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Challenges to solar cell manufacturing in India

The National Solar Mission was launched in 2010, and along with 100 gigawatt (GW) of solar installations, one of its objectives was to enhance the solar photovoltaic (PV) manufacturing capacity to 4-5GW by 2017. Currently, the Indian solar PV manufacturing sector consists of crystalline Silicon (c-Si) cells and PV module manufacturing. The c-Si technology is expected to dominate the Indian PV sector. The supply chain for c-Si-based PV consists of production of metallurgical grade silicon, polysilicon, ingot, wafer, cells, and finally modules. Cells are the most important component in a PV module; they contribute approximately 55% of the total cost of modules.

India's present module manufacturing capacity is around 5.7GW; however, cell manufacturing is still lagging behind with only 1.4GW of manufacturing capacity. Hence, the domestic cell manufacturing capacity is inadequate to cater to the 5.7GW module manufacturing capacity. The reasons behind the slow growth trend of cell manufacturing capacity additions are unavailability of raw materials, lack of technology know-how, lack of large-scale demand for domestically manufactured cells, and unskilled technical workforce.

Polysilicon is the basic raw material for a cell. It is further processed into a wafer with the addition of a layer of metal conductors, also known as metallisation pastes, to form electrical contacts. Silver and aluminium are used in metallisation pastes.

Polysilicon manufacturing is the most complex process in the entire supply chain. There are three processes to manufacture polysilicon; Siemens process, fluidised bed reactor (FBR) process, and upgraded metallurgical grade silicon process. Currently, Siemens technology is the mostly widely used and it produces polysilicon at higher costs, as compared to other processes. Polysilicon is currently priced at $13 per kg. FBR technology produces polysilicon at a cheaper cost but has challenges in scaling-up to large capacity.

Wafers are processed from polysilicon ingots and the most widely used technology for wafer processing is slurry-based wafer sawing. The current wafer thickness standard in the industry is 180µm. The wafer processing industry requires efficient technology for cutting and storing wafers in a clean room. A very high level of precision and accuracy is needed to avoid damages. Wafer processing facilities are missing in India because the technical know-how is available only with a few countries. Wafers are fully imported by all the cell manufactures in India. In addition, the import duties on raw materials is high, thus it makes sense for them to directly import wafers.

Cell manufacturing involves placing electrical contacts on wafers. Wafers and metallisation pastes are the key components in cell manufacturing. A wafer accounts for about 60% of the cost of a cell. The rest includes the cost of metallisation pastes along with other costs. The metallisation paste is used in cell coating and it plays a crucial role in the performance of a cell. This paste is applied on the front as well as rear sides of a cell. As per current industry standards, around 95 mg of silver is used in a cell for coating.

The lack of demand for domestically manufactured cells is hampering the growth of this industry. The major reason is cost competitiveness; imported cells are much cheaper than domestically manufactured ones. The current price of an Indian cell is ₹17-19/Wp, which is 10-15% more than an imported one. In FY 2015-16, India imported cells worth $2,345 million. Lack of interest in using domestic cells by developers also arises from the fact that India has no quality assurance standards for domestically produced cells.

Another big challenge in indigenous cell manufacturing is the unavailability of upstream supply chain (polysilicon/ingot/wafer) facilities in India. The technical know-how to set-up such facilities in India are lacking. So, collaborations with foreign technology providers are needed to set-up polysilicon manufacturing and ingot/wafer processing facilities in India. In order to reduce our dependence on imports and achieve price competitiveness, India should develop these upstream supply chain facilities. The government can support the industry by providing low-cost finance and low-tariff power, similar to China. Under the ‘Make in India’ initiative, the government could consider incentivising the cell manufacturing industry. Exemptions in import duties and taxes on raw materials should be given to support wafer manufacturing. Cheap wafer imports will encourage domestic cell manufacturing.

To achieve better cost competitiveness, the government should support the facilitation of a vertically integrated c-Si PV module manufacturing facility. Moreover, research and development in innovative and emerging technologies such as ‘direct gas to wafer’ should also be pursued simultaneously.

Efficient technologies for ingot cutting and wafer processing can aid in reducing silicon wastage and hence reduce the cost of wafers. Large-scale deployment of FBR technology will enable the production of silicon at cheaper costs as compared to those produced using Siemens technology. Also, reduction in the usage of silver and cheap alternate materials for metallisation will significantly help in cost reduction.

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