Netherlands Enterprise Agency

INDO-DUTCH COOPERATION ON SOLAR PV

IDENTIFICATION OF PROJECTS

FINAL REPORT FEBRUARY 2016

Auroville Consulting

Energy Indeed

COLOPHON

Title
Indo-Dutch cooperation on solar PV: identification of projects

Version
Final report

Date
February 2016

An assignment of
Netherlands Enterprise Agency (RVO.nl), International Energy Programme (PEI)

Project coordinator
Leon Wijshoff, Senior Advisor, Netherlands Enterprise Agency

A production of
Auroville Consulting and Energy Indeed

Authors

Mark Meijer	+31 6 41 70 96 52	mark@energyindeed.com
Martin Scherfler	+91 9486 144 076	martin@aurovilleconsulting.com
Nitin Cherian	+91 9655 933 511	nitin@aurovilleconsulting.com

TABLE OF CONTENTS

1 – INTRODUCTION

India has high ambitions when it comes to solar photovoltaic (PV). The country aims to have 100 gigawatt (GW) of solar PV installed capacity by the year 2022. This is about twenty times as much as the currently installed solar PV capacity in India. More specifically, the country aims to divide the 100 GW target into 60 GW of utility-scale solar and 40 GW of rooftop solar.

Regarding these high ambitions and regarding the strengths of the Dutch solar PV sector[1], the Dutch Ministry of Economic Affairs has decided to appoint solar PV as the focus area for their activities under their Memorandum of Understanding (MoU) with the Indian Ministry of New and Renewable Energy (MNRE). This MoU aims at intensifying cooperation on renewable energy between the two countries.

At the Dutch side, the Netherlands Enterprise Agency (RVO.nl) and particularly its International Energy Programme (PEI) is assigned by the Dutch Ministry of Economic Affairs to put this focus into practice. The basis for this is a market study that was assigned by RVO.nl and performed by Auroville Consulting from India and Energy Indeed from the Netherlands in 2014-2015.[2]

This market study shows that there are several solar PV related business opportunities for Dutch organizations in India. Among others, these opportunities concern research and development (R&D) activities, the supply of production machines, project finance and the supply of solar PV systems and components like inverters, mounting systems, monitoring instruments, chargers and others.

Especially with respect to the latter – the supply of solar PV systems and components – RVO.nl has requested the authors of the market study to set up follow-up activities for the identification of relevant niche markets and projects for Dutch organizations in India. This document provides a brief report of those activities.

***Figure 1** – 7.5 MW rooftop system (Beas, Punjab)*

***Figure 2** – 10 MW canal-covering system (Vadodara, Gujarat)*

[1] Atrivé & Energy Indeed – International positioning of the Dutch PV sector, July 2014 (assigned by the Netherlands Enterprise Agency, RVO.nl)

[2] Auroville Consulting & Energy Indeed – New solar PV business opportunities between the Netherlands and India, March 2015 (assigned by the Netherlands Enterprise Agency, RVO.nl). See: http://www.rvo.nl/sites/default/files/2015/05/Solar%20PV%20Netherlands-India%20final%20report.pdf

2 – AIM AND APPROACH

Assigned by RVO.nl, Auroville Consulting from India and Energy Indeed from the Netherlands have been working together on Indo-Dutch solar PV cooperation since September 2014. The first result of this was a market study that was published in March 2015. The following chapter briefly describes the aim and approach of the follow-up activities of this market study.

2.1 – Aim

In brief, the follow-up activities aim:

1. To provide Dutch companies a better insight in niche markets and projects where they can showcase their products/expertise on solar PV and where they can build up experience in cooperation with Indian Partners;
2. To provide the Dutch government with insight whether existing support schemes are useful for Dutch companies who want to do solar PV related business in India, as well as what kind of support could be requested from the Indian Government as part of the MoU activities.

2.2 – Approach

In succession, the following steps have been taken:

a. Brief summaries of Dutch organizations – We have contacted about 20 Dutch organizations that have shown interest in solar PV in India before in order to make brief summaries about their current activities and the kind of projects and/or partners that they are looking for in India (see *Chapter 3*). Some organizations like Cityblob, DNV GL, Esdec, Orange Solar, Philips Lighting, PR Electronics and Solarus have provided input during face-to-face meetings with Leon Wijshoff (RVO.nl), Mark Meijer (Energy Indeed), and/or Vijay Kumar (Netherlands Business Support Office, Chennai). Others have provided input by mail and/or by phone.

b. Visit to InterSolar India – Together with RVO.nl, we have joined the InterSolar India exhibition and conference in Mumbai on November 18-20, 2015 (see *Chapter 4*). We have shared the results of this with the Dutch organizations.

c. Selection of states – In order to create focus and to make opportunities more specific, we have made a selection of states in India where the conditions for the Dutch organizations are good in the short and medium term (see *Chapter 5*).

d. Identification of niche markets and projects - Based upon the briefs of the Dutch organizations, we have identified interesting niche markets and project types for Dutch organizations in the selected Indian states (see *Chapter 6*).

e. Identification of launching customers – Thanks to support from the Netherlands Business Support Offices (NBSOs) in India, we have had discussions with Dutch organizations in India about launching an Indo-Dutch solar PV demonstration project at their site/building(s).

f. Identification of Indo-Dutch partnerships – In order to make such a demonstration project happen, we have linked Dutch solar PV organizations with organizations in India, both potential launching customers as well as potential partners in India (see *Chapter 7*).

g. Business case analysis – We have explored the business case of a demonstration project at one specific site of a Dutch company in India. This business case analysis is part of a feasibility study that has been performed, which covers both technical and financial aspects.

h. Usefulness of existing support schemes – We have assessed the usefulness of existing support schemes of the Dutch government for this matter, in particular the DHI-regulation for demonstration projects, feasibility studies and investment preparation studies.

3 – CONTACTED DUTCH ORGANIZATIONS

This chapter provides brief summaries of 20 Dutch organizations with a (potential) link to solar PV in India. In practice, more than 20 organizations have been contacted, but organizations without a potential link to solar PV in India in the near future are left out here. Later on, *Chapter 5* describes Dutch organizations who are based in India and who might become a launching customer.

Most of the organizations mentioned have already been involved in the discussion on results of the first market study about solar PV in India. The others have been added as a result of new contacts by RVO.nl or by the authors.

3.1 – 4Washing

4Washing is a sales and marketing organization that sells fully automated window and solar PV cleaning systems to distributors and dealers. In the Netherlands, the company also works on demonstration projects for building-integrated PV (BIPV) systems. The company's main R&D and assembly location is in India (Chennai).
www.4washing.com

3.2 – Cityblob

Cityblob is an Amsterdam-based architecture, urban planning and real estate development company. The company has several projects in India, including the development of social housing units in India and the development of solar PV systems for schools in India. The latter project has also been the subject of a Master thesis by a student of the Delft University of Technology.
www.cityblob.com

3.3 – DNV GL

Since 2011, the former Dutch company KEMA is part of DNV GL. DNV GL provides services in several sectors (Maritime, Oil & Gas, Energy, Business Assurance and Software), including independent accredited certification services. DNV GL has about 100 solar PV professionals worldwide. The contact point of DNV GL for solar PV in India is their office in Singapore.
www.dnvgl.com/solar

3.4 – DOEN Foundation

DOEN is a non-profit foundation, set up in 1991 by the Dutch Postcode Lottery, to invest in social, cultural and environmental entrepreneurs as well as a variety of charity organisations that are unable to directly receive funding from the lottery.

The focus of DOEN is on starting entrepreneurs who want to create sustainable access to energy in rural areas. The foundation is purely focussed on impact and prepared to take risks in early stages. The foundation's geographical focus is on India and East Africa.
www.doen.nl

3.5 – DSM

The Dutch multinational DSM has developed an anti-reflection coating for solar panels (Khepricoat) that can improve the panels' efficiencies. The company has also acquired a Dutch start-up (Solar Excel) that had developed a foil that 'catches' sunlight using a unique light management technology.

To increase the demand for these products, DSM works on demonstration projects to proof the performance of their products. An example of such a project is the 1 MW PV system next to their factory in Pune, India. The overall focus of DSM is to create the lowest Life Cycle Costs of Ownership (LCCO).
www.dsm.com/solar

3.6 – Esdec

Esdec develops, manufactures and supplies professional mounting structures for the mounting of solar panels on roofs. These structures are called ClickFit for slanted roofs and FlatFix for flat roofs. Since the establishment of Esdec in 2004, more than three million solar panels with a combined capacity of more than 500 MW have been installed on ClickFit and FlatFix mounting structures.
www.esdec.nl

3.7 – Eternal Sun

Eternal Sun is an original equipment manufacturer (OEM) of AAA class large area solar simulators. The company mainly works with solar R&D, certification bodies and manufacturers. A brief impression of the company can be found on: https://www.youtube.com/watch?v=Njsvzaxd-Ls

Eternal Sun already has several projects in India and a local representative in India to promote, sell and service their equipment in the region.
www.eternalsun.com

3.8 - Exasun

Exasun manufacturers innovative back-contact glass-glass all-black solar panels. Their manufacturing takes place in the Netherlands. So far, the focus of the company has not been on India, but this might be different next year.

In particular, the company might be looking for building-integrated PV (BIPV) projects in India.
www.exasun.com

3.9 – Heliox

Heliox is a company specialized in switch mode power technology. The company designs and manufactures products and solutions for a broad range of markets, such as PSUs, Class D amplifiers, lamp drivers, chargers and inverters. This includes inverters for special purposes, like solar PV micro-inverters for the built environment.

The company is not just a design company. Their product can be manufactured by themselves or by another company, but they always want to have a share in the sales revenues and they ask for a partial compensation when there is a shared development of a product.

Since recently, the company is active in India with Electric Vehicle (EV) chargers for heavy vehicles like buses. The company also has an agent in Mumbai. Heliox does not have any solar PV projects yet in India, but they are open for collaboration.
www.heliox.nl

3.10 – Hukseflux

Hukseflux supplies monitoring equipment for solar PV systems. Customers are served through their main office in the Netherlands and locally owned representations in the USA, Brazil, India, China and Japan. The company is very active in India. In fact, Hukseflux is currently setting up an independent company in India: Hukseflux India.
www.hukseflux.com

3.11 – Kipp & Zonen

Hukseflux originates from another Dutch company, Kipp & Zonen. Kipp & Zonen supplies monitoring equipment for solar PV systems as well. The company is active almost all around the world and currently has one distributor in India, in New Delhi. In the near future, the company might expand its number of representatives in India.
www.kippzonen.com

3.12 – Orange Solar

Orange Solar provides solar panels, inverters and solar production lines. The solar panels can be divided into two categories: (1) specials (e.g. flexible, light-weight, custom-made panels) and (2) more ‘standard’ solar panels. The first category is produced in the Netherlands, while the second category is produced at several other locations in Europe. The company sells worldwide.
www.o-solar.com

3.13 – Philips Lighting

The Dutch multinational Philips is present in India since the year 1938 (!). In India the company for instance supplies street lighting on solar energy. The solar part of these projects is performed by an Indian company, Topsun Energy. In general, the company is in the middle of a business transformation from products to services, so for instance from supplying lamps to supplying a certain amount of lumen for a certain amount of time.
http://www.lighting.philips.com/main/products/solar.html

3.14 – PR Electronics

PR Electronics develops power electronics technology for original equipment manufacturers (OEMs). This includes the development of technology for solar inverters, but also for (fast) charging stations for electric vehicles. For instance, the company has developed the technology for the famous FastNed charging stations in the Netherlands: http://fastned.nl/en/.

Since recently, PR Electronics is also the R&D partner of Rural Spark.
www.prelectronics.com

3.15 – Rural Spark

Rural Spark is a Dutch start-up, founded in 2013 by Evan Mertens, Harmen van Heist and Marcel van Heist. The company delivers smart grid solar solutions at the 'base-of-the-pyramid' (BoP) in rural India. The company has an office in Delhi and a project with over 1,500 households in Bihar. So far, Rural Spark has received around $750k of investments and $125k in grants.
www.ruralspark.com

3.16 – Solarus

Solarus develops, manufactures and supplies innovative CPVT systems, which concentrate sunlight for both solar PV and thermal energy. The output of these systems is 80% heat and 20% electricity. Therefore, the most interesting clients for Solarus are industrial buildings with a substantial heat demand. However, the systems can also be used for cooling purposes.

The company is based in Venlo, the Netherlands. This is also where the core of the systems is produced. The company can supply up to 25,000 collectors per year. Solarus has MoUs with two Indian organizations: TARA and Sunquest. Solarus also has a partner in Chennai, who is also involved in the solar cooling projects of TNO in India.
www.solarus.com

3.17 – TNO

The Netherlands Organisation for Applied Scientific Research (TNO) was founded by law in 1932. With approximately 3,800 employees, it is the largest research institute in the Netherlands. Besides pure research, the organization also offers consulting services and grants licences for patents

and specialist software. Moreover, TNO sets up new companies to market innovations.

Regarding solar PV in India, TNO does several things: (1) FDOV, adjusting and implementing a solar powered cooling technique for decentralized storage and cooling of agricultural products, (2) MPEDA, using solar energy for water purification at fish farms, in collaboration with CSIRO, and (3) using solar energy to convert biogas into CNG for transport purposes.
www.tno.nl

3.18 – Triodos Foundation

Triodos Foundation supplies small donations – typically 5,000 or 10,000 euro – to projects, which are not too big (the donation should make a difference) and often non-profit. In the past, the foundation had a specific fund for renewable energy projects, but the money of this fund is spent. Currently, there is not such a fund. Occasionally, energy projects might be funded by general means.
www.triodosfoundation.nl

3.19 – Victron Energy

Victron Energy is the world's market leader in quality products for autonomous power supply. The company supplies solar charge controllers and inverters, as well as batteries and solar panels.

The company produces in India and also has projects in India. A project example is the transition of a guesthouse in Auroville from an oversized diesel generator to a solar-based electricity supply.
www.victronenergy.nl

3.20 – Walraven

Walraven is a Dutch multinational, founded in 1942. The company is still in the same family hands. Walraven's products are used by tens of thousands of installation companies in Europe, North America, Latin America, Africa, the Middle East, Asia and Australia. The company has about 950 active employees.

The company has three product groups: (1) fire protection systems, (2) sanitary systems and (3) fixing systems. The latter group includes mounting systems for solar PV, both for rooftop systems as well as for ground-mounted systems (including large solar farms in China).

The company recently started a production facility in India (in a joint-venture with their partner in Dubai), which is now fully ready for large and medium-sized systems (at least >24 panels). Their strategy is 'local for local': their products produced in India are for the Indian market.

Currently, the company focuses on large PV projects (both from public and private organizations). They are not really competitive concerning small

systems. Their added value is that they can provide a total solution, including all calculations, project engineering, etc.
www.walraven.com

3.21 – ZigZagSolar

ZigZagSolar supplies a smart solar facade system. This system offers both high architectural exposure and energy harvesting options. A brief impression of the company can be found on:
https://www.youtube.com/watch?v=yMVsxy_EHfg

ZigZagSolar focuses on new buildings with many facades. The company is preferably already involved in the first design. ZigZagSolar can make all the solar calculations, including the shadow effects from surrounding buildings.
www.zigzagsolar.com

4 – VISIT TO INTERSOLAR INDIA

We have asked the Dutch organizations mentioned above if they would be interested to visit the InterSolar India conference and/or exhibition in Mumbai on November 18-20, 2015. Intersolar is India's largest solar exhibition and conference. With enough interest, visiting this event could have been combined with other solar PV related visits in India. Unfortunately, at that moment in time, there was not yet enough interest. Still though, several Dutch companies were present and we managed to collect information and contacts for Dutch organizations that were not yet present.

Three Dutch companies were present with a booth at the exhibition: Hukseflux (see *paragraph 3.9*), Kipp & Zonen (see *paragraph 3.10*) and Victron Energy (see *paragraph 3.18*). Besides, DSM (see *paragraph 3.4*) was present as the main partner of the conference. RVO.nl, Auroville Consulting and Energy Indeed were present at both the conference and exhibition to collect (sometimes specifically requested) information and contacts for Dutch organizations that were not yet present. After the event, relevant information (for instance typical prices) and contacts have been shared with the Dutch organizations. Below *Figure 3* a brief summary of the event is given.

Figure 3 (a) *– Impression of the InterSolar India 2015 in Mumbai (source: InterSolar, 2015)*

Figure 3 (b) *– Impression of the InterSolar India 2015 in Mumbai (source: InterSolar, 2015)*

The conference program, which can be found in *Annex I*, focussed on a broad range of subjects of interest for the on-going developments in India. Part of the program was dedicated to the Indo-German cooperation which showed to be very strong and strongly supported by the 1 billion euro loan arrangement made between Prime Minister Modi and German Chancellor Merkel.

Besides many research related issues, the development of the large solar PV projects was a topic of high interest. Dr. Kahre, head of the solar programme of the Ministry of New and Renewable Energy, paid specific attention to the fact that the tender system had already led to strong price reductions as the latest that tender in the state of Maharashtra has resulted in a price below of 5 INR/kWh (0.06-0,07 euro) for a 500 MW solar farm. Next to these promising messages there were also some critical notes; quality might get to too little attention because of the strong focus on price.

The exhibition showed that the solar PV business in India is growing. Solar PV cells and modules are still mainly produced abroad, but production of other parts of solar PV systems is already strongly present in India. Contacts were made with several exhibitors to inform them about the opportunities from the Netherlands using the brochure of RVO.nl[3]. First impressions from Victron Energy on the results of the exhibition were positive.

The visit to InterSolar confirmed the assumptions by RVO.nl and the authors that no direct role is foreseen for the Dutch organizations mentioned in *Chapter 2* in the development of large solar farms. For the Dutch, niche markets with small and medium scale solar PV projects (mainly rooftop) would be more interesting, as the price focus might also be less in these markets.

[3] Brochure: Let the Dutch provide you with smart solutions for Solar challenges". See: http://www.rvo.nl/sites/default/files/2015/05/Zon%20PV%20HB%20brochure%2C%20spread.pdf

5 – SELECTION OF STATES IN INDIA

In order to better deal with the scale and magnitude of the Indian solar PV market we have decided to focus the initial efforts in bringing Dutch solar PV technology and know-how on 2 or 3 federal states in India that currently promise a conducive market trend and policy environment for small and medium scale solar PV projects (mainly rooftop).

For this selection procedure we have used selection criteria such as: a supportive solar PV policy environment, attractive electricity tariffs, good national and international transport connectivity and ideally a good presence of Dutch organizations. We have given each of these criteria a qualification from reasonable (1 point), medium (2 points) to good (3 points). These results have been multiplied by the importance factor (1-3) allocated to the criteria. *Table 1* shows a summary of the results of this exercise. Details behind these numbers can be found in *Annex II*.

In line with *Table 1*, the states of Tamil Nadu, Maharashtra and Karnataka have been shortlisted as states that show a favourable environment for solar PV. The three states also have a strong presence of the Netherlands Business Support Office (NBSO) and a sizable number of Dutch companies. Different components that where compared have been weighted to arrive at the final rating for the shortlisting.

No	State	Rooftop solar PV policy	Type of policy	Special features of existing policy	Subsidies for rooftop solar PV	Rooftop solar PV targets till 2022	Load Shedding	Rating
	Importance:	**High (max. 9)**	**High (max. 9)**	**Low (max.3)**	**High (max. 9)**	**Medium (max. 6)**	**Medium (max. 6)**	**(max. 42)**
1	Tamil Nadu	9	6	2	6	6	4	**33**
2	Maharashtra	9	6	2	3	6	4	**30**
3	Karnataka	9	9	2	3	4	2	**29**
4	Gujarat	6	6	1	3	6	6	**28**
5	Kerala	9	6	3	3	2	4	**27**
6	Puducherry	9	6	2	3	2	4	**26**
7	Odisha	9	6	2	3	4	2	**26**
8	Rajasthan	9	6	2	3	4	2	**26**
9	Delhi	6	6	2	3	4	2	**23**

***Table 1** – Shortlist of Indian states based on rooftop solar PV policy*

6 – SELECTION OF MARKET SEGMENTS

Besides reducing the complexity of the Indian solar PV market by focusing on some selected Indian federal states, we have decided to identify specific market segments that present opportunities for Dutch organizations with solar PV related activities.

We have identified market segments that have a promising trajectory for short and medium deployment of solar PV systems. We have done this identification through face-to-face talks with industrial experts and through information gained at the InterSolar (see *Chapter 4*).

Additionally, Dutch strengths such as a good track record in hybrid and off grid-solutions, solutions for solar PV thermal hybrid systems, good products in the mounting structures and inverter segment have been considered to identify the following potential market segments:

a. Telecom towers;
b. Petrol stations
c. High-end guest houses/spas in rural areas;
d. Shopping malls;
e. Educational institutes, colleges and campuses;
f. Hospitals;
g. Facilities of Dutch organizations in India;
h. Food processing industries.

A more detailed description of segment a), the telecom tower segment, has been completed for the state of Tamil Nadu to enable a better discussion with the Dutch organisations, see Annex III. This description includes the following components: market size and trends, energy requirements for this segment, policies and regulatory frameworks, current trends for deployment of renewable energy technologies (RETs), major industries in the market and project costs and financials.

This more detailed description of segment a has been shared with Dutch organizations in the solar PV sector (see *Chapter 3*). It turned out that the telecom tower segment could specifically be interesting for Orange Solar, since they are already working on solar PV for telecom towers in West-Africa.
In general the Dutch companies indicated not to have a specific focus yet on certain sectors as they missed the launching customers. Some indicated their focus on India is not a priority but they have a more medium term focus.. Therefore, it was decided to take another approach in which we have tried to arrange links with Dutch organizations which have production facilities in India and might be interested in Solar projects and a Dutch touch. Another advantage of this segment would be that the Solar companies might feel more at ease to do business with a Dutch company.

7 – POTENTIAL CLIENTS AND PROJECTS IN INDIA

In order to accelerate the deployment of Dutch solar PV technology and knowledge in India, Dutch organizations operating in India have been identified as potential entry points. A total of 17 Dutch organizations have been contacted in order to identify their interest in installing solar PV demonstration projects using Dutch technology.

With the assistance of the NBSOs and the Dutch Consulate General in Mumbai, Dutch organizations operating in the shortlisted states – Karnataka, Maharasthra and Tamil Nadu – have been identified. 17 Dutch organizations have been contacted (mail and telephone) in order to find out about their interest in collaborating on demonstration projects that showcase Dutch solar PV technology to India (see *Table 2*).

In addition, via these Dutch organizations, contacts have been established with 7 Indian organizations (see *Table 3*). So, in total 26 organizations have been contacted. 18 out of the 24 organizations have initially responded and expressed an interest. With about 11 organizations a dialogue has been initiated with potential Dutch partners. To highlight some (initial) results at the time of reporting:

a. **Solarus** – Solarus and Auroville have signed a non-disclosure agreement (NDA) and are planning to install a demonstration project at a local community kitchen within the next 3 months. This was initiated through a meeting of a representative of Auroville to Solarus in January 2016 and followed up by a visit of the CEO of Solarus and local Solarus representatives to Auroville in February 2016. Based on the exchange of first ideas we also looked into the opportunities for subsidy from the DHI scheme. The DHI scheme is a subsidy scheme for demonstration, feasibility and investment preparation (see: http://www.rvo.nl/subsidies-regelingen/dhi in Dutch). Given the fact that Solarus had been assigned a subsidy in 2015 for another project they could not apply for a subsidy for the India project. A second demonstration by Solarus at a location in Puducherry Unity Territory is currently under discussion and may be finalized soon.

b. **Hunter Douglas** – Hunter Douglas has asked for an initial indication of the technical and financial feasibility of installing a solar PV rooftop system at one of their manufacturing units. This feasibility study has been completed and shared with Hunter Douglas. Hunter Douglas agreed that this initial feasibility study is shared Orange Solar in order to explore future cooperation.

c. **PR Electronics** – The CEO of PR-Electronic visited India in January 2016 and met with the Managing Director of Su-Kam, an Indian company that manufactures solar PV inverters to explore possible collaboration with regard to grid-interactive and hybrid inverters.

d. **Rural Spark** – Rural Spark was introduced to Kusters Engineering BV with regard to a project that aims at bringing solar street lighting to rural villages in Maharashtra. Rural Spark was also introduced to Indian Engineering Company, Prakti Design, which focuses

on the manufacturing of energy efficient cooking stoves and focuses on the same market segment (the bottom of the pyramid market) as Rural Spark. A possibility for collaboration in marketing and distribution is currently being explored. Further, Rural Spark was introduced to Auroville Energy Products, a potential partner in the distribution of their solar light products.

e. **Fourth Partner** – Fourth Partner, an Indian solar PV project developer, expressed interest in a series of Dutch solar PV related technologies such as anti-reflection coating for solar panels, micro-inverters, monitoring equipment for solar plant, flexible panels, module cleaning technology and on-site portable power storage. An introduction to the following Dutch Organizations has been facilitated: Alfen, DSM, Heliox, Hukseflux, Kipp & Zonen, Orange Solar, PR Electronics, 4Washing/Endotec and Victron Energy.

f. **Solarus and DSM** – DSM is considering the installation of additional solar PV systems at new locations in India and is currently considering options to work with Solarus (as the hybrid collector of Solarus also provides hotwater at temperatures that are attractive for industrial applications).

g. **Aditya Solar** – Aditya Solar, an Indian solar PV project developer, installer and distributor of solar PV products, expressed an interest in Dutch grid-interactive inverter technologies and in partnering with a Dutch solar PV installer. Introductions to Heliox,, Orange Solar, PR Electronics and Victron Energy have been facilitated.

No	Organization	State	Status
1	Philips Innovation Campus	Karnataka	Initially interested, no further communication
2	Shell Research Centre	Karnataka	Initially interested, no further communication
3	Paques B.V.	Tamil Nadu	Initially interested, no further communication
4	Hunter Douglas	Tamil Nadu	**Site assessment for solar PV system completed**
5	DFE Pharm	Tamil Nadu	No response
6	Honicel BV	Tamil Nadu	No response
7	Shell Shared Services	Tamil Nadu	No response
8	Lemon Tree Hotels	Multiple	No response
9	Hindustan Unilever Ltd.	Maharashtra	Initially interested, no further communication
10	Kusters Engineering BV (India)	Maharashtra	**Interested in solar street lighting for rural areas**
11	Rabo India Finance Ltd.	Maharashtra	No response
12	Akzo Nobel Chemicals (India) Ltd	Maharashtra	Initially interested, no further communication
13	DSM Engineering Plastics Pvt. Ltd.	Maharashtra	Considering new installations on various locations
14	Fugro Survey (India) Pvt. Ltd.	Maharashtra	Initially interested, no further communication
15	Heineken / United Breweries Ltd	Maharashtra	No response
16	Philips Healthcare Development & Manufacturing Center (Factory)	Maharashtra	No response
17	TomTom India Limited	Maharashtra	No response

***Table 2** – Contacted Dutch organizations in India*

No	Organization	State	Status
18	Twin City Group	Maharashtra	Initially interested, no further communication
19	Aditya Solar	Telangana	Interested in grid-interactive inverter technology and partnership with solar PV installers
20	Fourth Partner Energy Pvt.	Telangana	Interested in various products such as: micro-inverters, monitoring systems, technologies for module cleaning, pre-paid metering systems, on-site storage solutions for applications such as mobile towers
21	ITC	Multiple states	Interested in demonstration project for solar PV thermal hybrid system
22	Auroville	Tamil Nadu	Interested in demonstration project for solar PV thermal hybrid system, NDA signed
23	Su-Kam	Delhi	Interested in hybrid inverter technology
24	Prakti Design	Tamil Nadu	Interested in co-distribution of Rural Spark solar light solutions
25	Auroville Energy Products	Tamil Nadu	Interested in co-distribution of Rural Spark solar light solutions
26	Sri Aurobindo Ashram	Puducherry	Interested in a Solarus demonstration project

***Table 3** – Indian contacts via Dutch organizations in Table 2*

8 – CONCLUSIONS AND RECOMMENDATIONS

As the first steps in increasing cooperation between Netherlands and India in the solar PV sector have been initiated and the first concrete collaborations are getting rooted, it becomes more evident that some substantial work will have to be done in relationship building in order to build bridges and build long-term and sustainable partnerships.

Face-to-face contact with potential business partners and the building of relationships will be essential for Dutch organizations in developing a presence in India. Whereas in the Netherlands it is not entirely necessary to have face-to-face communications, as business can be done through telephone communication; in India, face-to-face communication is preferred. Casual conversation typically precedes discussion concerning business development. New and emerging opportunities require personal contact and face-to face meetings.

Besides the necessity for personal contact a certain lead-time is required to identify concrete opportunities for products and for projects. A comparison on products and services with regard to quality and pricing will greatly help in taking this forward.

Another way to facilitate the necessary personal contacts in India is to find an Indian partner/agent that can takes care of the local work in India.

As the “Make in India” campaign of the Indian Government focuses on boosting local production, companies can also consider having their products (partially) produced in India. This can also contribute to reducing the price of the product, but requires the right domestic partner to be found.

A gap in terms of knowledge and understanding of the Indian Solar PV market of many Dutch organizations has been identified. This may be due to the geographical size of Indian, the fact that each federal state in India has its own solar PV policies and regulatory frameworks and the big number of domestic and international players in the solar PV market already active in India.

Some concrete recommendations that can be given at this stage are:

a. Invest in time if you consider to enter the Indian market;
b. Initiate face-to-face meetings between representatives of Dutch and Indian organizations;
c. Use the network of the Netherlands Business Support Offices (NBSOs) in India[4];
d. Prepare the pricing of products and services and a comparison with competitive products and services at the Indian market before reaching out to Indian partners and clients;
e. Look into opportunities for subsidy from the Dutch Government (DHI or DEI scheme).

More specifically, with respect to the demonstration projects that have been initiated:

f. Follow-up on the Auroville-Solarus demonstration project by performance monitoring and communication of the project to potential clients and partners;
g. Invite Indian public and private organisations to visit demonstration projects of Dutch organizations in India;
h. Initiate and exchange experiences of Dutch solar PV organizations working in India (such as Solarus, Rural Spark, Victron Energy, DSM and 4Washing) with other Dutch organisations.

With this study, first steps are made to collaborate in solar PV projects. Though small, these steps can be very useful for the future. At the moment of reporting Indian and Dutch organisations are still negotiating on what can be done together, so the report provides just the status at the time of writing. Hopefully the connections that were created through this study will become sustainable for the long term and can be a base for further Indo-Dutch partnerships in the field of solar energy.

[4] See: http://india.nlembassy.org/doing-business/trade-network-india

ANNEX I – PROGRAM OF THE INTERSOLAR INDIA 2015

Wednesday, November 18:

10:15 am 12:05 pm	Conference Program	Shifting Gear from MW to GW - India's Emergence as a Prominent Global PV Market	PV
10:30 am 04:00 pm	Exhibition Program	Intersolar AWARD Finalist Presentations	PV
02:00 pm 03:30 pm	Conference Program	India's Solar Thermal Market - Neglected Potential?	ST
02:00 pm 03:25 pm	Conference Program	India's PV Market: Driving A New Momentum	PV
02:00 pm 03:30 pm	Conference Program	Side-Event: 4th Indo-German Energy Symposium - Solar PV Rooftop – Market Development in India and International Trends	PV
04:00 pm 05:15 pm	Conference Program	Side-Event: Intersolar Study Program	PV
04:00 pm 05:30 pm	Conference Program	Executive Panel	PV
04:00 pm 05:30 pm	Conference Program	Side-Event: 4th Indo-German Energy Symposium - Planning for 175 GW Grid Connected Renewable Energy Capacity by 2022 – Transmission Infrastructure & System Balance	PV

Thursday, November 19:

10:00 am 10:50 am	Exhibition Program	Side-Event: Business to Government Forum and Panel Discussion	PV
10:00 am 11:30 am	Conference Program	India's Off-Grid PV Market: Tapping The Potential of 400 Mio with no Access to Electricity	PV
10:00 am 11:30 am	Conference Program	Project Development: What does it Take to Accomplish a Successful Project	PV

10:00 am 11:30 am	Conference Program	Side-Event: 4th Indo-German Energy Symposium - Making RE and EE Business a Win-Win for Private and Public	PV
12:00 pm 01:25 pm	Conference Program	Solar/Diesel Power Supply: Replace Polluting Diesel with PV Solutions	PV
12:00 pm 01:30 pm	Conference Program	Project Financing: Promising Prospects in the Indian Context	PV
12:00 pm 01:30 pm	Conference Program	Side-Event: 4th Indo-German Energy Symposium - Bankable Business Models to Finance Solar Projects in India	PV
01:15 pm 03:00 pm	Exhibition Program	PV Manufacturing: India's 100 GW Target - What it Takes to Get There!	PV
02:30 pm 03:55 pm	Conference Program	Electrical Energy Storage: Prospects in India's Storage Market	ees
02:30 pm 03:15 pm	Conference Program	Side-Event: Concentrated Solar Technologies for Medium & High Temperature Heat Applications - Inaugural Session	ST
02:30 pm 04:00 pm	Conference Program	Optimizing Operation and Maintenance Practices for Solar Power Plants	PV
03:15 pm 04:30 pm	Conference Program	Side-Event: Concentrated Solar Technologies for Medium & High Temperature Heat Applications - Technologies, Case Studies & Standards, Policies	ST
03:15 pm 05:00 pm	Exhibition Program	PV Manufacturing: The Kaleidoscope of Current and Future Cell Technologies	PV
04:30 pm 06:00 pm	Conference Program	Electrical Energy Storage - Pro's and Con's in the Indian Context	ees
04:30 pm 06:00 pm	Conference Program	PV Power Plants: High Quality Equals High Returns	PV
04:50 pm 06:00 pm	Conference Program	Side-Event: Concentrated Solar Technologies for Medium & High Temperature Heat Applications - Plenary Session	ST

Friday, November 20:

10:00 am 11:30 am	Conference Program	Field Experience of Ground-Mounted PV Power Plants in India	PV
10:00 am 11:30 am	Conference Program	RE Hybrid Energy Parks - Take Full Advantage of Local Environmental Conditions	PV
10:30 am 01:20 pm	Exhibition Program	Exhibitor Presentations	PV
12:00 pm 01:25 pm	Conference Program	Field Experience of Rooftop PV Power Systems in India	PV
12:00 pm 01:30 pm	Conference Program	Novel Applications: A Part of India's Solar DNA	PV

ANNEX II – COMPARISON BETWEEN INDIAN STATES

	Tamil Nadu	Kerala	Karnataka	Puducherry	Odisha	Delhi	Maharashtra	Rajasthan	Gujarat
SPV Policy for rooftop	Yes	Yes	Yes	Yes	Yes	Yes (Draft version)	Yes	Yes	Yes
SPV Policy/Year	2013	2013	2014	2014	2013	2015	2015	2014	2015
Type of policy	Net metering	Net metering	Net metering plus fixed tarif for surplus export	Net metering/ gross metering	Net metering	Net metering	Net Metering	Net metering	Net metering
Special features of existing policy	(a) Energy export credit capped at 90% of imported energy; (b) Not all consumer tariffs are eligible for net metering (see note 1) (c) Solar PV grid penetration capped at 30% of distribution transformer capacity	(a) All HT consumers will have to sign Solar Purchase Obligations (SPO), and have to purchase 0.25% of their consumption with 10% increase every year. For LT consumers, the above may be applicable from April 2015. (b) All new domestic buildings with floor area from 2000 sq.ft to 3000 sq.ft, will have to install 100 litres solar water heater & 500W solar PV system. (c) The capacity range for solar rooftop system is from 1kWp to 1MWp.	(a) Distribution Transformer can be loaded upto 70% of capacity, (b) The payment to be paid by the distribution licensee to SPG by 30 days through NEFT. (c) Also ,the SPG developer can only inject a value equal to 70% of the power that he consumes from the grid. (d) The maximum capacity for solar rooftop is 1MWp. [28]	(a) Range of SPGs from 1kW to 500kWp but grid penetration of Distribution Transformers (DT) should not be more than 30%. [22]	(a) Capacity of PV system should be equal to that of the sanctioned load. (b) The grid penetration to DTs should not exceed 30%. Also, the generation is capped at 90% of electricity consumed and credit will be given only for 90%. The minimum capacity is 1kWp to 500kWp. [41]	(a) Minimum Capacity of 1kWp and if grid penetration is above sanctioned load, service line connection and other charges to be born by the SPG developer.	(a) Cumulative capacity utilization of distribution transformer (DT) should not exceed 40% of the rated capacity of the DT[8].	(a)Solar PV grid penetration capped at 30% of distribution transformer capacity; (b) The maximum capacity of SPV installation cannot exceed 80% of sanctioned load/demand of the consumer [5].	(a) Generation capacity capped at 50% of sanctioned load (for residential).[24]
Subsidies for Rooftop Solar	(a) Rs. 20,000 per kW for 1 kW residential systems in addition to 15% capital subsidies by MNRE, Electricity tax exempted (Subsidy applicable only under *Tariff LT-1A*	(a) 15% capital subsidies by MNRE, Electricity tax exempted (only residential Tariff)	(a) 15% capital subsidies by MNRE, Electricity tax exempted (only residential Tariff)	(a) 15% capital subsidies by MNRE, Electricity tax exempted (only residential Tariff)	(a) 15% capital subsidies by MNRE, Electricity tax exempted (only residential Tariff)	(a) 15% capital subsidies by MNRE, Electricity tax exempted (only residential Tariff)	(a) 15% capital subsidies by MNRE, Electricity tax exempted (only residential Tariff)	(a) 15% capital subsidies by MNRE, Electricity tax exempted (only residential Tariff)	(a) 15% capital subsidies by MNRE, Electricity tax exempted (only residential Tariff)
Installed Rooftop SPV Solar Capacity by June 2015 Mw	36	8	25	no data	14	8	39	21	25

	Tamil Nadu	Kerala	Karnataka	Puducherry	Odisha	Delhi	Maharashtra	Rajasthan	Gujarat
Tariff structure payable to the utility (In Rs./kWh sold) (HT consumers)	HT consumers: Highest- Rs. 11 Lowest- Rs.7.22 [32];	HT consumers: Lowest- Rs. 2.80; Highest- Rs. 7.30 [33].	HT consumers: Highest- Rs. 9 Lowest- Rs.1.50 [34];	HT consumers: Highest- Rs. 9.45 Lowest- Rs.4.75;	HT consumers: Highest- Rs. 7.20 Lowest- Rs.1.40;	HT consumers: Highest- Rs.9.50 Lowest- Rs.2.75 [37];	HT consumers: Highest- Rs.12.50 Lowest- Rs.3.32 [38];	HT consumers: Highest- Rs. 7.45 Lowest- Rs.5.50 [39];	HT consumers: Highest- Rs. 4.65 Lowest- Rs.1.80 [40];
Tariff structure payable to the utility (In Rs./kWh sold) (LT consumers)	LT consumers: Lowest- Rs. 3 Highest- Rs. 12.10 [32].	LT consumers: Lowest- Rs.1.50 Highest- Rs. 14 [33].	LT consumers: Highest-Rs. 9 . Lowest- Rs.5.36 [34]	LT consumers: Highest- Rs. 5.40. Lowest- Rs. 1.10 [35].	LT consumers: Highest- Rs.7 [36] Lowest- Rs.2.50	LT consumers: Highest- Rs.9.95; Lowest- Rs. 4 [37]	LT consumers: Highest- Rs. 17 Lowest- Rs.0.87 [38]	LT consumers: Highest- Rs.7.85. Lowest- Rs. 3.27 [39]	LT consumers: Highest- Rs. 5.30 Lowest- Rs. 1.5 [40]
Utility Scale Solar Installed capacity by June 2015 in MW 43	164	no data	104	no data	71	4	344	1128	953
Solar rooftop targets in MW till 2022 (42)	3500	800	2300	100	1000	1100	4700	2300	3200
Tariffs range for Utility Scale SPV	Rs. 7.01/kWh (Without AD) and Rs. 6.27 (With AD) [1(a)].	Averaged Power Purchase Cost (APPC) is used for purchase of excess energy. The APPC is at the rate of 3.06/unit	Rs. 9.56/kWh (without subsidy), Rs. 7.20 (with 30% subsidy) [1(a)], along with a 15% central subsidy .	Rs. 8.73 (Without AD), Rs. 8.26 (With AD),	Averaged Power Purchase Cost (APPC) is to be used for purchasing surplus power exported to the grid. The APPC rate is Rs. 3 /kWh	Averaged Power Purchase Cost (APPC) is to be used for purchasing surplus power exported to the grid. The APPC rate is around Rs.4.75-5 /kWh [33].	Averaged Power Purchase Cost (APPC) is to be used for purchasing surplus power exported to the grid. The APPC rate is Rs. 3.76/kWh	Rs. 7.50/kWh (without AD), Rs. 6.63/kWh (with AD) [1(a)].	(a)Rs. 9.63/kWh (With AD), (b) Rs. 10.76/kWh (Without AD) [27].
Electrification rate (In MU for the period April-Sept' 2015) [11]	0.986	0.9913	0.951	0.995	0.992	0.998	0.9966	0.997	0.999
Load Shedding	20% power cut on heavy users (industrial & commercial) [15]. 8-10 hours/day in rural areas.	As of 2014, the Kerala State board has implemented a 30- minute power cut over North & South Kerala on alternate days to stem over the power crisis [18].	The shortage in Karnataka is resulting in 3-4 hours of load shedding in and around Bengaluru and other places [19].	The power cuts range from 30 minutes to a maximum of 4 hours in places in & around Puducherry boulevard [26].	As of 2015, power cuts last for two - two and a half hours. This is due to insufficient monsoon rains according to the administration [20].	On average, New Delhi experiences power cuts ranging from one to two hours every day. Various reasons are attributed to it [21].	Suburban areas of Mumbai, like Mulund are already facing power cuts up to 3 to 4 hours/day. The number is higher at six-seven hours in other parts of the state [25].	Power cuts range from 2 - 4 hours every day in villages & municipal towns, while 2 hours in districts [17].	Power cuts in the case of Gujarat has been minimal and not much information could be found.
No of Installers (recognized) [12]	16	8	19	No data yet	1 Installer	22 installers	23	2	15

Table 4 *– Comparison of states, detailed information*

References for Comparison of States

1 - Ministry of New and Renewable Energy (MNRE), Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/State-wise-and-year-wise-target-for-installation-of-40000MWp-GCRT-systems.pdf)
1(a) - Ministry of New and Renewable Energy (MNRE) Policy and Regulatory framework, Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/Policy-and-Regulatory-Framework-in-Various-States.pdf)
2 - The hindu paper, Accessed October 2015 (Source: http://www.thehindu.com/news/cities/chennai/shadow-over-solar-power-scheme/article7008145.ece)
3 - The economic times, Accessed October 2015 (Source: www.economictimes.indiatimes.com)
4 - Handbook for beneficiaries, Accessed October 2015 (Source:http://anert.gov.in/index.php?option=com_content&view=article&id=145:10000-solar-rooftop-power-plants-programme-&catid=18:curr-re-prog&Itemid=52)
5 - Rajasthan Electricity Regulatory Commission (RERC) connectivity & Net metering of rooftop systems, Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/RERC-Connectivity-and-Net-Metering-2015.pdf)
6 - Indian Institute of Technology (IIT) Kanpur presentation at the " 7th Capacity Building program for Officers of the regulatory commission" , Accessed October 2015(Source: http://www.iitk.ac.in/ime/anoops/for15/ppts/Day-3%20IITK/Rooftop%20PV%20-%20Mr.%20B%20D%20Sharma.pdf)
7 - Rajasthan State solar policy FAQ document, Accessed October 2015 (Source: http://www.rrecl.com/PDF/Final%20FAQ%20Booklet.pdf)
8 - Maharashtra Electricity Regulatory Commission (RERC) , Accessed October 2015 (Source: http://www.mercindia.org.in/pdf/Order%2058%2042/Draft%20MERC%28Net%20metering%20for%20Rooftop%20Solar%20Systems%29%20Regulations,2015.pdf)
9 - Kerala State policy, 2013, Accessed October 2015 (Source:http://mnre.gov.in/file-manager/UserFiles/state-power-policies/Kerala-Solar-Power-Policy.pdf)
10 - Odisha state solar policy 2013, Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/state-power-policies/Odisha-Solar-Power-Policy.pdf)
11 - Central Electricity Authority (CEA) Power supply position document, Accessed October 2015 (Source: http://www.cea.nic.in/reports/monthly/powersupply/2015/psp_energy-09.pdf)
12 - Solar Photovoltaic Installers (SPIN) website, Government of India, Accessed October 2015 (Source: http://223.31.33.76/public/spin-grid/public/Agencies_list.html)
13 - Green Energy Development Corporation of Odisha Ltd (GEDCOL), Accessed October 2015 (Source: http://gedcol.com/Home/Projects)
14 - New Delhi Solar Policy, Accessed October 2015 (Source: http://delhi.gov.in/wps/wcm/connect/224a890049cda85ca0aae8124fa22605/Delhi_Solar_Policy_Draft_150910.pdf?MOD=AJPERES&lmod=-1181892927&CACHEID=224a890049cda85ca0aae8124fa22605)
15 - Business Standard news report, Accessed October 2015 (Source: http://www.business-standard.com/article/current-affairs/tamil-nadu-announces-20-power-cut-for-industrial-commercial-users-114092401069_1.html)
16 - Kerala State Electricity Regulatory Commission (KSERC), Accessed October 2015 (Source: http://www.erckerala.org/userFiles/634177281778750000_JawaharSolarOrder_04-08-10__FINAL_.pdf)
17 - Rajasthan Power shortage, Accessed October 2015 (Source: http://www.indiatvnews.com/news/india/rajasthan-heat-wave-power-cuts-in-rajasthan-discom-41020.html)
18 - Kerala power crisis, Accessed October 2015 (Source: http://www.newindianexpress.com/states/kerala/Power-Cut-to-Go-from-Friday/2014/06/24/article2297021.ece)
19 - Karnataka power situation, Accessed October 2015 (Source: http://www.ndtv.com/bangalore-news/why-bengalurus-power-cuts-are-the-worst-in-25-years-1216347)
20 - Odisha power situation, Accessed October 2015 (Source: http://www.ndtv.com/india-news/power-cuts-likely-to-continue-till-june-2016-odisha-minister-1216881)
21 - New Delhi power situation, Accessed October 2015 (Source: http://indianexpress.com/article/cities/delhi/1000-long-power-cuts-in-june/)
22 - Solar power generation regulations across Uts, Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/Solar-Power-Generation-Regulations-Goa-and-UTs-2014%20.pdf)

23 - Grid connected rooftop solar generation status, Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/Status-of-Grid-Connected-SPV-Rooftop-Projects-Sanctioned-to_States_UTs_SEC_PSUs_OGA.pdf)
24 - Gujarat Energy Development Agency (GEDA), Accessed October 2015 (Source: http://geda.gujarat.gov.in/policy_files/jnnsm-g170610.pdf)
25 - Maharashtra power situation, Accessed October 2015 (Source: http://www.livemint.com/Politics/xz0tQD4bYhRgdadSMsrVgL/Shortage-of-5500-MW-to-fuel-power-cuts-in-Maharashtra.html)
26 - Puducherry power situation, Accessed October 2015 (Source: http://www.thehindu.com/news/cities/puducherry/unscheduled-power-cut-spectre-back-to-haunt-puducherry-residents/article6344607.ece)
27 - Gujarat Solar Tariff order 2012, Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/Gujrat-Solar-Tariff-Order-of-2012.pdf)
28- Karnataka tariff order 2014, Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/Karnataka_Tariff_Order-2014_2018.pdf)
29 - Kerala State Electricity Regulatory Commission (KSERC) order, Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/Kerala-ERC_Order_2014.pdf)
30 - Delhi Electricity Regulatory Commission (DERC), Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/DERC_Renewable_Energy_Net_Metering_Regulations_2014.pdf)
31 - Bridge to India website, Accessed October 2015 (Source: http://www.bridgetoindia.com/blog/derc-releases-implementation-guidelines-for-rooftop-solar/)
32 - Tamil Nadu Retail Supply Tariff Schedule, Accessed November 2015 (Source: http://tnerc.tn.nic.in/press%20release/2014/Tariff%202014-15%20For%20Hosting%20in%20Web/TANGEDCO%20FY%20201415/Public%20Notice-Tarif-23-09-2014.pdf)
33 - Kerala Retail supply tariff, Accessed November 2015 (Source: http://www.tced.in/admin/Magazine/5_2319.pdf)
34 - Karnataka Electricity supply tariff, Accessed November 2015 (Source: http://bescom.org/wp-content/uploads/2011/11/TO-BESCOM-2014.205-244.pdf)
35 - Puducherry retail supply tariff for Control period FY 2015-16 - FY 2016-18,Accessed November 2015(Source: http://electricity.puducherry.gov.in/jerc/tariff_order.htm)
36 - Odisha Electricity Regulatory Commission (OERC) tariff report, Accessed November 2015 (Source:http://www.cescoorissa.com/tariff/DISCOMs_Notification_2015-16.pdf)
37 - Delhi Electricity Regulatory Commission (DERC), Accessed November 2015 (Source: http://www.derc.gov.in/)
38 - Maharashtra Electricity Regulatory Commission (MERC), Accessed November 2015 (Source: http://www.mercindia.org.in/pdf/Order%2058%2042/Order-121of2014-26062015.pdf)
39 - Rajasthan Electricity Regulatory Commission (RERC), Accessed November 2015 (Source: http://rerc.rajasthan.gov.in/TariffOrders/Order203.pdf)
40 - Gujarat Electricity Regulatory Commission (GERC), Accessed November 2015 (Source: http://www.gercin.org/index.php/en/tariff-schedule)
41 - Odisha Electricity Regulatory Commission (OERC) Net metering document, Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/OERC-Net-Metering-Dated-26.11.2014.pdf)
42 - Karnataka Solar policy 2014-21 document, Accessed October 2015 (Source: http://mnre.gov.in/file-manager/UserFiles/Grid-Connected-Solar-Rooftop-policy/Karnataka_Solar_Policy_2014-2021.pdf)
43 - Odisha solar power project, Accessed October 2015 (Source: http://solar-power.industry-focus.net/orissa-solar-projects/163-acme-bikaner-solar-to-set-up-25-mw-solar-power-plant-in-orissa.html)
44 - Rajasthan solar power project, Accessed October 2015 (Source: http://articles.economictimes.indiatimes.com/2014-01-09/news/46029983_1_godawari-power-rajasthan-sun-technique-energy-reliance-power)
45 - Maharashtra Electricity Regulatory Commission (MERC), Accessed October 2015 (Source: www.ireeed.gov.in/policyfiles/171-35_MH98R01220313.pdf)
46 - Delhi Electricity Regulatory Commission (DERC), Accessed October 2015 (Source: http://www.derc.gov.in/Public%20Notice/Net%20Metering/DERC%20Net%20Metering%20Proposal.pdf)
47 - Kerala State Electricity Regulatory Commission (KSERC), Accessed October 2015 (Source: http://www.erckerala.org/regulations/KSERC%20%28Renewable%20Energy%29%202015%20-31.3.15.pdf)
48 - Delhi solar power tariff, Accessed October 2015 (Source: http://indianexpress.com/article/cities/delhi/boost-for-solar-power-same-tariff-for-25-yrs-2000-mw-use/)

ANNEX III – SOLAR PV FOR TELECOM TOWERS

1 – Market size and trends

The telecommunication industry in India has seen a huge growth in the last decade. It is currently the second largest telecommunication market in the world with over 1 billion subscribers as of May 2015[5]. Private companies and Joint Ventures have started installing telecom towers and leasing them to multiple telecom operators, thus, bringing down the investment cost for telecom operators and hence the customers. Currently close to 400,000 telecom towers are installed in India, and with an annual growth rate of 3% it is estimated to grow to 510,000 by the year 2020[6].

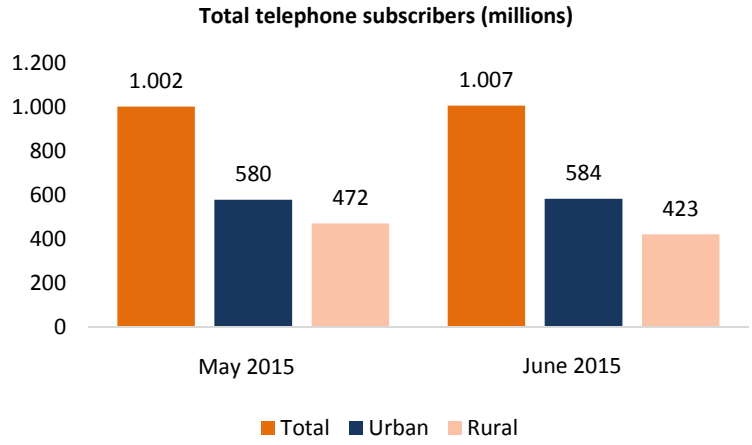

***Figure 4** – Graph showing number of telecom subscriptions in India in May and June 2015*

Taking a look at Tamil Nadu, the biggest telecom tower installer is Indus Towers Ltd. With 13,000 telecom towers, Indus Towers Ltd has 52% market share in Tamil Nadu[7].

2 – Energy requirements

A Telecom Tower requires on an average 3.5kWp, but it can range from 1kWp to 8.5kWp. Generally, each Telecom Tower has its own Diesel Generator (DG) of 10kVA to 15kVA capacity and a battery bank of 300Ah to 900Ah[8] (see *Figure 5* for a schematic diagram). Telecom towers are required to work 24 hours a day throughout the year and therefore uninterrupted power is a backbone to maintain the service level uptime obligation of 99.5%[9]. On an average throughout India, a telecom tower site receives grid power for 13.5 hours per day[10]. Thus, for other 10.5 hours per day DG or batteries are used. This leads to high consumption of Diesel fuel resulting in energy expenses accounting for approximately 67% of operating costs. The grid availability in Tamil Nadu is better than most of the other states in India. Tamil Nadu, on an average has grid availability of 20.3 hours

5 IBEF:Telecommunications, Accessed November 2015
6 American Tower Corp to buy majority stake in Indian telecom tower co Viom - DealStreetAsia, Accessed November 2015
7 Indus to Add Telecom Towers to Boost Market Share in Tamil Nadu, Accessed November 2015
8 The True Cost of Providing Energy to Telecom Towers in India, Accessed November 2015
9 DoT Directive on Green Telecom regarding powering up of Telecom Towers by RET, Accessed November 2015
10 Recommendations on Approach towards Green Telecommunications, Accessed November 2015

per day for Telecom Towers[11]. Therefore, lower diesel costs are incurred. Typically a Telecom Tower of 3-4 kW per requirement consumes about 100 kWh of electricity per day[12]. It is estimated that Telecom Towers in India consume 11 billion kWh of electricity every year. An increase to 17 billion kWh by the year is expected by 2016 resulting in Green House Gas (GHG) emissions equivalent to 11 million tonnes of CO_2 per year[13].

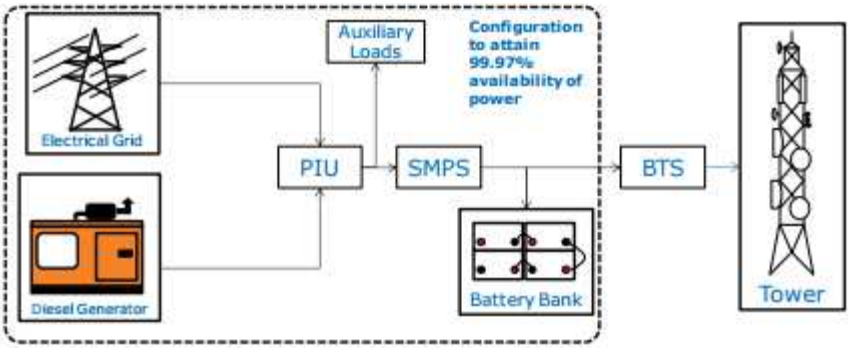

Figure 5 *– Schematic of power supply at telecom tower [where PIU: Power Interface Unit, SMPS: Switched Mode Power Supply, BTS: Base Transceiver Station]*

3 – Policies and regulatory frameworks

In 2012 the Department of Telecommunications (DoT), Government of India (GoI) has decided to adopt the following measures:

a. 50% towers should run on hybrid power (Renewable Energy Technologies (RETs) + grid) in rural and 20% in urban by 2015, while 75% rural and 33% urban towers by 2020.
b. All the instruments used should be energy efficient and should be certified "Green Passport (GP)" after energy and performance assessment.
c. All service providers should submit carbon footprint of their network operations in the format prescribed by TRAI bi-annually.
d. Base year of calculating carbon footprint is 2011. Carbon footprint should be reduced to 5% by 2012-2013, 8% by 2014-2015, 12% by 2016-2017 and 17% by 2018-2019.

This was based on a recommendation by [14] as recommended by Telecom Regulatory Authority of India (TRAI).

4 – Current trends for deployment of renewable energy technologies (RET)

The industry has identified three RET which can be implemented within the Telecom towers (see *Table 5*):

[11] India Energy Security Scenarios, 2047: User Guide for Telecom Sector, Accessed November 2015
[12] Is There Real Scope For Solar In Telecom Industry?, Accessed November 2015
[13] Indian Cell Tower Companies Eye Renewable Energy To Cut Costs | CleanTechnica, Accessed November 2015
[14] Implementation of Green Technologies in Telecom Sector, Accessed November 2015

Telecom Tower Company	Bio-Fuel (kW)	Fuel-Cells (kW)	Solar PV (kW)	Total (kW)
Bharti Infratel	4	5	1,650	1,659
GTL	0	0	80	80
Idea Cellular	1	35	590	626
Indus Towers	8	0	650	658
Vodafone Essar	0	0	390	390
National Total	13	40	3,360	3,413

***Table 5** – Penetration of different RETs in Telecom Tower Industry till 2014 in India*[15]

Towers and Infrastructure Providers Association (TAIPA) has mentioned that, they would like to use a future proof energy efficient technologies and RETs which would help in creating a win-win proposition. A capital investment of estimated INR 66,000 crore by 2020 is required[16]. Further it is aimed at reducing carbon emissions through the application of more energy efficient technologies.

5 – Major industries in the market

The Telecom Tower Industry in India is different from rest of the world. In India, private companies as well as Telecom Operator Joint Ventures (JV) are in the business of installation of tower unlike only Telecom Operator in the installation of towers. Major companies are as follows:

1. Operator owned JV:
    a. Indus Towers Ltd.^
    b. Viom Networks Ltd.^
2. Operator owned:
    a. Reliance Telecom Infrastructure Ltd.
    b. Bharti Infratel^
    c. BSNL Telecom Tower Infrastructure
3. Independent:
    a. GTL infrastructure Ltd.^
    b. Essar Tower Enterprises
    c. ATC India Tower Corporation Pvt. Ltd.^
    d. Tower Vision India Pvt. Ltd.^

^: Part of TAIPA (Tower and Infrastructure Providers Association)

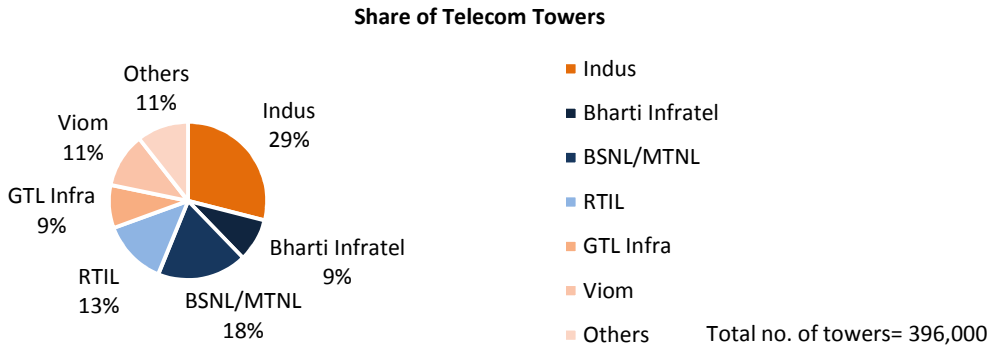

***Figure 6** – Market share of telecom tower companies*[17]

[15] Applications Integrating Renewable Energy and Energy Efficiency, Accessed November 2015
[16] Telecom department urges industry to go green - timesofindia-economictimes, Accessed November 2015
[17] BIL Investor Presentation, Accessed November 2015

6 – Project costing and financials

To understand the project cost, three different scenarios are considered:

1. Scenario 1: Solar + Grid +Battery
2. Scenario 2: Solar + DG + Grid (+ small battery for switchover)
3. Scenario 3: Solar + DG + Battery

These scenarios will help cover different areas/regions where system installation can be done. Scenario 1 can be used in urban areas as grid availability is high (20 hours or more) and only solar PV system is installed. Scenario 2 can be installed in areas where grid availability is medium (16 to 20 hours) and a solar PV & DG hybrid system is installed. At last, scenario 3 can be considered for completely off grid system. High grid availability is considered because in Tamil Nadu on an average 20.3 hours of grid is available.

To determine the system size, it is important to know how much electricity would be consumed by the system. It is estimated that a Telecom Tower consumes 100 kWh per day. Thus, it will consume approx. 40MWh per annum. *Table 6* shows the system size, cost of the system for different scenario, IRR, payback period and LCOE.

	Scenario 1	Scenario 2	Scenario 3
Electricity Requirement by other than grid source per annum	Approx. 7MWh	Approx. 14MWh	40MWh
System Size	Solar: 4.5kW Battery: 300Ah	Solar: 5kW DG: 3.5kW (20% availability) Battery: 150Ah	Solar: 14kW DG: 6.3kW (34% availability) Battery: 600Ah
Project Cost (INR)	540,000.00	500,000.00 (DG set cost is not accounted)	1,560,000.00
Financial Viability			
Pre-tax IRR- equity	13.8%	8.2%	5.8%
Pre-tax IRR-assets	7.5%	3.8%	2.0%
Simple payback (years)	13.5	20.2	25.1
Equity payback (years)	12.5	16.1	18.2
LCOE (Rs./kWh)	14.59	12.15	14.59

***Table 6** – IRR, payback period and LCOE for different scenarios (all the calculations done are excluding subsidies)*

Typically the levelized cost of a kWh electricity generated by diesel generator is in the range of INR 18-20.