



## Proposed Global & India Market Research Analysis & Demand Assessment of Polysilicon & Monosilane

**Submitted To:**



**Submitted By:**



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## Polysilicon Market Assessment

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## Product Overview:

### Polysilicon

Polysilicon, a high-purity form of silicon, is a key raw material in the solar photovoltaic supply chain. Polysilicon ingots are melted at high temperatures to produce solar modules, which are then sliced into wafers and processed into solar cells and modules. It is a major material used in making semiconductor chips and solar cells. Polysilicon is produced from three processes namely Siemens process, fluidized bed reactor, Upgraded Metallurgical-Grade Silicon Process.

## 4. Polysilicon Demand Supply Scenario Assessment, 2021

### 4.1. Global Overview of Major Producing Countries by Production Output

Region	Country	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
Asia Pacific	India	0	0	0	0	0	0	0	0	10	25
Asia Pacific	China	235	291	337	452	489	556	1006	1106	1521	2011
Asia Pacific	Japan	9	6	6	6	6	6	6	6	6	6
Asia Pacific	Malaysia	10	10	27	27	30	35	35	35	35	35
Asia Pacific	South Korea	3	3	3	3	3	3	3	3	3	3
<b>Asia Pacific</b>	<b>Asia Pacific</b>	<b>257</b>	<b>310</b>	<b>373</b>	<b>488</b>	<b>528</b>	<b>600</b>	<b>1050</b>	<b>1150</b>	<b>1575</b>	<b>2080</b>
Europe	Germany	60	60	60	60	60	60	60	60	60	60
<b>Europe</b>	<b>Europe</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>
<b>Americas</b>	USA	76	76	76	76	76	76	76	76	76	76
<b>Americas</b>	<b>Americas</b>	<b>76</b>	<b>76</b>	<b>76</b>	<b>76</b>	<b>76</b>	<b>76</b>	<b>76</b>	<b>76</b>	<b>76</b>	<b>76</b>
<b>Global</b>	<b>Total</b>	<b>393</b>	<b>446</b>	<b>509</b>	<b>624</b>	<b>664</b>	<b>736</b>	<b>1186</b>	<b>1286</b>	<b>1711</b>	<b>2216</b>

Source: TechSci Research

Polysilicon is the basic semiconductor material utilized in the assembling of the most used kind of solar based photovoltaic (PV) cells as well as the ubiquitous integrated circuit (IC) chips. With expanded significance of environmentally friendly power, the manufacturing of polysilicon worldwide has expanded from hundreds to thousands of tons. Among the major producing countries, China holds around 75% of the total production capacities in the world and is likely to capture 90% market in the forecast period due to massive capacity expansions of Chinese players. These reports should be a reminder for western countries. If these countries did not expand their capacities of polysilicon in the coming years, then would end up depending fully on imports by China for solar related energy. The countries should implement an effective policy or strategy for a non – Chinese solar supply chain, particularly for polysilicon. Other notable countries in Asia also include ASEAN countries such as Malaysia & Japan owing to sumptuous resources of raw silicon and integrated infrastructure of polysilicon purification of value chain.

It is to be noted that though East Asian Countries lead the forefront of production and supply of polysilicon to the prime extent and also have been instrumental in pricing, yet the purity levels obtained by China

based Manufacturers which constitute the bulk of polysilicon production and supply at present are confined only upto 7N purity levels. Purity Levels greater than 7N for fabrication of Mono wafer (ultra-High Efficiency PERC & N-type cells) is only currently being fulfilled by 4 companies i.e., Wacker Chemie AG, REC Silicon, Hemlock Semiconductor & OCI whose technology related upto 11N purification is closely guarded.

#### 4.2. Production Capacity and Actual Production Statistics by Leading Companies, 2021

Company	Capacity (KT)	Production (KT)
Tongwei Company Limited	100	96.52
GCL Poly Energy Holdings Limited	90	87.58
Wacker Chemie AG	80	74.75
Xinte Energy Co	80	73.09
Daqo New Energy Corp	70	67.56
Xinjiang East Hope New Energy Company	40	38.27
REC Silicon	40	36.32
Hemlock Semiconductor Corporation	36	34.13
OCI Company Limited	30	26.42
Asia Silicon (Qinghai) Limited	20	18.33

Source: TechSci Research

From the stated actual production figures in 2021 against total planned capacity, the industry has witnessed an average capacity utilization rate of 94% mainly boosted from China based manufacturers. This is owing to robust demand in domestic photovoltaic cells and modules fabrication as well as supply to export markets.

Non-China based companies have also been focusing on semi-conductor component-based sales coupled with optimization of production in terms using recycled grade apart from virgin polysilicon production as witnessed a marginal dip from industry average rate. Product differentiation in terms of purity levels (upto 11N) is being sought by these manufacturers to cover maximum end use verticals and expand their customer base.

#### 4.3. Demand Supply Gap Analysis (in terms of Actual Production vs. Consumption), 2017-2030

Description	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2029F	2030F
Capacity	393	446	509	624	664	736	1186	1286	1711	2216	2216
Production	374	425	493	543	627	665	1075	1157	1548	2052	2055
Import	26	27	23	14	20						
Export	26	27	23	14	20						
Domestic Consumption by Volume (Kilo Tonnes)	374	425	493	543	627	692	785	917	1089	2369	2934
Demand-Supply Gap	0					-27	289	241	459	-317	-879

Source: TechSci Research

The above table shows the total production capacity available for polysilicon production with the historical and forecasted production figures. According to the data, there will be significant demand supply gap in 2022 as there will not be enough polysilicon manufacturing capacity expansions in the year but in 2023,

surplus in supply of polysilicon is expected as massive solar power capacity expansions are planned in the coming years. It is being opined by industry experts that solar energy is expected to gain greater share of 10% by 2030 as against 2% of global energy source in 2021. Moreover, massive undersupply is anticipated in the years 2029 and 2030 due to rising demand of PV cells would be seen for achieving the net zero emission target by most of the western countries and emerging regional markets of South America and Asia Pacific.

#### 4.4. Overview of major end use verticals and consumers with apparent consumption volume

Photovoltaics is understood to be the major end use vertical with consumption share estimated to contribute over 92% of the overall. The segment is expected to record a CAGR of 16.7% in the forecast period 2022-2030 on the backdrop of investments in solar farms and zero carbon emissions reach initiative by 2050.

Semiconductors on the other hand will also in neck-to-neck with photovoltaics with an estimated CAGR of 15.2 during the forecast period. The demand will be buoyed by defence, aerospace, industrial and automotive electronics in the upcoming years.

#### 4.5. Outline of Imports by Top 10 countries (including India) and Exporting Countries, 2017-2021

##### Top 10 Polysilicon Importing Countries, By Volume (Kilo Tonnes), By Value (USD Million), 2017-2021

Importing Countries	2017		2018		2019		2020		2021	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Japan	2.86	115.65	2.71	109.89	1.84	70.16	1.50	59.86	1.49	66.35
Germany	0.40	10.82	0.13	3.23	0.62	11.22	0.48	16.49	0.61	16.20
China	0.55	8.83	1.25	8.89	0.76	7.20	0.13	4.27	0.21	5.19
USA	0.18	8.73	0.17	10.31	0.16	11.41	0.09	8.27	0.19	12.85
South Korea	0.31	0.39	0.13	0.28	0.26	0.46	0.25	0.39	0.19	0.68
Malaysia	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.85	0.17	1.69
Indonesia	0.10	2.76	0.07	2.58	0.08	1.62	0.05	0.68	0.14	1.78
Brazil	0.04	0.30	0.04	0.28	0.04	0.14	0.03	0.08	0.04	0.13
Vietnam	0.01	1.18	0.02	1.27	0.00	0.63	0.00	0.00	0.03	0.11
Italy	0.01	1.26	0.05	1.35	0.01	0.36	0.00	0.32	0.02	0.10
Others	21.53	333.74	22.02	344.56	18.97	216.94	11.50	128.42	17.08	358.48
<b>Total</b>	<b>25.98</b>	<b>483.67</b>	<b>26.59</b>	<b>482.65</b>	<b>22.75</b>	<b>320.14</b>	<b>14.13</b>	<b>219.63</b>	<b>20.16</b>	<b>463.57</b>

Source: UN Comtrade

Contd....

### Top Polysilicon Exporting Countries, By Volume (Kilo Tonnes), By Value (USD Million), 2017-2021

Exporting Countries	2017		2018		2019		2020		2021	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
China	15.53	294.44	17.35	323.69	15.06	226.14	10.24	170.05	14.84	358.85
USA	5.02	95.22	4.53	84.54	3.40	51.00	1.72	28.59	2.31	55.77
Germany	3.97	75.18	3.58	66.74	2.68	40.26	1.36	22.57	1.82	44.03
Malaysia	0.66	12.53	0.60	11.12	1.21	18.12	0.61	10.16	0.91	22.02
Japan	0.59	11.28	0.36	6.67	0.27	3.28	0.14	2.26	0.18	4.40
South Korea	0.20	3.76	0.18	3.34	0.13	2.76	0.07	1.13	0.09	2.20
<b>Total</b>	<b>25.98</b>	<b>492.40</b>	<b>26.59</b>	<b>496.10</b>	<b>22.75</b>	<b>341.56</b>	<b>14.13</b>	<b>234.76</b>	<b>20.16</b>	<b>487.27</b>

Source: UN Comtrade

### 4.6. India Market Assessment by Domestic Produce vs. Imports in existing and upcoming scenario

Company	2017	2018	2019	2020	2021	2022E	2025F	2026F	2027F	2028F	2029F	2030F
Capacity (KT)	0	0	0	0	0	0	10	10	20	20	25	25
Production (KT)	0.00	0.00	0.00	0.00	0.00	0.00	2.50	4.40	11.40	11.60	14.75	15.00
Import (KT)	0.03	0.02	0.02	0.07	0.00							
Export (KT)	0.00	0.00	0.00	0.00	0.00							
Domestic Consumption (KT)	0.03	0.02	0.02	0.07	0.00	0.01	0.18	1.68	2.31	4.41	6.21	7.57
ASP (USD/Kg)	17.75	14.76	9.87	9.69	26.00	20.53	13.15	12.72	13.00	13.18	13.53	13.81
Demand-Supply Gap (KT)	0					0	2	3	9	7	9	7

Source: TechSci Research

India needs a sustainable, vertically integrated domestic solar manufacturing ecosystem. Dozens of companies are vying to make a mark in the Indian solar sector. Favourable scenarios have generated huge interest for companies to invest in India although currently there has been no production capacity of polysilicon and related solar energy products, but the country has got the huge potential in the solar industry. Some of the key drivers which stimulates the investment in India are-

- Favourable government policy environment
- Augmentation of required demand
- Availability of raw materials
- Easier financing options
- Predicted technological changes

India's solar sector is primarily import dependent of solar equipment from countries such as China, Malaysia, Taiwan, Hong Kong and Singapore. From 1 April 2022, in a move that would make imports costlier and encourage local manufacturing, the Indian government has announced imposition of 40%

basic customs duty (BCD) on solar modules and 25% on solar cells where this move is being seen to replace a 15% safeguard duty currently imposed on imports currently from China and Malaysia. Also to enable as a leading global supplier of in addition to domestic market requirements, the government is also implementing a production-linked incentive (PLI) scheme that offers manufacturers in 10 sectors, including those of high-efficiency solar modules, a total benefits of ₹1.97 trillion. The plan has gained traction with 15 companies considering total investments of around ₹232 billion to build solar equipment manufacturing facilities in the country. This move is also due to the reason that several countries are dumping solar cells and modules to kill the nascent domestic industry

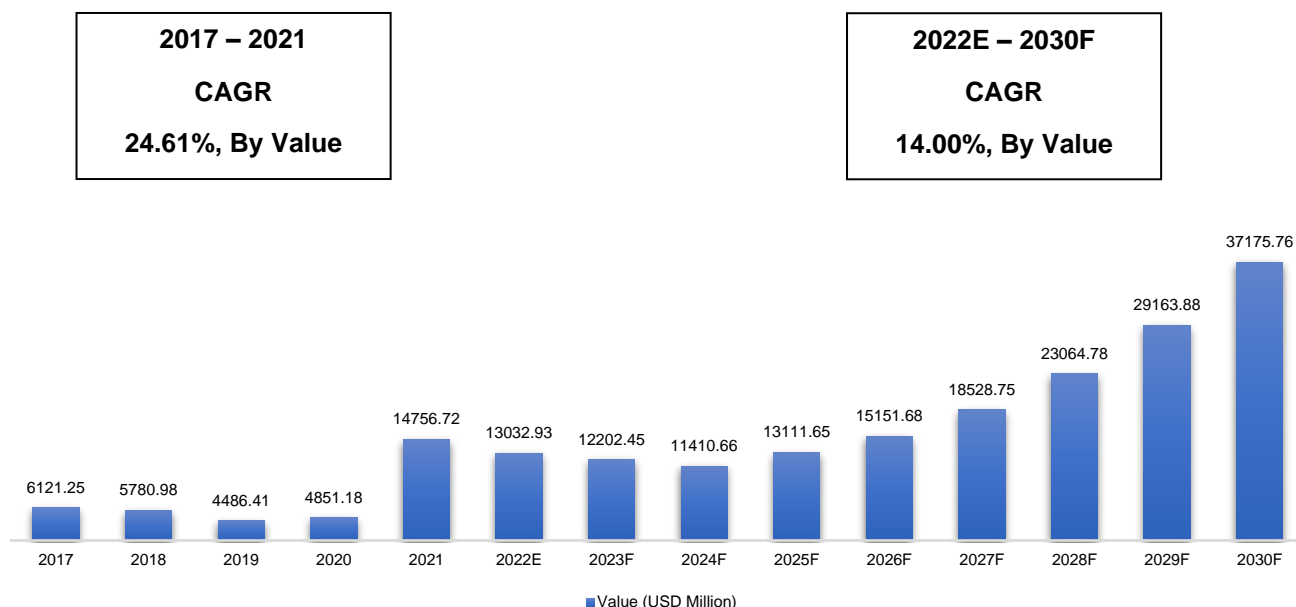


## 5. Global Polysilicon Market Outlook

### 5.1. Market Size & Forecast, 2017-2030

#### 5.1.1. By Value

#### Global Polysilicon Market Size, By Value (USD Million), 2017-2030F



Source: TechSci Research

Global polysilicon market is valued at 14756.2 USD Million in 2021 and is expected to grow at a CAGR of 14.00% in the forecast period reaching to 31175.78 USD Million in 2030. Polysilicon's popularity has grown as its range of applications in solar panels, semiconductors, and electronics has expanded significantly. Due to rapid urbanisation and increased use of renewable energy sources across numerous geographies, solar installations are fast increasing and are likely to spike in the future years.

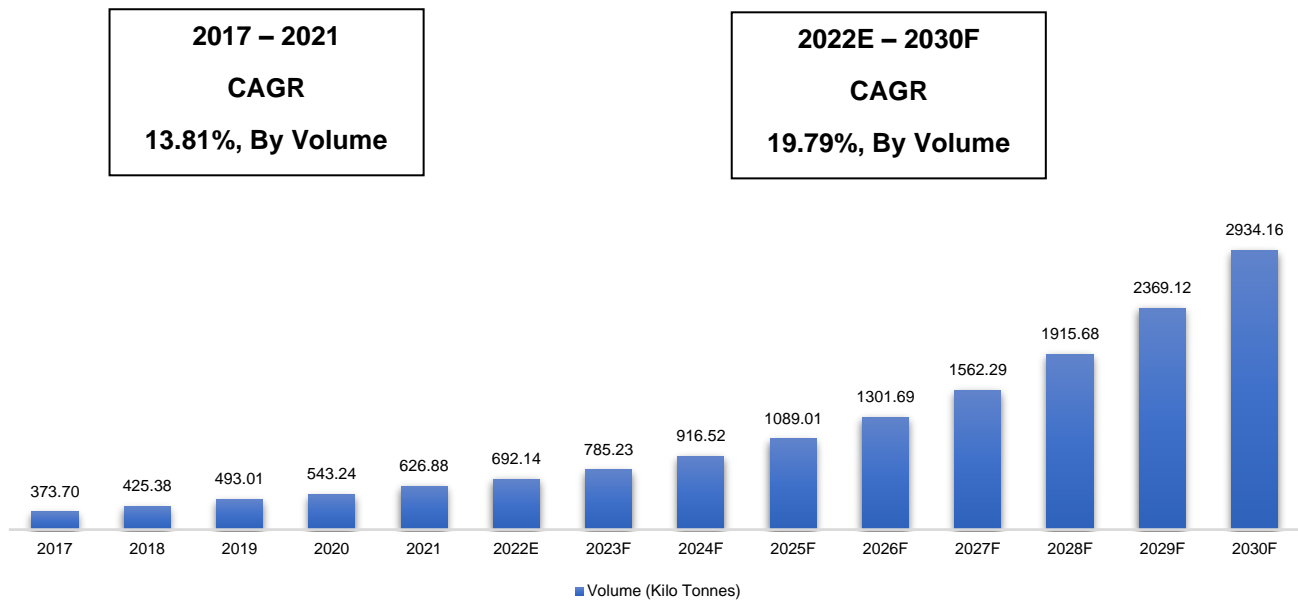
Sustainability has been a dominant trend in recent years, and it has fundamentally transformed the trajectory of numerous industrial verticals. Therefore, Solar PV generation grew by 156 TWh (23%), reaching 821 TWh in 2020. In 2020, it had the second-highest absolute generation growth of any renewable technology, after only wind but ahead of hydropower. Due to looming policy deadlines in China, the United States, and Vietnam, PV capacity increases, reached an all-time high of 134 GW stimulating the utilization of polysilicon which is used as a raw material. In most parts of the world, solar PV is becoming the cheapest choice for electricity generation, which is projected to drive investment in polysilicon manufacturing industry.

Between 2020 and 2030, the Net Zero Emissions by 2050 Scenario shows average annual generation increase of 24%, resulting in 630 GW of net capacity additions in 2030. This nearly fivefold increase in annual deployment until 2030 will necessitate far more policy ambition and efforts from both public and private stakeholders to establish PV supply chain including polysilicon, particularly in the areas of grid

integration and the mitigation of policy, regulatory, and financing challenges, especially in emerging and developing countries.

### 5.1.2. By Volume

#### Global Polysilicon Market Size, By Volume (Kilo Tonnes), 2017-2030F



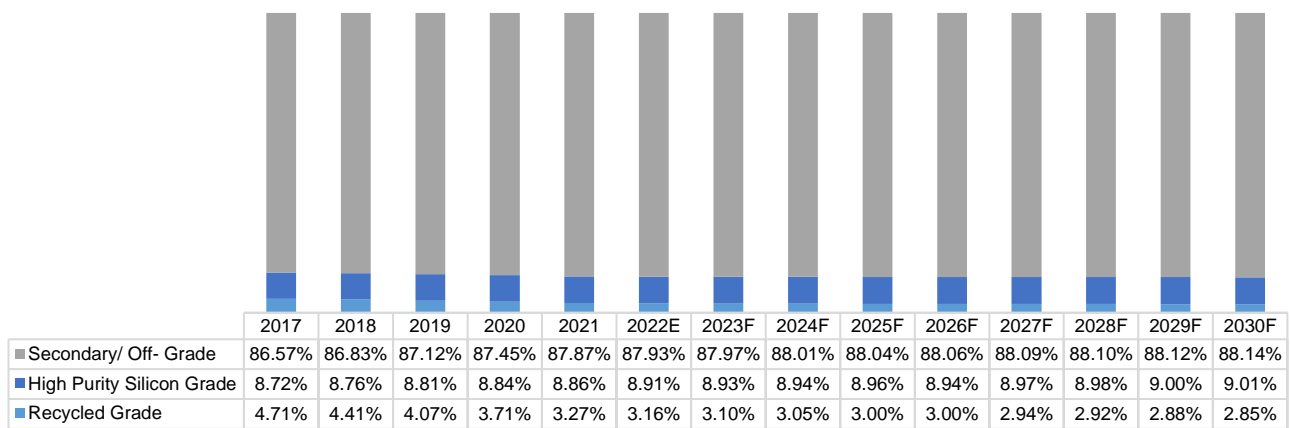
Source: TechSci Research

The market size of polysilicon reached 626.88 Kilo tonnes in 2021 and is expected to reach 2934.88 Kilo tonnes by 2030 growing with a healthy CAGR of 19.79% in the forecast period. This is owing to increased demand for solar cells and electrical semiconductors in the market. Polysilicon was first employed in integrated circuits in the electronics sector. With more solar project installations, the market trend for polysilicon has shifted. The market for polysilicon is rising as solar PV is the fastest-growing industry globally. PV demand is quickly growing over the world because of consumer awareness and government incentives. PV demand is also bolstered by government initiatives aimed at reducing carbon dioxide emissions in nations such as Japan, China, and the United States.

### 5.2. Market Share & Forecast 2017-2030

#### 5.2.1. By Grade (High Purity Silicon Grade, Secondary/ Off- Grade, Recycled)

#### Global Polysilicon Market Share, By Grade, By Volume (Kilo Tonnes), 2017-2030F

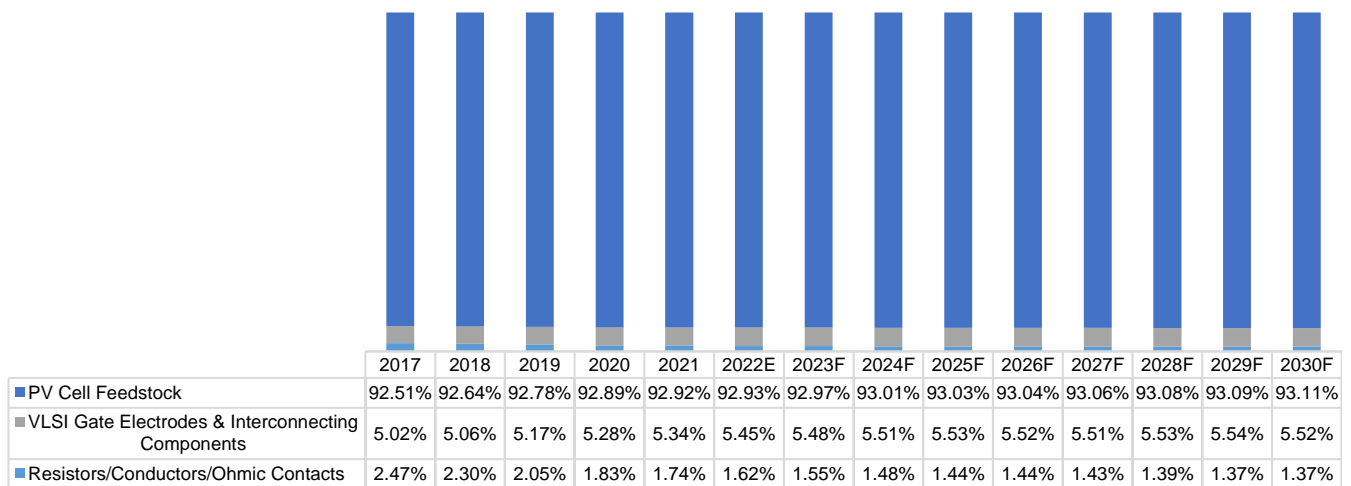


By Grade (KT)	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
High Purity Silicon Grade	33	37	43	48	56	62	70	82	98	264
Secondary/ Off-Grade	324	369	430	475	551	609	691	807	959	2586
Recycled Grade	18	19	20	20	20	22	24	28	33	84
<b>Total</b>	<b>374</b>	<b>425</b>	<b>493</b>	<b>543</b>	<b>627</b>	<b>692</b>	<b>785</b>	<b>917</b>	<b>1089</b>	<b>2934</b>

Source: TechSci Research

### 5.2.2. By Application (PV Cell Feedstock, VLSI Gate Electrodes & Interconnecting Components, Resistors/Conductors/Ohmic Contacts)

#### Global Polysilicon Market Share, By Application, By Volume (Kilo Tonnes), 2017-2030F

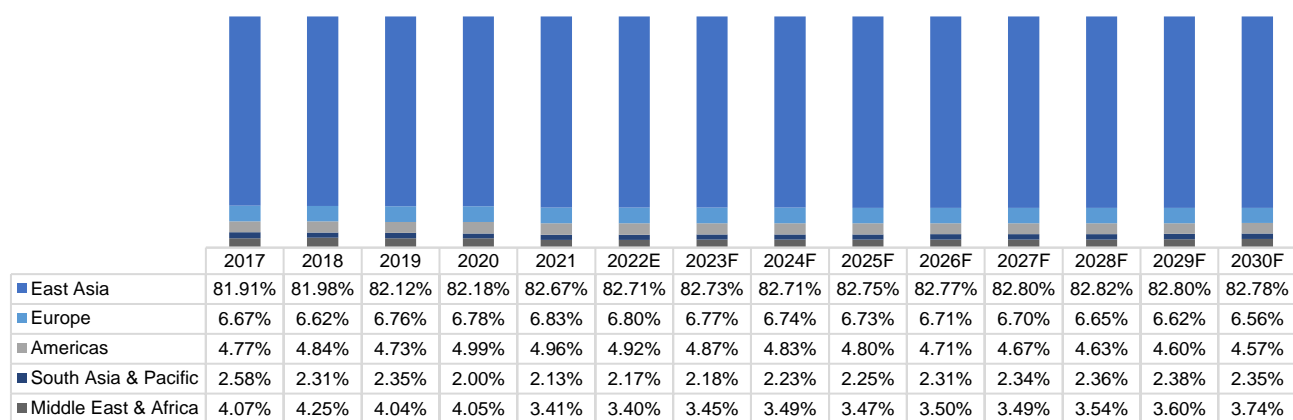


By Application (KT)	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
PV Cell Feedstock	346	394	457	505	582	643	730	852	1013	2732
VLSI Gate Electrodes & Interconnecting Components	19	22	25	29	33	38	43	51	60	162
Resistors/Conductors/Ohmic Contacts	9	10	10	10	11	11	12	14	16	40
<b>Total</b>	<b>374</b>	<b>425</b>	<b>493</b>	<b>543</b>	<b>627</b>	<b>692</b>	<b>785</b>	<b>917</b>	<b>1089</b>	<b>2934</b>

Source: TechSci Research

### 5.2.3. By Region (East Asia, Americas, Europe, South Asia & Pacific, Middle East & Africa)

## Global Polysilicon Market Share, By Region, By Volume (Kilo Tonnes), 2017-2030F



By Region (KT)	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
East Asia	306	349	405	446	518	572	650	758	901	2429
Americas	18	21	23	27	31	34	38	44	52	134
Europe	25	28	33	37	43	47	53	62	73	192
South Asia & Pacific	10	10	12	11	13	15	17	20	25	69
Middle East & Africa	15	18	20	22	21	24	27	32	38	110
<b>Total</b>	<b>374</b>	<b>425</b>	<b>493</b>	<b>543</b>	<b>627</b>	<b>692</b>	<b>785</b>	<b>917</b>	<b>1089</b>	<b>2934</b>

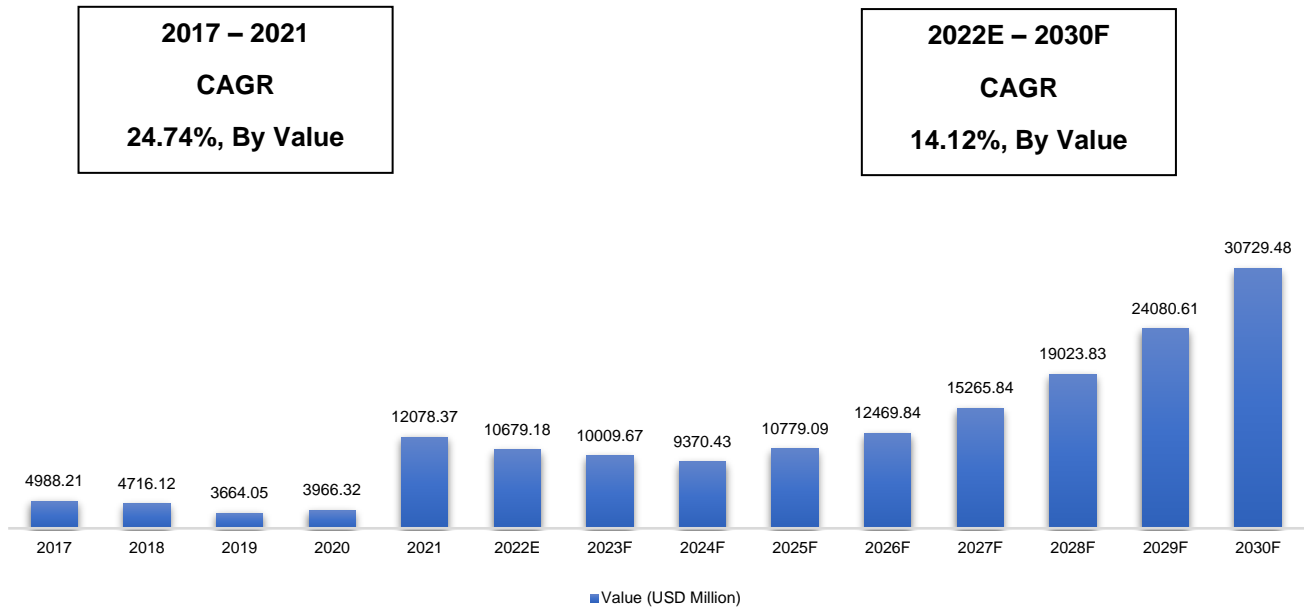
Source: TechSci Research

## 6. Global Off-Spec Grade Polysilicon Market Outlook by Region and Utilization by Application

Secondary Off- Grade has purity level of 6N to 8N and is used usually in manufacturing of solar photovoltaics. The segment is the most consumed grade owing to per MW production requirement of photovoltaic cell.

### 6.1. By Value

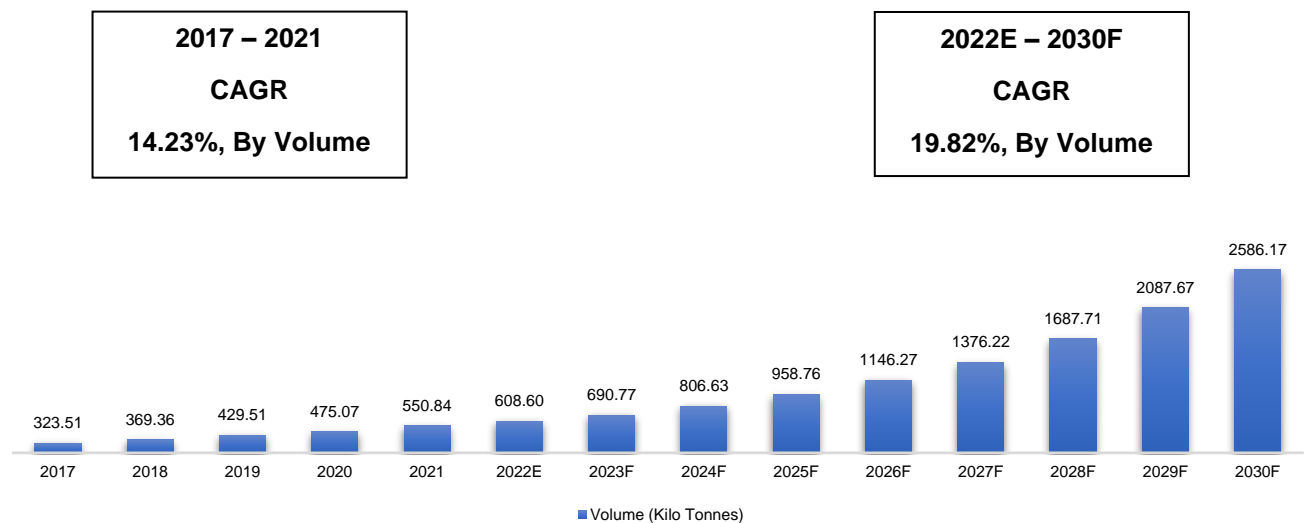
#### Global Off-Spec Grade Polysilicon Market Size, By Value (USD Million), 2017-2030F



Source: TechSci Research

### 6.2. By Volume

#### Global Off-Spec Grade Polysilicon Market Size, By Volume (Kilo Tonnes), 2017-2030F



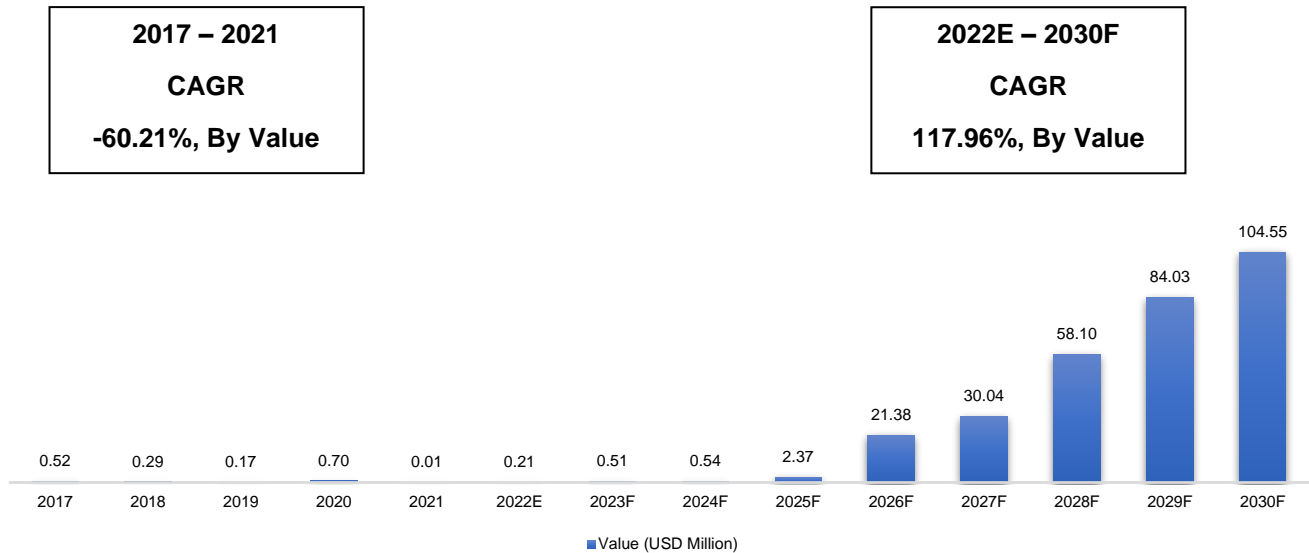
Source: TechSci Research

## 7. India Polysilicon Market Outlook

### 7.1. Market Size & Forecast, 2017-2030

#### 7.1.1. By Value

#### India Polysilicon Market Size, By Value (USD Million), 2017-2030F



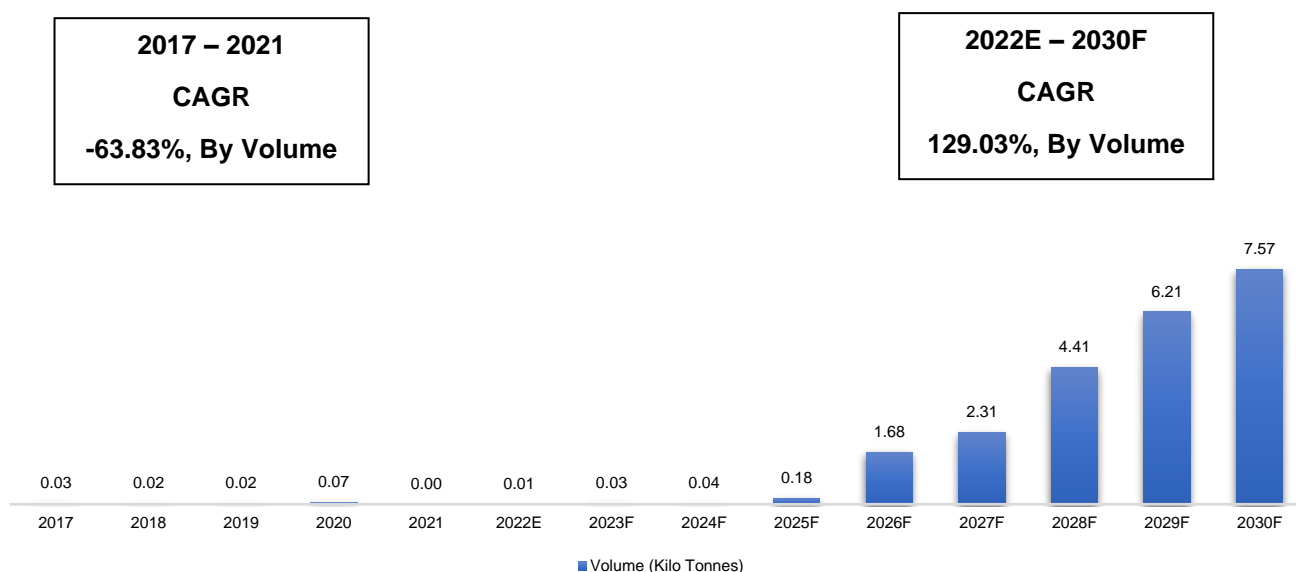
Source: TechSci Research

The overall market size of India is valued at 0.01 USD Million in 2021 and is expected to reach 104.55 USD Million by 2030 growing with a healthy CAGR of 117.69% in the forecast period. Currently, India has no experience in polysilicon manufacturing, but the government of India is assisting the players through production linked schemes & implementation of basic custom duty for imported cells and modules. India has tremendous solar energy potential. India's land area receives about 5,000 trillion kWh of energy each year, with most sections receiving 4-7 kWh per sq. m per day. Solar photovoltaic power may be effectively harnessed in India, allowing for massive scalability. Rural electrification and addressing other energy need for power, heating, and cooling in both rural and urban areas through solar energy will increase the demand of polysilicon in the country in the manufacturing of PV modules and cells.

Moreover, National Solar Mission (NSM), which was launched on 11<sup>th</sup> January 2010, plans to target of installing 100 GW of grid-connected solar power plants by 2022. This is in accordance with India's Intended Nationally Determined Contributions (INDCs) goal of achieving roughly 40% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 and reducing the emission intensity of its GDP by 33 to 35% from 2005 levels. India recently surpassed Italy to take fifth place in the world for solar power deployment. In the last five years, solar power capacity has expanded by more than 11 times, from 2.6 GW in March 2014 to 30 GW in July 2019.

### 7.1.2. By Volume

#### India Polysilicon Market Size, By Volume (Kilo Tonnes), 2017-2030F



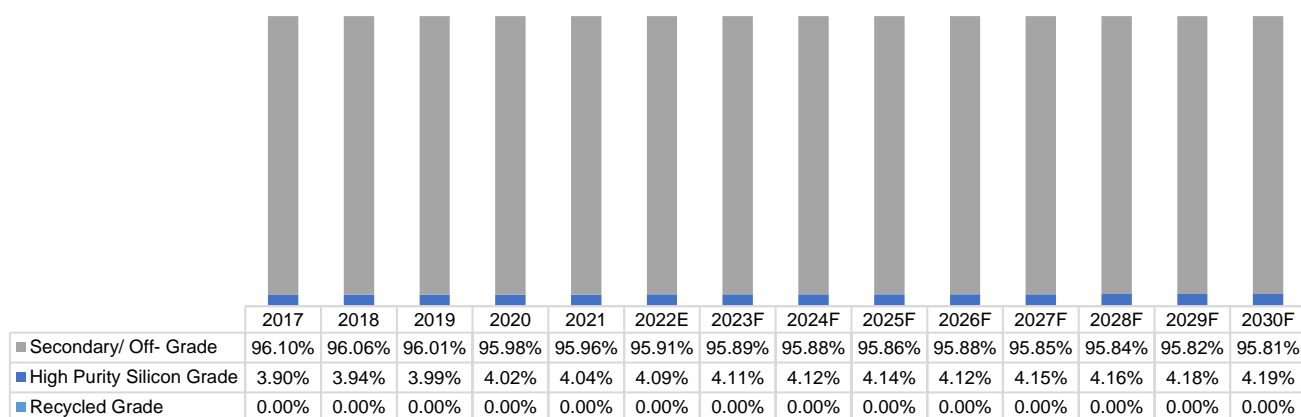
Source: TechSci Research

India polysilicon market by volume is anticipated to reach 7.57 Kilo tonnes by 2030 growing with a healthy CAGR of 129.03% in the forecast period. India plans to install 450 gigawatts of renewable energy capacity by 2030, with solar accounting for the majority of that - 280 GW (nearly 60%). To ensure that the sun shines over the country's dawn sector over the next ten years, roughly 25 GW of solar energy capacity will need to be added each year. The government has taken several initiatives to boost indigenous industry, including raising import duties. However, India's domestic manufacturing capability is currently unable to meet the annual demand for the installation of 25 GW of solar generating capacity. The government has also observed instances of some countries dumping solar cells and modules to undermine the budding home industry, resulting in the imposition of safeguard levies by the government. As stated by Power and New & Renewable Energy Minister R K Singh, India will have around 60 percent of its installed electricity generation capacity from clean sources by 2030. Therefore, to achieve the stated targets, India needs to think about maintaining the PV value chain.

## 7.2. Market Share & Forecast, 2017-2030

### 7.2.1. By Grade (High Purity Silicon Grade, Secondary Grade, Recycled)

#### India Polysilicon Market Share, By Grade, By Volume (Kilo Tonnes), 2017-2030F

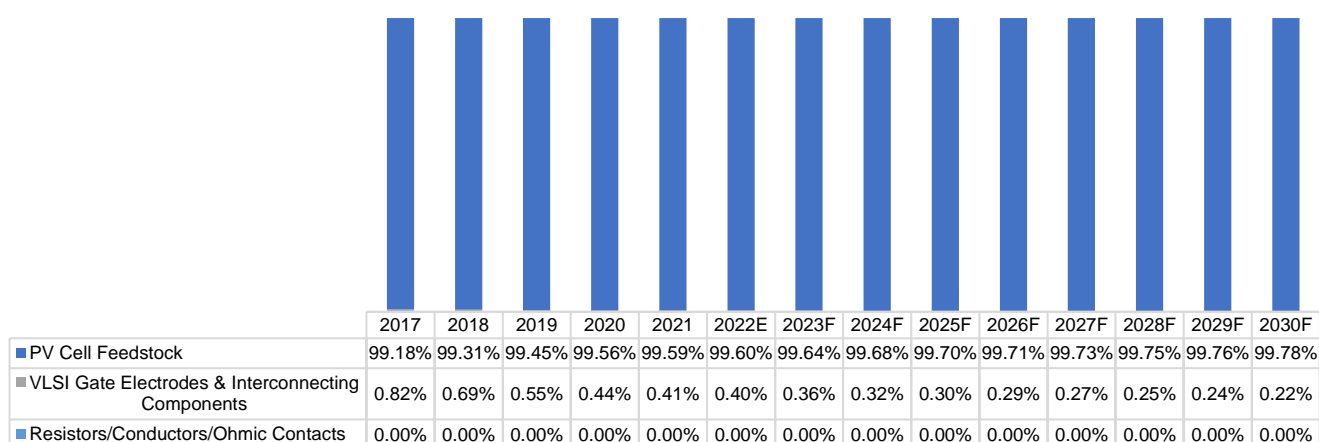


By Grade (KT)	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
High Purity Silicon Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.32
Secondary/ Off- Grade	0.03	0.02	0.02	0.07	0.00	0.01	0.03	0.04	0.17	7.25
Recycled Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>0.03</b>	<b>0.02</b>	<b>0.02</b>	<b>0.07</b>	<b>0.00</b>	<b>0.01</b>	<b>0.03</b>	<b>0.04</b>	<b>0.18</b>	<b>7.57</b>

Source: TechSci Research

### 7.2.2. By Application (PV Cell Feedstock, VLSI Gate Electrodes & Interconnecting Components, Resistors/Conductors/Ohmic Contacts)

#### India Polysilicon Market Share, By Application, By Volume (Kilo Tonnes), 2017-2030F



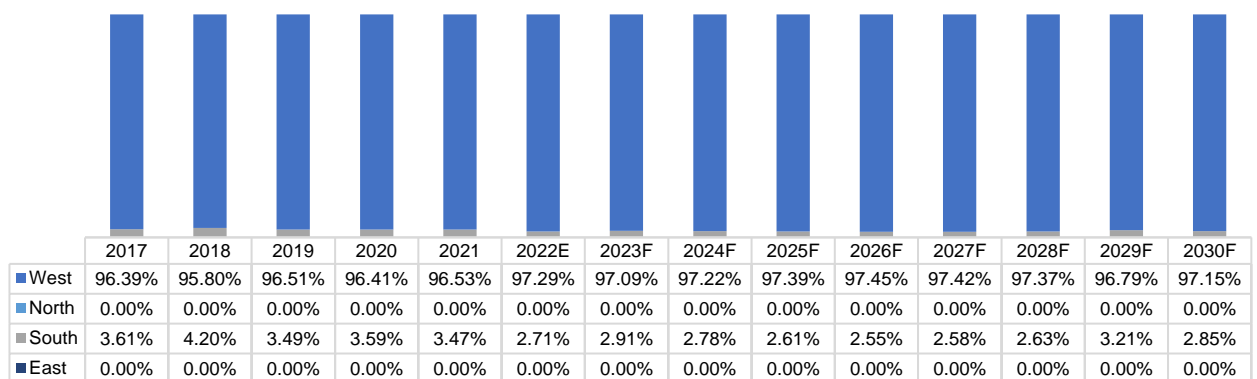


By Application (KT)	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
PV Cell Feedstock	0.03	0.02	0.02	0.07	0.00	0.01	0.03	0.04	0.18	7.55
VLSI Gate Electrodes & Interconnecting Components	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Resistors/Conductors/Ohmic Contacts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>0.03</b>	<b>0.02</b>	<b>0.02</b>	<b>0.07</b>	<b>0.00</b>	<b>0.01</b>	<b>0.03</b>	<b>0.04</b>	<b>0.18</b>	<b>7.57</b>

Source: TechSci Research

### 7.2.3. By Region (North India, West India, South India, East India) Overview of Key States by Each Region

#### India Polysilicon Market Share, By Region, By Volume (Kilo Tonnes), 2017-2030F



By Region (KT)	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
West	0.03	0.02	0.02	0.07	0.00	0.01	0.03	0.04	0.18	7.35
South	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22
North	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
East	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>0.03</b>	<b>0.02</b>	<b>0.02</b>	<b>0.07</b>	<b>0.00</b>	<b>0.01</b>	<b>0.03</b>	<b>0.04</b>	<b>0.18</b>	<b>7.57</b>

Source: TechSci Research

## 7.3. Demand Supply Scenario

### 7.3.1. Overview of Imports by Country of Origin

#### India Imports of Polysilicon Country wise (Value- USD Million, Volume- Metric Tonnes)

Importing Countries	2017		2018		2019		2020		2021	
	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume
China	0.01	0.02	0.00	0.00	0.02	0.01	0.08	0.05	0.00	0.00
Japan	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00
Germany	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
USA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Korea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Others	0.01	0.00	0.08	0.00	0.02	0.00	0.03	0.00	0.00	0.00
<b>Total</b>	<b>0.02</b>	<b>0.03</b>	<b>0.09</b>	<b>0.02</b>	<b>0.04</b>	<b>0.02</b>	<b>0.12</b>	<b>0.07</b>	<b>0.01</b>	<b>0.00</b>

Source: UN Comtrade

China, Japan, Germany, USA, South Korea are the major exporters. In 2020, China exported 51MT of polysilicon in India.

### 7.3.2. Overview of Domestic Producer

In India, the polysilicon market is import-driven, there is not any manufacturing plant for polysilicon in India. In the forthcoming years, the government is planning to establish a manufacturing plant in the country by providing support to the companies through various schemes such as “Make in India” Initiatives, Solar programs, and PLI Scheme.

Four companies, Reliance New Energy, Adani Infrastructure, Jindal India Solar, and Shirdi Sai Electricals proposed to the government for 4GW solar factory that is fully integrated from polysilicon production through the wafer, solar cell, and module manufacturing. Shirdi Sai Electricals received the Letter of Award from the Indian Renewable Energy Development Agency for setting up its integrated 4 GW polysilicon-to-module factory under the PLI (Production-Linked Investment) scheme. The PLI beneficiaries are Shirdi Sai Electricals, Reliance New Energy, and Adani Infrastructure.

Furthermore, Lanco Solar Private Ltd initiated manufacturing of polysilicon in 2011 with a modest production capacity of 1800MT, but due to several untoward circumstances, the company failed to establish itself. With the help of government initiatives, now the company is planning to manufacture 1500 TPA of 99.9999999% pure polysilicon from manufacturing-grade silica using hydrochlorination technology in India. It is the first composite polysilicon plant in India to use manufacturing-grade silica to produce solar-grade polysilicon.

### 7.3.2. Overview of Key Customers

The key customers of polysilicon in India are solar photovoltaic industry, semiconductor industry etc.

Key customers of polysilicon in solar photovoltaic industry:

Company	Location	Types of Production	Production Capacity
Tata Power Solar Systems Limited,	Bengaluru	Solar Modules and Cells	1100 MW
Samsung India	Greater Noida, Uttar Pradesh	Mobile Phone	60 million unit per year 2021.
PLG Power Limited	Nasik, Maharashtra	Multi – Crystalline and Mono-Crystalline Solar Photovoltaic Modules	40 MW
Indosolar Ltd.	Greater Noida, Uttar Pradesh	Photovoltaic Cell	500MW
XL Energy Ltd	Hyderabad, Andhra Pradesh	Solar Module	~75MW
Surana Solar Limited	Gujarat and Telangana	Solar Photovoltaic Modules	5MW each
Bharat Heavy Electricals Ltd	Bengaluru	Solar Module, Semiconductor	465 MW (2021), 65000PV modules per annum (2020)

Waa Solar Ltd	Gujarat	Photovoltaic	10.25 MW
Foxconn India	Tamil Nadu	Smartphone	~48 million per year
Lava International	Noida, Uttar Pradesh	Smartphone & Feature Phone	4 crore feature phones and 2.6 crore smartphones per annum (2021)
Reliance JIO Mobiles	Chennai	Feature Phone	165 million (2020)

Source: TechSci Research

## 8. Polysilicon Production Scenario Assessment

### 8.1. Planned Capacities by Key Countries vs. Actual Capacity Utilization Rate

#### Key Country Planned Capacity Vs Capacity Utilization Rate in 2021:

Country	Planned Capacity	Capacity Utilization Rate (%)
China	489	95%
Japan	6.2	92%
Malaysia	30	88%
South Korea	3	92%
Germany	60	94%
United States	76	94%

Source: TechSci Research

China is a leader in the manufacture of polysilicon that used as raw material in solar panels. There are numerous companies involved in the manufacturing of polysilicon such as Tongwei Company Limited, Daqo New Energy Corp, GCL Poly Energy Holdings Limited, Xinte Energy Co, Xinjiang East Hope New Energy Company, Asia Silicon (Quinghai) Limited are the major manufacturers. The country has the highest planned capacity i.e., 489 with a capacity utilization rate is 95% followed by Japan, Malaysia, South Korea, Germany, and United States.

### 8.2. Product Quality/ Grade and Development Trends

Solar Photovoltaics is a fast-evolving industry, where polysilicon is used as raw materials. Polysilicon is the feedstock for the solar and semiconductor industries. The solar photovoltaics market is optimistic about demand in the foreseeable future. Henceforth, major manufacturers are increasing capital spending and expanding polysilicon production operations to position themselves to capitalize on the growth. Polysilicon manufacturing companies across the globe manufacture polysilicon with the purity levels of 6N to 8N (Secondary/ Off- Grade) for solar photovoltaics, 9N to 11N (High Purity Silicon Grade) for semiconductors. Moreover, these companies manufacture polysilicon with a purity level of 9N as this grade is also used in some premium solar cells.

Nowadays, there is rising trend of recycled polysilicon. The aluminium, glass, and copper from discarded modules are currently recycled all around the world. However, there is no method for recycling silicon solar cells. Researchers from the Fraunhofer Center for Silicon Photovoltaics CSP and the Fraunhofer Institute for Solar Energy Systems ISE, in collaboration with Reiling GmbH & Co. KG, Germany's largest PV module

recycling company, developed a solution in which the silicon in discarded modules is recycled on an industrial scale and reused to produce new PERC solar cells. Now, recycled silicon used in 19.7% efficient PERC Solar cells.

**There are three main technologies to produce polysilicon:**

Siemens Process	Fluidised Bed Reactor Process	Upgraded Metallurgical-Grade Silicon Process
<b>Features and Advantages:</b> <ul style="list-style-type: none"> <li>Siemens process is the most widely used technology to produce high-quality pure polysilicon.</li> <li>This process manufactures polysilicon with a purity level of 9N-11N and uses an energy intensity of 60-80 (KWh/Kg).</li> <li>It requires cycle time of 60-150hrs.</li> <li>This method recycles all the various components in the tail gas, which can reduce the consumption of raw materials.</li> <li>This process is a closed loop</li> </ul>	<b>Features and Advantages:</b> <ul style="list-style-type: none"> <li>A fluidized bed reactor is a less mature technology and is used by a few polysilicon producers.</li> <li>This process manufactures polysilicon with a purity level of 6N-9N and uses an energy intensity of ~55 (KWh/Kg).</li> <li>It does not waste energy by placing heated gas and silicon in contact with cold surfaces.</li> <li>It produces more silicon per cubic meter of reactor space because the silicon crystals have a larger total surface area.</li> <li>It is a continuous process. so, there is less wasted downtime, and do not require setup effort.</li> <li>And finally, unlike the Siemens process which requires the breaking of polysilicon rods, FBR</li> </ul>	<b>Features and Advantages:</b> <ul style="list-style-type: none"> <li>UMG uses physical methods to extract impurities directly from silicon metal instead of chemical processes, which reduces energy usage.</li> <li>Silicon produced using UMG process is not widely used.</li> <li>This process manufactures polysilicon with purity level of 6N.</li> </ul> <b>Disadvantages:</b> <ul style="list-style-type: none"> <li>It has limited capacity.</li> <li>It requires high cost</li> <li>This process does not produce polysilicon of high purity level.</li> </ul>

<p>system, various materials used in polysilicon production are fully utilized and discharged. Hence, there is very little waste.</p> <p><b>Disadvantage of siemens process</b></p> <ul style="list-style-type: none"> <li>It is batch process so there is loss of downtime and require setup effort.</li> <li>This process requires important security measures due to the handling of hydrogen and hydrochloric acid.</li> </ul>	<p>granular is harvested in a ready to use form.</p> <ul style="list-style-type: none"> <li>FBR granular polysilicon can be packaged in bulk containers, increases logistics efficiency.</li> <li></li> </ul> <p><b>Disadvantage:</b></p> <ul style="list-style-type: none"> <li>It requires high cycle time of 60-120 days.</li> </ul>	
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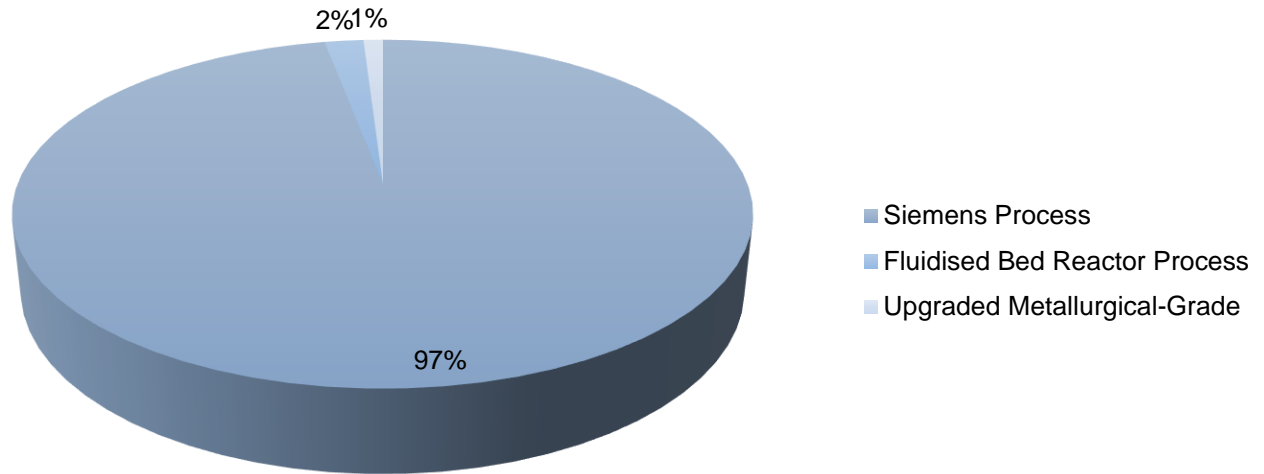
### Technologies with Purity Level:

	6N	7N	8N	9N	10N	11N
<b>Siemens Process</b>						
<b>Fluidised Bed Reactor Process</b>						
<b>Upgraded Metallurgical-Grade Silicon Process</b>						

Source: TechSci Research

	<b>Siemens Process</b>		<b>Upgraded Metallurgical-Grade</b>
	<b>Fluidised Bed Reactor Process</b>		

### Technologies Usage:



Source: TechSci Research

### 8.3. Overview of Production Process and Existing Plant Configurations\*\*

There are three main production method of polysilicon:

- **Siemens process:**

The Siemens Process is the dominant process to produce polysilicon for electronics and photovoltaics from MG-Si. It is similar to distillation, so that silicon reacts with HCl gas in a reactor at about 300°C:  $\text{Si(s)} + 3\text{HCl(g)} = \text{SiHCl}_3\text{(g)} + \text{H}_2\text{(g)}$ . Then the trichlorosilane gas will thermally decompose on heated silicon rods (>1300°) in a hydrogen atmosphere:  $\text{SiHCl}_3\text{(g)} + \text{H}_2\text{(g)} = \text{Si(s)} + 3\text{HCl(g)}$ .

To remove the 0.5% to 1.5% impurities contained in metallurgical-grade (MG) silicon, the siemens process creates trichlorosilane, a highly volatile liquid, as an intermediate product.

For that purpose, MG silicon is ground up into small particles which react with hydrogen chloride (HCl). The resulting TCS has a low boiling point of 31.8 degrees centigrade (°C) so that it can be purified in tall distillation columns relatively easily.

Silicon is then deposited from the TCS on highly pure, slim silicon filaments that are electrically heated to up to 1,150 °C in a steel bell-jar reactor until they have grown to polysilicon rods with a diameter of 15 to 20 cm. This energy-intensive step is called chemical vapor deposition (CVD). The long rods are broken into small chunks. The by-product silicon tetrachloride is recycled to TCS mostly through hydrochlorination: STC is fed along with hydrogen (H<sub>2</sub>) and MG silicon particles into the reactor for TCS production. Depending on how thoroughly TCS is distilled and whether impurities on the surface of the polysilicon chunks are etched off, different levels of polysilicon purity are achieved: solar grade

for multicrystalline cells 7N to 8N, a solar grade for monocrystalline cells 9N to 10N, an electronic grade for semiconductors 10N to 11N.

- **Fluidized Bed Reactor:**

With the Fluidized Bed Reactor process, REC Silicon has taken a major step forward in silicon purification using less energy. Instead of using seed rods, FBR uses seed granules of purified silicon. The seed granules are fed into a chamber that has heated silane gas entering from below and exiting above. The flow of gas “fluidizes” the silicon granules, causing them to flow like a liquid, as the silane gas breaks down and deposits silicon layers on them. The granules grow larger and heavier and exit when they are sufficiently large. As they do so, new seed granules and gas are introduced into the chamber and the process continues.

- **Upgraded Metallurgical-Grade Silicon:**

Unlike in the standard production process for polysilicon, manufacturers of upgraded metallurgical-grade (UMG) silicon do not pursue a chemical route to purify the raw material of metallurgical-grade silicon. Instead, they use physical methods, such as vacuum melting of the silicon metal, blowing of reactive gases through the melt, treating it with slags, leaching of solidified and crushed silicon with acids or directional solidification of molten silicon. All these methods serve to extract impurities directly from the silicon. This method consumes much less energy than the standard Siemens process. Initially, this method only reached a purity of 5N, and then it improved to 6N.

## 9. Polysilicon Usage Assessment

### 9.1. Usage Analysis of Individual Grades by Respective End Use

- **High Purity Silicon Grade:** High purity silicon grade has purity level of 9N to 11N. The high purity silicon grade is used in manufacturing of solar photovoltaics and semiconductors.
- **Secondary Off- Grade:** Secondary Off- Grade has purity level of 6N to 8N. The Secondary Off- Grade poly silicon grade is usually used in the manufacturing of solar photovoltaics.
- **Recycled:** Purity level of recycled polysilicon is not defined. The recycled polysilicon is planned to reuse to produce new PERC solar cells.

### 9.2. Usage Analysis of Polysilicon by Products

#### 9.2.1. Hydrogen

Hydrogen is found as the by-product of polysilicon production. According to the Norwegian polysilicon manufacturer Elkem Bremanger, surplus hydrogen would be suitable for passenger vehicles. Once dried and compressed it could power 1,000 cars per year. The company is working with independent research institute SINTEF to check the quality of hydrogen. In Addition to it, Elkem Bremanger has received funding to develop hydrogen capture technology and to properly use of hydrogen gas to avoid wastage.

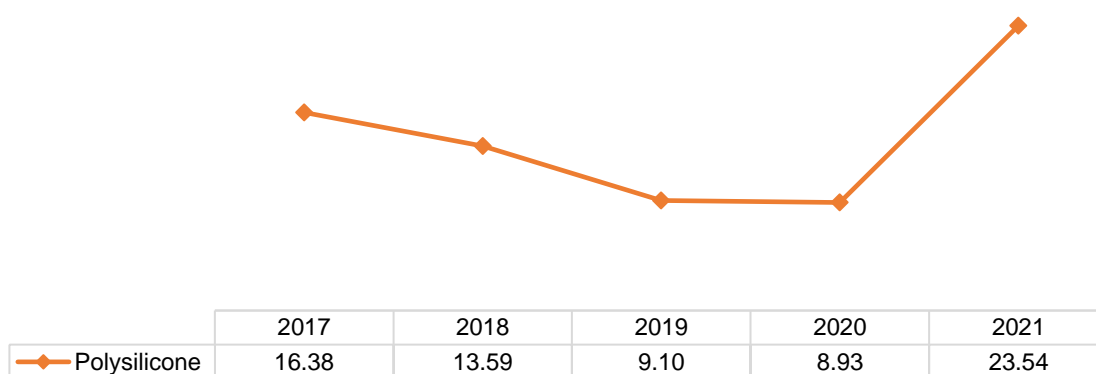
#### 9.2.2. Silicon Tetrachloride

Silicon tetrachloride is a by-product in the production of polysilicon. For each ton of polysilicon produced, at least four tons of silicon tetrachloride liquid are generated. When polysilicon gas plants had production capacities below 1,000 metric tons per year, the by-product gas from both the gas plant and the Siemens deposition reactor was often burned, especially in non-integrated facilities.

Now, by-product silicon tetrachloride is recycled to the hydrochlorination reactor in an integrated plant or distilled and sold as a separate by-product in a non-integrated polysilicon plant. The polysilicon gas plants with production capacities exceeding 10,000 metric tons per year now have the economic incentive to recover the by-product gases and recycle them efficiently to the gas plant in an integrated facility. In a non-integrated plant, current technology allows for 'closed loop' operation by converting STC back to feedstock TCS, which is recycled to the Siemens reactor for polysilicon deposition.

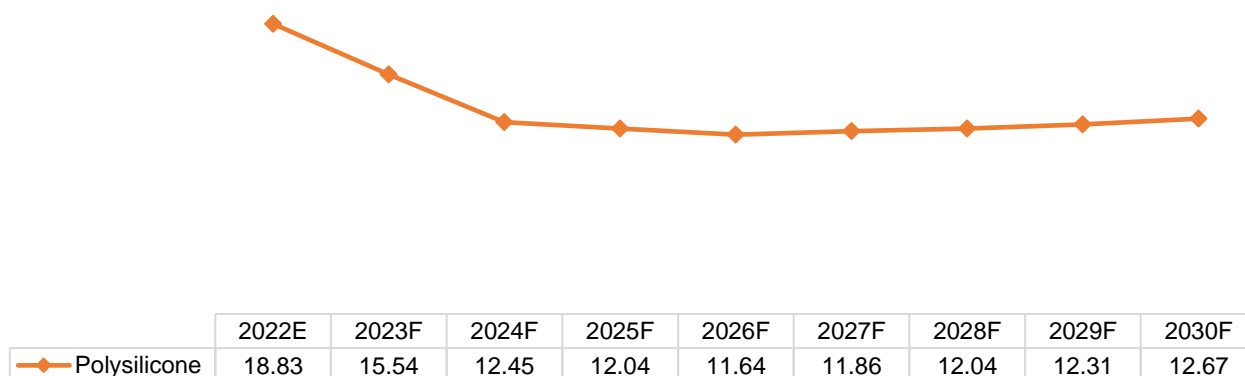
## 10. Polysilicon Pricing Analysis

### 10.1. Historical Pricing Analysis (USD/Kg), 2017 - 2021



Source: TechSci Research

### 10.2. Forecasted Pricing Forecast (USD/Kg), 2022E – 2030F



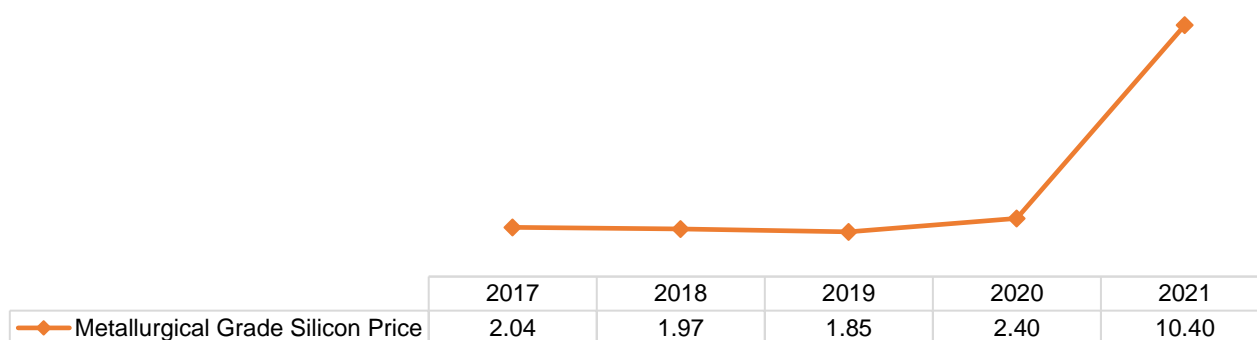
Source: TechSci Research

Polysilicon prices have been steadily climbing since February 2021, reaching new highs in the last four months, with the average selling price reaching peaks without VAT in December. Despite the fact that



polysilicon production in China surged in the first two months of 2022, polysilicon prices are now remarkably high. The surge in the prices have impacted the whole PV value chain of renewable energy. According to the various industry experts the prices are unlikely to fall until 2023. The extended hostilities between Eastern European nations have drastically impacted the trade dynamics and provoked fear of a steep surge in prices among domestic market players, forcing them to build up inventories. Moreover, the ongoing conflict between Russia and Ukraine led to the whole value chain and supply chain disruption. Prices of the materials witnessed a sharp rise due to this conflict. Furthermore, the steep rise in the prices of raw material has also accounted for the surge in price of polysilicon.

### 11. Raw Material / Feedstock Price trends (USD/Kg), 2017 - 2021



Source: TechSci Research

The market proficiency prompted the price decline in the 2018–2020 period. Demand has increased since 2020, and prices have risen as a result. The enormous excess of accumulated manufacturing facilities that would not be employed for several years was projected to restrain price growth to some extent. However, due to a decline in China supply, the price of metallurgical grade silicon increased in 2021. Prices increased by 300 percent from September to October 2021. The drop in production was driven by a Chinese energy crisis that affected nearly half of the country's businesses.

China's new air pollution reduction policy is the reason for the energy scarcity. The Chinese government's objectives to erase carbon footprints by 2060, as well as their commitment to environmentally safe and low-carbon development, are detailed. The coal industry provides 56 percent of China's energy, but the Chinese government has imposed tight environmental restrictions on coal extraction and established peak energy consumption limits across the country. The energy deficit has impacted at least 44% of China's businesses, leading many to shut down, including those producing metallurgical grade silicon.

Because a substantial portion of Chinese metallurgical grade silicon manufacturing facilities are in the Xinjiang Uygur Autonomous Region, the Chinese government's policy toward which has been severely criticised, the price has been heavily influenced by US sanctions. Elkem ASA, a Norwegian manufacturer of silicones, silicon, and other silicon-containing products, has likewise ceased operations. As a result, the

price of metallurgical grade silicon has risen from 1.2–2.6 \$/t to 10.4 \$/t at its peak, and is now between 3 and 4 \$/t.

## 12. Monosilane Demand Supply Scenario Assessment, 2021

### 12.1. Global Overview of Major Producing Countries by Production Output

Region	Country	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
Asia Pacific	China	24	30	33	48	49	74	110	117	161	286
Asia Pacific	Japan	1	1	1	1	1	1	1	1	1	1
Asia Pacific	Malaysia	1	1	3	3	7	7	7	7	7	7
Asia Pacific	South Korea	1	1	1	1	1	1	1	1	1	1
<b>Asia Pacific</b>	<b>Asia Pacific</b>	<b>27</b>	<b>33</b>	<b>38</b>	<b>53</b>	<b>58</b>	<b>83</b>	<b>119</b>	<b>126</b>	<b>170</b>	<b>295</b>
Europe	Germany	7	7	7	7	7	7	10	10	10	10
<b>Europe</b>	<b>Europe</b>	<b>7</b>	<b>7</b>	<b>7</b>	<b>7</b>	<b>7</b>	<b>7</b>	<b>10</b>	<b>10</b>	<b>10</b>	<b>10</b>
<b>Americas</b>	<b>USA</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>12</b>	<b>12</b>	<b>12</b>	<b>12</b>
<b>Americas</b>	<b>Americas</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>8</b>	<b>12</b>	<b>12</b>	<b>12</b>	<b>12</b>
<b>Global</b>	<b>Total</b>	<b>42</b>	<b>48</b>	<b>53</b>	<b>68</b>	<b>73</b>	<b>98</b>	<b>141</b>	<b>148</b>	<b>192</b>	<b>317</b>

Source: TechSci Research

### 12.2. Production Capacity and Actual Production Statistics by Leading Companies, 2021

Company	Capacity (KT)	Production (KT)
REC Silicon	10	9.18
Wacker Chemie AG	6	5.48
Linde	5	4.67
Air Liquide	4.8	4.36
GCL Poly	4	3.59
Inner Mongolia Xingyang Technology	3	2.72
Shin-Etsu	3	2.77
Mitsubishi Gas Chemical Company, Inc.	3	2.78
GT Advanced Technologies	3	2.79
Youser Group Joint Venture	2	1.80

Source: TechSci Research

### 12.3. Demand Supply Gap Analysis (in terms of Actual Production vs. Consumption), 2017-2030

Company	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2028F	2029F	2030F
<b>Capacity</b>	42	48	53	68	73	95	141	148	192	248	317	317
<b>Production</b>	39	45	50	53	67	83	124	129	168	229	285	290
<b>Import</b>	2.65	1.69	2.44	1.67	2.67							
<b>Export</b>	2.65	1.69	2.44	1.67	2.67							

<b>Domestic Consumption by Volume (Kilo tonnes)</b>	39	45	50	53	67	77	89	105	127	240	301	382
<b>Demand-Supply Gap</b>	0					6	35	24	41	-10	-16	-92

Source: TechSci Research

## 12.4. Overview of major end use verticals and consumers with apparent consumption volume

## 12.5. Outline of Imports by Top 10 countries (including India) and Exporting Countries, 2017-2021

### Top 10 Monosilane Importing Countries, By Volume (Kilo Tonnes), By Value (USD Million), 2017-2021

Importing Countries	2017		2018		2019		2020		2021	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
Brazil	0.03	0.71	0.03	0.65	0.04	0.57	0.05	0.51	0.51	1.09
Belgium	0.23	0.88	0.27	0.89	0.31	0.87	0.35	0.76	0.44	1.01
China	0.32	0.87	0.38	0.91	0.36	0.86	0.33	0.72	0.36	1.04
Sweden	0.24	1.05	0.27	1.07	0.26	1.04	0.23	0.97	0.32	1.18
USA	0.27	3.14	0.25	3.16	0.20	3.08	0.17	3.01	0.25	3.73
Canada	0.17	1.05	0.13	1.12	0.10	1.04	0.07	0.98	0.18	1.14
Germany	0.15	4.25	0.12	4.13	0.09	3.93	0.06	3.76	0.17	4.52
Italy	0.12	1.29	0.10	1.17	0.07	1.14	0.05	1.02	0.16	1.86
Japan	0.08	4.18	0.06	4.15	0.04	4.03	0.02	3.91	0.10	4.91
United Kingdom	0.07	0.48	0.05	0.51	0.04	0.46	0.01	0.34	0.10	0.95
Others	0.97	0.55	0.03	1.91	0.93	1.55	0.33	1.58	0.09	0.40
<b>Total</b>	<b>2.65</b>	<b>18.45</b>	<b>1.69</b>	<b>19.67</b>	<b>2.44</b>	<b>18.57</b>	<b>1.67</b>	<b>17.56</b>	<b>2.67</b>	<b>21.83</b>

Source: UN Comtrade

### Top Monosilane Exporting Countries, By Volume (Kilo Tonnes), By Value (USD Million), 2017-2021

Exporting Countries	2017		2018		2019		2020		2021	
	Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
China	1.54	29.80	1.03	32.73	1.51	22.97	1.02	17.37	1.73	36.25
USA	0.55	9.88	0.31	8.81	0.45	5.46	0.28	3.22	0.46	5.94
Germany	0.41	7.88	0.24	7.03	0.27	4.39	0.28	2.62	0.35	4.76
Malaysia	0.07	1.61	0.06	1.47	0.18	2.17	0.06	1.38	0.09	2.56
Japan	0.06	1.49	0.04	1.03	0.03	0.69	0.01	0.59	0.03	0.80
South Korea	0.02	0.74	0.02	0.69	0.01	0.64	0.01	0.47	0.01	0.58
<b>Total</b>	<b>2.65</b>	<b>51.40</b>	<b>1.69</b>	<b>51.77</b>	<b>2.44</b>	<b>36.32</b>	<b>1.67</b>	<b>25.64</b>	<b>2.67</b>	<b>50.89</b>

Source: UN Comtrade

## 12.6. India Market Assessment by Domestic Produce vs. Imports in existing and upcoming scenario

Company	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2026F	2027F	2028F	2029F	2030F
Capacity	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Import (KT)	0.00	0.00	0.01	0.00	0.02									
Export	0.00	0.00	0.00	0.00	0.00									
Domestic Consumption by Volume (Kilo Tonnes)	0.00	0.00	0.01	0.00	0.02	0.03	0.07	0.10	0.21	1.75	2.57	5.21	6.87	7.96
Demand-Supply Gap	0					0	0	0	0	-2	-3	-5	-7	-8

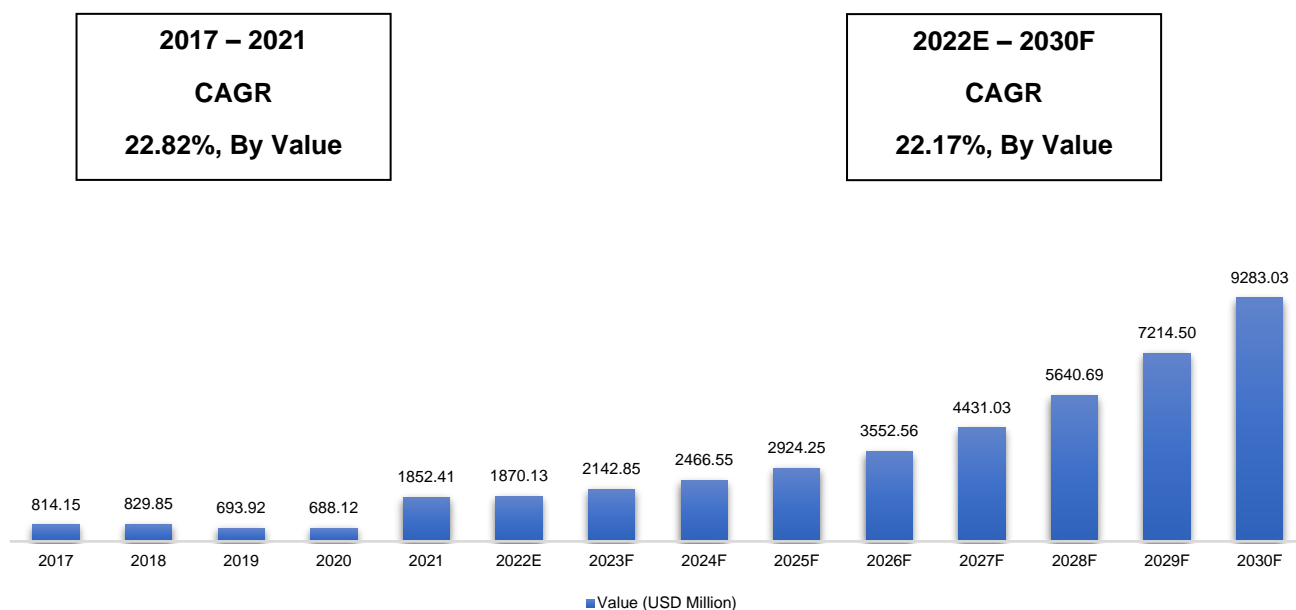
Source: TechSci Research

## 13. Global Monosilane Market Outlook

### 13.1. Market Size & Forecast, 2017-2030

#### 13.1.1. By Value

#### Global Monosilane Market Size, By Value (USD Million), 2017-2030F



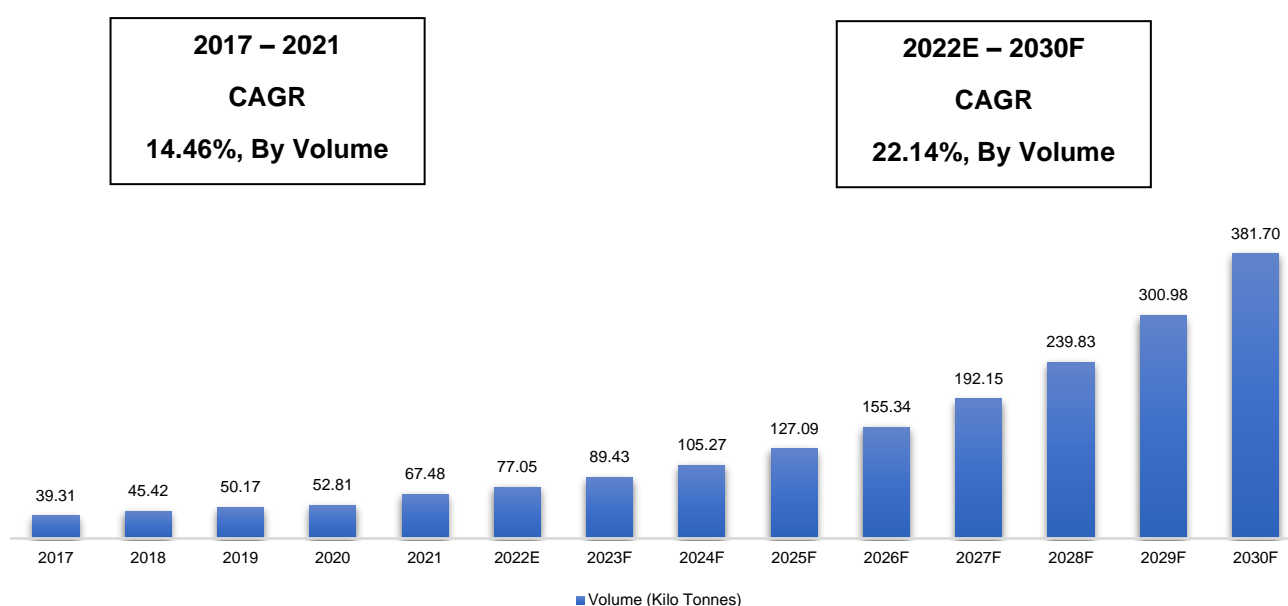
Source: TechSci Research

Global monosilane market by value is reached 1852.41 USD Million in 2021 and is estimated to reach 9283.03 USD Million in 2030 growing with a healthy CAGR of 22.71%. H4Si is frequently utilised in the production of semiconductors and the insulation of low-voltage cables in electronic goods. Glass, metal, paper, plastic, quartz, and elastomer are among the substrate materials used. One of the primary drivers driving market expansion is the rising trend of smart consumer electronics as a result of increased

disposable incomes, rapid urbanisation, and the advent of smart homes. Apart from that, it is used to create amorphous silicon sheets, which are then used to make solar cells, along with other gases. This, together with tax credits, incentives, and price reductions on a variety of solar panel components granted by governments in a number of nations, is pushing the market. It's also gaining popularity in the treatment of natural fibres and the manufacture of polycrystalline silicon.

### 13.1.2. By Volume

#### Global Monosilane Market Size, By Volume (Kilo Tonnes), 2017-2030F



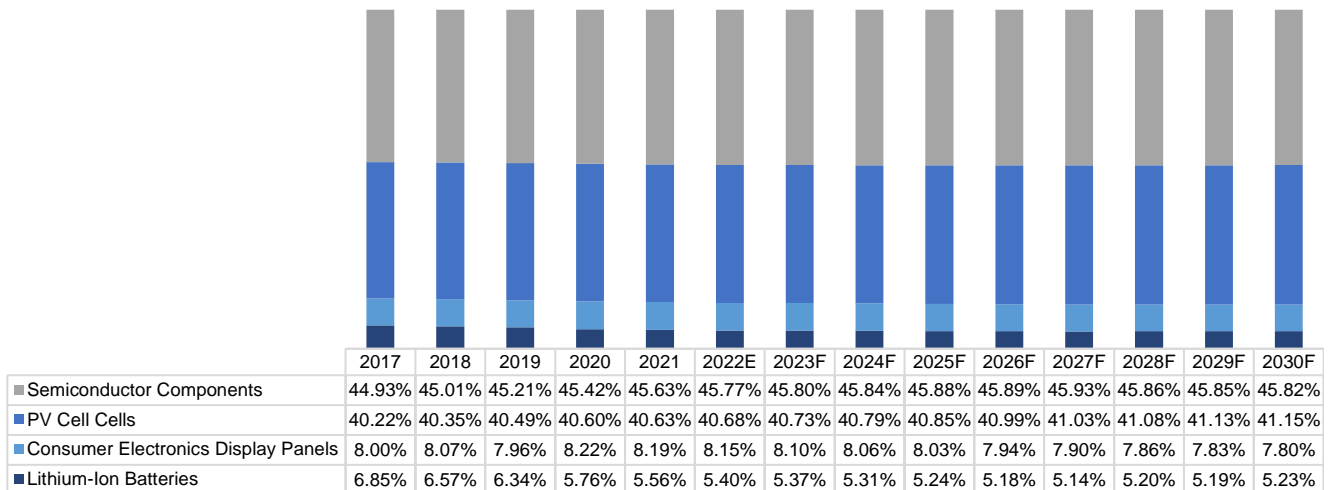
Source: TechSci Research

The demand of global monosilane market by volume reached 67.48 Kilo tonnes in 2021 and is anticipated to reach 381.70 Kilo tonnes in 2030 growing with a healthy CAGR of 22.14%. The need for alternative clean energy has risen as the government's focus on net zero emissions and the adoption of sustainable energy resources has increased. Solar power is a self-sustaining green energy source. Silanes are commonly utilised in the production of solar panels, particularly crystalline silicon cells. Emerging economies like India, Japan, and China have seen a considerable growth in annual photovoltaic cell installations. Furthermore, the green planet project includes the installation of solar panels. Asian governments are providing incentives and implementing various policies to encourage the use of solar energy and reduce carbon emissions.

## 13.2. Market Share & Forecast 2017-2030

### 13.2.1. By Application (PV Cell Cells, Semiconductor Components, Consumer Electronics Display Panels, Lithium-Ion Batteries)

#### Global Monosilane Market Share, By Application, By Volume (Kilo Tonnes), 2017-2030F

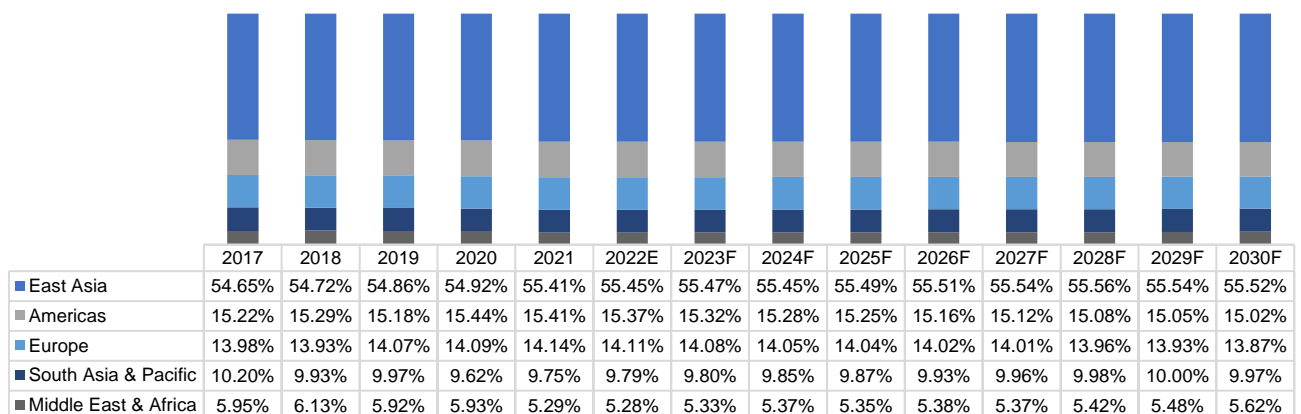


By Application (KT)	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
PV Cell Cells	16	18	20	21	27	31	36	43	52	157
Semiconductor Components	18	20	23	24	31	35	41	48	58	175
Consumer Electronics Display Panels	3	4	4	4	6	6	7	8	10	30
Lithium-Ion Batteries	3	3	3	3	4	4	5	6	7	20
<b>Total</b>	<b>39</b>	<b>45</b>	<b>50</b>	<b>53</b>	<b>67</b>	<b>77</b>	<b>89</b>	<b>105</b>	<b>127</b>	<b>382</b>

Source: TechSci Research

### 5.2.3. By Region (East Asia, Americas, Europe, South Asia & Pacific, Middle East & Africa)

#### Global Monosilane Market Share, By Region, By Volume (Kilo Tonnes), 2017-2030F



By Region (KT)	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
East Asia	21	25	28	29	37	43	50	58	71	212

Americas	6	7	8	8	10	12	14	16	19	57
Europe	5	6	7	7	10	11	13	15	18	53
South Asia & Pacific	4	5	5	5	7	8	9	10	13	38
Middle East & Africa	2	3	3	3	4	4	5	6	7	21
<b>Total</b>	<b>39</b>	<b>45</b>	<b>50</b>	<b>53</b>	<b>67</b>	<b>77</b>	<b>89</b>	<b>105</b>	<b>127</b>	<b>382</b>

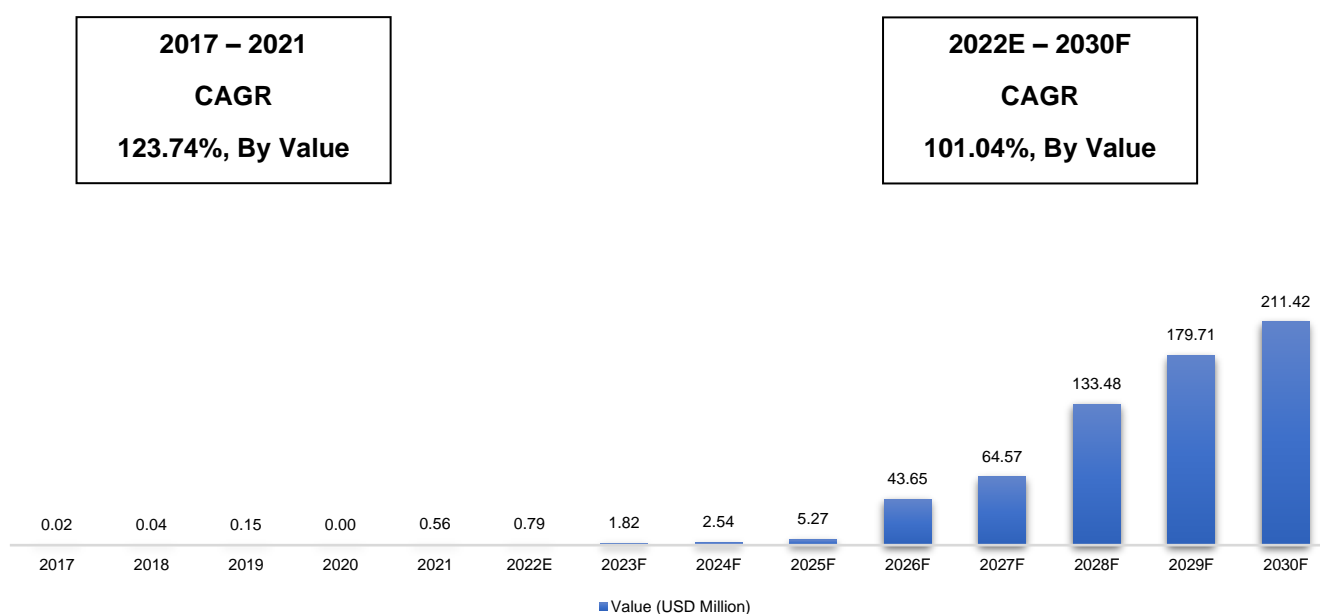
Source: TechSci Research

## 14. India Monosilane Market Outlook

### 14.1. Market Size & Forecast, 2017-2030

#### 14.1.1. By Value

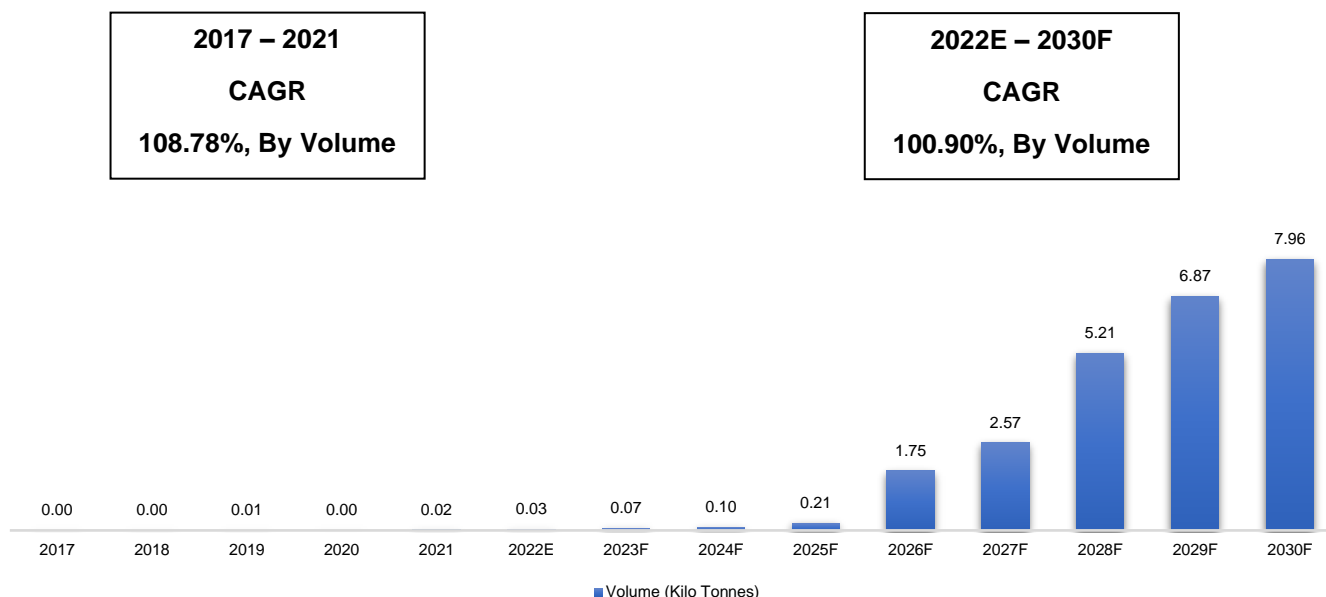
#### India Monosilane Market Size, By Value (USD Million), 2017-2030F



Source: TechSci Research

#### 14.1.2. By Volume

## India Monosilane Market Size, By Volume (Kilo Tonnes), 2017-2030F

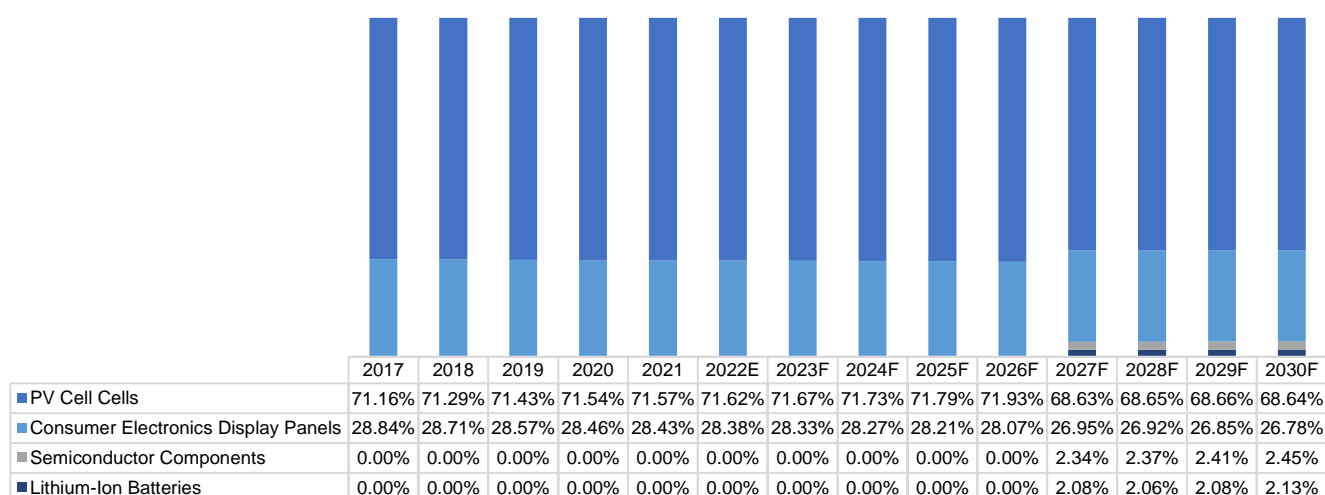


Source: TechSci Research

## 14.2. Market Share & Forecast, 2017-2030

### 14.2.2. By Application (PV Cell Feedstock, Semiconductor Components, Consumer Electronics, Lithium-Ion Batteries)

#### India Monosilane Market Share, By Application, By Volume (Kilo Tonnes), 2017-2030F



By Application (KT)	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
PV Cell Cells	0.00	0.00	0.01	0.00	0.01	0.02	0.05	0.07	0.15	5.46
Semiconductor Components	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20
Consumer Electronics Display Panels	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.06	2.13

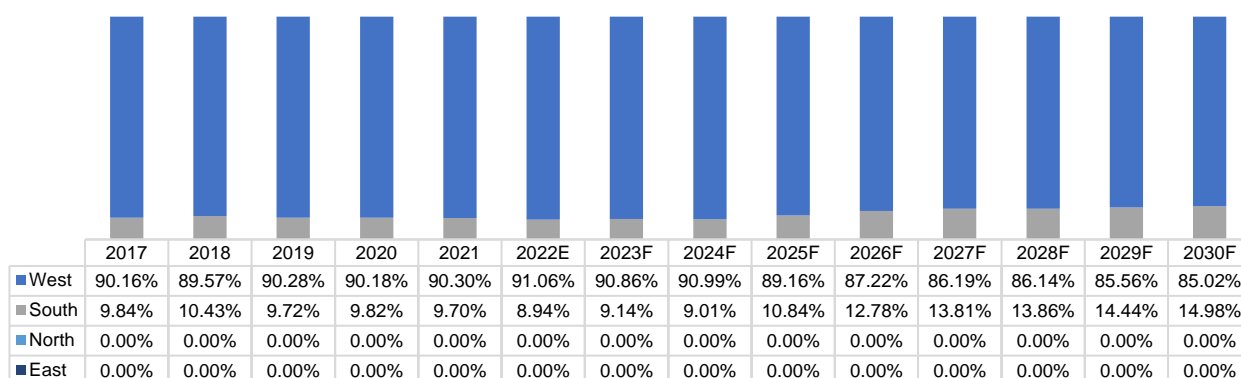


Lithium-Ion Batteries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>0.01</b>	<b>0.00</b>	<b>0.02</b>	<b>0.03</b>	<b>0.07</b>	<b>0.10</b>	<b>0.21</b>	<b>7.96</b>

Source: TechSci Research

### 14.2.3. By Region (North India, West India, South India, East India)

#### India Monosilane Market Share, By Region, By Volume (Kilo Tonnes), 2017-2030F



By Region (KT)	2017	2018	2019	2020	2021	2022E	2023F	2024F	2025F	2030F
West	0.00	0.00	0.01	0.00	0.02	0.03	0.06	0.09	0.19	6.77
South	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	1.19
North	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
East	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>0.01</b>	<b>0.00</b>	<b>0.02</b>	<b>0.03</b>	<b>0.07</b>	<b>0.10</b>	<b>0.21</b>	<b>7.96</b>

Source: TechSci Research

### 14.3. Demand Supply Scenario

#### 14.3.1. Overview of Imports by Country of Origin and Key Customers, 2021

Consignee Name	Shipper Name	Quantity (Kg)
Praxair India Pvt Ltd	Inner Mongolia Xingyang Technology, China	14958
Mundra Solar Pvt Limited	Inner Mongolia Xingyang Technology, China	4400
<b>Total</b>		<b>19358</b>

Source: International Trade Statistics

### 16. Monosilane Production Scenario Assessment

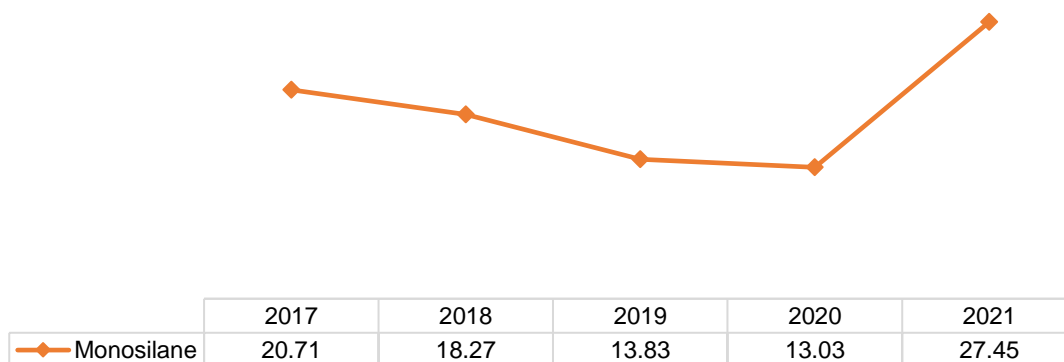
#### 16.1. Planned Capacities by key countries vs. actual capacity utilization rate

Country	Capacity (KT),2021	Capacity Utilization Rate
China	49	94.05%
Japan	1	92.78%
Malaysia	7	91.17%
South Korea	1	94.23%
Germany	7	92.62%
USA	8	93.41%
<b>Total</b>	<b>73</b>	<b>93.04%</b>

Source: TechSci Research

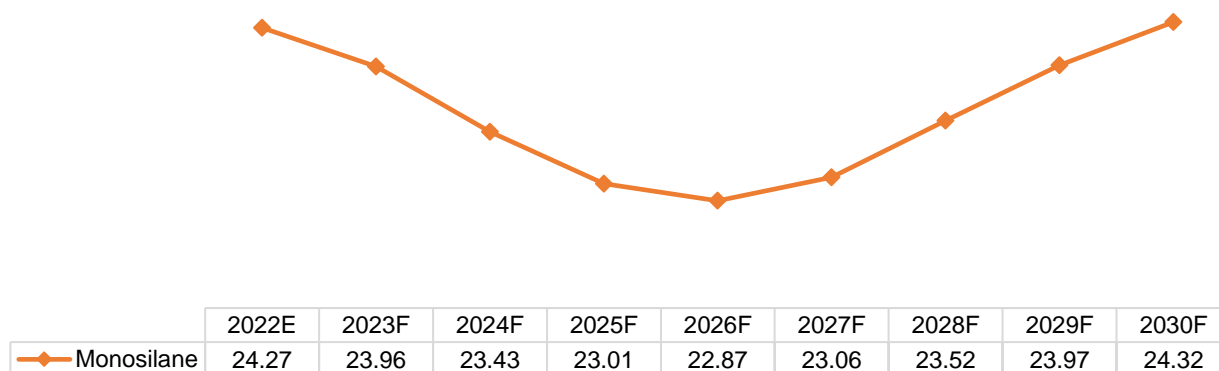
## 17. Monosilane Pricing Analysis

### 17.1. Historical Pricing Analysis, 2017-2021



Source: TechSci Research

### 17.2. Forecasted Pricing Forecast (USD/Kg), 2022E – 2030F



Source: TechSci Research

The consistent demand from end-use industries provided a silver lining for traders for undertaking a positive price revision to extend their profit margins. Owing to this bullish buying momentum of Silane, its prices showcased a consistent surge. Escalating demand for Photovoltaic cells which are used in solar panels especially stimulated the hike in the prices of silane feedstock. Moreover, surging demand from the downstream electronics and global inflation in the ocean freight soared Silane values in this timeframe. Additionally, substantial deals of upstream aluminium silicide and an acute energy crisis further sent ripples

to silane fundamentals during the first quarter. The market traders reported strong gains in the downstream solar module prices and other downstream material constraints due to a critical shortage of the key raw material of Silane. Several Silane gas producers reported higher demand for silane-based products in photovoltaics and for TFT/LCD manufacturing with the sharp rebound in the economic outlook. Prices rose in response to various market conditions and economic factors including ramped up manufacturing, rising distribution costs, high demand and tightening raw materials. With a marked growth in semiconductor content in electronic systems during the quarter, the demand for Silane gas in chemical vapor deposition jumped by double digits.

## **18.Global Solar Photovoltaics Industry Overview**

### **Global**

Rising concerns about climate change, the health effects of air pollution, energy security, and energy access, along with volatile oil prices in recent decades, have led to the need to produce and use an alternative, low-carbon technology such as renewables. Solar Photovoltaics is one of the fastest-growing, most mature, and cost-competitive renewable energy technology.

Considering various resource availability, significant market potential, and cost competitiveness, solar photovoltaics is expected to continue dominance over renewable energy in several regions over the next decade. The major factor driving the global solar photovoltaics industry is the declining cost of solar photovoltaics and related equipment. In 2020, solar photovoltaic module prices reduced by more than 80%, as compared to that in 2010.

Globally, Asia would continue to dominate solar PV use, with over 50% of installed capacity, followed by North America (20%) and Europe (10%). Despite the COVID-19 pandemic, demand for solar in the European Union region increased to 18.2 GW in 2020 from 16.2 GW in 2019. The region is revising several policies and regulations to achieve its carbon-neutrality goal by 2050 which is expected to offer strong advantages to solar photovoltaics.

According to The International Renewable Energy Agency, globally the total installed capacity of solar Photovoltaics reached 480 GW in 2018 and is expected to reach 2840GW by 2030 and 8519GW by 2050. As of 2020, Asia-Pacific is the largest solar photovoltaics market across the globe and is expected to continue its dominance in the forthcoming year. China, Japan, and India are the key markets in the region.

### **India**

India has made substantial progress in domestic solar module manufacturing capacity in recent years. Government of India is taking massive initiatives to support solar photovoltaics Industry in India.

#### **Schemes to Support Solar Industry in India by Government of India:**

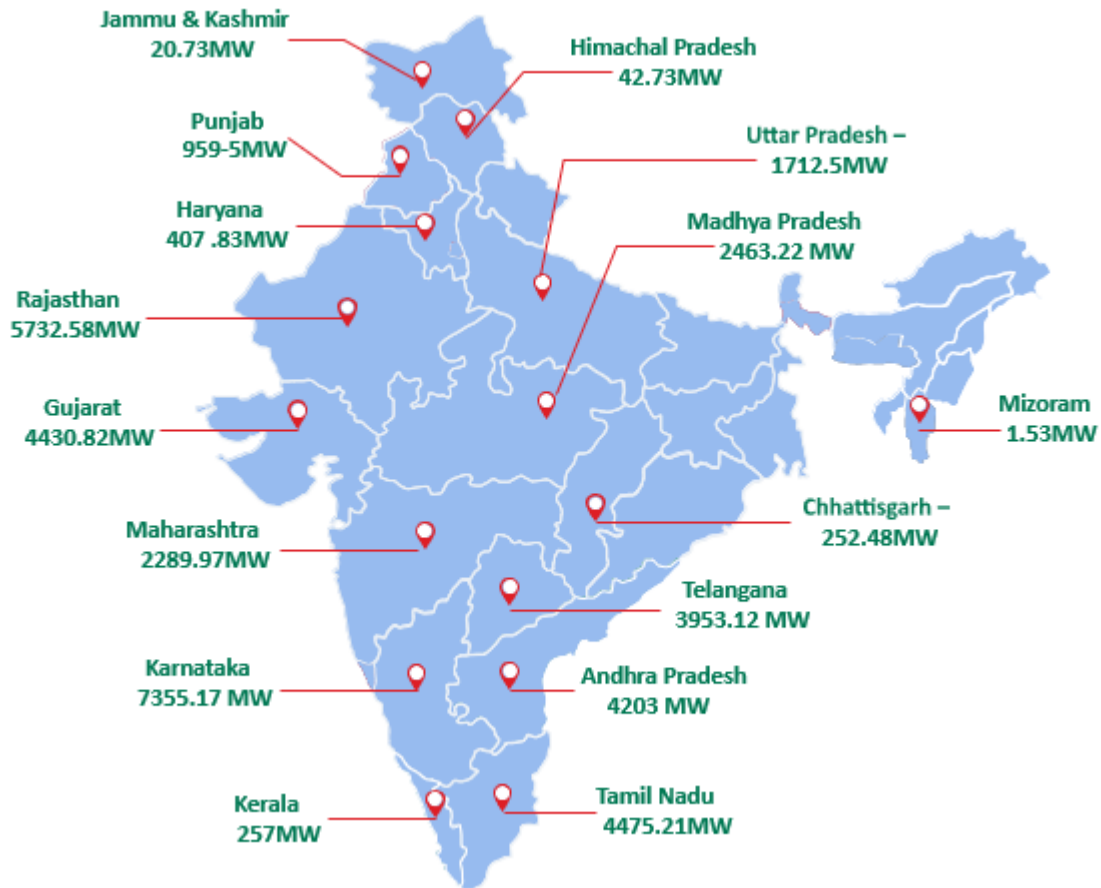
Grid Connected	Solar Off grid
Development of Solar Parks and Ultra Mega Solar Power Projects (Up to FY2022-FY23)	Off- Grid and Decentralized Solar PV Applications Programme -Phase III (Till 31.03.2021)
Scheme for setting up of over 5000MW grid-connected SPV power projects under IV of JNNSM PHASE-II. (FY2015-FY16 to FY2018-FY19)	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan (PM KUSUM) (Till 31.12.2022)
Grid Connected Solar Rooftop Programme (Till 31.12.2022)	Atal Jyoti Yojana (AJAY): Phase III (Till 31.03.2020)
Scheme for setting up of distributed grid-connected solar PV Power projects in Andaman & Nicobar and Lakshadweep Islands with Capital Subsidy from MNRE (FY2016-FY17 to FY2019-FY20)	Scheme on Scale Up of Access to Clean Energy for Rural Productive Uses" (Till June 2020)
Central public sector undertaking scheme phase II for setting up 12000MW grid-connected solar photovoltaic power projects by the government producers with Viability Gap Funding support for self-use or use by government/ government entities , either directly or through distribution companies.	Seven Million Solar Study Lamp Scheme for School Going Children (30.09.2019)

Source: Ministry of New & Renewable Energy

According to the Ministry of New and Renewable Energy, India achieved the 5th global position in solar power deployment, and solar power capacity has increased by more than 11 times in the last five years from 2.6 GW in March 2014 to 30 GW in July 2019. India added a record 10 Gigawatt (GW) of solar energy to its cumulative installed capacity in 2021. As of 202, the country has now surpassed 50 GW of cumulative installed solar capacity.

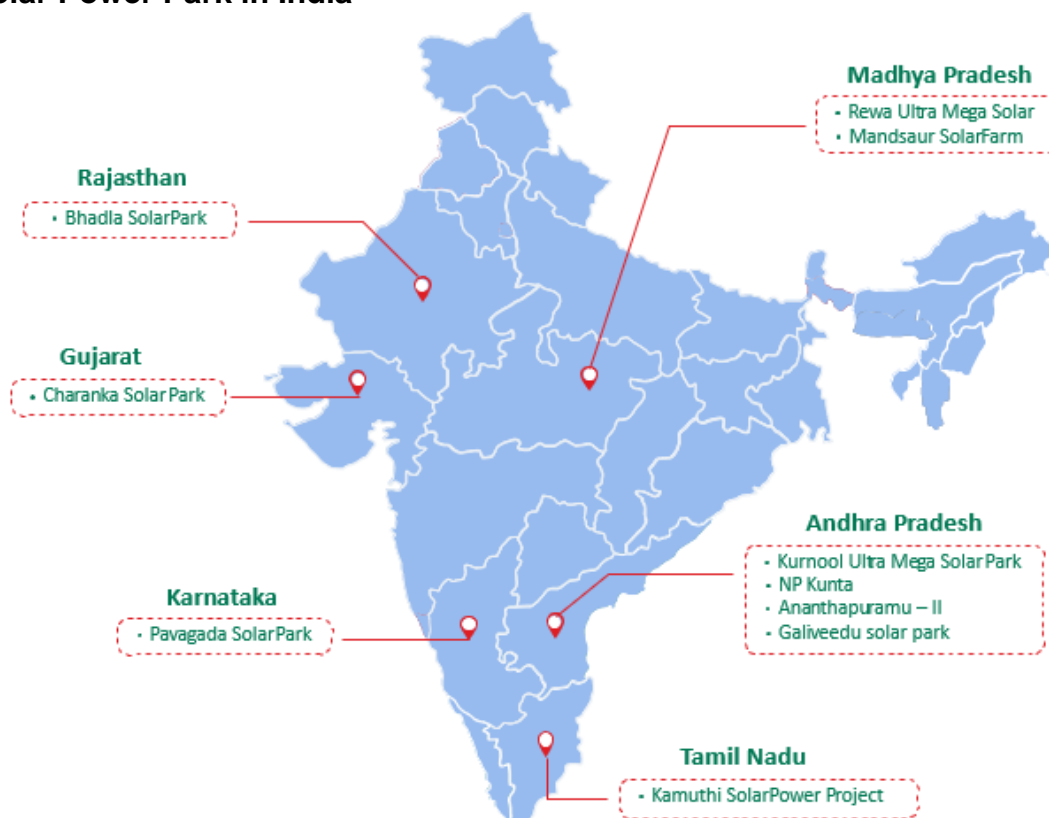
Companies are continuously focussing on the expansion of solar photovoltaics through mergers and acquisitions, receiving funds, contracts, increasing manufacturing capacity, etc. For Instance, Solar Energy Corporation of India Ltd. implemented large-scale central auctions for solar parks and has awarded contracts for 47 parks with over 25 GW of combined capacity. Likewise, The NTPC is expected to commission India's largest floating solar power plant in Ramagundam, Telangana by May June 2022. The expected total installed capacity is 447MW

**As on 31<sup>st</sup> March 2021 India's solar plant installed capacity State-wise:**



Source: Ministry of New & Renewable Energy

## Solar Power Park in India



Source: Ministry of New & Renewable Energy

## 19. Macroeconomic Scenario Assessment

### 19.1. Polysilicon

Consumption of polysilicon is directly dependent on consumption of solar photovoltaic industry and semiconductor industry. Globally, market size of semiconductor is around US\$ 600 bn and is expected to rise in the forthcoming year whereas solar photovoltaic generation increased a record 156 TWh (23%) in 2020 to reach 821 TWh. Solar photovoltaic accounted for 3.1% of global electricity generation, and it remains the third-largest renewable electricity technology behind hydropower and onshore wind. Globally, China alone was responsible for 75% of the increase in annual solar PV installations from 2019 to 2020.

Rising demand from corporate through power purchase agreements, driven by declining costs and continued growth in residential and commercial markets, are driving the solar photovoltaic market.

The polysilicon market is depending on numerous factors including, logistic, import duties, consumption of polysilicon, Trade war, natural disaster etc. During 2020 & 2021, several companies entered the solar wafer market, increased the demand for polysilicon resulted in rise in price of polysilicon. In 2018, consumption of polysilicon in the solar photovoltaic industry in United states was impacted since United States government-imposed tariffs between 10% and 25% on solar module imports from China. Likewise, due to the outbreak of COVID-19 pandemic, production of polysilicon was affected as China is the largest producer of polysilicon almost 27% (510,000 ton) of the China's annual polysilicon capacity was affected.

## 20. Polysilicon Market Dynamics

### 20.1 Drivers

- **Growing Demand of Solar Photovoltaics panels:**
  - Polysilicon is the major raw material used for solar photovoltaic panels. The rising need for alternate energy sources due to the depletion of fossil fuels across the globe is expected to increase the demand for solar photovoltaics, which in turn will drive the polysilicon market.
  - Governments of developing and developed countries and industrial sectors are emphasizing the expansion of renewable energy sources, and solar energy has high potential. Thus, policymakers, regulatory bodies, and industrial sectors are investing enormously in the solar energy sector. This is generating remarkable demand for solar panels across the globe. In India, Solar power installed capacity has increased by more than 18 times from 2.63 GW in March 2014 to 49.3 GW at the end of 2021 and the government has an ambitious goal of 280GW of installed solar capacity by 2030, resulting in an increased market of polysilicon and monosilane market in India.
- **Government Initiatives:**
  - To support the production of polysilicon, governments of various countries are promoting industrial policy with measures that included innovation funds, exemption of land fees, exemption on the electricity bill, low-rate loans, tax credits and grants, and public financing initiatives increasing investment in research & development of solar.
  - In the USA, Solar Energy Manufacturing for America Act was introduced in the Senate, and the government would provide tax credits to American manufacturers at every stage of the solar panel manufacturing supply chain, from the production of polysilicon to solar cells to fully assembled solar modules.
  - In India, government initiatives like the PLI scheme, Atmanirbhar Bharat, and Make in India Initiatives facilitate domestic manufacturing of polysilicon. The PLI scheme, which was approved by the central government in April, has a budget of US\$611 million to promote 10 GW of integrated solar manufacturing capacity in India with an expected direct investment of around US\$2.33 billion. Likewise, the Ministry of Electronics & Information Technology approved two specific schemes to reduce India's dependency on imports and build an ecosystem to produce semiconductors. The First Scheme, the design-linked incentive (DLI) scheme, aims to help budding Indian semiconductor design firms. The second scheme provides incentives for specialized fabs used to manufacture high frequency, high power, optoelectronic devices. It will also cover Assembly, Testing, Marking, and Packaging units of conventional silicon semiconductor chips. Assembly, Testing, Marking, and Packaging
- **Digital Evolution:**
  - Digitalization is dominating many areas of everyday lives. The increased use of electronic items such as smartphones, laptops, digital music players, tablets, and desktop computers has

increased the production of electronic gadgets, leading to the increased use of microchips. The microchips constitute polysilicon, resulting in driving the market of polysilicon market.

- **Increasing Mergers & Acquisitions, Joint Ventures, Investments:**

- To remain competitive in the market companies are continuously engaged in mergers & acquisitions, joint ventures, and investments to satisfy the demand for polysilicon in the market and to reduce the price.
- For instance, U.S.-based polysilicon manufacturer Hemlock Semiconductor has acquired the trichlorosilane (TCS) business of DuPont to better control supply and reduce costs by becoming vertically integrated in terms of polysilicon production.
- Likewise, JinkoSolar Holding Co., Ltd., a subsidiary company named Jinko Solar Co., Ltd. invested RMB450 million for equity in Sichuan Yongxiang Energy Technology Co., Ltd. a subsidiary of Tongwei Co., Ltd. for the construction of a high-purity polysilicon production line with an annual capacity of 100,000 tons.

## 20.2 Challenges

- **Unreliable Power Supply:**

Polysilicon production is an energy-consuming process (60-100 kWh/kg) and needs reliable power sources for continuous operations. An unreliable power supply is a crucial factor in the manufacturing of polysilicon. For Instance, there is not any manufacturing plant for polysilicon in India owing to high power tariffs and unreliable power supply. According to the Global Competitiveness Report 2019 of the World Economic Forum, India ranks 108th among 141 economies in the quality of electricity supply.

- **Volatile cost of polysilicon:**

The cost of polysilicon depends on numerous factors such as natural disasters, demand, supply, and labor force. With the advent of the pandemic, there is a rise in the price of polysilicon owing to a shutdown of manufacturing plants and fallen demand for solar photovoltaics panels across the globe. In 2021, polysilicon prices reached 10-year highs which were \$36 per kg.

- **Supply Chain Barrier:**

Trade barriers, trade restrictions, unfair trade practices, the trade war between countries, and sudden outbreaks like the COVID-19 pandemic may adversely affect the polysilicon manufacturing companies to freely serve all markets. For Instance, the export of polysilicon manufacturing company named REC silicon was impacted due to the trade war between USA and China.

- **High Capital Requirements:**

The production of polysilicon requires large investments to build a plant, large corporate investment to learn and refine the production process, highly skilled Labor to operate the plant, and low electricity costs due to the large amount of energy needed to produce polysilicon.



## Monosilane Market Dynamics

### Drivers:

- **Increasing Market of Semiconductor:**

- The market for semiconductors is growing owing to the increasing use of mobile phones, notebooks, servers, automotive, smart home, gaming, wearables, and Wi-Fi access points. In the semiconductor industry, monosilane is used for polycrystalline deposition for interconnects or masking, growth of epitaxial silicon, and chemical vapor deposition of silicon dioxide, silicon nitride, silicon carbide, and refractory metal silicides. It also helps in the implantation of silicon sources, and amorphous silicon devices such as photosensitive drums or solar cells. Monosilane in semiconductor helps in thin layer deposition on flat glass.
- Globally, revenue from the semiconductor is projected to be US\$ 676 billion in 2022, an increase of 13.6% from 2021 resulted in driving the market for monosilane. According to “The Indian Electronic and Semiconductors Association (IESA)” the semiconductor market of India was valued at US \$27 billion in 2021 and is expected to reach \$64 billion in 2026.

- **Increasing Market of Solar Photovoltaics Panel:**

- The demand for electrical energy is increasing all over the world since nowadays, electrical energy is the basic need. Over the decade, countries like China, the USA, and Germany, have come up with solar powerhouses and increased the production of electricity using solar energy, which in turn drives the solar photovoltaic panel market.
- With the increasing penetration of solar power in the Indian energy blend, the solar panel market is also seeing tremendous growth over the past years. Currently, India ranks as the third-largest solar energy market globally. Country's solar module production capacity will almost double to 36GW in two years, from 18GW in 2021. Cell production capacity will rise to 18GW by the end of 2023. Production-Linked Incentive (PLI) scheme for solar PV manufacturing is a major catalyst for the whole Indian solar industry. Rising market of solar photovoltaic panel is driving the monosilane market.

### Challenges:

- **Emergence of Alternative Renewable Energies:**

- As a result of global warming, depleting fossil fuel stocks, and volatile oil prices, countries across the globe started focusing on development of renewable energy strategies to increase the global clean energy transition. The benefit of using renewable energy is potentially life-changing for the world's population. It includes reductions in air and water pollution, damage to public health, wildlife and habitat loss, and global-warming emissions. Furthermore, there is increasing use of renewable energy sources like wind, hydropower, tidal energy, nuclear energy, and biomass fuel, whereas hydropower is the most

widely used renewable energy source worldwide. Renewable energy sources are typically derived from natural resources that will not deplete over time. The wide use of other renewable energy will create a hindrance for the solar photovoltaics market, which directly affects the monosilane market.

## 21. Key Success and Risk Factors

### Key Success Factors for Polysilicon & Monosilane:

The growing market of solar photovoltaic industry and semiconductor industry is the success factor for Polysilicon & Monosilane. Polysilicon is used as raw material for photovoltaic solar panels and the semiconductor industry. In the semiconductor industry, monosilane is used for polycrystalline deposition for interconnects and helps in the implantation of silicon sources. Thus, the increasing demand for photovoltaic and semiconductor industry is driving the polysilicon and monosilane market.

### Risk Factors for Polysilicon

- **Low Threat of Substitution:**

The only alternative to polysilicon comes in the form of thin-film technologies. However, due to lower module efficiencies, a thin film might not always be a suitable alternative, especially when space is at a premium. Switching costs, however, are very high, as manufacturing processes for crystalline and thin-film modules are very different. In the electronics market, there is no substitute for high purity silicon.

- **Production of Harmful Substance in the Polysilicon Production Process:**

Polysilicon production process include hydrogen, chlorine, trichlorosilane and silicon and other harmful substances. When hydrogen gas mix with air, it forms explosive whereas hydrogen chloride is noncorrosive, but when in contact with water, it becomes corrosive. It can react with reactive metal powders, releases hydrogen gas. Whereas other risk factors such as mechanical damage, fire, explosion, and poisoning. In addition, there is electric shock, mechanical damage, corrosion, dust, and other hazardous and harmful factors.

- **Economic Crisis in Countries:**

Economic crisis in the countries is the major risk factors for polysilicon market as polysilicon is used as raw material in solar photovoltaic panel and semiconductor. These two industries, i.e., solar photovoltaic panel, and semiconductor are widely adopted across the globe. Currently countries such as Sri Lanka, Afghanistan, Venezuela, Middle East, Russia, Sudan are facing economic crisis. The economic crisis in the country would affect the solar photovoltaic panel and semiconductor industry.

### Risk Factors for Monosilane:

- **Explosive in Nature:**

Monosilane gas is made up of silicon and hydrogen that explodes when it gets in contact with air. Over the last 40 years, monosilane has been involved in several severe incidents. For Instance, in

Taiwan, a routine procedure at a manufacturing plant caused an unplanned explosion in the factory in 2005. In India outside Bangalore, there was an explosion that decollated an industrial worker and threw his body through a brick wall in 2007. There were 36 incidents occurred between 1982 and 1997 in the American semiconductor industry. There were two accidents in Japan i.e., in a gas cabinet (1989), and in a laboratory at Osaka University (1991).

- **Difficulty in Storage:**

Monosilane is difficult to store since it is highly combustible. Monosilane storage requires a number of precautions. Cylinders of monosilane should be secured in an upright posture and stored in a well-ventilated, weather-protected environment. Access to the storage area should be restricted. Because silane is flammable, it must be monitored for leaks in areas where it is kept and utilised. Temperatures in the storage compartment should not exceed 125°F (52°C), and it should be free from combustible materials and ignition sources. Storage should be kept away from high-traffic areas and exits. If salt or other caustic materials is present, it should be avoided. Valve protection caps and valve outlet seals must be left on disconnected cylinders. The valve outlet seal must be placed leak tight when returning a cylinder to storage. Reduce inventory and storage costs. Silane is often stored in silane-specific storage rooms. Storage spaces must be clearly marked with appropriate signage.

## **22. Overview of Regulatory Scenario Related to Production, Environment Management Compliance and Product Design Standards**

- **Ambient Air Monitoring:**

United States Environmental Protection Agency has introduced Ambient Air Monitoring, which is systematic, long-term assessment of pollutant levels, and an integral part of an effective air quality management system. It measures the quantity and types of certain pollutants in the surrounding and outdoor air.

Following are the reasons to collect such data:

- To assess the extent of pollution.
- To provide air pollution data to the public in a timely manner.
- To support implementation of air quality goals or standards.
- To evaluate the effectiveness of emissions control strategies.
- To provide information on air quality trends.
- To provide data for the evaluation of air quality models.

- **Withhold Release Order:**

U.S. Customs and Border Protection has introduced Withhold Release Order to prohibit the import of goods manufactured, by the use of forced Labor. U.S. Customs and Border Protection has listed out documents that require to prove that the supply chain does not include forced Labor:




1. The supplier must sign a special certificate of origin attesting to the sourcing of the products.

2. The importer must also sign a statement that it has made every reasonable effort to ascertain the character of the Labor used in the merchandise.
3. Along with those statements, Customs and Border Protection may require any or all of the following documents:
  - Affidavit from the provider of the silica and its initially processed forms (i.e., silicon metal, metallurgical grade silicon, chemical-grade silicon, silicon, etc.) and identification of the source of the silica and its initially processed forms that identifies where the silica and its initially processed forms were sourced.
  - Purchase Orders, Invoices, and Proof of Payment for the silica and its initially processed forms and/or silica containing components.
  - List of production steps and production records from the imported merchandise back through the supply chain to the unprocessed silica and its initially processed forms.
  - Transportation documents from raw silica source (quarry or other) through silica's initially processed forms to the imported merchandise.
  - Daily process reports that relate to the unprocessed silica and its initially processed forms sold to the downstream producers and the list of entities that supplied inputs for the silica containing products being imported.

## 23. Polysilicon and Monosilane Competition Scenario

### 23.1. Global Polysilicon Market Analysis by leading 8-10 players (Estimated Revenue & Market Share, Regional Presence, Competition Benchmarking, Profile Brief)




#### Tongwei Company Limited

 <b>634.91 RMB 100 billion (2021)</b>	 <b>15.40%</b>
 <b>Sichuan, China</b>	

- Tongwei Company Limited is the subsidiary of Tongwei Group Co., Ltd. listed in stock in 2004.
- Tongwei Company Limited has annual feed production capacity of over 10 million.
- The company engaged in the production of high-purity crystalline silicon in the upstream and high-efficiency solar cells in the midstream as well as the construction and operation of PV power stations in the downstream.
- The Company has capacity utilization rate of 129.91%.




- Company has production capacity of polysilicon constitute 180,000 tons and sales constitute 107700 tons.
- Tongwei Company Limited planned to invest RMB 14 billion in the 200,000 t/a high -purity crystalline silicon project in Leshan.

### GCL Poly Energy Holdings Limited Holdings Limited

	<b>19,697,978 RMB thousand</b>		<b>13.97%</b>
	<b>Suzhou, China</b>		

- GCL Technology Holdings Co., Ltd. was established in 2006 and listed in Hong Kong in November 2007.
- The company is headquartered in Suzhou, China.
- The company with subsidiaries and R&D centers in Hong Kong, Xuzhou, Leshan, Baotou, Ningxia, and other places.
- The Company having 3 production base and 3 R&D Centre.
- The company has innovatively developed the GCL method polysilicon production technology, which can utilize trichlorosilane more efficiently. Compared with the traditional Siemens method, the whole process of product manufacturing is green and environmentally friendly.
- The Company constitute market share of 13.97% across the globe in 2021.
- GCL-Poly Energy Holdings Limited subsidiary company named Jiangsu Zhongneng Polysilicon Technology Development Co., Ltd., an entity for Research & Development and manufacturing of FBR-produced FBR granular polysilicon, had an annual production capacity increase from 6,000 tons to 10,000 tons.



### Wacker Chemie AG

	<b>1529.8 Euro Million (2021)</b>		<b>11.92%</b>
	<b>Munich, Germany</b>		

- Wacker Chemie AG is German chemical company founded in 1914, headquartered in Munich, Germany.
- The Company having 26 production Sites, and 52 sales offices.




- The company is producing hyper pure (99.9999999 %) purity polysilicon on an industrial scale since 1959, initially for the semiconductor industry and, since 2000, company increased production for the photovoltaic sector.
- In 2021, Wacker Chemie AG polysilicon sales was 1529.8 Euro million.
- The Company constitute market share of 11.92% across the globe in 2021.
- The company plant utilization rate of polysilicon is 100% in 2021.

### Xinte Energy Co., Ltd

 <p><b>22,523.04 RMB Million</b> <b>11,575.63 RMB Million</b> <b>(Polysilicon Business)</b></p>	 <p><b>11.66%</b></p>
 <p><b>Urumqi, China</b></p>	

- Xinte Energy Co., Ltd. subsidiary of TEBA Co. Ltd, is a high-tech enterprise group specialized in the research and development of photovoltaic new energy products, new silicon-based materials, advanced ceramics, zirconium-based materials, powder materials and other products.
- Xinte Energy Co., Ltd was founded in 2008 and is headquartered in Urumqi, China.
- The Company constitute market share of 11.66% across the globe in 2021.
- The company has a research and development capacity of 80,000 tons/year of high purity crystalline silicon.
- The company had generated RMB 11,575.63 million from Polysilicon Business.
- The Company polysilicon production capacity ranks second in China and second in the world.




### Daqo New Energy Corp.

 <p><b>864,847USD Thousand</b></p>	 <p><b>10.78%</b></p>
 <p><b>China</b></p>	

- Daqo New Energy Corp is a leading manufacturer of high-purity polysilicon for the global solar PV industry.
- The company was founded in 2008 and is headquarter in China.
- The Company is one of the world's lowest cost producers of high-purity polysilicon.
- Daqo's New Energy Corp has highly efficient and technically advanced manufacturing facility in Xinjiang, China has annual polysilicon production capacity of 70,000 metric tons.




- The company utilize a closed-loop modified Siemens process to produce high quality polysilicon. The company produces medium to large blocks of solar-grade polysilicon using chemical vapor deposition process reactors.
- The Company constitute market share of 10.78% across the globe in 2021.

## REC Silicon

	<b>143.2 USD Million (2021)</b>		<b>5.79%</b>
	<b>Fornebu, Norway</b>		




- REC Silicon is a global leader in silane-based, high-purity silicon materials.
- REC Silicon founded in 1996 and is headquartered in Fornebu, Norway.
- The company delivers high-purity polysilicon and silicon gases to the solar and electronics industries.
- REC Silicon operates manufacturing facilities in Moses Lake, Washington and Butte, Montana in the USA.
- The company two U.S. based plants (Moses Lake, WA, and Butte, Montana) have a production capacity of more than 20,000 MT high-purity polysilicon.
- World's largest manufacturer of Granular Polysilicon (NextSi™) from Fluid Bed Reactor (FBR) technology for solar applications.
- REC Silicon is one of the world's largest producers of ultra-pure Float Zone (FZ) Polysilicon for electronic industry.
- The Company constitute market share of 5.79% across the globe in 2021.

## OCI Company Limited

	<b>3,244.0 KRW Billions</b>		<b>4.21%</b>
	<b>Seoul, Korea</b>		

- The company is founded in 1959 as Oriental Chemical Industries and is headquartered in Seoul, Korea.
- The company has polysilicon manufacturing plant in Korea (Gunsan Plant: Electronic-grade Polysilicon), and in Malaysia ((Samalaju Plant: Solar-grade Polysilicon (Capa: 30,000MT/yr)).
- The company provides high-purity polysilicon of 10N grade or higher by innovative production process and cutting-edge technology.
- OCI company Ltd. major markets are China, Taiwan, Europe, USA, Japan.
- The Company constitute market share of 4.21% across the globe in 2021.

**Asia Silicon (Qinghai) Co., Limited**

	 <b>2.92%</b>
	<b>Qinghai, China</b>

- Asia Silicon (Qinghai) Co., Ltd. was founded in December 2006 in Qinghai, China.
- The company operates a polysilicon plant in Xining, Qinghai in an area of 750 mu (500,000 square meters)
- The company has developed a proprietary variant of the Advanced Siemens Process to manufacture high-purity polysilicon at the lowest capital expenditure in the industry.
- The company has an annual production capacity of 20,000 tons of polysilicon (equivalent to 5GW), and 200MW of crystalline silicon PV modules.