GOGLA

The Voice of the Off-Grid Solar Energy Industry

# Transforming India into a Global Solar DRE Manufacturing Hub: A Study into Market Requirements and Readiness

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*Source: Simpa Networks*

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- **The increase in the landed cost of imported solar modules, lanterns, and home systems due to COVID-19 disruptions in China provides an opportunity for India to explore greater local manufacturing.** India has become a more competitive place for the manufacturing of solar lighting products, as supply chain disruption due to the COVID-19 pandemic has increased the cost of imports. For example, between 2019-20 and 2021-22, there has been an estimated five times increase in freight costs for solar modules imported from China. Industry experts also advise that India has advantages due to its reliable supply chains, shorter lead times and greater policy for SME support.

- **The solar DRE segment in India is moving beyond only off-grid lighting systems to direct current (DC) consumer appliances, which are anticipated to see significant growth in demand.** In urban areas, DRE consumer appliances, such as brushless direct current (BLDC) fans and industrial-scale solar induction cookers, solar dryers etc., can lead to energy savings and increased emission reductions, helping India and other countries to achieve their net zero targets. The DC appliance market is currently in its infancy, but several products and core components are already being manufactured in India, including those for export. By designing initiatives to increase the adoption, the government can help to create the economies of scale needed to increase local manufacturing.

- **To maximise on the potential for local manufacture, India can also position itself as a global hub for the manufacture/assembly of DRE products and enhance efforts to cater to the large South-Asian, Pacific, and African markets.** In 2021, 34 million solar lighting products and 5 million appliances and PUE technologies were sold around the world, with demand for these technologies expected to grow and accelerate. However, to compete within the global market, India must be cost-competitive with other countries that manufacture DRE. Activities to support local production should consider the relative cost competitiveness of India with its competitors in different DRE technology and component segments and provide a tailored approach to increasing demand for each.

- **DRE companies already manufacture some components or products in India, but a concerted package of support focussed on the assembly of final products and key intermediary components is needed to create a step-change in activity and capitalise on this opportunity.** A staged approach, focussed on growing demand, whilst building the foundations for local manufacturing, would ensure that the positive impacts of the sector are heightened whilst the base for local manufacturing is expanded. While the opportunity for local manufacturing of solar lighting systems can be maximised in the short term, manufacturing certain DRE components, such as solar cells, will take longer, as India does not produce the raw materials to create these within the country.

- **With a budget of Rs 24,000 crores (USD 3.21 billion) in production-linked incentives for the solar sector, manufacturing of solar in India is expected to increase significantly.** Solar manufacturing has already increased due to support from initiatives such as 'Make in India' and 'Production-linked Incentives'. While incentives have been focussed on the production of larger grid-linked and C&I systems, increased capacity in the wider solar sector is also expected to drive up demand for efficient DC appliances, a key focus of the DRE sector. The government should consider including the DRE sector enterprises and manufacturers under the purview of these incentives to create additional economic activity and job creation potential in the solar manufacturing sector.

- **The manufacturing of batteries for DRE in India could present an opportunity due to the increasing focus on this technology by the government through its various initiatives. However, in the immediate term battery manufacturing is focussed on serving the growing EV market.** As the market for battery manufacturing in India grows, greater economies of scale will result in significant cost reduction. The ripple effect may also be felt in the availability of batteries for DRE manufacturing. This will result in less dependence on imports for batteries and greater local procurement. Initiatives to support manufacturing of batteries for EV could also consider inclusion of low-capacity batteries for DRE within their purview.

- **Limited term tax reductions could play a key role within a staged approach, as heightened Basic Customs Duty (BCD) on imported solar cells to 25% and modules to 40% have made them more expensive.** As India does not yet have the capacity to meet its solar module

# Headline Messages

demand through local manufacturing, this increases the overall cost of the local production of solar lanterns, home systems and other DRE technologies, with a knock-on impact on retail prices and consumer demand. A simultaneous increase in GST on all DRE products has further made DRE products dearer. This may result in lower demand for solar lighting, which can potentially reduce the technologies' ability to complement grid power and reach the extreme vulnerability. To protect consumers and accelerate the switch to clean energy infrastructure, the Indian government is therefore encouraged to:

- Categorise the DRE industry as a priority sector to help build demand for products and provide support for the development of a manufacturing base for high-quality products,
- Provide reductions in GST and import duties on cells and modules designed for the DRE market for a limited period, allowing for the growth of the local manufacturing base and the development of supply chains for raw materials without driving up costs.

- **Most solar DRE products available in the Indian market are developed using components sourced from informal enterprises that seldom follow quality certifications, hence cheaper but of doubtful quality standards.** Providing support to informal manufacturers in terms of technological know-how, subsidies on equipment, personnel training etc. may help them to produce better quality products without a significant increase in costs. Further, product quality-based tax incentives along with mandatory certification clauses and checks for government tenders could address the quality considerations without adversely impacting demand. A direct consequence of better-quality products in the market would be better consumer sentiment as they would get efficient and durable products. This would help to drive up demand, create a positive impact for the country's net zero targets and contribute to India's role as a quality-conscious manufacturing hub for solar DRE.

- **Transformation of India into a manufacturing hub for solar DRE products can make the most of the emerging opportunities for manufacturing in the country.** These opportunities are available in the form of production-linked incentives, focus on 'Make in India', support for solar cell and module and li-ion battery production and the increased cost of imports, which have improved the cost-competitiveness of locally produced DRE products. At the same time, it is imperative that any push to increase local production of DRE products must not increase the price of products or reduce quality, to ensure that the positive impacts of DRE technologies on the lives, livelihoods and reaching India's net-zero targets are not inadvertently curtailed

- **Pursuing the development and adoption of Internationally aligned Quality Certification and Standards for DRE products will expand access to international markets for Indian Manufactured DRE Products while reducing compliance burdens.** It is clear that compliance costs are one barrier to accessing international markets and companies incur additional costs to both develop and manufacture individual products to meet differing national market standards. In some cases, standards for Indian products remain specific only to India and companies don't develop export ready products. Increased adoption of internationally aligned standards for the national market will ensure companies can avoid incurring additional costs to pursue export markets.

*Source: Sun King*

# Introduction

**India is one of the largest markets for solar distributed renewable energy (DRE) products in the world.** Despite grid expansion, several areas in the country continue to be underserved with low access to reliable energy. In these areas, DRE technologies such as solar lanterns and solar home systems (SHS) play a crucial role in providing people with reliable energy supply. Since 2018, the market has witnessed a decrease in the demand for DRE products due to the rapid increase in electrification rate and the COVID-19 pandemic. However, despite the downward trend, over ~800,000 solar lanterns and home systems were sold in India in 2021, which indicates the presence of a considerable market in the country.[1] India also has emerging markets for other DRE products and efficient DC appliances, including solar-powered irrigation systems, refrigeration, and fans.

**There is significant demand for DRE products in Africa, South Asia and East Asia and the Pacific which could be served by manufacturers in India.** Although global sales of off-grid solar products slowed because of the COVID-19 pandemic, the market began a return to growth in 2021, with around 34 million solar lanterns and home systems sold globally.[2] This growth is expected to continue. Solar DRE products provide the least cost way to electrify a majority of the 733 million people living without electricity.[3] Over a billion more are estimated to be living with weak grid.[4] DRE solutions are also increasingly recognized by governments, development partners and customers for their potential to complement grid-power and provide energy for agriculture, health, and enterprise.[5] This opens a large potential market for Indian DRE product manufacturers.

**Given the local and global demand for DRE products, this report provides insight into opportunities and challenges of DRE product manufacturing and / or assembly in India.** Benefits include the expansion of India's capacities to fulfill its own, and global, demand for DRE products. This could help to meet national and international energy access and climate goals, whilst growing the country's low carbon work-force. Challenges include the low-income levels of many DRE customers, leading to price sensitivity. This means that any policies to drive greater local manufacturing of DRE technologies in India should


Source: IFC

be staged so that they do not inadvertently increase the end price of products for consumers and dampen demand in the short term. Reduced demand could ultimately slow the rate of clean energy adoption and undermine jobs currently created by the DRE distribution chain.

**With this context, the research explores the status of Indian manufacturing for solar and takes a deep dive into various DRE components and products.** Core components profiled in the report are solar cells and modules, li-ion cells and batteries, charge controllers, motors, plastic moulds and luminaries. DRE products covered are solar lanterns, home systems, streetlights, water pumps and efficient DC fans. There are several other products sold in the DRE sector, including cooling systems and processing equipment. However, these have not been assessed in this report due to either a) the existence of complementary research into these technologies (cooling), or b) the more nascent nature of the technologies. The report also explores the regulatory landscape for the sector, including related policies, programs, taxes, and duties.

**Finally, it makes recommendations and provides a strategic roadmap for the development of greater DRE product assembly and manufacturing in India.** The insights gathered can help sector stakeholders to explore where they can benefit from local supply chain models and develop capacity to manufacture or assemble DRE products in India. The report also reveal the market catalysts and policy actions that would be needed to fully capitalize on the potential of local manufacturing and assembly. A case study of the growth of local manufacturing for the adjacent mobile phone industry is included in Annex 2.

1 GOGLA (2022) Analysis of semi-annual sales data and ESMAP's multi-tier framework data sets.
2 GOGLA (2022) Analysis of semi-annual sales data and ESMAP's multi-tier framework data sets.
3 IEA, IRENA, UNSD, World Bank, WHO (2022) Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank.
4 ESMAP, GOGLA, IFC, Vivid Economics (2020) Off-Grid Solar Market Trends Report 2020. Washington DC.
5 Efficiency for Access, ESMAP, GOGLA, IFC, Open Capital Advisors (2022) Off-Grid Solar Market Trends Report 2022 (forthcoming).

# Objective

**The objective of this study is to highlight the opportunity and challenges in establishing local manufacturing and assembly of solar based DRE products in India, and to explore what actions are needed to maximize available opportunities.** The aim of the report is to help enterprises decide if, and how, to approach setting up manufacturing /assembly units (parts of) for DRE products in India, and to offer recommendations to maximize potential development benefits, such as improved energy access and in-country job creation throughout the supply chain.

The study will enable companies to understand the current production landscape in India and inform decision making on production/assembly decisions. This will include an overview of:

The current regulatory landscape
The ecosystem for local manufacturing/ assembly in India
A competitiveness analysis to include cost of production and quality
Recommendations to enable the local industry to become globally competitive

*Source: Sun King*

# Research Methodology and Scope

**Intellecap adopted a three-pronged approach for this study which comprises of literature review, consultations with key ecosystem players, and analysis of captured data.** The insights were generated using a mixed methods approach, incorporating qualitative and quantitative data collected during the research.

**A literature review was undertaken to assess the existing landscape of solar DRE manufacturing in India.** This included capturing information on the current manufacturing capacity, manufacturing-related policies/schemes, demand and demand stimulation initiatives, business models, financing for manufacturers, supply chain, and the barriers/challenges impacting growth of the sector.

**The team collated data on critical aspects related to solar DRE manufacturing market, such as current capacities and landed costs, to assess the potential to set up manufacturing units in India.** The main sources of information/data consisted of:

- research and market studies on the solar DRE products market;
- databases by the government, development partners and non-governmental organizations (e.g. Ministry of New and Renewable Energy Statistics, Index of Industrial Production, etc.);
- published reports and brochures by companies;
- policy guideline documents by the government; and
- websites/blogs of stakeholders including companies, development partners and financial institutions. The list of references is provided along with this report.

**Intellecap has analyzed data from GOGLA and ESMAP to provide estimated global volumes for off-grid lighting and appliance sales.** For India, data from the Ministry of New and Renewable Energy has also been analyzed as it covers a larger number of DRE sub-segments.

**Intellecap interviewed more than 30 stakeholders to gain insights into the state of DRE sector and undertake a qualitative assessment of local manufacturing needs, opportunities, and challenges.** In its approach to these interviews, the research team:

- Mapped all the relevant stakeholders into four key groups i.e., entrepreneurs, government institutions, financial institutions (including development financial institutions), and other key stakeholders (relevant non-governmental organizations/think tanks) supporting the DRE products sector.
- Prepared specific key informant interview (KII) guides customized for each stakeholder. Interviews were conducted via phone or online video/voice conference calls. DRE companies engaged where chosen to provide insights into a range of DRE technologies.

Amongst other aspects, stakeholders provided information on the evolution of DRE products market, existing market segments, business models, financing support, availability and needs, supportive regulations/schemes, distribution channels, and challenges.

## Scope

This report explores and captures the assembly and manufacturing ecosystem of several DRE components, and products. The research explores the most common components detailed below, found in most DRE products. These are:

- Solar Cells
- Solar Modules
- Li-ion Batteries

As noted in Figure 1, the report also profiles the status of assembly and manufacture for:

- Solar lanterns
- Solar home systems
- Solar streetlights
- Solar water pumps, and,
- BLDC fans

There are several other technologies in the solar DRE sector, including but not limited to, solar cooling systems, induction cookers, irons, radios, and mixer-grinders. However, it has not been possible to explore all DRE technologies within the scope of this report. Solar cooling was explicitly left out of scope due to the recent research into this DRE area found in the report Decentralised Solar Refrigeration: Opportunities in the Livelihood Appliances Market in India[6], whilst deep dives into other technology types will be needed to provide a complete picture of the DRE sector.

# Research Methodology and Scope

**Figure 1: List of solar DRE products covered in this project and associated components**

| Solar lanterns | Solar home lighting system | Solar streetlights | Solar water pump | Solar powered Dc fans |
|---|---|---|---|---|
| Solar Module | Solar Module | Solar Module | Solar Module | Solar Module |
| Lamp | Luminaire (White LED) | Luminaire (White LED) | Luminaire (White LED) | Luminaire (White LED) |
| Battery | Battery | Battery | Module Mounting Structure | Battery |
| Electronics | Charging Controllers | Charging Controllers | Tracker | Charging Controllers |
| Plastic or Fiber Glass | | Inter connecting wires and cables | SPV Controller | Cable |
| | | Module mounting pole | | Rotar Blades |
| | | Battery Box | | |

*Source: Various sources; Intellecap research*

*Source: Sun King*

# 1: Solar DRE Market Overview

## Key Messages

- **India has a significant market for solar lanterns and home systems, with over ~800,000 sales in 2021.**
- **These products primarily serve those who have limited or intermittent grid access, who are commonly living on relatively low incomes and in rural areas of the country.**
- **Demand for DRE productive use of energy (PUE) appliances is likely to grow in the coming years due to increasing government support and their potential to improve livelihoods. The markets for some PUE technologies, such as solar water pumps (300,000 sold in 2021), have already reached notable scale.**
- **Globally, sales of DRE products were estimated at around 34 million in 2021, with sales expected to rise after a contraction in the market due to the COVID-19 pandemic. Major global markets for DRE products are found in Africa, Southeast Asia, and the Pacific.**

## 1.1 Status of current electrification and solar lighting

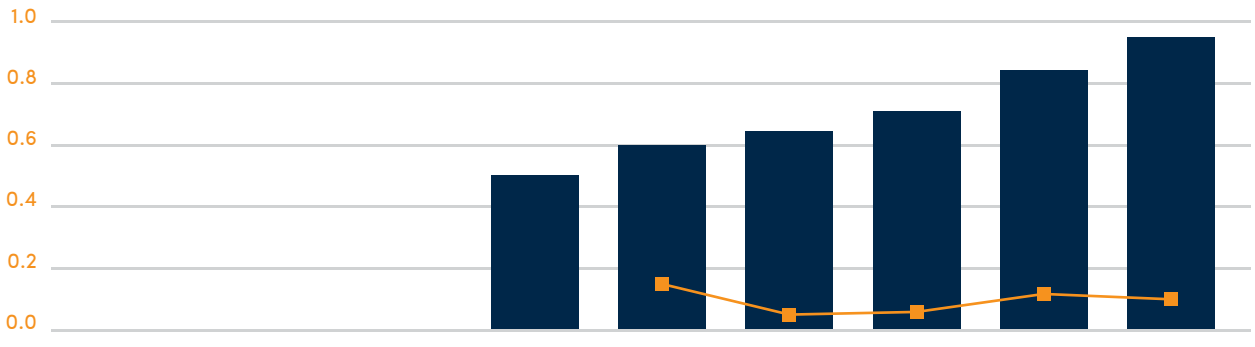
**India has achieved nearly 100% electrification at household level (SAUBHAGYA dashboard).**[7] As a result, electricity reliability has improved in most parts of the country, with the average Indian household receiving around 20.6 hours of electricity supply from the grid per day. Urban areas in most states have better supply, with 22 hours of reliable grid-based electricity supply.

**However, some urban and rural areas in states, such as Assam, Manipur, Jharkhand, and Bihar, still struggle to receive reliable supply of electricity.**[8] Populations in such areas therefore use DRE products including solar lanterns, solar home systems, mini grids to provide complementary supply of light and electricity.[9]

**Over the past few years, the Indian solar lantern and home system market has achieved maturity.** Government efforts to provide reliable electricity supply across the country and the impact of COVID-19 have led to a fall in demand since the peak in 2019. However, despite this, sales of solar lanterns and home systems still reached an estimated 3.1 million in 2021, with India representing one of the largest markets in the world.

**India also has a strong solar streetlight market.** The Ministry of New and Renewable Energy Statistics estimated that the overall installations of solar streetlight in India were 100,000 units in 2021-22 and have reached 930,000 units installed cumulatively[10] (see Figure 2).

**Figure 2: Annual and cumulative installation of solar streetlights in India**




| | 2016-17 | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 |
|---|---|---|---|---|---|---|
| Cumulative Installation of Solar Street Light | 0.45 | 0.6 | 0.65 | 0.71 | 0.83 | 0.93 |
| Yearly Installation | | 0.15 | 0.05 | 0.06 | 0.12 | 0.1 |

*Source: MNRE*[11]

7 Government of India, Ministry of Power, Saubhagya Dashboard
8 CEEW (2020) State of Electricity Access in India
9 GOGLA (2022) Analysis of semi-annual sales data and ESMAP's multi-tier framework data sets.
10 a MNRE (2021) Solar Power Current Status
11 MNRE (2021) Solar Power Current Status

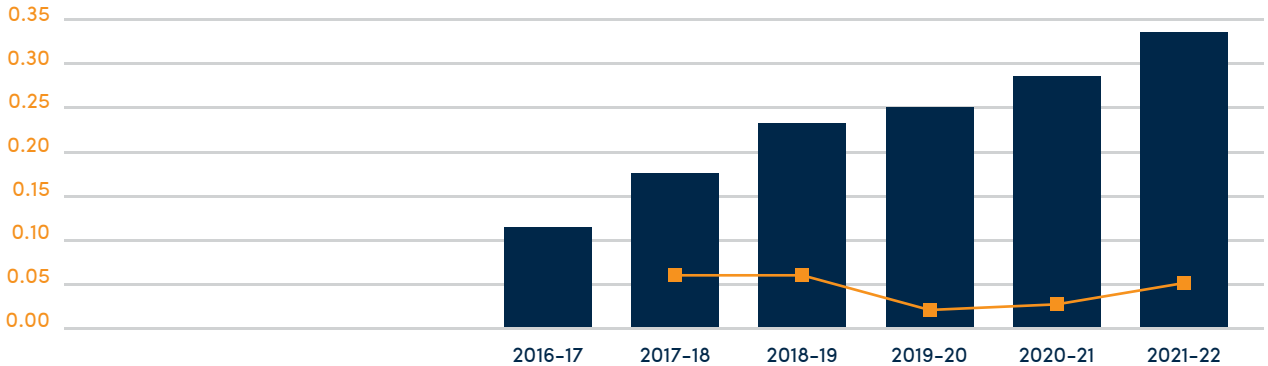
# 1: Solar DRE Market Overview

**The country is also one of the largest markets for efficient DC appliances, with some technologies specifically designed for productive use.** Although the market for these technologies is at an earlier stage, some technologies such as solar water pumps (see Figure 3) have already been deployed at scale and there is a widespread use of these appliances in areas with poor connectivity and low power quality. In urban areas, solar-based consumer appliances can also lead to energy savings and reduce emissions as India aims to achieve its Net Zero target by 2070.[12] There are several benefits created by using DC-based appliances and productive use technologies. For example:

- DC power is significantly more energy efficient than AC power.
- DC motors and appliances have higher efficiency and power to size characteristics.
- DC-based lighting (LED) is 75% more efficient than incandescent lighting.
- Recent developments in DC converter technology results in reduced losses in electricity transmission over long distances.

**There is a growing focus on the future demand for DC appliance and DRE productive use technologies in India, with the Government specifically recognizing productive use applications as a priority area.** The Framework for Promotion of Decentralized Renewable Energy Livelihood Applications was released on February 14, 2022, by MNRE[16]. This policy aims to provide a favorable ecosystem for scaling up successful business models and pilot projects for DRE livelihood applications in agriculture, agro-processing, dairy, poultry, fisheries, tailoring, etc. This is expected to provide a significant consumer push to the efficient appliance and productive use market. This may also have knock on benefits for the wider DRE sector if this leads to the sale of more solar home systems and panels in conjunction with appliances. Further details on the Framework and the emerging policy support for DC productive use appliances can be found in Section 4.1.

**Figure 3: Cumulative installation of solar water pumps in India**




| | 2016-17 | 2017-18 | 2018-19 | 2019-20 | 2020-21 | 2021-22 |
|---|---|---|---|---|---|---|
| Cumulative Installation of Solar Water Pump | 0.11 | 0.17 | 0.23 | 0.25 | 0.28 | 0.33 |
| Yearly Installation | | 0.06 | 0.06 | 0.02 | 0.03 | 0.05 |

*Source: MNRE[13 14 15]*

12 Government of India (2021), India's net zero target by 2070
13 MNRE (2021) Solar Pumps Installed
14 MNRE (2021) Solar Power Current Status
15 MNRE (2021) Solar Power Current Status
16 MNRE (2022), Policy on DRE Livelihood Applications

## 1.2 Demand for DRE in the global market

**India has the potential to become a hub for assembly and manufacturing of DRE products for the global market.** While programs such as Atmanirbhar Bharat and Make in India have pushed for increased domestic manufacturing to cater to India's internal demand, they have also positioned India as an export hub for products and services. In 2021-22, India's exports reached a record high value of USD 400 billion, surpassing the peak exports of USD 330 billion achieved in 2018-19[17]. Given that this growth has been seen as the world still recovers from the COVID-19 pandemic, it indicates that:

India's manufacturing policies have created a strong impact in the international market, where quality of products from India are preferred over the products from some other countries
The price of products manufactured in India is competitive with that of products manufactured in other countries.

**With this backdrop, the DRE export market provides a strong opportunity for manufacturers of solar DRE products in India to scale up their operations.** The national and international demand together may be able to solve the challenge of economies of scale that has been often cited as a challenge by manufacturers in India.

**The global demand of solar lighting products stood at around 34 million units in 2021.[18]** Sales of off-grid appliances were estimated at 5 million for the same period[19]. The demand for solar DRE products is high in three regions: Africa, South Asia, and East Asia & Pacific. Within these, there are different sub-regions that exhibit varied demand owing to multiple factors including:

- **National electricity access rates:** Countries in these regions typically have low-to-medium electricity access. While the access rates in urban areas are higher, those in rural areas are lower owing to lack of grid expansion.
- **Affordability and willingness to pay:** DRE consumers commonly live in rural areas and on low incomes. Affordability and willingness to pay have a significant impact on demand.
- **Quality of Power:** DRE products such as solar home systems and solar lanterns help provide a reliable means of electricity for households and businesses.
- **Means of livelihood:** Solar DRE products can help create business opportunities and increase income. For example, solar water pumps increase crop yields for over 90% of users.[20]

**733 million people are still living without energy access, and over a billion more have insufficient power.[21]** Governments in countries with high energy access deficits are increasingly recognizing the potential of DRE products to help them to meet their national electrification goals, and only eight years remain to achieve universal energy access as part of SDG7 targets. Development partners are also increasingly focused on the potential of DRE solutions to help power health facilities, agriculture, and other sectors. Although global markets contracted by 22% in 2020 due to the COVID-19 pandemic in 2020, they saw a return to growth in 2021, illustrating the continued demand from consumers.[22] Market leaders also attracted significant levels of investment.[23] This suggests that, on the current trajectory, global demand will continue to rise.

> The demand for solar lamps is high in Africa. Often, organizations and NGOs working in conflict areas procure stock but there is no visibility regarding when the products will be utilized or distributed.
>
> Manufacturing of solar DRE products in India can be competitive but the market needs to rethink the product mix. Even in a price sensitive market like India if a player is able to sell at competitive prices the volume can provide the scale for lowering cost of production which can lead to sustainable margins.
>
> - Large solar DRE product manufacturer and exporter

17 Government of India (2022), India's Annual Exports Cross USD 400 billion in March 2022
18 Efficiency for Access, ESMAP, GOGLA, IFC, Open Capital Advisors (2022) Off-Grid Solar Market Trends Report 2022 (forthcoming).
19 Efficiency for Access, ESMAP, GOGLA, IFC, Open Capital Advisors (2022) Off-Grid Solar Market Trends Report 2022 (forthcoming).
20 Efficiency for Access Coalition and 60 Decibels (2021), Uses and Impact of Solar Water Pumps.
21 IEA, IRENA, UNSD, World Bank, WHO (2022) Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank.
22 Efficiency for Access, GOGLA, IFC, Lighting Global and Open Capital Advisors (2022) Market Trends Report: State of the Sector (forthcoming).
23 Ibid

# 2: Indian Manufacturing Sector Landscape

## Key Messages

- **India is ranked second in the world for its attractiveness as a manufacturing hub, and both the manufacturing and solar industries are supported by several Government initiatives**
- **India's key manufacturing costs for land and electricity are higher than those in China, but India has lower labor costs**
- **The COVID-19 pandemic and other global events have increased the global cost of shipping by 5-8 times. This has had a knock-on impact on the cost of goods imported into India, with benefits for local manufacturers**

## 2.1 Manufacturing in India

**Manufacturing has grown steadily in India over the past few years, with the country becoming increasingly competitive.** In 2020, manufacturing generated 17.4% of India's GDP, compared to 15.3% in 2000.[24] In the Global Manufacturing Competitive Index, 2016 Ranking, India secured the 11th rank with an index score of 67.2. In comparison, China secured rank 1 with a score of 100.[26] In the Global Manufacturing Risk Index Ranking, India secured the second rank among 47 countries, just behind China (first rank).[26] The Global Manufacturing Risk Index indicates the interest shown by manufacturers as an ideal manufacturing hub over other countries. India's move saw it knock the United States from second place.

**The current gross value added by the manufacturing sector in India stands at USD 97.41 billion in the first quarter of 2021-22.** The policies and initiatives undertaken by the government, are anticipated to enhance its role as global manufacturing hub, adding over USD 500 billion annually to the global economy by 2030.[27]

**Capacity utilization in India's manufacturing sector has improved.** According to a survey by the Federation of Indian Chambers of Commerce and Industry (FICCI), capacity utilization in India's manufacturing sector stood at 72% in the second quarter of 2021-22. The country's score in Index of Industrial Production (IIP) stood at 133.7 in October 2021, a yearly growth of 3.2%. Among the various sectors considered for the IIP parameter, the manufacturing sector grew at 2% in a year.[28] In September 2021, the manufacturing component of IIP stood at 129.9.

*Source: Sun King*

24 McKinsey (2020), Manufacturing in India
25 Deloitte (2016), Global Manufacturing Competitive Index
26 Indian Express (2021), Most Attractive Manufacturing Hub
27 IBEF (2022) Manufacturing Sector in India
28 Ministry of Statistics and Planning of India (2021), Index of Industrial Production

# 2: Indian Manufacturing Sector Landscape

## 2.2 Recent Investments and Government Initiatives

**The government's 'Make in India' initiative has attracted several international manufacturers to the country and is helping to cement the countries position as a manufacturing hub.** For example, international manufacturers such as GE, Siemens, HTC, Apple, and Toshiba have either set up, or are in the process of setting up, manufacturing plants in India. The market volume of over 1.3 billion consumers, with growing purchasing power, has the potential to attract some of the largest enterprises in the world. According to Department for Promotion of Industry and Internal Trade (DPIIT), cumulative foreign direct investment (FDI) inflows in the manufacturing subsectors amounted to Rs 4.3 lakh crore (USD 570.78) billion between April 2000 and September 2021.[29] In 2021-22, India received a total FDI inflow of Rs 62.5 thousand crores (USD 81.72 billion), a 10% year on year increase.

**Noteworthy recent investments and developments in the manufacturing sector in India are:**

In October 2021, information technology major Zoho, announced an investment of Rs 50-100 crores (USD 6.7–13.4 million) to focus on research and development (R&D) in the manufacturing sector.

In August 2021, Wistron Corp. collaborated with India's Optiemus Electronics, giving a major boost to the 'Make in India' initiative and electronics manufacturing.

In July 2021, First Solar, an American solar panel manufacturer, announced plans to invest Rs 4,800 crores (US$ 645.7 million) in its new 3.3 GW manufacturing facility in Tamil Nadu.

On February 16, 2021, Amazon India announced that it would start manufacturing electronic products in India, starting first with Amazon Fire TV stick manufacturing.

In April 2021, Samsung started manufacturing mobile display panels at its Noida plant and the company plans to ramp up manufacturing IT display panels soon. This has been possible due to special incentives provided to Samsung by the government to move its plant from China to India (Uttar Pradesh) at an investment of Rs 4,825 crores (US$ 650.42 million).

In April 2021, Godrej Appliances launched a range of Made-in-India air conditioners with plans to invest Rs. 100 crore (US$ 13.48 million) in its manufacturing units.

**Manufacturing is a key focus for the Government of India with multiple initiatives supporting the sector, including 'Make in India' and 'Atmanirbhar Bharat'.** Under these initiatives, several activities have been undertaken to ensure that investors and manufacturers willing to set up facilities in India are provided with a favorable ecosystem. In August 2021, the Government announced its plans to enable exports of USD 1 trillion in manufactured goods.[30] Supported by these initiatives, India's annual exports crossed the USD 400 billion milestone in March 2022 (cumulative exports for the year 2021-22).[31] Key government initiatives in this regard are highlighted below and in Box 1 which provides an overview of the Make in India programme.

*Source: KPay*

29 IBEF (2022), FDI inflows into India

30 Press Information Bureau, Government of India (2021), Targeting USD 1 Trillion in Exports

31 Press Information Bureau, Government of India (2022), India's Annual Exports Cross USD 400 Billion in March 2022

# 2: Indian Manufacturing Sector Landscape

## Make in India

The Make in India programme developed by the Government of India is designed to facilitate investment, encourage innovation, enhance skill and capacity building, and build a globally competitive manufacturing ecosystem in India. With this initiative, the government aims to attract investments from across the globe into the country's manufacturing sector. It is being led by the Department for Promotion of Industry and Internal Trade (DPIIT), Ministry of Commerce and Industry, Government of India. The Make in India initiative is based on four pillars:

**New Processes:** Make in India recognizes ease of doing business as a critical factor for entrepreneurship. The aim is to de-license and de-regulate the industry during the entire life cycle of a business.

**New Infrastructure:** Availability of modern and facilitating infrastructure is an important requirement for manufacturing. The Government intends to develop industrial corridors and smart cities to provide infrastructure based on state-of-the-art technology with modern high-speed communication and integrated logistic arrangements. Existing infrastructure to be strengthened through upgradation of infrastructure in industrial clusters. The skillsets required for a particular industry will be identified and accordingly workforce will be developed.

**New Sectors:** Make in India has identified 25 sectors in manufacturing, infrastructure, and service activities. The information on them is being shared through interactive web-portal and professionally developed brochures. Foreign Direct Investment (FDI) has been allowed in Defense Production, Construction and Railway infrastructure.

**New Mindset:** The Government has traditionally played the role of a regulator in the industry. With Make in India, the Government intends to change the way it interacts with the industry and play the role of a facilitator. The Government will partner with the industry for the economic development of the country.

With the Make in India program, the focus has increased on manufacturing in India, which will create a positive impact in making India a hub for manufacturing for sectors such as solar DRE.

*Source: Government of India*[32]

*Source: Simpa Networks*

32 Government of India, Make in India Program

# 2: Indian Manufacturing Sector Landscape

- **Production Linked Incentive (PLI) scheme:** The PLI scheme provides incentives for setting up manufacturing facilities in India in various industries. The Financial Budget of India 2020, included a total outlay of Rs 1.97 lakh crores (USD 257.2 billion) for manufacturing with specific allocations for the solar manufacturing sector (Rs. 4500 crore (USD 0.6 billion)). In the Union Budget 2022, an additional allocation of Rs 19,500 crores[33] (USD 2.56 billion) was made, taking the total allocation to Rs 24,000 crores (USD 3.21 billion) for setting up solar manufacturing plants with a capacity of over 1 GW.[34]

- **Electronics sector:** In March 2021, to expand India's smartphone assembly industry and improve its electronics supply chain, the government announced funds worth USD 1 billion to each semiconductor company that establishes manufacturing units in the country.

- **Research and Development:** In November 2021, the Experts' Advisory Committee (EAC) of DPIIT approved Rs. 3 crores (US$ 403,293) for the Atal Incubation Centre, Pondicherry Engineering College Foundation, under the Start-up India Seed Fund scheme. It will include research and incubation support for solar product manufacturing.

- **Innovation focus:** In July 2021, the government launched six technology innovation platforms to develop technologies and thereby, boost the manufacturing sector in India to compete globally.[35] These include platforms developed by IIT Madras, Central Manufacturing Technology Institute (CMTI), International Centre for Automotive Technology (iCAT), Automotive Research Association of India (ARAI), BHEL and HMT in association with IISc Bangalore.

- **Lower corporate tax rate:** The government has introduced a favourable tax regime for new manufacturing companies, reducing corporate tax rate to 15% for new manufacturing units, one of the lowest tax rates for manufacturing units globally.

*Source: d.light*

33 Government of India (2022), Union Budget 2022 Highlights
34 Government of India (2020), PLI Scheme
35 Government of India (2021), Press Information Bureau

## 2.3 Manufacturing Cost Comparison and Analysis

**India's primary competition in the manufacturing sector is with China.** Currently ranked number 1 in the Global Manufacturing Competitiveness Index and Global Manufacturing Risk Index, China is the foremost location for global manufacturing. In the Ease of Doing Business Ranking 2019, China achieved a rank of 46 while India's rank was 77.[36] India has emerged as a strong competitor to China in manufacturing but continues to lag. This is largely due to the manufacturing cost differential among the two countries linked to the price of land, skilled resources, and the current scale of production. In this sub-Chapter, we provide a comparative analysis of these three elements between India and China (see Figure 4).

### Land

**The cost of land is one of the most expensive aspects of setting up manufacturing units.** It constitutes the bulk of the capital costs. In India, agricultural or private land cannot be used for manufacturing until it is converted or registered as industrial land. Conversion of land is a long and detailed process and requires significant levels of capital and time. Although, the process has become increasingly simple. In China, in some cases, land is provided at very low costs to set up manufacturing units. Incentives are also provided in terms of land location, such as the proximity to raw materials or export hubs/ports.[37]

### Human Capital

**China's human capital or labour used to be one of the cheapest in the world.** This trend has now changed over the past few years. In 2018, manufacturing labour costs in China stood at USD 5.51 per hour. In comparison, the labour cost in Mexico was USD 4.45 per hour and in Vietnam it was USD 2.73 per hour.[38] In India, the cost of manufacturing labour was USD 2 per hour (2018).[39] This gives India a slight advantage over China in terms of labour costs.

**However, the availability of skilled labour remains an issue in India.** Some manufacturing processes, especially solar manufacturing, are skill intensive and require experience. China, given its vast experience in solar manufacturing, has the skilled labour required for domestic manufacturing. Although there is a capacity gap in the Indian market, the low cost of building a trained work force can help to mitigate this issue in the longer term should training and upskilling be prioritized.

*Source: Devidayal*

36 Doing Business (2019), Ease of Doing Business
37 Intellecap analysis based on primary research
38 Statista, Manufacturing Labour Costs
39 Economic Times, India Manufacturing Labour Costs

# 2: Indian Manufacturing Sector Landscape

**Figure 4: Summary of comparative analysis for manufacturing in China and India**

| Parameter | China (A) | India (B) | Percentage Differential [(A-B)/A]*100 | Inference |
|---|---|---|---|---|
| **Land Costs** | USD 0-132[40] per square meter (land is allotted at zero cost to some industries) Average cost = USD 66 per square meter | USD 40-261[41] per square meter (land varies by location as it is governed by state) Average = USD 150.5 per square meter | (56%) | India's land costs are 56% higher than China's |
| **Labour Costs** | USD 5.51 per hour[42] | USD 2 per hour[43] | 175.5% | India's labour costs are 175.5% lower than China's |
| **Electricity Costs** | USD 0.12 per kWh[44] | USD 0.14 per kWh[45] | (14.3%) | India's electricity costs are 14.3% higher than China's |

## Economies of Scale

**In addition to the differences in land and electricity costs, the low price of China's solar modules is also linked to the economies of scale derived from its large-scale manufacturing base.[46]** The difference in scale can be understood as per the following mathematical formula:

**Total cost of production (CP)/Unit (UP) = [Capital cost (C) + Cost of labour per hour (CL) + Electricity cost (CE)] / Number of units produced (UP)**

If the cost of setting up the manufacturing facility, labour, electricity, and equipment is constant, the cost of production (CP) will be inversely proportional to the number of units produced (UP). Therefore, scale of production plays a significant role in reducing the cost of production per unit.

**In 2021, China's solar module manufacturing capacity was around 500 GW[47], whereas in India, it was around 15 GW[48].** For India to become more competitive with China in the manufacture of solar and solar DRE products, it will need to address the higher cost of land and the favourable economies of scale. For example, by:

- **Land:** subsidizing land costs for DRE manufacturers and/or providing land in special economic zones
- **Scale of manufacturing:** increasing the scale of DRE manufacturing by helping to drive up local demand, and supporting efforts to export DRE products and component parts to other countries

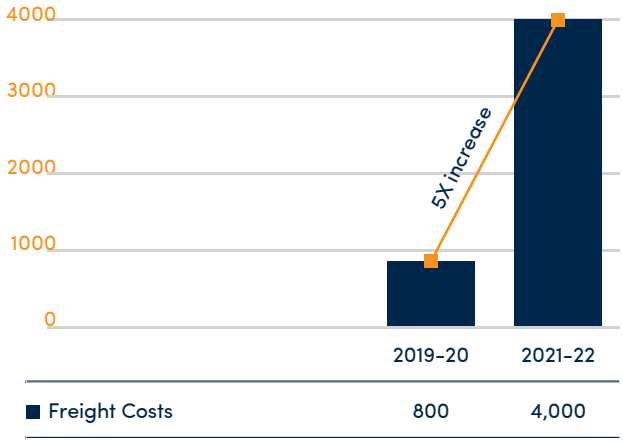
40 China industrial land prices
41 India industrial land prices
42 China labour wages
43 India labour wages
44 China electricity costs
45 India industrial electricity costs
46 Royal Society of Chemistry, Why Chinese Solar Panels are Cheaper
47 Chinese solar module capacity
48 India solar cell and module manufacturing plans

## 2.4 Freight Costs

**Freight charges have increased by 5-8 times the costs from 2019-20 to 2021-22.**[49] These increases in freight charges have resulted in the increased cost of imported products and reduced vendor margins. For example, the increase in freight costs resulted in increased price for each kW of solar modules that are imported in India of USD 16 per kW. Figure 5 shows the difference between freight costs for a container of solar modules between 2019-20 and 2020-21. Overall, the contribution of freight costs to the total cost of imported DRE products, thus, increased from 2-3% to 8%.

**Longer lead times have also increased for the import of some products.** For example, one DRE retailer reported that lead-times for products imported from China are now 2-3 times longer than for those in the Indian market[51]. COVID-19 also led to the closure of Indian ports for imports during the crisis. As well as the rising cost of freight, security of supply issues may also help to make India a more attractive market for local manufacture and encourage global players to diversify their supply chains.

**Figure 5: Change in freight costs for a container of solar modules from China to India (USD)**




*Source: Mercom India* [50]


*Source: IFC*

**Figure 6: Freight cost comparison of solar module imports into India**

| Average Load of Modules per Container | Freight Cost 2019-20 | Revised Freight Costs in 2021-22 | Freight Cost per kW (2019-20) | Freight Cost per kW (2021-22) | Difference in Freight Cost per kW |
|---|---|---|---|---|---|
| 200 kW | USD 800 | USD 4,000 | USD 4 | USD 20 | **USD 16** |

49 Mercom, Additional Freight Costs
50 Mercom, Additional Freight Costs
51 Intellecap primary interviews

# 3: Solar DRE Manufacturing in India

## Key Messages

- **The supply chain of DRE products can be categorized into three broad segments: base components, intermediary components, and finished products**
- **As raw materials are not available locally, India has a limited production of base components. The assembly of intermediary components and finished products therefore provide the largest opportunity for manufacturing in India**
- **Most assemblers of DRE products in India are currently using components sourced from informal enterprises that seldom follow quality certifications, hence cheaper but of doubtful quality standards**
- **Practical support for informal manufacturers to produce higher quality products without raising costs, such as tax incentives for the assembly of quality assured products and/or only allowing quality products to be accepted for government tenders, could help to address the issue of quality without undermining demand**

## 3.1 Overview

**There are three levels of procurement in the supply chain for the manufacture of solar products:**

Base components: such as semiconductor wafers and ingots required for solar panels, these are typically imported as they are not currently manufactured in India.
Intermediary components: such as solar panels, luminaires, charge controllers and batteries that are assembled to make finished DRE products. There is some domestic manufacturing of these components, but most demand is fulfilled through imports.
Finished products: finished DRE product, include solar lanterns, streetlights, and solar fans. Most of these products are assembled in India using the two categories of components profiled above. In some cases, finished goods are also directly imported, white labelled (a practice used by vendors to put their own branding on goods manufactured by another company) and sold in India.

**Overall, the solar DRE product market is dependent upon imported components which are assembled by manufacturers in India.** An estimated 80-90% of the solar DRE products in India are assembled products using imported components.[52] These are mostly imported from China, with a few components imported from countries such as Taiwan, Indonesia, and Malaysia. The most common solar DRE components that are imported into India are:

Solar cells
Lithium-ion cells

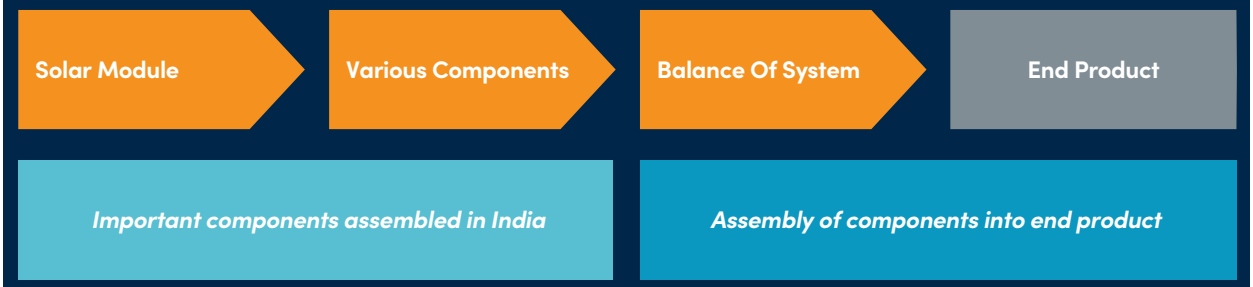
Although the process for manufacturing DRE products will vary between different companies and for different technology types, Figure 6 provides a profile of the typical process for manufacturing DRE products in India today.

*Source: Devidayal*

52 Intellecap analysis based on primary research

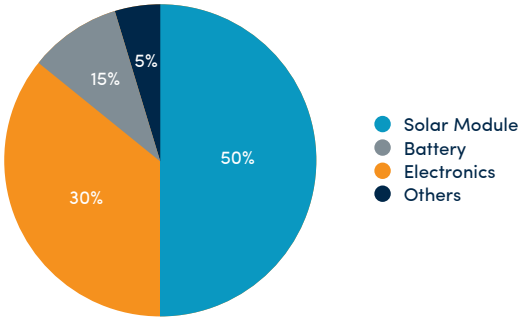
# 3: Solar DRE Manufacturing in India

**Figure 7: Typical process for the current manufacturing of DRE products in India**




This Section further explores the status of DRE manufacturing in India for base and intermediary level components, and for five categories of finished products: solar lanterns, solar home systems, solar water pumps, solar streetlights and BCLD fans. It will take a deep dive into the manufacture and assembly of solar modules and batteries as, combined, these components account for 70-80% of the cost of a DRE solar lighting product (see Figure 7), and a significant proportion of the cost of other solar DRE technologies.[53]

**Figure 8: Average cost break-down of solar DRE products, by components**




*Source: Primary interviews*

## Base components for solar cells and modules

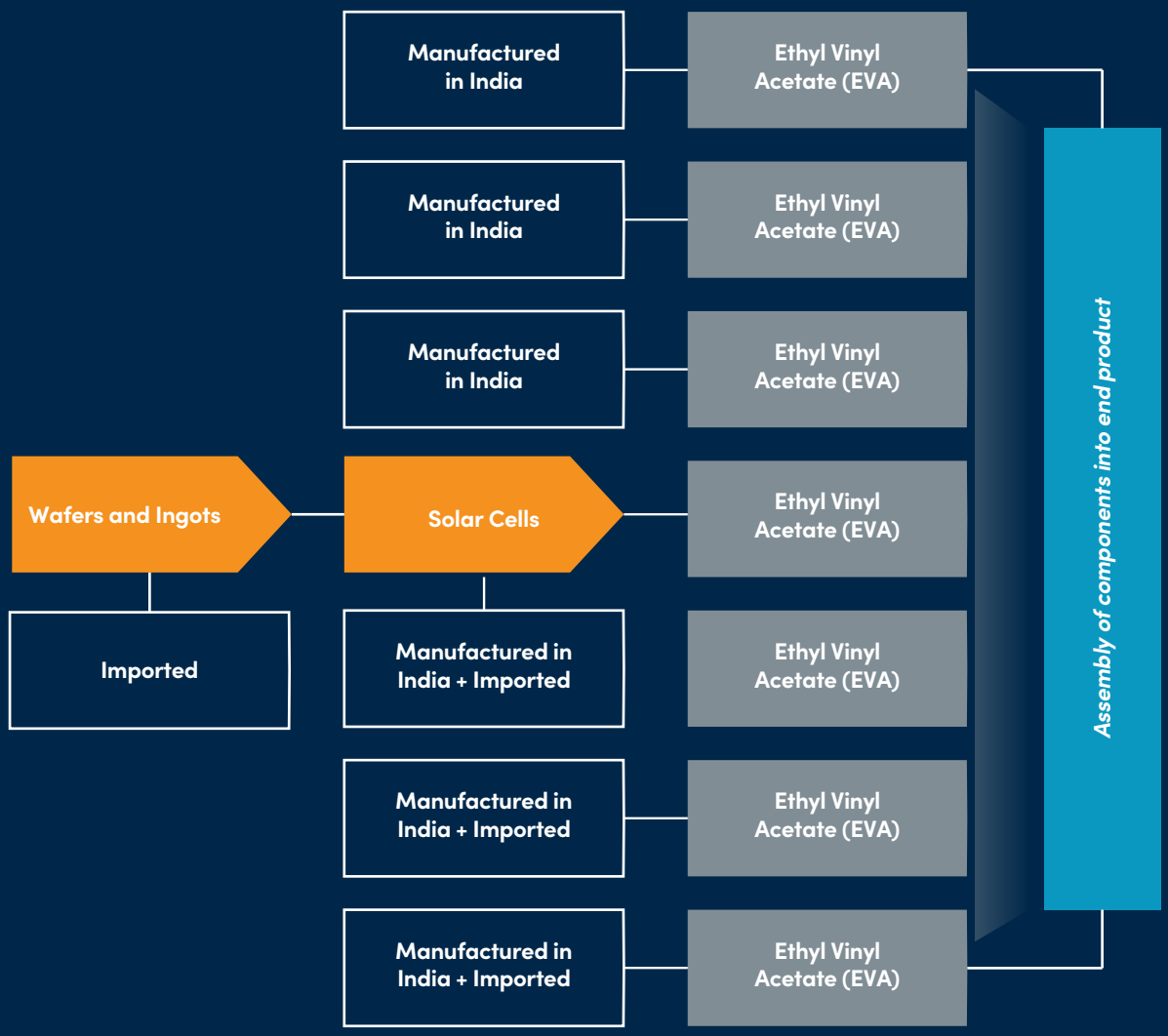
**The base components for solar cells and modules are largely procured from enterprises in China.** A solar module is comprised of many components, ranging from raw material, such as wafers and ingots, to the aluminum frame structures on which the panels are fixed. Figure 8 shows the module components which are currently being manufactured in India, which are manufactured as well as imported, and which are only imported into India at present.

*Source: Devidayal*

53 Intellecap analysis based on primary research

# 3: Solar DRE Manufacturing in India

**Figure 9: Solar module value chain**




*Source: Intellecap research*

**Currently, India does not manufacture enough base components to meet its domestic demand for solar modules.** Figure 9 provides an overview of the current solar module manufacturing capacity in the country vs the estimated demand.

**Figure 10: Solar module manufacturing supply chain components and quantities required**

| Supply Chain Components | Quantities to meet total domestic requirement by 2022 | Existing capacities in India as of 2021 |
|---|---|---|
| Si Wafers | 2.4 billion/year | Nil |
| Si Ingots | 15,000-20,000 MT/year | Nil |
| Polysilicon | 17,000-23,000 MT/year | Nil |
| PV Cells | 3,500-6,000 MW/year | 3,000 MW |
| Low Iron Glass | 3,500-6,500 tons/day | >100 tons/day |
| Junction boxes | 10-40 Million | >5 million[54] |

*Source: Securing the supply chain for solar in India[55]; FICCI*

54 Energetica India (2020) 'Make in India' for PV Junction Boxes and Cables
55 FICCI, Securing the Supply Chain for Solar in India

# 3: Solar DRE Manufacturing in India

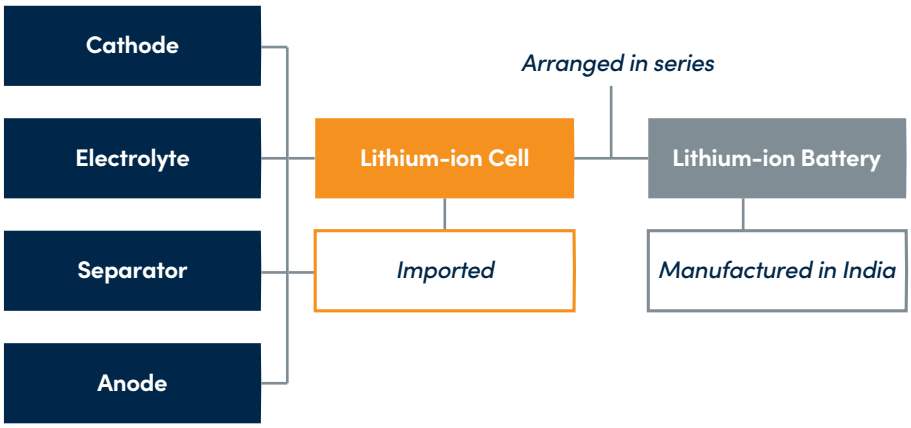
## Local Manufacturing Opportunity Analysis: Base Components for Solar Cells and Modules

**China is a hub for raw materials needed to manufacture solar cells, including rare-earth metals, which are found in limited commercial quantity in India. To compete globally in the manufacture of base components, India would need to develop and promote a strong supply chain of raw materials from other countries which have reserves of these rare earth metals. This could take several years. If a supply chain for raw materials cannot be established, creating base components for solar cells is unfeasible.**

## Base components for lithium-ion batteries

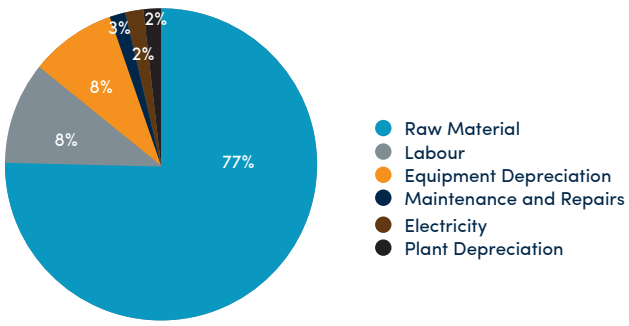
**Light-weight, high power devices, lithium-ion (Li-ion) batteries are an essential component of most solar DRE products.** Li-ion batteries have high efficiency, capacity, and energy density compared to traditionally used lead-acid batteries. Figure 10 illustrates the various components of Li-ion batteries along with information on the current manufacturing capacities in India.

**Figure 11: Anatomy of a li-ion battery**




For the cell production, 77% of the costs are of raw materials, while manufacturing of the cell accounts for the remaining 23% of the costs. This can be seen in Figure 11.

**Figure 12: Manufacturing cost breakdown of Li-ion cell**




*Source: BNEF; IEEFA*

# 3: Solar DRE Manufacturing in India

## Local Manufacturing Opportunity Analysis: Li-ion Cells

**With the government bringing in battery manufacturing under the purview of the 'Production Linked Incentive' scheme, it is expected that several incentives will be accorded to companies manufacturing li-ion batteries in India. While India does not yet have the capacity to manufacture li-ion cells, the growing battery manufacture for EVs may also hasten the country's ability to manufacture these base components. However, this is not expected in the short term, and the initial focus of any efforts would be on the EV market, rather than the production of li-ion cells for smaller industries such as DRE.**

*Source: IFC*

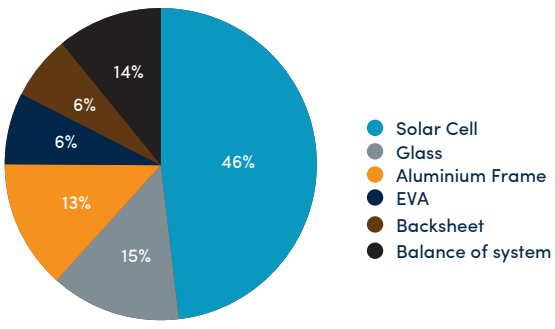
## Intermediary Components

### Solar Modules

**As the raw materials for solar modules are not yet available in India, most local solar manufacturers only assemble modules and do not manufacture solar cells or their base components.** While there are a few large enterprises that produce solar cells,70-80% are imported[56]. As noted above, this is primarily due to the lack of availability of raw material – rare earth metals and silicon that are used for semiconductor manufacturing to form wafers. To reduce India's dependence on imports for solar manufacturing of wafers and ingots, more manufacturing facilities that are backward integrated (manufacturing wafers, ingots, cells, and modules) across the value chain are needed and supply chains for raw materials must be built.[57]

**Solar cells are the most expensive part of the solar module, accounting for 46% of the total costs.** Figure 12 shows the percentage share of components for manufacturing of solar modules.

**Figure 13: Manufacturing cost breakdown of Li-ion cell**




*Source: IEEFA[58]*

56 Financial Express (2022), Solar Cell Imports from China
57 Intellecap analysis based on primary research
58 IEEFA (2021), Share of Components in Module Cost

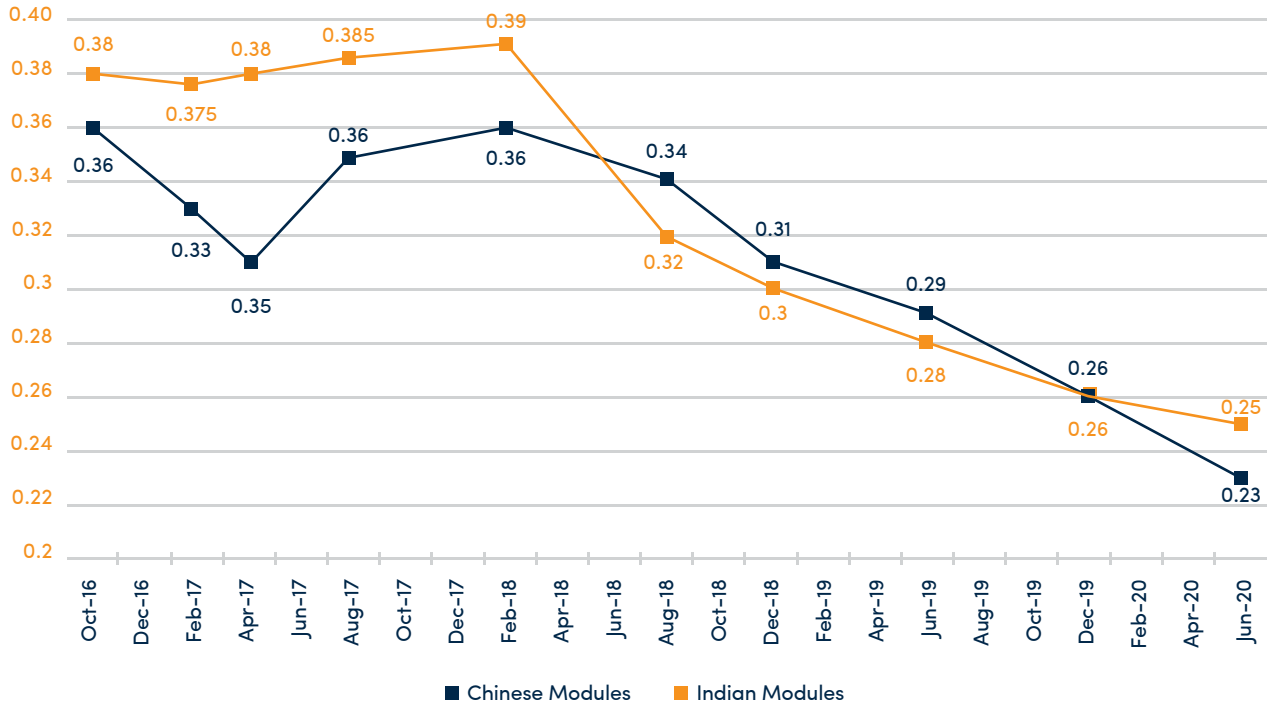
# 3: Solar DRE Manufacturing in India

**To promote domestic manufacturing of solar modules, the Indian government introduced safeguard duties (SGD) in July 2018.** This was akin to an import tax or anti-dumping duty levied on modules from China which increased their landed cost and narrowed the difference between Indian and Chinese modules. Before the SGD was levied, modules from China were around 5-10 cents/watt cheaper than Indian modules.[59] Over the past five years, with improvements in R&D and increasing demand volumes, the cost of both Chinese and Indian modules has decreased. Figure 13 shows the post-SGD comparison of landed solar module prices from China vs locally produced modules between October 2016 and June 2020. From 5-10 cents/watt before levying of SGD (in July 2018), the costs have now narrowed down to only 2 cents/watt.

**As can be seen in Figure 13, in the first wave of COVID-19, module suppliers in China were adversely affected.** The supply chain was impacted for a brief period as the international trade rules were suspended and the cargo coming in from China was stuck at ports. This increased the cost of Chinese products by 15-20% and the uptake of domestic solar modules improved.[62]

**A new rate of basic customs duty for solar modules and cells, means that the landed cost of solar modules may surpass the cost of those produced locally.** In April 2022, a basic customs duty (BCD) of 40% for solar modules and 25% for solar cells was implemented. Figure 14 provides an insight into the manufacturing cost of solar modules in India and China before and after the introduction of the BCD. The effect of the tax is expected to be revealed in late 2022, once stock bought before its introduction has been exhausted. The potential impact of taxes on cost, demand, and the ability to engage with the export market is further discussed in Chapter 4.

**Figure 14: Price trend of Chinese versus Indian solar PV modules (multi-crystalline)**




*Source: IEEFA[60]; Mercom India[61]*

59 Economic Times (2020), Chinese Module Prices Before Safeguard Duties
60 IEEFA (2021) Solar Module Prices, China and India
61 Mercom (2017) Solar Module Prices, China and India
62 Financial Express (2020), BIS Norm Delay in Panel Supplies from China

# 3: Solar DRE Manufacturing in India

**Figure 15: Summary of manufacturing cost, taxes, and landed costs for solar modules**

| Country | Manufacturing cost (USD per watt) | Form of taxes levied | Tax applicable | Total landed cost (USD per watt) |
|---|---|---|---|---|
| India | 0.22 | GST | 12% | 0.25 |
| China (with SGD) | 0.20 | SGD | 15% | 0.23 |
| China (with BCD April 1, 2022 onwards) | 0.20 | BCD | 40% | 0.28 |

**The COVID-19 pandemic also led to a delay in the BIS certification of new and existing solar module models.** Along with the increased cost of modules has led to renegotiation of contracts by developers. This has increased interest in procurement from Indian manufacturers.

## Local Manufacturing Opportunity Analysis: Solar Cells and Modules

**While the local manufacture of most base components for solar cells in India is a long-term ambition due to the lack of raw materials, the potential to increase the direct import of base components to expand the manufacture of solar cells and modules is more feasible. While cell manufacture is at an earlier stage, a number of companies already manufacture solar modules.**

### Li-ion Batteries

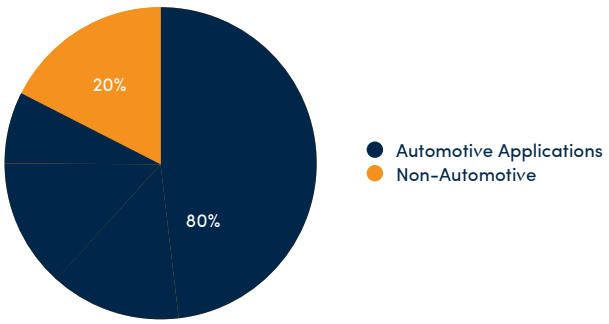
**The battery market in India has evolved significantly over the past decade in terms of technology adoption and demand.** The technology has shifted rapidly from lead-acid batteries to li-ion batteries due to better efficiency, lower weight, and lower maintenance costs, driven especially by the energy and automotive applications. The electric vehicle industry accounts for 80% of the demand for li-ion, with the remaining 20% of demand in the non-automotive segment, including off-grid solar and energy storage applications (see Figure 15).

**In the overall battery pack, Li-ion cells constitute about 65% of the total cost of production (see Figure 16).** The remaining cost is from the manufacture of the battery pack.

### Battery Manufacturing Value Chain in India

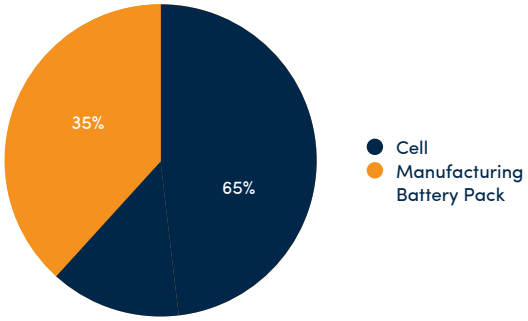
**The primary model for manufacturing batteries in India is to assemble imported cell packs, mostly from China, into the plastic casing along, adding the manufacturer's branding on the case (see Figure 17).** There is some, limited, cell production in India, but it has not yet achieved commercial scale to become cost effective. As well as using locally assembled batteries, some DRE vendors also use packaged imported batteries in their products.

**Figure 16: Share of application of lithium-ion batteries in India**




*Source: IEEFA (2021)*

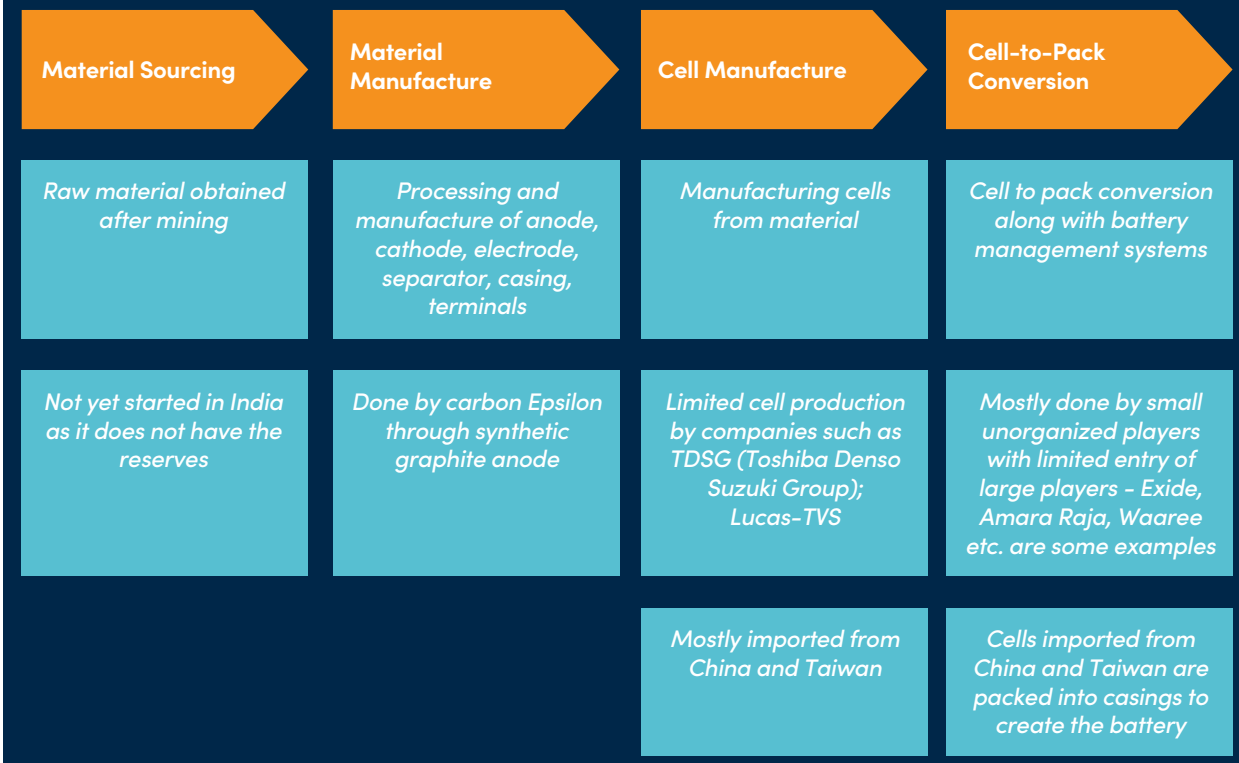
**Figure 17: Manufacturing cost of battery pack**




*Source: BNEF; IEEFA*

# 3: Solar DRE Manufacturing in India

**Figure 18: Typical battery manufacturing value chain in India**




*Source: IEEFA*

**There is a strong local demand for greater manufacture of batteries locally in India.** This is due to a range of factors, including:

- **Cells specific to Indian conditions:** Most cells imported from China are not able to withstand the high temperatures in India. The recent series of electric scooter fires (that included cells imported from China) have indicated that the batteries must be created specifically to meet the ambient environmental conditions in India.
- **Price-sensitive market:** In the aftermath of the pandemic, the supply chain disruption in China has led to an increase in battery prices, freight prices and lead times. This has had a direct impact on the cost of the battery to the consumer. The increase in import duties for assembled battery packs has also had a detrimental effect on the price of batteries in India.
- **Surge in global demand:** With an increase in the global demand for lithium-ion batteries, especially from Western Europe and the US for use in EVs, most of the manufactured products have been diverted to these countries and away from India. With a relatively lower volume demand, India has become a secondary market for Chinese battery manufacturers.

**The current capacity of Li-ion battery manufacturing in India stands at 2.6 GWh (2020-21) and is expected to grow to over 116 GWh by 2029-30.**[63] Most battery manufacturers are in the western states of Gujarat and Maharashtra, while some can also be found in Telangana, Andhra Pradesh, Tamil Nadu, Delhi, Uttar Pradesh, Himachal Pradesh, and Punjab.

**Battery assembly and manufacturing capacity is expected to double over the next 2-3 years, with many EV players, setting up their own battery manufacturing facilities**[64]**.** However, challenges prohibiting scaling-up of manufacturing of cells in India include:

63 PV Magazine (2022), India's Annual Lithium Battery Market will Reach 116 GWh in Eight Years

64 IEEFA (2022), Lithium-Ion Battery Manufacturing Landscape in India

# 3: Solar DRE Manufacturing in India

- **Raw material unavailability:** key elements such as lithium, cobalt, and nickel are not available in India at a large scale, which prevents the direct manufacture of cells.

- **Low research and development:** the R&D on battery cell technology has traditionally been low but it is now increasing as the scope of demand and investments increases.

- **Supply chain challenges:** the sensitive nature of geopolitical relations between India and China has the potential to disrupt the supply chain for batteries, as most of the cells are being imported from China. Moreover, with the ongoing semiconductor and other raw material issues in China, the availability of cells has also been impacted.

Initiatives to counter these challenges have been undertaken by the government. These include:

- **Policy initiatives:** Initiatives such as the Faster Adoption and Manufacturing of Electric vehicles (FAME) scheme and Production-Linked Incentives (PLI) are expected to drive EV adoption and li-ion cell manufacturing in India. Many companies have already begun operationalizing plans to develop battery manufacturing capacity in India. For instance, Suzuki has partnered with Toshiba and Denso to set up a cell manufacturing facility. TVS Lucas has also partnered with US-based 24M Technologies to develop cell manufacturing facilities, while Hyderabad's GODI has also developed in-house Li-ion batteries.

- **Production-Linked Incentives:** The government has allocated about Rs 18,100 crore ($2.5 billion) for the development of advance chemistry batteries, with a planned manufacturing capacity of 50 GWh. The subsidy under this scheme has been limited to Rs 2,000 per kWh ($27.2 per kWh). Firms will be eligible for subsidies only if they set up a minimum capacity of 5 GWh, achieve a domestic value addition of at least 25% (which essentially means that the company should procure at least 25% of its components from domestic sources) and invest a minimum of Rs 2,250 million per GWh ($30.6 million). The domestic value addition component must be increased to 60% within five years.

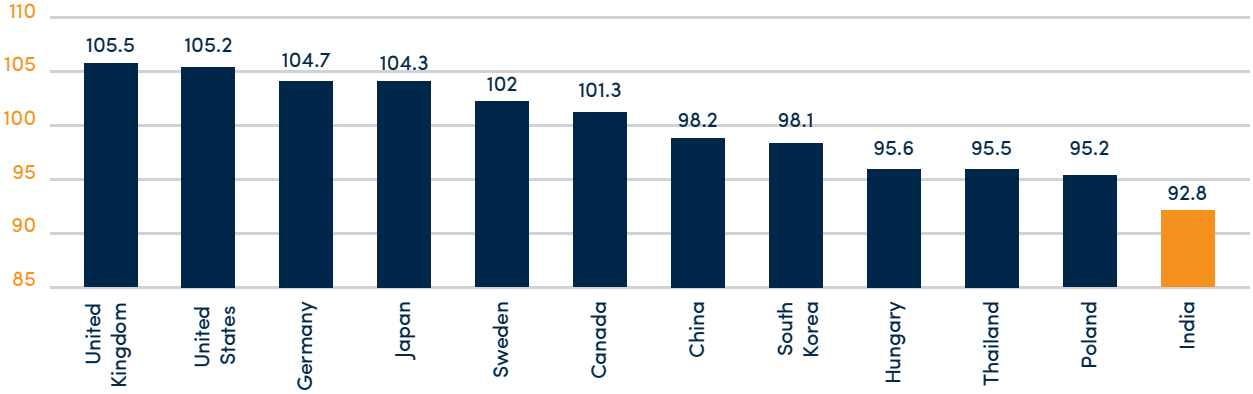
- **Foreign Direct Investment (FDI):** The government has permitted 100% FDI into the battery manufacturing sector, which means that no financial entry barriers have been set for international firms looking to enter India for manufacturing battery management systems.

- **Non-tariff barriers:** the government tripled the import duty on assembled battery packs, from 5% to 15% in April 2021[65]. This was done to discourage the import of assembled packs and to encourage the local manufacturing of battery packs in India, using imported cells.

- **Local procurement:** The government has mandated that EV manufacturers assemble the traction battery packs used in the vehicles locally, by linking it to the FAME-II incentives. This has increased the scale and demand for battery pack manufacturing in India.

**Outside of li-ion cell production, the cost of manufacturing batteries in India is lower than in most other countries, including China (see Figure 18).** This is due to India's competitive cost of labour. The incentives highlighted above are expected to make battery manufacturing in India even more cost effective.

**Figure 19: Landed cost of battery manufactured in India versus other countries**




*Source: IEEFA (2021)*

65 Financial Express (Nov 2021)

## Local Manufacturing Opportunity Analysis: Li-ion Batteries

**The expected growth in the manufacture of li-ion batteries in India due to the growth of the EV market could benefit the manufacture of li-ion batteries for use in the assembly of DRE products. Further research is needed to explore specific actions that could enhance the local production of li-ion batteries for use in the assembly of DRE products.**

**A charge controller is a voltage and/or current regulator that prevents a battery from overcharging.** It regulates the voltage and current generated by the solar panels that charges the battery to provide power at the time of requirement. Most charge controllers used in solar panels and solar DRE products in India are domestically manufactured. A small percentage of charge controllers are imported from China, usually when they are included as part of a complete product.[66]

## Local Manufacturing Opportunity Analysis: Charge Controllers

**The manufacturing of charge controllers has already matured in India. As capacity can be found locally, manufacturing is expected to grow organically if there is greater assembly and manufacture of solar modules, li-ion batteries, and final products for DRE.**

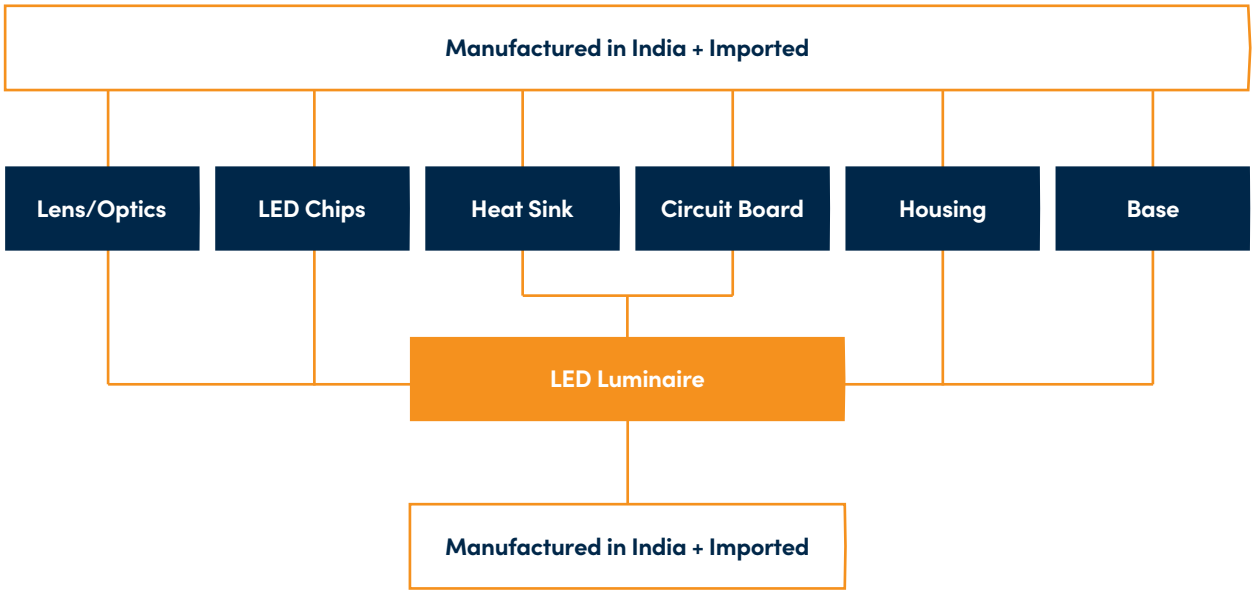
## Luminaire LEDs

**Luminaire LEDs are used in solar lanterns and solar lighting systems in India.** They are comprised of six primary components (see Figure 19):

- **Lens/optics:** used to evenly distribute light in the bulb and is made of plastic.
- **LED chips:** components that create light and are glued to a piece of metal known as the printed circuit board. Single or multiple chips can be used in a bulb, depending upon the wattage required.
- **Heat sink:** a piece of metal upon which the LED chips are fixed, it absorbs the heat from the chips to provide a cooling effect.
- **Circuit board:** also known as the driver, it is a smart part of the LED luminaire that signals the bulb to turn on/off.
- **Housing:** usually made of aluminum, it is a heat-conductive part of the bulb.
- **Base:** the part of the bulb that is connected with the holder to complete the circuit.

**LED luminaires are manufactured in India, along with all their components.** However, a large proportion of luminaries are imported from China due to lower pricing and greater choice in styles and packaging when compared to those manufactured in India. Luminaries are also imported when they make up a part of a solar lantern imported as a complete product. For the small percentage of solar lanterns assembled/manufactured in India, the LED luminaires are also procured from domestic manufacturers.

**Figure 20: Components of LED Luminaires**




66 Intellecap analysis based on primary research

# 3: Solar DRE Manufacturing in India

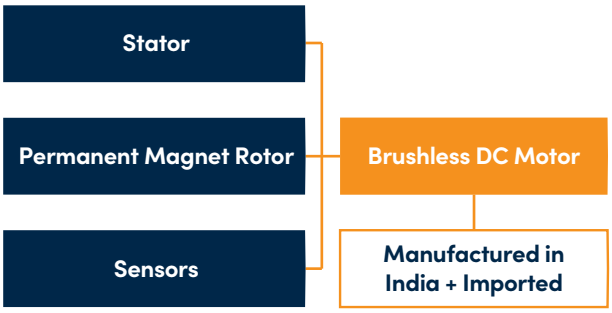
## Local Manufacturing Opportunity Analysis: LED Luminaries

**The manufacturing of LED luminaires in India is widespread and has grown in recent years due to the government's push on energy efficient lighting. There is an opportunity for the DRE market to tap into this local manufacturing base, especially if manufacturers can provide more competitive pricing and a greater variety of styles.**

## DC Motors

**A Brushless DC (BLDC) motor is a magnetic electric motor driven by direct current electricity.** It has an electronically controlled system that produces rotational torque by changing phase currents at regular intervals. Solar DRE products such as solar fans use BLDC motors to operate directly using the DC current produced by solar panels. In brushed-type traditional DC motors, the brushes make mechanical contact with a commutator on the rotor to form an electric path between a DC electric source and rotor armature windings. In a BLDC motor, a permanent magnet (or field poles) rotates and current carrying conductors are fixed (see Figure 20).

**Figure 21: Components of BLDC motors**




BLDC motor manufacturing happens in India and there is good availability of high-quality products in the market. Due to cost considerations, BLDC motors are also imported from countries like China, although the scale of import is low.

## Local Manufacturing Opportunity Analysis: BLDC Motors

**Domestic manufacturing of BLDC motors in India is high. As the DRE market grows and the push on more efficient motors is provided, the manufacturing for BLDC motors in India is expected to grow organically.**

## Plastic Moulds

**Within DRE lighting products, a plastic mould is attached to the outer case of the light which encases the luminaire LED.** The LED is manufactured by employing injection moulding technology, a commonly used method for high volume plastics production. Manufacturing of plastic moulds in India is a mature market, as it is required in several other systems including non-lighting products. Most DRE product manufacturers either procure plastic moulds from domestic sub-manufacturers or manufacture the mouldings themselves. The plastic moulds are not separately imported as individual components in India.

## Local Manufacturing Opportunity Analysis: Plastic Mouldings

**Plastic mouldings manufacturing in India is already at a mature stage. Owing to the other applications that use mouldings, the pricing of the product has also stabilized. As the DRE market grows, it will also provide opportunities for the plastic mouldings segment to grow.**

## Balance of system

**For solar DRE products, the balance of system includes wires, cables, printed circuit boards, and switches.** These are domestically sourced from manufacturers in India. Printed circuit boards are mostly manufactured in-house by solar DRE product manufacturers as these need to match the product specifications.

*Source: IFC*

# 3: Solar DRE Manufacturing in India

## Local Manufacturing Opportunity Analysis: Balance of System

**Balance of system components are readily available in the Indian market and are locally procured by domestic manufacturers. Growth of DRE product manufacturing in India will also lead to a simultaneous growth in the manufacturing of these components.**

> In the solar DRE market, some components are made in India and some are imported. We are working on how to increasingly localize the value chain. The landed price of Chinese components, including freight costs, is still more competitive than the Indian price. There is a need to develop economies of scale in India. The Chinese get aggregated orders from across the world which provides the scale for manufacturing at low costs.
>
> - Leading Indian think tank

## Finished products

### Solar Lanterns

*Source: Sun King*

A solar lantern is a portable lighting device that consists of PV module, battery, lamp, and electronics. Battery, lamp, and electronics are placed in a suitable outer case, made of metal or plastic or fiber glass. Solar lanterns are widely used in the rural parts of the country.

**Standards and Specification**

In India, LED based solar lanterns are split into three categories by the MNRE. Specifications are noted in the table below:

**Figure 22: Solar lantern specifications**

| Item | Model-I | Model-IA | Model-II |
|---|---|---|---|
| Light Source | 4Wp under standard test conditions (STC) | 4Wp under STC | 8Wp under STC |
| | The PV module should have crystalline silicon solar cells, and should have humidity, freeze and damp heat tests certificate conforming to IEC 61215 Edition II / BIS 14286 from an NABL or IECQ accredited Laboratory | | |
| Battery | Lead acid battery with a capacity up to 7 AH, at voltage up to 12V @ C/20 rate of discharge or NiMH or Lithium-Ion | Lithium-Ferro Phosphate of 3x 3.2V, 1450 mAh | lead acid battery with a capacity up to 7 AH, at voltage up to 12V @ C/20 rate of discharge or NiMH or Lithium-Ion or Lithium-Ferro Phosphate |
| | The battery must conform to the latest BIS/ International standards | | |
| Autonomy | Minimum of 3 days or 12 operating hours per permissible discharge | Minimum of 6 operating hours per permissible discharge | Minimum of 3 days or 12 operating hours per permissible discharge |
| Light Source | 2.0 Watts (max.) W-LED luminaire | 2.0 Watts (max.) W-LED luminaire | 4.0 Watts (max.) W-LED luminaire |
| Duty Cycle | 4 hours a day (at full brightness level), under average daily insolation of 5.5 kWh/ sq.m. on a horizontal surface | | |

*Source: MNRE, 2021*[67]

67 MNRE (2021), Technical Specification for Solar Photovoltaic Lighting Systems & Power Packs

# 3: Solar DRE Manufacturing in India

## Local Manufacturing Opportunity Analysis: Solar Lanterns

**Finished solar lantern products are both assembled in India, using a mix of imported and domestic components, and imported as a final product from China. The lower price point and better style and finish are cited as reasons why retailers and consumers can prefer Chinese solar lanterns over those made locally.**

**The local base for manufacturing provides an opportunity to increase the domestic assembly of solar lanterns if this is linked to greater demand that can unlock economies of scale, or other mechanisms to keep costs low. Indian DRE manufacturers can also focus on building stronger research and development capacity to innovate in this category, and build their reputation for providing high quality, durable products. Assembling high-quality products at low costs would boost local demand and expand the potential for export to the global market.**

## Solar Home Systems

A solar home lighting system (SHS) provides illumination in a single or multiple rooms of a house and can be used for illumination and phone charging by micro-small businesses. The SHS constitutes a PV module, control electronics, battery, and luminaire(s). There are several SHS models featuring one, two, or four luminaries based on White Light Emitting Diode (W-LED). The system could also be used to operate a small DC fan or a 12-V DC television along with the W-LED Lamps.

*Image source: d.light*

### Technology Overview: Standards and Specification

In India, solar home systems are categorized into six models. The configuration of each model is captured below:

**Figure 23: Configuration of SHS models in India**

| Items | Model-I One White LED luminaire | Model-IA One White LED luminaire | Model- II Two White LED luminaire | Model –III Two White LED luminaries and one DC fan of wattage up to 10 W | Model –IV Four White LED luminar-ies | Model –V Two W-LED luminaries and one DC fan of wattage up to 20 W |
|---|---|---|---|---|---|---|
| PV Module | 6 Wp under STC | 6 Wp under STC | 12 Wp under STC | 24 Wp under STC | 24 Wp under STC | 40 Wp under STC |
| | The PV module should have crystalline silicon solar cells, and should have humidity, freeze, and damp heat tests certificate conforming to IEC 61215 Edition II / BIS 14286 from an NABL or IECQ accredited Laboratory. | | | | | |
| Battery | Lead acid Sealed maintenance free, 12V-7 AH @ C/20 or NiMH or Lithium-Ion of requisite capacity | Lithium-Ferro Phosphate of 3X 3.2V, 1800 mAh (or requisite e.g. 12.8 x 1400mAh) | Lead acid Tubular flooded or Gel / VRLA, 12V – 12AH @ C/20 | Lead acid Tubular flooded or Gel / VRLA, 12V- 20AH @ C/20 | Lead acid Tubular flooded or Gel / VRLA, 12V- 20AH @ C/20 | Lead acid Tubular flooded or Gel / VRLA, 12V- 40A |
| | The battery must conform to the latest BIS/ International standards. | | | | | |

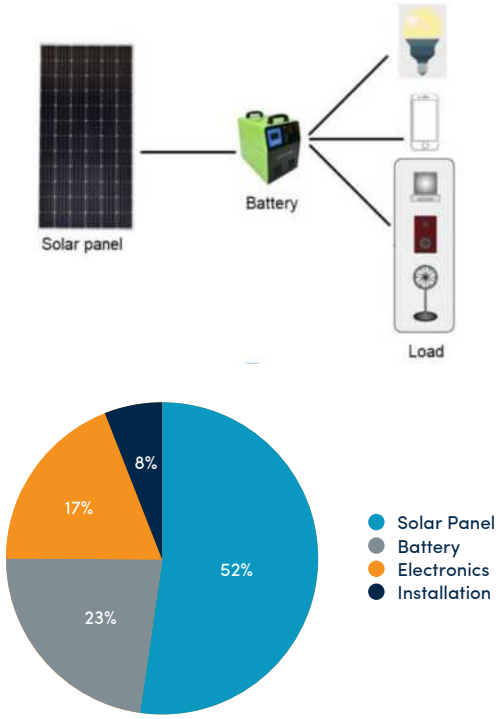
*Source: MNRE, 2021*[68]

68 MNRE (2021), Technical Specification for Solar Photovoltaic Lighting Systems & Power Packs

# 3: Solar DRE Manufacturing in India

**The cost of solar home systems in India is currently between Rs 60,000 to Rs 100,000 per kW, depending upon the number of batteries being used.**[69] For a single battery system which would typically be enough to run a load of two bulbs, a fan, and a mobile charger. With two batteries, the load can be significantly increased to additionally run other appliances, such as television, refrigerator, fans etc. This system cost is indicative of systems that include components imported from China and assembled in India, and those that are locally sourced within India. The price range is largely conformed to by all vendors, with slight variations. The solar panel and battery are the primary costs in a solar home system, accounting for around 75% of the total cost of the system (see Figure 23).

**Figure 24: Anatomy of a solar home system and cost breakdown by %**[70]




## Local Manufacturing Opportunity Analysis: Solar Home Systems

**The manufacturing of solar home systems in India is primarily via the assembly of components into finished products. These exist in all sizes and quality ranges, starting from the top-quality SHS provided by formal manufacturers to the poor-quality SHS products produced by small assemblers. The components are typically procured from China, as India does not have the capacity to provide very small-scale solar modules, batteries etc. required for SHS systems. Therefore, at present, there is significant capacity for assembly of finished SHS products using mostly imported components.**

**The local assembly of finished SHS is not expected to grow rapidly in the short term, as product sales numbers are lower than those for solar lanterns. However, in the medium-to-long term, given the growth in the demand for SHS in India and other countries, domestic assembly may become more attractive.**

## Solar Street Lights

A standalone solar photovoltaic street lighting system (SLS) is an outdoor lighting unit used for illuminating a street or an open area. The components of a solar streetlight are solar photovoltaic (SPV) module, a luminaire, storage battery, control electronics, inter-connecting wires/cables, module mounting pole including hardware and battery box. The luminaire is based on white light emitting diode (W-LED).

### Standards and Specification

In India, solar streetlights are categorized into four models. The configurations of model are as follows:


*Source: Devidayal*

69 Loom Solar
70 EAI

**Figure 25: Configurations of LED-based solar street lights**

| Items | Model-I | Model-II | Model-III | Model-IV |
|---|---|---|---|---|
| PV Module | 40 Wp under STC | 30 Wp under STC | 40 Wp under STC | 30 Wp under STC |
| | The PV module should have crystalline silicon solar cells, and should have humidity, freeze and damp heat tests certificate conforming to IEC 61215 Edition II / BIS 14286 from an NABL or IECQ accredited Laboratory. Module efficiency should not be less than 12% | | | |
| Battery | Lead acid Tubular Flooded or Tubular GEL / VRLA , 12V- 40 AH @ C/10 | Lead acid Tubular Flooded or Tubular GEL / VRLA , 12V- 20 AH @ C/20 | Minimum 160 Wh Lithium Ferro phosphate battery | Minimum 120 Wh Lithium Ferro phosphate battery |
| | The battery must conform to the latest BIS/ International standards | | | |
| Light Output | Minimum 16 Lux when measured at the periphery of 4 meter diameter from a height of 4 meter | Lamp should have two levels of light: Minimum 16 Lux when measured at the periphery of 4 meter diameter from a height of 4 meter. Minimum 8 lux at lower illumination level | Minimum 16 Lux when measured at the periphery of 4 meter diameter from a height of 4 meter | Lamp should have two levels of light: Minimum 16 Lux when measured at the periphery of 4 meter diameter from a height of 4 meter. Minimum 8 lux at lower illumination level |
| Light Source | LED Chip should be compliance to IES: LM-80 | | | |
| Duty Cycle | Dusk to dawn at full brightness | 4 Hours full light, rest of the time at lower light level | Dusk to dawn | 4 Hours full light, rest of the time at lower light level |
| Autonomy | 3 days or Minimum 42 operating hours per permissible discharge | 3 days or Minimum 42 operating hours per permissible discharge | | |

*Source: MNRE*

## Local Manufacturing Opportunity Analysis: Solar Streetlights

**Solar streetlights in India are usually assembled using imported as well as domestically procured components. While the mounting poles and casings are procured domestically, the solar modules, luminaires etc. are usually imported. A few manufacturers provide complete finished solar street-lights, manufacturing most of the components in the value chain. Solar streetlight manufacturing is a developed segment in India.**

**In the short-term, manufacturers are likely to increase component imports to cater to the demand as part of the government initiatives to replace all streetlights with solar streetlights. In the medi-um-to-long term, it may be expected that manufacturers move from only assembly to complete manufacturing of all components required for solar streetlights.**

# 3: Solar DRE Manufacturing in India

## Solar Water Pump

A solar water pumping system consists of motor-pump set, solar photovoltaic module, module mounting structure, tracking system, SPV controller. Solar water pumps have been categorized as a productive-use DRE appliance.

### Standards and Specification

The components of solar water pumping systems need to meet specific standards as per IS/IEC guidelines to be sold in India. Details of these components and standards are provided in Figure 25:

**Figure 26: Details of standards for solar water pumps**

| Component | Standards/Specification |
|---|---|
| Solar PV Modules | Modules shall have certificate as per IS14286/IEC 61215 specifications or equivalent National or International/ Standards.<br>Modules must qualify to IS/IEC 61730 Part I and II for safety qualification testing.<br>Modules must qualify to IEC TS 62804-1:2015 for the detection of potential-induced degradation - Part 1: Crystalline silicon.<br>In case the SPV water pumping systems are intended for use in coastal areas the solar modules must qualify to IEC TS 61701:2011<br>Module to Module wattage mismatch in the SPV array mismatch shall be within ± 3 percent.<br>Variation in overall SPV array wattage from the specified wattages shall be within zero percent to +10 percent |
| Module Mounting Structure | The module mounting structure should be hot dip galvanized according to IS 4759.<br>Foundation can be done either with the help of 'J Bolt' (refer IS 5624 for foundation hardware) or direct pilling, and relevant IS i.e. IS 6403/456/4091/875 should be referred for foundation design |
| SPV Controller | Provision for a reliable DC Circuit Breaker as per IS/IEC 60947-2 suitable for switching DC power ON and OFF within the SPV controller |
| Cables | Selection of the cable shall be as per IS 14536. |
| Earthing Arrangement | Earthing of the motor shall be done as per IS 9283 in accordance with the relevant provisions of IS 3043 |
| Pump-motor set | In case of submersible pump, the external parts of motor should be of stainless steel of grade 304 or higher |

*Source: MNRE*

### Local Manufacturing Opportunity Analysis: Solar Water Pumps

**Solar water pump manufacturing is a matured segment in India. There are multiple high-quality pump manufacturers who cater to the domestic as well as the export market. These manufacturers assemble the pumps with the solar modules and provide them as solar water pumps, primarily for government initiatives.**

**The local manufacturing opportunity for solar pumps is significant. Solar pump manufacturers may see a boost in manufacturing as the demand continues to rise on the back of schemes such as PM-KUSUM. Further, Indian manufacturers are primary providers of high-quality pumps for exports. The manufacturing in this segment is expected to grow considerably over the next few years.**

### BLDC Fans

BLDC (Brush-less Direct Current) fans are energy efficient fans and usually rated 5-star by Bureau of Energy Efficiency. A BLDC fan typically consumes 25-40 watts of electricity, 40-70% less than traditional fans.

**Standards and Specification**

The DC fan manufacturers' needs to comply IS 374:2019 standard for manufacturing energy efficient BLDC fans and adhere to BEE star rating scheme[72].

### Local Manufacturing Opportunity Analysis: BLDC Fans

**BLDC fans have emerged as a strong DRE product. India has a mature market for manufacturing BLDC motors that are a key component of fans. With the government promoting energy efficient technologies, manufacturing of BLDC fans is expected to get a boost. Recently, many leading brands such as Havells, Crompton, Orient etc. have started manufacturing BLDC fans. The local manufacturing opportunity for BLDC fans in India is therefore significant.**

## 3.2 Characteristics of the Indian DRE manufacturing sector

**DRE manufacture in India is focused on the assembly of intermediary components and final products.** As noted above, the manufacture of solar cells and modules and li-ion batteries within India is currently limited. This means that, where DRE manufacture takes place in the country, manufacturers are mostly focused on the assembly of DRE products into larger intermediary components and finished products.

This is done by Original Equipment Manufacturers (OEMs). Indian OEMs both 'white label' products which are then sold to other DRE businesses to brand and sell to consumers or sell products directly to consumers themselves.

**The solar DRE manufacturing market in India has a semi-formalized value chain: a hybrid model of domestic manufacturing and imports.**

**Informal segment:** Most of DRE product manufacturing in India is managed by medium, small, and micro enterprises (MSMEs). Most of these players are part of the informal economy, with only the finished product assemblers being part of the formalized value chain.

**Formal segment:** The larger DRE manufacturers and vendors comprise most of the formal business segment. They commonly import some high-quality components but get other components from the local, informal market segment. They then assemble them to manufacture finished DRE products.

Figure 27 provides the typical features of the formal and informal manufacturing segments for the solar DRE manufacturing market:

**Figure 27: Various aspects of formal and informal manufacturing in India**

| Formal Manufacturing Segment | Informal Manufacturing Segment |
|---|---|
| Large scale enterprises | Small-to-medium scale enterprises |
| Manufacturers/assemblers of branded components and DRE products | Manufacturers of components; act as sub-contractors to formal manufacturing players |
| Own brands and original equipment manufacturers (OEMs) to other brands | Low-end product manufacturing |
| High quality standards | Inadequate quality standards |
| Premium pricing | Discounted pricing |
| Adherence to both domestic and international quality certifications | Poor adherence to quality certifications – often do not have certification or testing procedures |
| State-of-the-art manufacturing equipment | Low-quality equipment |
| Skilled labour | Unskilled labour |

72 BEE (2019), New BEE Star Rating Standards for Ceiling Fans in India

# 3: Solar DRE Manufacturing in India

**Most solar DRE products manufactured in India are assembled using a mixture of components imported from China and components taken locally from informal manufacturers.** This creates a 'semi-formal' DRE manufacturing base. High quality products such as solar modules, batteries, solar cells, rotor blades and glass have a more formalized manufacturing and/or import system in India. Components such as casings, aluminum frames and plastic molds are procured in the informal sector. Figure 28 provides an insight into the components primarily procured from the informal and formal manufacturing segments. Those components or products described as semi-formal are produced using a mix of components from the formal and informal sectors.

**Procurement by retailers, assemblers, or manufacturers from the semi-formal segment of the DRE manufacturing base is the highest in terms of volume, as the semi-formal segment provides the inputs for finished products.** Figure 29 highlights the share of the market from which different components are procured for solar DRE manufacturing in India.

**In terms of revenues, the formal segment has a higher share of the total market (~50% of the market).** This is because the large OEMs typically charge a slight premium for ensuring product quality and durability. Products manufactured in the informal market are priced lower. In terms of revenue, the semi-formal market captures a 30% share of the market, slightly higher than its size by volume (20%). This is due to the mix of high-quality, higher priced, and lower-quality, lower priced components in the products assembled. Figure 30 provides an estimated comparison of the revenue share among the three markets.

**Figure 28: Illustrative categorization of the type of DRE components that are procured in the formal and informal manufacturing segments**

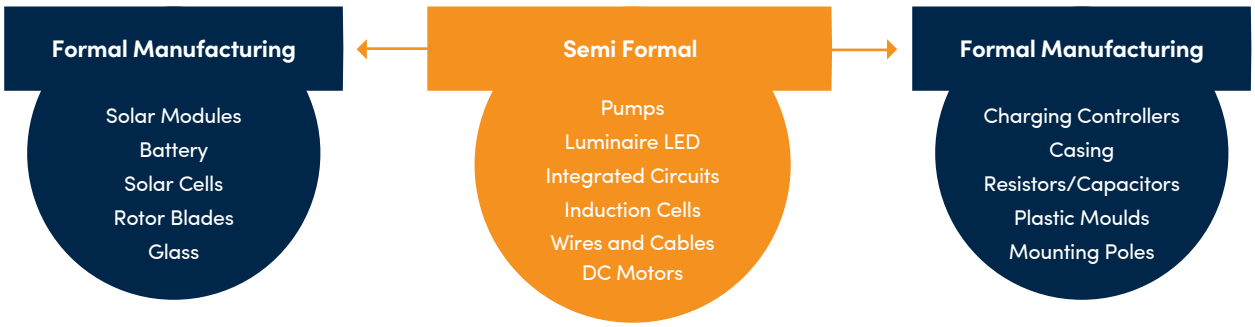
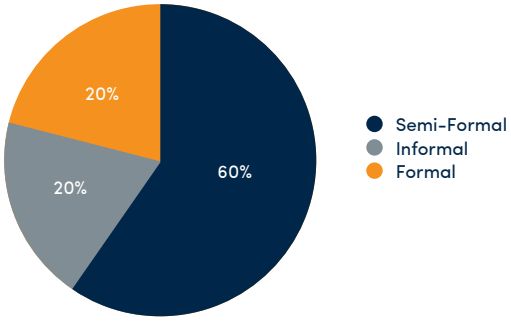
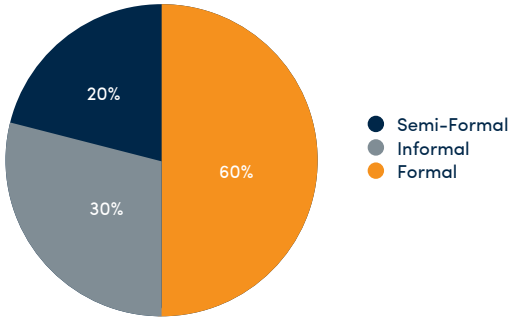



**Figure 29: Market share of components formal, semi-formal, and informal segments for the solar DRE manufacturing market in India**




*Source: Intellecap research*

**Figure 30: Market share of revenue among formal, semi-formal, and informal markets for manufacturing of solar DRE products in India**




*Source: Intellecap research*

73 Intellecap analysis based on primary research

# 3: Solar DRE Manufacturing in India

**Components developed in the informal part of the sector are generally created at a lower quality.** While module manufacturing and retail for large-scale solar projects is largely formalized, the assembly of low-capacity low-quality modules for the DRE market is often undertaken in facilities owned by small-scale enterprises. This leads to the following challenges:

- **Low quality products and reduced impact for consumers:** Vendors in the informal segments provide affordable products, however, to improve margins, these enterprises have little focus on the quality standards of products being imported and seldom follow India's designated quality standards. Customers report that low-quality products have limited lifespans, thus reducing the length of time that they are creating positive impact.

- **Negative perception of DRE:** Prevalence of poor-quality products, especially in the needs-based target market (primarily rural consumers of solar lanterns, solar home systems, and solar pumps, and others that do not have access to good quality electricity) leads to negative consumer sentiment and a general perception that DRE products are unreliable.

- **Investor sentiment:** Experts have often cited poor consumer perception of the market as a challenge in securing investments in the solar DRE manufacturing sector.

Introducing incentives, such as lower taxes for quality products or only allowing products and components tested on quality standards to apply for government orders, would help drive better quality in the informal market. Support in skill building, sourcing, and use of high-quality manufacturing equipment would also be key for building the foundations for greater quality in locally produced products. Such incentives and support could drive up demand for DRE technologies while keeping the costs low, provide better quality and build skills and capabilities within the Indian workforce.

*Source: Simpa Network*

# 4: Analysis of the Enabling Environment for Manufacturing DRE Products in India

## Key Messages

- **There are no specific policy or financial support mechanisms for the manufacture of DRE in India**
- **Given the high price sensitivity of DRE consumers, and India's current inability to manufacture base components for DRE products, import taxes could undermine competitiveness, limit demand, and reduce the incentive for manufacturers to produce DRE products locally**
- **There is little adoption of standards in the informal DRE manufacturing sector today. Enforcement of quality standards for local and imported components and finished products would help to improve quality, durability, and impact for consumers**

## 4.1 Policy Landscape

### Overview

**Supportive policy for manufacturing solar in India currently focuses on large-scale solar products and does not include specific provisions for DRE products.** For example, the recently released Production Linked Incentive (PLI) scheme has provisions for supporting the manufacture of components (solar cells and solar modules) but does not specifically mention the DRE product segment. Most policy initiatives for DRE focus on demand stimulation for solar lighting products. Further demand stimulation initiatives to promote the uptake of products such as solar fans, solar coolers, solar mixer-grinders, and solar irons are expected[74]. However, policies for providing finance for setting-up manufacturing units, tax incentives, testing and certification, and research and development are currently limited in the DRE segment.

**Policy support for greater local production of solar cells and modules and Li-ion batteries may create benefits for the local manufacture of DRE products but the sector may be overlooked if supply is absorbed by adjacent sectors.** For example, the PLI scheme includes manufacturing of Li-ion batteries with an outlay of Rs 18,000 crore (USD 23.5 billion)[75]. Under this scheme, the Government has set a target of setting up manufacturing facilities for around 50 GWh of Li-ion cells. To avail of the benefits of the PLI scheme, manufacturers must commit to developing a minimum annual capacity of 5 GWh and ensure that at least 60% of production comes from the domestic value chain within 5 years. However, most of the Li-ion batteries manufactured with the support of this scheme will be used in the electric vehicles business. Specific efforts may be needed to ensure that the development of domestic Li-ion cell manufacturing capacity can also support the manufacture of DRE products and reduce costs for end consumers.

> There is no preferential market for local manufacturers. The manufacturers from special economic zones (SEZ) get tax benefits and waived off duties that allow them to sell products at lower prices than local manufacturers in and around the demand areas. A plea was filed by the small-scale solar manufacturer association requesting the government to extend similar benefits as provided to manufacturers in the SEZ.
>
> - Small-scale Indian solar module manufacturer

### Taxes and duties

**There are two key taxes levied on solar modules and DRE products: Goods and Service Taxes and Import Duties (Basic Customs Duty).** Due to the price sensitivity of the DRE customer base, these have a significant impact on the sale of solar DRE products in India as they lead to cost increases for the end consumer. Outside of impact on purchasers, there is a tradeoff between higher import taxes and duties making the local manufacture of DRE more competitive with China, and cost increases suppressing demand and reducing economies of scale. The implementation of taxes and duties also has implications on the production of products for the export market. Higher priced products are less competitive on the global market.

74 Framework for promotion of decentralized renewable energy livelihood applications (MNRE)
75 Mint (2021), PLI scheme for Li-ion battery manufacturing

# 4: Analysis of the Enabling Environment for Manufacturing DRE Products in India

## Goods and Service Tax (GST)

**GST is levied in lieu of multiple taxes such as Central Excise, Service Tax, and State VAT that were previously applicable on goods and services (see Figure 31).** Under GST, there are three components: Central GST (CGST), State GST (CGST), and Inter-state GST (IGST). All products sold in India are taxed according to the GST regime. When the supply of goods or services happens within a state, then both the CGST and SGST will be levied. If the supply of goods or services happens between states, known as inter-state transactions, then only IGST is levied. Since solar DRE products are typically targeted at low-income consumers, levying high taxes can lead to increase in costs and reduce affordability which can have a direct impact on the demand and subsequently on manufacturing of solar DRE products.

## Basic Customs Duty (BCD)

**BCD has been imposed on the importation of solar cells (25%) and modules (40%) (see Figure 8).** This was done to achieve the following key objectives:

1. to scale domestic solar manufacturing by making imported products more expensive and making Indian products more competitive in local markets; and,
2. to make India competent in manufacturing high quality products by increasing domestic manufacturing.

This is expected to support India's ambition to become a global manufacturing hub for solar products.

**Earlier taxes in the form of Anti-Dumping Duty (ADD) and Safeguard Duties (SGD) were levied on solar cells and modules from China and other countries.** The SGD at 14.5% was applicable till July 30 2021, and has been removed since. However, the impact of the ADD and SGD (initially at 25%, later reduced to 15%) was limited on utility-scale solar projects as China further reduced the cost of its products and remained competitive despite its imposition[79].

After the imposition of BCD, cost of solar modules is expected to increase by Rs 0.40-0.45 per kWh ($0.0054 per kWh-$0.006 per kWh) (post import of solar modules from China). If solar cells are imported from China to manufacture solar modules domestically, the cost of modules is expected to increase by Rs 0.25-0.30 per kWh[80] ($0.0033 per kWh-$0.0040 per kWh). The impact of BCD is expected to be significant on large-scale solar installations and for the DRE segment as well.

**Figure 31: Summary of GST on solar products in India**

| Products | CGST | SGST | IGST |
|---|---|---|---|
| Solar Pumps | 6% | 6% | 12% |
| Solar Controllers[76] | 18% | 18% | 18% |
| Solar Panels/Modules | 6% | 6% | 12% |
| Solar Inverters[77] | 6% (12% from October 2022) | 6% | 12% |
| Solar Street Light | 6% | 6% | 12% |
| Solar Lanterns | 6% | 6% | 12% |
| Lithium-ion Batteries | 9% | 9% | 18% |
| Printed Circuit Boards | 9% | 9% | 18% |

*Source: Central Board of Indirect Taxes and Customs[78]*

76 GST (2021), GST Rates for Solar Devices
77 GST (2021), GST Rate for Solar Inverters
78 GST (2021), Rates for Other Solar Devices
79 Intellecap analysis based on primary research
80 Renewable Watch (2021) Barriers for Import of Solar Modules

# 4: Analysis of the Enabling Environment for Manufacturing DRE Products in India

**Figure 32: Comparative analysis of import duties on solar products in India**

| Products | Earlier Applicable Safeguard Duty | Basic Customs Duty Applicable from April 1 |
|---|---|---|
| Solar Modules | 25%, later reduced to 14.9% | 40% |
| Solar Cells | 14.5% | 25% |

*Source: MNRE*[81]

**Given the price sensitivity of DRE customers, and the impacts that DRE products bring for energy supply and security for low-income homes and businesses, a staged approach to the imposition of BCD, or exemptions for very small modules, should be considered.** Given the current focus of the Indian solar manufacturing industry on sectors with larger demand profiles, such as commercial-scale solar, this would allow prices of DRE products to remain attractive to consumers until such time the manufacturing base for DRE can grow. This is anticipated to take place after the expansion of the wider solar market has been achieved and once there is greater supply of locally produced solar cells and modules is available.

Taking a phased approach to taxation of solar modules and other solar equipment essential for solar DRE products will ensure three primary objectives:

1. Ensure affordable energy access to the population at the base of the pyramid with limited access to modern forms of energy. The immediate price hike on solar DRE products can be prevented by exempting small-wattage solar modules from BCD, thereby reducing the pressure on enterprises and consumers alike.
2. Ensure use of solar DRE technologies for productive use of energy in rural areas. As the taxes would be lower, the proliferation of solar DRE technologies for applications that improve livelihood opportunities are expected to increase.
3. The demand stimulation owing to reduced taxes may help provide greater volumes for local manufacturing of solar DRE products.

## Demand stimulation policies

**The Ministry of New and Renewable Energy (MNRE) has introduced several schemes to push the demand for solar DRE products such as Atal Jyoti Yojana and PM-KUSUM, focused on solar streetlights and solar water pumps respectively.** The impact of these policies on manufacturing include:

- **Market ecosystem creation**

When products are mandated for use by consumers, a demand ecosystem is developed which provides impetus to the uptake of the product. For example, when the demand for solar pumps was mandated under the PM-KUSUM initiative, it led to an uptake in pumps, solar panels, and controllers. It created a demand for the sub-components from the vendors/suppliers. Similarly, for the solar streetlight initiative, an entire ecosystem was developed that included mounting structures, luminaires, housing, wires and cables, plastic molds, among others.

- **Direct and indirect growth in demand**

As the deployment under government initiatives increases, the benefits of these technologies also become well-known in communities beyond the direct beneficiaries of the initiatives. This creates a phenomenon known as 'demand spill' which encourages adoption of the technology by a greater number of consumers. Therefore, along with a government-mandated market for products, a commercial market also gets created.

*Source: Simpa Network*

81 MNRE (2021) Basic Customs Duty

# 4: Analysis of the Enabling Environment for Manufacturing DRE Products in India

## Testing, certification, and R&D

**While testing and certification policies for DRE exist, implementation has not been effective in the informal market.** This allows low quality products to infiltrate and impact the reliability of DRE products for consumers. Enforcement of quality standards for local and imported components and finished products would help to improve quality, durability, and impact for consumers. Robust quality and the harmonization of standards with internationally accepted certification (e.g., IEC) is also key for unlocking global DRE markets.

**Accessing international markets is extremely cost competitive and companies incur additional costs to both develop, and manufacture products to meet differing national market standards.** Standards for Indian markets remain specific only to India and companies must develop export ready products which require meeting international standards. Increased adoption of internationally aligned standards for the national market will ensure companies avoid incurring additional costs to pursue export markets.

**There is a significant gap in research and development (R&D) of solar DRE products that is needed to ensure better efficiency and durability of the products.** It has been observed that vendors and consumers prefer imported products due to a better look and feel, which has often lacked in products manufactured in India. Therefore, focusing on R&D and increasing the spending on this segment is also imperative to build a world-class manufacturing hub in India.

## Special Economic Zones

**India has established Special Economic Zones for manufacturing, including those for the manufacture of larger solar PV applications.** These zones have different business and trade laws to the rest of the country, and they are developed to increase trade, investment, and employment and can improve the ease of export. To encourage businesses and manufacturers to set up in the zones, enabling investment, tax and trade policies are adopted which apply within their borders. However, the DRE sector is not included in the industries currently supported by SEZ in India.

## Financial Incentives

**Renewable energy is a priority sector in India and yet there are no financial incentives specifically for manufacturers setting up solar DRE manufacturing facilities.** Financial incentives such as low-cost land, corporate tax rebates, manufacturing equipment subsidies etc. are not available for manufacturers leading to poor investor and manufacturer interest in production for the DRE sector. While production-linked incentives are available for solar manufacturing, there is a minimum threshold for setting up a facility which does not help the MSMEs which constitute the bulk of enterprises developing DRE and DRE components. In addition, the equipment required for setting up solar manufacturing facilities is not considered as collateral for borrowing capital. The lack of perception of solar manufacturing as a specialized sector results in a high cost of finance for manufacturers, which leads to low interest in solar manufacturing and manufacturing for the DRE sector.

> For DRE manufacturers, there's a need for easy access to low-cost finance. Subsidies should be provided to reduce challenge of upfront capital investment required in setting up manufacturing facilities. Schemes like Modified-Special Incentive Packaging Scheme (primarily for the electronics sector) are required in the solar sector as well. Moreover, low-cost financing is not available for solar manufacturing facilities. Equipment is not considered as collateral for procuring loans. Banks are reluctant to fund solar manufacturing facilities.
>
> - Large OEM for solar module and DRE products

## Consumer financing

**Despite the relatively low cost of many DRE products, the audience for these technologies are often rural and living on relatively low incomes.** Even where customers may be wealthier and/or purchasing a product to enhance their livelihood, the upfront costs can be prohibitive. Consumer financing is therefore an important aspect of the DRE product ecosystem. Greater access to consumer financing can lead to higher uptake of products and increase the demand for manufacturers, thereby providing economies of scale and reducing product costs.

**Currently, there is little use of the pay-as-you-go (PAYGo) technology in DRE products sold in India, however, this may accelerate the sale of consumer durables and appliances for livelihood generation.** PAYGo can unlock demand for larger, more expensive, DRE productive use technologies

81 MNRE (2021) Basic Customs Duty

and is commonly used in the export market. Given the emerging government focus on DRE for livelihoods generation, support for PAYGo financing may be timely.

### Role of Development Financial Institutions (DFIs) in Financing

**DFIs have been instrumental in developing the solar power market especially through project financing for solar parks and solar rooftop projects.** The initiatives and low-cost funds by DFIs have resulted in enabling extensive growth across these sectors. For example, 750 MW Rewa solar park was supported by The World Bank with technical and financial advisory support from International Finance Corporation (IFC). The enabling environment and crucial role played by the World Bank and IFC provided a comprehensive operational direction to the Rewa solar park. In addition to financing the transmission infrastructure for the solar park, the World Bank also supported key institutional strengthening activities that resulted in participation of private investors. This resulted in significant participation in the tender and reduced tariffs for power purchase agreement. IFC expertise as a transaction advisor enabled successful public-private-partnership structure.

**Similarly, low-cost financing and technical assistance from DFIs may be able to provide a stimulus to the DRE manufacturing sector in India.** Bringing solar DRE manufacturing under the purview of climate financing can unlock low-cost financing available through DFIs for setting up capital-intensive solar DRE product manufacturing enterprises. According to stakeholders, DRE solar manufacturing could be a potential focus area for DFIs considering the benefits involved in promoting the use of domestically manufactured appliances and products. Consumer financing for DRE products may also be an area of interest for DFIs. This may either be done by supporting DRE consumer programs or extending lines of credits to government initiatives and programs.

> If there are large private investors committing capital (equity or debt) and bringing innovative technology along with distribution, then the organization can consider investing in such manufacturing facilities. We provide equity capital in the range of USD 0.5 million and USD 50-100 million. We also provide debt at competitive market standard rates. Additionally, we also provide grant capital. Grant is also provided for technical assistance component supporting large scale manufacturing facilities.
>
> - Senior official of a leading DFI

*Source: Simpa Networks*

# 5: Challenges and Opportunities in the Solar DRE Manufacturing Sector

## Key Messages

- **There is a large opportunity to transform India into a manufacturing hub for solar DRE products. However, there are several challenges that could hamper the growth and development of the Indian DRE manufacturing base**
- **Opportunities include the recent focus on manufacturing by the Indian government, increased freight costs for imported products and increased interest in the diversification of supply chains**
- **Challenges include a lack of incentives, lack of low-cost financing, and low R&D support needed to improve the cost competitiveness of Indian DRE manufacturers. Gaps also exist in skills and standards enforcement**

## 5.1 Opportunity Assessment

The demand for solar DRE products is expected to increase in the coming years, including in the export market and for efficient appliances and productive use applications. This presents a considerable opportunity for the Indian DRE manufacturing sector to grow to help meet this demand. Several opportunities to increase Indian manufacturing in the immediate and the long term exist, including:

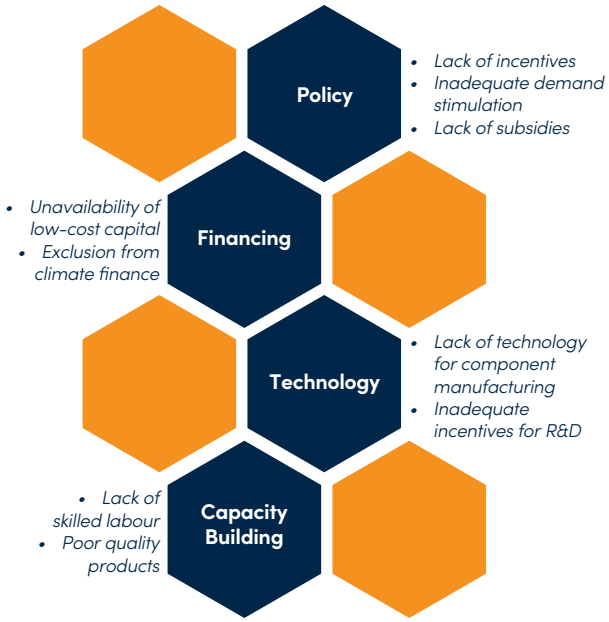
- **Expanded manufacturing base in India:** With initiatives such as 'Make in India' and Production Linked Incentive schemes, the government is focusing heavily on creating manufacturing capacity in India. For the solar DRE segment, this is expected to translate to more cost-effective manufacturing, increase in the domestic procurement of intermediary components creating economies of scale, and better research and development.
- **High interest in diversifying supply chains:** The solar industry, including the DRE segment, is heavily dependent on China. However, following the challenges of the COVID crisis on security of supply, domestic and international manufacturers are exploring opportunities to diversify their supply chains.
- **Competition on pricing and quality:** Increased cost of freight and greater economies of scale that can result from India producing more solar modules and li-ion cells creates an opportunity for India to improve the cost and quality of DRE products manufactured in the country. This would allow India to become globally competitive and be able to avail of even greater economies of scale. Given the lower costs of labour in India, this would be supported by improvements in local skills and capacities for DRE manufacture.

**However, multiple challenges impede the realization of these opportunities.**

## 5.2 Challenge Assessment

**Several challenges exist that impede the growth of DRE product manufacturing sector in India.** The challenges are prevalent across the overall ecosystem that constitutes the fundamentals of manufacturing, as highlighted in Figure 33:

**Figure 33: Key ecosystem-based challenges for solar DRE manufacturing in India**



# 5: Challenges and Opportunities in the Solar DRE Manufacturing Sector

## Policy

- **Lack of incentives:** The solar DRE manufacturing segment is not provided any priority sector lending incentives in terms of lower land costs, production incentives etc. With import duties such as BCD now being levied on solar cells, the manufacturing of DRE product components may become dearer. Further, lack of inclusion of solar DRE manufacturing enterprises specifically in the special economic zones does not allow for incentives to be extended for export of solar DRE products.

- **Inadequate demand stimulation:** The government has launched several demand stimulation initiatives including the Off-grid and Decentralized Solar PV Applications Programme which is aimed at greater adoption of solar lighting systems, Atal Jyoti Yojana (AJAY) for solar streetlights, and PM-KUSUM for solar pumps. While the targets are high, these have not been enough to stimulate large-scale adoption and the demand for DRE products. Moreover, many schemes such as AJAY have been discontinued, overlooking the demand stimulation activities.

- **Lack of support for establishing DRE manufacturing:** Setting up DRE product manufacturing plants is capital intensive, and subsidies/incentives may be able to help manufacturers set up large capacity plants in India. However, lack of incentives/subsidies on capital equipment leads to low interest in setting up manufacturing units.

## Financing

- **Unavailability of low-cost capital:** Setting up manufacturing facilities for DRE products is capital intensive. However, there is unavailability of low-cost capital for manufacturing plant setup that is provided to large scale power projects. Lack of awareness regarding the volume and benefits of domestic manufacturing in India keeps the cost of capital from traditional financial sources high.

- **Exclusion from climate finance:** The low-cost capital provided to power projects as part of climate finance deployment is not extended to DRE product manufacturing. Despite DRE projects using solar modules and other products, the manufacturing of these is not supported through the same pool of climate finance.

## Technology

- **Lack of technology for component manufacturing:** Manufacturers in India import components and assemble them to manufacture the end-product due to lack of availability of technology for manufacturing the components. Inadequate facilities for vertical integration across the value chain leads to low technological advancement and poor opportunities for component manufacturing in India.

- **Inadequate incentives for R&D:** There is limited financing support for R&D in the DRE product segment. The government has recently introduced an R&D policy for renewable energy, but the corpus and the number of projects allocated is very low. R&D to develop technology for manufacturing in India is essential to create a favorable manufacturing ecosystem.

## Capacity building

- **Lack of skilled labour for DRE product manufacturing is an impediment to the growth of the sector.** DRE product manufacturing requires specific knowledge of equipment and technology for greater product precision and quality of solar DRE products. Given the lack of capacity for DRE product manufacturing in India, there are not enough skilled personnel to support the growth of solar manufacturing facilities.

- **Lack of focus on enforcement of quality standards also impacts the quality of products available in the market.** Poor quality products break down frequently and often lead to negative consumer sentiment which can hamper the perspective of the solar DRE product and the segment in the market. Poor quality products may also hamper the export market since exporters in other countries may expect a certain standard of quality from manufacturers in India. Indian companies, therefore, need to adopt international standards and a harmonized quality standard (BIS with VeraSol for e.g.) will save cost for the Indian manufacturers and make their products competitive.

## Risk Mitigation Mechanisms

Key selected risks from the abovementioned challenges have been outlined below with possible mitigation mechanisms. An overview of potential mitigation actions can be found in Figure 34.

# 5: Challenges and Opportunities in the Solar DRE Manufacturing Sector

**Figure 34: Risks involved in solar DRE manufacturing and mitigation mechanisms in India**

| Risk | Possible Mitigation Mechanisms |
|---|---|
| Low demand for DRE products | **Unlock demand in rural areas for lighting and livelihood generation**<br><br>It is perceived that the demand for DRE products in India is low owing to increased electrification. However, there are remote areas in India that still do not have adequate access to electricity and an estimated 3 million people bought solar lanterns or home systems in 2021 to supplement their electricity supply. Most energy poor consumers are concentrated in the rural areas of Uttar Pradesh, Madhya Pradesh, Rajasthan, and Bihar. These are the target areas that can potentially be serviced by DRE products. Further, livelihood generation through solar appliances and consumer durables is a critical market with demand/volumes for manufacturers. |
| Poor quality products | **Lack of enforcement of quality standards in solar DRE manufacturing**<br><br>Lack of quality of solar DRE products can lead to inconsistency in the market and negative perception of the durability of the solar DRE products. This can significantly hamper demand. Mandating certifications, domestic such as BIS and harmonizing with international standards such as IEC (VeraSol), will help in standardizing the quality of products availability in the market. Capacity building of personnel to ensure the quality of solar DRE products is as per the standards is also required. |
| Domestic market does not have enough volumes | **Look beyond domestic Indian market to create an export hub**<br><br>Cost competitive DRE products could be exported to other large markets in Africa, Southeast Asia, and other regions to create demand for manufacturers. Development of an export hub with tax incentives, lower port costs, and seamless export mechanisms can help to build a strong export market for manufacturers. |
| Lack of support from government and private sector for domestic manufacturing of DRE products | **Create taxation benefits for DRE products**<br><br>Awareness around the scale of solar modules required over the next few years for meeting India's solar energy targets, potentially huge demand for consumer durables and appliances, along with the untapped demand in rural areas for solar pumps will help drive policy and financial support for the domestic manufacturing of DRE products and components. Further, taking a phased approach towards taxation by providing short-term exemption to solar DRE products under GST and small-scale solar modules under BCD, will help in stimulating the demand for these products. |
| Lack of policy focus on manufacturing in solar DRE segment | **Policy advocacy to incentivize manufacturing at all levels**<br><br>Policy advocacy for incentivizing domestic manufacturing of DRE products and components may be essential to support DRE products. These could be equipment subsidies, reduced cost of land, development of special solar economic zones with tax incentives, among others. |
| Inadequate enterprise financing for manufacturers | **Including DRE product manufacturing in climate finance and other priority areas**<br><br>DRE product manufacturing may be accorded the benefits that projects are given under the paradigm of climate finance. It includes low-cost blended finance for DRE product manufacturing and setting up state-of-the-art facilities in India. |

Solar manufacturing in India has been adversely impacted by increased import duties on solar components and GST imposition on solar products in recent times. Moreover, quality of solar products manufactured in India is not assured and there's is large inconsistency in the quality of products. There are no mandatory BIS certifications required for retail sales of solar panels in the Indian market. Also, there is no mandate for mentioning quality parameters on the packaging. As a result, there is no way through which consumers can be assured of the product meeting all requisite quality parameters. Some large players do provide quality specifications to the consumer but there is no directive that mandates it.

- Large solar DRE product manufacturer and exporter

# 6: Making India a Solar DRE Manufacturing Hub

## Key Messages

- **To develop a comprehensive and sustainable solar DRE manufacturing sector in India, it is imperative that multi-level solutions are undertaken**
- **Development of competitive advantage over China in terms of technological expertise and skill development is highly recommended to build a secure manufacturing supply chain in India for the sector**
- **Demand stimulation can lead to a greater opportunity for manufacturing by providing higher volumes. It is, therefore, recommended that solar application for DC appliances is encouraged. There is also a key opportunity to increase demand by tapping into the export market in regions such as Africa and Southeast Asia**
- **Specific policy initiatives should be undertaken which may include developing solar economic zones and providing low-cost financing for producers of high-quality DRE products**

## 6.1 Summary of Recommendations

**Several actions would need to be taken to develop a comprehensive DRE manufacturing sector in India that can serve the local and export markets.** Figure 35 highlights some key actions that would support an increase in local manufacturing which are detailed further in Section 6.2.

**Figure 35: Ecosystem-based recommendations for solar DRE manufacturing and exports in India**

| Ecosystem Element | Recommendations | Stakeholders Involved | Tools Deployed | Estimated Time Taken (High/Low) |
|---|---|---|---|---|
| **Competitive advantage** | Develop component manufacturing capacity in India | Technology Enterprises and Manufacturers | Technical assistance and technological R&D | High |
| | Enable semi-formal manufacturing enterprises to become mainstream players | Technology Enterprises and Government of India | Policy changes to develop comprehensive incentive programs | High |
| | Skill development and capacity building | NISE and other agencies | Capacity building and training programs for enterprises | Low |
| | Alignment and harmonizing of standards | BIS and VeraSol | International standards to be adopted by the local standard agencies | Medium |
| **Demand** | Encourage solar application for DC appliances | Technology Enterprises and Manufacturers Government of India and Development Partners | Demand stimulation programs | Low |
| | Encourage solar application for DC appliances | | | Medium |
| **Export** | Tap the large opportunity for exports | Technology Enterprises and Manufacturers | Supply chain development | Low |
| | Promote south-south cooperation | GOGLA | Cooperation studies, mobilization of regional associations and B2B networks | Low |
| | Partnerships/ understanding of quality standards across globe or requirement | GOGLA, VeraSol and IEC | | Low |

# 6: Making India a Solar DRE Manufacturing Hub

| Ecosystem Element | Recommendations | Stakeholders Involved | Tools Deployed | Estimated Time Taken (High/Low) |
|---|---|---|---|---|
| **Policy** | Develop solar economic zones – saves freight costs and time | Government of India | Policy and fiscal support from the Ministry of New and Renewable Energy, Ministry of Finance, NITI Aayog, among others | High |
| | Undertake strategic tax approach | | | High |
| | Incentivize enterprises even at small capacities – PLI lower limit to be removed | | | Low |
| | Provide land and electricity at subsidized rates | | | Low |
| **Financing** | Subsidize or provide low-cost line of credit for solar manufacturing equipment | FIs and DFIs | Greater awareness by climate financiers and DFIs; Financial programs | High |
| | Include solar manufacturing in climate finance | | | Low |

*Source: Intellecap primary research and consultations*

## 6.2 Recommendations

**Develop component manufacturing capacity in India for solar modules and li-ion batteries**

**Recommendations for expanding the manufacture of DRE products in India**

To build DRE component manufacturing capacity in India, the following steps are recommended:

Standardized manufacturing of components, such as solar cells, modules, and li-ion batteries, in line with global standards and certifications, to allow local manufacturers to cater to the domestic and global exports markets
More investment into research and development of components will help to make them more efficient, durable, and cost effective
The development of mass component production capability to achieve economies of scale

**Support informal manufacturing enterprises to become formal players**

India's solar DRE product manufacturing is currently dominated by the informal and semi-formal segments. The business models and technologies used by this segment are not advanced and can result in the manufacture of low-quality products. To bring this segment into the mainstream and take advantage of the already established manufacturing market, the following activities may be considered:

Provide informal manufacturers with updated technology at low cost to enable them to develop better quality products
Provide incentives to encourage informal manufacturers to invest in the manufacture of high-quality products
Provide incentives for each high-quality product sold in the market
Enable a cluster-based approach, where several informal or semi-formal manufacturers are clubbed together to develop a streamlined manufacturing system. Support capacity building to help these manufacturers provide high-quality products that meet quality standards

**Create skill enhancement programs to develop talent at the local and regional levels for solar DRE product manufacturing.**

India has not yet developed a workforce specifically skilled to support the manufacture of DRE products. Capacity building training programs may be developed by institutions in association with the National Institute of Solar Energy (NISE), TERI and other organizations. These courses / training programs can focus on resolving operational skill-based challenges for manufacturers and creating export-quality products.

# 6: Making India a Solar DRE Manufacturing Hub

## Demand stimulation-based recommendations

- **Develop demand stimulation initiatives for solar based DC appliances**

**The market for solar based DC consumer durables for livelihood applications is expected to increase with the recent government focus.** In the initial phases, the market may require demand stimulants as observed in the case of solar pumps or solar streetlights. It will lead to the development of an ecosystem for manufacturing as the demand and the scale for the product increases.

- **Encourage solar-based consumer durables**

**Along with demand stimulation initiatives which can provide an ecosystem and incentives for solar based DC appliances, initiatives to improve adoption around solar-based consumer durables can be undertaken.** These would include building awareness regarding the use of solar-based appliances for consumers and propagating financial and health benefits, providing consumer financing models, and developing business models for enterprises. With greater penetration of solar-based consumer durables into the segment, the solar DRE manufacturing segment will likely get a boost as well.

## Recommendations for increasing solar DRE exports from India

- **Tap the large opportunity for exports**

**In 2021, an estimated 34 million solar lighting products and 5 million efficient appliances and productive use technologies were sold globally, and sales are expected to increase in the coming years.** Alongside India, East Africa already has already developed strong DRE markets and sales are growing in West and Central Africa, with several countries seeing significant scale. DRE is now recognized as a key tool for accelerating the clean energy transition and reaching national and international targets for universal access by 2030. DRE manufacturers in India should explore the opportunity of serving the global market with clean energy technologies.

- **Promote south-south cooperation**

**South-south cooperation between India and the global south, especially in regions such as Southeast Asia and Africa may be developed to increase solar DRE exports.** These programs may include:

Technical assistance to enterprises and distributors for supply chain development
Business model development and replication from India to other countries
Development of conducive freight management policies such as reduction in export taxes from India and lowering of import taxes in target regions

- **Develop partnerships for understanding of global quality standards**

**Industry associations like GOGLA could undertake study tours and knowledge exchange programs to understand global standards used in solar DRE manufacturing.** This will include hands-on training on manufacturing equipment, business models, quality certifications, supply chain process, etc. with the support from the relevant partners. The insights so procured may be inculcated in the enterprise training and skill development programs to develop export-quality solar DRE product manufacturing capability in India.

## Policy-based recommendations for solar DRE manufacturing market

- **Develop solar economic zones**

**The government may consider development of solar economic zones.** This could be in the form of specific economic clusters where solar manufacturers are provided similar facilities as given to special economic zones (SEZs) in India. Some of the benefits[82] provided under the special economic zones in India that may be extended to solar economic zones are:

10-year tax holiday (in a block of the first 20 years)
Exemption from duties on all imports for project development
No foreign ownership restrictions in developing zone infrastructure and no restrictions on repatriation
Income tax holidays on business income
Exemption from import duty, VAT, and other taxes
100% FDI allowed through the automatic route for all manufacturing activities
Procedural ease and efficiency for speedy approvals, clearances and customs procedures and dispute resolution
Simplification of procedures and self-certification in the labor acts
Artificial harbor and handling bulk containers made operational throughout the year

82 Benefits of SEZ in India

In-house customs clearance facilities
Abundant supply of technically skilled manpower and semi-skilled labor across all industry sectors

The solar economic zones may also include manufacturing facilities for batteries, charge controllers, glass, LED luminaires, plastic moulds etc. This co-location of components and finished products will help in creating greater scale, sharing of services, development of synergies, and saving time and costs on freight management.

- **Undertake a strategic tax approach**

**Domestically manufactured solar products in India are more expensive than imported products due to the high manufacturing costs.** Reduction in taxes will improve affordability and provide an equal opportunity for domestically manufactured solar products in India. This may lead to improved adoption of products which can increase the scale for manufacturers.

- **Incentivize enterprises even at small capacities**

**Solar manufacturing in India is largely based in the MSME segment, especially for solar DRE products and components.** Therefore, medium-to-small manufacturers who have small manufacturing capacities or potential manufacturers looking to set up manufacturing facilities with small capacities must also be similarly incentivized as large manufacturers. The lower limit of 1 GW for the Production Linked Incentive may be relaxed for the solar manufacturing segment considering the market structure and medium-to-small capacities may also be brought under its purview.

- **Provide land and electricity at subsidized rates**

**The government may provide land at concessional rates to manufacturers for setting up solar manufacturing facilities in India.** This will help in reducing the cost of setting up the facilities. The cost intensive nature of solar manufacturing facilities is a primary concern for potential manufacturers and investors. The high tariffs of industrial and commercial electricity further exacerbate the cost of production. With subsidized land and electricity support, domestically manufactured products may be able to compete with the low-cost imported products. Further, this may enable manufacturer to setup vertically integrated facilities to manufacture components as well as finished products in India.

## Financing-based recommendations

- **Subsidize or provide low-cost line of credit for solar manufacturing equipment**

**Equipment required for manufacturing solar products is significantly expensive and accounts for around 40% of the total cost of setting up the manufacturing facility[83].** Subsidizing the equipment or providing low-cost lines of credit to manufacturers will help in reducing the cost of setting up solar manufacturing facilities. Further, awareness of traditional financial institutions and banks on the benefits of solar manufacturing in India may help reduce their risk consideration which will help in reducing the overall lending rates. Considering solar manufacturing under the purview of the overall solar sector which has been accorded priority sector lending status will also help in reducing the cost of finance for manufacturers.

- **Include solar DRE manufacturing in climate finance**

**It may be useful to include solar DRE manufacturing, battery manufacturing, and manufacturing of other components under the purview of climate finance.** It will help in diverting low-cost capital to the segment. At present, in the solar sector, only solar power generation projects are provided with the benefits of climate finance. These include low-cost capital, technical assistance by various agencies and institutions, availability of financing through green bonds or solar bonds, and other such tools. Extending these to solar DRE manufacturing will help in reducing overall manufacturing costs and provide domestically manufactured products at lower costs.

*Source: Simpa Network*

83 Intellecap research with primary stakeholders

## 6.3 Impact versus Feasibility Matrix for Recommendations

**The recommendations suggested as part of this report, synthesized from insights gathered from various sources and stakeholders, have been analyzed for their feasibility and impact.** While each of these recommendations is important, understanding the feasibility or ease of implementation and impact of the recommendation can help prioritize them for implementation which can help streamline and speed up transformation.

**The following matrix provides a snapshot of the impact versus feasibility for each of the recommendations that are required to transform India into a solar DRE manufacturing hub.** While this map is done keeping the Indian context in mind, the parameters can similarly be applied and replicated to other geographies, with the mapping of parameters being changed according to the country context.

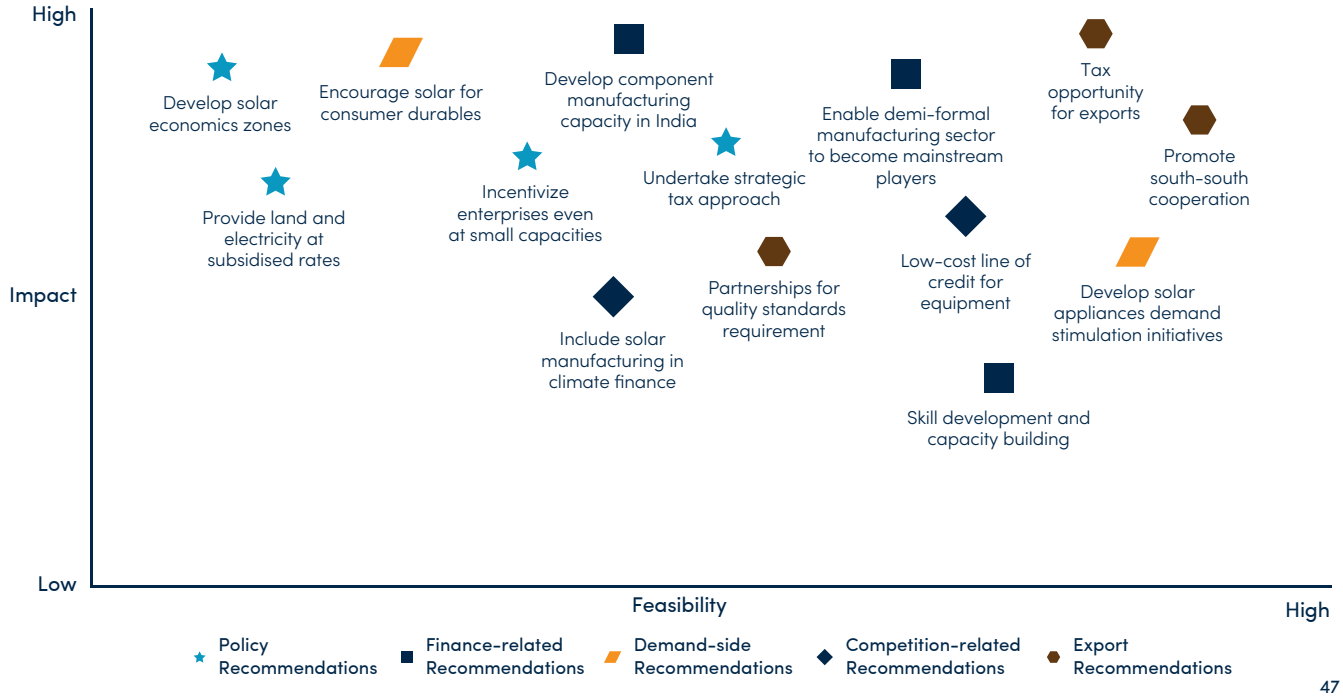
### Impact

**We define impact as the number of stakeholders or stakeholder types that are positively affected with the implementation of these recommendations.** It also defines the scale at which the recommendations can impact the functions of the stakeholders. In other words, impact can be defined as the opportunity cost for the ecosystem, the stakeholders, enterprises, or even consumers if the recommendations were not implemented. In the summary table, we have provided the stakeholders that would be involved in developing the recommendations and the stakeholders that stand to be impacted with the implementation of the recommendation. The matrix helps us further understand how easy it will be for the recommendations to be developed and implemented. Impact has been defined as high and low for mapping the recommendations. High impact recommendations translate to the intervention having a large-scale impact on many stakeholders, whereas low impact would pertain to low-scale impact on a limited number of stakeholders.

### Feasibility

**Feasibility is defined as the ease of implementation of the recommendation.** It is a measure of how extensive or intensive will it be for the implementing agency to execute the processes required for developing the system needed to create the desired impact of the recommendation. Feasibility as a concept is qualitative and underlines the confluence of various executionary aspects – stakeholder coordination, ecosystem changes, challenges in execution, leadership, engagement process, commitment of stakeholders, shared purpose, and planning. In terms of feasibility, the recommendations have been mapped as high and low. High feasibility is defined when the recommendation is easily feasible without multiple systemic changes, while low feasibility is defined as the recommendation that requires various changes, will take greater amount of time in making those changes, and will be relatively more difficult to implement.

**Figure 36: Impact versus feasibility matrix for suggested interventions**



# Annexure 1: Key Case Studies

**The case studies provided here have been designed to provide a bird's eye view into the manufacturing business in India.** Along with a brief overview and profile of the manufacturer, the case studies provide insights into the following:

- A deep dive into the business models undertaken by solar DRE manufacturers
- Geographical reach to determine the export potential
- Supply chain and procurement of essential materials
- Key success factors and future plans

The case studies are aimed at providing the key constituents of developing a successful business to potential entrants into the solar DRE manufacturing sector in India.

## Case study I:

**Ritika Systems Private Limited**

**Ritika Systems is a solar module and DRE products manufacturer.** Its journey over the past 35 years in the solar manufacturing space makes it a classic case of resilience and adaptation in the industry. Its business model allows it to not only sells products under its own brand name but also to cater to other DRE manufacturers as an original equipment manufacturer (OEM), which helps it diversify its revenue streams. Further, it caters to the Indian market while also undertaking exports to neighboring countries such as Nepal and Afghanistan. Understanding the business model, procurement, and exports business of Ritika Solar provides key insights into the functioning of a successful manufacturer in the sector.

*Source: d.light*

# Annexure 1: Key Case Studies

## Ritika Systems Pvt. Ltd.

**Company Profile:**

Ritika Systems Private Limited (RSPL) is a solar module manufacturer, EPC services provider, and also acts as an original equipment manufacturer for its strategic partners. It has a research and development center and a centralized manufacturing hub in Noida, Uttar Pradesh. RSPL designs, manufactures and validates balance of system (BOS) for solar projects. RSPL has participated in 'Lighting a Billion Lives' program and is a supplier of DRE systems to TERI.

**Manufacturing capacity:**

RSPL has a totally solar manufacturing capacity of 40 MW across two facilities – Neemrana, Rajasthan, and Bawal, Haryana.

**Products:**

Solar modules: 3 W to 400 W
Solar street lights
Solar power conditioning unit
Solar home lights
Solar lanterns

**Business models:**

OEM for partners
Solar modules sold under RSPL branded
Participation in government tenders for solar DRE products such as solar lighting systems and solar street lights

**Revenue share of solar module sales:**

As OEMs: 40%
Sales of solar modules under RPSL brand: 60%

**Geographical reach:**

Domestic: Pan-India services
Exports: Nepal, Afghanistan

**Business models:**

OEM for partners
Solar modules sold under RSPL branded
Participation in government tenders for solar DRE products such as solar lighting systems and solar street lights

**Revenue share of solar module sales:**

As OEMs: 40%
Sales of solar modules under RPSL brand: 60%

**Geographical reach:**

Domestic: Pan-India services
Exports: Nepal, Afghanistan

**Success factors:**

Over 35 years of experience
SP1A rated solar organization by CRISIL and SMERA
Control over 70% of value chain – only cells imported from China, rest procured domestically
IEC, ISO, BIS, NISE, TUV certifications – ensures high quality standards
Government approved module manufacturer (part of Approved List of Module Manufacturers)
In-house research and development
High quality systems provided as OEM partner to organizations such as Moserbaer, Tata Power Solar, BHEL, Reliance, Vimal Group, d.Light among others

**Future plans:**

RSPL has plans to expand its module manufacturing capacity to 100 MW and is already in the process of building a new facility along the Yamuna Expressway, Uttar Pradesh.

**Supply chain procurement:**

| Solar cells | Aluminium frame | Glass | Battery |
|---|---|---|---|
| Imported from China | Procured domestically | Procured from Borosil | Procured domestically |

| EVA | Backsheet | Junction Box | Printed Circuit Board |
|---|---|---|---|
| Procured domestically | Procured domestically | Procured from Borosil | Manufactured in-house |

# Annexure 1: Key Case Studies

## Case study II:

**Goldi Solar**

**Goldi Solar is an Indian solar module manufacturer which has quickly become one of the preferred OEMs for many solar DRE product manufacturers.** It now plans to foray into cell manufacturing, becoming one of the few manufacturers in India to do so. Its backward integration into cell manufacturing makes it a relevant case study for manufacturers in India to understand developing value-added capacity across the supply chain.

## Goldi Solar

**Company Profile:**

Goldi Solar Pvt. Ltd. (Goldi Solar) is a solar module manufacturing company with operations in Surat, Gujarat. It was established in 2011. It has also forayed into EPC for solar power projects as well. Goldi Solar is part of the SRK group.

**Manufacturing capacity:**

Goldi Solar has a solar module manufacturing facility in Surat, Gujarat with 500 MW of annual module manufacturing capacity.

**Products:**

Mono and polycrystalline solar modules: 180 W to 320 W
EPC for solar power plants
Building integrated photovoltaics
Bi-facial modules
Earlier supplied solar street lights through government tenders – have discontinued

**Geographical reach:**

Domestic: Pan-India services
Exports: Over 20 countries including USA, UAE, Turkey, Myanmar, Italy, Greece, Germany, France, Denmark and Croatia

**Supply chain procurement:**

| Solar cells | Aluminium frame | Glass | Battery |
|---|---|---|---|
| Imported from China | Procured domestically | Procured from Borosil | Procured domestically |

| EVA | Backsheet | Junction Box | Printed Circuit Board |
|---|---|---|---|
| Procured domestically \| Imported from China | Imported from China | Imported from China | Manufactured in-house |

**Success factors:**

Over 10 years of experience – growth from 10 MW to 500 MW in a decade
IEC, BIS, IECEE certifications
Government approved module manufacturer (part of Approved List of Module Manufacturers)
Robotic production facility
Dedicated R&D lab
Best-in-class power rating
High temperature co-efficient ensures loss minimization

**Future plans:**

Goldi Solar has plans to expand its solar module manufacturing facility to 2.5 GW (2 GW additional annual manufacturing capacity) at its new facility being manufactured in Navsari, Surat, Gujarat, by 2022.

It also has plans to backward integrate and set up a solar cell manufacturing facility of 1 GW by 2023, taking advantage of the PLI scheme

# Annexure 1: Key Case Studies

## Case study III:

**d.light**

**d.light is a global solar technology provider in the form of transformative products, making them available and affordable to low-income families.** Its primary business in India was selling solar lanterns before it ventured into the DC solar home systems over the years. d.light's profile and reach across the Indian as well as the global market makes it a relevant case study for manufacturers.

*Source: d.light*

**Company Profile:**

d.light is a global leader which makes transformative products available and affordable to low-income families. d.light enables reliable power through its solar energy solutions and enables financing with the Pay-As-You-Go model. d.light has sold over 25 million products including solar lanterns, solar home systems, TVs, radios, and smartphones, impacting the lives of over 125 million people.

**Products:**

Solar lanterns
Solar home systems
Solar appliances (fans)
Portable solar chargers

**Geographical reach:**

Domestic: Pan-India services
Exports: Africa, Asia, and Southeast Asia

**Supply chain procurement:**

d.light imports assembled and packaged products from China

**Suggestions on need for manufacturing of DRE products in India:**

High taxes in the form of custom duties and the GST component potentially make imports unviable (with added pressure of reducing margins on businesses). Therefore, d.light suggests that local manufacturing of DRE products must be encouraged to make the solar DRE products more affordable.
Long lead time of 90-120 days to get products from China. This lead time can be considerably reduced to 30-50 days if products are manufactured in India.
d.light suggests that products manufactured specifically for the Indian market may be customized considering the price sensitivity, lack of awareness, and power needs. This may help provide better products which may scale up demand.
Considering the evolving Indian solar market, it may be prudent to develop more manufacturing units for larger power products such as inverters, etc. If the manufacturing is supported at a large scale, it may work to be more responsive to needs of the Indian market.
It is suggested that the enabling ecosystem provides greater support for local contract manufacturers in India (with low-cost financing for SMEs) to research and design products aligned to global requirements and standards.

# Annexure 2: Comparative Analysis with Mobile Manufacturing Industry

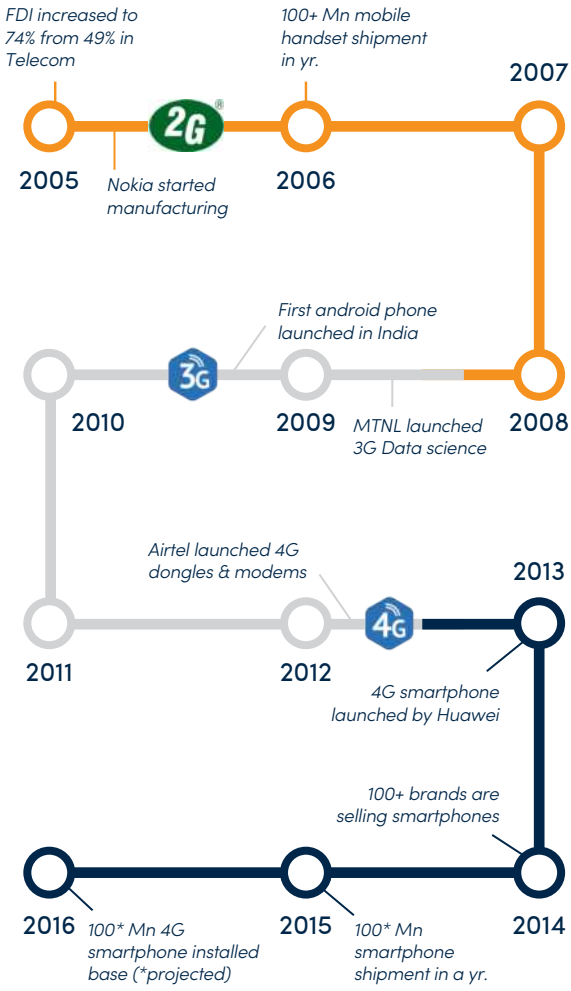
**The Indian mobile phone market grew tremendously during 2006-10.** The demand for mobile phones increased significantly with the introduction of Android smartphones by international players in 2009 and later by domestic players in 2010. The advent of smartphones has propelled the growth in "mobile first" economies such as India.

**The DRE product industry can learn from the mobile phone manufacturing industry considering the similarity in the following aspects:**

- Limited/nil domestic mobile phone manufacturing until about 2005 with most products and components being imported from other countries
- Huge demand from the peri-urban and rural areas
- Price sensitivity amongst lower income customers
- Strong impetus to promote domestic manufacturing to create a sustainable, high quality and low cost supply chain

**The DRE market is currently at the same stage as the mobile phone manufacturing industry was between 2006 and 2010.** In this period, the manufacturing landscape for mobile phones in India experienced huge transition to make them more accessible and affordable for the Indian population. This section captures information on how the mobile phone manufacturing industry has evolved over the years. We have also provided key recommendations parallel to those seen in the mobile phone manufacturing industry for the DRE product segment. Figure 1 illustrates the growth of the Indian mobile phone market and manufacturing base.

**Figure 1: Evolution of the Indian mobile phone market[84]**




*Source: Maximizing Domestic Value Addition in Indian Mobile Phone Manufacturing: A Practical Phased Approach*

## Evolution of domestic manufacturing

**Mobile phone manufacturing has been prevalent in India since 2005.** Large companies like Nokia, Samsung, LG, and Motorola setup their manufacturing plants alongside smaller players such as Elcoteq. While some of those companies exited manufacturing a few years ago, as their own global position deteriorated and their sales volumes reduced, after the announcement of the 'Make in India' program, many other domestic, as well as new international players, have ramped up manufacturing in India.

**During the evolution period of 2005-15, the domestic production of mobile phones peaked in 2012 when Nokia and Samsung dominated the Indian market.** During this time, several small manufacturers setup in the Indian market to provide low-cost handsets to compete with the global brands. This reduced the overall cost of mobile phone ownership. These include Indian brands such as Lava, Micromax, Intex, Karbonn, IBall, among others. The manufacture of portable internet devices such as dongles and modems had also become popular, India became a major export hub for these companies. With the government's "Make in India" initiative brought in with necessary policy reforms, the total manufacturing players reached almost 50 with a combined output of close to 180 million units in 2016.

84 IIM Bangalore (2016), Maximizing Domestic Value Addition in Indian Mobile Phone Manufacturing

# Annexure 2: Comparative Analysis with Mobile Manufacturing Industry

**Figure 2: Mobile manufacturers present in India**


*Source: Maximizing Domestic Value Addition in Indian Mobile Phone Manufacturing: A Practical Phased Approach*

**The Phased Manufacturing Program (PMP) introduced in the Union Budget of 2015-2016 was designed to encourage indigenous production of mobile phones for the global market by offering a different excise duty for domestic mobile manufacturers.** A countervailing duty (CVT) on imports at 12.5% and excise duty at 1% without input tax credit (or 12.5% with input tax credit) were rolled out. In September 2018, the government notified further exemption of customs duties on 35 items used as intermediary goods in mobile phone production to further reduce the cost of local manufacturing[85].

The National Policy on Electronics (NPE) launched by the Indian Government in 2019 also supports the local manufacture of mobile phones and targets a turnover of USD 400 billion by 2025. The three new schemes under NPE 2019 were:

Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors, Production Linked Incentive (PLI) Scheme
Modified Electronics Manufacturing Clusters (EMC 2.0) Scheme

**The mobile manufacturing sector is open for 100% foreign direct investment.** The industry attracted FDI of about USD 235 million in 2018[86]. Companies from China have dominated the list of investors. Organizations such as Oppo, Vivo, and Xiaomi were the prominent Chinese players, while Samsung, Apple and Taiwanese contract manufacturer Foxconn have also invested in India.

**Two out of every three mobile phones sold in India were manufactured in India[87].** Since the launch of the 'Make in India' program by the government, complemented by associated central and state-led incentive schemes, domestic manufacturing of mobile phones has expanded.

It is estimated that over the next few years almost 96% of the phones to be sold in India will be manufactured domestically.[88] It is feasible that these support mechanisms will also help India to become the second largest mobile phone manufacturing hub globally behind China.

85 Economic Times (2018), Exemption of customs duty for 35 items for mobile phone production
86 Policy Circle (2020) India's Mobile Manufacturing Success Story
87 The Mobile India, 66% mobile phones sold in India in 2016 were domestically produced
88 Policy Circle (2020) India's Mobile Manufacturing Success Story

# Annexure 2: Comparative Analysis with Mobile Manufacturing Industry

## Key Recommendations Based on Mobile Manufacturing Industry

**Based on the journey of mobile phone manufacturing in India, the following recommendations can be drawn for application in the expansion of the solar DRE manufacturing sector.**

**Figure 3: Recommendations based on mobile industry for solar DRE manufacturing**

| Ecosystem Element | Recommendations |
|---|---|
| Policy Push | Initial manufacturing will require a strong policy push from the government in the form of initiatives and incentives |
| Budget outlay | Specific budget outlays will be required to develop the solar DRE manufacturing industry. At present the focus is entirely on developing manufacturing capacity for the utility-scale solar power generation segment. There are very few manufacturers/assemblers that serve the complete solar DRE manufacturing value chain. |
| Value chain integration | Development of holistic value chain, including raw materials. Specific policies and standards mandates will be required to develop the complete value chain in India. This was one of the reasons for the mobile telephone manufacturing industry to manufacture products in a cost-effective manner. In the solar manufacturing supply chain, the manufacturing of the raw materials such as wafers and ingots is absent from India, which increases its dependence on Chinese imports. |
| Production-linked incentives | The government introduced PLIs to enable greater manufacturing capacity in the country. A similar exercise has been introduced for the solar module manufacturing wherein utility-scale capacity development has been linked to module manufacturing facilities. However, PLIs in the DRE sector can also be encouraged. |
| Demand stimulants | Demand stimulants can enable economies of scale and reduce cost to consumer. Several demand stimulants and consumer financing models have been introduced in the solar DRE space to encourage its procurement. The domestic mobile manufacturing industry has grown extensively due to the sheer demand of the product across the country. |
| Duties and taxes (to be introduced when domestic manufacturing has achieved sustainable capacity) | In the mobile industry, as well as solar DRE market, Chinese products are significantly cheaper. As a result, domestic assemblers prefer these over the more expensive domestically manufactured products. Duties can be used to support the Indian manufacturing industry once it has developed a sustainable and cost competitive manufacturing base. Tax support can also be provided to encourage the export market. |

# Annexure 3: List of Stakeholders Consulted

## Enterprises

| | |
|---|---|
| 1. | Agni Solar |
| 2. | d.light |
| 3. | Sun King |
| 4. | Dharma Life |
| 5. | Intelizon |
| 6. | Futurepump |
| 7. | Devidayal Solar |
| 8. | Shanti Solar |
| 9. | Shaheb Shiraj industries |
| 10. | Green World Corporation |
| 11. | ALPHA Solar |
| 12. | Aditya Solar |
| 13. | Novasys Greenergy Pvt Ltd |
| 14. | Sungarner |
| 15. | Ignite Solar |
| 16. | Energiaa |
| 17. | Navitas Solar |
| 18. | Shemesh Energy |
| 19. | Prakruthi Solar Systems |
| 20. | Shiv Green Solar System |
| 21. | Sunrays Green Solutions |
| 22. | Sunlite solar |
| 23. | Loom Solar Pvt Ltd |
| 24. | Dynamic Solar |
| 25. | Ritika Systems |
| 26. | Evolute |
| 27. | Goldi Solar |
| 28. | SS Solar |

## Development Partners and Think Tanks

| | |
|---|---|
| 1. | NSEFI |
| 2. | ADB |
| 3. | NITI Aayog |
| 4. | KfW |
| 5. | CEEW |

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The Voice of the Off-Grid Solar Energy Industry