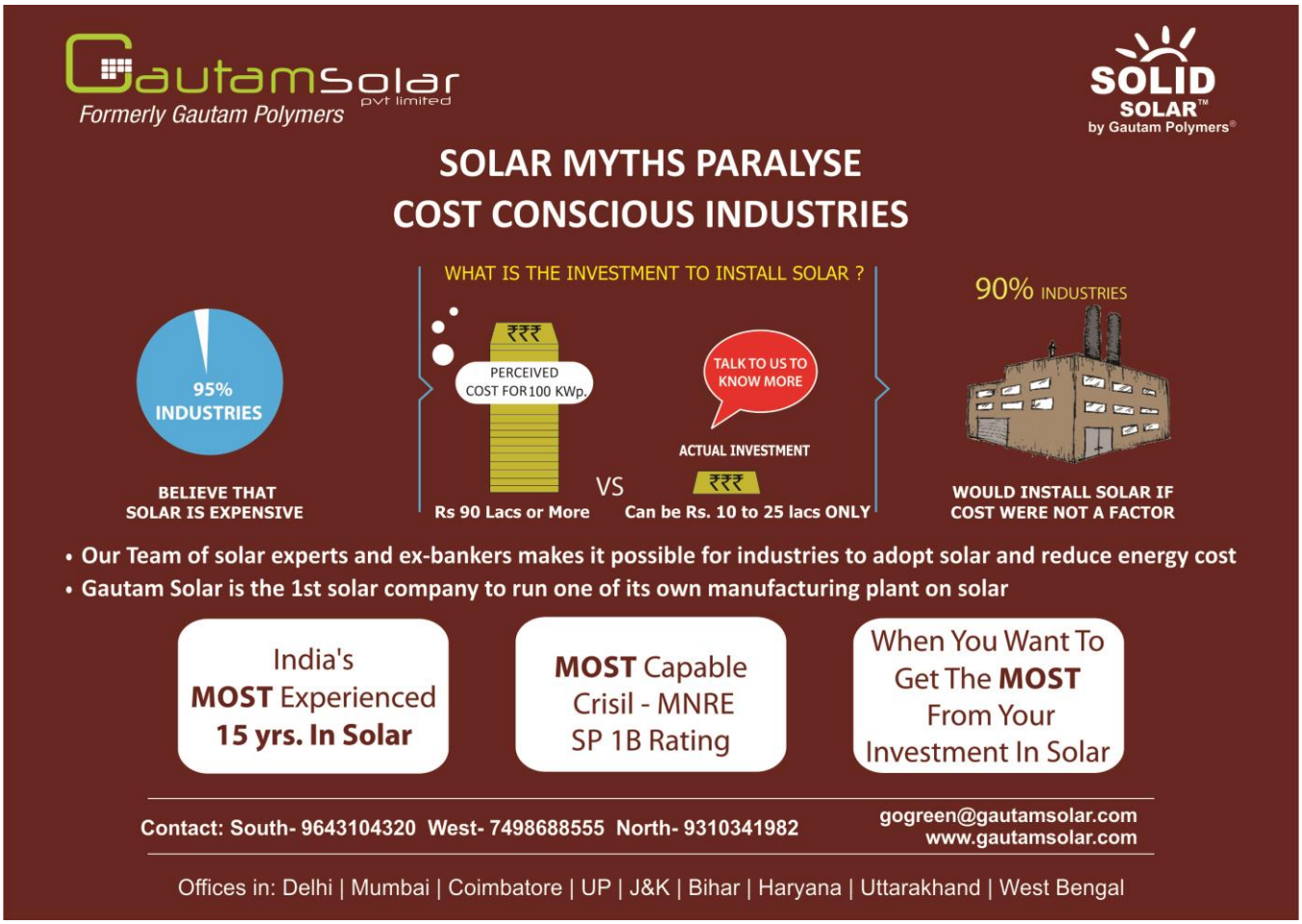
Other than the cost, residential consumers should consider these factors when deciding on implementing a solar solution

- **Nature of load –** If the residential load includes equipment that requires heavy starting current (such as air conditioners) a much larger solar installation may be required
    - Alternatively, the solar plant may be balanced against grid power/diesel power to meet part of the load

- **Timing of the load –** If most of the residents are away from home during the day, which is when the solar power is being generated, a battery pack may be required to supply power during the night. The cost and maintenance of batteries should be included in the evaluation of costs and benefits from the solar plant
    - Alternatively, net metering policies of the state, if any, can be considered to monetise generation during the day

- **Ownership of roof area –** If the roof is considered common area (such as in apartments) permission from the building society may be required for installation

- **Distance from roof to load –** In the case of residential apartments, where the roof may be several floors above the apartment to which the solar power must be fed, DC losses due to the length of cabling from the solar panels should be considered when planning the location of the inverter (that converts DC to AC power)Alternatively, thicker cabling can be used to reduce the DC loss




M+
SOLAR
Amplus Solar
Get Solar Power with
Zero Capital Investment.
1
On-site Captive Plant under OPEX Model
2
100% Maintenance by Amplus Solar
3
Savings from Day 1
4
Highest standards of safety
Amplus Solar
Your Partner for a Greener World
Visit us: www.amplussolar.com
Contact us: sales@amplussolar.com
Call us: +91 99719 44883
Meet us: Level 6, JMD Regent Square, M.G. Road, Gurgaon, NCR


Get rid of Power Cuts affecting your business with Solar PV cutting down on Diesel Consumption and Trimming Utility Bills over 25 years project life cycle.
Presenting a scalable battery less hybrid power solution combining Solar-Grid-Diesel with Premium Quality Equipments to meet your daily energy consumption in an Uninterruptible manner.
Payback < 4 years
Scalability to any capacity possible
Zero Maintenance Costs
Utilize Empty Rooftops to install Solar PV Plants
Solar Project Costs bound to increase and not decrease as perceived
Rooftop Urja™
'Energy Unlimited'
Rooftop Urja Pvt Ltd
5A, Plot No. 17 18 19 D4, Movva Nest, Nizampet,
Kukatpally, Hyderabad - 500 062.
Cell: 91-98200 39468
Email: info@rooftopurja.in
Web: www.rooftopurja.in

Chapter 2

Simple Steps for You to Have Your Own Solar Rooftop

2. Simple Steps for You to Have Your Own Solar Rooftop

When planning your solar rooftop system, follow these steps to ensure your plant satisfies your needs and provides reliable performance

1. Lay down the purpose for which the solar plant is desired
2. Estimate the amount of energy required from the solar plant
3. Identify the amount of shade-free rooftop area available for installation and estimate the capacity of plant that can be installed
4. Speak to vendors and obtain quotations for your requirement
5. Evaluate vendor quotations based on price, warranties, and vendor credentials before finalising the vendor

2.1 Lay down the purpose for which the solar plant is desired

This is the first and most important step as it forms the basis on which the other decisions can be made. Some of the alternatives before you include

a. **Feeding into the grid –** If the state solar policy permits, power generated from your rooftop can be fed into the grid and payment received based on a Feed-in-Tariff (FIT)
b. **Diesel substitution –** The plant will need to integrate with the diesel generator and the grid power supply, and the inverter should be capable of switching between sources. This solution can be quite complex if multiple diesel generators are used
c. **Off-grid solution –** Used in areas where grid power is absent, this solution requires an off-grid inverter
d. **Night-time usage –** As solar power is generated during the daytime, energy storage solutions will need to be considered as part of the plant

2.2 Estimate the amount of energy required from the solar plant

The amount of energy needed is determined based on the load that needs to be supported. Since we have already determined the scope of the project in step 1 we know what equipment needs to be supported. The load represented by this equipment can be calculated as

Total energy requirement/day (Wh) = Wattage of appliance * No. of appliances * Hours of working

This should be divided by 1,000 to be converted into kWh/day. We can illustrate this formula by calculating the load for a sample home

Appliance	Number	Wattage	Working Hours	Energy (kWh/day)
Lights	8	30	8	1.92
Fans	5	50	8	2.00
TV	1	120	4	0.48
Computer	1	100	4	0.40
Refrigerator	1	300	12	3.60
Charging points	4	100	3	1.20
Total				**9.60**

This home would require 10 kWh of power per day to satisfy the load. At this point the plant designer might wish to identify large/variable loads that need not be supported by solar power or that can be operated through some other power source to reduce the investment in the solar system.

Let us assume that we have limited the load to be supported by the solar PV plant to this:

Appliance	Number	Wattage	Working Hours	Energy (Kwh/day)
Lights	5	30	4	0.6
Fans	2	50	4	0.4
Computer	1	100	2	0.2
Charging points	2	100	3	0.6
Total				**1.8**

System size

This load requires 1.8 kWh/day.

Adding a 30% safety margin to this, and assuming the insolation to be 4kWh/m2/day, we get

System size = (Energy Requirement * 1.3) / insolation level = 1.8 * 1.3 / 4 = 0.585 or 585 Wp.

Panel size

We calculate the panel requirement for this system size assuming we are using 130 kWp panels at 12V.

No. of panels = System size / Panel Rating = 585 / 130 = 4.5
Therefore the system requires 5 panels of 130 Wp at 12V

At this point the system designer may wish to verify if there is sufficient roof space available for installing five 130 Wp panels. Typically, a 1 kWp system requires 100-130 SF so a 585 Wp (0.585 kWp) system would occupy about 59-76 SF of shade-free roof area.

If sufficient roof space is not available, the system designer could revisit the loads that need to be supported to determine which critical loads can be supported based on the amount of energy generation that the available roof area permits.

Inverter size

We use a 45% safety margin when calculating the inverter size.

Required Inverter size = Total Wattage of all appliances * (1+45%)

Total wattage of appliances is calculated in this table:

Appliance	Number	Wattage	Total Wattage
Lights	5	30	150
Fans	2	50	100
Computer	1	100	100
Charging points	2	100	200
Total			**550**

Therefore, required inverter size = 550 * (1+45%) = 798 W

The inverter size is greater than the required solar panel capacity (585 Wp), eliminating the risk of the inverter throttling the panel's output.

The solar PV system required to power this load would need 5 x 130 Wp 12V panels and an inverter of at least 800 W.

2.3 Identify the amount of shade-free rooftop area available/required for installation

2.3.1 Factors affecting roof area required by rooftop solar PV plants

The extent of roof area required by a solar PV plant (and therefore the amount of energy that can be generated) is dependent on two factors

- Shade-free roof area
- Panel efficiency

Shade-free roof area

Unused rooftop area will have to be assessed for incidence of shadows through the year to determine the extent of shade-free area available for installing a rooftop solar PV plant.

We emphasise shade-free roof area because shadows affect the PV plants' performance in two ways

- **Output –** When a shadow falls on a PV panel it reduces the output from the plant. Where string inverters are used, a bit of shadow on one panel can curtail the output from the entire string of panels
- **Panel damage –** When a shadow falls on part of a panel, that portion of the panel turns from a conductor into a resistance and starts heating up. That portion of the panel will eventually burn out and the entire panel will have to be replaced. This will not be covered by warranty

It is therefore critical to ensure that no shadow falls on the PV plant throughout the year

Panel efficiency

Panel efficiency influences rooftop space requirement because efficiency is calculated with respect to the area occupied by the panel. A simple way to understand the relationship between panel efficiency and rooftop space required is to remember that a rooftop plant that uses panels with a lower efficiency rating will require greater rooftop space than a plant that uses panels with higher efficiency rating.

Shade-free area required at different plant capacities and panel efficiencies

If a 1 kW plant with 15% efficiency panels requires 100 SF of rooftop space, then a 1 kW plant with 12% efficiency panels will require 125 SF of rooftop space. We can extend this to different combinations of rooftop plant capacity and panel efficiency for our understanding.

Plant capacity	*1 kW*	*2 kW*	*5 kW*	*10 kW*
Panel efficiency	**Rooftop space required (SF)**			
12.0%	125	250	625	1,250
12.5%	120	240	600	1,200
13.0%	115	231	577	1,154
13.5%	111	222	556	1,111
14.0%	107	214	536	1,071
14.5%	103	207	517	1,034
15.0%	100	200	500	1,000
15.5%	97	194	484	968
16.0%	94	188	469	938

Note: *These numbers are indicative only. Actual roof area required at your installation could vary based on site-specific conditions and vendor's recommendations.*

Based on the above, we can see that a rooftop solar PV system typically requires 100-130 SF (about 12 m^2) of shade-free roof area per kW of capacity

MITRAMAX ENERGY INDIA & GERMANY

ANNOUNCES

SUNFED™
OFF GRID SINE-WAVE SOLAR INVERTERS

EFFICIENT
- Maximum efficiency 90%
- Low no load losses saves big energy loss
- Intelligent battery management –longer life

FLEXIBLE
- SUNFED systems; 1kVA to 10kVA
- Ideal to go with Sun in any place;
- In deserts, forests and hinterlands

SIMPLE
- Easy and Quick commissioning
- Complete off-grid management
- Excellent for battery + Line back-up

DURABLE
- High short term overload capability
- Active thermal management system
- Two-year standard warranty

SYSTEM SUPPLIERS AND INTEGRATORS PLEASE CONTACT in INDIA

Mr. Narayana Moorthy
+91 9819739560 or info@mitramax.com

MITRAMAX™
www.mitramax.com

The new Range of **SUNFED**™ Sine-wave Solar Inverters from **MITRAMAX** ENERGY are based on the carefully developed technology that enables harvesting of 10 to 15% more solar energy than conventional Inverters. **SUNFED**™ Solar inverter uses high efficiency torroid-cored output transformer and high 90% efficiency which ensures peak production while providing simplified system planning, long endurance and maintenance free operation. **SUNFED**™ Inverters can be integrated into any off-grid power systems up to 10kVA in size.

SolarTown Energy Solutions Pvt. Ltd is a fast growing leading EPC company headquartered at Chennai offering premium solar turn key solutions and present across Tamilnadu and Andhra Pradesh. We enable Domestic and Organizations to adopt solar power as a viable cost saving solution.

SOLAR TOWN
Powering Your World

payback of 4.5yrs

What it can save?

A 1KW (Kilo Watts) HOME SOLAR PANEL SYSTEM WILL PREVENT...

- 170 pounds of coal from being burned.
- CO_2 300 pounds of CO2 from released into the atmosphere
- 300 105 gallons of water from being consumed.

Comfy Off-Grid series : Solar power system coupled with battery backup

Comfy On-Grid series : Solar power system coupled with Grid and Diesel generator

Solar Pump : Solar power system coupled with motor/pump

Solar-street light : Solar powered street lights

Highlights

- Expert system integration with assured quality customer service.
- Attractive EMI Schemes including financial Tie-ups with banks.
- Customer Delight Index Rating of 4/5 across 90+ installations across Tamilnadu.
- Young Passionate team with rich experience in Cost-efficient system design and installation.

Core Competence

- Our Team has combined experience of 50KW off-grid rooftop installations and 20MW solar power plant (EPC) installations.SolarTown Energy has installed around 90 SPV installations all over Tamil Nadu since its inception.
- Innovative product portfolio and Unique solutions addressing all segments of the society. Enabling every individual to relish the power of solar energy.
- Brand Consciousness, Efficient Project Management, Proficient After-Sales Service, Cost Efficient Solutions.
- Assured Quality in Design, Procurement & Installations - International standard.

Head Office: Solar Town Energy Solutions pvt ltd, No: 140 Janaki Commercial Complex, 1st floor, L. B. Road, Thiruvanmayur.
044 - 6604772, 04 - 42131961, 8939951237, sales@solartown.in, www.solartown.in

2.3.2 Other considerations

Weight of the rooftop PV plant

Rooftop solar PV plants are fairly heavy (about 30-60 Kgs/m^2). They do not pose a problem for concrete roofs but cannot be installed on asbestos roofed sheds. Metal roofed facilities may or may not be able to withstand the weight and wind load and will need to be assessed by an expert.

Based on their capacity, inverters can be very heavy. A 100 kW inverter can weigh more than 1 tonne and occupy only a few square feet, creating a load of several hundred kilograms per square foot. Similarly, batteries can also be very heavy, depending on the extent of autonomy required. Such heavy components may need to be installed on the ground, or carefully placed over roof beams and columns to avoid overloading the roof.

Mountings that can withstand wind pressure

Rooftop solar panel mountings would need to withstand wind pressure building up under the panels during storms. This is an important consideration if you are located in a region prone to cyclones. 2009's Cyclone Aila, with wind speeds up to 120 kph, took away about 60,000 solar power systems attached to homes in the Sunderbans; the recent Cyclone Phailin brought winds of up to 200 kph. The kind of mounting required for your location and type of roof should be discussed with the installer.

2.4 Speak to vendors and obtain quotations for your requirement

Once the initial assessment of requirements, available space, and generation potential is done, the next step is to speak to solar solution vendors and obtain quotations. This serves the purpose of ascertaining the options available within your budget, and adjusting your assessment for site-specific conditions.

2.5 Evaluate vendor quotations based on price, warranties, and vendor credentials before finalising the vendor

Choosing a good vendor is critical to getting the most out of your rooftop PV system as carelessness in design or construction/installation can either significantly reduce the power output from your plant or deliver a plant that isn't suited to your needs. A few things to keep in mind when finalising a vendor are:

- Supplier Background & Credibility
- Ask for details of projects that they have already implemented
- Check if they are MNRE authorised, or registered under your state's energy development agency (or equivalent body)
- Check if the supplied products have been manufactured in a ISO-9001 certified plant

- Verify supplier's claims about the product/component with datasheets available on the manufacturer's website (e.g., if the supplier claims that the panels are suitable for coastal areas, check the product datasheet to see if it has cleared the salt mist corrosion test)

2.5.1 Price

The cheapest vendor is not necessarily the best vendor. A vendor who has a well-established after-sales service network may quote a higher price but will provide greater benefits in the long run.

2.5.2 Warranties

- **PV Panels –** Industry standard warranty is
  - 5-year manufacturer's warranty
  - 0-10 years for 90% of the rated output power
  - 10-25 years for 80% of the rated output power
- **Other systems –** Inverters, mounting structures, cables, junction boxes, etc. typically come with a 1 year manufacturer warranty which can be extended to 5 years
- Manufacturer warranties are preferred to dealer warranties

When evaluating different vendors, ensure that the plant specification, and not just the description, is the same. E.g., 1 kW panel + 5 kW inverter may be sold as a 5 kW plant but is actually only a 1 kW plant. Similarly, 5 kW panels + 1 kW inverter is also a 1 kW plant. Such plants can be offered at a much lower price than a genuine 5 kW plant, but will not generate anywhere near the same amount of power.

Time for a SMART decision?

Soltech, in collaboration with its global partners, introduces a set of next-gen modules and inverters that are technologically advanced by a long way ahead of the other options available in the market. If you are investing in solar power for tomorrow, you must not miss out on this opportunity today.

To know more, reach out to us right now!

ON-GRID

REFUsol

OFF-GRID

AEG

HYBRID

STUDER

NET METERING

T-SOL

SOLTECH EQUIPMENTS
Solar Power Solutions

Channel Partner of
CanadianSolar Inc

27/12, Cresent Park Street,T.Nagar, Chennai - 600 017, Tamilnadu, India.
91 44 4212 9118 / 24339130/ 097910-94980
info@soltechindia.com | www.soltechindia.com

Chapter 3
Cost Economics of Solar Rooftop

3. Cost Economics of Solar Rooftop

The cost of a rooftop solar PV system depends on the function it serves (to feed power into the grid, to support the load during a power failure, etc.) and incentives/subsidies available. It should be noted that all solar PV systems function by matching the voltage from some other source. Therefore the system has to be integrated with the grid, a battery backup, or a diesel generator.

Types of rooftop solar PV systems

Rooftop solar PV systems are of 3 types:

1. **Grid-tied –**These rooftop systems are primarily designed to supply the generated power to the grid and also power the load. These systems will NOT generate power during a power failure as the inverter shuts down the system to stop sending power into the grid and avoids the risk of electrocuting utility personnel who are working to repair the grid
2. **Grid-interactive –**This system works in conjunction with either a battery backup or diesel generator to support the load even during a power failure.
3. **Off-grid** – This system does not work with the grid and is designed to work only with a battery backup or diesel generator in off-grid applications

The difference between the systems lies in the kind of inverter used, and the inclusion of batteries. As various vendors use different terminology for these systems we urge you to verify the functions of the offered system rather than going by the name alone.

3.1 Component cost of rooftop PV systems

A rooftop solar PV system costs approximately Rs. 1,00,000 per kWp (kilowatt peak) including installation charges but without batteries and without considering incentives (which are discussed further below). The cost breakup for a 1 kWp system is given below:

Component	Amount (Rs.)	% of total cost
PV modules (Crystalline)	52,000	52%
Inverters	23,000	23%
Balance of System (cables, etc.)	17,000	17%
Installation	8,000	8%
Total	**1,00,000**	

Note 1: *The above prices are for components from Tier 1 manufacturers with 5-year manufacturer's warranty. In addition the PV modules have output warranty of 90% of rated capacity for the first 10 years and 80% of rated capacity for the next 15 years.*

Note 2: *We have not considered battery backup as that can alter the economics significantly depending on the extent of battery backup (autonomy) required. Not only do batteries add to the initial cost, recurring maintenance, and replacement expenditure, the energy loss on charging and drawing from the battery also adds to the cost of power. A battery backup providing one-day autonomy (i.e., storing about 4 kWh of energy) would add about Rs. 25,000-30,000 to the cost of the above system.*

Note 3: *We have not considered Thin-Film modules as they require more installation area for the same capacity as Crystalline modules and are therefore not preferred for rooftop installations where space is usually a constraint.*

3.2 Incentives/Subsidies

Several incentives are available for rooftop solar PV plants through the Jawaharlal Nehru National Solar Mission.

3.2.1 Accelerated Depreciation (AD)

Accelerated depreciation of 80% is available under the Income Tax act for rooftop solar PV systems. This can provide significant savings to a solar plant developer who is a taxable assessee and has sufficient profits against which the depreciation can be charged. This is illustrated in this table:

Tax savings from accelerated depreciation

Item	Rs.
Cost of a 100 kW rooftop solar plant (A)	1,00,000.00
Accelerated depreciation @80%	80,000.00
Corporate tax rate*	35%
Tax saved through depreciation (B)	28,000.00
Net cost of rooftop solar plant (A)-(B)	**72,000.00**

**Tax rate can vary for different assesses*

Please note that depreciation can be claimed only on business assets and only against business income.

3.2.2 MNRE Subsidy

The Ministry of New and Renewable Energy (MNRE) provides Central Financial Assistance through capital and/or interest subsidy (depending on the nature of the applicant). The summary of the subsidy scheme is provided in the table on the following page:

S. No.	Category	Maximum capacity	GOI Support		
			System with battery backup	System without battery backup	Interest Subsidy
1	Individuals for all applications	1 kWp	Rs.51/watt or 30% of project cost whichever is less	Rs.30/watt or 30% of project cost whichever is less	Soft loans @5% p.a.
2	Individuals for Irrigation, & community drinking water applications	5 kWp	Rs.51/watt or 30% of project cost whichever is less	Rs.30/watt or 30% of project cost whichever is less	Soft loans @5% p.a.
3	Non-commercial/ commercial/industrial applications	100 kWp	Rs.51/watt or 30% of project cost whichever is less	Rs.30/watt or 30% of project cost whichever is less	Soft loans @5% p.a.*
4	Non-commercial/ commercial/industrial mini-grids	250 kWp	Rs.90/watt or 30% of project cost whichever is less		Soft loans @5% p.a.*

*for commercial/ industrial entities either of capital or interest subsidy will be available

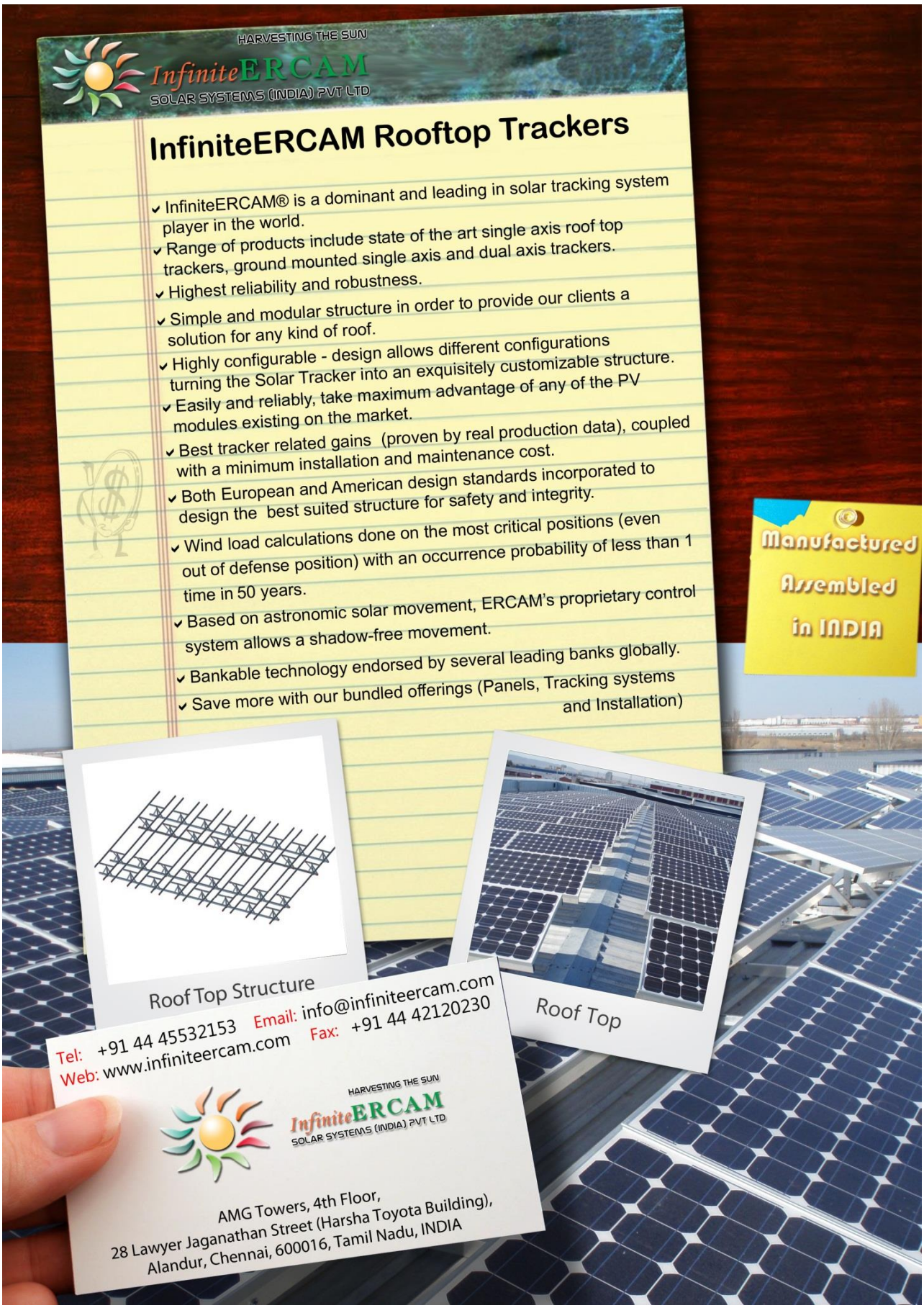
Note: 1 *The benchmark cost for setting up a solar PV plant is Rs. 170/Wp (With battery providing 6 hours of autonomy) and Rs. 100 per Wp (without battery) i.e. if the actual project cost exceeds this amount then project cost will be deemed to be the benchmark cost for calculating the subsidy.*

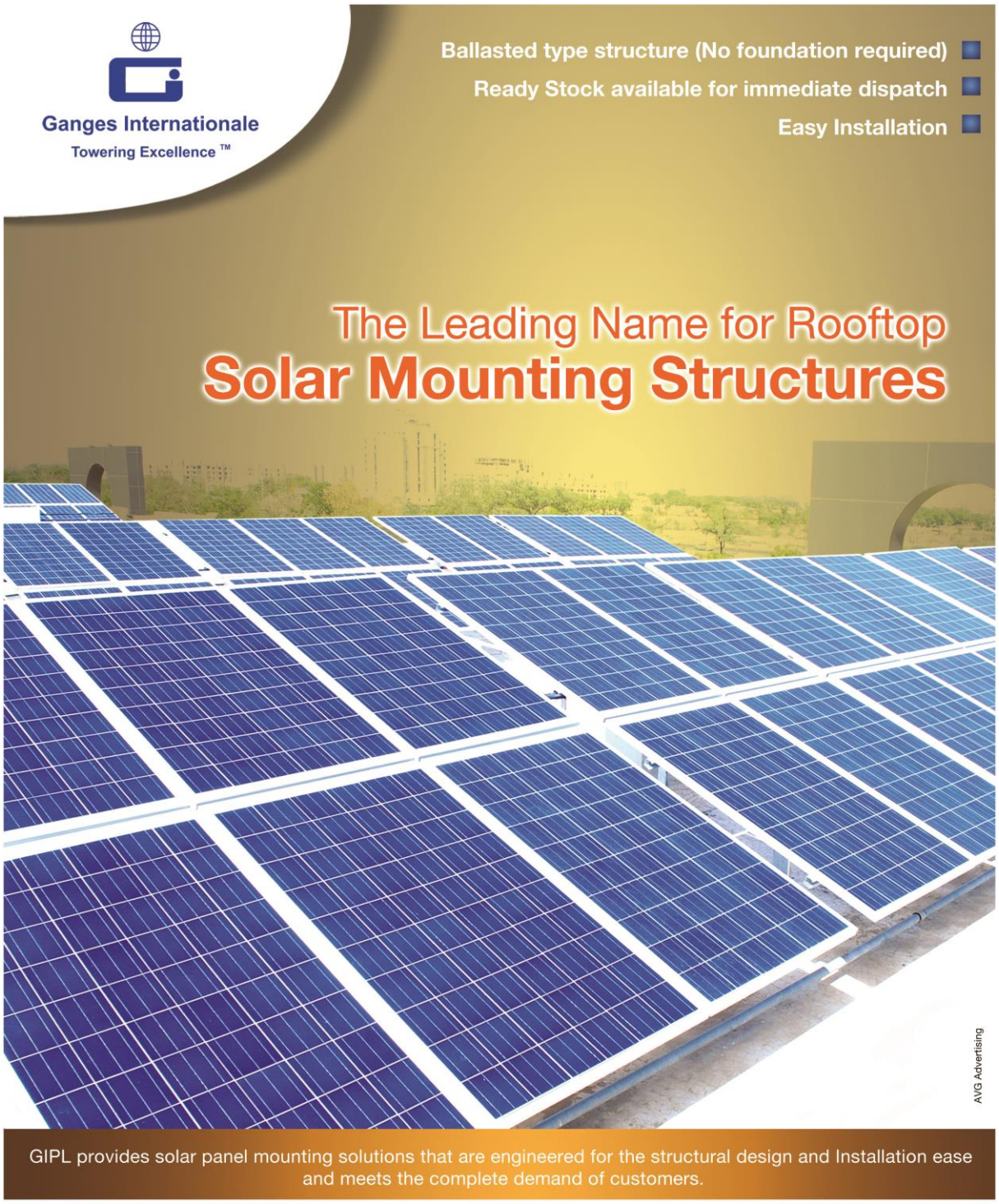
Note 2: *Benchmark costs are for systems with 5-year warranty for all components (inverters, batteries, switchgear, etc.) other than PV modules which are warranted for 90% of output at end of year 10 and 80% at end of year 25. PV modules have to be made in India to avail subsidy.*

Note 3: *Capital subsidy is increased to 90% of benchmark cost for special category states (North Eastern states, Sikkim, Jammu & Kashmir, Himachal Pradesh, and Uttarakhand).*

The subsidy calculation is illustrated in this table:

Savings from capital subsidy	
Item	**Rs.**
Cost of a 1 kW rooftop solar plant with battery backup	1,60,000.00
Benchmark cost	1,70,000.00
Subsidy @30% of actual cost	48,000.00
Net cost after subsidy benefit	**1,12,000.00**


HARVESTING THE SUN
InfiniteERCAM
SOLAR SYSTEMS (INDIA) PVT LTD
InfiniteERCAM Rooftop Trackers
InfiniteERCAM® is a dominant and leading in solar tracking system player in the world.
Range of products include state of the art single axis roof top trackers, ground mounted single axis and dual axis trackers.
Highest reliability and robustness.
Simple and modular structure in order to provide our clients a solution for any kind of roof.
Highly configurable - design allows different configurations turning the Solar Tracker into an exquisitely customizable structure.
Easily and reliably, take maximum advantage of any of the PV modules existing on the market.
Best tracker related gains (proven by real production data), coupled with a minimum installation and maintenance cost.
Both European and American design standards incorporated to design the best suited structure for safety and integrity.
Wind load calculations done on the most critical positions (even out of defense position) with an occurrence probability of less than 1 time in 50 years.
Based on astronomic solar movement, ERCAM's proprietary control system allows a shadow-free movement.
Bankable technology endorsed by several leading banks globally.
Save more with our bundled offerings (Panels, Tracking systems and Installation)
Manufactured Assembled in INDIA
Roof Top Structure
Roof Top
Tel: +91 44 45532153 Email: info@infiniteercam.com
Web: www.infiniteercam.com Fax: +91 44 42120230
HARVESTING THE SUN
InfiniteERCAM
SOLAR SYSTEMS (INDIA) PVT LTD
AMG Towers, 4th Floor,
28 Lawyer Jaganathan Street (Harsha Toyota Building),
Alandur, Chennai, 600016, Tamil Nadu, INDIA



Ganges Internationale Pvt. Ltd

B - 36, Lawrence Road, Industrial Area, New Delhi - 110035, INDIA,
Ph.: +91 11 47090225, 47090228, 47090229, 9311811923
email : info@gangesintl.com, www.gangesintl.com

3.3 Final cost of Rooftop PV system factoring in AD and Subsidies

The final cost to setup the PV plant, after factoring in Accelerated Depreciation and Subsidy benefit will be:

Final cost of 1 kW rooftop PV plant	
Item	**Rs.**
Cost of a 1 kW rooftop solar plant	100,000.00
Subsidy @ 30%	30,000.00
Net cost after subsidy	*70,000.00*
Accelerated depreciation @80%	56,000.00
Tax rate	35%
Tax saved through depreciation	19,600.00
Net cost after both AD and Subsidy	**50,400.00**

Please note that there are issues with subsidy payment and many PV plant owners have not received subsidy. We therefore urge you to speak to your solar vendor on status of subsidy payments and calculate the economics of rooftop solar both with and without subsidy

3.4 Variations in pricing

Prices of solar PV systems offered by various vendors can differ significantly. There can be several reasons for the variations in price, such as

- **Overstatement of capacity** – Some vendors advertise a rooftop system with 1 kW modules (solar panels) and a 5 kW inverter as a 5 kW system. As the electricity is generated by the modules this system only has a 1 kW capacity and the price offered by the vendor should be compared with other 1 kW systems and not 5 kW plants
- **Compromised installations** –Lower prices can come at the cost of component and installation quality
- **Brands –** Products from Tier I manufacturers are typically more expensive but offer much better performance and reliability
- **Certifications/Standards –** Products that are certified and meet quality standards are more expensive
- **Warranties –** The price of the system can depend on the warranties offered.
    - PV Panels – Industry standard warranty is
        - 5-year manufacturer
        - 0-10 years for 90% of the rated output power
        - 10-25 years for 80% of the rated output power
    - Other systems – Inverters, mounting structures, cables, junction boxes, etc. typically come with a 1 year manufacturer warranty which can be extended to 5 years

Chapter 4

Components of a rooftop solar system

4. Components of a rooftop solar system

4.1 Basics of rooftop Solar PV

- **Solar PV panels** (also known as solar PV modules) work by converting sunlight into electricity. They do not use the heat from the sun, and in fact can see a reduction in power output in hot climates
- The electricity generated by the PV panels is Direct Current (DC). This needs to be converted into Alternating Current (AC) using an **inverter**
- The panels are mounted on the rooftop using special **mounting structures**
- If solar power is required when there isn't enough sunlight for the panels to generate electricity (such as at night), **a battery** backup is required
- A **charge controller** is required to regulate the charging of batteries

These are the primary components of a rooftop solar PV plant. Other components include the cables, switchgear, fuses, etc.

As the amount of sunlight falling on the panels varies during the day (due to clouds, etc.), the power output from the panels also varies. As this variation in power could damage equipment, the inverter continuously matches the PV plant's output to another source of steady power.

Therefore a rooftop solar PV that generates AC power will always needs another source of power (whether the grid or diesel generator or batteries) to provide a reference voltage in order to function. If such a source of power is absent, the plant will not generate power even if there is ample sunlight.

4.2 Components of a rooftop solar PV plant

From the above, we can see that a rooftop solar PV plant primarily requires 3, and in some cases 5, components

- PV modules (panels)
- Inverters
- Mounting structures
- If battery backup is required
    - Batteries
    - Charge controller

4.2.1 PV modules (panels)

There are two kinds of modules: Thin-film, and Crystalline. Rooftop solar plants predominantly use crystalline panels because they are more efficient and therefore better suited to installations like rooftops where space is a constraint.

4.2.1.1 Panel efficiency

It should be noted that the efficiency of a solar panel is calculated with reference to the area it occupies. Two 250 Wp panels of different efficiency rating will generate the same amount of power, but occupy different amounts of space on your rooftop.

4.2.1.2 Capacity rating

The capacity of a solar panel is denoted in terms of watts as Wp (watt peak). E.g., 250 Wp. This is the power output of the plant at 25°C. The capacity of the plant reduces at temperatures above 25°C and increases at temperatures below 25°.

4.2.2 Inverters

Inverters are a very important component of your rooftop solar PV plant because they determine the quality of AC power you get, and also the kind of loads that can be powered with solar – different inverters support different levels of starting current requirements which affects the kind of machinery that can run on solar power. Inverters are also the only major component of your solar plant that are replaced during the lifetime of the plant.

4.2.2.1 Will I get power during a power failure?

Not all rooftop solar PV plants generate power during power failures. The solar inverter uses another source of power as a reference voltage. If the inverter is designed to use only grid power as a reference voltage, then the inverter will not be able to function in the absence of grid power and the solar plant will not generate power.

Therefore, if you are interested in rooftop solar to provide power during grid failures it is critical to choose an inverter that can use other sources of power as a reference voltage and continue to function even when the grid is down.

4.2.2.2 Kinds of inverters

Based on the explanation above, we can classify inverters into 4 types

1. **Grid-tied –**These inverters are primarily designed to supply the generated power to the grid and also power the load while grid power is available. This inverter will NOT generate power during a power failure, not only because it needs grid power as a reference voltage, but also because the inverter shuts down the system to stop sending power into the grid and avoids the risk of electrocuting utility personnel who are working to repair the grid (known as Anti Islanding)
2. **Off-grid** – These inverters do not work with the grid and are designed to work only with a battery backup or diesel generator in off-grid applications. They are suitable for

applications where grid power is not available at all, but are not the right choice if you need your solar plant to work in conjunction with grid supply

3. **Grid-interactive –**These inverters work both with the grid supply and with either a battery backup or diesel generator to support the load even during a power failure.

Hybrid inverters (also known as Bidirectional or magical inverters) are a one system solution for a complete solar PV system. They can automatically manage between 2 or more different sources of power (grid, diesel, solar).

They have inbuilt charge controllers, MPPT controller, Anti Islanding solutions, DC and AC disconnects and other features like automatic turning on/off of the diesel generator, automatic data logging, and various kinds of protection for the different components of the system, making them ideally suited for applications that require management of power from different sources

4.2.3 Mounting structures

Solar panels are mounted on iron fixtures so that they can withstand wind and weight of panels. The panels are mounted to face south in the Northern Hemisphere and north in the Southern Hemisphere for maximum power tracking. The tilt of the panels is at an angle equal to the latitude of that location.

The proper design of mounting structures is important to power plant performance as the power output from the PV plant will not be maximised if the mountings buckle and the panels are not optimally oriented towards the sun. In addition, improperly mounted panels present a ragged appearance that is not pleasing to the eye. Allowing sufficient air circulation to cool the PV panels is also an important factor that mounting structures should be designed for because, as mentioned above, rooftop PV plant output reduces as temperatures rise above 25°C.

4.2.3.1 Trackers

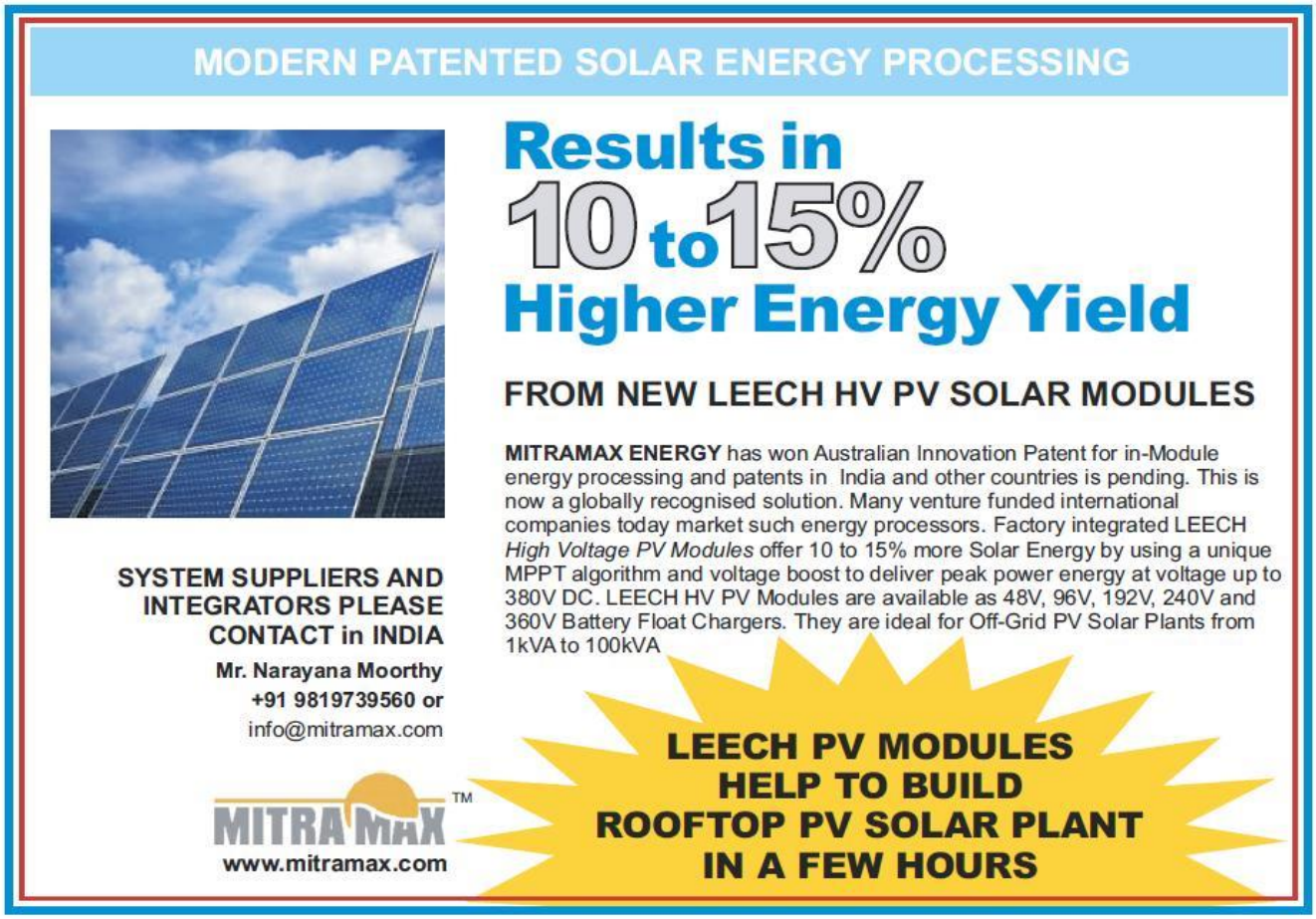
Tracking is a way of mounting the panels through a mechanism that allows the panels to follow the sun as it moves across the sky. Single-axis trackers follow the sun as it moves from East to West during the day, while dual-axis trackers also follow the sun on its North-South journey over the course of a year.

Trackers can increase the power output from the PV plant but add significantly to both the initial cost of the plant and maintenance expenditure; utilisation of trackers should be decided on a case-to-case basis after performing a cost-benefit analysis over the lifetime of the rooftop plant.

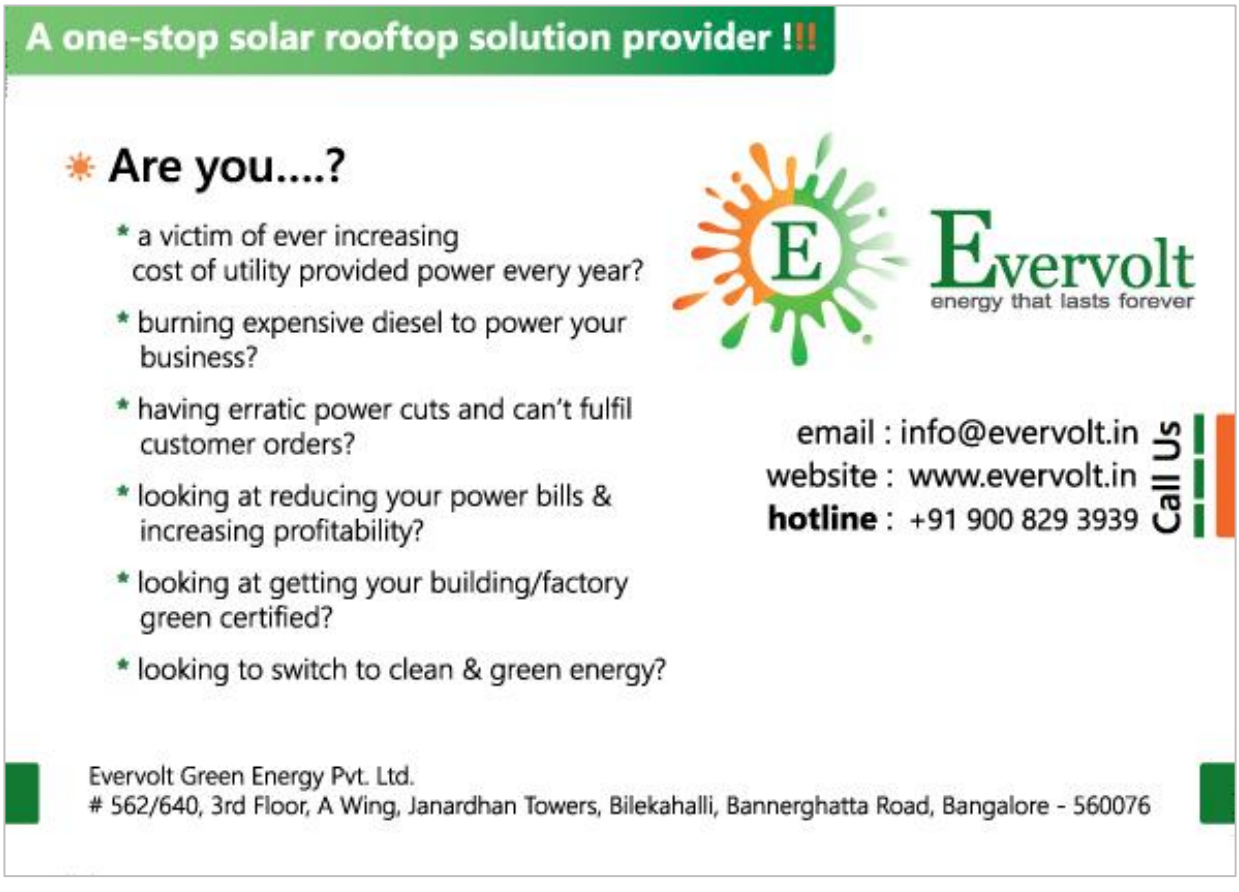
4.2.4 Batteries

4.2.4.1 Reasons to use batteries

- **Make power available when the sun isn't shining –** This can be particular useful for applications where electrical consumption is greater during the night than in the day, such as BPOs that work on night shifts, or even residential apartments where most people are away during the day and at home during the night
- **Smoothen power delivery during the day –** Clouds moving across the sun can suddenly reduce the output from your rooftop plant. A battery backup can ensure that the load gets sufficient power during such dips in plant output
- **Immediately cut-in during power failures –** If space isn't available for a large rooftop plant, solar panels with batteries can be used to support the load until a diesel generator can be turned on
- **Optimise time-of-use billing –** If the utility charges different tariffs based on time of day, power from the batteries can be used to reduce consumption at those times when utility power is very expensive




iKUBE
KiT. solar PV generator
CE
* Size:0.90x0.90x1.01 m * Hybrid SOLAR Power Conditioning Unit - 3 kW with Data Log
* Built in Modular Battery Pack 12 kWh * SOLAR PV modules 3 kWp.(Mono/Poly - Si.)
iKUBE is a SOLAR Generator able to guarantee up to 4 kW of power supply. Designed to provide electricity in all areas of the globe. iKUBE can work even in the absence of sunshine offering the advantages of compactness, low noise, no fumes and fuel costs. The iKIT contains batteries that are recharged by the PV modules and the inverter will provide AC current for your appliances.Free yourself from power-cuts and rising energy costs, Take the energy you need wherever you go, Help clean up the environment, with the iKUBE....the ENERGY is where YOU want it!
AUTONOMY OF THE BATTERY PACK
Power(W) Remaining Hours
100 174
500 24
1000 10
1500 6
2000 4
2500 3
3000 2.5
India Solar Resource
CONTURA SOLAR (INDIA) PRIVATE LIMITED
#9-B, Oil Mill Road, Industrial Colony S.O.,Trichy - 620019, Tamilnadu, India
Tel.:+91-431-2441383 | +91-431-2444383 | Mob.:+91-8754021383
email: info@conturaindia.com | web: www.conturaindia.com
iKUBE
Free Mobile Green ENERGY
* Hybrid SOLAR PCU 3 kW. with Data Log.
* Built in Modular Battery Pack 12 kWh.
* SOLAR PV modules 1.4 kWp/ 3kWp.
* Auxiliary Power Option with Wind / DG...
F150. CONTURA SOLAR mobile solar PV generator
The iKUBE is ready to use in seconds... No Installation Required!


A one-stop solar rooftop solution provider !!!
Are you....?
* a victim of ever increasing cost of utility provided power every year?
* burning expensive diesel to power your business?
* having erratic power cuts and can't fulfil customer orders?
* looking at reducing your power bills & increasing profitability?
* looking at getting your building/factory green certified?
* looking to switch to clean & green energy?
Evervolt
energy that lasts forever
email : info@evervolt.in
website : www.evervolt.in
hotline : +91 900 829 3939
Call Us
Evervolt Green Energy Pvt. Ltd.
562/640, 3rd Floor, A Wing, Janardhan Towers, Bilekahalli, Bannerghatta Road, Bangalore - 560076

4.2.4.2 Drawbacks to using batteries

- **Charge/discharge efficiency –** Batteries and their charging equipment are not 100% efficient. There is a loss of energy both while charging and discharging the battery. Different models of batteries can have different charge/discharge efficiencies. If we lose 15% of the energy while charging and another 15% while discharging, we get back only about 72% of the power that was sent to the battery

- **Maintenance –** Battery packs require careful maintenance. Maintenance isn't limited to the physical condition of the battery (amount of electrolyte, cleaning of terminals) but also extends to the way we charge and discharge the battery. Repeatedly deep discharging the batteries, discharging before the battery has reached full charge, etc., are ways in which the life of the battery can be significantly reduced. Batteries can last as long as 10 years or give trouble within a few days, depending on how they are used.

A battery pack can add about 25-30% to the initial system cost of a rooftop PV solar system for one day autonomy (storing an entire day's output).

Due to the above drawbacks, we do not recommend coupling solar PV plants with battery backup unless absolutely necessary. If batteries are required, we urge you to perform a lifetime cost-benefit analysis to understand the effect on cost of solar power from your rooftop.

4.2.5 Charge Controllers

A charge controller regulates the DC power output from the rooftop solar panels that is used to charge the batteries. It provides optimum charging current, and protects the batteries from overcharging. There are two kinds of charge controllers

- Pulse Width Modulated (PWM)
- Maximum Power Point Tracking (MPPT)

MPPT charge controllers are more expensive than PWM but they offer much better performance in terms of efficiency, flexibility in solar panel plant configuration, and capacity supported.

Charge controllers that are integrated into the inverter are preferred as the inverter directs either grid power or solar power, based on availability and demand, to charge the batteries. This extends the battery life compared with using stand-alone charge controllers that allow parallel charging between grid and solar power at different power levels, damaging the battery

4.3 Maintenance of rooftop solar PV systems

The basic rooftop solar PV system has no moving parts and therefore requires very little maintenance. Additional components, such as trackers and batteries, can significantly increase the maintenance effort and expenditure.

- **Solar panels –** These typically require little to no maintenance beyond having the dust cleaned off them. Solar panels can be expected to last for 25 years
- **Inverter –** This can be affected by grid power quality or other issues common to power equipment such as humidity or short-circuits caused by insects, and may require some maintenance such as replacement of capacitors. The lifespan of an inverter is 5-10 years
- **Mounting structures –** These typically last the lifetime of the plant and do not require maintenance, unless tracking systems are used
    - Tracking mechanisms involve moving parts that can wear out and/or break. The require lubrication, parts replacement, and sufficient room on the rooftop for maintenance access
- **Other parts of the system –** Cabling, switchgear, fuses, etc. will require minor maintenance to ensure correct operation
- **Batteries –** As discussed above, batteries require careful maintenance to function reliably. Typical lifespan is 3-5 years

4.4 How long does it take to install a rooftop PV system?

This can vary based on plant size, site conditions, and permissions required, but typically rooftop plants can be installed within two weeks to 3 months of the project being confirmed. It should be noted here that processing of subsidies may take much longer.

U-Solar is a clean energy enterprise specialising in Rooftop Solar Photovoltaic solutions. We are a leading EPC (Engineering, procurement and construction) company, offering innovative and customized rooftop solar PV solutions to our industrial, institutional & residential customers.We offer specialised mounting structures for various kinds of industrial rooftops & our choice of system components caters to the customer's requirements. U-Solar offers multiple financial options including a Non-Capex, Power Purchase Agreement (PPA) with our customers. We work with top manufacturers of system components from across the world and in India, to deliver aptly engineered and highly efficient PV power plants for captive consumption.

Healthcare | Industrial | Hospitality

130 kW | Kerala | 50 kW | Chennai | 25 kW | Hyderabad

Why go with U-Solar ?

Rooftop solar photovoltaic system specialists
with multiple commercial & residential installations across South India
Light weight, robust & customized mountings structures
causing minimum or no damage to the roof
Superior Generation
through innovative design & installation standards leading to higher generation and longer life

Contact today for a quick study and proposal for a Solar Energy Solution designed especially for your needs!
U-SOLAR CLEAN ENERGY SOLUTIONS PVT.LTD
#6, 1st Floor, 9th A Main, Behind J.B. Nagar Police Station,New BDA Layout, HAL 3rd Stage, Bangalore - 560 075 Contact: Mob +91 9986943767 | Email: info@usolar.in www.usolar.in

Consult,
Design,
Install,
Support . . .

VIGOR
Solar Energy Pvt Ltd

Why we are the perfect partner for your solar venture....

- Trustworthy design
- Competitive rates
- Quality products
- Best trained and most passionate engineers in the field
- Excellent service and support

"So whatever your application demands, partner with a trusted company"

Head Office - G-13 Elcanso Complex, No 10 Casa Major Road, Egmore, Chennai 600 008.
Branch Office - Bait ul Fazilat, 8 - 2 - 612 / B / 1, Road No. 11, Banjara Hills, Hyderabad - 500034.
Mobile: +91 90030 47542, +91 99625 88533, Phone: +91 44 2819 1091 Email: info@vigorsolar.in

Chapter 5

Best Regions for Solar Rooftops

5. Best Regions for Solar Rooftops

While rooftop solar plants can be installed in most parts of India, it is good to know the amount of power that can be generated in different parts of the country, making it easier to assess the amount of power you can expect from your plant.

5.1 Factors affecting rooftop solar plant output

The power output of a rooftop solar system is dependent on several factors such as

- Location
- Orientation of the roof
- Ambient temperature

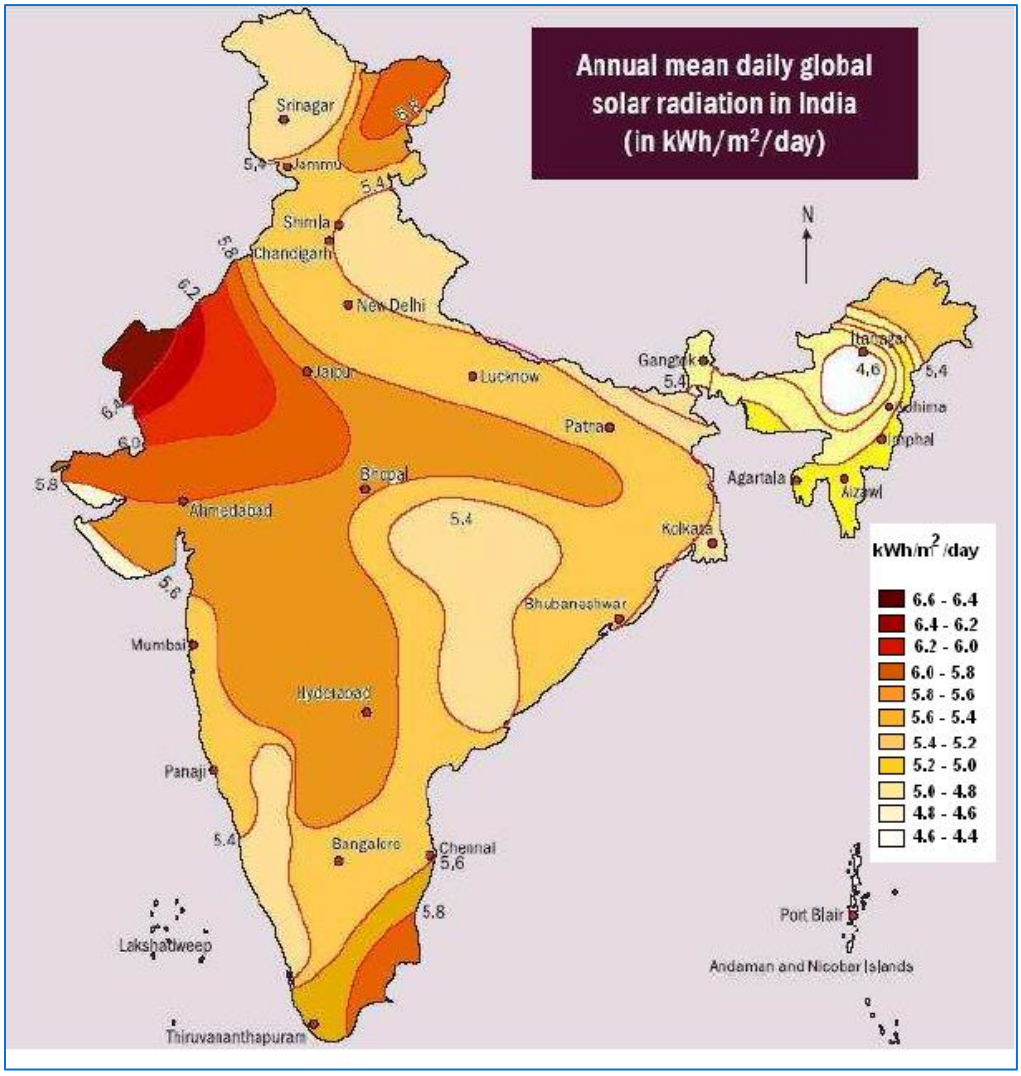
5.1.1 Location

Your location determines the amount of solar insolation (sunlight falling on the panel per day).

- We generally receive 4-7 kWh of solar insolation per square metre in India
- The approximate solar insolation at your location can be ascertained by entering the latitude and longitude of your location at the NASA website[2]
    - Latitude and longitude of your location can be obtained from **Google Maps**
- To be absolutely certain of solar insolation at a particular site we would have to place sensors on-site that measure the actual insolation received over a period of time. This is both an expensive and time consuming process

[2] https://eosweb.larc.nasa.gov/sse/RETScreen/

This map shows the solar insolation across different regions in India.



5.1.2 Orientation

In the northern hemisphere a south-facing roof is ideal as the sun is always to the south if you are in the temperate zone and predominantly in the south for many parts of the tropical zone.

If a south-facing roof is not available an east-west facing roof could also be considered (as it will cover the sun's movement across the sky from east to west during the day). As the output of the solar plant reduces in proportion to a horizontal angle greater than 15% from due south, the output for the particular site should be calculated and assessed to understand the impact on power generation from an east-west facing roof.

Solar PV plants are not restricted to flat roofs – they can be mounted on sloped roofs as well, with a correction in the angle of mounting for the slope of the roof.

5.1.3 Ambient Temperature

Solar panel temperature is an often ignored but critical parameter in a hot country like India. Though it might seem counter-intuitive, solar PV panels generate less power in very hot summers as the heat reduces their efficiency (the voltage reduces). In Chennai, the month of January delivers better output than May.

5.1.3.1 Temperature Coefficient

The rated capacity, or power, of a solar panel (e.g. 250 Wp) is measured at 25°C. The effect of temperature on the solar panel's power is measured by its thermal coefficient, expressed as %/K or %/°C. It denotes the % change in power for 1 degree change in Kelvin or Celsius (both are the same on a unit level) above 25°C. A negative (-) sign indicates the direction of the change.

A temperature coefficient of -0.447 indicates that every 1°C **increase** in temperature over 25°C will cause a 0.447% **decrease** in power. Equally, every 1°C **decrease** in temperature over 25°C will cause a 0.447% **increase** in power. This is illustrated in this table:

Rated panel capacity (Wp)	Temperate (° C)	Temperature Coefficient	Effective panel capacity (Wp)	Change in Wp
250	20	-0.45%	255.59	102.24%
250	25	-0.45%	250.00	100.00%
250	35	-0.45%	238.83	95.53%
250	45	-0.45%	227.65	91.06%

5.2 Approximation of PV plant output

As we have seen, estimating the power output from your rooftop solar plant can be a complex exercise. Luckily we can use a simple heuristic for calculating the power output in India:

1 kWp of panel will generate about 1,400-1,600 kWh (units) per year i.e., about 4 kWh per day.

This is broadly representative of output from rooftop PV plants in India. It is an average calculated over a year. Generation on individual days at your location will vary based on meteorological conditions.

PV power plant performance is often denominated as Capacity Utilisation Factor or CUF. CUF is the ratio (expressed as a percentage) of the actual output from a plant to the maximum possible output under ideal conditions if the sun shone throughout the day and throughout the year.

$$\text{Capacity Utilisation Factor (CUF)} = \frac{\text{Actual energy from the plant (kWh)}}{\text{Plant capacity (kWp) x 24 x 365}}$$

The CUF for several solar-friendly Indian states and the approximate output per day for a 1 kWp panel (calculated from the CUF) is given below.

State	CUF (%)	Output for 1 kWp panel (kWh/day)
Gujarat	18	4.32
Karnataka	19	4.56
Madhya Pradesh	19	4.56
Maharashtra	19	4.56
Punjab	19	4.56
Rajasthan	20	4.80
Seemandhra/Telangana	20	4.80
Tamil Nadu	19	4.56
Uttarakhand	19	4.56

Note: The above calculation is an estimation based on average plant performance across the state. Output at your location may vary from these estimates.

5.2.1 PV plant outputs in different states for different roof areas

Based on the above, we can estimate the approximate power output for PV plants on different roof sizes in different parts of India:

Roof area (SF)	500	1,000	1,500	2,500	5,000	10,000
Plant capacity (kW) 1 kW = 100 SF	5	10	15	25	50	100
State	Output (kWh/day)					
Andhra Pradesh	24.00	48.00	72.00	120.00	240.00	480.00
Gujarat	21.60	43.20	64.80	108.00	216.00	432.00
Karnataka	22.80	45.60	68.40	114.00	228.00	456.00
Madhya Pradesh	22.80	45.60	68.40	114.00	228.00	456.00
Maharashtra	22.80	45.60	68.40	114.00	228.00	456.00
Punjab	22.80	45.60	68.40	114.00	228.00	456.00
Rajasthan	24.00	48.00	72.00	120.00	240.00	480.00
Seemandhra/Telangana	24.00	48.00	72.00	120.00	240.00	480.00
Tamil Nadu	22.80	45.60	68.40	114.00	228.00	456.00
Uttarakhand	22.80	45.60	68.40	114.00	228.00	456.00

Chapter 6
Innovations in Rooftop Solar

6. Innovations in Rooftop Solar

Several innovations in solar rooftop, both at the technical and commercial level, have made the solutions viable for a greater variety of users and increased its adoption.

6.1 Technology innovations

6.1.1 Non-penetrating mounting structures

The typical solar installation on a concrete roof requires mounting structures that penetrate the roof, raising concerns with waterproofing and other structural issues in some buildings. The use of non-penetrating mountings has allowed solar plants to be mounted on such buildings.

6.1.2 Elevated mounting structures

Mounting structures that elevate the solar panels above the roof allow the roof to be also used for other purposes, may create a slightly cooler top floor, and increase panel cooling due to greater exposure to the wind.

6.1.3 East-West layout

Solar plants in the northern hemisphere are typically mounted facing south in the direction of the Sun. However, locations within the tropical zone do not always have the sun towards the south. L&T has experimented with East-West layout for panels in such locations and claims increased energy output.

6.1.4 Diesel substitution

Diesel for power generation is a problem unique to India and several other developing countries. The need to maximise diesel savings from solar with has given rise to several solutions, such as special inverters that can control multiple diesel generators, and software solutions that can manage multiple solar inverters and diesel generators based on load.

6.1.5 Critical load support

By isolating critical loads through a dedicated electrical feeder, a solar power plant with battery backup can ensure that the critical load is always supported, and no disruption of production is experienced despite unscheduled load shedding.

6.2 Commercial innovations

6.2.1 Build Own Operate (Transfer) – BOO(T)

This innovative business model allows energy consumers to have a solar plant on their rooftop, but instead of paying for the entire plant upfront, they only pay for the energy generated by the plant on a per-unit basis by signing a Power Purchase Agreement (PPA).

The vendor who provides the plant Builds, Owns, and Operates the plant for the consumer. A variation on the model allows the plant to be Transferred to the consumer after a period of time. As the ownership of the plant remains with the vendor, the energy consumer cannot claim depreciation on the plant.

BOO(T) vendors typically require the consumer to maintain a credit rating or bank guarantee to avail the facility, and usually do not offer the solution for residential rooftops.

Chapter 7

Warranties and Certifications

7. Warranties and Certifications

7.1 Typical Warranties and Certifications

A rooftop PV system is made up several components each of which have their own performance parameters. We provide a list of the prominent warranties and certifications for each component in the table below.

Warranties	Certifications
7.1.1 Solar Panels	
Modules are typically warranted against manufacturing defects for a period of 5 years. In addition, their power output is also warranted • **0-10 years for 90% of the rated output power** • **10-25 years for 80% of the rated output power** **This means that a 200 Wp panel will generate as much power as a 180 Wp panel in 10 years' time (90%) and 160 Wp panel in 25 years' time (80%).** **Note: It is normal for solar panels to lose some of their generating power over time (about 0.5% a year). This is known as degradation.**	The crystalline PV module (which are predominantly used in rooftops over thin-film modules) should be certified to comply with • IEC 61215/IS 14286 – Design qualification and type approval • IEC 61730 – Safety • IEC 61701/IS 61701 – Salt mist corrosion testing (for panels installed in coastal areas or in maritime applications) Panels should also be supplied with the MNRE mandated RFID tag that allows the panels to identified and tracked to the manufacturer for verifying performance.
7.1.2 Inverters	
Inverters are typically warranted for 1 year, with optional extension up to 5 years.	• IEC 61683/IS 61683 – Efficiency • IEC 60068-2 (1, 2, 14, 30) – Environmental testing (Cold, Dry heat, Change of temperature, Damp heat cyclic)
7.1.3 Mounting structures	
Mounting structures are typically warranted for 1 year, with optional extension up to 5 years.	
7.1.4 Batteries	
Batteries are typically warranted for 1 year, with optional extension up to 5 years.	While battery certifications would depend on the application for which they are required, consumers can perform simple checks to verify if the battery is genuine • Capacity-weight – Capacity should correspond with the weight e.g., a 100 Ah battery should weigh about 32 Kgs. • Batch number – This should be embossed (and not provided through a sticker) on the body

7.1.5 Charge Controller/MPPT units	
Charge controllers and MPPT units are typically warranted for 1 year, with optional extension up to 5 years.	• IEC 60068-2 (1,2,14,30) – Environmental testing (Cold, Dry heat, Change of temperature, Damp heat cyclic)
7.1.6 Cables	
Cables are typically warranted for 1 year, with optional extension up to 5 years.	• IEC 60227/IS 694 – General test and measurement of PVC cables • IEC 60502/IS 1554 (Part I & II) – Working voltage up to and including 1100 V and UV resistance for outdoor installation of PVC cables
7.1.7 Junction Boxes/Enclosures for Inverters/Charge Controllers/Luminaries	
Junction boxes and enclosures are typically warranted for 1 year, with optional extension up to 5 years.	• IP 54 (of IEC 529) – Outdoor use • IP 21 (of IEC 529) – Indoor use

The certification for each component can be found on the datasheet for the component.

7.2 Expected lifetime of rooftop PV plant components

Rooftop PV plants have no moving parts and therefore don't suffer from wear and tear, making them extremely reliable. The expected lifetime for the major components in your rooftop solar PV system is given below

- **PV modules –** These should last 25 years, or even longer
- **Inverter –** This is the only major component in the rooftop plant that will require replacement during the lifetime of the plant. Typical life is 5-10 years
- **Mounting structures –** These should last the full 25 years of the plant's lifetime
- **Batteries –** Battery banks can last as long as 10 years with careful maintenance, but 3-5 years is a more typical lifespan

7.2.1 Examples of component failure

While solar PV plants have no moving parts, the components of a plant can fail and require replacement due to several factors. A few examples are given here

- **Modules –** Leakage of current into the frame of the module, resulting in 20-50% reduction in power output
- **Inverters –** Capacitor failure due to ageing of electrolytic materials

- **Junction boxes –** Improper fixing on panel causes the box to fall off the panel, creating a fire hazard

Failures not covered by warranty

Not all component failures are covered by warranties. These are typically due to poor design of the rooftop solar plant. Examples include

- **Modules –** Shadows falling on the panels causes them to burn out
- **Connectors –** Overheating caused by poor fastening
- **Wiring –** Squirrel or bird damage

Chapter 8

Prominent Solar Rooftops

8. Prominent Solar Rooftops

Thanks to favourable policies, both from Central and Stage governments, India has already seen many solar rooftop projects being implemented. Some noteworthy ones include

- **Alpine Knits (Tirupur, Tamil Nadu)**
  Alpine Knits, a spinning mill in Tirupur, Tamil Nadu, commissioned a 1 MW rooftop, grid-connected, DG synchronised solar plant in March 2013. Construction time was 2 months

- **L&T (Chennai, Tamil Nadu)**
  L&T constructed a 1 MW rooftop solar plant on their campus roof in Chennai. The installation incorporates different kinds of solar technology, including Solyndra circular panels, and was constructed in phases from 2010 till 2013. The plant is also notable for its experimental East-West layout which results in greater power generation in the tropical zone

- **Sri Vishnu Educational Society (West Godavari, Andhra Pradesh)**
  The Sri Vishnu Educational Society commissioned a 200 kW rooftop solar plant at their Bhivaram Campus at the end of 2013. The plant is expected to supply 10% of the campus's power needs and break even in 5 years

- **Thermax (Pune, Maharashtra)**
  Thermax constructed a 100 kW solar PV plant on the roof of their Pune office to offset grid power consumption. The plant utilises both mono and polycrystalline panels, dual-axis tracking, and remote monitoring. Construction time was 8 weeks

- **J Mitra Associates (New Delhi)**
  J Mitra Associates has a 100 kW solar PV plant on the roof of their Delhi manufacturing unit. The plant utilises elevated mounting structures to permit other uses for the roof. The weight of the plant is placed on the columns, ensuring no load on the roof plate of the building

- **Scope International (Chennai, Tamil Nadu)**
  Scope International (the BPO division of Standard Chartered Bank) has a 100 kW rooftop solar plant spread over 20,000 SF of roof in its Chennai facility. The pioneering installation is the first commercial rooftop solar PPA project in India, where Scope International only pays for the power generated, rather than owning the asset outright

- **TTK Prestige (Coimbatore, Tamil Nadu)**
  TTK Prestige have installed a 100 kW solar plant on the roof of their Coimbatore facility. The system includes battery backup

- **Engineers India Ltd (Gurgaon, Haryana)**
  Engineers India Ltd commissioned a 90 kW rooftop plant in Gurgaon at the end of 2013. The mounting features a non-penetrating design to avoid waterproofing issues and was completed in just 4 weeks

- **Indian Institute of Technology – Madras (Chennai, Tamil Nadu)**
  IIT-M commissioned a 90 kW plant on the roof of their Electrical Sciences Block in October 2013. The plant is elevated by 8 feet to allow the roof's regular use to continue.

- **Parliament House (New Delhi)**
  The Parliament House Annex has an 80 kW grid connected rooftop plant since 2011. The plant generates about 400 kWh of power per day

- **Mahindra World City (Chennai, Tamil Nadu)**
  Mahindra World City have installed a 75 kW plant on 800 sq.mtrs of the commercial complex roof at their Chennai facility. The unit is expected to generate 1,16,000 kWh annually

- **Sunderlal Jain Hospital (New Delhi)**
  The Sunderlal Jain Hospital in New Delhi features a 50 kW rooftop system. The plant was designed to accommodate the structure's mixture of flat and sloping roofs, and also includes a battery backup system

- **Stella Maris College (Chennai, Tamil Nadu)**
  Stella Maris College have installed 200-panel 50 kW rooftop system at their Chennai campus. The plant features lightning arresters and mounting structures that can withstand 200 kph winds

- **Indian Institute of Science and Education Research (Mohali, Punjab)**
  IISER have installed a 40 kW plant at their Mohali campus. The plant generates up to 200 kWh of power on any sunny day

Rooftop Vendor Directory

Mitramax

Name of the Company	Mitramax Energy Private Limited
Headquarters City	Mumbai
Headquarters Address	Deodhar Centre, 424, Marol Maroshi Road, Andheri East Mumbai 400059, India
Overseas Branch	Putzbrunn, Germany Mitramax Energy GmbH
Highlights of Company & Products	• Holds Patents for on-panel embedded Energy Harvesting and DC Boost increasing PV Array's energy harvesting Efficiency by 10 to 15% compared to conventional array • LEECH HV PV High-yield Modules; 180 -250Wp • 1kW to 50kW Roof-top Back yard Off Grid Solar Systems • Efficient, Simple, Flexible & Durable SUNFED Solar 1kW to 10kW Inverters with 90% efficiency and less than 0.2% of full load current and torroidal output transformer. Line Power as backup • Ruggedized Suryapasad *Lightup India* Home Solar Systems 20Wp to 40Wp
Details of Activities in Solar Rooftop	MITRAMAX ENERGY offers all System Components for Roof-top Off-grid Solar to System Suppliers/Installer. These systems are uniquely engineered for India by most accomplished designers to ensure elegant, durable and reliable Solar Systems
E-Mail Contact	info@mitramax.com
Telephone	+91 22 2829 2055

Gautam Solar

(Formerly Gautam Polymers)

Name of the Company	Gautam Solar Pvt Ltd. (formerly Gautam Polymers)
Headquarters City	New Delhi
Headquarters Address	F-35, Okhla Phase 1, New Delhi-110020
Cities in which branches available	Coimbatore, Mumbai, Delhi, Varanasi, Kanpur, J&K, Bihar, Haryana, West Bengal, Uttarakhand
Highlights of Company & Products	Gautam Solar is amongst the most experienced solar company with 16+ years of experience in solar industry. We are the largest manufacturer of solar lights in India. We are MNRE accredited channel partner with CRISIL-MNRE rating of SP1B which signifies highest technical competence to execute solar projects. We are a company focussed on solar and our 100% revenues come from solar industry. All this signifies a long term commitment to solar market and assurance that the company will be able to provide after sales service support over the long term to projects. Gautam Solar has in-house expertise in solar projects as well as structural engineering that gives us a leading edge in rooftop segment. Our focus is to execute Industrial rooftop solar projects of capacity upwards of 50 KWp. We offer both CAPEX and OPEX models to industries.
Details of Activities in Solar Rooftop	• Turnkey execution of rooftop solar projects for industries and educational institutes • Industry leading comperehensive warranty of 5 + 5 years. Offer long term warranties and after sales service support for rooftop solar projects • Help industries meet energy requirements from solar without any capital investment. OPEX model offers solar power Power Purchase Agreement (PPA) • Assists investors with investment in solar projects with long term secured and attractive returns
Prominent rooftop installations	Gautam Solar is the 1st leading solar company in India to run its own manufacturing operations on solar. 100 KWp solar with battery bank running successfully at Gautam Solar factory, Haridwar has eliminated the need to use DG set during load shedding, Solar project implemented at IIT Kanpur with Dual Axis tracking technology for higher generation, 100 KWp industrial rooftop project in Delhi, synchronized with DG set running successfully for 2+ years at Delhi. Innovative raised platform of 9 ft height allows the roof and valuable real estate to be used as open air meeting room and cafeteria for employees, 3 Industrial projects for textile and gear manufacturing industries in Maharashtra running successfully for more than a year, Several projects under implementation in Tamilnadu for leading industries, educational institutes and a leading retail chain, Off-grid solar projects across 2000+ villages in partnership with TERI and MNRE
Contact Person	Sourabh Jain
Contact No	07498688555 / 96193 80052
Contact Email	gogreen@gautamsolar.com
Website	www.gautamsolar.com

Ganges Internationale

Name of the Company	Ganges Internationale
Headquarters City	New Delhi
Headquarters Address	B-36, Lawrence Road Industrial Area, Delhi 110035
Cities in which branches available	
Highlights of Company & Products	Module Mounting Structures
Details of Activities in Solar Rooftop Prominent rooftop installations if applicable)	❖ Standard structure for 10deg to 25 deg can be used for any part of India ❖ Design compatible for all types of polycrystalline modules ❖ Ballast type design eliminates foundation work on roof and damage to roof ❖ Ready stock and can be dispatched within 5 days ❖ Minimum parts and easy for installation Supplied to EPC players • Inert Kerala • SMC/GEDA Gujarat • CREDA Chattisgarh • BREDA Bihar
Contact Person	Santhosh R Patil
Contact No	011- 47090225, 47090228, 47090229 ; 09311811923
Contact Email	spatel@gangesintl.com , info@gangesintl.com
Website	www.gangesintl.com

Soltech Equipments

Name of the Company	Soltech Equipments
Headquarters City	Chennai
Headquarters Address	No.27/12, Crescent Park Street, T.Nagar, Chennai – 600 017
Cities in which branches available	Chennai
Highlights of Company & Products	Solar Power Solutions / Canadian Solar Inc - Channel Patner, Refusol, Studer
Details of Activities in Solar Rooftop Brief details of prominent rooftop installations	We do Roof-Top, Solar Power System, Off–Grid, On-Grid, Hybrid with reputed make inverters. We did from 1kWp – 200kWp such Systems. SCHOOL INSTALLATION: We did 20kWp Grid – Tie Solar Rooftop system. The system installed with "Refusol" Inverters from "Germany". The Solar power connected with Grid. During day time whatever solar power generated will be put on to usage in priority. The system usage made huge amount of power savings to the school.
Contact Person	T. Sriraman
Contact No	9791094980
Contact Email	info@soltechindia.com
Website	www.soltechindia.com

U-Solar

Headquarters City	Bangalore
Headquarters Address	#6, 1st Floor, 9th 'A' Main, Behinf J.B Nagar Police Station, New BDA Layout, HAL 3rd Stage, Bangalore- 560075
Cities in which branches available	Hyderabad, Chennai
Highlights of Company & Products	U-Solar (www.usolar.in) is a clean energy enterprise specialising in Rooftop Solar PV solutions for institutional, retail and residential customers. We provide turnkey implementation of customised rooftop Solar PV systems for our customers' energy requirements. U-Solar works with top manufacturers of system components from across the world and in India to deliver aptly engineered and highly efficient PV power plants for captive consumption.
Details of Activities in Solar Rooftop Brief details of prominent rooftop installations	U-Solar works across the southern states of India to set up rooftop Solar PV projects for captive consumption. U-Solar's installations run across organisations from various industries such as healthcare, hospitality, retail, manufacturing, publishing, R& D centres and educational institutes among others. Our customers include NIMS hospital (130 kw), Westin Hotels (25 kw), Vasan publications (25 kw), Vinplex India(50 kw), Vidyamandir School (14 Kw), Gudalur Adivasi Hospital(8 Kw), to name a few.
Contact Details	Piyush Kapoor, M: +91 9986943767, E: piyush.kapoor@usolar.in
Website	www.usolar.in

Vigor Solar

Headquarters City	Chennai
Headquarters Address	G-13 Elcanso Complex No 10 Casa Major Road Egmore, Chennai 600008
Cities in which branches available	Hyderabad
Highlights of Company & Products	• Rooftop Solar Power Plants • Solar Plant Consultancy Services • EPC services for solar power plants • Solar Pumps • Solar Streetlights
Details of Activities in Solar Rooftop Brief details of prominent rooftop installations	Consulting Services, Engineering Design, Procurement, Installation & Support • TTK Prestige • Akshaya Homes • Shantiniketan Properties • L&T • Lincoln Electric • National Institute of Ocean Technology • UNDP
Contact Details	Sikkander Amin, M: +91- 9003047542, E: samin@vigorsolar.in
Website	www.vigorsolar.in

CONTURA SOLAR

Headquarters City	Trichy
Headquarters Address	9-B, Oil Mill Road, Industrial Colony SO., Trichy – 620019, Tamilnadu, India.
Cities in which branches available	Trichy, Nagapattinam, Chennai, Kanyakumari, Erode, Pudukkottai, Mahapallipuram, Pune, Faridabad, Torino-Italy, Singapore
Highlights of Company & Products	• Solar PV Mobile Generator. • SOLAR PV Generator KIT. • SOLAR PV Roof-Tops • SOLAR Freezer. • SOLAR DC Kits. • SOLAR Street Lights. • SOLAR Water pumps • SOLAR CAR Ports • Special Purpose SOLAR Electrification Projects • SOLAR TUBE – Daylight Solution
Brief details of prominent rooftop installations	1st Police Station Completely Electrified by SOLAR ENERGY, 1st Temple Completely Electrified by SOLAR ENERGY, 1st Housing Apartment Completely Electrified by SOLAR ENERGY
Contact Details	Arun Rebero, +91-9994921997, +91-8754021383, info@conturaindia.com
Website	www.conturaindia.com

Solar Town Energy Solutions Pvt Ltd

Headquarters City	Chennai, Tamilnadu
Headquarters Address	140, Janaki Commercial Complex, L.B Road, Tiruvanmiyur Chennai - 600041
Details of Activities in Solar Rooftop	SolarTown Energy Solutions Pvt. Ltd. is a fast growing leading EPC system integrator headquartered at Chennai offering premium solar turn key solutions and present across Tamilnadu and Andhra Pradesh. We enable Domestic and Organizations to adopt solar power as a viable energy saving solution. We offer end to end energy saving solutions to the customer with established service network across Tamilnadu and Andhra Pradesh
Brief details of prominent rooftop installations	• 36KW Grid Tie Power Plant - V.V. Rajan & Co -. We have installed a bi-directional meter to export the solar power generated to the grid and avail of the net metering facility announced by the TN Govt. This has helped reduce the energy bill by 25%, 8KW Power Plant for a 7.5Hp Agriculture Pump - We helped the customer eliminate the diesel Operations and maintenance cost for running the pump. This resulted in a payback of less than 2 years , 7KW Grid Tie Power Plant - PSBB School , 10 Clever Square Installations across Tamilnadu - Clever Square is a low cost innovative solution to convert existing inverters into a solar product, Spearheaded the installation and commissioning of a 300KW Power Plant for Infosys, Chennai
Contact Details	Dhanush, +91- 8939951237, dhanush@solartown.in
Website	www.solartown.in

Amplus Solar

Headquarters City	Gurgaon
Headquarters Address	Level 6, JMD Regent Square, Mehrauli-Gurgaon Road, Gurgaon - 122002
Details of Activities in Solar Rooftop	At Amplus Solar, we create value for our customers through efficiencies in development, finance, construction and operation of distributed solar energy projects across the country. We specialise in building rooftop solar power plants for on building rooftops, car parks, and open spaces within the premises on Build Own Operate Transfer (BOOT) basis. Electricity from these plants is sold to the rooftop owner at a price which is competitive to the grid electricity price and the plant is transferred to the rooftop owner at the end of a pre-agreed term. Amplus Solar currently has operations all across India with special focus on Maharashtra, Karnataka, Andhra Pradesh, Delhi and Haryana.
Brief details of prominent rooftop installations	100 kWp for a chain of Educational Institute in Central India – flat RCC rooftop, non penetrating, 940 kWp for a leading automobile compnent industry in Uttar Pradesh – slanting roof, metal sheets, 150 kWp at Rudrapur, Uttarakhand supplying power to grid – slanting roof, metal sheets, 250 kWp at Lalpur, Uttarakhandsupplying power to grid - slanting roof, metal sheets, 250 kWp for an International Hotel Chain in Maharashtra – ground mounted, 100 kWp for an international oil company in Maharashtra - flat RCC rooftop, non penetrating In addition to the above, we are in discussions with consumers across states to set up solar projects totalling more than 20 MW at their facilities.
Contact Details	Abhishek Goyal M: +91- 9971944883 E: sales@amplussolar.com
Website	www.amplussolar.com

Rooftop Urja

Headquarters City	Hyderabad
Headquarters Address	5A, Plot no 17 18 19 D4, Movva Nest, Nizampet, Kukatpally, Hyderabad - 500062
Brief details of prominent rooftop installations	• Rooftop Solar-Grid-Diesel Hybrid Plants, Rooftop Wind-Solar-Grid-Diesel Hybrid Plants • Rooftop Plants comprising Solar PV and Wind Turbine combined with Diesel Generators where Grid Connectivity is not available 18KW Wind-Solar-Diesel Hybrid Plant with battery Backup, 17KW Solar Grid-Tied Hybrid Plant with Net-Metering, 18KW Solar-Grid Hybrid Plant with Net-Metering with battery backup
Contact Details	Satish Inaganti, +919820039468, info@rooftopurja.in
Website	rooftopurja.in

Evervolt Green Energy Pvt. Ltd.

Headquarters City	Bangalore
Headquarters Address	# 562/640, 3rd Floor, A Wing, Janardhan Towers, Bilekahalli, Bannerghatta Road, Bangalore- 560076, India
Details of Activities in Solar Rooftop	Evervolt helps more & more companies, factories, malls, educational institutions, hotels & resorts etc. to switch to clean and affordable solar energy. Evervolt offers industry leading end to end solar solutions to its customers ranging kilowatts to megawatts. Our solutions enable customers to benefit both in terms of cost and continuous supply of energy over a long run. Our strength lies in providing the best technology at affordable cost for all customers. Evervolt provides various financing options to its customers keeping in mind the cost of the system & customer requirement, because no single customer is same. Our cash back performance guarantee program shows our quality strength and long term commitment to our customers.
Contact Details	Mr. Krishna Thimmaiah M: +91 988 071 0526 E: info@evervolt.in
Website	www.evervolt.in

Sree Nandhee's Technologies Pvt Ltd

Headquarters City	**Chennai**
Headquarters Address	No.A2/1, Second Floor, 1st Cross Street, 1st Main Road, Ambattur Industrial Estate, Chennai – 600 058
Details of Activities in Solar Rooftop	We are MNRE channel partner and ISO certified company. We do design, installation and commissioning of solar power plant for the application from domestic to industries, having the experience in rooftop, ground mounting and metal sheet slope roof and Cement sheets. We have supplied and installed in KW to MW, Acsys Software , CAMS, Dr. MCET, Sona college of Technology, Rajendran Association ,L&T Chennai ,Hexaware, Godrej and many other domestic customers
Contact Details	Mr. Nagarajan C R, 044 43436969 , nagarajancr@sreenandhees.in
Website	www.sreenandhees.in

Avant-Garde Systems and Controls (P) Ltd

Address	67A, Porur Kundrathur High Road, Porur Chennai – 600 116
Details of Activities in Solar Rooftop	• EPC Services for Roof Top Solar PV Systems • Tailor-made Engineering Solutions for Roof Top Solar PV Systems for Industries, Commercial complexes, Institutions & Residential Buildings • Consultancy and Detailed Engineering Services for Rooftop & Ground Mounted Solar PV Systems • Project Management Services • Accredited Channel Partner of MNRE
Contact Details	Phone: 044 – 4598 1200 E-Mail: agsc@vsnl.com | sbalaguru@avant-garde.co.in Website: www.agsc.in | www.avant-garde.in

Ads Projects and Systems

Address	First Floor, 40, Hanuman Lane, Connaught Place, New Delhi - 110001, India
Details of Activities in Solar Rooftop	ADS Projects & Systems is an Expert Engineering & Design Consultancy and Training services provider having already completed more than 21MW Consultancy on the Utility Scale and + 2 MW Consultancy on the Rooftop Solar Power Plants. Provided trainings to C-level Executives /Directors /Top Management/Managers and Engineers of leading Consultancy firms, Developers, Manufacturing & EPC companies plus Scientists/Research Associates/Students of premium research and educational establishments. The client list includes big names like Enfinity Solar Solutions, Vikram Solar, Emergent Ventures, Azure Power, Moser baer, HBL, Jain Irrigation, C-WET (MNRE, Govt. of India), TERI, GERMI, IIT Roorkee and many other prestigious organisations.
Contact Details	Mr. Vinay Goel, Executive – Projects,011 - 2336 4217 ; +91 - 965 400 4138

Kotak Urja

Address	No. 378, 10th Cross, 4th Phase, Peenya Industrial Area Bangalore - 560 058
Details of Activities in Solar Rooftop	KOTAK URJA established in the year 1997 and specialized in Solar Roof top system, both in Off-grid and Grid Tie Project with capacity ranging from 1 KW to 100 KW and above and are having presence in PAN India operation with Clients existing both in Private and Govt. segments.
Contact Details	Mr. Manoj Kumar P B, Vice President - Mktg & Projects Ph: 9611109762

Delta	
Address	Delta Power Solutions India Pvt Ltd Ozone Manay Tech Park, "A" Block, 3rd Floor, Hosur Road, Hongasandra Village, Bangalore-560068
Details of Activities in Solar Rooftop	Delta's state-of-the-art SOLIVIA and RPI Solar Inverters' portfolio includes grid-tied transformerless range of 3KW, 5KW, 12KW, 15KW, 20KW, 30KW and 50kW in string series; 250kW and 500KW in central inverters with Industry's high efficiency up to 98.3%. These inverters are aimed at catering customers with home, commercial and utility scale inverter requirements including rooftop applications. These inverters are multifaceted and are compatible with all commercially available solar modules and system components.
Contact Details	Phone : +91-80-67164777 / 60 / 11 / 07 Email : sales.india@solar-inverter.com | support.india@solar-inverter.com Website: www.deltaelectronicsindia.com
Sunair Power	
Address	S60, 4th Cross, 3rd Stage, 4th Block, Basveswarnagar, Bangalore 560079. Tel: +91 80 22256895 / 23221596
Details of Activities in Solar Rooftop	MNRE Empanelled Vertical Axis Wind Turbine - SPVAWT1-650W coupled with Solar PV on rooftops to implement hybrid power solutions up to 5KW for Indian conditions. Increase capacity with multiple VAWT and PV for space available. Power Steering MPPT charge controllers for existing UPS upgrade to Solar. Zero Drop charge controllers, MPPT charge controllers for Solar. Do It Yourself Kits and complete solutions for Wind or Solar only or Hybrid. Dealers Distributors inquiries welcome. Visit www.sunairpower.co.in
Contact Details	Venkatesh Prasad - 9243106962 Ramesh Viswanath 9341245654 Website - www.sunairpower.co.in Email - venkatesh@sunairpower.co.in
Genus Power	
Address	SPL – 3, RIICO Industrial Area, Sitapura, Tonk Road, Jaipur-302022 (Rajasthan) T: +91-141-7102400/500
Details of Activities in Solar Rooftop	We offer turnkey rooftop solar power plants for residential applications from 1 kW to 10 kW. Our comprehensive rooftop solar power plants include: • Grid Connected solar plant with Net metering system • Grid Connected solar plant with battery bank • Hybrid Solar power plant with & without battery bank We also provide solar rooftop power plants with Net Meter and Smart Metering System with integrated communication and control supporting the Smart Grid-PV model.
Contact Details	Mr. S P Singh ,Email - sp.singh@genus.in ,M. +91-9828521275 , D. +91-141-7102542

SOLFREEDOM (SUNSHINE SOLPOWER GENERATION LTD)

Address	602, A Wing, Prathmesh Tower, Raghuvanshi Mill Compound, Senapati Bapat Marg, Lower Parel (West), Mumbai -400013
Details of Activities in Solar Rooftop	1) Pioneers of the Solar Rooftop OPEX/BOOT model in India. 2) There would be no Upfront Costs and Investment from the client. 3) We invest, install, own and operate the Solar Plants set up on the rooftops/open areas at the clients site. 4) We charge on a per unit basis only for the electricity consumed by the client. 5) Solar Tariff would be lower than the Grid/Diesel Tariff and the client would avail guaranteed savings.
Contact Details	Tel No. 022-61524301,61524305,61524335,61524323

Evolve

Address	Shimato Enterprises Pvt Ltd., No. 102, Armenian street, Chennai - 600 001. Billing address : Shimato Enterprises Pvt Ltd., No.371, Sidco industrial estate, NP Ambathur,– 600 095.
Details of Activities in Solar Rooftop	• ISO 9001 Certified & High quality focused EPC with World class components and installation practices and project has been showcased in Times now TV. • Exclusive distributor of UPSOLAR in India • Distributor of SCHNEIDER ELECTRIC, SMA Inverters and LEONI Cables. • Complete concept to completion for Grid tie, off grid & Hybrid systems with NET METERING. • Various projects completed. • We offer BOSCH Solar water heaters for Homes & Large commercial applications.
Contact Details	Rajesh V Shah, CEO - Mobile : 72999 22535, Murrugan General Manager (Operations & Marketing) - Mobile : 72999 09695, Satheesh, Dy. Sales Manager - Sales - Mobile 72999 09691

Tapan Solar Energy Pvt. Ltd.

Address	SF-40, Crossriver Mall, CBD Ground, Shahdara, Delhi-110032
Details of Activities in Solar Rooftop	Tapan Solar Energy Pvt. Ltd. (ELECSSOL) is the leading Solar PV manufacturer and EPC company. With more than 2000+ distribution/dealer Network, we have one of largest teams to serve our clients. We offer services to personal residences, educational institutes, hospitals, manufacturing plants and various Govt. organizations. We would be happy to offer our expertise to give you your ideal rooftop solar plant. We are accredited MNRE Channel partner & undertake all kinds of consultancy services for Solar Power plants.
Contact Details	Ph No.: +911142111913/14/15 E: info@tapansolar.com | offgrid@tapansolar.com Website: www.elecssol.com

Veyyon Power Solutions Pvt Ltd.,	
Address	No. A2/1, First Floor, 1st Cross Street, 1st Main Road, Opp. To AIEMA Technology Centre, Ambattur Industrial Estate, Chennai – 600 058
Details of Activities in Solar Rooftop	We introduce ourselves as business partners for KACO range of products for southern India. We can support across the country. We can install and maintain the system anywhere in India. Some of our Prestige's customers are L&T, Computer Age Management Services, Sona College, Avtec Limited, Hexaware, Godrej
Contact Details	Contact No: 044 – 26254447, 9840337404 Email ID : veyyonpowersolutions@gmail.com , crnvps@gmail.com

About EAI

Energy Alternatives India (EAI) is a boutique research and consulting firm focusing on the Indian Renewable Energy and Cleantech industry. We operate across the spectrum of sustainable technologies, from mainstream areas such as **Substitution of Diesel with Solar** to niche domains such as **Algae Fuels**, with a **special focus on rooftop Solar PV**.

Solar Assist

Our rooftop solar programme is designed to help industrial and commercial energy consumers implement reliable, high performance rooftop solar PV systems that provide highly favourable financial returns.

We emphasise integration with diesel generators as a key area where energy consumers can extract significant value through diesel savings.

More information on Solar Assist can be found here:
http://www.solarmango.com/in/our-services/

Our Team

Founded by professionals from IITs and IIMs, our team comprises professionals with diverse expertise – renewable energy/ cleantech, energy engineering, management consulting, and finance specialists. Detailed team profiles can be found here: http://www.eai.in/ref/team/team.html

Should you have any questions on the guide or being a sponsor / promoter of the guide, send a note to Siva – mgsiva@eai.in

EAI

Solar Mango

Everything about Rooftop Solar

Are you a Commercial or Industrial unit looking to have rooftop solar?

Making mistakes in rooftop solar can be costly. Talk to us first!

TAKE EAI'S **FREE EXPERT ASSISTANCE** BEFORE YOU MAKE YOUR **INVESTMENT**

Solar Assist is a consultation service provided by the rooftop solar experts at EAI's Solar Mango division. At the end of this consultationsession you get the following:

- Clear estimate of the solar power plant capacity you will require
- Realistic estimate of the costs
- Details of technical architecture and latest innovations
- Guidelines to significantly reduce diesel consumption using solar
- Suggestions on suitable vendors

You get all the above inputs at no cost!

Interested?

Send an email to
enquiry@solarmango.com

www.solarmango.com