

Solar PV Module Market – Global Industry Size, Share, Trends, Opportunity, and Forecast, Segmented By Technology (Thin Film, Crystalline Silicon), By Product (Monocrystalline, Polycrystalline, Cadmium Telluride, Amorphous Silicon, Copper Indium Gallium Diselenide), By Connectivity (On-Grid and Off-Grid), By Mounting (Ground Mounted, Roof Top), By End-Use (Residential, Commercial, Utility), By Region, By Competition, 2018-2028

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Abstracts

Global Solar PV Module Market was valued at USD 168 Billion in 2022 and is anticipated to project robust growth in the forecast period with a CAGR of 5.8% through 2028. The global Solar PV Module market is experiencing significant growth, driven by the increasing adoption of renewable energy sources and the growing awareness of environmental sustainability. With advancements in technology and declining costs, solar photovoltaic (PV) modules have become a cost-effective and efficient solution for harnessing solar energy. The market is characterized by intense competition among key players, fostering innovation and driving down prices. Government initiatives and favorable policies promoting clean energy further contribute to market expansion. Asia-Pacific dominates the market, led by China, a key player in both production and consumption. North America and Europe follow closely, with a rising focus on clean energy transitions. The demand for high-efficiency modules, coupled with improvements in energy storage solutions, is reshaping the industry landscape. As the world increasingly emphasizes the transition to sustainable energy, the Solar PV Module market is poised for sustained growth, offering promising opportunities for investors and stakeholders alike.

Key Market Drivers

Increasing Energy Demand and Environmental Awareness

The momentum of the global Solar PV Module market is propelled by an escalating demand for energy and an elevated awareness of environmental sustainability. With the global population expanding and industrialization reaching new heights, the imperative for reliable and clean energy sources has become paramount. In response to this imperative, solar PV modules have emerged as a scalable and environmentally friendly solution. Their capacity to harness solar energy not only addresses the increasing demand for power but also aligns with a growing acknowledgment, both by consumers and businesses, of the critical need to transition towards renewable energy sources. This recognition is driven not only by the desire for a sustainable future but also by a collective understanding of the imperative to mitigate the far-reaching impact of climate change. Governments worldwide are actively participating in this paradigm shift, implementing policies and incentives that foster the adoption of solar energy. These initiatives create a conducive environment, propelling the Solar PV Module market to thrive as a pivotal player in the global transition towards sustainable and cleaner energy solutions.

Technological Advancements and Efficiency Gains

At the core of the ascent of the global Solar PV Module market lies the instrumental role of technological advancements. A relentless commitment to innovation has yielded substantial improvements in the efficiency and overall performance of solar PV modules. This transformative journey is marked by advancements in materials, refined manufacturing processes, and an elevated comprehension of photovoltaic technologies. The collaborative impact of these enhancements has culminated in elevated energy conversion rates coupled with a parallel reduction in costs. The ongoing pursuit of higher efficiency modules stands out as a key catalyst, enabling heightened energy production while concurrently minimizing the environmental footprint. This phenomenon renders solar energy an increasingly appealing and sustainable option across residential and commercial applications alike. The dynamic landscape of innovation has instigated a robust competition among market players, propelling a continual evolution in solar PV technology, promising not just incremental improvements but a paradigm shift in the capabilities and accessibility of solar energy solutions globally.

Declining Costs and Improved Affordability

A fundamental impetus propelling the global rise of the Solar PV Module market is the significant reduction in the cost of solar panels. This reduction is underpinned by a confluence of factors, including transformative technological advancements, economies of scale, and heightened manufacturing efficiency. The cumulative effect of these advancements has yielded a consistent decline in the overall production cost of solar panels. This downward trajectory in costs initiates a domino effect, rendering solar energy increasingly economically feasible for a more extensive spectrum of consumers. The concurrent role of government incentives and subsidies further amplifies the affordability of solar energy, effectively incentivizing businesses and individuals to make substantial investments in solar PV installations. The consequential shift towards cost-competitive renewable energy solutions is not merely reshaping but fundamentally transforming the global energy landscape. Solar PV modules are emerging as not just an environmentally conscious choice but a financially prudent and sustainable investment, marking a pivotal evolution in the dynamics of the energy market.

Supportive Government Policies and Incentives

Central to the expansion of the global Solar PV Module market is the pivotal role played by supportive government policies and incentives. Numerous nations are strategically implementing favorable regulations aimed at incentivizing and accelerating the adoption of solar energy. These regulatory measures encompass a spectrum of initiatives, including feed-in tariffs, tax credits, and rebates, collectively designed to diminish the financial impediments that might deter prospective consumers. In doing so, governments not only facilitate broader access to solar technology but also cultivate a stable and conducive investment environment for businesses operating within the solar industry. The discernible shift towards renewable energy is underscored by the increasing awareness of its enduring benefits, extending beyond environmental sustainability to encompass energy security. Governments worldwide are progressively attuned to the imperative of transitioning towards sustainable energy sources, recognizing the intrinsic link between renewable energy and long-term environmental resilience. The alignment of policy frameworks with ambitious renewable energy goals acts as a catalyzing force, propelling the widespread deployment and integration of solar PV modules, thereby facilitating the global transition towards a more sustainable and secure energy landscape.

Rising Focus on Energy Security and Grid Resilience

The global focus on ensuring energy security and bolstering grid resilience stands as a

compelling driver behind the widespread adoption of solar PV modules. Solar power's decentralized nature plays a pivotal role in diminishing reliance on centralized grids, concurrently fortifying resilience against power disruptions. In the face of escalating occurrences of extreme weather events and natural disasters, the distributed configuration of solar PV installations emerges as a linchpin in establishing a more robust and dependable energy infrastructure. Governments and businesses alike are increasingly cognizant of the strategic imperative to diversify energy sources, recognizing the intrinsic link between diversified energy portfolios and heightened overall energy security. Against this backdrop, the innate resilience embedded within solar PV systems positions them as a cornerstone in crafting a more reliable and robust energy landscape. As a result, the sustained growth of the global Solar PV Module market is intricately interwoven with its instrumental role in contributing to the development of a resilient and secure global energy ecosystem.

Key Market Challenges

Intermittency and Reliability Issues

One significant challenge facing the global Solar PV Module market is the intermittency of solar power generation and associated reliability issues. Solar energy production is contingent upon weather conditions and daylight availability, leading to fluctuations in output. This intermittency poses challenges for maintaining a stable and reliable power supply, especially during periods of low sunlight or adverse weather conditions. While energy storage technologies, such as batteries, are evolving to mitigate this challenge, addressing the inherent intermittency remains a priority for the solar industry. Innovations in energy storage, grid management, and hybrid renewable systems are crucial to overcoming the reliability concerns associated with solar PV modules.

High Initial Costs and Return on Investment

Another hurdle facing the global Solar PV Module market is the high initial costs of installation and the time required to achieve a satisfactory return on investment (ROI). Despite the declining costs of solar PV modules, the upfront expenses associated with system installation, including inverters, mounting structures, and installation labor, can be a barrier for many consumers and businesses. While government incentives and subsidies aim to alleviate these costs, the timeline for realizing a substantial ROI may deter some potential investors. Striking a balance between reducing installation costs and improving the efficiency and longevity of solar PV systems is essential to making solar energy a more attractive and economically feasible option for a broader range of

stakeholders.

Land Use and Aesthetic Concerns

Land use and aesthetic considerations pose challenges to the widespread adoption of solar PV modules. Large-scale solar installations require significant land area, leading to concerns about habitat disruption, agricultural land use conflicts, and visual impact. Balancing the need for expansive solar farms with environmental conservation and community aesthetics is a delicate challenge. Innovations in solar technology, such as building-integrated photovoltaics and solar panels with transparent coatings, aim to address these concerns by integrating solar modules into existing infrastructure and minimizing the environmental footprint. Stricter regulations and guidelines that balance energy needs with environmental and visual considerations are crucial to navigating this challenge.

Recycling and End-of-Life Management

The global Solar PV Module market faces a growing challenge related to the recycling and responsible disposal of end-of-life solar panels. As the installed base of solar PV systems increases, there is a corresponding rise in the volume of decommissioned modules. Solar panels contain materials that can be harmful to the environment if not managed properly, such as lead and cadmium. Developing effective recycling processes for solar panels, ensuring the safe disposal of hazardous materials, and promoting a circular economy for photovoltaic components are critical steps in addressing this challenge. Collaborative efforts among manufacturers, policymakers, and the recycling industry are essential to establishing comprehensive and sustainable solutions for the end-of-life management of solar PV modules, minimizing environmental impact and maximizing the long-term viability of solar energy as a clean and responsible energy source.

Key Market Trends

Increasing Dominance of Monocrystalline Technology

A distinctive and noteworthy trend permeating the global Solar PV Module market is the escalating dominance of monocrystalline technology. Distinguished by its superior efficiency and sleek design, monocrystalline solar panels have garnered substantial traction within the market. The impetus behind this surge in popularity lies in the pursuit of attaining higher energy yields within limited spatial confines, propelling a pronounced

preference for monocrystalline modules, particularly in residential and commercial installations. As manufacturing processes undergo continual refinement, yielding cost reductions, the market is witnessing a discernible shift away from conventional polycrystalline modules. The ascendancy of monocrystalline technology is underscored not only by its superior performance metrics but also its aesthetic appeal, positioning it as a pivotal trend charting the course of evolution within the Solar PV Module market. This shift signifies not merely a preference but a transformative trajectory that is reshaping the market landscape, emphasizing the growing significance of technological advancements in defining the industry's future.

Growth of Bifacial Solar Panels

Bifacial solar panels represent a noteworthy trend in the global Solar PV Module market, offering enhanced energy capture by utilizing sunlight from both the front and rear sides of the module. This innovative design allows for increased energy generation, particularly in locations with reflective surfaces such as snow, sand, or water. Bifacial technology has gained momentum as the efficiency gains outweigh the incremental cost, making it an attractive option for utility-scale projects. The market is witnessing a growing adoption of bifacial solar panels as developers seek to maximize energy output and improve the overall performance of solar installations.

Integration of Artificial Intelligence (AI) and IoT in Solar PV Systems

The integration of artificial intelligence (AI) and the Internet of Things (IoT) is a transformative trend in the Solar PV Module market. AI algorithms and IoT sensors are increasingly being employed to optimize the performance, monitoring, and maintenance of solar PV systems. Predictive analytics enhance the efficiency of energy production by forecasting weather patterns and optimizing system parameters. Additionally, IoT-enabled devices provide real-time data, enabling remote monitoring and proactive maintenance. This trend not only improves the reliability of solar installations but also contributes to the overall intelligence and resilience of the energy grid.

Rise of Energy Storage Solutions

A pivotal and prominent trend within the global Solar PV Module market revolves around the emergence of energy storage solutions, strategically designed to counter the intermittent nature of solar power generation. The landscape is witnessing transformative progress in battery technologies, complemented by a parallel reduction in costs, catapulting energy storage into an integral role within solar installations. This

innovation heralds a fundamental shift in the approach to energy utilization, as energy storage systems now facilitate the accumulation of surplus energy during periods of sunlight, subsequently deploying stored energy during low-light intervals or periods of heightened demand. This trend seamlessly aligns with the overarching movement towards decentralized and resilient energy systems. By affording consumers the capability to maximize self-consumption, reducing dependence on the grid, and enhancing energy autonomy, the integration of energy storage solutions stands out as a linchpin in shaping a future-oriented, sustainable energy landscape. The symbiotic relationship between solar PV modules and energy storage not only addresses the challenges posed by intermittency but also underscores a transformative paradigm that amplifies the role of solar energy in fostering resilience and autonomy within the broader energy ecosystem.

Increasing Popularity of Solar as a Service (SaaS)

The Solar as a Service (SaaS) model is gaining popularity as a trend in the global Solar PV Module market. This model involves third-party ownership and operation of solar installations, allowing businesses and consumers to access solar energy without the upfront costs of installation and maintenance. SaaS providers design, install, and maintain solar PV systems on behalf of customers, who then pay for the generated electricity or lease the equipment. This trend democratizes access to solar energy, making it more financially feasible for a broader audience. As the SaaS model continues to evolve and mature, it is reshaping the solar market by expanding its reach and making solar power accessible to a diverse range of stakeholders.

Segmental Insights

Technology Insights

The global Solar PV Module market witnessed the dominance of the crystalline silicon technology segment, a trend anticipated to persist throughout the forecast period. Crystalline silicon solar panels, both monocrystalline and polycrystalline, have emerged as the cornerstone of the solar industry, commanding a substantial market share. This dominance is attributed to the well-established manufacturing infrastructure, continuous advancements in production processes, and the proven reliability and efficiency of crystalline silicon modules. The maturity of crystalline silicon technology has led to economies of scale, resulting in cost reductions and increased competitiveness. Moreover, the market preference for high-efficiency modules, especially in residential and commercial applications, has further bolstered the dominance of crystalline silicon.

While thin-film technology continues to exhibit potential in specific niche applications, the broader market has leaned toward the proven performance, bankability, and scalability offered by crystalline silicon. As the solar industry continues to expand globally, crystalline silicon technology is poised to maintain its dominance, supported by ongoing innovations and incremental efficiency improvements that reinforce its position as the preferred choice for solar PV modules.

Connectivity Insights

In 2022, the global Solar PV Module market witnessed the on-grid connectivity segment dominating, and this dominance is projected to persist throughout the forecast period. The on-grid segment, also known as grid-tied or grid-connected systems, held a significant market share due to several key advantages. On-grid solar PV modules are integrated into existing utility grids, allowing for the seamless exchange of electricity between the solar installation and the grid. This connectivity enables users to feed excess energy back into the grid, often resulting in financial incentives or credits. The on-grid approach provides a reliable and stable power supply, as users can draw electricity from the grid when solar production is insufficient. This adaptability and reliability have made on-grid systems the preferred choice for residential, commercial, and utility-scale installations. Additionally, favorable government policies and incentives for grid-tied systems, along with the increasing focus on energy transition and grid stability, further contribute to the dominance of on-grid connectivity in the global Solar PV Module market. As the industry continues to evolve, the on-grid segment is expected to maintain its dominance, driven by the ongoing expansion of electricity grids, the demand for seamless integration with existing infrastructure, and the pursuit of a balanced and sustainable energy ecosystem.

Product Insights

The global Solar PV Module market was predominantly led by the monocrystalline product segment, and this dominance is anticipated to persist throughout the forecast period. Monocrystalline solar panels have established themselves as the frontrunners in the market, commanding a substantial share due to their superior efficiency and space utilization. The monocrystalline technology, characterized by its single-crystal structure, enables higher energy conversion rates compared to other technologies. This heightened efficiency is particularly attractive for applications where space is limited or for projects aiming to maximize energy output. Monocrystalline modules also possess a sleek and uniform appearance, making them popular in residential and commercial installations. The continuous advancements in manufacturing processes have led to

cost reductions, further enhancing the competitiveness of monocrystalline technology. While other technologies such as polycrystalline, cadmium telluride, amorphous silicon, and copper indium gallium diselenide continue to have their niche applications, the overall market dominance of monocrystalline solar PV modules is driven by their proven performance, efficiency gains, and widespread acceptance across diverse solar projects. As the industry evolves, the monocrystalline segment is expected to maintain its dominance, supported by ongoing innovations aimed at increasing efficiency, reducing costs, and meeting the growing demand for high-performance solar solutions globally.

Regional Insights

Asia-Pacific emerged as the dominant region in the global Solar PV Module market, and this dominance is anticipated to persist during the forecast period. The Asia-Pacific region, led by China, played a pivotal role in driving the growth of the solar industry. China, as a major player in both production and consumption of solar PV modules, significantly contributed to the region's dominance. The robust demand for renewable energy, ambitious government targets, and supportive policies promoting solar adoption have fueled the rapid expansion of the solar market in Asia-Pacific. Additionally, countries like India, Japan, and South Korea have made substantial investments in solar infrastructure, further bolstering the region's prominence. The availability of skilled labor, established manufacturing capabilities, and a favorable regulatory environment have attracted significant investments in solar projects. As the global focus on clean energy intensifies, and with Asia-Pacific leading the way in solar capacity additions, the region is expected to maintain its dominance in the Solar PV Module market. The continual growth in solar installations, combined with advancements in technology and supportive government initiatives, positions Asia-Pacific as a key driver shaping the trajectory of the global solar industry in the coming years.

Key Market Players

Jinko Solar Holding Co., Ltd.

Trina Solar Limited

Canadian Solar Inc.

First Solar, Inc.

Hanwha Q CELLS Co., Ltd.

JA Solar Holdings Co., Ltd.

LONGi Green Energy Technology Co., Ltd.

Risen Energy Co., Ltd.

SunPower Corporation

REC Group

Report Scope:

In this report, the Global Solar PV Module Market has been segmented into the following categories, in addition to the industry trends which have also been detailed below:

Solar PV Module Market, By Technology:

Thin Film

Crystalline Silicon

Solar PV Module Market, By Connectivity:

On-Grid

Off-Grid

Solar PV Module Market, By Product:

Monocrystalline

Polycrystalline

Cadmium Telluride

Amorphous Silicon

Copper Indium Gallium Diselenide

Solar PV Module Market, By Mounting:

Ground Mounted

Roof Top

Solar PV Module Market, By End-Use:

Residential

Commercial

Utility

Solar PV Module Market, By Region:

North America

United States

Canada

Mexico

Europe

France

United Kingdom

Italy

Germany

Spain

Belgium

Asia-Pacific

China

India

Japan

Australia

South Korea

Indonesia

Vietnam

South America

Brazil

Argentina

Colombia

Chile

Peru

Middle East & Africa

South Africa

Saudi Arabia

UAE

Turkey

Israel

Competitive Landscape

Company Profiles: Detailed analysis of the major companies present in the Global Solar PV Module Market.

Available Customizations:

Global Solar PV Module market report with the given market data, Tech Sci Research offers customizations according to a company's specific needs. The following customization options are available for the report:

Company Information

Detailed analysis and profiling of additional market players (up to five).

Contents

1. PRODUCT OVERVIEW

- 1.1. Market Definition
- 1.2. Scope of the Market
 - 1.2.1. Markets Covered
 - 1.2.2. Years Considered for Study
 - 1.2.3. Key Market Segmentations

2. RESEARCH METHODOLOGY

- 2.1. Objective of the Study
- 2.2. Baseline Methodology
- 2.3. Formulation of the Scope
- 2.4. Assumptions and Limitations
- 2.5. Sources of Research
 - 2.5.1. Secondary Research
 - 2.5.2. Primary Research
- 2.6. Approach for the Market Study
 - 2.6.1. The Bottom-Up Approach
 - 2.6.2. The Top-Down Approach
- 2.7. Methodology Followed for Calculation of Market Size & Market Shares
- 2.8. Forecasting Methodology
 - 2.8.1. Data Triangulation & Validation

3. EXECUTIVE SUMMARY

4. IMPACT OF COVID-19 ON GLOBAL SOLAR PV MODULE MARKET

5. VOICE OF CUSTOMER

6. GLOBAL SOLAR PV MODULE MARKET OVERVIEW

7. GLOBAL SOLAR PV MODULE MARKET OUTLOOK

7.1. Market Size & Forecast

7.1.1. By Value

7.2. Market Share & Forecast

7.2.1. By Technology (Thin Film, Crystalline Silicon)

7.2.2. By Product (Monocrystalline, Polycrystalline, Cadmium Telluride, Amorphous Silicon, Copper Indium Gallium Diselenide)

7.2.3. By Connectivity (On-Grid and Off-Grid)

7.2.4. By Mounting (Ground Mounted, Roof Top)

7.2.5. By End-Use (Residential, Commercial, Utility)

7.2.6. By Region (North America, Europe, South America, Middle East & Africa, Asia Pacific)

7.3. By Company (2022)

7.4. Market Map

8. NORTH AMERICA SOLAR PV MODULE MARKET OUTLOOK

8.1. Market Size & Forecast

8.1.1. By Value

8.2. Market Share & Forecast

8.2.1. By Technology

8.2.2. By Product

8.2.3. By Connectivity

8.2.4. By Mounting

8.2.5. By End-Use

8.2.6. By Country

8.3. North America: Country Analysis

8.3.1. United States Solar PV Module Market Outlook

8.3.1.1. Market Size & Forecast

8.3.1.1.1. By Value

8.3.1.2. Market Share & Forecast

8.3.1.2.1. By Technology

8.3.1.2.2. By Product

8.3.1.2.3. By Connectivity

8.3.1.2.4. By Mounting

8.3.1.2.5. By End-Use

8.3.2. Canada Solar PV Module Market Outlook

8.3.2.1. Market Size & Forecast

8.3.2.1.1. By Value

8.3.2.2. Market Share & Forecast

8.3.2.2.1. By Technology

8.3.2.2.2. By Product

8.3.2.2.3. By Connectivity

8.3.2.2.4. By Mounting

8.3.2.2.5. By End-Use

8.3.3. Mexico Solar PV Module Market Outlook

8.3.3.1. Market Size & Forecast

8.3.3.1.1. By Value

8.3.3.2. Market Share & Forecast

8.3.3.2.1. By Technology

8.3.3.2.2. By Product

8.3.3.2.3. By Connectivity

8.3.3.2.4. By Mounting

8.3.3.2.5. By End-Use

9. EUROPE SOLAR PV MODULE MARKET OUTLOOK

9.1. Market Size & Forecast

9.1.1. By Value

9.2. Market Share & Forecast

9.2.1. By Technology

9.2.2. By Product

9.2.3. By Connectivity

9.2.4. By Mounting

9.2.5. By End-Use

9.2.6. By Country

9.3. Europe: Country Analysis

9.3.1. Germany Solar PV Module Market Outlook

9.3.1.1. Market Size & Forecast

9.3.1.1.1. By Value

9.3.1.2. Market Share & Forecast

9.3.1.2.1. By Technology

9.3.1.2.2. By Product

9.3.1.2.3. By Connectivity

9.3.1.2.4. By Mounting

9.3.1.2.5. By End-Use

9.3.2. France Solar PV Module Market Outlook

9.3.2.1. Market Size & Forecast

- 9.3.2.1.1. By Value
- 9.3.2.2. Market Share & Forecast
 - 9.3.2.2.1. By Technology
 - 9.3.2.2.2. By Product
 - 9.3.2.2.3. By Connectivity
 - 9.3.2.2.4. By Mounting
 - 9.3.2.2.5. By End-Use
- 9.3.3. United Kingdom Solar PV Module Market Outlook
 - 9.3.3.1. Market Size & Forecast
 - 9.3.3.1.1. By Value
 - 9.3.3.2. Market Share & Forecast
 - 9.3.3.2.1. By Technology
 - 9.3.3.2.2. By Product
 - 9.3.3.2.3. By Connectivity
 - 9.3.3.2.4. By Mounting
 - 9.3.3.2.5. By End-Use
- 9.3.4. Italy Solar PV Module Market Outlook
 - 9.3.4.1. Market Size & Forecast
 - 9.3.4.1.1. By Value
 - 9.3.4.2. Market Share & Forecast
 - 9.3.4.2.1. By Technology
 - 9.3.4.2.2. By Product
 - 9.3.4.2.3. By Connectivity
 - 9.3.4.2.4. By Mounting
 - 9.3.4.2.5. By End-Use
- 9.3.5. Spain Solar PV Module Market Outlook
 - 9.3.5.1. Market Size & Forecast
 - 9.3.5.1.1. By Value
 - 9.3.5.2. Market Share & Forecast
 - 9.3.5.2.1. By Technology
 - 9.3.5.2.2. By Product
 - 9.3.5.2.3. By Connectivity
 - 9.3.5.2.4. By Mounting
 - 9.3.5.2.5. By End-Use
- 9.3.6. Belgium Solar PV Module Market Outlook
 - 9.3.6.1. Market Size & Forecast
 - 9.3.6.1.1. By Value
 - 9.3.6.2. Market Share & Forecast
 - 9.3.6.2.1. By Technology

- 9.3.6.2.2. By Product
- 9.3.6.2.3. By Connectivity
- 9.3.6.2.4. By Mounting
- 9.3.6.2.5. By End-Use

10. SOUTH AMERICA SOLAR PV MODULE MARKET OUTLOOK

10.1. Market Size & Forecast

10.1.1. By Value

10.2. Market Share & Forecast

10.2.1. By Technology

10.2.2. By Product

10.2.3. By Connectivity

10.2.4. By Mounting

10.2.5. By End-Use

10.2.6. By Country

10.3. South America: Country Analysis

10.3.1. Brazil Solar PV Module Market Outlook

10.3.1.1. Market Size & Forecast

10.3.1.1.1. By Value

10.3.1.2. Market Share & Forecast

10.3.1.2.1. By Technology

10.3.1.2.2. By Product

10.3.1.2.3. By Connectivity

10.3.1.2.4. By Mounting

10.3.1.2.5. By End-Use

10.3.2. Colombia Solar PV Module Market Outlook

10.3.2.1. Market Size & Forecast

10.3.2.1.1. By Value

10.3.2.2. Market Share & Forecast

10.3.2.2.1. By Technology

10.3.2.2.2. By Product

10.3.2.2.3. By Connectivity

10.3.2.2.4. By Mounting

10.3.2.2.5. By End-Use

10.3.3. Argentina Solar PV Module Market Outlook

10.3.3.1. Market Size & Forecast

10.3.3.1.1. By Value

10.3.3.2. Market Share & Forecast

- 10.3.3.2.1. By Technology
- 10.3.3.2.2. By Product
- 10.3.3.2.3. By Connectivity
- 10.3.3.2.4. By Mounting
- 10.3.3.2.5. By End-Use
- 10.3.4. Chile Solar PV Module Market Outlook
 - 10.3.4.1. Market Size & Forecast
 - 10.3.4.1.1. By Value
 - 10.3.4.2. Market Share & Forecast
 - 10.3.4.2.1. By Technology
 - 10.3.4.2.2. By Product
 - 10.3.4.2.3. By Connectivity
 - 10.3.4.2.4. By Mounting
 - 10.3.4.2.5. By End-Use
- 10.3.5. Peru Solar PV Module Market Outlook
 - 10.3.5.1. Market Size & Forecast
 - 10.3.5.1.1. By Value
 - 10.3.5.2. Market Share & Forecast
 - 10.3.5.2.1. By Technology
 - 10.3.5.2.2. By Product
 - 10.3.5.2.3. By Connectivity
 - 10.3.5.2.4. By Mounting
 - 10.3.5.2.5. By End-Use

11. MIDDLE EAST & AFRICA SOLAR PV MODULE MARKET OUTLOOK

- 11.1. Market Size & Forecast
 - 11.1.1. By Value
- 11.2. Market Share & Forecast
 - 11.2.1. By Technology
 - 11.2.2. By Product
 - 11.2.3. By Connectivity
 - 11.2.4. By Mounting
 - 11.2.5. By End-Use
 - 11.2.6. By Country
- 11.3. Middle East & Africa: Country Analysis
 - 11.3.1. Saudi Arabia Solar PV Module Market Outlook
 - 11.3.1.1. Market Size & Forecast
 - 11.3.1.1.1. By Value

- 11.3.1.2. Market Share & Forecast
 - 11.3.1.2.1. By Technology
 - 11.3.1.2.2. By Product
 - 11.3.1.2.3. By Connectivity
 - 11.3.1.2.4. By Mounting
 - 11.3.1.2.5. By End-Use
- 11.3.2. UAE Solar PV Module Market Outlook
 - 11.3.2.1. Market Size & Forecast
 - 11.3.2.1.1. By Value
 - 11.3.2.2. Market Share & Forecast
 - 11.3.2.2.1. By Technology
 - 11.3.2.2.2. By Product
 - 11.3.2.2.3. By Connectivity
 - 11.3.2.2.4. By Mounting
 - 11.3.2.2.5. By End-Use
- 11.3.3. South Africa Solar PV Module Market Outlook
 - 11.3.3.1. Market Size & Forecast
 - 11.3.3.1.1. By Value
 - 11.3.3.2. Market Share & Forecast
 - 11.3.3.2.1. By Technology
 - 11.3.3.2.2. By Product
 - 11.3.3.2.3. By Connectivity
 - 11.3.3.2.4. By Mounting
 - 11.3.3.2.5. By End-Use
- 11.3.4. Turkey Solar PV Module Market Outlook
 - 11.3.4.1. Market Size & Forecast
 - 11.3.4.1.1. By Value
 - 11.3.4.2. Market Share & Forecast
 - 11.3.4.2.1. By Technology
 - 11.3.4.2.2. By Product
 - 11.3.4.2.3. By Connectivity
 - 11.3.4.2.4. By Mounting
 - 11.3.4.2.5. By End-Use
- 11.3.5. Israel Solar PV Module Market Outlook
 - 11.3.5.1. Market Size & Forecast
 - 11.3.5.1.1. By Value
 - 11.3.5.2. Market Share & Forecast
 - 11.3.5.2.1. By Technology
 - 11.3.5.2.2. By Product

- 11.3.5.2.3. By Connectivity
- 11.3.5.2.4. By Mounting
- 11.3.5.2.5. By End-Use

12. ASIA PACIFIC SOLAR PV MODULE MARKET OUTLOOK

- 12.1. Market Size & Forecast
 - 12.1.1. By Technology
 - 12.1.2. By Product
 - 12.1.3. By Connectivity
 - 12.1.4. By Mounting
 - 12.1.5. By End-Use
 - 12.1.6. By Country
- 12.2. Asia-Pacific: Country Analysis
 - 12.2.1. China Solar PV Module Market Outlook
 - 12.2.1.1. Market Size & Forecast
 - 12.2.1.1.1. By Value
 - 12.2.1.2. Market Share & Forecast
 - 12.2.1.2.1. By Technology
 - 12.2.1.2.2. By Product
 - 12.2.1.2.3. By Connectivity
 - 12.2.1.2.4. By Mounting
 - 12.2.1.2.5. By End-Use
 - 12.2.2. India Solar PV Module Market Outlook
 - 12.2.2.1. Market Size & Forecast
 - 12.2.2.1.1. By Value
 - 12.2.2.2. Market Share & Forecast
 - 12.2.2.2.1. By Technology
 - 12.2.2.2.2. By Product
 - 12.2.2.2.3. By Connectivity
 - 12.2.2.2.4. By Mounting
 - 12.2.2.2.5. By End-Use
 - 12.2.3. Japan Solar PV Module Market Outlook
 - 12.2.3.1. Market Size & Forecast
 - 12.2.3.1.1. By Value
 - 12.2.3.2. Market Share & Forecast
 - 12.2.3.2.1. By Technology
 - 12.2.3.2.2. By Product
 - 12.2.3.2.3. By Connectivity

- 12.2.3.2.4. By Mounting
- 12.2.3.2.5. By End-Use
- 12.2.4. South Korea Solar PV Module Market Outlook
 - 12.2.4.1. Market Size & Forecast
 - 12.2.4.1.1. By Value
 - 12.2.4.2. Market Share & Forecast
 - 12.2.4.2.1. By Technology
 - 12.2.4.2.2. By Product
 - 12.2.4.2.3. By Connectivity
 - 12.2.4.2.4. By Mounting
 - 12.2.4.2.5. By End-Use
- 12.2.5. Australia Solar PV Module Market Outlook
 - 12.2.5.1. Market Size & Forecast
 - 12.2.5.1.1. By Value
 - 12.2.5.2. Market Share & Forecast
 - 12.2.5.2.1. By Technology
 - 12.2.5.2.2. By Product
 - 12.2.5.2.3. By Connectivity
 - 12.2.5.2.4. By Mounting
 - 12.2.5.2.5. By End-Use
- 12.2.6. Indonesia Solar PV Module Market Outlook
 - 12.2.6.1. Market Size & Forecast
 - 12.2.6.1.1. By Value
 - 12.2.6.2. Market Share & Forecast
 - 12.2.6.2.1. By Technology
 - 12.2.6.2.2. By Product
 - 12.2.6.2.3. By Connectivity
 - 12.2.6.2.4. By Mounting
 - 12.2.6.2.5. By End-Use
- 12.2.7. Vietnam Solar PV Module Market Outlook
 - 12.2.7.1. Market Size & Forecast
 - 12.2.7.1.1. By Value
 - 12.2.7.2. Market Share & Forecast
 - 12.2.7.2.1. By Technology
 - 12.2.7.2.2. By Product
 - 12.2.7.2.3. By Connectivity
 - 12.2.7.2.4. By Mounting
 - 12.2.7.2.5. By End-Use

13. MARKET DYNAMICS

- 13.1. Drivers
- 13.2. Challenges

14. MARKET TRENDS AND DEVELOPMENTS

15. COMPANY PROFILES

- 15.1. Jinko Solar Holding Co., Ltd.
 - 15.1.1. Business Overview
 - 15.1.2. Key Revenue and Financials
 - 15.1.3. Recent Developments
 - 15.1.4. Key Personnel/Key Contact Person
 - 15.1.5. Key Product/Services Offered
- 15.2. Trina Solar Limited
 - 15.2.1. Business Overview
 - 15.2.2. Key Revenue and Financials
 - 15.2.3. Recent Developments
 - 15.2.4. Key Personnel/Key Contact Person
 - 15.2.5. Key Product/Services Offered
- 15.3. Canadian Solar Inc.
 - 15.3.1. Business Overview
 - 15.3.2. Key Revenue and Financials
 - 15.3.3. Recent Developments
 - 15.3.4. Key Personnel/Key Contact Person
 - 15.3.5. Key Product/Services Offered
- 15.4. First Solar, Inc.
 - 15.4.1. Business Overview
 - 15.4.2. Key Revenue and Financials
 - 15.4.3. Recent Developments
 - 15.4.4. Key Personnel/Key Contact Person
 - 15.4.5. Key Product/Services Offered
- 15.5. Hanwha Q CELLS Co., Ltd.
 - 15.5.1. Business Overview
 - 15.5.2. Key Revenue and Financials
 - 15.5.3. Recent Developments
 - 15.5.4. Key Personnel/Key Contact Person

- 15.5.5. Key Product/Services Offered
- 15.6. JA Solar Holdings Co., Ltd.
 - 15.6.1. Business Overview
 - 15.6.2. Key Revenue and Financials
 - 15.6.3. Recent Developments
 - 15.6.4. Key Personnel/Key Contact Person
 - 15.6.5. Key Product/Services Offered
- 15.7. LONGi Green Energy Technology Co., Ltd.
 - 15.7.1. Business Overview
 - 15.7.2. Key Revenue and Financials
 - 15.7.3. Recent Developments
 - 15.7.4. Key Personnel/Key Contact Person
 - 15.7.5. Key Product/Services Offered
- 15.8. Risen Energy Co., Ltd.
 - 15.8.1. Business Overview
 - 15.8.2. Key Revenue and Financials
 - 15.8.3. Recent Developments
 - 15.8.4. Key Personnel/Key Contact Person
 - 15.8.5. Key Product/Services Offered
- 15.9. SunPower Corporation
 - 15.9.1. Business Overview
 - 15.9.2. Key Revenue and Financials
 - 15.9.3. Recent Developments
 - 15.9.4. Key Personnel/Key Contact Person
 - 15.9.5. Key Product/Services Offered
- 15.10. REC Group
 - 15.10.1. Business Overview
 - 15.10.2. Key Revenue and Financials
 - 15.10.3. Recent Developments
 - 15.10.4. Key Personnel/Key Contact Person
 - 15.10.5. Key Product/Services Offered

16. STRATEGIC RECOMMENDATIONS

17. ABOUT US & DISCLAIMER

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