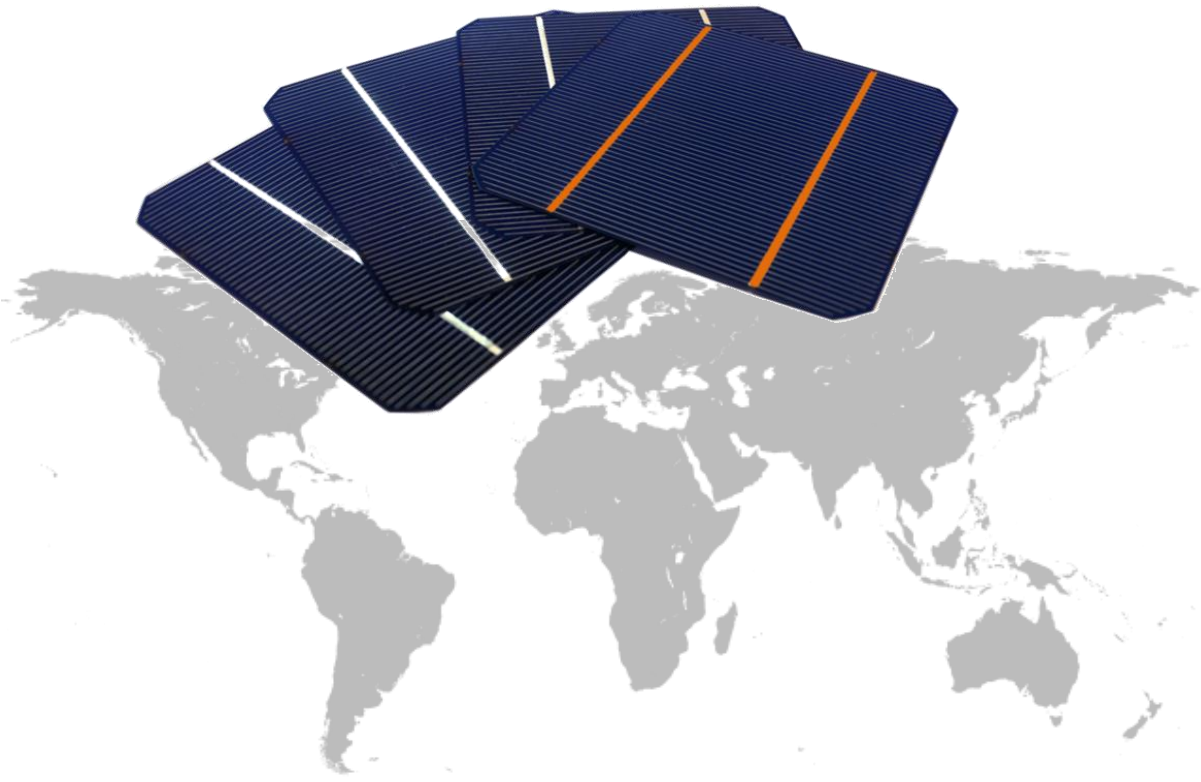
Rijksdienst voor Ondernemend Nederland

NEW SOLAR PV BUSINESS OPPORTUNITIES BETWEEN THE NETHERLANDS AND INDIA



FINAL REPORT

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Auroville Consulting

Energy Indeed

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1 – Background

India has been showing a consistent economic growth over the past decade. The country boosts of a positive foreign investment climate and experiences a fast population growth. The power sector is among the fastest growing industries. To meet its current and future power requirements, India will have to substantially increase its installed capacity.

The solar photovoltaic (PV) energy sector has been identified by the national government of India as an industry with strategic significance and it will play an important role in the future energy security of India. Particularly, the government recently announced to aim for a total installed PV capacity of 100 gigawatt by the year 2020, starting from about 3 gigawatt today.

2 – Aim

Since the year 2013, the Indian Ministry of New and Renewable Energy (MNRE) and the Dutch Ministry of Economic Affairs (EZ) have a Memorandum of Understanding (MoU) on cooperation in the field of renewable energy. Solar energy is one of the areas this cooperation focuses upon.

To explore opportunities for Dutch organizations to partner with Indian organizations in the PV value chain, requirements of the Indian PV value chain are identified and juxtaposed with the strengths of Dutch PV value chain. An overview of this value chain, divided into 11 segments, can be found in Figure 1.

3 – Method

The exploration of opportunities is based upon a desk study, followed by 19 face-to-face interviews, 5 telephone interviews and an electronic survey among 35 organizations. The face-to-face interviews have been scheduled prioritizing Channel Partner organizations of MNRE that were rated as 1A, 1B or 1C players, while simultaneously attempting to sufficiently cover each of the 11 segments of the PV value chain

The preliminary results of these activities were presented and discussed with Dutch organizations during a meeting in Utrecht on January 20th, 2015. This meeting gave rise to more detailing of some of the preliminary results, rather than changes in these results.

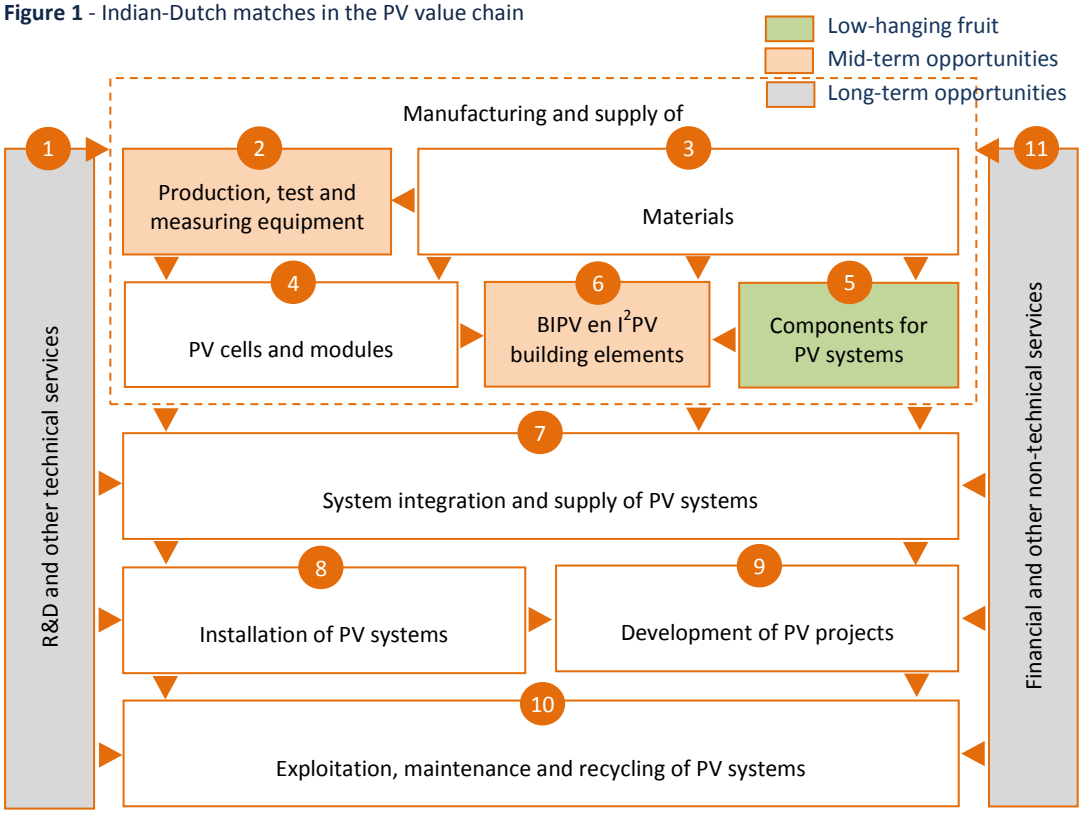
4 – Results

Based upon the above activities, Table 1 lists the requirements identified per segment. By combining these requirements with the strengths of the Dutch PV sector, Figure 1 indicates the segments that seem to provide the best opportunities for collaboration.

Table 1 – Summary of Indian requirements per segment

Segments		Requirements
1	R&D and other technical services	R&D on low-cost silicon, battery technologies and storage, micro-grids, thin film technologies and manufacturing processes
2	Production, test and measuring equipment	Advanced testing and manufacturing equipment, testing and repair facilities, technology transfer, joint ventures for manufacturing, waste slurry treatment technology
3	Materials	Wafer manufacturing capacity, silicon mining technology and know-how
4	PV cells and modules	More efficient cell- and module-manufacturing processes, thin film technology, investors, skilled manpower, oversee markets, strategic partnerships for manufacturing
5	Components for PV systems	Inverter technologies (grid, hybrid, micro), distributor networks, investors, smart-grid and micro-grid applications, mounting structures, monitoring and irradiation equipment
6	BIPV en I^2PV building elements	Market readiness, applications for mobile towers, car parking and petrol stations
7	System integration and supply of PV systems	Capacity building and training, investment, supply of components
8	Installation of PV systems	Cost-effective PV cells and modules, BIPV, components of PV-systems, investments, project management training
9	Development of PV projects	System integration and supply of PV systems, installation of PV systems, operation and maintenance, investments
10	Exploitation, maintenance and recycling of PV systems	R&D and know-how for silicon- and module-recycling, battery-recycling systems and processes
11	Financial and other non-technical services	Investments to increase the domestic manufacturing capacity for cells, modules and inverters, policy support, new business models, investments into project development, distribution partnerships for Indian modules oversees

Figure 1 - Indian-Dutch matches in the PV value chain



5 – Recommendations

R&D and other non-technical services:

- Explore a strategic partnership with the National Institute of Solar Energy (NISE);
- Initiate a more detailed mapping of PV-related R&D activities in the public and private sectors of India.

Production, test and measuring equipment:

- Present Dutch knowhow/products to potential clients and identify their specific needs;
- Promote and share the Dutch approach of a strong relationship and cooperation between R&D and equipment manufacturers;
- Follow the market trends and future developments to identify the right entry point;
- Build a local service team for production equipment, as this may establish a first presence in India.

Components like (hybrid) inverters, batteries/storage, micro-grids and mounting structures:

- For existing products, identify clients in niche and high-end markets;
- For the development of lower-priced products, identify and partner with local organisations;
- Consider a collaborative platform for Dutch electronics companies;
- Partner with Indian organizations for the supply or joint ventures in the manufacturing of advanced mounting structures.

Building-integrated (BIPV) and infrastructure-integrated PV (I^2PV) elements:

- Deepen the understanding of the actual requirements and areas of BIPV and I^2PV applications in India;
- Explore opportunities to offer BIPV and I^2PV training programs for building professionals like architects, engineers and installers;
- Seek partnerships with industrial federations like FICCI and CII for the promotion of BIPV and I^2PV into the national dialogue on smart cities.

Installation of PV systems:

- Explore the actual status of training programs by Indian associations on PV installations and look for partnerships in offering training;
- Offer support in developing a certification system for PV installers, using the Dutch experience with such a system.

Development of PV projects:

- Identify the willingness of Dutch financial institutions to develop PV projects in India;
- Identify Dutch companies active in India that are willing to set up PV projects on their premises and partner with those for PV project development.

Financial and other non-technical services:

- Inform national or state government organizations on various financial models applied in the Netherlands;
- Identify the willingness of Dutch banks to partner with Indian banks for credit lines dedicated to PV project development;
- Explore the possibility for special credit lines to Indian organizations for the import of Dutch manufacturing equipment.

1 INTRODUCTION

1.1 Background

Since the year 2013, the Indian Ministry of New and Renewable Energy (MNRE) and the Dutch Ministry of Economic Affairs (EZ) have a Memorandum of Understanding (MoU) on cooperation in the field of renewable energy. Solar energy is one of the areas this cooperation focuses upon.

An important direction point for this cooperation is India's Jawaharlal Nehru National Solar Mission (JNNSM). At the same time though, higher ambitions are reaching the surface. This includes a recently proposed photovoltaic (PV) solar energy target of 100 gigawatt (GW) in 2022. Up till 2014, about 3 GW is reached, which is already a tripling compared to 2012.

In the same period, the Netherlands faced a tripling of its cumulative amount of PV installations as well. As a result, the country passed its first 1 GW milestone around the summer of 2014. Propelled by this development, solar energy is expected to contribute substantially to the national renewable energy target of 14 percent in 2020.

In addition, the Netherlands is one of the world's leading exporters of solar-related products and services. In line with this, solar energy is one of the focus areas of the Dutch so-called Topsector policy. This implies intensive cooperation on solar energy between the government, the industry and knowledge institutes.

Building upon a recent study[1] about the strong points of the Dutch PV sector, the following report elaborates on (enhanced) PV collaboration between India and the Netherlands. The report is assigned by the Netherlands Enterprise Agency (RVO.nl) and written by Auroville Consulting and Energy Indeed. The latter is also one of the authors of the Dutch study.

Under the above mentioned MoU a Joint Working Group will be established that will coordinate and set priorities in the activities. This Joint Working Group will consist of representatives from the government, scientific institutions as well as the industry.

1.2 Aim

The aim of the report is to explore opportunities for Dutch organizations to partner with Indian organizations in the PV value chain. This aim is pursued by identifying the requirements of the Indian PV value chain and juxtaposing it with the strengths of Dutch PV value chain. Through the exploration, the report aims to initiate an increased collaboration between the two countries. The results of the report are meant to serve as input for the International Energy Programme (PEI) of RVO.nl.

[1] Netherlands Enterprise Agency (RVO.nl). 2014a. International Positioning of the Dutch PV Sector.

1.3 Method

In November and December 2014 information from 59 Indian organizations, that work in the PV sector, was collected with the aim to develop a first inventory of new PV business opportunities between Netherlands and India. The steps taken to fulfil the aims of the report are the following:

1. **Desk study:** consulting literature on the current situation regarding PV in the Netherlands and India and existing collaborations between the two countries;
2. **Interviews:** consulting public and private organizations with PV related connections in India. In total, 19 face-to-face interviews and 5 telephone interviews have been conducted (see detailed listing in Annexure 1*).* The face-to-face interviews have been scheduled prioritizing Channel Partner organizations of the Ministry of New and Renewable Energy (MNRE) that were rated as 1A, 1B or 1C players, while simultaneously attempting to sufficiently cover each of the 11 segments of the Indian PV value chain (see Figure 8).
3. **Electronic survey:** an electronic survey has been sent to a list of 233 Indian organizations active in the PV sector. A response rate of 15 percent (35 players) has been achieved (see detailed listing in Annexure 1*).*
4. **Meeting:** sharing the preliminary results with Dutch organizations and discussing possible follow-up actions on January 20th, 2015, at the NH Hotel in Utrecht.

1.4 Report outline

The report starts with an overall introduction of PV in India, its evolution and policies (Chapter 2) and proceeds with an analysis of the Indian PV value chain by segment and its opportunities for collaboration (Chapter 3). Thereafter, the requirements of the Indian solar value chain are mirrored with the Dutch strengths (Chapter 4). The report concludes with a list of recommendations for an enhanced and mutually beneficial collaboration (Chapter 5).

1.5 Disclaimer

As the setting-up of this exploration of the whole Indian PV value chain has been done within a limited period of time, this report is not exhaustive, nor does it attempt to describe opportunities in minor detailing. It attempts to provide a generic summary. Opportunities highlighted cannot be seen as specific business opportunities on a company level or even a project level, neither is it yet a commitment by the Indian PV organizations to engage in business partnerships with organizations from the Netherlands. In order to provide such information, additional efforts in both the Netherlands and India are required.

2 PV MARKET AND POLICY IN INDIA

2.1 Demographic and geopolitical background

India has the second largest population in the world with an estimated number of 1.26 billion people. A further population increase by an estimated 600 million people is expected by the year 2050.[2] The country also has a relatively young population, with a median age of 27 years[3] compared to 42 years in the Netherlands[4]. The proportion of the working-age population in India is likely to increase from around 58 percent in 2001 to more than 64 percent by 2021, with a large number of young persons in the 20-35 age group.[5]

The total surface area of India is about 3.29 million square kilometers, covering various climatic zones (tropical, hot-dry, temperate). This is about a hundred times the total surface area of the Netherlands. The country shares land borders with China, Pakistan, Bangladesh, Burma, Nepal and Bhutan. Border issues with Pakistan and China have been unresolved for decades and create political tension between these nations.

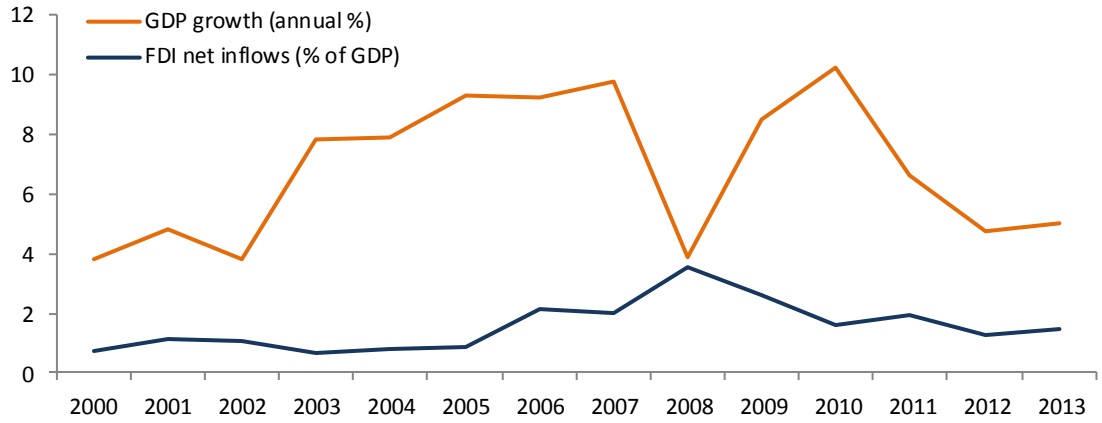
2.2 International trade position

India ranks on position 96 of the Enabling Trade Index of the World Economic Forum.[6] The country is preceded in the ranking by Argentina (rank 95) and followed by Egypt (rank 97). Among the BRICS economies, it lags far behind China and South Africa, but it is nine places ahead of the Russian Federation. Thanks to good maritime and air connectivity and its extensive rail network, India ranks on a satisfactory position 34 of the transport infrastructure pillar. Nevertheless, heavy investments for upgrading this infrastructure in order to respond to the needs of industrial development are needed.

India has emerged as one of the fastest growing economies in the world. Its current economic performance is reflected in an upward trend, based upon an increase in domestic consumption, foreign investment and exports. The investment climate for the Indian power sector is seen as positive. Due to policy liberalization, the industry has attracted Foreign Direct Investments (FDI) worth US$ 9.3 billion during the period April 2000 to August 2014.[7] India's economy has grown at an average annual rate of approximately 7 percent since 2000 and it proved relatively resilient following the 2008 global financial crisis.[8] Figure 2 reflects the evolution of India's Gross Domestic Product (GDP) and FDI net inflows in percentages.

[2] World Bank. 2014. World Development Indicators.
[3] Statista. Median Age of the Population in Selected Countries in 2014.
[4] Eurostat. 2013. Population Structure and Ageing.
[5] Ministry of Finance, Government of India. 2014. Economic Survey 2013–14
[6] World Economic Forum (WEF). 2014.The Global Enabling Trade Report 2014.
[7] India Brand Equity Foundation (IBEF). 2014. Foreign Direct Investment.
[8] U.S. Energy Information Administration (EIA). 2014. India Report. Accessed November 2014

Figure 2 – Evolution of FDI and GDP in India, 2000-2013



Source: *World Bank. World Development Indicators. 2014. www.data.worldbank.org*

The Indian manufacturing sector is not very dynamic. Its contribution to the GDP has been stable at around 15 percent for almost two decades, which is significantly lower compared to China and some Southeast Asian nations such as Thailand and Malaysia. As of May 2014, India has a new Government headed by Prime Minister Narendra Modi. Before being elected to this post, Mr. Modi was Chief Minister in the state of Gujarat, one of India's most rapid developing states. Mr. Modi recently launched several ambitious national programmes. Amongst them is "Make in India", which aims to facilitate investments to build a high-quality manufacturing infrastructure, to foster innovation and to enhance skill development. The renewable energy sector is one of the focus areas of this programme.

2.3 Energy challenges and demand

In India, the rise of a consumer class with disposable income, modernization of infrastructure and facilities and changing life styles are contributions to the increase of the per capita electric energy demand. Primary energy consumption in the country has more than doubled between the years 1990 and 2013, reaching an estimated gross generation of 931 billion kWh per year. This makes India the fourth largest energy consumer in the world after China, the USA and Russia. India's annual per capita electricity consumption by 2014 is about 900 kWh, which is one third of the global average. This clearly indicates the potentially higher energy demand in the near future. At the same time, there are about 300 million people, primarily in the rural areas of India, who do not have access to the electricity grid.[9] Consequently, access to the electricity grid as well as 24/7 availability of electricity is a major ambition of the Indian Government.

An increase of India's electricity requirement by a factor of 2.5 is predicted within the next 12 years.[10] This makes the electric power sector one of the fastest growing sectors in India. To meet this trend, huge deployment of energy resources needs to be undertaken.

[9] Ministry of New and Renewable Energy (MNRE). 2014b. Renewable Energy at a Glance.
[10] U.S. Energy Information Administration (EIA). 2014. India Report. Accessed November 2014.

2.4 PV market in India

India is endowed with a high band of average solar irradiation. With an equivalent energy potential of about 6 billion GWh per year, the country is an ideal place for the deployment of solar technologies. The average solar irradiation in India is 5.1 kWh per m^2 per day,[11] but regional differences are large (see Annexure 2). India shows a clear upward trend in terms of installed PV capacity from about 54 MW of installed PV capacity in 2010 to an estimated 2,632 MW in 2014.[12] This impressive growth has been driven by favorable government policies such as the Jawaharlal Nehru National Solar Mission (JNNSM) and by the fact that India is facing large energy deficits (see Table 2).

Table 2 – Overview Indian power sector

Characteristic	Value
Installed Capacity (2013)	250 GW
Gross Generation (2013-2014)	931 billion kWh per year
Consumption per Capita (2012-2013)	917 kWh per year
Energy Shortage (June 2014)	3.9%
Peaking Shortage (June 2014)	4.5%
Electrification rate: national (2011)*	75%
Electrification rate: urban areas (2011)	94%
Electrification rate: rural areas (2011)	67%

Sources: *Ministry of New and Renewable Energy (MNRE). 2014a. Renewable Energy in India. U.S. Energy Information Administration (EIA). 2014. India Report * 300 million people without electricity*

The JNNSM envisions a total installed PV capacity by the year 2022 of 22,000 MW. KPMG India[13], a major consulting firm working on finances and technology, projected a total installed capacity of 67,000 MW for 2020, exceeding the JNNSM targets by a factor of three. The current Bharatiya Janata Party (BJP) lead government recently announced even more ambitious targets of 100,000 MW.[14] Mega utility scale plants in the form of solar parks of 1 GW each are being envisioned. The government aggregates land for such parks and then calls for project bids inside these parks in order to accelerate the deployment of solar. Figures 3 and 4 provide an overview of the annual PV capacity additions and indicate the envisioned targets for the year 2017 and 2022 based upon the JNNSM targets and recent announcements by the new government.

The Jawaharlal Nehru National Solar Mission (JNNSM) reflects the national targets. As India is a federation, each state has its own PV state targets and tariff regulations (for some state examples please see Annexure 3). In most cases these targets reflect the Central Government of India's road map. Two Indian states stand out in terms of commissioned PV capacity as by November 2014: Gujarat and Rajasthan. These two states in the Northwest of India are the leading solar states in India, sharing a combined installed PV capacity of 1,657

[11] NASA Surface meteorology and Solar Energy: RETScreen Data.
[12] Energy Alternatives India (EAI). 2014. Solar Business Opportunities in India. A Value Chain Perspective.
[13] KPM India. 2012. The Rising Sun. Grid parity gets closer. A point of view on the Solar Energy sector in India.
[14] Energy Next. 2014. Solar on Growth Mission. Volume 4, Issue 11, September 2014, Hyderabad

MW (61 percent of the national capacity). The total cumulative commissioned capacity by November 2014 for India stood at 2,908 MW. Figure 5 indicates the total grid-tied PV capacity commissioned by state, whereas Figure 6 lists the total grid-tied capacity by source of commissioning.

Figure 3 – Overview installed PV capacity India

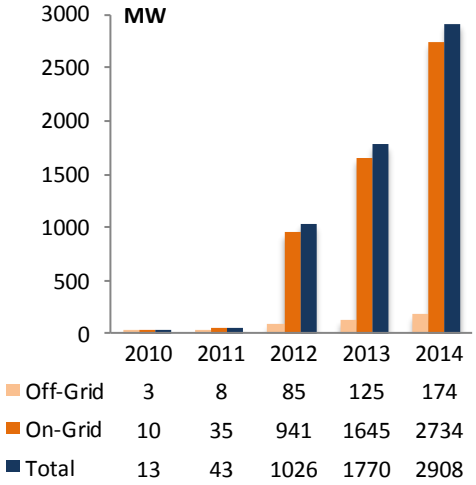
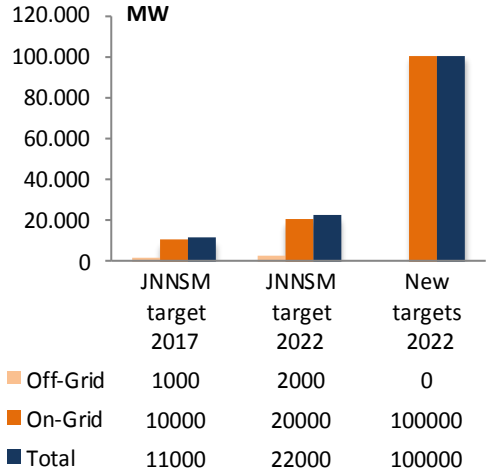


Figure 4 – JNNSM targets and new targets



Sources: *Bridge to India. 2014b. India Solar Compass October 2014; Ministry of New and Renewable Energy (MNRE). 2014b. Renewable Energy at a Glance; National Renewable Energy Laboratory (NREL). 2010/ Indian Renewable Energy Status Report. Background Report. * No specific targets for off-grid installation for the New Government targets have been announced as per December 2014.*

Figure 5 – Total Grid-Tied PV Capacity Commissioned by State till November 2014

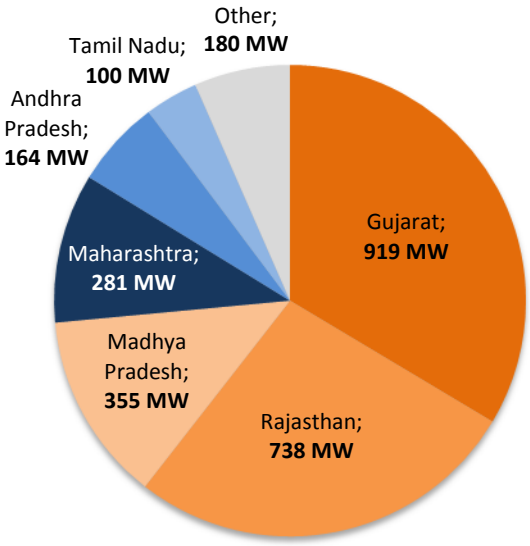
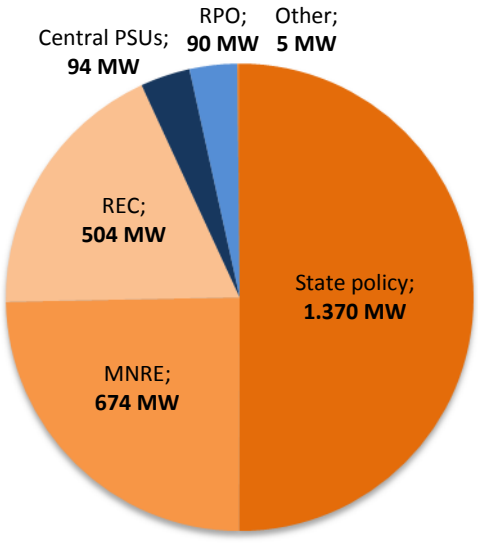


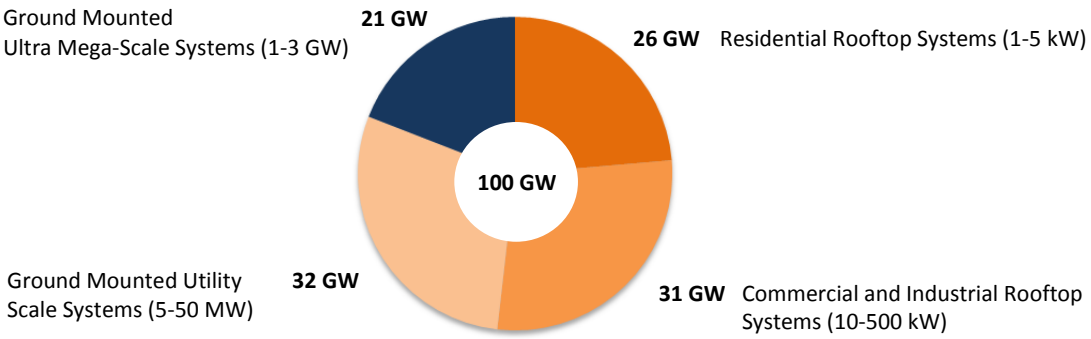
Figure 6 – Total Grid-Tied PV Capacity Commissioned by Source till November 2014



Source: *Ministry of New and Renewable Energy (MNRE). 2014b. Renewable Energy at a Glance*

Bridge to India, a consulting firm in the renewable energy sector, has estimated the deployment of PV installations in India till the year 2024. Having categorized the systems by scale (Residential, Commercial & Industrial, Utility Scale and Ultra Mega Scale), the firm projects that rooftop solar (Residential and Industrial-Commercial) and ground mounted utility scale systems have similar deployment potential and scale within the next ten years (see Figure 7).[15]

Figure 7 – Comparison of PV options and their deployment potential till 2024



Source: *Bridge to India. 2014a. Beehives or Elephants.*

2.5 Policy landscape

India's energy policy has been shaped by its need to ensure energy security and by a larger goal of attaining energy self-sufficiency. The Jawaharlal Nehru National Solar Mission (JNNSM) is one of several initiatives under the National Action Plan on Climate Change. The mission envisions a gradual shift from dependence on conventional sources of energy to renewable ones. The objectives of the JNNSM are to harvest solar energy on a large scale, to create a strong manufacturing base for solar energy, employment generation and the long-term sustainability of the Indian solar energy sector.

The National Manufacturing Policy identifies solar energy sector as an industry with strategic significance along with defence, aerospace and telecom and classifies it as a "strategic industry" under the special focus sectors.[16] JNNSM has three phases, spanning 15 years that coincide with India's five-year plans. The short-term objective is to ensure an enabling framework for investment in solar energy. Two recent announcements by the government were key in ensuring that India reaches its ambitious PV targets:

- The rejection of the proposal to impose anti-dumping duties on the import of solar cells and modules;
- The proposed ambitious new target of 100 GW installed capacity by 2022.

[15] Bridge to India. 2014a. Beehives or Elephants. Accessed November 2014.
[16] Federation of Indian Chambers of Commerce and Industry (FICCI). 2014. Securing the Supply Chain for Solar in India. FICCI Solar Energy Task Force Report.

As the current domestic capacity is not large enough to meet the revived JNNSM targets, the government recently decided not to impose anti-dumping duties on the import of solar cells or modules. However, the government did announce to support the Indian manufacturers in the form of domestic procurement from public sector companies. Other key points the government said it would address are:

- Lower the costs of capital in India are very high (12.5-14% and short loan durations);
- Speed up procurement process of land for PV development;
- Increase availability of a power evacuation infrastructure;
- Streamlining of policy implementation processes;
- The central government's focus was mainly on large projects.;
- Enforce Renewable Energy Purchase Obligations (RPOs). (Is being addressed in an amendment of the Indian Electricity Act 2003);
- Increased focus on rooftop segments (currently the Central Government focus was largely on larger projects)

Electricity in India is a concurrent subject; responsibility is shared between the central and state governments. The central government is a facilitator with various central government schemes. State governments are responsible for sub-transmission and distribution. According to The Electricity Act (2003), state and central regulatory bodies are mandated to promote renewable energy. For that matter, regulatory bodies have taken a number of measures, including the adoption of the Renewable Purchase Obligation (RPO). Distribution companies have to purchase a portion of their electricity from renewable energy sources. A list of some of the major central government players related to PV is shown in Table 3.

Table 3 – Central government players for the solar sector

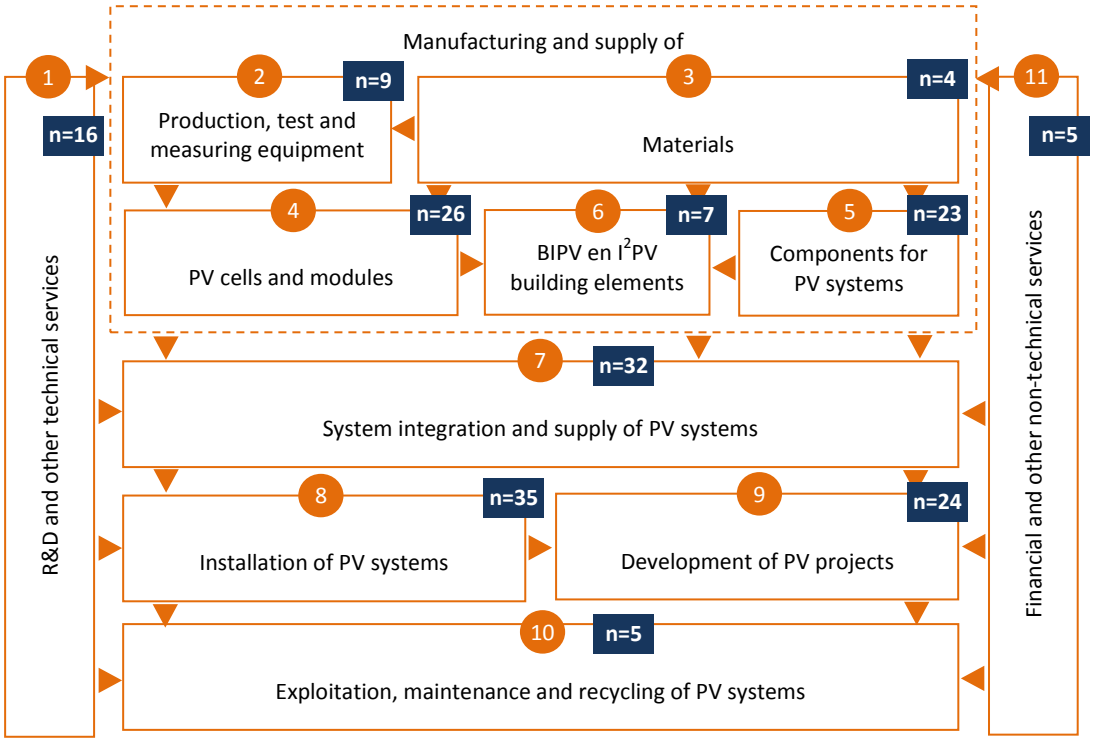
Key player	Role
Ministry of Power (MoP)	In charge of policy in the electric power sector
Ministry for New and Renewable Energy (MNRE)	In charge of promotion of renewable energy
Indian Renewable Energy Development Agency Ltd (IREDA)	Under MNRE. Provides financial support to projects in the form of loans (e.g. lending of KFW Germany funds)
Electricity Regulatory Commissions	Regulations, tariffs and supervision of distribution licensees
National Institute of Solar Energy (NISE)	National R&D institution in the field Solar Energy

Adapted from: *Centre for Strategy and International Relations (CSIS). 2014. India's Solar Energy Future.*

3 PV VALUE CHAIN IN INDIA

This chapter indicates requirements and strengths of the Indian PV sector and its players. Thereby it divides the PV sector into 11 segments (see Figure 8). These are the same segments as defined in the study about the strengths of the Dutch PV sector. The chapter briefly describes each of these segments, lists existing collaborations and indicates opportunities for collaboration.

Figure 8 – PV value chain: schematic representation and number of respondents



2 The number of the segment

n=9 The number of respondents from the interviews and the electronic survey. Please keep in mind that single players may be active in multiple PV segments.

Source: *Netherlands Enterprise Agency (RVO.nl). 2014a. International Positioning of the Dutch PV Sector.*

3.1 R&D and other technical services

"Initiate a program to evolve available technologies for local application in **collaboration with private players or educational institutions**"

Currently, the national government organizes most of the R&D efforts in India. The National Institute of Solar Energy (NISE) serves as an interface between the government and academic institutions, industry and user organizations for development, promotion and widespread utilization of solar energy. The primary focus lays on fundamental research. Funding for the government's R&D initiatives is channelled to prestigious educational institutes like the Indian Institute of Technology (IIT), which has many branches spread out all over India. The National Center for Photovoltaic Research and Education (NCPRE) at IIT Bombay performs research on thin film technologies such as Copper Indium Gallium Selenide (CIGS) and Cadmium Telluride (CdTe). Other notable players are the Council for Science and Industrial Research (CSIR) and its branches, with R&D activities in screen-printed silver-aluminium (Ag-Al) back contact, indigenization of fabrication for polycrystalline silicon solar, hydrogen production by splitting water using solar energy and initiatives in Organic PV (OPV). Annexure 9 lists major PV R&D public sector organizations, their respective R&D initiatives and some of their current international collaborators.

Besides government-driven R&D, many Indian companies in the solar PV value chain have their in-house R&D and product development programs. Examples of these players are Sukam (inverters), PPS Enviro Power (inverters), OPS India (inverters and product testing). The Federation of Indian Chambers of Commerce and Industry (FICCI) recently identified a lack of industry participation in the R&D initiatives of the Indian Government, resulting in a lack of alignment between the needs of the private sector and the initiatives taken by government institutions.[17]

Existing relations

The Energy Research Institute (TERI), a not-for-profit policy research organization with some activities in applied research for rural applications, has established a presence in North America and Europe. Its European head office has been set up in Utrecht, where it collaborates with the Utrecht University. The collaboration between the Solar Energy Research Institute for India and the United States (SERIIUS), which is co-led by the Indian Institute of Science (IISc) and the National Renewable Energy Laboratory USA (NREL), is another example of an existing international collaboration in the R&D Segment.

Shell and the Netherlands Organization for Scientific Research (NWO) have joined hands in a public-private partnership on fundamental research in the energy domain. This has resulted in a large-scale initiative called 'Computational Sciences for Energy Research' (CSER). Through this initiative trainings are provided to a large number of Indian PhD students in the Netherlands and ties between Indian and Dutch research communities are strengthened.[18]

[17] FICCI. 2014. Securing the Supply Chain for Solar in India. FICCI Solar Energy Task Force Report.
[18] Embassy of India, The Hague. 2014. India Netherlands 2014. Extraordinary and Plenipotentiary Diplomats. Special Report.

Opportunities

Opportunities in the R&D segment include collaboration with academic institutions on:

- Materials and devices;
- Storage and battery technology;
- Micro-grids;
- Availability of low-cost silicon and thin film technologies;
- Applied research on existing processes and development of new technologies;
- Technology validation aimed at field evaluation of materials;
- Components and systems;
- Development of Centers of Excellence on different aspects of solar energy;
- PPP mode development and support for incubation and innovation.[19] [20]

The opportunities for collaborations exist in technology transfer and in bringing more R&D efforts to India, while simultaneously tying these efforts up with the commercial sector for faster commercialization of new technologies. An area of great interest that is linked to the application of PV is research on smart-grid and micro-grid development. Smart-grid technology is also an area of great interest to the Indian government as there is a Smart grid Mission that includes the set-up of 1,000 micro-grids in India, in which solar PV will surely have a role.[21]

3.2 Production, test and measuring equipment

The second segment is primarily dominated by foreign companies, as most of the production, test and measuring equipment for the Indian PV industry is imported. Some of the key players currently are AW Solution and ECOPROGETTI, providing equipment such as tabber stringer, laminators, module testers, front back end machinery and equipment for electroluminescence inspections of cells and automation. Aster Technologies and SBC Solar are two domestic companies offering equipment such as solar laminators, automatic tabber stringer, a range of testing equipment, glass-processing equipment and ultra-precision cutting equipment (UCP).

"There is an **urgent need to bring European technology** in to India for our projects. This could be done through duty exemptions, local collaborated manufacturing, etc."

Existing relations

Eternal Sun and Tempress are examples of Dutch companies that have entered the Indian market. The first supplies solar simulation systems, while the second supplies systems for silicon wafer handling and thermal processing equipment for the advanced research sector.

[19] European Business and Technology Centre (EBTC). 2010. Partnerships in India. A report on EU-India Renewable Energy Opportunities.
[20] Department of Science and Technology. Government of India. Solar Energy Research Initiative.
[21] Energerati. The Smart Energy Network. More Microgrids Coming To Remote Villages In India.

Opportunities

In India at present, falling prices, outdated machineries, imports of materials, new emerging materials and economic slowdown have created a challenge for the PV cells and module manufacturing segment. An upgrade of existing facilities with state of the art technology may therefore be required and Dutch organizations with their high-quality products may find opportunities in the supply of manufacturing and product testing equipment.[22] These imports are exempt from customs duty since July 2014. Moreover, Indian states like Gujarat[23], Rajasthan and Maharashtra provide technology up-gradation support to various sectors to improve their efficiency, quality and production.[24]

On the other hand, this segment is closely tied up with the domestic PV cells and module manufacturing capacity, which is currently suffering from overcapacity (see paragraph 3.4). For this reason, opportunities for Dutch organizations should not be seen as low-hanging fruits, but rather as long-term opportunities. A few domestic players (Vikram Solar, Chemtrols Solar, Titan Industries) in the PV cells and module manufacturing have indicated that they would like to scale up their operations and upgrade their current manufacturing machinery. Another player (L&T) has a long-term goal of setting up a PV cell and module-manufacturing unit.

From the industrial side it has been indicated that processing of waste slurries from PV wafer manufacturing is a rising environmental issue.[25] Therefore, providing appropriate processing technology may be an interesting additional opportunity for Dutch companies to explore further.

3.3 Materials

India's PV industry has been dependent on imports of most of the critical raw materials needed for the manufacturing of PV cells. Silicon wafers and ingots, polysilicon, silver paste, graphite, quartz crucibles, metallurgical grade (MG) silicon, reflective coating, absorber coatings etc. are materials of which the current domestic supply capacity is currently nil.[26] On the other hand, there is a good number of domestic players providing glass, EVA film and backsheet, sand and aluminium to the industry. Some of these companies are Jindal Aluminium Ltd. (solar panel frames), Allied Glasses (EVA film and low-iron solar glass), Borosil Glass Works, Emmvee, HNG Float Glass, GSC glass (all low-iron glass), and Aster Technologies (aluminium frames, solar glass, soldering ribbon, EVA and backsheets). Two domestic players, Lancon Solar and the state-owned Bharat Heavy Electricals Ltd. (BHEL), have announced to set up wafer manufacturing units.

[22] Federation of Indian Chambers of Commerce and Industry (FICCI). 2014. Securing the Supply Chain for Solar in India. FICCI Solar Energy Task Force Report
[23] Industries and Mines Department. State Government Gujarat. Large Medium and Small Scale Industries.
[24] KPMG. 2014. Skill, Build & Transform. Indian Union Budget 2014.
[25] Federation of Indian Chambers of Commerce and Industry (FICCI). 2014. Securing the Supply Chain for Solar in India. FICCI Solar Energy Task Force Report
[26] Federation of Indian Chambers of Commerce and Industry (FICCI). 2014. Securing the Supply Chain for Solar in India. FICCI Solar Energy Task Force Report

Existing relations

Existing relations are primarily on a supplier-buyer basis. Royal DSM recently inaugurated its Solar Technologies Demonstration Center at its DSM Engineering Plastics facility in Pune, testing the efficiency of its anti-reflective coating and its new light trapping technology. DuPont Photovoltaic Solutions (USA) is a major importer of materials to India, supplying frames, glass, encapsulant, cells, backsheets and junction boxes. GT Solar (USA) and Mayer Berger (Germany) are examples of companies supplying wafers to India.

Opportunities

There is clearly a scope for the development of a domestic production base for some of the key inputs such as polysilicon (mining), ingots and wafers (manufacturing). This could secure and strengthen the supply chain to reduce the foreign exchange outflow and create direct and indirect long-term employment in the solar industry. Currently there is no polysilicon plant in India and there are practically no domestic experts available for this technology. Some small and medium enterprises (SMEs) in the PV cell and module manufacturing segment indicate a requirement for wafers and other materials. These are Shri Sai Technologies, Soles Energy Private Limited, Thrive Soar Energy Private Limited and Swelect.

3.4 PV cells and modules

Like the previous segment, the Indian PV cell and module manufacturing segment is highly dependent on imports of material. This dependence on imports has resulted in significantly high costs at cell level for Indian manufacturers compared to the competitors from China and other Asian countries.[27]

"Cell manufacturing is very tough in India, due to the **Chinese competition**"

Currently the domestic PV module and cell manufacturing capacity suffers from significant overcapacity, despite a domestic content requirement (DCR) imposed by some of the government sponsored schemes on the origin of c-Si PV cells used in the PV modules for power generation. Moreover, significant portions of the PV plants installed were set up using imported c-Si and thin film modules. Table 4 indicates the domestic cell and module manufacturing capacity and is capacity utilization.

Table 4 – Indian cell and module manufacturing capacity utilization, FY 2013-14

Characteristic	PV cells	PV modules
Domestic Manufacturing FY 2013-14	1.2 GW	2.3 GW
Total Installed Capacity FY 2013 -14	-	1.1 GW
Cell Manufacturing Capacity Utilized FY 2013 -14	250 MW	-
Export of Modules FY 2013 -14	-	300 MW

Source: *Investment Information & Credit Rating Agency Limited (ICRA). 2014. Indian Solar Photovoltaic Industry*

[27] Federation of Indian Chambers of Commerce and Industry (FICCI). 2014. Securing the Supply Chain for Solar in India. FICCI Solar Energy Task Force Report

Examples of domestic companies in this segment are: Tata Power Solar, Reliance, Solar EMMVEE Photovoltaic Power, Titan Energies Pvt. Ltd., Vikram Solar, Swelect, Titan Energy Systems, Chemtrols Solar, Web Solar, Lancon Solar, Bharat Heavy Electricals Ltd., Central Electronics Ltd. and KCP Solar Industry.

Existing relations

International players with a (future) presence in India are: ReneSola (imports materials and manufactures modules in India), Solar Semiconductor (module manufacturing in India), Trina Solar (plans to set up a manufacturing unit in India), First Solar and SunEdison.[28]

Opportunities

The Indian PV industry is interested in technology for the manufacture of PV modules, especially based on thin film materials.[29] Some companies such as PPS Enviro Power, Titan Energy Systems, KCP Solar Industry have indicated an interest in setting up strategic partnerships and joint ventures for targeting both the domestic and the international market. There is a requirement for technical assistance to improve the efficiency of the cells and modules and the manufacturing process in order to produce more cost-effective cells and modules. Skilled manpower and finances (in terms of capital investment) are other requirements mentioned.

3.5 Components for PV systems

Examples of products in the components segment are inverters, batteries, mounting structures and trackers, monitoring equipment and junction boxes. India has a huge manufacturing capacity for non-solar inverters. It is estimated that an average of 4 million non-solar inverters are sold per year.[30] This indicates that with the right up-gradation and technology transfer from conventional inverters to solar PV inverter technology, the domestic manufacturers should be capable to meet the PV inverter requirements for the governments' PV target of 100 GW for the year 2022 (see Figure 4). Available foreign grid-inverter technologies need to be adapted to the Indian conditions, where the utility grid is unstable (power cuts) and has high voltage fluctuation. Thermal stress due to local weather conditions of up to 40°C needs to be considered in the design of PV inverters.[31]

"Biggest challenge is **indigenization of PV technologies,** which are Europe / US centric, for tropical areas of India and Africa"

Components required for manufacturing PV inverters such as Insulated Gate Bipolar Transistor (IGBT) modules and Digital Signal Processor (DSP) based controllers are largely imported. Examples of domestic players in the inverter segment are Sukam Power Systems, Swelect, PPS Enviro Power, Solkar, Nordic India, Chemtrols Solar and Novergy Energy.

[28] Forbes. 2015. SunEdison Plans To Build A 4B Mega Solar Factory In India. January 12, 2015.
[29] IMaCS VIRTUS Global Partners. 2010. India Renewable Energy and Solar Photovoltaic Market Opportunities for US Companies.
[30] Federation of Indian Chambers of Commerce and Industry (FICCI). 2014. Securing the Supply Chain for Solar in India. FICCI Solar Energy Task Force Report
[31] ABB. 2014. Ensuring Success In Global Utility Solar PV Projects. A GTM Research Whitepaper.

Battery manufactures traditionally supplying to the automotive industry have started production of deep cycle tubular batteries for PV standalone systems and have a huge manufacturing capacity. The high demand for battery back-up systems is due to frequent grid failures and the fact that there are still more than 300 million people not connected to the grid. Examples of local battery manufacturers are Amara Raja, TAFE and Tudor. Similar to the inverter and battery manufacturing segment, the domestic cables, junction boxes and connecter manufacturers have a good manufacturing capacity. Still though, the majority of the junction/combiner boxes used are imported.[32] Examples of domestic suppliers are Nordic India, Hanut India and Cape Electric.

Mounting structures and tracking systems are another product line in this segment. Mounting structures are used to mount PV panels at the desired angle to absorb the maximum solar radiation. Mounting structures that are available in the market are made from galvanized steel or aluminium. Tracking systems are add-ons to the regular mounting systems or they are integrated with the mounting structure; they improve the Capacity Utilization Factor (CUF) of the PV system. As the cost of adding a tracking system is high, tracking systems are not yet widely used in India. Examples of domestic companies providing mounting structures and tracking systems are Neuvosol, Strut Support Systems India, Vishal Engineers & Galvanizers Pvt. Ltd., Jurchen Technology India Pvt. Ltd.

Existing relations

Victron Energy, a Dutch inverter and battery supplier, already manufactures and supplies in India. Kipp & Zonen and Hukseflux are examples of Dutch companies supplying solar irradiation measurement and test equipment to Indian organizations. Global inverter majors such as Bonfilioli, Hitachi, SMA, ABB, Schneider, Techser Power Solutions, Maruthi Solar Systems, Consul Consolidated are among the leading suppliers in India. Moser Baer and Du Point are major suppliers of junction boxes. GNB (USA) is an example of an international battery manufacturer with a base in India. Schletter GmbH, a German company, has set up a branch office in India, supplying PV mounting structures.

Opportunities

A scope for technology transfer and partnerships on grid-tied inverters, hybrid inverters, micro inverters and smart grid applications has been indicated by organizations in this segment. Examples of Indian companies who indicate requirements for partnership in these technologies are: Sukam, Solkar, OPS India, KCP Solar Industry, L&T (micro-grids). Capacity building and training of engineers in the installation of new inverter technologies as well as financing (in terms of equity) are other requirements indicated. BKC Weathersys, a company providing irradiation and monitoring equipment has indicated an interest in a joint venture on manufacturing equipment in this product line. There is also room for collaboration with regard to junction boxes and connectors. Jindal Aluminium, one of India's largest steel and aluminium consortium, has indicated an interest in partnering with a Dutch organization in the field of advanced PV mounting structures. Highly efficient and robust solar pumping systems have been named as another requirement.

[32] Federation of Indian Chambers of Commerce and Industry (FICCI). 2014. Securing the Supply Chain for Solar in India. FICCI Solar Energy Task Force Report

3.6 Building-integrated (BIPV) and infrastructure-integrated PV (I^2PV) elements

This segment of the PV value chain is at an infant stage in India. BIPV is often associated with the green building segment. During the face-to-face interviews with Indian organizations the authors found that rooftop-mounted PV is often considered as BIPV. An example of an implemented BIPV project in India can be found at the headquarter of Emmvee, a domestic module manufacturing company. It has installed a 39 kW BIPV-system on the facade of its head office, using 69 modules of 230 W. Tata Power Solar, Topspun India, Rely On Solar and Emerald Energy Solutions are examples of Indian companies that have ventured into BIPV (solar roof-tiles) and I^2PV (mobile tower applications). Infrastructure-integrated PV solutions have not yet been available in India, although the Ministry of New and Renewable Energy and the National Institute of Solar Energy have shown great interest in such solutions.

Existing relations

Waaree is one of the major multinational players in India that offers BIPV-modules.

Opportunities

As there are only a few companies currently working in the BIPV and I^2PV segment, Dutch companies may find good opportunities given the more mature stage of development in the Netherlands. During the interviews, some reservations were voiced among the contacted organizations with regard to BIPV and its repercussions on the thermal comfort of buildings. Interest in BIPV and I^2PV has been also been indicated for specific applications, like car parking structures, petrol stations and for mobile towers (as a standalone system in combination with other renewables). Another opportunity in the near future for both BIPV and I^2PV may arise with the plans of the government of India to set up 100 smart cities all over the country. The SolaRoad initiative in Krommenie (the Netherlands) has gained interest form the Ministry during their visit to the Netherlands and is clearly something further cooperation could be possible.

3.7 Integration and supply

Integration and supply is one of the strongest segments of the Indian SPV value chain. This segment overlaps with the installation segment, as around 90 percent of all the installers have incorporated the tasks of integration and supply under one roof.[33] Examples of Indian companies in the integration and supply segment are: Acme, Rays Power Infra, Solkar, L&T, Sukam, Swelect, Tata Power Solar and Emvee.

"Currently, European technology is being used by **the creamy layer of integrators** which deliver a markedly high level of performance and ease of maintenance"

Existing relations

Lanco, Sterling & Wilson, First Solar, Belelectric, Sun Edison, Welspun Energy are examples of multinational companies active in India. Most of them are active in multiple segments such as manufacturing, integration and supply, installation and development (EPC).

[33] Federation of Indian Chambers of Commerce and Industry (FICCI). 2014. Securing the Supply Chain for Solar in India. FICCI Solar Energy Task Force Report

Opportunities

Requirements of this segment for growth include, but are not limited to, availability of cheaper finance to procure higher volumes of materials and skilled manpower. The supply of components such as hybrid or grid-inverters and monitoring equipment may present another opportunity.

3.8 Installation

Another strong segment of the Indian PV value chain is the installation segment. This segment has proved its potential for growth over the last four years, and further growth is expected given the new government targets. Constraints faced by the installers are financial capital to buy components in bulk, to reduce their inventory costs, storage space and a stable government policy implementation framework. The majority of the small and medium sized installers focus on PV installations on residential, commercial, institutional and industrial rooftops. Rooftop installations are expected to see substantial growth, as some of the Indian states (Rajasthan, Gujarat, Kerala, Karnataka, Tamil Nadu, Delhi, Punjab) recently announced a policy for net metering (see Annexure 3). Examples of some major Indian installers are: TATA Power Solar, Vikram Solar, RelyOn Solar, Acme, Azure Power, Solairedirect India and Jakson Power.

"Primary requirements of the Indian PV sector: cells manufacturing base, **finance and insurance services** and software platforms for data and systems designing"

Existing relations

Examples of other multinational organizations in this segment are Waaree Solar, Sun Edison and Solon.

Opportunities

Competition in this segment is extremely high and it may be difficult for new players to enter the market. Strategic partnerships with domestic installers with a good reputation and client base can be considered. Further a need for an installer quality assurance certifications schemes in collaboration with the nodal agencies (state agencies) of the Ministry of New and Renewable Energy and the National Institute of Solar Energy has been indicated.

3.9 Project development

Market trends regarding utility scale projects have displayed a considerable increase in the size of the projects. Most PV systems installed in the FY 2012-13 were in the range of 1 MW to 25 MW. Only a few projects were in the range of 100 MW capacity and larger. Ultra-mega projects in the size of gigawatts are currently planned. To achieve these ambitious projects, developers will require

"**Mad growth** in solar energy sector is on the anvil. High level of cooperation and synergy is needed amongst companies to deliver"

considerable amounts of financial capital. Examples of domestic companies in this field are Neyveli Lignite, ACME Tele power, Renew Power, Mahindra EPV, Vikram Solar, Moser Baer, Sri Power Generation, Rays Power Infra, Coal India, Reliance Industries Limited (Solar group), Larson & Toubro, Green Infra and Godrej & Boyce.

Existing relations
There is a good number of multinational players represented in this segment. Examples are Azure Solar Power, First Solar, Welspun, Sterling & Wilson, Juwi and Lanco Infratech.

Opportunities
Opportunities in this segment may be in financing PV projects in India, either on a loan or equity basis. During the interviews, some organizations said they have requirements for system integration, exploitation and maintenance services. Technical know-how to engineer, procure and construct (EPC) the projects, skilled labour and software tools for operation and maintenance are required.

3.10 Exploitation, maintenance and recycling

Many of the companies in the exploitation and maintenance of PV systems are also in the installation and integration segment. No company could be found regarding the recycling of PV modules. Poseidon Solar & Torp Systems is probably the only domestic player that purifies silicon waste, which can be used for the manufacturing of silicon ingots. They have indicated that they wish to get into module recycling within the next five years. Though, limitations for growth in the recycling segment are high costs, a lack of modules to be recycled and the absence of wafer manufacturing in India. Battery recycling from stand-alone PV systems or simple Uninterrupted Power Systems (UPS) systems remains a big unknown as no appropriate collection and recycling processes are in place. Companies such as Amara Raja, TAFE and Tudor run a take-back program of old batteries, but the actual implementation on this is questionable. Examples of companies in maintenance are Mas Solar Systems, Jakson Engineers Limited, Vivan Solar and Green Secure Energy. Along with them, most of the major EPC players provide operation and maintenance services.

Opportunities
Technology and knowledge transfer for appropriate battery recycling technologies and business models is required. Poseidon Solar & Torp Systems has indicated a requirement in R&D and knowledge transfer for recycling of silicon and PV modules. As the recycling demand is expected to increase in the near future due to more PV modules for recycling and the first wafer manufacturing units being planned, this segment promises opportunities for collaboration. Developers have also indicated maintenance service requirements, which are expected to steeply increase in the near future with the addition of new PV capacity.

3.11 Finance and other non-technical services

"**We need financial assistance** to develop solar parks and plants to take long term advantage of power purchase agreement by the Indian government"

Financial assistance available to developers and installers in India currently comes with 12.5-14 percent interest loans and relatively short loan durations. There is a higher interest rate for Small and Medium Enterprises (SMEs) due to a lack of collateral. This has hampered the growth of PV implementation in India to a great extent.[34] MNRE, with the help of its nodal agencies in each state, has managed to fulfil parts of the JNNSM through subsidy programs. To meet the targets for the year 2022, new policy mechanisms, better feedback processes between the government and private players, a strong domestic PV material, cells and modules supply chain and an investor friendly climate will be required.

Scepticism among financial institutions, due to some scams and cases of non-performance of companies that underbid in the competitive bidding process of government-initiated PV development projects, has hindered faster deployment of PV in India.

Existing relations

Development banks such as the Export-Import Bank (Ex-Im) of the United States, Germany's KfW and the Asian Development Bank (ADB) are the largest financers of renewable energy projects in India.[35] Ex-Im's current portfolio of Indian PV projects stands at USD 353.4 million, financing 289 MW. Ex-Im Bank and the Indian Renewable Energy Development Agency (IREDA) recently signed a US$ 1 billion Memorandum of Understanding (MoU) aimed at financing the sale of US clean energy exports to India.[36] KfW provides concessionary financing or financial support in the form of Compulsory Convertible Debentures (CCD). Triodos Bank, a Dutch bank, has been giving loans to IntelleGrow. This is a financial institution that provides debt funding to companies with a high social and environmental impact. An example of such a company is Orb Energy, a PV integrator and installer with a strong rural focus.

Indian governmental institutions such as MNRE and NSEFI and industry federations such as FICCI and CII have close partnerships with various international organizations, such as the German Government Agency for International Cooperation (GIZ), the United States Agency for International Development (USAID) and the European Business and Technology Center (EBTC). PricewaterhouseCoopers (PwC) has been advising the Indian regulators, financial institutions, utilities and government in framing renewable energy policies and regulations.

On the non-technical services it is worth mentioning that DSM is an active member of the Federation of Indian Chambers of Commerce and Industry (FICCI) solar energy taskforce.

[34] Federation of Indian Chambers of Commerce and Industry (FICCI). 2014. Securing the Supply Chain for Solar in India. FICCI Solar Energy Task Force Report

[35] U.S. Agency for International Development (USAID). 2014. U.S.-India Partnership to Advance Clean Energy (PACE). An Initiative of the U.S.-India Energy Dialogue. A Progress Report July 2014.

[36] PV Magazine. 2014. US Ex-Im Bank signs $1 billion agreement to support clean energy exports to India.

This taskforce aims to provide a platform for the leading players in the Indian solar industry to come together and work collectively on issues of common interest.

Opportunities
The expected rapid development of PV in India will require a significant increase in technically qualified human resource availability of an international standard. It is estimated that at the end of the JNNSM period in 2022, the PV industry in India will employ at least 100,000 trained and specialized people, including engineering, management and R&D functions.

The government of India plans to train 1,000 young scientists and engineers to introduce national and international fellowships for research, to certificate courses for existing engineers and to develop special training courses for technicians.[37] Some of the interviewed players also express the need for capacity building and training, especially for installation and project management. This may be considered as an opportunity for Dutch players.

Dutch private and development banks may see an opportunity in providing finance to the PV segments where opportunities for companies from Netherlands are the highest. This may be in the form of export finance, concessionary financing or Compulsory Convertible Debentures (CCD).

3.12 SWOT

To end this chapter and, to some extent, to summarize the results from the previous paragraphs, Figure 9 presents a small SWOT-table about the Indian PV sector

Figure 9 – SWOT of the Indian PV sector

Strengths	**Weaknesses**
- Access to system components - Scalability - Availability of labor and machines - Strong installation and development segments	- Absence of silicon mining - High dependency on import of materials (high costs) - Overcapacity in the manufacturing segment
Opportunities	**Threats**
- Abundant solar irradiation - Energy and environment driven market - Government policy support - Growing economy - Smart- and micro-grid applications - Conversion to a more localised supply chain with foreign collaboration	- International competition - Policy implementation process issues - Unstable grid - Lack of funding

[37] European Business and Technology Centre (EBTC). 2010. Partnerships in India. A report on EU-India Renewable Energy Opportunities

4 MIRRORING WITH DUTCH STRENGTHS

Following the same segmentation as used in the previous chapter, this chapter lists the main requirements of the Indian PV sector. Next, it mirrors these requirements with the strengths of the Dutch PV sector. This results in the definition of low-hanging fruit, mid-term opportunities and long-term opportunities.

4.1 Indian requirements

Based upon the interviews and the electronic survey, Figure 10 shows how many times a certain segment has been mentioned as a segment with requirements. The figure shows that there are high requirements for finances (capital investment, loans, equity, etc.), R&D (which may often refer to product development and technology transfer), followed by project development, components (inverters, mounting structures, batteries, irradiation equipment, etc.) and manufacturing of cells and modules. Table 5 summarizes the requirements for all segments.

Figure 10 – Frequency of Indian requirements mentioned per segment

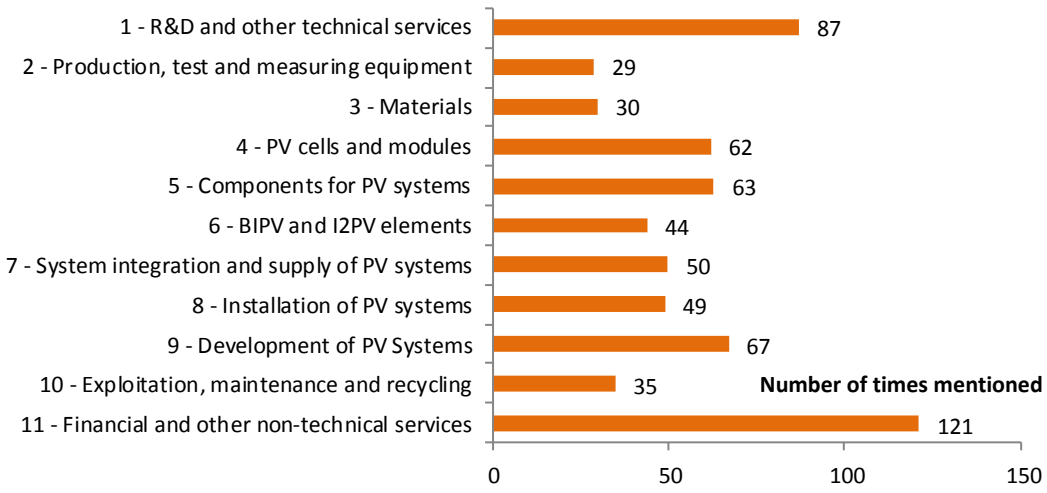


Table 5 – Summary of Indian requirements per segment

Segments		Requirements
1	R&D and other technical services	R&D on low-cost silicon, battery technologies and storage, micro-grids, thin film technologies and manufacturing processes
2	Production, test and measuring equipment	Advanced testing and manufacturing equipment, testing and repair facilities, technology transfer, joint ventures for manufacturing, waste slurry treatment technology
3	Materials	Wafer manufacturing capacity, silicon mining technology and know-how
4	PV cells and modules	More efficient cell- and module-manufacturing processes, thin film technology, investors, skilled manpower, oversee markets, strategic partnerships for manufacturing
5	Components for PV systems	Inverter technologies (grid, hybrid, micro), distributor networks, investors, smart-grid and micro-grid applications, mounting structures, monitoring and irradiation equipment
6	BIPV en I^2PV building elements	Market readiness, applications for mobile towers, car parking and petrol stations
7	System integration and supply of PV systems	Capacity building and training, investment, supply of components
8	Installation of PV systems	Cost-effective PV cells and modules, BIPV, components of PV-systems, investments, project management training
9	Development of PV projects	System integration and supply of PV systems, installation of PV systems, operation and maintenance, investments
10	Exploitation, maintenance and recycling of PV systems	R&D and know-how for silicon- and module-recycling, battery-recycling systems and processes
11	Financial and other non-technical services	Investments to increase the domestic manufacturing capacity for cells, modules and inverters, policy support, new business models, investments into project development, distribution partnerships for Indian modules oversees

4.2 Mirroring with Dutch strengths

Even though Dutch PV organizations are largely unknown to Indian PV organizations, a strong general openness among the Indian PV organization towards collaboration with Dutch organizations has been found. On average, the openness to collaborate with Dutch organizations is found to be 7.6 on a 0-10 scale. (see Table 6).

Table 6 – Openness to collaborate with Dutch organizations on a 0-10 scale

Answer	0	1	2	3	4	5	6	7	8	9	10
Number of times answered	3	2	0	0	0	9	2	4	7	7	22

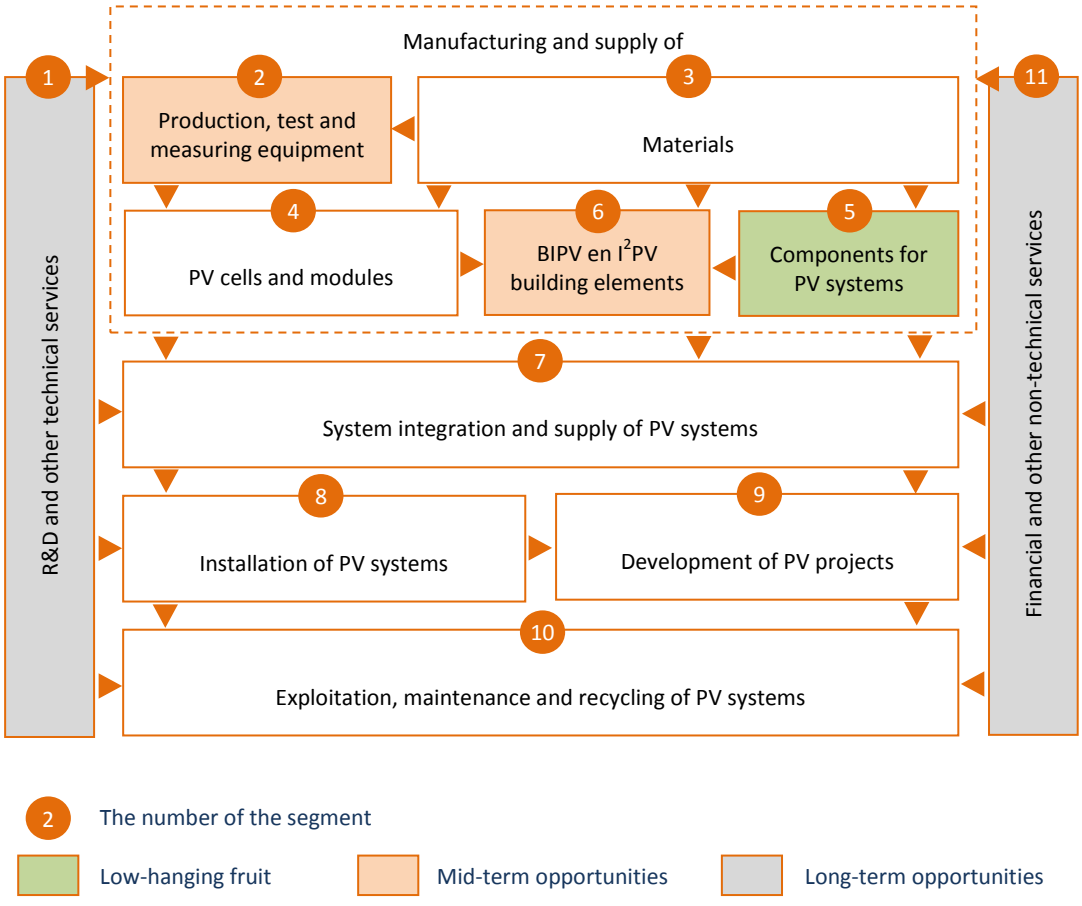
Associations with the Dutch PV sector include:

- Rugged technology, good workmanship;
- Good quality products;
- They are strong in wind, but not sure about solar;
- Dutch are hardworking and not much fanfare;
- Europe has lost its battle, scale is small;
- Strong in solar systems for the oil and gas, good track record;
- Not enough present at India, more presence desired;

Strengths of the Dutch PV sector include (a) a strong link between R&D and the PV equipment manufacturing industry, (b) innovative, high-quality, high-tech solutions and (c) linkages with Dutch Design.[38] Figure 11 visually matches these strengths with the requirements of the Indian organizations. The figure indicates in which segment of the PV value chain opportunities for enhanced collaboration can be found:

- Low-hanging fruits, chances for a fast development of a partnership, are primarily found in the component segment. This includes for instance the manufacturing and supply of advanced inverter technologies and mounting structures.
- Mid-term opportunities, opportunities that will require more lead time, but shall be initiated soon, are found in relation with the manufacturing and supply of production, test and measurement equipment and building- and infrastructure-integrated PV elements.
- Long-term opportunities are found in R&D, finance and other services.

Figure 11 – Indian-Dutch matches in the PV value chain



[38] Netherlands Enterprise Agency (RVO.nl). 2014a. International Positioning of the Dutch PV Sector.

5 RECOMMENDATIONS

The following chapter lists recommendations addressed to organizations that are in or linked with the Dutch PV sector. These recommendations are formulated based upon the findings and insights gained while working on the tentative version of this report and upon the feedback received by Dutch PV organizations during the meeting in Utrecht (see 1.3). The recommendations are limited to segments with the best opportunities.

5.1 General

One definite advantage of doing business in India is the fact that English is the common business language. Additionally the 'drive' that the new government under Prime Minister Modi brings to renewable energy might trigger Dutch companies to start doing business in India. Not all Dutch companies are experienced in doing business in India; therefore support may be required to introduce Dutch companies into the management and business culture of this country. This support can come through the Netherlands Embassy, the Netherlands Business Support Offices (NBSO) and the Netherlands Enterprise Agency (RVO). These institutions will also be instrumental in creating a better accessibility to the Indian market and its opportunities. Their support may relate to very core business related issues like import duties, but also to the access and use of existing support mechanisms from the Dutch government such as the Partners for International Business programme and the Dutch Good Growth Fund (see Annexure 10). Moreover, a regular exchange of experiences amongst Dutch companies active in this sector could provide a win-win situation for all. Therefore, it is recommended to establish a platform for Dutch PV organizations to facilitate the exchange of experiences, foster new collaborations and to carry out new ideas.

5.2 R&D and other non-technical services

The Netherlands is one of the global leaders in PV-related R&D activities, with strong initiatives in the second and third generation of PV cells and modules. As collaboration on R&D and other technical services is seen as a long-term opportunity (see Figure 11), the major aim for this segment is to start building long-term relationships with Indian partner institutes. This can be initiated and/or supported through the creation of a platform for R&D collaboration on fundamental and applied research as well as collaboration on the commercialization of R&D outputs. It is therefore recommended to:

- Explore a strategic partnership with the National Institute of Solar Energy (NISE). This may be initiated by inviting NISE, its associated R&D-centers and some public sector PV cell and module manufacturers for a mission to the Netherlands. In particular, the following organizations could be looked at: NISE, IIT Delhi, IIT Mumbai, IIT Guwahati, Bharat Heavy Electricals Ltd. (BHEL), Central Electronics and Rajasthan Electronics & Instruments Ltd.
- Arrange a more detailed mapping of PV-related R&D activities in the public and private sectors of India, their existing national and international partners, their requirements and their sources of funding.

5.3 Production, test and measuring equipment

The government of India focuses on growing the home market first and then using that promote domestic manufacturing. Therefore, the supply of production, test and measuring equipment is seen as a mid-term opportunity. In order to be present at the time when the Indian local production market will be initiated it is recommended to:

- Present Dutch knowhow/products at potential clients and identify their specific needs;
- Promote and share the Dutch approach of a strong relationship and cooperation between R&D and equipment manufacturers;
- Follow the market trends and future developments to identify the right entry point and time;
- Build a local service team for production equipment as this may establish a first presence in India.

5.4 Components

With regard to the components segment, the two most promising matches between Dutch strengths and the Indian requirements are electronic components (inverters, storage, micro-grids, etc.) and advanced mounting structures.

Recommendations for electronic components are:

- For existing products, identify clients in niche and high-end markets and partner with strong domestic distribution partners. These products are usually higher-priced than locally manufactured products, for instance because of a stronger focus on quality and import duties. Price differences can be a factor 2 or 3;
- For the development of lower-priced products, identify and partner with a local partners, for instance inverter manufacturers, for technology transfer, co-development, assembly and/or manufacturing;
- Consider a collaborative platform for Dutch electronics companies that have their market focus on distinct niches.

Recommendations for mounting structures:

- Partner with Indian organizations for the supply or joint ventures in the manufacturing of advanced mounting structures for the utility and bigger rooftop-scale market.

5.5 Building-integrated (BIPV) and infrastructure-integrated PV (I^2PV) elements

The BIPV and I^2PV segment in India is currently only marginally developed, but regarding developments on for instance smart cities, mobile towers applications, train stations and airports, it promises some interesting growth in the near future. Proof of concepts of these technologies through demonstration projects may help in the market development. For application in the residential housing sector, the Dutch and Indian market might differ too much to work on cooperation. On the other hand, commercial- and industrial-building BIPV-solutions from the Netherlands might be well-applicable in India. The Dutch expertise in the

field of installation is considered as a strong point. The actual study has not brought forward specific opportunities, so follow-up work is required. It is recommended to:

- Deepen the understanding of the actual requirements and areas of BIPV and I^2PV applications in India and the opportunities to exchange Dutch knowledge, projects and products;
- Explore opportunities to offer BIPV and I^2PV training programs for building professionals like architects, engineers and installers. This may be done with central and/or state level government agencies such as NISE, MNRE or the nodal state agencies;
- Seek partnerships with industrial federations like FICCI and CII for the promotion and inclusion BIPV and I^2PV into the national dialogue on smart cities.

5.6 Installation of PV systems

In order to achieve is PV targets, India needs to emphasize on quality standards and quality assurance. For that matter, training and a certification system for PV installations is required. The Dutch experiences with PV training and quality assurance and specifically the Dutch PV certification system could therefore be very useful for India. It is recommended to:

- Explore the actual status of training programs by Indian associations on PV installations and look for partnerships with these associations as well as with central government organizations (NISE, MNRE) or with the nodal state agencies;
- Offer support in developing a certification system for PV installers, using the Dutch system and experiences;

5.7 Development of PV projects

The project development segment is one of the strongest and most competitive segments of the Indian PV value chain. It already includes some prominent national and international players. The recommendations for this segment are:

- Identify the willingness of Dutch financial institutions to develop PV projects in India;
- Identify Dutch companies active in India that are willing to set up PV projects on their premises and partner with those for PV project development (like Dutch multinational Heineken does with regard to their international facilities).

5.8 Financial and other non-technical services

With regard to financing, one can distinguish between large projects such as large-scale rooftop and solar farms and rooftop applications for houses. Both require extensive funds:

- For the housing sector further research would be required to identify if this sector would be interesting for Dutch investors or financial institutes at all. Currently, the Indian government has indicated a move away from upfront capital subsidy for PV installation to generation-based incentives, which will make project financing more attractive to financial institutions.
- With respect to the larger-scale projects, involvement of Dutch banks is already in place and it might be interesting to expand this. The question is if this needs any

support from the Dutch government, as many banks know how to find their way in funding such large-scale projects.

For this segment, it is recommended to:

- Inform national- or state-government organizations such as MNRE and the nodal state agencies on various financial models applied in the Netherlands over the years to explore possibilities for assistance in implementing support schemes;
- Identify the willingness of Dutch banks to partner with Indian banks for credit lines dedicated to PV project development, as limited knowledge exists on project-based financing;
- Explore the possibility for special credit lines to Indian organizations for the import of Dutch manufacturing equipment;

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ABBREVIATIONS

Abbreviation	Meaning
AD	Accelerated Depreciation
ADB	Asian Development Bank
Ag-Al	Silver Aluminum Alloy
Al	Aluminum
BCD	Basic Customs Duty
BHEL	Bharat Heavy Electricals Ltd
BIPV	Building-Integrated PV
BJP	Bharatiya Janata Party
BRICS	Brazil, Russia, India, China and South Africa
CCD	Compulsory Convertible Debentures
CdTe	Cadmium Telluride
CDV	Countervailing Duty
CERC	Central Energy Regulatory Commission
CIGS	Copper Indium Gallium Selenide
CII	Confederation of Indian Industry
CSER	Computational Sciences for Energy Research
CSIR	Council for Science and Industrial Research
CUF	Capacity Utilization Factor
DCR	Domestic Content Requirement
DGGF	Dutch Good Growth Fund
DSP	Digital Signal Processor
EBTC	European Business and Technology Center
ECN	Energy research Centre of the Netherlands
EL	Electroluminescence
ESA	European Space Agency
ETI	Enabling Trade Index
EU	European Union
EVA	Ethylene-vinyl acetate
Ex-Im	Export-Import Bank of the United States
EZ	Economic Affairs
FC-GPR	Foreign Collaboration - General Permission Route
FDI	Foreign direct investment
FICCI	Federation of Indian Chambers of Commerce and Industry
FIPB	Foreign Investment Promotion Board
FIT	Feed-In Tariff
GDP	Gross Domestic Product
GIZ	German Government Agency for International Cooperation
GW	Gigawatt
GWh	Gigawatt hour
I^2PV	Infrastructure-Integrated PV
IGBT	Insulated Gate Bipolar Transistor
IISc	Indian Institute of Science

IITs	Indian Institutes of Technology
IP	Intellectual Property
IREDA	Indian Renewable Energy Development Agency
ISIS	Innovative Solutions In Space
JNNSM	Jawaharlal Nehru National Solar Mission
JV	Joint Venture
KFW	Kreditanstalt für Wiederaufbau
kW	Kilowatt
kWh	Kilowatt hour
LED	Light Emitting Diode
MG silicon	Metallurgical grade silicon
MLPM	Module Level Power Management
MNRE	Ministry of New and Renewable Energy, India
MoP	Ministry of Power India
MoU	Memorandum of Understanding
MW	Megawatt
MWT	Metal Wrap Through
NCPRE	National Center for Photovoltaic Research and Education
NISE	National Institute of Solar Energy
NREL	National Renewable Energy Laboratory (USA)
NSEFI	National Solar Energy Federation of India
NWO	Netherlands Organisation for Scientific Research
OPV	Organic Photovoltaics
PEI	International Energy Programme of the Netherlands
PIB	Partners for International Business
PV	Photovoltaic
PVPS	Photovoltaic Power Systems Programme
PWC	PriceWaterhouseCoopers
R&D	Research & Development
RE	Renewable Energy
REC	Renewable Energy Credits
RPO	Renewable Purchase Obligation
RVO.nl	Netherlands Enterprise Agency
SDE	Stimulation Renewable Energy
SEAC	Solar Energy Application Centre
SECI	Solar Energy Cooperation of India
SERC	State Energy Regulatory Commission
SERIIUS	Solar Energy Research Institute for India and the United States
SiCC	Silicon Competence Centre
SME	Small or Medium Enterprise
TERI	The Energy Research Institute, India
TKI	Topconsortium Knowledge & Innovation
TU	Technical University
UPC	Ultra Precision Cutting
UPS	Uninterrupted Power Supply
USA	United States of America
USAID	United States Agency for International Development
USP	Unique Selling Point
VAT	Value Added Tax

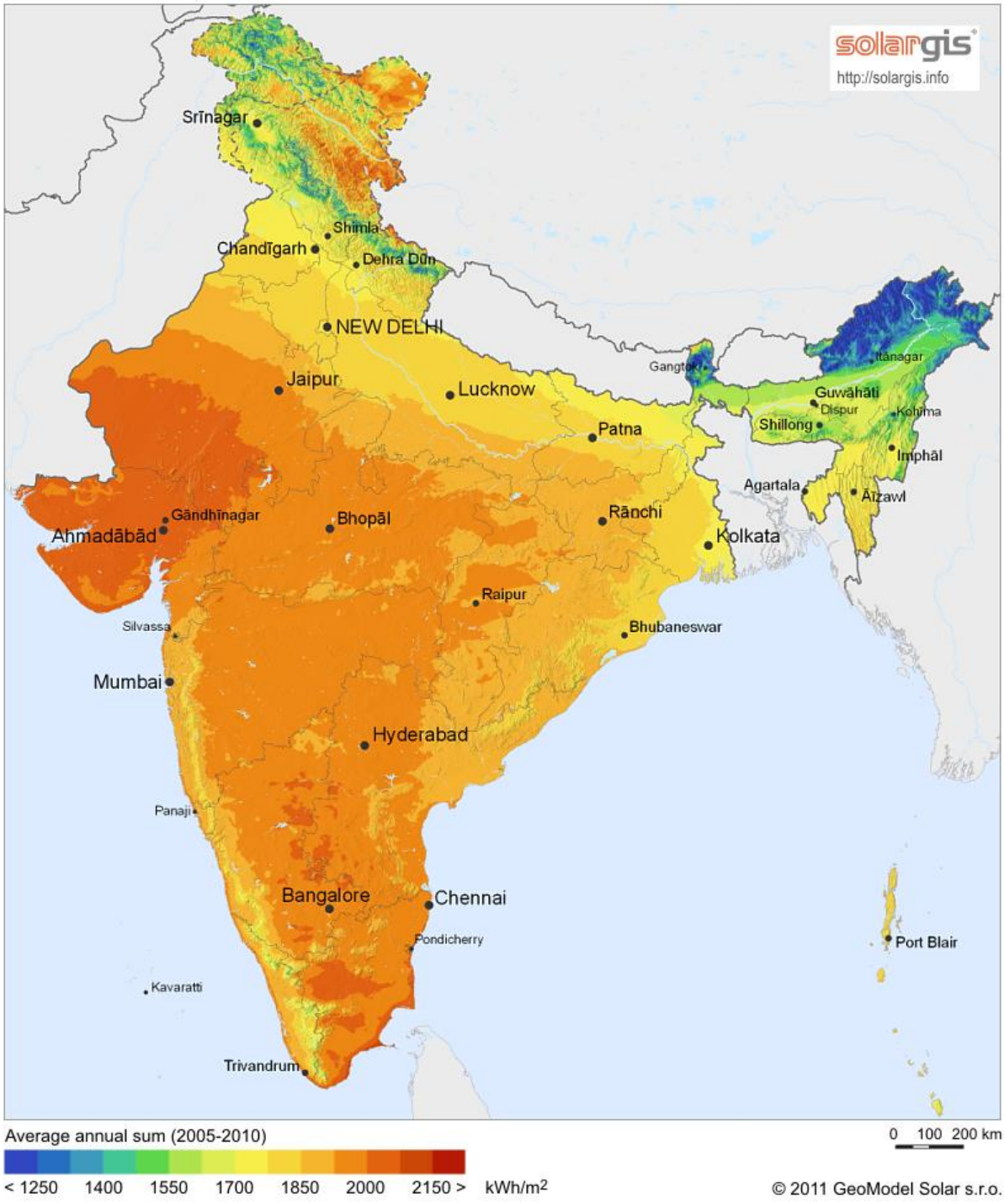
ANNEXURES

Annexure 1 – Organizations interviewed

No.	Organization	Segments	Contact person	Designation	Interview
1	Federation of Indian Chambers of Commerce and Industry (FICCI)	1,11	Ms. Rita Roy Choudhury	Senior Director	Face to face
2	PPS Enviro Power	1,5,7,11	Mr. Vijayaraghavan	Director	Face to face
3	SunEdison (MEMC)	4,7,9	Mr. Pashupathy Gopalan	President	Face to face
4	Swelect	4,5,7,9	Mr. R Chellappan	Managing Director	Face to face
5	Sukam	4,5,8,9	Mr. Kunwer Sachdev	MD & CEO	Face to face
6	Poseidon Solar & Torp Systems Pvt. Ltd.	5,8,9	Mr. Narayanan	MD	Face to face
7	Tamilnadu Energy Development Agency	11	Mr. Sudeep Jain	Head	Face to face
8	CII, Green Business Centre	1,11	Mr. Ravi Chander	Senior Counsellor	Face to face
9	Optimal Power Solutions (OPS)	1,5,7,8	Mr. Ashok Prakash		Face to face
10	Solkar	1,2,5,7,8	Mr. K.E. Raghunathan	Chief Technology Officer	Face to face
11	Titan Energy Systems	4,8	Mr. Rao SYS Chodagam	Managing Director	Face to face
12	L&T Construction	7,8	MR. Shaji john	Head, Solar Business	Face to face
13	Nordic India	5,7,8	Mr. Satish Nair	Managing Director	Face to face
14	Vikram Solar	4,9	Mr. K Subramanya	Advisor	Face to face
15	Chemtrols Solar	4,5,8,9	Mr. Anish Rajgopal	Founder Director	Face to face
16	NCPRE	1,3	Dr. Chetann Singh Solanki	Professor	Face to face
17	Jindal	2,5	Mr. K.R. Raghunathan	Vice Chairman	Face to face
18	Sunlit Future	5,8	Mr. Rishi		Face to face
19	Auroville Energy Products	5	Mr. Carsten		Face to face
20	National Institute of Solar Energy (NISE)	1,11	Dr. P. Saxena	Director General	Face to face
21	Novergy Energy Solutions Pvt. Ltd.	4,5,6,7,8			Online
22	Nature 2 Nature Ecosystem Pvt. Ltd.	1,7,8	Mr. Sunil		Online
23	Thrive Solar Energy Pvt. Ltd.	7,8	Mr. Dhanu		Online
24	AVI Appliances Pvt. Ltd.	4,7	Mr. Jain		Online
25	Instruments Techniques Pvt. Ltd.	5,6,7,10,11	Mr. Ravi		Online

26	ACVA Solar Pvt. Ltd.	1,5,6,7,8,9	Mr. Chetan		Online
27	Bosch Ltd.	7,8	Mr. Venugopalan		Online
28	Sree Nandhees Technologies Pvt. Ltd.	3,7,8,9	Mr. Nagarajan		Online
29	Emeral Energy Solutions Pvt. Ltd.	1,6,7,8,11			Online
30	JUWI	8,9	Mr Rajesh Bhat		Online
31	SS Solar Pvt. Ltd.	4,9	Mr. Sheshank		Online
32	International Marketing Corporation Pvt. Ltd.	7,8,9	Mr. Amish		Online
33	UM Green Lighting Pvt. Ltd.	1,3,7,8,9			Online
34	Modern Solar Pvt. Ltd.	2,4,7,8,9			Online
35	Deshmukh Solar Energy Pvt. Ltd.	4	Mr. Pratik		Online
36	JJ PV Solar Pvt. Ltd.	4,7,8	Mr. Rajesh		Online
37	Sun Energy Systems	4,5,6,7,8,9	Mr. Sesin		Online
38	Shri Sai Technologies	2,4			Online
39	Green Secure Energy	1,5,7,8,10			Online
40	Big Switch India	7,8	Mr. Kulkarni		Online
41	Kohima Energy Pvt. Ltd.	4,7,8,9,11			Online
42	Jakson Engineers Ltd.	3,4,5,7,8,9	Mr. Gupta		Online
43	Arka Green Power Pvt. Ltd.	2,4,8,9	Mr. Satya		Online
44	Mas Solar Systems Pvt. Ltd.	1,2,4,5,8,9 ,10	Mr. Anbazhagan		Online
45	Bergen Solar Power & Energy Ltd.	2,3,4,5,7,8 ,9,11	Mr. Singh		Online
46	Topsun Energy Ltd.	4,8,9	Mr. Naduri		Online
47	KRV International	2,4,7,8	Mr. Parikh Ritesh		Online
48	Radiant Solar Pvt. Ltd.	4,7,8,9	Mr. Viswanathan		Online
49	Plaza Power & Infrastructure Company	1,4,5,7,8,9	Mr. Pawan		Online
50	Gensol Consultants Pvt. Ltd.	1			Online
51	Sol2Sys	1,4,5,6,7,9	Mr. Vaman Kuber		Online
52	Novus Green EnergySystems Pvt. Ltd.	1,2,5,7,8,9	Mr. Anshuman		Online
53	Green Ripples Pvt. Ltd.	7,8,9,11	Mr. Rajeev		Online
54	GalileiSolar India Pvt. Ltd.	5,8	Mr. Saikat		Online
55	BKC Weathersys	1,2	Dr. Jaya Singh	Director	Telephone
56	Versa Drives	6	Mr. Sundararajan Muruganandhan	Managing Director	Telephone
57	KCP Solar Industry	6,7,8	Mr. P. Ashokkumar	CEO	Telephone
58	Rabobank	11	Mr. Amardeep Parmar	Senior Director & Head | India, Project Finance	Telephone
59	Indian Renewable Energy Development Agency (IREDC)	11	Mr. Satish Kumar Bhargava	Director, Finance	Telephone

Annexure 2 – Horizontal solar irradiation map India



Annexure 3 – Selected examples of Indian state policies on PV

Grid Connected PV Rooftop Systems:

State	Metering mechanism	Solar tariff (INR) *	Capping of System Capacity/ generation	Incentives
Karnataka	Net and gross metering	9.56 (without subsidy) 7.20 (with subsidy)	Not mentioned	Wheeling, banking and cross subsidy surcharge exempted for 10 years.
West Bengal	Net metering	Consumer tariff as applicable for net energy supply - 16.13 (100KW to 2MW)	Injection not more than 90% of the consumption from the licensee's supply in a year.	Wheeling, banking and cross subsidy surcharge as applicable.
Gujarat	Feed-In tariff	11.14 (with AD) 12.44 (without AD)	Not mentioned	Exemption from wheeling, banking and cross subsidy surcharge.

Source: *Indian Environmental Portal. 2014. Grid Connected SPV Rooftop Systems. Policy and Regulatory Framework in Various States*

Utility Scale PV Systems:

State	Off taker	Financial incentives	Exemptions /other key benefits	Tariff (INR)*
Karnataka	State distribution Companies	Preferential tariff based on reverse bidding	No exemption /none	7.94–8.5 (60 MW) 5.51–8.05 (130 MW)
Madhya Pradesh	State distribution Companies	Preferential tariff based on reverse bidding	No exemption /none	7.9–8.05
Gujarat	State distribution Companies	Preferential tariff based on reverse bidding and fixed tariffs for solar parks	No exemption /solar park infrastructure provided	JNNSM (competitive bidding) <u>State Policy (GERC): Solar parks fixed tariff</u> Utility Scale (>1 MW)** 8.03 INR/kwh (with AD) 8.97 INR/kwh (without AD) Utility Scale (< 1 MW)** 9.63 INR/kwh (with AD) 10.76 INR/kwh (without AD)

Sources: *The Energy Research Institute (TERI). 2014. Background paper Governance of renewable energy in India: Issues and challenges; PwC. 2014. Business models for Solar Parks.*

** 10 INR = 0.14 euro (March, 2014)*
** Average for 25 years*

Annexure 4 – Key economic indicators India

Indicator	Value
GDP 2013-14 (US$ billions)	2.047
GDP per capita 2013-14 (US$)	1.625
Share of world trade (%)	2.07
Total Exports 2013-14 (US$ billions)	462
Total Imports 2013-14 (US$ billions)	617
Total Trade Value 2013-14 (US$ billions)	778
Imports Oil 2013-14 (US$ billions)	165
Trade deficient 2013-14 (US$ billions)	155
FDI 2013-14 (US$ billions)	28

Sources: *Ministry of Commerce & Industry Department of Commerce Economic Division Government of India. 2014. Press Release: India's Foreign Trade. United Nations*

Annexure 5 – Comparison of average solar irradiation of leading markets

Country	Value
India	5,10
Spain	4,75
USA	4,68
Australia	4,16
Italy	3,81
Japan	3,63
China	3,61
Germany	2,90

Source: *Surface meteorology data and solar energy data provided by RETScreen and NASA satellite data.*

Annexure 6 – Foreign Direct Investments (FDIs) and Joint Ventures (JVs)

FDI – Foreign Direct Investment
- 100% FDI under the Automatic Route
- Does not require approval from the Government of India
- The Indian Company receiving FDI is required to:
- Report to the Reserve Bank of India the receipt of FDI within 30 days
- File form FC-GPR within 30 days of issue of shares
- Shares are issued to the Investor within 180 days of receipt of FDI
- Financial and fiscal advantages, such as preferential tariff or payment security mechanism
- Government encourages transfer of foreign technology

JV – Joint Venture
- Automatic approval for up to 74% foreign equity participation in a JV
- Liberalized foreign investment approval regime
- 100% foreign investment as equity is permissible with the approval of Foreign Investment Promotion Board (FIPB)
- Various chambers of commerce and industry associations in India provide guidance to investors in finding appropriate Partners
- Investors can set up a liaison office in India
- Foreign investors are encouraged to set up RE-based power generation projects on build-own-operate basis

Source: *Ministry of New and Renewable Energy (MNRE). 2014c. First Renewable Energy Global Investment Promotion (RE-INVEST)*

Annexure 7 – Tax and non-tax incentives for solar by the government of India

Tax incentives	Details
Income tax Holiday	100% for 10 consecutive years - MAT @ 20% to apply
Accelerated depreciation	Accelerated depreciation @ 80% on solar assets
	Additional depreciation @ 20% on new plant/machinery in the 1st year
Deemed export benefits	Available to specified goods manufactured and not actually exported
	Advance authorization from Directorate General of Foreign Trade
	Deemed export drawbacks
	Exemption/return of Terminal Excise Duty
Service tax based on negative list	Certain services are exempted from service tax
	Services of transmission or distribution of electricity by an electricity utility
Customs and Excise Laws	Various duty concessions and exemptions to RE Sector
Reduced VAT	Certain States allow reduced VAT rates (5%) on RE projects
Additional one-time allowance	Available @15% in Budget 2014 on new plant and machinery
Tax-free Grants	Grants received from the holding company engaged in generation, distribution or transmission of power

Non-tax incentives	Details
Feed-in-tariffs	When renewable generators sell to state utilities under the MoU route
	Rates decided by the CERC and the SERC
Rebates	Available on the manufacturing of solar and wind components
	Targeted at specific types of renewable energy technology
	Include subsidies and rebates on capital expenditures
Favourable land policies	By various state governments for renewable development
	Reduce capital costs and favour ease of land allocation
Government R&D programmes	Improve renewable energy technologies
	Lead to growing performance, importance and reducing costs

Source: *Ministry of New and Renewable Energy (MNRE). 2014c. First Renewable Energy Global Investment Promotion (RE-INVEST).*

Exemption from excise duty to:

- EVA and backsheet and specified raw material used in manufacture of backsheet and EVA sheet used in manufacture of solar photovoltaic cells or modules
- Solar tempered glass used in manufacture of solar photovoltaic cells or modules, solar power generating equipment or systems and flat panel solar collectors
- Flat copper wire used in manufacture of PV ribbons for use in manufacture of solar or modules
- Machinery, equipment, etc. required for initial setting up of solar energy production projects.

Exemption from basic custom duty to:

- Exemption from BCD on specified raw materials used in manufacture of EVA sheets or backsheet used in the manufacture of solar PV cells or modules
- Exemption from BCD allowed to flat copper wire for use in the manufacture of PV ribbon (tinned copper interconnect) for manufacture of SPV cells or modules
- BCD and CVD on machinery and instrument required for initial setting up of solar energy projects has been reduced to 5 per cent and NIL respectively.

Source: *KPMG. 2014. Skill, Build & Transform. Indian Union Budget 2014.*

Annexure 8 – Relevant points for Joint Ventures (JVs)

Relevant points on Joint Ventures (JVs)
Automatic approval for up to 74% foreign equity participation in a JV
Liberalized foreign investment approval regime 100% foreign investment as equity is permissible with the approval of Foreign Investment Promotion Board (FIPB)
Various chambers of commerce and industry associations in India provide guidance to investors in finding appropriate Partners
Investors can set up a liaison office in India
Foreign Investors are encouraged to set up RE-based power generation projects on build-own-operate basis

Source: *Ministry of New and Renewable Energy (MNRE). 2014c. First Renewable Energy Global Investment Promotion (RE-INVEST)*

Annexure 9 – List of public-sector PV R&D institutions in India

	Institution	Focus areas in PV	Collaborators
1	The Energy and Resources Institute (TERI)	GIS mapping on renewable energy potential	University of Alabama (Huntsville), University of Basel (Switzerland), FiBL (Switzerland), IRTA, Centre de Cabrils, Carretera de Cabrils (Spain), INRA (France), VTT (Finland), European Commission ,etc.
2	Sardar Patel Renewable Energy Research Institute (SPRERI)	Design, development and evaluation of PV systems (effect of dust deposition)	Indian Council of Agricultural Research, Ministry of New and Renewable Energy, Department of Biotechnology, and Gujarat Council of Science and Technology (GUJCOST).
3	Centre for Energy Studies (CSE) IIT Delhi	PV Test Facilities, Inverter testing, Photoluminescence set-up, Negative Ion Generating System etc.	University of Bradford (U.K.), Council of Scientific and Industrial Research, Ministry of New and Renewable Energy, University of Newcastle Australia, Trinity College Dublin.

4	School of Solar Energy – Pandit Deendayal Petroleum University (PDPU)	Solar cell technologies, such as crystalline and amorphous silicon. Nanostructured and hybrid solar cells and Photovoltaic systems. Storage, inverter technologies. Low cost Kesterite (CZTS) thin-film solar cells. Concentrated PV.	University of Tulsa-USA, University of Houston-USA, and University of Western Ontario-Canada.
5	Department of Energy, University of Madras	Solar Photoactive Materials, Dye-sensitized Solar Cells	Department of Energy has collaborations with STERIS Corporation MO, USA; University of Melbourne, Australia; Department of Chemistry - NIT Tuiruchirapalli and International Biographical Centre - UK.
6	School of Energy Studies (SES) – Jadavpur University	Solar Photovoltaic Technology and Systems, Coating Technologies	Some of the collaborations are: University of Calcutta, Lund University, and West Bengal University of Technology.
7	School of Energy Studies (SES) – University of Pune	Synthesis of Nano-Crystalline Si:H using Hot-Wire CVD (UoP). Regional Test and Technical Back-up Centre	Thermax Ltd, Bharati Vidyapeeth University, and Symbiosis International University.
8	University of Petroleum and Energy Studies (UPES)	Performance Evaluation of Solar Equipment's, Hydrogen Production and Utilization Facility Through Photovoltaic Electrolysers System	IBM India Pvt. Bangalore, Suzlon Energy Centre (SEZ), University of Nairobi, Kenya DST – Sri Lanka, UKIERI-DST, University of Edmonton, Carleton University Ottawa, Marist College, European Business School University, University of Aberdeen, Coventry University etc.
9	Amity Institute of Renewable and Alternative Energy (AIRAE)	Photovoltaic Devices: Organic and Inorganic, 3rd Generation Solar Cells based on nanomaterials	Claflin University – USA, University Of Indianapolis – USA, International School Of Management (ISM) – USA, International Business School – Germany, Napier University – UK, Newcastle University – UK, and National Tsing Hua University –Taiwan.
10	Gujarat Energy Research & Management Institute (GERMI)	Consulting on policies and tariff orders for Gujarat. Net-zero energy building	University of Western Ontario, Canada; University of Sasksatchewan, Canada; University of Houston, USA; University of Tulsa, USA; Georgia Tech, Atlanta, USA.
11	Centre for Energy – IIT Guwahati	Energy spectrum measuring facility; spectral response/ photoconductivity/ quantum efficiency. Facility for preparation of thin films by physical vapour deposition method	Oil India Ltd, Grassroot Innovation Augmentation Network, IIT Guwahati, Defence Research Laboratory Tezpur, Assam Science Technology and Environment Council (ASTEC)
12	National Center for Photovoltaic Research and Education (NCPRE) - IIT Mumbai	Silicon wafer based cell technology, High Efficiency crystalline Si solar cells, 3D junctions, plasmonics for PV applications, innovative concepts in thin film PV technology for production cost reduction; Module characterization (I-V, Electroluminescence), Array characterization (infrared thermography).	MNRE, Thermax Ltd., Lanco Solar Private Ltd. SunEdison Energy India Private Ltd

Adapted from: *European Business and Technology Centre (EBTC). 2014. Science and Technology Research Players in India.*

Annexure 10 – Existing Financial Support Schemes for Dutch organizations

Partners for International Business (PIB):
The PIB programme focuses on a group of companies / institutes who want to enter a foreign market using a coordinated strategy instead of individual activities. PIB is a demand-driven, flexible and effective program. The contribution of the government focuses on economic diplomacy. There are also additional activities in the field of promotion and matchmaking, government-to-government cooperation (G2G) and knowledge exchange programs (K2K). All these activities support the entrepreneurial opportunities. India is one of the focus countries for PIB

Dutch Good Growth Fund (DGGF):
DGGF supplements private investments by means of guarantees and direct financing with a repayment obligation, such as loans and equity investments in projects. Its financial support can be tailored to the circumstances. India is one of eligible countries for DGGF.

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