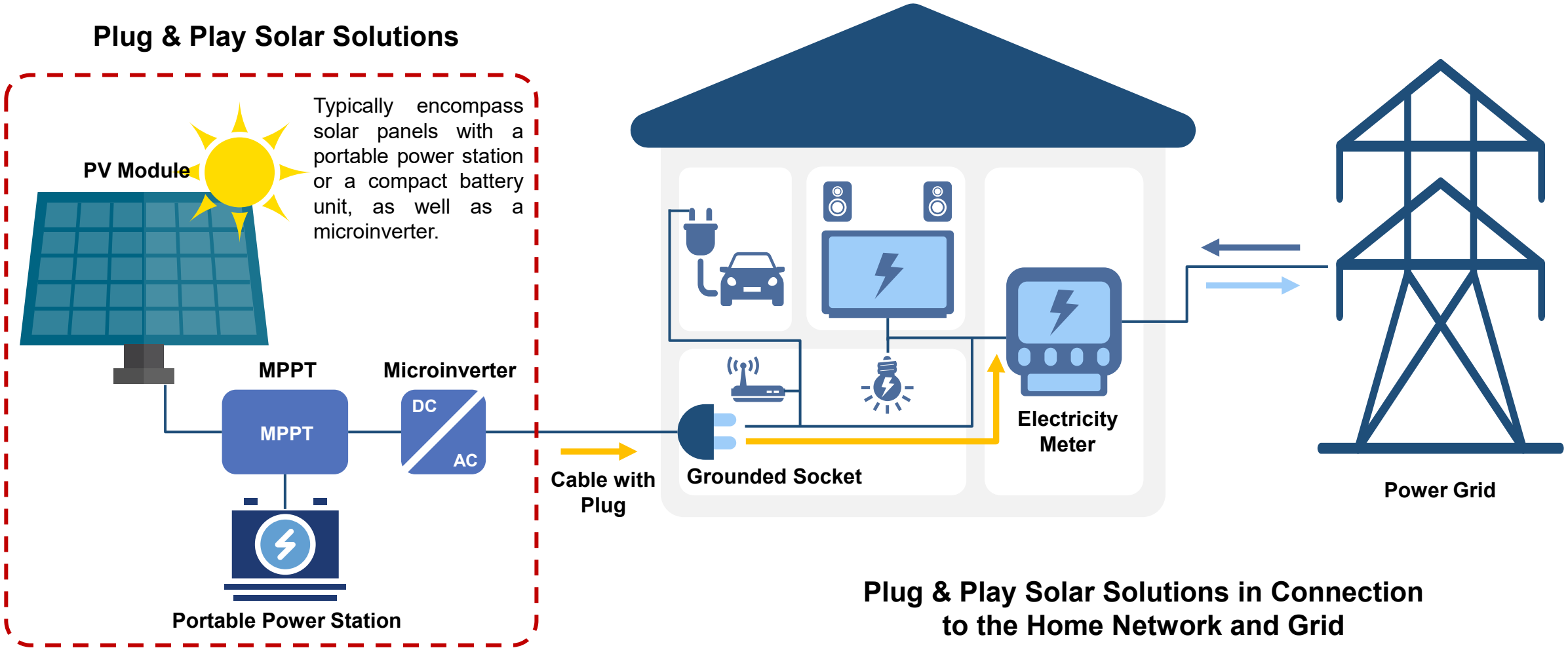
FROST & SULLIVAN

GLOBAL PLUG & PLAY SOLAR SOLUTIONS INDUSTRY RESEARCH REPORT

June, 2025

Plug & Play Solar Solutions are user-friendly systems combining 100–2000W solar panels with 100–4000Wh portable power stations or plug & play solar plants, offering pure sine wave AC output and quick, tool-free setup.



Plug & Play Solar Solutions in Connection to the Home Network and Grid

Source: Solar Power Europe, Frost & Sullivan Analysis

Value chain of global plug & play solutions industry mainly comprises upstream raw material suppliers, midstream plug & play solar solutions providers, and downstream scenarios including apartment, camping, recreational vehicle and commercial property.

Value Chain of Global Plug & Play Solar Solutions Industry

Upstream

Raw Material Suppliers

- Solar Polysilicon and Solar wafer
- Inverter and Power Electronic
- Battery Cell
- Other Raw Materials

Midstream

Plug & Play Solar Solutions Providers

- Solar Panel Manufacturer
- Inverter and Portable Power Station Manufacturer
- Plug & Play Solar System Integrator

Downstream

Downstream Scenarios

- Apartment

- Camping

- Recreational Vehicle

- Commercial Property

Source: Frost & Sullivan Analysis

Driven by advances in technology, safety standards, and consumer demand, plug & play solar solutions evolved from early concepts into easy-to-use energy solutions, and now widely adopted for homes and small spaces, offering flexible, affordable access to clean power.

Before 2010

Conceptualization and Early Innovation

The genesis of the plug & play solar solution concept can be traced back to the early 2000s when distributed solar generation began gaining traction among residential users and small businesses. At this stage, the solar market was dominated by complex, professionally installed systems requiring inspections, and electrical work. Early innovators began to envision modular solar products that could be easily deployed by consumers themselves—mirroring trends in consumer electronics and DIY home improvement.

2010-2015

Technological Foundation and Product Prototyping

As inverter technology, especially microinverters and plug-compatible power electronics, matured, the plug & play solar prototypes began to emerge. Companies in Germany, the United States, and Japan experimented with compact solar kits that could be plugged directly into standard power outlets. This period was marked by innovation in safety mechanisms, form factor optimization, and early commercialization. Despite this progress, regulatory uncertainty and a lack of standardized safety certifications continued to hinder widespread rollout. Nevertheless, this phase saw important groundwork being laid in terms of product design and feasibility demonstration.

2016-2021

Commercialization and Regulatory Recognition

The turning point came in the late 2010s when advancements in inverter miniaturization, smart metering, and IoT connectivity enabled more robust and compliant plug & play solar solutions. Markets like Germany and the Netherlands began to adapt regulations, allowing limited-capacity (e.g., ≤600W) plug & play systems to be installed without a licensed electrician. In the U.S., although federal incentives like the Investment Tax Credit (ITC) supported solar broadly, local permitting rules still posed barriers. By this stage, early adopters embraced plug & play as an accessible alternative to rooftop solar—ideal for renters, small households, and low-income users.

2022-Present

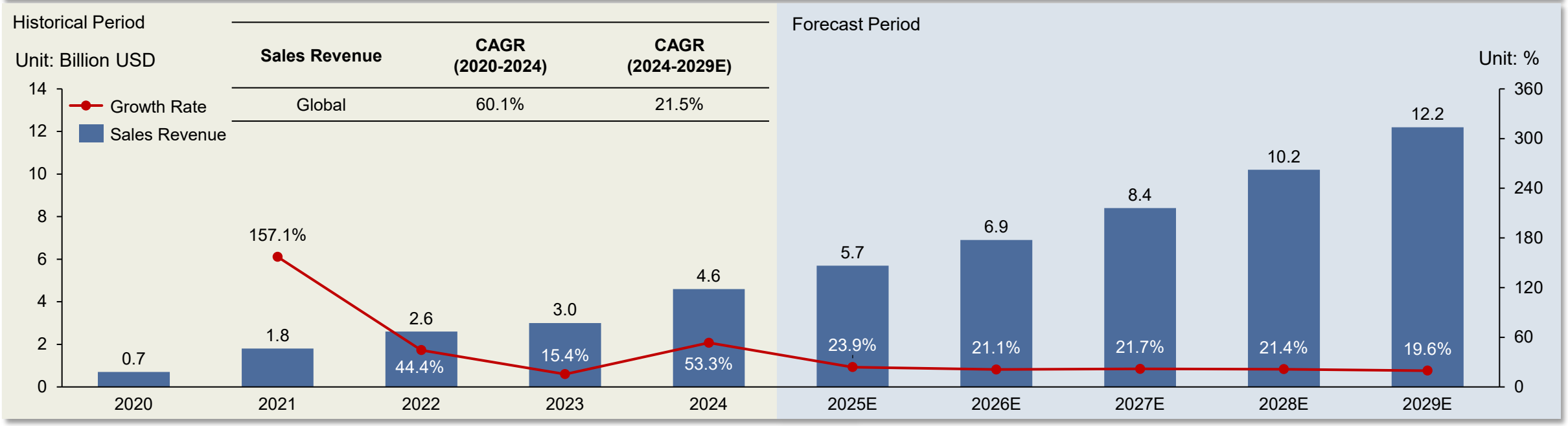
Mass Market Adoption and Ecosystem Integration

The current phase is characterized by growing consumer demand for energy resilience, decarbonization, and energy independence, driven by climate events, rising utility costs, and geopolitical disruptions. In 2024, Germany increased the approval-exempt capacity for plug & play solar systems from 600W to 800W. Plug & play solar solutions have become increasingly mainstream, with product offerings now including solar panels, portable power stations, and microinverters.

Source: Frost & Sullivan Analysis

Sales revenue of global plug & play solar solutions industry reached USD4.6 billion in 2024, and is projected to grow to USD12.2 billion by 2029, with a CAGR of 21.5% from 2024 to 2029.

Sales Revenue of Global Plug & Play Solar Solutions Industry, 2020-2029E



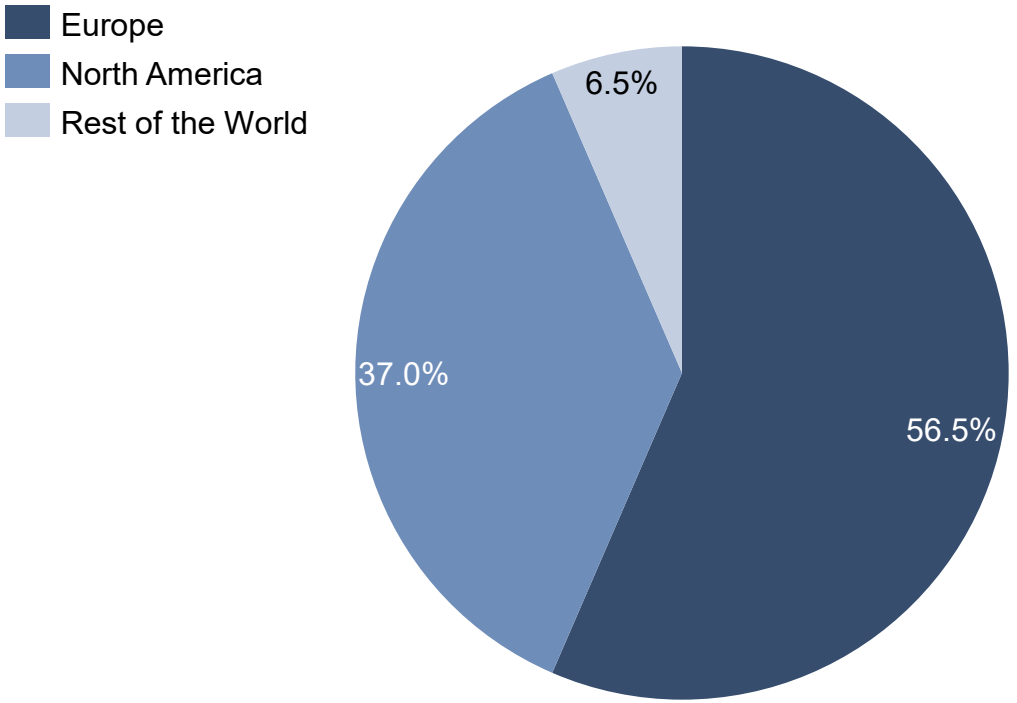
- In recent years, the plug & play solar solutions industry experienced a significant breakthrough, marking a pivotal moment in its development and adoption. Driven by the rapid advancements in technology, increased affordability, and growing consumer interest, the market size of plug & play solar solutions industry has experienced a significant growth. The global market size of plug & play solar solutions industry in terms of sales revenue increased to USD4.6 billion in 2024. By 2029, the global market size of plug & play solar solutions industry in terms of sales revenue is expected to reach USD12.2 billion, with a CAGR of 21.5% from 2024 to 2029.

Note: Sales revenue of global plug & play solar solutions industry includes sales revenue derived from the products in plug & play solar solutions, including plug & play solar systems, solar panels, microinverters, and portable power stations.

Source: Frost & Sullivan Analysis

Europe and North America are two key markets of plug & play solar solutions industry, accounting for 56.5% and 37.0% in terms of sales revenue in 2024, respectively.

Share of Major Regions, in Terms of Sales Revenue, 2024



- The plug & play solar solutions industry has seen significant growth in recent years, particularly in regions like Europe and North America, where energy prices are high, and there is strong government support for renewable energy. In 2024, Europe dominated the global market demand for portable power stations, accounting for 56.5%, whilst North America is the second largest market in the global plug & play solar solutions industry, with a share of 37.0%.

Source: Frost & Sullivan Analysis

Major countries in Europe are accelerating the introduction of incentives, driving the rapid growth in plug & play solar solutions industry.

Key Incentives of Plug & Play Solar Solutions Industry

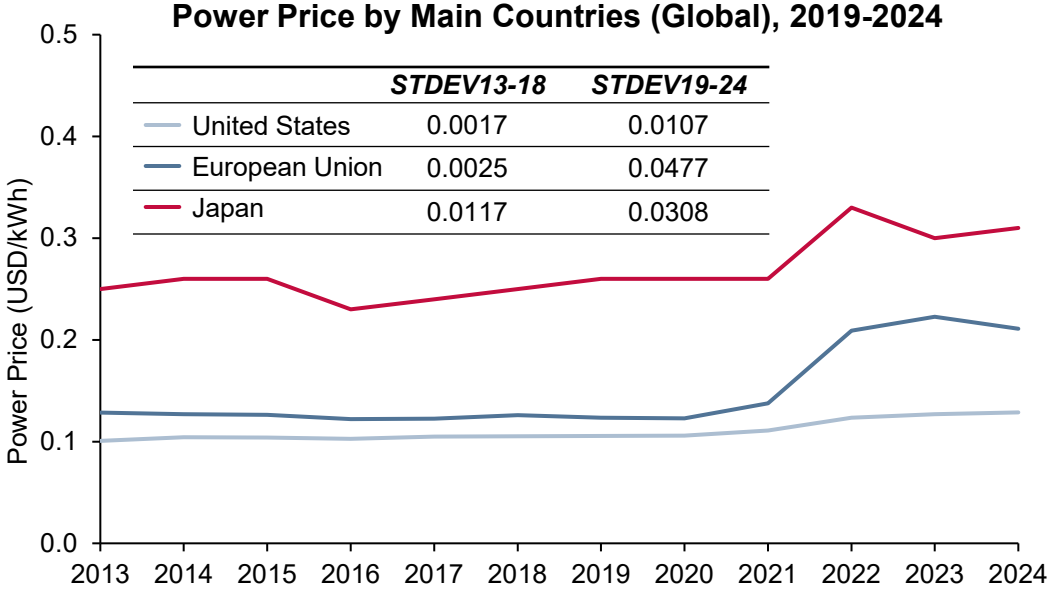
	Policies and Regulations	Issue Year	Description
Germany	Solarpaket I	2024	• Simplified the registration, requiring only a simple notification to the market master data register within one month of commissioning. • The threshold for simplified registration of balcony power plants is proposed to increase from 600 to 800 watts.
Ireland	Budget 2024	2023	• The Sustainable Energy Authority of Ireland is allocated €380 million to fund their community and residential energy upgrades schemes. This includes a solar PV grant program for homeowners.
Austria	2025 Rebate Program for Rooftop PV Systems	2025	• Launch €60 million rebate program for rooftop PV.
UK	ECO4 (Energy Company Obligation)	2022	• Local Grant target low-income and vulnerable households. They offer funding for renewable energy solutions, such as solar panels.
Italy	Superbonus 110%	2020	• The program includes a tax credit of up to 110% for expenses related to energy efficiency in house constructions and renovations, which includes the installation of solar panels.
France	French Budget Bill 2025	2024	• Cutting the value-added tax (VAT) to 5.5% for PV systems up to 9 kW from October 2025.

Source: Frost & Sullivan Analysis

Volatility of power prices has increased demand for energy independence, particularly in developed countries, which accelerated the demand for plug & play solar solutions.

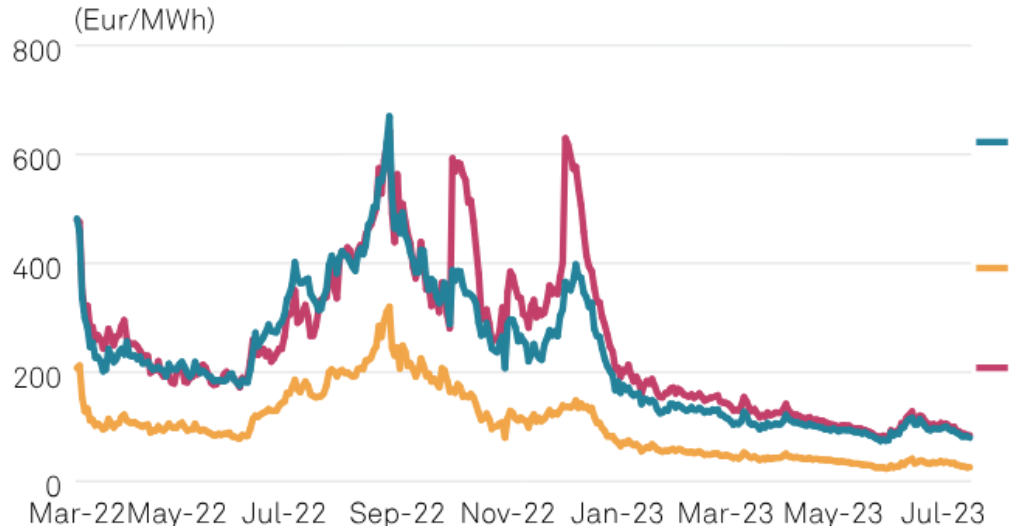
Increasing Awareness and Demand for Energy Independence

Power Price by Main Countries (Global), 2019-2024



	STDEV13-18	STDEV19-24
United States	0.0017	0.0107
European Union	0.0025	0.0477
Japan	0.0117	0.0308

Power Price of Main European Countries During 2022-2023



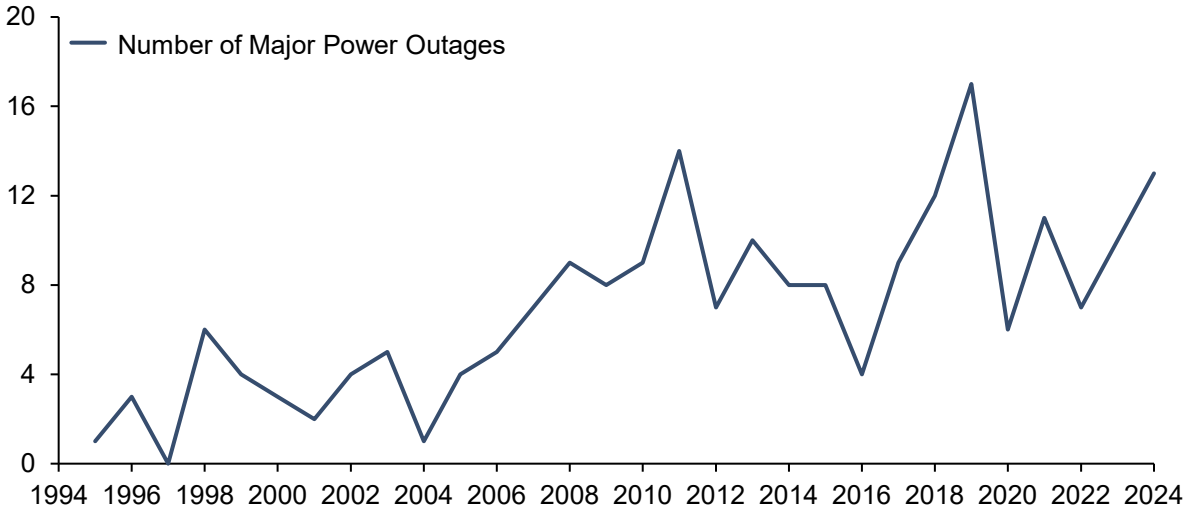
- Volatility of power prices has been a key driver for increasing demand for energy independence, particularly in developed countries. For example, Europe's power demand patterns have changed post energy crisis. The 2022 Russian-Ukraine conflict led to disruption of European gas markets and surge of energy costs. Germany and UK have witnessed power price spikes of over EUR600/MWh. According to BloombergNEF, record-high power prices and policies to limit demand reduced European electricity consumption by 6% in 2022-2023, arousing demand for power independence and accelerating the demand for plug & play solar solutions. In addition, the increasing penetration of renewable energy also increases the power price volatility. As a result, power prices have become more volatile due to the growing share of intermittent generation plants and a stronger link to the global gas market. Elevated power price caused by high gas prices and rising volatility create arbitrage opportunities for plug & play solar solutions.

Source: BNEF, Frost & Sullivan Analysis

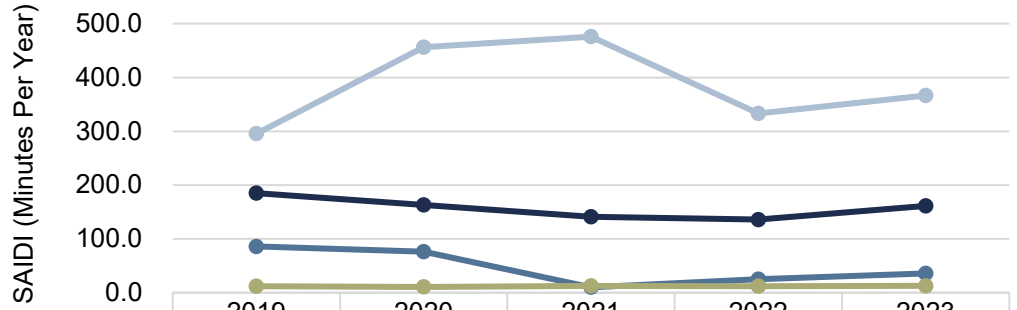
The need for energy reliability is a key driver of the global plug & play solar solutions market, driven by aging infrastructure and climate challenges.

Need for Energy Reliability Driving the Demand for Plug & Play Solar Solutions

Number of Major Power Outages*



System Average Interruption Duration Index (SAIDI) by Main Countries (Global), 2019-2023



	2019	2020	2021	2022	2023
United States	295.5	456.1	475.8	333.0	366.6
Japan	86.0	76.0	10.0	25.0	36.0
Germany	12.2	10.7	12.7	12.2	12.8
G20	185	163	141	136	161

- The aging power grid and power plants, coupled with the increasing frequency of natural disasters, have significantly heightened the need for power reliability. The United States, in particular, faces substantial challenges due to its aging infrastructure and prevalent underinvestment. Much of the United States power grid was constructed in the 1960s and 1970s, and as of 2023, approximately 70% of transmission lines and transformers are over 25 years old, and the average age of large power transformers is about 40 years. The aging infrastructure is not only struggling to meet the growing electrical demand but is also highly vulnerable to failures caused by extreme weather events. The increasing frequency and intensity of natural disasters, such as hurricanes, wildfires, and ice storms, further exacerbate the problem. These events can cause widespread and prolonged power outages, severely impacting public safety, economic stability, and quality of life. During 2019-2023, the System Average Interruption Duration Index (SAIDI) of the United States is over 380 min/year on average, significantly higher than the 151 min/year of the G20, indicating more than 2 times the power disruption duration as compared to G20 countries. To meet these challenges, it is critical for power supplies to be more resilient and reliable and to have plug & play solar solutions.

*Note: A major power outage must meet the criteria including: (1) it is not an outage planned by power suppliers; (2) it affects at least 1,000 people; (3) it lasts at least one hour; and (4) the total person-hours of disruption from the outage amount to at least 1 million person-hours.

Source: U.S. Energy Information Administration, Bundesnetzagentur of Germany, Frost & Sullivan Analysis

Technological advancements, expanding application scenarios, and community energy sharing will be the key future development trends in the plug & play solar solutions industry.

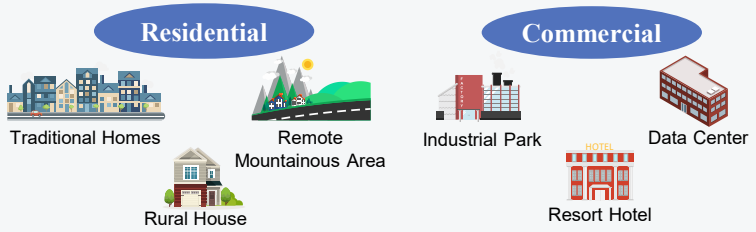
Technological Advancement

- Continuous technological advancements are expected to drive the rapid development of the global plug & play solar solutions market. On the one hand, innovations in battery and solar panel technology, such as the development of solid-state batteries and perovskite solar cells, have increased the energy density of plug & play solar solutions, extended service life, and strengthened safety performance while effectively cutting costs. On the other hand, the introduction of smart energy management technologies, especially the integration of AI and IoT technologies, has enabled plug & play solar solutions to more accurately and efficiently regulate energy use, such as by using a distributed architecture and AI algorithmic scheduling to maximize the power output of the plug & play solar solutions.

Expanding Application Scenarios

- The application scenarios for plug-and-play solar solutions will continue to expand and deepen, extending beyond traditional residential rooftops and small commercial buildings to more diverse settings. In the residential sector, in addition to conventional single-family and multi-family homes, these solutions will see wider adoption in rural housing and remote mountainous areas, providing convenient and reliable power solutions for regions lacking stable grid coverage, thereby improving local residents' quality of life. In the commercial sector, beyond office buildings and shopping malls, high-energy-demand facilities such as data centers, industrial parks, and resort hotels will increasingly adopt plug-and-play solar solutions to reduce operational costs, enhance energy self-sufficiency, and support environmental sustainability. Additionally, niche applications such as outdoor camping, emergency rescue operations, agricultural greenhouses, and aquaculture will become important markets for plug-and-play solar solutions.

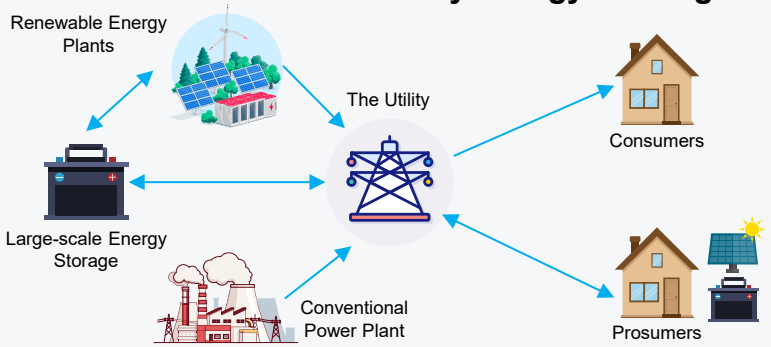
Expanding Application Scenarios



Community Energy Sharing

- The rise of community energy sharing is driving the adoption of plug-and-play solar solutions, facilitating localized energy exchange and microgrid development. Within a community, multiple users can integrate their plug-and-play solar systems into the microgrid, enabling energy sharing and complementarity. For example, when a user generates surplus electricity, they can sell the excess power to others via the microgrid or store it for community facilities. Conversely, when their generation is insufficient, they can draw electricity from the microgrid. This model can enhance the efficiency of solar energy and strengthen a community's energy self-sufficiency and supply reliability. In the future, as the concept of community energy sharing becomes more widespread, plug-and-play solar solutions will play a crucial role in building a low-carbon, intelligent, and shared community energy ecosystem.

The Model of Community Energy Sharing



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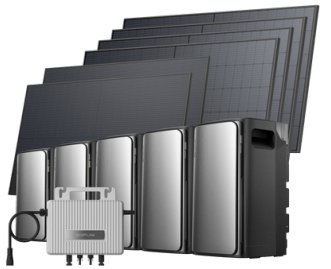
Source: Frost & Sullivan Analysis

EcoFlow's STREAM Series Plug & Play Solar Plant is industry's first to achieve maximum output of 2,300W through a single system and industry's first distributed smart home energy solution.

Main Brand	Main Balcony Solar System	Capacity	Maximum Output	Maximum PV Input	Distribution Form
EcoFlow	STREAM Series Plug & Play Solar Plant	1.92kWh-23.04kWh	2,300W	12,000W	Distributed
Anker SOLIX	Anker SOLIX Balcony Power Storage System	2.68kWh-16kWh	2,000W	3,600W	Centralized
Jackery	Jackery Home Power 2000 Ultra	2kWh-8kWh	800W	2,800W	Centralized
BLUETTI	2nd Gen Balcony Solar System	2kWh-6kWh	800W	1,100W	Centralized
Growatt	NEXA 2000	2kWh-8kWh	800W	2,600W	Centralized
Enphase	IQ Balcony Solar System	1.5kWh	800W	1,200W	Centralized
Zendure	SolarFlow	1.92kWh-7.68kWh	1,200W	1,800W	Centralized
BSLBATT	MicroBox 800	2kWh-7.832kWh	1,200W	2,000W	Centralized

Source: Company Website, Frost & Sullivan Analysis

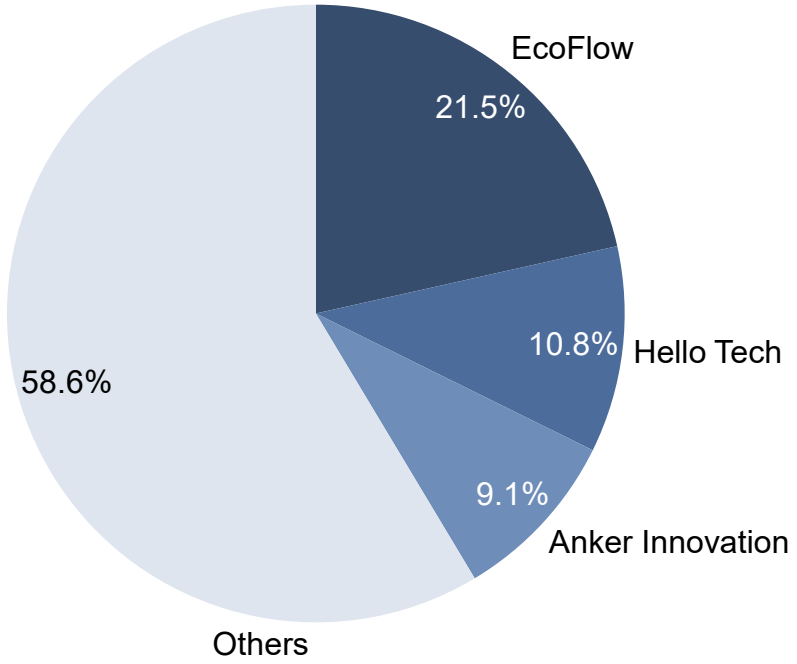
There are numerous players in global plug & play solutions industry, and the main participants include EcoFlow, Hello Tech, and Anke Innovation.

Main Participants	Introduction	Main Product Series
EcoFlow	• Founded in 2017, EcoFlow is a national high-tech enterprise in the field of portable power station and clean energy. EcoFlow is a global industry pioneer in portable power station and clean energy, with over 5 million users worldwide, products sold in over 140 countries and regions, and owned over 1,100 patented technologies.	EcoFlow STREAM Series 
Hello Tech (stock code 301327)	• Founded in 2011, Hello Tech is mainly engaged in the research, development, production and sales of portable power station and home energy storage products. Hello Tech was listed on China GEM in September 2022, and has two major brands, including Jackery and Geneverse.	Jackery Home Power 2000 Ultra 
Anker Innovation	• Founded in 2011, Anker Innovation specializes in the design, development and sales of smart accessories and smart hardware. Anker Innovation launched Anker SOLIX, a consumer-grade new energy brand and the Anker SOLIX home energy product series in 2023, which covers portable power station, balcony solar system and residential energy storage.	Anker SOLIX Balcony Power Storage System 

Source: Frost & Sullivan Analysis

Global plug & play solar solutions industry is relatively concentrated. In 2024, the top three participants accounted for 41.4% in terms of sales revenue in global plug & play solar solutions industry.

Competitive Landscape of Global Plug & Play Solar Solutions Industry, in Terms of Sales Revenue, 2024



- Driven by the increasing demand for small-scale clean energy solutions among residential users in Europe and North America, as well as the supportive photovoltaic policies in countries such as Germany and the Netherlands, the plug and play solar solutions industry has experienced rapid growth in recent years. The global plug and play solar solutions industry is composed of key players such as portable power stations companies, inverter companies, residential energy storage companies, photovoltaic companies, among others. Among them, portable power stations companies maintain a leading position due to their strong brand influence and well-established distribution channels. In 2024, the top three participants accounted for 41.4% in terms of sales revenue in global plug & play solar solutions industry. In 2024, EcoFlow ranked first in global plug & play solutions industry, in terms of sales revenue, with a market share of 21.5%.

Note: Sales revenue of global plug & play solar solutions industry includes sales revenue derived from the products in plug & play solar solutions, including plug & play solar systems, solar panels, microinverters, and portable power stations.

Source: Annual Reports, Frost & Sullivan Analysis

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