

Flexible PV Cell Industry Research Report 2023

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Abstracts

A flexible PV cell which is also known as thin film solar cell that is made by depositing very thin layers of photovoltaics material on any kind of substrate, such as, paper, tissue, plastic, glass or metal. It is one of the most revolutionary and epoch making technologies in the sector of solar energy.

The significance of the word “flexible” is that, these kind of solar cells are not like those traditional big, bulky solar panels which is very common nowadays, these are literally flexible, very thin, lightweight, have very little installation cost and can be installed anywhere without going much trouble.

Thickness of a typical cell varies from a few nanometers to few micrometers, whereas its predecessor crystalline-silicon solar cell (c-Si) has a wafer size up to 200 micrometers.

In this report, we define flexible PV cells as PV modules fabricated on flexible substrate materials (most commonly used substrates are polyimide, polyethylene terephthalate (PET), polyethylene naphthalate (PEN), and metal foils such as stainless steel (SS) and titanium (Ti)), including flexible a-Si thin film cells, flexible CIGS cells, flexible CdTe cells, OPV cells, flexible DSSC and flexible perovskite PV.

Silicon (Si) solar cells dominate the PV market (92%) followed by cadmium telluride (CdTe, 5%), copper indium gallium selenide (CuInGaSe₂ or CIGS, 2%) and amorphous silicon (a-Si:H, ~1%). Si wafer with thickness around 180 μm is the traditional material being used for module manufacturing and it has attained significant level of maturity at the industrial level. Its production cost is a major concern for energy applications. About 50% of the cost of Si solar cells production is due to Si substrate, and device processing and module processing accounts for 20% and 30% respectively.

An alternate to Si solar cells is the thin μm solar cells fabricated on glass substrates. The main demerits of using glass substrates are fragile nature of modules, cost of glass wafer having thickness of 300–400 μm , and low specific power (kW/kg) etc. Specific power is an important factor when solar cells are used in space applications. A high specific power exceeding 2 kW/kg can be achieved by flexible solar cells on polymer μms which is useful for terrestrial as well as space applications. Production cost can be lowered by using flexible substrates and roll-to-roll production (R2R) technique. Apart from light weight, flexibility and less cost of installation, flexible cell processing involves low thermal budget with low material consumption. Other than solar cell applications, smaller specialized applications are beginning to become more viable independent markets, including applications for mobile power and building or product integration, which can benefit greatly from flexible thin μm options. Flexible cells on buildings (known as building integrated photovoltaics or BIPV) can minimize the cost of support, shipments etc., and installations can be handled easily. However, flexible solar cell technology is less mature when compared to the cells fabricated on rigid substrate counterpart.

Due to four main requirements - high efficiency, low-cost production, high throughput and high specific power, a major research and development focus has been shifted towards flexible solar cells. It can offer a unique way to reach terawatt scale installation by using high throughput R2R fabrication technique. Most commonly used substrates are polyimide, polyethylene terephthalate (PET), polyethylene naphthalate (PEN), and metal foils such as stainless steel (SS) and titanium (Ti).

The performance of flexible solar cells is comparable to rigid substrates. Flexible substrates are more advantageous than standard soda-lime glass (SLG) substrates. As mentioned below, there are several merits of using flexible substrates:

- Flexible modules are best suited for curved surfaces and used in BIPV. Since modules are produced from thin μm materials it is suitable for mass production.
- An important benefit is that it has potential to reduce the production cost. R2R deposition is beneficial in terms of production cost than that of rigid substrates. Glass cover is an added expense when rigid substrates are used.
- Materials required to produce CIGS, CdTe and a-Si:H flexible modules are much cheaper than conventional Si wafer, glass cover, frames used in Si modules.
- For roof top application, flexible modules are ideal due to light weight. Using

lightweight support, it can be installed over the rooftop where glass covered conventional heavy and bulky Si modules are not suitable when roof test fails due to an added weight and structural issues. Flexible modules can also be installed over the roof of the vehicle, uneven surfaces of building.

- Installation/labor cost is much lower for flexible modules due to less installation time since racking assembly, glass cover etc. are not required.
- Low power output flexible modules for example a-Si:H require large number of modules to get desired output which can be installed easily above the roof top.
- Glass covered rigid modules are fragile. Flexible modules are not fragile it can be rolled up, transported and handled easily.

Photovoltaic (PV) technologies are basically divided into two big categories: wafer-based PV (also called 1st generation PV) and thin-film cell PV. The emerging thin-film PVs are also called 3rd generation PVs, which refer to PVs using technologies that have the potential to overcome Shockley-Queisser limit or are based on novel semiconductors. The 3rd generation PVs include DSSC, organic photovoltaic (OPV), quantum dot (QD) PV and perovskite PV. The cell efficiencies of perovskite are approaching that of commercialized 2nd generation technologies such as CdTe and CIGS. Other emerging PV technologies are still struggling with lab cell efficiencies lower than 15%.

Highlights

The global Flexible PV Cell market is projected to reach US\$ million by 2028 from an estimated US\$ million in 2022, at a CAGR of % during 2024 and 2029.

In the industry, Sun Harmonics shipments most in 2019 and recent years, while HyET Solar and PowerFilm, Inc. ranked 2 and 3. The top 3 Flexible PV Cell manufacturers accounted for around 62% revenue market share in 2019.

The manufacturer headquarters is mainly distributed in North America, Europe, China and Japan.

There are six types of Flexible PV Cell including Flexible CIGS Solar Cells, Flexible a-Si Solar Cells, Organic Solar Cells (OPV), Flexible CdTe Solar Cells, Flexible DSSC, Flexible Perovskite Solar Cells. In addition, the application consists of BIPV,

Transportation & Mobility, Defense & Aerospace, Consumer & Portable Power. BIPV occupied nearly 51% of global flexible PV Cell sales market share in 2019.

Report Scope

This report aims to provide a comprehensive presentation of the global market for Flexible PV Cell, with both quantitative and qualitative analysis, to help readers develop business/growth strategies, assess the market competitive situation, analyze their position in the current marketplace, and make informed business decisions regarding Flexible PV Cell.

The Flexible PV Cell market size, estimations, and forecasts are provided in terms of output/shipments (MW) and revenue (\$ millions), considering 2022 as the base year, with history and forecast data for the period from 2018 to 2029. This report segments the global Flexible PV Cell market comprehensively. Regional market sizes, concerning products by types, by application, and by players, are also provided. The influence of COVID-19 and the Russia-Ukraine War were considered while estimating market sizes.

For a more in-depth understanding of the market, the report provides profiles of the competitive landscape, key competitors, and their respective market ranks. The report also discusses technological trends and new product developments.

The report will help the Flexible PV Cell manufacturers, new entrants, and industry chain related companies in this market with information on the revenues, production, and average price for the overall market and the sub-segments across the different segments, by company, product type, application, and regions.

Key Companies & Market Share Insights

In this section, the readers will gain an understanding of the key players competing. This report has studied the key growth strategies, such as innovative trends and developments, intensification of product portfolio, mergers and acquisitions, collaborations, new product innovation, and geographical expansion, undertaken by these participants to maintain their presence. Apart from business strategies, the study includes current developments and key financials. The readers will also get access to the data related to global revenue, price, and sales by manufacturers for the period 2017-2022. This all-inclusive report will certainly serve the clients to stay updated and make effective decisions in their businesses. Some of the prominent players reviewed in the research report include:

PowerFilm, Inc.

Panasonic

infinityPV

Flisom

Sun Harmonics

F-WAVE Company

Heliatek GmbH

HyET Solar

Ascent Solar Technologies, Inc

Product Type Insights

Global markets are presented by Flexible PV Cell type, along with growth forecasts through 2029. Estimates on production and value are based on the price in the supply chain at which the Flexible PV Cell are procured by the manufacturers.

This report has studied every segment and provided the market size using historical data. They have also talked about the growth opportunities that the segment may pose in the future. This study bestows production and revenue data by type, and during the historical period (2018-2023) and forecast period (2024-2029).

Flexible PV Cell segment by Type

CIGS

a-Si

OPV

Others

Application Insights

This report has provided the market size (production and revenue data) by application, during the historical period (2018-2023) and forecast period (2024-2029).

This report also outlines the market trends of each segment and consumer behaviors impacting the Flexible PV Cell market and what implications these may have on the industry's future. This report can help to understand the relevant market and consumer trends that are driving the Flexible PV Cell market.

Flexible PV Cell segment by Application

BIPV

Transportation & Mobility

Defense & Aerospace

Consumer & Portable Power

Others

Regional Outlook

This section of the report provides key insights regarding various regions and the key players operating in each region. Economic, social, environmental, technological, and political factors have been taken into consideration while assessing the growth of the particular region/country. The readers will also get their hands on the revenue and sales data of each region and country for the period 2018-2029.

The market has been segmented into various major geographies, including North America, Europe, Asia-Pacific, South America. Detailed analysis of major countries such as the USA, Germany, the U.K., Italy, France, China, Japan, South Korea, Southeast Asia, and India will be covered within the regional segment. For market estimates, data are going to be provided for 2022 because of the base year, with estimates for 2023 and forecast value for 2029.

North America

United States

Canada

Europe

Germany

France

U.K.

Italy

Russia

Asia-Pacific

China

Japan

South Korea

India

Australia

China Taiwan

Indonesia

Thailand

Malaysia

Latin America

Mexico

Brazil

Argentina

Key Drivers & Barriers

High-impact rendering factors and drivers have been studied in this report to aid the readers to understand the general development. Moreover, the report includes restraints and challenges that may act as stumbling blocks on the way of the players. This will assist the users to be attentive and make informed decisions related to business. Specialists have also laid their focus on the upcoming business prospects.

COVID-19 and Russia-Ukraine War Influence Analysis

The readers in the section will understand how the Flexible PV Cell market scenario changed across the globe during the pandemic, post-pandemic and Russia-Ukraine War. The study is done keeping in view the changes in aspects such as demand, consumption, transportation, consumer behavior, supply chain management, export and import, and production. The industry experts have also highlighted the key factors that will help create opportunities for players and stabilize the overall industry in the years to come.

Reasons to Buy This Report

This report will help the readers to understand the competition within the industries and strategies for the competitive environment to enhance the potential profit. The report also focuses on the competitive landscape of the global Flexible PV Cell market, and introduces in detail the market share, industry ranking, competitor ecosystem, market performance, new product development, operation situation, expansion, and acquisition. etc. of the main players, which helps the readers to identify the main competitors and deeply understand the competition pattern of the market.

This report will help stakeholders to understand the global industry status and trends of Flexible PV Cell and provides them with information on key market drivers, restraints, challenges, and opportunities.

This report will help stakeholders to understand competitors better and gain more insights to strengthen their position in their businesses. The competitive landscape section includes the market share and rank (in volume and value), competitor ecosystem, new product development, expansion, and acquisition.

This report stays updated with novel technology integration, features, and the latest developments in the market

This report helps stakeholders to understand the COVID-19 and Russia-Ukraine War Influence on the Flexible PV Cell industry.

This report helps stakeholders to gain insights into which regions to target globally

This report helps stakeholders to gain insights into the end-user perception concerning the adoption of Flexible PV Cell.

This report helps stakeholders to identify some of the key players in the market and understand their valuable contribution.

Core Chapters

Chapter 1: Research objectives, research methods, data sources, data cross-validation;

Chapter 2: Introduces the report scope of the report, executive summary of different market segments (by region, product type, application, etc), including the market size of each market segment, future development potential, and so on. It offers a high-level view of the current state of the market and its likely evolution in the short to mid-term, and long term.

Chapter 3: Detailed analysis of Flexible PV Cell manufacturers competitive landscape, price, production and value market share, latest development plan, merger, and acquisition information, etc.

Chapter 4: Provides profiles of key players, introducing the basic situation of the main companies in the market in detail, including product production/output, value, price, gross margin, product introduction, recent development, etc.

Chapter 5: Production/output, value of Flexible PV Cell by region/country. It provides a

quantitative analysis of the market size and development potential of each region in the next six years.

Chapter 6: Consumption of Flexible PV Cell in regional level and country level. It provides a quantitative analysis of the market size and development potential of each region and its main countries and introduces the market development, future development prospects, market space, and production of each country in the world.

Chapter 7: Provides the analysis of various market segments by type, covering the market size and development potential of each market segment, to help readers find the blue ocean market in different market segments.

Chapter 8: Provides the analysis of various market segments by application, covering the market size and development potential of each market segment, to help readers find the blue ocean market in different downstream markets.

Chapter 9: Analysis of industrial chain, including the upstream and downstream of the industry.

Chapter 10: Introduces the market dynamics, latest developments of the market, the driving factors and restrictive factors of the market, the challenges and risks faced by manufacturers in the industry, and the analysis of relevant policies in the industry.

Chapter 11: The main points and conclusions of the report.

Frequently Asked Questions

Which product segment grabbed the largest share in the Product Name market?

How is the competitive scenario of the Product Name market?

Which are the key factors aiding the Product Name market growth?

Which are the prominent players in the Product Name market?

Which region holds the maximum share in the Product Name market?

What will be the CAGR of the Product Name market during the forecast period?

Which application segment emerged as the leading segment in the Product Name market?

What key trends are likely to emerge in the Product Name market in the coming years?

What will be the Product Name market size by 2028?

Which company held the largest share in the Product Name market?

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