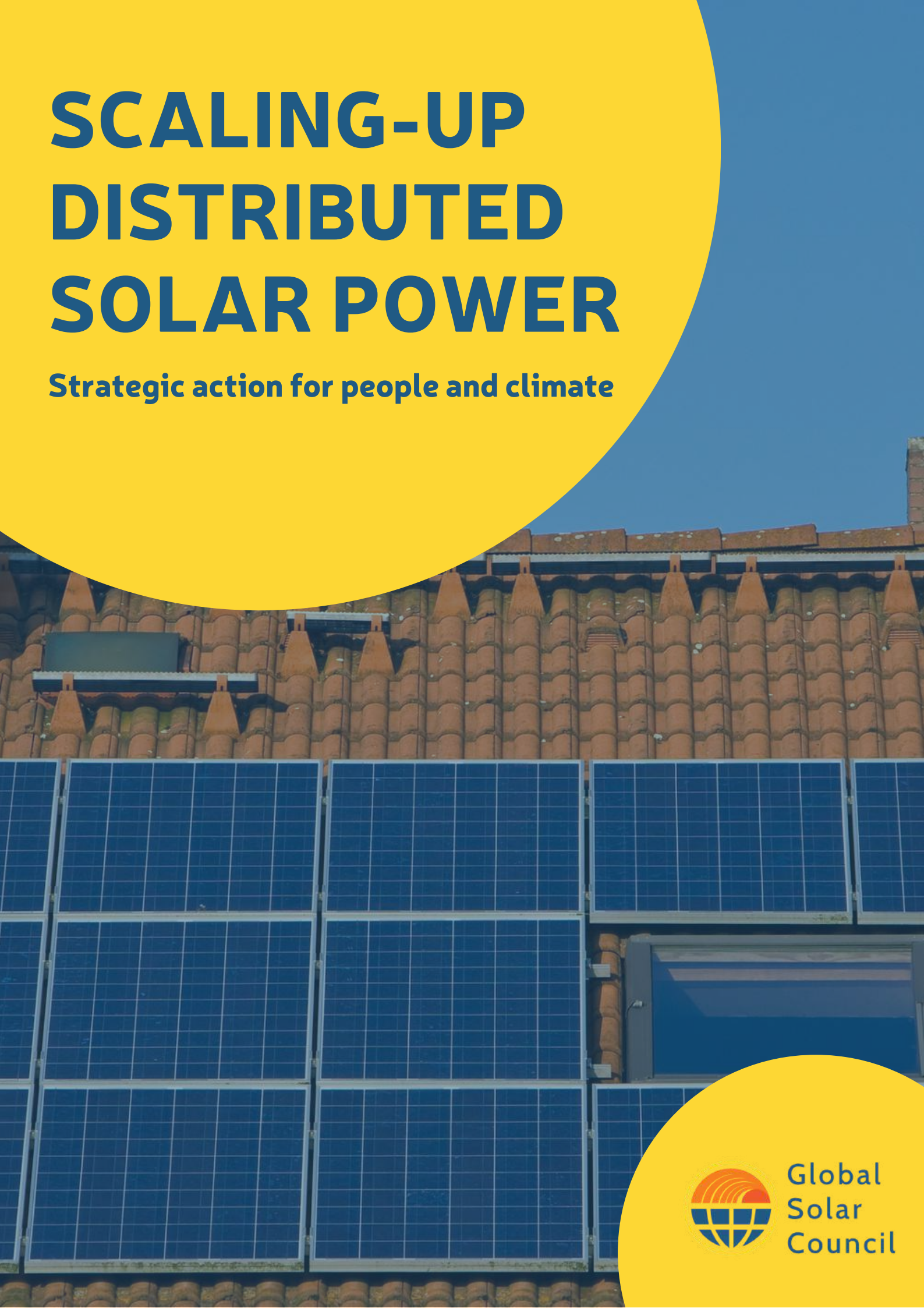
SCALING-UP DISTRIBUTED SOLAR POWER

Strategic action for people and climate



Global Solar Council

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Published: September 2023

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Foreword

Solar PV is already leading the energy transition and providing immediate solutions to the global energy crisis. It is time to raise ambitions and target 100% renewable energy systems, which is proven to be feasible and cost effective. The global solar market is ready to power our increased objectives, and the distributed segment can offer a significant contribution. With this work, the Global Solar Council (GSC) focuses on distributed solar PV to demonstrate its potential, identify barriers to be removed and best practices to be replicated in order to boost deployment. The complexity of permitting procedures remains the critical bottleneck hindering the full speed development and representing a cost whose incidence became higher as technological costs have sharply decreased. Hence, this document is directed to decision-makers and regulators in par ticular.

The GSC activities, initiatives and partnerships at COP 27 have all focused on showcasing the potential of solar power and the opportunities from the integration with storage and other renewables and clean technologies, as well as on highlighting the barriers that still need to be removed. During COP 27, the GSC, its members and partners, showcased the role of distributed solar PV for people empowerment, broader energy access, and more efficient land use. Rooftop and off-grid solar PV systems can increase energy resiliency and access while lowering power costs, unlocking a broad range of socio-economic benefits for people around the globe while empowering them to contribute to the clean energy transition. Faster distributed solar PV deployment can also help diversify supply chains and create millions of new jobs.

Through a global communication campaign activated in conjunction with the study on the distributed solar PV market's policies and regulations, the GSC seeks to help empower the millions of citizens who want to play a role in reversing the climate crisis today, help regulators and legislators put in place regimes that facilitate their desire to invest in solar solutions and promote a cultural shift about how they understand their role as prosumers and invest in both their homes and a sustainable future. In doing so, the GSC is unique in joining the entire global solar industry, with the ability to compare markets in the Global North and Global South, and activate partnerships with relevant organizations, even beyond the power sector.

Gianni Chianetta
CEO

Máté Heisz
Chair

Executive Summary

The events of 2022, as the Russian invasion of Ukraine sparked an unprecedented global energy crisis that hit Europe first, and has then quickly unfolded worldwide, have unequivocally highlighted the risk of over-dependences from fossil fuels and remarked the role of solar PV as a leading force towards international energy security and socio-economic development in a context of international instability, energy and climate crises. Solar PV is a uniquely versatile and reliable technology, and this makes distributed solar generation highly beneficial for economies and societies. Exploiting a natural resource available locally and freely, people around the globe can benefit from greater independence and resilience through self-consumption, lower power costs, and broader access to energy, empowering themselves to contribute personally to the clean energy transition. Distributed solar power can impulse a flourishing green economy creating jobs and incentivizing local supply chains, while supporting the overall electrification of the economy, even beyond the power sector.

However, the distributed market faces specific barriers, bottlenecks and constraints that need to be addressed from a comparative, inter-regional viewpoint. This is essential and urgent in order to accelerate the global energy transition, scaling up solar capacity with 2030 as a key, fast-approaching milestone to limit the most disastrous effects of climate change.

Drawing on its unique position as the global solar industry association, the GSC has gathered its members around the globe to shed light on the potential of distributed solar PV as a much-needed solution to the energy and climate crises, and key enabler of 100% renewable electricity systems. The GSC campaign “Empowering people with solar PV” has disseminated, throughout the year and in multiple languages, knowledge about the vast benefits associated with distributed solar generation. The GSC has also gathered insights on the distributed solar PV markets from a group of 13 countries around the world,

analysing policies, permitting and regulatory frameworks to identify main barriers to faster deployment as well as best practices to unlock faster uptake.

This report highlights how **distributed solar power can contribute a significant portion of the total installed solar capacity while vast potential is still untapped** for countries to advance on their decarbonization targets, in the power sector and beyond. Several large solar markets are emerging in different parts of the globe. In particular, **five respondents reported distributed solar capacities above 2 GW**: Italy (16.6 GW), Brazil (7.3 GW), South Africa (3.75 GW), Spain (2.7 GW), Mexico (2.01 GW). Furthermore, **distributed solar PV accounts for at least 10% of the total solar capacity in 8 countries of the group, while it reaches at least one quarter of the total installed solar PV capacity in 5 countries:** Colombia (89%), Italy (66%), South Africa (59%), Brazil (46%), and Mexico (25%).

Yet, regulatory bottlenecks and political opposition, translated into complex and fragmented authorization procedures and inadequate policy frameworks, remain the main factors that slow down the full-speed rollout of distributed solar PV. Key barriers are represented by the **complexity of the grid connection process, inhomogeneous national authorization procedures, and insufficient financial support.**

The analysis identifies best practices that proved able to accelerate the uptake of distributed solar PV in several countries, which can be replicated worldwide to sustain more ambitious decarbonization targets and unlock solar power's full potential to be the leading technology for a clean and sustainable future. In fact, despite an acceleration in solar PV deployment originated by the global energy crisis, progress towards climate neutrality is still insufficient while fossil fuels consumption keeps being heavily subsidized with public resources that should be redirected to finance solar PV's development. There is growing perception that global solar PV, that is becoming a market shaper for the power sector, can outperform the projections of the leading net zero scenarios.

The GSC calls for increased ambitions in line with a 100% renewable electricity target. This is feasible, both technically and economically, and solar PV plays a critical role:

- The global solar industry estimates that the annual solar PV market will reach the **1 TW** mark by 2030;
- **11 countries** have potential to reach around **240 GW** aggregated rooftop PV capacity. Together, Mexico, Spain, France, South Africa, Brazil, and Italy alone could reach 200 GW of installed distributed PV capacity;
- The global solar PV sector could generate **60 million jobs** worldwide by 2050, with the distributed solar sector counting for around **16 million jobs**.

As a result of a global benchmarking on regulations for distributed solar PV, the GSC puts forward specific recommendations for policymakers and regulators to boost deployment of distributed solar PV.

The GSC recommends:

- **Streamlining permitting for rooftop solar PV;**
- **Simplifying the authorization processes establishing "one-stop shops" and providing mandatory maximum mandate times;**
- **Setting out legislation to provide guaranteed grid connection for distributed solar PV systems;**
- **Introducing mandates to equip rooftop solar PV for all new constructions and renovated buildings;**
- **Homologating the authorization procedures at a national level;**
- **Increasing the clarity and stability of regulatory frameworks;**
- **Setting specific national targets for rooftop solar PV;**
- **Adopting and promoting net-metering and energy communities;**
- **Replicating best practices from other countries.**

Introduction

The awareness of consumers about climate change and a related desire to act on an individual level is rapidly increasing globally. As power grids are in different countries experiencing disruption and outages due to extreme weather events[1, 2, 3] consumers are gaining a whole different perspective towards residential solar power, which can make them more energetically resilient and independent[4]. This is escalated by critical factors such as inadequate grid capacity, unstable networks, and insufficient investment in power grids in several countries, particularly in the Global South. Moreover, there is increasing recognition of the key role solar PV plays in enabling decentralised solutions – including mini- grid, off-grid and stand-alone systems – for broader energy access in areas where national grids are absent and power generation is dependent upon unreliable and expensive, often diesel-based, power generation. In fact, around 80% of the 700 million people without access to electricity live in rural areas, three-quarters of them in Sub-Saharan Africa[5]. At the same time, policy and cost conditions have improved and made PV more attractive driving a rise in awareness of the financial benefits for prosumers as collective self- consumption and energy communities develop. This results in an increased sophistication of common knowledge of panels and appliances' functioning and characteristics, as well as in greater purchase rates for solar home systems.[6]

Further acceleration of such trends resulted from the unprecedented global energy crisis sparked by Russia's invasion of Ukraine in early 2022, which has confirmed the risk of over dependences from fossil fuels, including the price volatility they entail, and remarked the role of renewables – and solar PV in particular – as a pivotal gateway to international energy security[7]. The crisis has impacted consumers and businesses heavily with soaring energy prices. The European gas benchmark

1. *https://time.com/6235156/extreme-weather-us-power-outages/*
2. *https://www.climatecentral.org/climate-matters/surging-weather-related-power-outages*
3. *https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/091422-pakistan-floods-endanger-power-plants-aggravate-energy-crisis*
4. *https://www.cnn.com/2022/10/02/us/solar-babcock-ranch-florida-hurricane-ian-climate/index. html*
5. *2022 Tracking SDG7 Report; Tracking SDG7: The Energy Progress Report.*
6. *https://www.euronews.com/green/2023/03/11/energy-crisis-solar-panel-sales-double-in-the- uk-as-homeowners-look-to-cut-soaring-bills*
7. *https://www.iea.org/news/renewable-power-s-growth-is-being-turbocharged-as-countries-seek- to-strengthen-energy-security*

peaked at more than €300/MWh in August 2022,[8] and higher energy commodity prices intensified the pressure on consumer prices in Q1 2022, with the European Harmonised Index of Consumer Prices (HICP) energy inflation rising to 32% in February and further to 44% in March.[9]

Although Europe is at the forefront of such crisis, shocks have quickly expanded to other countries directly affecting the costs of heating, cooling, lighting, and mobility, indirectly pushing up the costs of other goods and services throughout global supply chains, and major impacts are being felt in several emerging and developing economies. This is reflected clearly in the number of people worldwide who still lack access to electricity – the large majority of whom live in Sub-Saharan Africa – which rose last year for the first time in decades as energy prices spiked amid the crisis.[10]

A recent analysis published in Nature Energy[11] shows that total energy costs (direct and indirect) for households have increased by at least 63% and as much as 113% from February until September 2022. This contributed to an increase in global household expenditure of between 2.7% and 4.8%, a massive economic shock for households, just to maintain their pre-2022 living standards.[12]

Thus, the global energy landscape has changed dramatically over the last months. The Russian war on Ukraine, with spiking energy prices and supply chain disruptions, has amplified calls for an accelerated energy transition. Energy security concerns have prompted countries worldwide to intensify deployment of renewables such as solar and wind to reduce reliance on imported fossil fuels. This is driving a sharp acceleration in renewable power installations, with total capacity growth set to almost double in the next five years, overtaking coal as the largest source of electricity generation and crucially contributing to keeping the 1.5 °C target in sight.

Indeed, global renewable power capacity is now expected to grow by 2.400 gigawatts (GW) over the 2022-2027 period, according to the International Energy Agency (IEA).[13] A massive increase that is 30% higher than what was forecasted one year earlier, showing how quickly governments can activate enabling policies for renewables.

For the first time in 2021, solar and wind surpassed 10% of global electricity generation.[14] As the fastest-growing source of power generation, solar photovoltaics currently accounts for around 4% of global electricity. However, as the High-Level Climate Champions 2030 Breakthrough target for Clean Power indicates, solar and wind power have to make up at least 40% of global electricity generation by 2030, in order to keep the 1.5 °C objective alive. Their share would then need to rise to 70% by 2050, according to the IEA's Net Zero scenario. Such a pathway would require 630 GW of solar PV to be added annually by 2030, up from the record 268 GW of new solar capacity added in 2022.[15] The net zero and 1.5C scenarios developed by the IEA and IRENA (International Renewable Energy Agency) project global solar capacity to reach around 5 TW in 2030 and 14 TW in 2050.

However, academic studies modelling the transition to 100% renewable energy systems project considerably higher figures. For 2030, solar PV capacities in the leading scenarios range between 5 TW and 10 TW based on the different levels of ambition towards the penetration of renewables in the electricity mix, and the contribution of solar power in their share. By 2050, as much as 63 TW of solar PV are globally deployed in a 100% renewable energy scenario.[16]

The current state of play of the solar market suggests such levels might be attainable. Solar PV has been growing at record rates for years, and in 2022 global installed capacity reached the terawatt (TW) scale with prospects of more than doubling by 2026 to 2.3 TW.[17]

8. *https://www.ft.com/content/3bb53193-da20-4860-bed6-c2781dff1ea0*
9. *https://www.ecb.europa.eu/pub/economic-bulletin/focus/2022/html/ecb.ebbox202204_01~68ef3c3dc6.en.html*
10. *https://www.iea.org/commentaries/where-things-stand-in-the-global-energy-crisis-one-year-on* 11. *https://www.nature.com/articles/s41560-023-01209-8*
12. *https://www.weforum.org/agenda/2023/02/russia-ukraine-war-energy-costs/,*
13. *https://www.iea.org/reports/renewables-2022*
14. *Global Electricity Review 2022; EMBER*
15. *https://www.pv-magazine.com/2022/12/23/global-solar-capacity-additions-hit-268-gw-in- 2022-says-bnef/*
16. *World Solar Market Report; International Solar Alliance (ISA).*
17. *Global Market Outlook for Solar Power 2022 – 2026; SolarPower Europe.*

According to industry estimates, the annual solar PV market will reach the 1 TW mark by 2030.

Ambitions need to be raised in line with a 100% renewable energy target. This is feasible, both technically and economically, and indeed advantageous. Research increasingly shows that 100% renewable energy systems are not only feasible but also cost effective, able to generate significant savings compared to current systems, unlock trillions in additional GDP while stimulating the economy through millions of new jobs and billions in avoided climate and health costs.[18, 19, 20]

For the massive deployment that is required onwards, it is clear we need solar to lead a diversified clean energy mix with wind, energy storage, green hydrogen, and other renewables and clean technologies. It is also clear that solar power, as the leading asset on the global pathway to full decarbonization, needs to be developed at all scales, hand in hand with energy storage. Solar PV generates the least cost energy
and, on a level playing field, with fossil fuels no longer heavily subsidized, its competitiveness within energy markets is unparalleled. In the race to decarbonize the global economy while ensuring a just transition and improving resilience of communities worldwide, distributed generation and self-consumption are crucially gaining consideration. The unique versatility of solar PV makes it the protagonist as it can be sized within an exceptionally wide range: from Giga-scale plants down to few-Watts charging appliances, solar panels are the most versatile source of clean energy to be employed in the major system shift we need to undertake. More than other means of the transition, solar PV is going to enter people's lives widely and soon, becoming the common-use technology through which people identify the energy revolution.

Distributed solar PV can increase energy security while lowering power costs, unlocking a broad range of socio-economic benefit for people around the globe while empowering them to contribute to the clean energy transition. Faster distributed solar PV deployment can also help stimulating local supply chains, creating millions of green jobs and addressing the need for well-functioning and diversified supply chains to ensure a secure energy transition.

The global solar PV sector is the largest employer among renewables with at least 4.3 million jobs in 2021.[21] In terms of gender balance, solar PV workforce fares better (with women accounting for 40% of the total) than the renewable energy sector as a whole (32%) and far better than the wind (21%) and the global oil and gas industry (22%). Research shows solar PV emerging as the prime electricity generation source and in the process creating as much as 60 million jobs worldwide by 2050, with solar PV prosumers covering residential, commercial, and industrial segments providing around 16 million jobs.[22] In the EU alone, solar PV employment could reach between 1 and 1.5 million jobs by 2030.[23]

When it comes to gender diversity, the solar PV workforce excels, boasting a 40% representation of women. This figure surpasses the broader renewable energy sector's 32% gender balance and stands head and shoulders above both the wind energy sector, with only 21% female participation, and the global oil and gas industry, where women make up just 22% of the workforce.[24, 25, 26]

Distributed solar PV can increase energy security while lowering power costs, unlocking a broad range of socio-economic benefit for people around the globe.

18. C. Breyer et al., "On the History and Future of 100% Renewable Energy Systems Research," in IEEE Access, vol. 10, pp. 78176-78218, 2022, doi: 10.1109/ACCESS.2022.3193402.
19. Manish Ram, Arman Aghahosseini, Christian Breyer, Job creation during the global energy transition towards 100% renewable power system by 2050, Technological Forecasting and Social Change, Volume 151, 2020.
20. Dmitrii Bogdanov, Ashish Gulagi, Mahdi Fasihi, Christian Breyer, Full energy sector transition towards 100% renewable energy supply: Integrating power, heat, transport and industry sectors including desalination, Applied Energy, Volume 283, 2021.

21. Renewable Energy and Jobs Annual Review 2022; IRENA, ILO.
22. Manish Ram, Arman Aghahosseini, Christian Breyer, Job creation during the global energy transition towards 100% renewable power system by 2050, Technological Forecasting and Social Change, Volume 151, 2020.
23. EU Solar Jobs Report 2022; SolarPower Europe.
24. Renewable Energy: A Gender Perpsective. 2019, IRENA
25. Wind Energy: A Gender Perspective. 2020. IRENA
26. Solar PV Energy: A Gender Perspective. 2023. IRENA

Solar PV's deployment also represents strategic climate action. In fact, distributed solar generation can vastly support the acceleration of total solar PV capacity globally. To be on track for net-zero by 2050, the IEA estimates that globally, 100 million households need to be equipped with rooftop solar PV by 2030 and 240 million by 2050 - up from the current 25 million.[28] Higher ambitions should be set forth within the distributed generation sector in order for countries to get on pathway to 100% renewable systems. These can be powered by policy mandates for all new or renovated buildings to be equipped with solar panels, one of the key GSC recommendations for distributed solar PV. Such requirements should become the norm in mature markets and, while they might not be immediately feasible for specific markets in the Global South, should be gradually introduced everywhere in order to provide even more roofs worldwide with solar panels.

The need for solar PV is also outlined by the latest intelligence across sectors and markets. The buildings sector (including residential, commercial and public buildings) is responsible for around one-third of total final energy consumption and generates nearly 40% of annual global energy-related CO2 emissions, almost 30% of which result from building operations. The IEA indicates that carbon emissions from buildings operations need to more than halve by 2030.[28] IRENA outlines how increasing energy conservation and efficiency in heating and cooling is critical for the energy transition in buildings, if we want to be on track to limiting global warming to 1.5°C above pre-industrial levels. In fact, the buildings sector will see the highest direct electrification rates, reaching 56% by 2030 and 73% by 2050, compared to about 30% at present.[29] Thus, overall, the buildings sector represents almost 28% of the total energy transition investment needed over the period to 2050. Solar energy plays a fundamental role for the transforming the buildings sector, such as in providing renewable energy to power energy efficient heat pumps and drive the integration of e-mobility.

The GSC seeks to contribute to the achievement of even higher figures, sustaining greater ambitions to empower 100% renewable energy scenarios, which will help solar PV unlock its full potential in mitigating the climate crisis; driving the development of smart cities, energy communities, and prosumerism (i.e., increased involvement of customers in the power generation process); empowering people and communities with sustainable and inclusive access to power. Furthermore, distributed solar PV has the unique ability to create positive externalities towards the overall electrification and energy efficiency of buildings, ranging from heating and cooling, lighting, cooking to e-mobility.

Yet, the rooftop sector presents a long series of specific barriers, bottlenecks and constraints that need to be addressed from a comparative, inter- regional viewpoint. While utility-scale plants are more likely to attract near-term investments on a sufficient scale to accelerate the share of PV installations, rooftop solar involves a deeper, long-term transformation of the electric system towards a more distributed model. Thus, this report includes an investigation of the state of distributed solar PV markets of a group of countries around the world, identifying regulatory barriers that need to be removed and setting forward key policy recommendations to accelerate deployment, building on best practices already in place.

27. https://www.iea.org/reports/approximately-100-million-households-rely-on-rooftop-solar-pv- by-2030
28. https://www.iea.org/reports/buildings
29. World Energy Transitions Outlook: 1.5°C Pathway; IRENA

Empowering people with solar PV

"Empowering people with solar PV" is a Global Solar Council initiative aimed at engaging people worldwide to learn how they can make a difference in the race to net zero supporting solar PV's capacity targets and at the same time becoming more energy independent. The focus of the initiative is the uptake of distributed solar PV in the buildings sector, thus mainly rooftop systems in private, public, commercial and industrial buildings.

The initiative seeks to capitalize on an unprecedented momentum and stimulate an even faster and broader uptake of distributed solar PV. Alongside a study conducted on the sector's regulations and authorization procedures to match main bottlenecks in emerging markets with good practices in mature ones, and issue policy recommendations for decision-makers, regulators, and industry leaders to maximize the uptake of rooftop solar PV, a global communication campaign directed to the public at large.

Distributed solar generation can vastly support the acceleration of total solar PV capacity globally. To be on track for net-zero by 2050, the IEA estimates that globally, 100 million households need to be equipped with rooftop solar PV by 2030 and 240 million by 2050 - up from the current 25 million.

Disseminating solar PV's benefits

Besides offering significant economic opportunities to consumers, solar power is key to decarbonizing the global economy and our cities while bringing a vast range of benefits to people, communities and t he planet. The GSC, with the involvement of its members and partners, and in collaboration with IRENA[30], has issued storytelling in eight chapters, including all the relevant information about distributed solar PV spanning the technology, the policies, the market, the benefits, and more, for consumers worldwide to start saving on their energy bills immediately while contributing to the global decarbonization targets.

Among the key benefits and aspects covered:

Greater independence and increased energy access

- Immediate relief on electricity bills; Self-consumption and additional income/tax breaks;
- Coupling storage, heat pumps, hybrid boilers to unlock even more savings;
- Electrification of rural areas of developing countries for cooking, refrigerating, lighting and more.

Energy security is a solar panel away

- Avoid risky fossil fuel dependencies and locking in new fossil infrastructure for years to come;
- Solar energy is freely available everywhere and can provide power that exceeds global energy demand;
- Accelerated deployment of distributed solar power can greatly help countries and societies secure energy supplies and achieve true independence.

30. The GSC has partnered up with IRENA to enrich the campaign with insightful videos on rooftop solar PV systems.

A flourishing green economy

- Create green jobs and more inclusive labour market;
- Incentivize local supply chains;
- With growing energy needs, rooftop solar, solar home systems and solar pumps can also enable progress in education, agriculture, cooking and cooling;
- Support the electrification of transportation and other sectors, sustaining the development of energy communities and smart cities.

The best time to invest is now

- Waiting to install panels means delaying savings on energy bills;
- Even people without suitable roofs can generate power with solar panels thanks to specific programs which are available in many countries. Passive income is also possible and can be considerable.

Reaching out to people around the globe

Thanks to the engagement of the GSC members worldwide, the “Empowering people with solar PV” is currently available in: English, Portuguese, Spanish, French, Chinese, Arabic & Ukrainian.

Engaging at COP 27

As part of its presence at COP 27 in Sharm El-Sheikh, Egypt, the GSC presented the campaign and the main outcomes from the study on policies and regulations in a dedicated session of the GSC Forum. In doing so, the GSC involved members from different continents as well as partners from the renewables world and beyond.

The GSC, WWF, Greenpeace International, Amarenco, and others, showed together at COP 27 that a shared vision and complementarity is possible between solar power and nature. As capacity can be deployed avoiding unnecessary land disruption, exploiting urban and suitable areas, and increasing recycling targets, solar PV actually brings opportunities for greater biodiversity, helping restore some of the vast amounts already lost. GSC hopes that as this is increasingly understood – the new partnerships with environmental groups and beyond the power sector go in this direction – it will stimulate simplification of the authorization processes, the definition of suitable areas and improved mandates for buildings worldwide.

Asia is the fastest growing region in the world. By keeping pace with the world's effort to shift to renewable energy, the region can be carbon neutral by 20250. By investing in solar, reshaping business around renewables, and making it a practical choice for all, Asia will be well on the path to slowing carbon emissions and realizing the endless benefits of solar energy. (APVIA)

It will also help motivate communities and make more people passionate about solar in line with climate targets, empowering them to push for change. Cooperation at the local level, engaging people on the ground, is the real way to call all stakeholders at different levels (municipalities, regions and central governments) to faster action and to achieve greater social acceptance.

A campaign in support of individual action

At COP 27, the Asian Photovoltaic Industry Association (APVIA), has launched the "I Pledge Solar campaign" in partnership with the Global Solar Council. APVIA, the largest organization representing the photovoltaic industry in the region, wants to lead a Net-Zero Future campaign in Asia disseminating the many benefits of solar energy among people and also go beyond that by offering a platform to encourage the people in supporting the collective race toward a net zero future and 240 million solar rooftops by 2050, promoting the uptake of distributed solar PV from the residential to the industrial level.

Currently, we are far from the many million rooftops that are needed for net zero. The pledging platform will record the commitments of individuals, as well as of solar companies, developers, funders, communities, and other stakeholders to undertake action. Through this platform, they are able to commit kilowatt hours (kWh) of production of solar energy, taking us one step closer to a carbon-neutral future, with low-cost and clean energy for all. The GSC is committed to helping disseminate and extend the campaign from Asia to the global level.

Analysis of the distributed solar PV sector

As mentioned, the rooftop solar sector presents specific barriers, bottlenecks and constraints that need to be addressed in a comparative approach. In order to scope down the main challenges and the key good practices to kick-start or accelerate the sector's growth, the GSC inspected a number of markets, through the involvement of its members around the world. This was possible thanks to the GSC's unique nature as the global solar industry association, gathering and representing the whole supply chain. The objective of the global benchmarking analysis of regulations and authorization procedures for distributed PV is to disseminate best practices and issue policy recommendations to reduce frictions and maximize the uptake of rooftop solar PV.

The analysis was conducted by engaging the GSC members as well as key stakeholders ranging from industry associations to regulators and administrations to understand potential distributed capacity and main challenges in different countries and collect good policy practices concerning grid connection, energy storage, tariffs and more. The outcomes will support the formulation of recommendations in this report, including mapping of most common challenges and main regulatory barriers in the emerging markets and matching them with good policy practices in mature markets.

The GSC, in close cooperation with its Strategy Committee, has developed an in-depth survey and submitted it to its members spread around the world in order to:

- Understand the current state of distributed solar markets across the globe;
- Find out the potential and targets for distributed solar PV of different countries;
- Identify bottlenecks in the development of distributed solar projects;
- Discover the best practices that can help accelerate the deployment of solar PV globally.

The GSC seeks to develop a comprehensive dataset which covers the widest range of solar markets possible, both those in maturity and those emerging. This can provide a reference point against which it is possible to highlight lessons learnt and hurdles to be avoided by developing markets, as well as innovative solutions that they may have found in their own journeys.

Thanks to the entries provided by the GSC members, twelve national markets are involved in the analysis. The following table and map show the countries that are included around the globe, as well as the national association that provided the data and information.

Country	National Industry Association
Argentina	Camera Argentina de Energias Renovables
Brazil	Brazilian Solar Photovoltaic Energy Association
Chile	Asociación Chilena de Energía Solar AG
Colombia	Colombian Renewable Energy Association
Ecuador	Asociación Ecuatoriana de Energías Renovables y Eficiencia Energética
France	Syndicat des Energies Renouvelables
Italy	Italia Solare
Malaysia	Malaysian Photovoltaic Industry Association
Mexico	Asociacion Mexicana de Energia Solar Fotovoltaica A.C.
Spain	Unión Española Fotovoltaica
South Africa	South African Photovoltaic Industry Association
Philippines	Philippine Solar and Storage Energy Alliance Inc.
Ukraine	Solar Energy Association of Ukraine

Key outcomes

This section presents the main results of the GSC's analysis on an aggregate level for capacity, potential, and permitting and authorization challenges. Key aspects emerged from the study: distributed solar PV capacity is spread across different continents and regions; rooftop solar can contribute a significant por tion of countries' total solar capacity; gaps between installed capacities and potential capacities signal vast untapped potential.

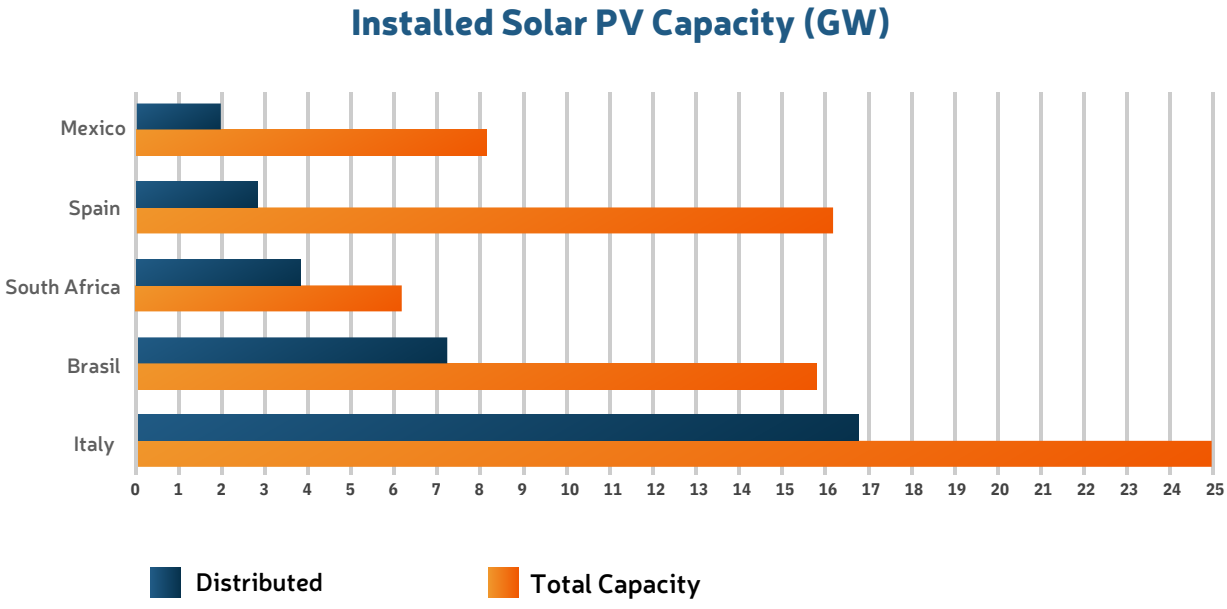
Installed capacity is spread

Distributed solar photovoltaic has become one of the more popular sources of renewable energy across the globe. This comes as a result of its unique ability to be employed at both utility and small scale, its cost leadership, and socio-economic benefits that can vary depending on the legislative framework in place.[31]

There are now several large solar markets emerging, but the most appealing factor is that these markets appear in different continents across the globe. Of the respondents, 5 markets appear the largest for rooftop solar PV, with capacity above 2 GW.[32]

1. **Italy** – 16.6 GW
2. **Brazil** – 7.3 GW
3. **South Africa** – 3.75 GW
4. **Spain** – 2.7 GW
5. **Mexico** – 2.01 GW

What is extremely encouraging to see is the variety of countries that appear with high capacity, and that this is not particularly concentrated geographically.



31. Solar PV is becoming the lowest-cost option for new electricity generation in most of the world, which is expected to propel investment in the coming years; https://www.iea.org/reports/ solar-pv

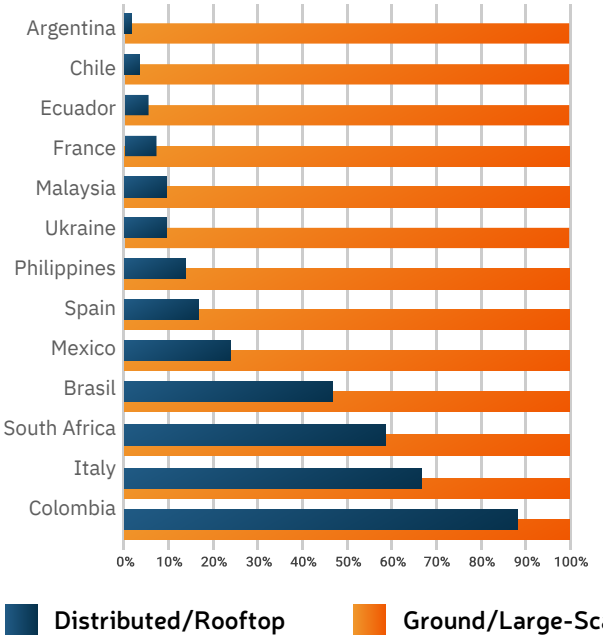
32. At the time of surveying.

Distributed generation can contribute to a significant portion of total capacity

In multiple countries, a significant amount of people is already turning to distributed solar generation as a means of generating their own energy, to reduce and stabilize their energy costs while enhancing their independence. There are many other reasons to turn to solar panels: absent or problematic access to the grid, environmental consciousness, health concerns, financial benefits, ESG goals, and more.

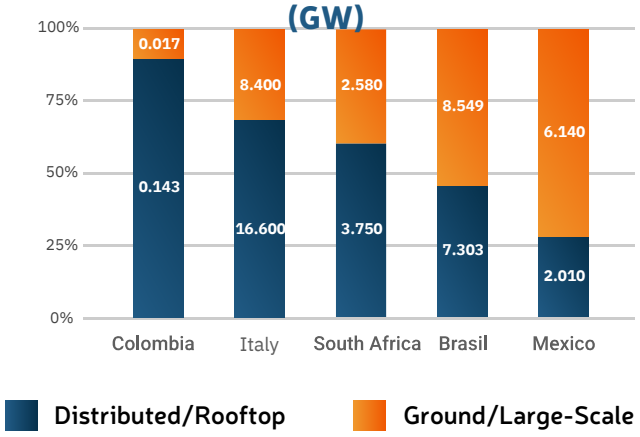
Such trends are increasingly allowing the distributed sector to contribute significantly to the total solar capacity in different countries, opening new possibilities for those facing geographical and environmental constraints. In fact, distributed solar PV accounts for at least 10% of the total solar capacity in 8 countries of the group: Malaysia, Ukraine, Philippines, Spain, Mexico, Brazil, South Africa, and Colombia.

Distributed Solar PV Share



Moreover, 5 of the respondents revealed that at least one quarter of the total solar energy capacity in the country comes in the form of distributed solar PV. Colombia – although housing a young solar market – shows the highest proportion of rooftop solar PV to total capacity in the group, at over 89% of the total. It is followed by Italy at 66%, South Africa at 59%, Brazil at 46%, and Mexico with 25% of the total solar capacity being represented by rooftop systems. The cases of Italy and Brazil highlight how distributed generation can significantly contribute to the overall capacity also in large, multi-gigawatts markets. This acts as testament to the concept that solar energy is a tool that can be used by consumers at all scales in order to take ownership not only over their energy but also of their role in the energy transition.

Installed Solar PV Capacity (GW)

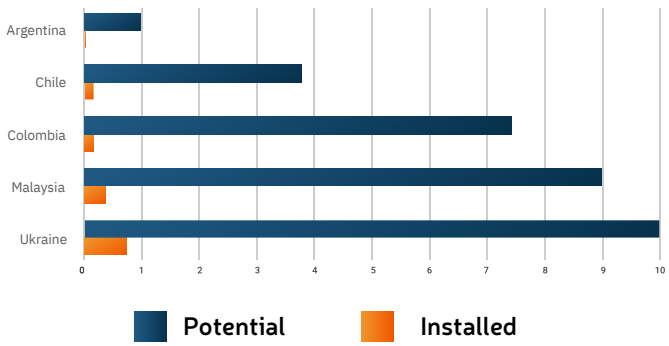


There is still great potential to unlock

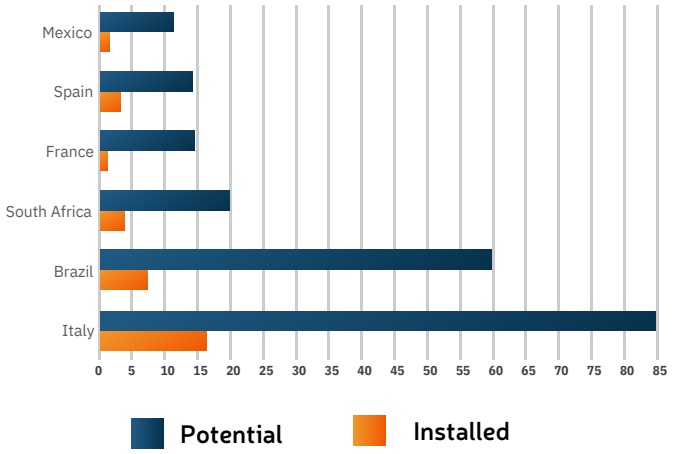
Despite the existence of well-established markets, several of which are over the 1 GW mark for the distributed segment, it is important to remark how there is still a vast potential to untap for countries to advance on their targets. A number of countries showcase big gaps between installed capacity and potential capacity.

Given the significant difference in scale, they are represented in two groups – up to 10 GW, and above. It must be noted how, in many cases, the potential can be underestimated due to a lack of specific studies.

Rooftop Solar Installation Gaps - Group 1



Rooftop Solar Installation Gaps - Group 2



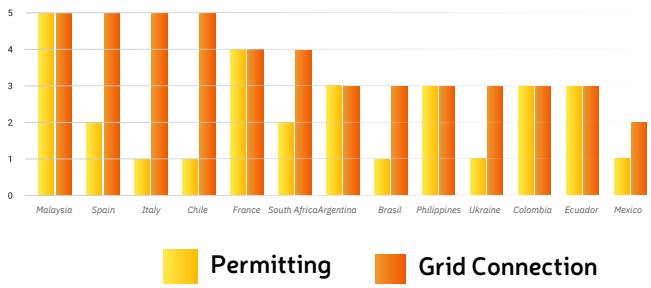
As part of the Paris Agreement, several countries made pledges to transition their energy mix to more sustainable and renewable forms of energy. A number of those has set ambitious targets to be completed over a relatively large amount of time, anticipating an accelerated deployment of solar PV in the near future in order to fill in the gap. These are significant targets which will not only require technological progress, but also accompanying policy and financial commitments from governments and private entities in order to create enabling environments and realise said targets. Brazil, France, Spain, and South Africa have all set solar power targets for 2030, and as such, it is clear that there needs to be a rapid and significant rollout of solar PV in these countries in order to stay on track for their net zero targets.

Overall, between 2028 and 2035, 11 countries alone have potential to reach around 240 GW aggregated distributed PV capacity. Together, Mexico, Spain, France, South Africa, Brazil, and Italy could reach 200 GW.

Authorization hurdles

Across the respondents, the most prevalent challenge in the process of deploying distributed solar PV systems is perceived as the connection to the grid. The GSC survey allows to highlight the perceived difficulty of the permitting and connection processes from 1 to 5, with 5 being very difficult. It emerges that connecting a solar PV system to the grid is perceived at least as difficult as obtaining permission to install it in the totality of cases.

Perceived Complexity



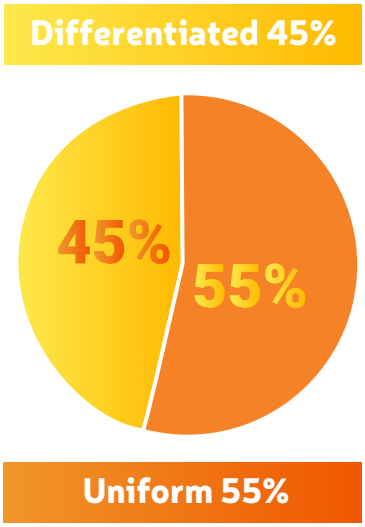
In the macro regions with sufficient data to generate average values, it emerges how the processes are not equally problematic, it is the grid connection that is more complex and time consuming. Furthermore, four countries specifically referred to the grid connection phase as the most difficult part of the entire authorization process:

- Ukraine;
- Mexico;
- Philippines;
- Malaysia.
- Italy

Another significant and diffused barrier is the non- uniformity of authorization procedures across the country. The pie chart shows the proportion of uniform versus local procedure across the respondents.

Country	Authorization Procedure
Brasil	Uniform
Chile	Uniform
France	Uniform
Malaysia	Uniform
Ukraine	Uniform
Colombia	Uniform
Argentina	Differentiated
Mexico	Differentiated
Italy	Differentiated
Spain	Differentiated
South Africa	Differentiated

National Authorization Procedures



A number of countries show generally uniform policy but some regional differences, such as Spain and Italy. These countries have been included as having differentiated procedure under the condition that any change at a local level disrupts the process causing delays. Mexico appears to have differentiated procedures at a regional level, which increases the complexity and length of the authorization process and leads to different results across the country. So much so that as a recommendation for the increased uptake of solar PV, is the homologation of policy. This can allow for easier upscaling of investments in solar projects as there can be similar applications for multiple processes, which ought to be processed for similar times.

Increased financial support is needed

Solar PV is mature, affordable, reliable, and does not require incentives in most mature markets. However, several countries employ tax incentives and capital investment refunds to stimulate their markets. Others (as in the case of South Africa) still have no incentives in place. Various instruments have proven useful to help households and attract investors into the market. In fact, depending on the instruments employed and the maturity of the market, incentives can attract a wide variety of companies and create a diversified portfolio of solar investors. Fiscal incentives like tax breaks are diffused but they can prove difficult to obtain or require long time in certain markets (as in the case of Argentina, with funds received after several months and impacted by high inflation). Overall, several responses highlighted the necessity of additional financial support, either through tax breaks, capital investment refunds, partial funding, or other means, identifying the right financial lines depending on the country's framework.

Country profiles

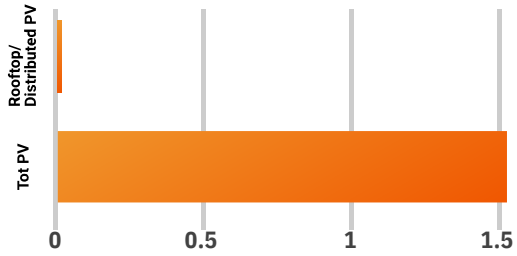
This section of the report presents an overview of distributed solar PV markets in a group of countries. This is possible thanks to the data and information provided by the following national solar industry associations:

- Asociación Chilena de Energía Solar AG (ACESOL);
- Asociacion Mexicana de Energia Solar Fotovoltaica A.C. (ASOLMEX);
- Brazilian Solar Photovoltaic Energy Association (ABSOLAR);
- Camera Argentina de Energias Renovables (CADER);
- Colombian Renewable Energy Association (SER Colombia);
- Italia Solare (IS);
- Malaysian Photovoltaic Industry Association (MPIA);
- Philippine Solar and Storage Energy Alliance Inc. (PSSEA);
- South African Photovoltaic Industry Association (SAPVIA);
- Syndicat des Energies Renouvelables (SER);
- Solar Energy Association of Ukraine (ASEU);
- Unión Española Fotovoltaica (UNEF).

Argentina

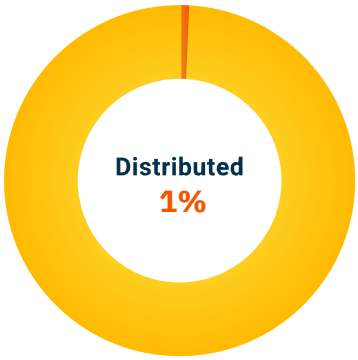
Argentina's current solar capacity has risen to 1.51 GW, an increment of over 400 MW since 2021. The Renewable Energy Law was amended in 2016 setting forth a goal for the country's energy mix to reach 20% renewables by the year 2025. Argentina has very good average daily irradiation at a level of 4.5 kWh/m2 in more than half of the country, indicating a promising future for the development of solar PV under the right conditions.[33] However, the distributed solar PV segment appears severely under dimensioned compared to the country's potential (1 GW by 2030).

Argentina - PV Capacity (GW)



Of the total solar capacity in the country, only 12 MW (0.8%) comes in the form of rooftop PV projects, with the rest being larger-scale direct grid input projects. 15% of the rooftop projects are residential, but all of them are self-consumption projects, in fact, bidirectional meters are already largely employed.

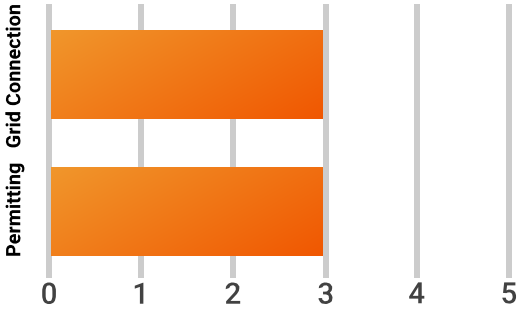
Solar PV Capacity Distribution



Permitting and grid connection

CADER provides a value of 3 out of 5 for the complexity and length of the permitting process for solar PV projects, a relatively higher value than what is observed for other countries in the region. The reason for this is varying, but CADER suggests that a simplification of the requirements in order to reserve power availability would significantly simplify the process. Significant barriers are also related to financial aspects. CADER provides a value of 3 out of 5 for the complexity of connecting to the grid, as well. This shows that both permitting and grid connection equally need to be simplified to accelerate solar PV development in the country.

Argentina - Perceived Complexity



The most critical step in deploying a rooftop PV project is identified in the requirement, when the power related to the current electrical tariff is exceeded, of an electrical study to be run by the utility company to determine whether or not it will be possible to continue to produce at that level. During that time, the solar panels must remain inactive, and this could potentially lead to the decommissioning of the project.

33. Global Market Outlook For Solar Power 2022 – 2026; SolarPower Europe.

Policy and incentives

In Argentina, there are some policy elements which are restricting the full-speed growth of the solar market. While there is a widespread use of bidirectional meters, which allow the exchange of electricity with the grid, the tariffs lack of the right financial lines, according to CADER. The government offers incentives based on the upfront investment made when starting a solar project, which serve to shorten the payback time. However, the repayment of a percentage (from 1% to 16% based on the project size) of the initial investment is difficult to obtain and, once successful, can take months to be received.

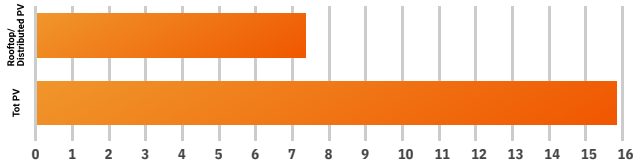
This, combined with the volatility of the local currency and the high inflation, reduces the appeal of solar energy for a variety of grid-connected consumers who would see their investment only partially and lately refunded. The government also offers tax breaks based on the power output produced by a solar project and injected into the grid, which can represent an enticing offer for large companies looking to maximise their profits over the long term. Finally, a major setback is the absence of an incentive for energy storage, hence limiting the potential of self-consumption across the country.

CADER recommends the expedition of the repayments for the upfront investment in order to make for a more attractive incentive for potential solar power producers. Fiscal incentives like tax breaks could also be considered for the initial expenditure, alongside broadening access to low- cost funding for the main rooftop solar components. CADER also references the PMGD project of Chile, as a useful policy to reduce the difficulty of grid connection and accelerate the deployment of small to medium scale decentralised solar projects.

Brazil

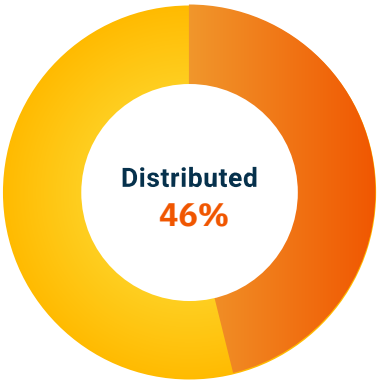
Brazil represents the largest solar market in Latin America and is stably in the top 10 globally, with a total solar PV capacity of 15.8 GW as of mid-2022 (where large-scale solar PV power plants account for 5 GW and distributed generation systems for 10.8 GW).

Brazil - PV Capacity (GW)



Rooftop PV makes up 46% of this, a massive 7.3 GW capacity that places the country in the first position for installed rooftop capacity among the examined group.

Solar PV Capacity Distribution



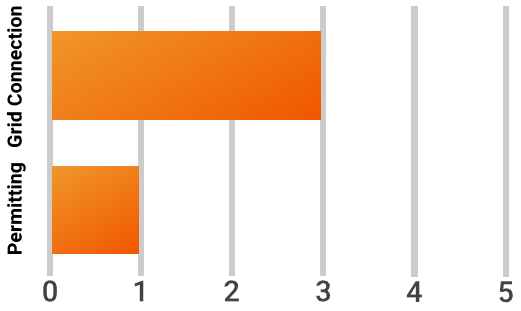
ABSOLAR reports that almost half of the whole distributed capacity in the country belongs to the residential segment. In fact, of the installed capacity, 3.57 GW are under the 10 kW mark. Almost every distributed plant is for self-consumption.

According to analysis by ABSOLAR and official projections from the Brazilian Energy Research Office (EPE), distributed solar PV in Brazil could reach between 19,515 MW and 29,609 MW of cumulative installed capacity by 2026. Whilst this is quite a wide range it shows that there is a healthy prospect for growth in the country's solar PV market. The share of residential systems market could near 52% of the total potential rooftop capacity, reaching between 10.2 GW and 15.5 GW by 2026. ABSOLAR sees it feasible for Brazil to reach 5 million solar PV rooftop systems (around 25 GW) by the end of 2026 and 12 million (around 60 GW) by 2030.

Permitting and grid connection

The decentralized nature of Brazil's solar market is reflected in a value of 1 out of 5 to complexity of the overall permitting procedure to install rooftop solar PV, that is, relatively simpler compared to other countries. ABSOLAR gives the connection to the grid procedure' complexity a value of 3 out of 5, instead. Brazil has great potential to generate electricity through solar PV, with some regions in the country experiencing irradiation levels above 2,200 kWh/ m2/year. The country has been experiencing strong growth in the renewable energy market for several decades, initially with large-scale hydropower, then with biomass, wind power and small hydropower, and more recently with a boom of its solar PV market. The government has been successfully establishing a positive legal framework, as well as regulating specific policies to attract foreign investments into the country.

Brazil - Perceived Complexity



In 2021, solar PV distributed generation registered its largest historic growth in the country. However, Brazil's market is headed for even larger growth in the coming years, especially after the approval of a long-awaited distributed generation law [34] that brought more legal certainty,

34. m Law No. 14,300/2022.

stability, predictability and transparency to the market. During 2022 and in following years, solar PV distributed generation is expected to experience a strong growth curve, due to the combination of rising electricity prices and falling system prices. This makes Brazil one of the most promising markets.

Policy and incentives

In distributed generation, 2021 was a record-setting year. The increasing competitiveness of solar PV under the national net-metering regulation led to a total capacity addition of 3,948 MW, compared to 2,767 MW in the previous year, which signals a 43% improvement for the segment. In this regard, the new distributed generation Law introduced clear rules for the market, creating a stable and balanced legal framework for the use of clean and sustainable renewable sources, such as solar PV in homes, small businesses, rural properties, and public buildings.

The legislation reforms the net-metering regulations, ensuring that all distributed solar PV systems in operation and all new connection requests performed until the beginning of 2023 will be eligible to full net-metering until the end of 2045. It also introduces a new net-metering regime for connection requests performed from 2023 onwards, gradually introducing grid fees only for the electricity injected into the power network. Although these grid fees will be gradually increased over the years, the Law provides a positive return on investment for Brazilian consumers with distributed generation, bringing more certainty and security to the market. With the new law, published in January 2022, PV systems remain eligible for net-metering tariffs through 2045 and existing systems and those installed in 2022 will not be subject to any additional fees. Consumers who install systems after that will begin to pay a tariff for use of the distribution system. These costs will be phased in starting in 2023 and will gradually increase over six years. With the law, the sector will get even hotter this year as installers race to build capacity.

The law is highly favourable to solar and will send the sector, already red-hot, into overdrive in 2022 as developers race to access generous net-metering benefits before they change in 2023. Reform of Brazil's net-metering regulations has been under discussion since 2018 and anticipation of a cut in benefits has driven unprecedented growth in sub- 5MW solar installations to date. Brazil's small-scale solar market accounted for nearly one third of total wind and solar capacity commissioned in Latin America in 2021.

China export data underscores the upsurge: the value of solar product sent to Brazil through November 2022 was $2.5 billion, nearly equal to the combined value of the prior three years. BloombergNEF expects Brazil to install 9 GW of small-scale PV in 2022, a pace that will nearly double the size of the market. Sustained yet moderated growth of around 6 GW per annum should follow in subsequent years.[35]

Gradually requiring new systems to pay for use of the distribution network will increase payback times for consumers. This will slow market growth starting in 2023. However, that is more than offset by the fact that the law provides much-needed legal certainty to the sector – for consumers, developers, investors and distribution companies. This should put Brazil's behind-the-meter solar on a more sustainable growth path beyond the current frenzy.

Important elements of the future framework for small-scale PV have yet to be defined. Most importantly, how producers of solar energy will be charged in the future for use of the distribution network. The Brazilian National Electric Energy Agency (ANEEL) and the National Energy Policy Council (CNPE) have until July 2023 to establish guidelines and value the costs and benefits of distributed generation. These will be used to define new tariffs to be implemented after the transition period when discounts on the use of the distribution network end.

35. Bloomberg NEF, 2022. New Law Primes Brazil's Red-Hot Rooftop Solar Market.

In assessing the overall impact of distributed generation, the law requires the CNPE to consider all its benefits, including environmental and emphasizing "locational benefits" associated with the generation, transmission, distribution and losses.

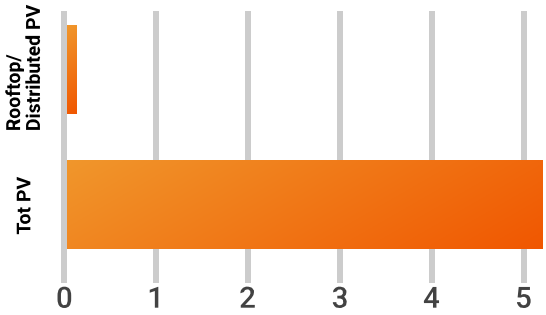
Useful resources

Solar Photovoltaic Energy in Brazil - Infographic n.44 June 3rd, 2022; Brazilian Solar Photovoltaic Energy Association (ABSOLAR); *http://www.absolar.org.br/market/infographic/.*

Chile

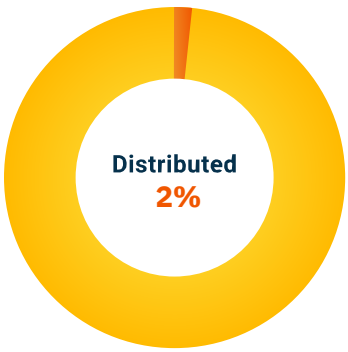
For the third year in a row, in 2022 BloombergNEF named Chile the best country for investment in renewable energy among emerging markets. In fact, 2021's increase of 1,343 MW was more than double its previous year (614 MW) and up from an average annual growth of around 525 MW in the period between 2015-2020. According to ACESOL, Chile currently has a total solar PV capacity installed of 5.2 GW, of which 2.3% comes in the form of installed rooftop photovoltaic panels, at a level of 118 MW (all under a net-billing scheme).[36] [37]

Chile - PV Capacity (GW)



The share of the residential segment is around 20.4 MW (17.3%). Interestingly, 26.4% of the net-billing capacity is constituted by plants that participate in energy communities or community power projects.

Solar PV Capacity Distribution

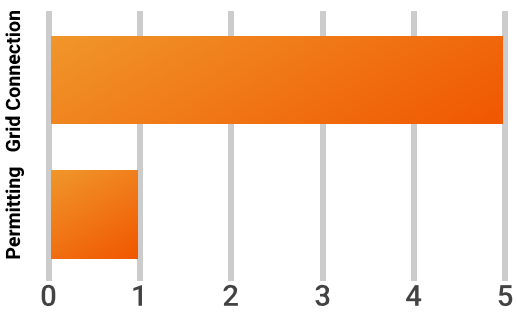


Based on current trends in the growth of the rooftop PV market, if no further incentives are implemented, ACESOL estimates the rooftop PV capacity to reach 536 MW in 2028. On the other hand, projections from the government identify a target for rooftop solar PV of 2.7 GW in the low scenario and 3.8 GW in the high scenario by 2030. The significant difference in governmental predictions come as part of a long- term planning that will account for new changes in policy. Annual average irradiation exceeds 2,000 kWh/m2 in most parts of the Chilean territory and can surpass 10.0 kWh/m2/day depending on location and time of the year, which makes for one of the highest solar potentials in the world. Hence although the rooftop segment provides a minor share of installations today, the government aims to reach 500 MW of residential PV systems by 2026. Chile also targets to have only smart meters by 2025.

Permitting and grid connection

A positive aspect of the Chilean permitting process described by ACESOL is the availability of multiple models that can be utilised by prospective solar producers: unitary plants, remote discounts plants, and community plants. This allows for a more streamlined process by differentiating the models based upon the needs of the consumer group and providing different routes through which applications are submitted. In fact, the difficulty of the overall permitting process in Chile is rated 1 out of 5.

Chile - Perceived Complexity



36. Climatescope 2022; BloombergNEF.
37. Global Market Outlook for Solar Power 2022 – 2026; SolarPower Europe.

Among the main barriers is the limited capacity of the power network, as well as the absence of incentives to encourage the distribution companies to integrate rooftop solar and other distributed energy resources (DERs)[38] in the system. This leads to unfulfilled potential in the country's solar PV market, with companies only aiming at the minimum standards and discouraged to increase the promotion of solar PV, and therefore failing to fully capitalize on its benefits. As for authorizations, Chile has a national procedure, although ACESOL reports that the process can become slower and defective for projects outside the metropolitan region.

On the other hand, ACESOL identifies the connectio n to the power grid as the most complex and time-consuming stage in the installation process, rating it 5 out of 5 in these terms, which is considerably higher than what is observed for other countries in the region, and overall in the examined group (only two other countries rated grid connection complexity at 5 out of 5: Spain and Malaysia). This represents a major barrier to entry for the solar market and leaves no doubt about the importance of simplifying the process. However, future prospects are positive as Chile introduced one of the most effective mechanisms for tackling this issue for small-scale installations: the Pequenõs Medios de Generación Distribuida (PMGD) model.

Policy and incentives

In Chile, most of the distributed generation capacity has so far been installed through PMGD model, which has stimulated the deployment of small installations offering financing and guaranteeing grid connection to solar PV systems of up to 9 MW. It also guarantees that the excess power produced is bought by the network at a fixed price (PPA). Furthermore, there is no requirement of an Environmental Impact Declaration for projects that are under 3 MW, which considerably reduces the development time and the upfront investment. The result is a more predictable income stream and certainty of connection when starting the project, two of the main concerns for potential investors.

The model is observed with interest by industry players in several other countries that could replicate it to unlock solar PV potential.

In addition, the net-billing scheme that supports small rooftop projects was amended in 2019 and the upper threshold raised from 100 kW to 300 kW, with an option to increase this limit further to 500 kW in the near future. Other incentive mechanisms are represented by the "Casa Solar" program, which allows financially distressed households to acquire solar PV systems at lower prices and includes variable state co-financing,[39] and the "Add energy to your company" program offering subsidies to small and medium enterprises for rooftop solar projects.

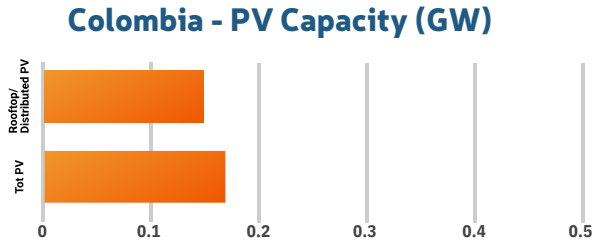
However, ACESOL indicates that negative effects on the development of the solar PV market are arising with the current regime of fixed energy prices for regulated customers, which limits the competitiveness of solar PV against other energy sources, especially fossil fuels. Thus, it is recommended that the current level of the green tax – 5 USD/CO2ton – is increased to ensure a level playing field for renewables. ACESOL also recommends reforming the distribution sector's regulation, in order for the planning and operation phases to properly include distributed resources, rather than basing the whole approach on consumption only.

38. Distributed energy resources (DERs) are small or medium-sized resources that can potentially provide services to the power system, directly connected to the distribution network or near the end-user. DERs include distributed generation, behind-the-meter batteries and controllable loads that can be used for demand response, e.g. household appliances, smart charging electric vehicles (EVs), power-to-heat (heat pumps, electric boilers, enabled by smart meters and data services). Market Integration of Distributed Energy Resources; Innovation Landscape Brief; IRENA; 2019.

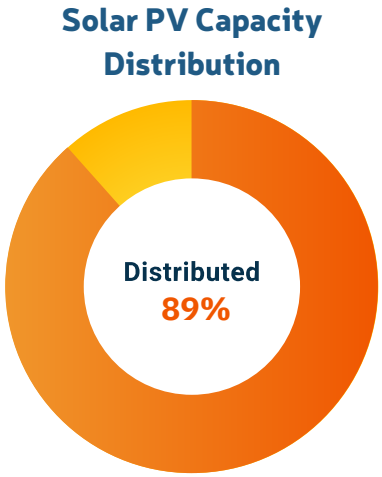
39. https://energia.gob.cl/noticias/aysen-del-general-carlos-ibanez-del-campo/casa-solar-iniciativa-para-instalar-sistemas-solares-en-viviendas-menor-precio-en-todo-chile

Colombia

Colombia has a current installed capacity of 160 MW, with a large proportion coming in the form of rooftop solar at 89.4% (143 MW) showing that distributed solar PV can go as far as represent the core of a national market by itself.



Currently, most meters in use are electromechanical, but Colombia has set a target of substituting 70% with advanced digital meters by 2030.



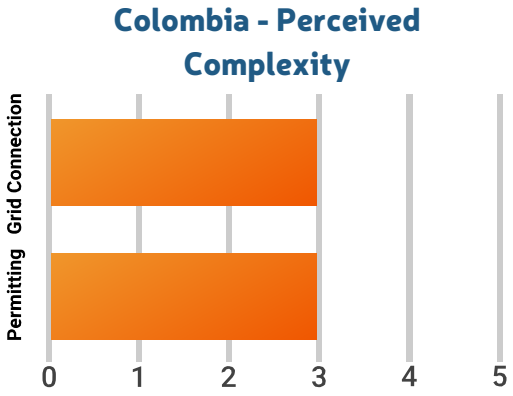
SER Colombia provides segmented data for the potential of rooftop solar PV across the country's building sector:

- **Residential:** 165MW
- **Commercial:** 2385MW
- **Industrial:** 3758 MW
- **Public:** 115 MW

This results in a potential of 7.4 GW for rooftop PV in the country.

Permitting and grid Connection

SER Colombia indicates that the permitting and grid connection processes are of a similar difficulty and time length, both with a value of 3 out of 5, hence towards the more complicated side.



While both steps need simplification to make it easier for prosumers to create projects of their own, the permitting is indicated as the most difficult phase of the process, with the national grid setting relevant barriers. For larger distributed projects, another barrier is represented by the difficulty in obtaining the social and environmental permits and licences.

In Colombia, there was a law change in regulation in 2021 which made the authorisation process uniform at a national level in order to streamline processes across the country.

Policy and incentives

Different incentives are in place for the installation of rooftop PV projects, in the form of fiscal detractions, VAT exemptions, and lower fees. For power production of rooftop solar PV, prosumers can count on net-metering and surplus remuneration.

SER Colombia recommends revision of the calculation method defining the cost charged to prosumers for having access to the grid's back-up capacity.

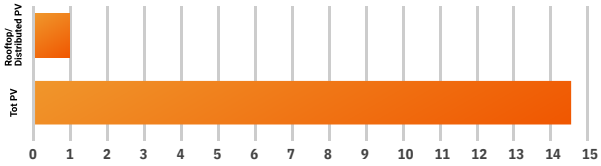
Useful resources

Proposed revision of the back-up capacity cost for prosumers:
https://ser-colombia.org/wp-content/uploads/2020/09/SER-Colombia_CargodeRespaldo_ InformeFinal.pdf

France

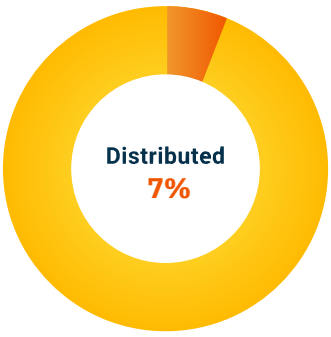
France was the fifth largest EU market for solar power in 2022.[40] The current installed solar PV capacity is 16.3 GW across the country, of which 1,1 GW is made up of distributed, self-consumption projects at a rate of 7%.

France - PV Capacity (GW)



France has a target to reach between 35 and 44 GW of total installed capacity by 2028, a third of which would be represented by rooftop solar PV projects – around 11.7 GW. This highlights a current gap of at least 20 GW, which must be breached in 6 years with the annual market rising to 3 to 4 GW per year between now and 2028. The target also includes reaching between 330 and 400 km² of ground-mounted PV area, with between 150 and 200 km² of rooftop installations.[41] By 2050, France aims to reach 100 GW of installed solar power.

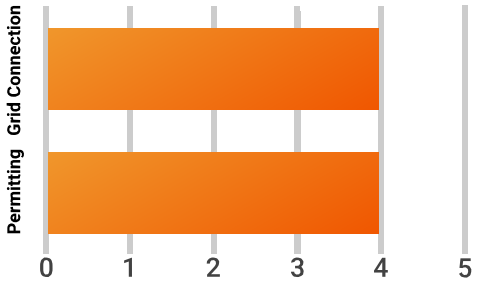
Solar PV Capacity Distribution



Permitting and grid connection

SER rates both the country's permitting process and connecting to the grid procedure a 4 out of 5 for complexity and length, which is significantly higher than what observed for other European countries.

France - Perceived Complexity



This, in part, is suggested to come as a result of the system in place for submission and processing of permits. In France, the process is uniform across the country making it consistent in all regions, which should simplify the process for those looking to secure a permit. However, applications must be submitted to and processed by local authorities, and this can lead to higher delays or deadlocks in specific regions or municipalities.

The French government is open to set up a "one-stop shop" to examine town planning and environmental authorizations. SER suggests this would have a significant impact allowing for a simultaneous review of all authorization proceedings, simplifying and accelerating the procedures for issuing authorizations.

Policy and incentives

France's legislation represents a relevant case for good practices in the distributed solar power context. It introduced the obligation for new building constructions – including those dedicated to commercial exploitation, industrial or artisanal use, or public parking carports – larger than 1,000 sqm, to be equipped with renewable energy systems covering 30% of the roof surface (or car park shades/coverings). The law has recently been extended lowering the 1,000 sqm threshold to 500 sqm for new buildings of commercial, industrial, and artisanal use, including warehouses, sheds, and covered car parks accessible to the public, and

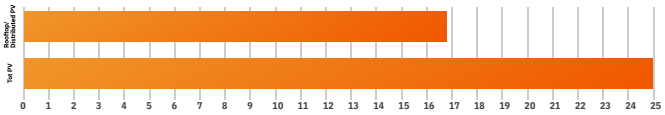
40. EU Market Outlook for Solar Power 2022-2026, SolarPower Europe.
41. . Global Market Outlook For Solar Power 2022-2026; SolarPower Europe.

increasing the surface requirement for solar panels to 50% by 2027. The obligation now also applies to office buildings (with a threshold of 1,000 sqm) and to the case of buildings extension or major renovation. For existing car parks larger than 1,500 sqm, the obligation is now to be equipped with renewable energy systems on 50% of their surface. Moreover, in 2021 the threshold of the feed-in tariff was extended to 500 kWp.

Italy

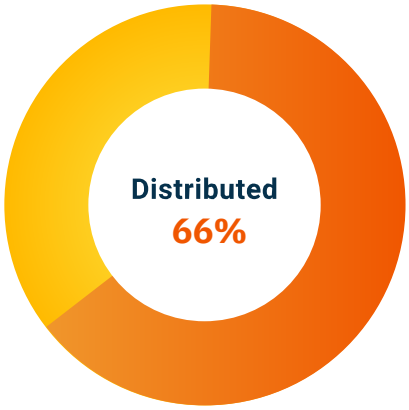
Currently, Italy has 25 GW of solar PV capacity installed, which makes it the largest market in the examined group.[42]

Italy - PV Capacity (GW)



As of 2022, the share of rooftop PV accounted for 66%, at 16.6 GW. Almost 40% of this (6.3 GW) belonged to the residential sector, with more than 1.1 million plants according to Italia Solare. About 43% of the total solar energy production results from self-consumption plants while 57% from plant for total grid input.

Solar PV Capacity Distribution



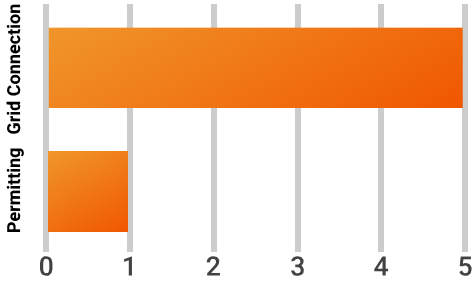
The magnitude of Italy's distributed market is due to geographical constraints as well as to a policy framework highly oriented towards self-consumption, until recently. The off-grid solar capacity is not largely developed, as Italy's power grid is thoroughly distributed across regions. By 2024, almost all meters employed will be digital, according to Italia Solare.

The potential of rooftop solar PV in the country ranges between 65 and 85 GW, with the residential segment accounting for 55%.[43] Italy has a target for total PV capacity of between 80 and 90 GW by 2023.

Permitting and grid connection

Italia Solare rates the complexity of the permitting process as relatively straightforward and simple with a value of 1 out of 5, thanks to an acceleration in policy improvements over the last years. On the other hand, the procedure for grid connection appears to be very complex, ranking at 5 out of 5. In fact, the authorization for grid connection can take up to 1 year.

Italy - Perceived Complexity



For rooftop PV, procedures are uniform at national level following significant progress towards simplification for self-consumption projects over the last two years. However, local procedures are still in place in case projects require building new power lines for connection to the grid or upgrading them. For this reason, similarly to the case of Spain, Italy's authorization procedure was classified as not uniform. An overall simplification of the process for new grid connections is required.

One of the main bottlenecks is represented by historical buildings and historical towns, whereas a positive aspect is reported to be the relatively ease to authorize rooftop solar PV systems on park area, although these are not yet much exploited.

42. Data have been collected between Q2 2022 and Q1 2023, so some observations are more recent/up to date than others.
43. Italia Solare's statistical elaboration based on "Rapporto sul consumo di suolo", Sistema Nazionale Protezione Ambientale, 2021, and "Potential for Building Integrated Photovoltaics", IEA report, 2002.

Policy and incentives

A variety of incentive mechanisms is in place for the installation of rooftop PV in the country. Most notable, for the residential sector, are:

- The so-called "Superbonus" program, which offers tax breaks for 110% of the upfront investment over the course of 5 years, for rooftop plants when they contribute, alongside other interventions, to significant energy efficiency improvements in buildings.
- A 50% tax deduction, over the course 10 years, for every rooftop plant under 20 kW.

Both these mechanisms are eligible for fiscal credit transfer, allowing households to obtain an immediate discount on the invoice. The Superbonus, in particular, has in most cases brought to zero the upfront costs for households' rooftop PV and stimulated significantly the deployment across the country (around 200.000 rooftop PV plants have been installed in 2022 alone, according to Italia Solare) but is going to cease by the end of 2023. For the industrial and commercial segments, 9% of the upfront investments can be deducted from taxes annually as a depreciation scheme.

As for the incentives for the power production, PV prosumers have at their disposal a net-metering scheme that allows rooftop PV projects in the residential and industrial/commercial sectors to remunerate the energy not self-consumed and injected into the grid, but with a cap based on the total power consumed. By 2024, Italia Solare reports, the mechanism will be replaced by an incentive dedicated to energy storage systems, in order to maximize self-consumption and collective self-consumption.

Italy is also experimenting energy communities, but only a few are operative. The final legislation should be in place by the last quarter of 2023. The members of the energy communities are remunerated through a monetary incentive for the electricity produced and injected in the local grid that is consumed within the same community (i.e., within the geographical boundaries defined by the HV/MV substations) on an hourly basis. It has to be noted that incentives decrease as the installed power of the PV plant increases, and no incentives are in place for plants above 1 MW. Also, incentives decrease as electricity prices increase.

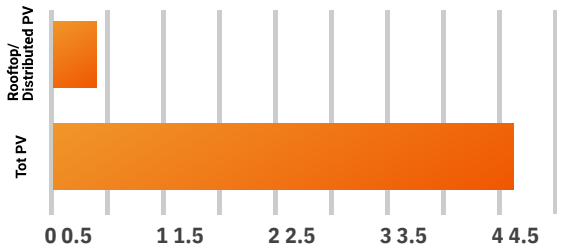
Furthermore, the Italian National Recovery and Resilience Plan (PNRR) includes funds to support energy communities in small towns (less than 5,000 inhabitants) with grants covering about 40% of the plants cost. Overall, the Plan allocates EUR 2,2 billion to energy communities and EUR 1,5 billion to agrisolar, namely to self-consumption PV plants on the roofs of agricultural buildings.

Finally, Italia Solare recommends the establishment of state guarantees for the construction of rooftop PV plants both for the residential and the industrial segments, as well as activating greater financial support for the deployment of solar PV on car parks, as these projects generally cost more compared with other buildings, which will contextually also promote the integration of e-mobility.

Malaysia

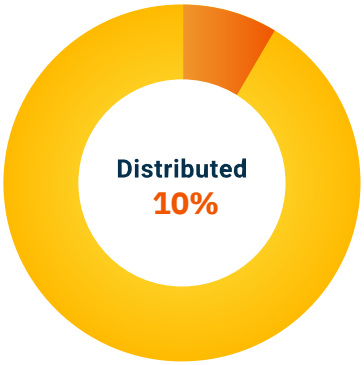
Malaysia's total solar PV installed capacity has surpassed the 4 GW mark.

Malaysia - PV Capacity (GW)



Rooftop systems account for 10% of this (around 408 MW), one-tenth of which belongs to the residential segment.

Solar PV Capacity Distribution

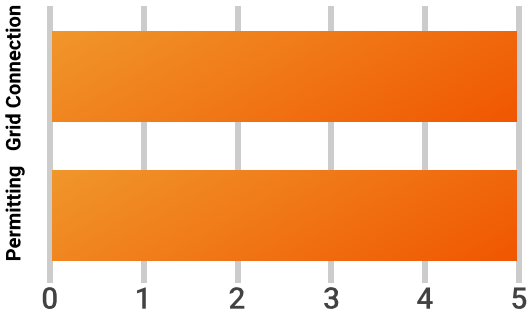


The country has an estimated potential rooftop capacity of 9 GW, which has been formalized as a target to be reached by 2035. This shows a strong commitment to the development of the rooftop PV market, with an aim to increase the capacity more than twenty times in the next 13 years. Still, one-tenth would come by the residential sector, growing at around 900 MW.

Permitting and grid Connection

The country's policy framework appears relatively hostile towards the installation of rooftop solar PV projects, as both permitting and grid connection receiving a rating of 5 out of 5 in reference to their complexity and time taken, indicating maximum perceived difficulty despite having uniform regulations in place across the country.

Malaysia - Perceived Complexity



Indeed, it typically takes around 2 years for a project to be approved and completed, a true drag on the progress of the energy transition in the country.

Policy and incentives

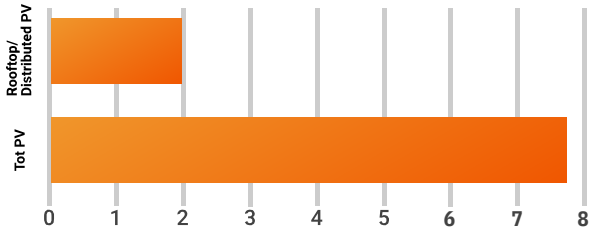
The government established a set of measures to accelerate the development of rooftop solar PV. Most notably, tax incentives are offered for 5 years, allowing for payback times of around 2-3 years. Furthermore, Malaysia made its net-metering scheme more attractive with the NEM 2.0 program in 2019, when the surplus power generated by the PV system was for the first time paid on a "one-on- one" offset basis, which meant that every kilowatt- hour injected into the network was offset against a kilowatt-hour of electricity taken from the grid. Under the previous regime, exported energy carried less value than consumed grid power.

Negative aspects are represented by the quota allocation systems for power generation capacity that the country is employing. It is recommended to improve the net-metering's conditions further and that the Malaysian Investment Development Authority (MIDA) – the government's principal agency for the promotion of the manufacturing and services sectors – keeps simplifying the authorization process.

Mexico

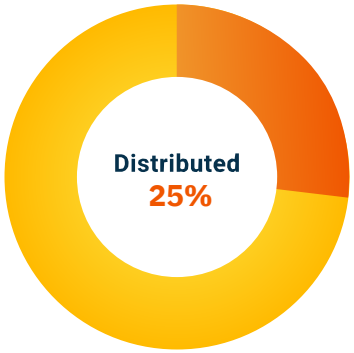
In 2021 Mexico was able to increase its solar capacity (utility scale plus distributed generation) by 1.47 GW, resulting in solar claiming a 9.4% share in the country's electricity mix, with natural gas still dominating at 39%, according to ASOLMEX. With a daily average solar irradiation of 5.5 kWh/ m2, Mexico's geographical location is ideal for the exploitation of solar resources.[44]The current installed solar PV capacity in Mexico is 8.15 GW, 6.14 GW of which is made up of utility scale projects, and the remaining 2.01 GW (24.7%) of distributed solar PV.

Mexico - PV Capacity (GW)



Taking a further look at the distributed sector, a large proportion of this is represented by residential plants at 66.7% (1.34 GW), while 98% of the plants use net-metering at a rate of 1.97 GW.

Solar PV Capacity Distribution



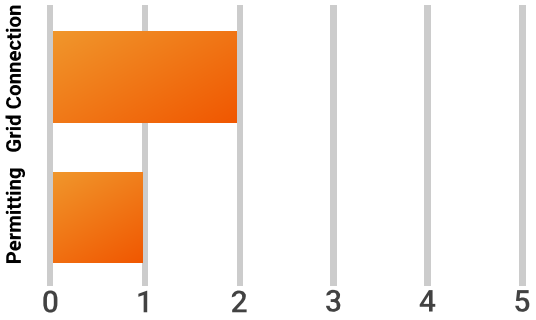
IRENA has estimated that the country's distributed solar market will reach a capacity of 12 GW by 2030, given their optimal environmental conditions, it would appear as though the only limiting factor would be that of policy, and the attractiveness of investment opportunities within the sector.

However, the country has not yet set an official target for rooftop solar PV.

Permitting and grid connection

Power plants under 500 kW, including solar PV, are not mandated to have a permit. All interconnection requests are submitted through state-owned company (CFE). This reflects in a relatively low value of 1 out of 5 when describing the length and complexity which is well below the levels reported by other countries in Latin America.

Mexico - Perceived Complexity



In Mexico there is a uniform authorization procedure at country level. However, there are procedural differences among regional offices of the state- owned company. For this reason, it is recommended by ASOLMEX that the state-owned company should homologate procedural criteria across the regions streamlining the process as a whole. ASOLMEX describes the administrative procedure to be interconnected to the grid by the state-owned company as being the most complex and time- consuming phase of the installation process, which is a feature that could also be ameliorated by the homologation of procedural processes.

44. Remap 2030, Renewable Energy Prospects: Mexico; IRENA, 2015.

Policy and incentives

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To encourage further investment in solar PV, Mexico has several incentive policies in place. As mentioned, any plants in the country with a capacity of less than 500 KW do not require an electricity generation permit. This is part of a concerted effort to reduce the perceived barriers to generating energy. Furthermore, tax deductions are offered for investments in renewable energy encouraging investment into the conversion to a green energy mix.

Finally, ASOLMEX recommends that the government offers partial funding for small and medium projects which could encourage a widespread adoption of solar PV as well as developing a decentralised network leading to a stronger and more stable grid. However, Mexico has experienced retroactive measures concerning renewable energy in the recent past through the reversals of key parts of the Electricity Act in 2021. The GSC had called for restoration of enabling condition for solar PV and other renewables investments issuing a joint statement with the Global Wind Energy Council (GWEC). The IRENA Coalition for Action acted as a signatory as well.

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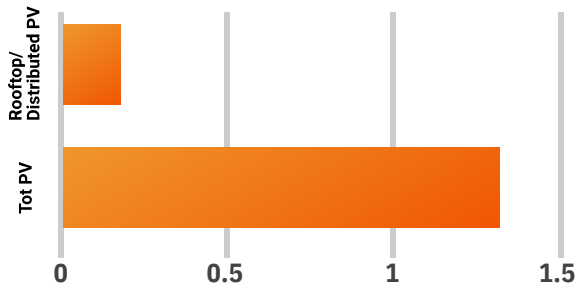
45. Global renewables bodies call on Mexico's government to restore the country's transition to clean energy (https://www.globalsolarcouncil.org/global-renewables-bodies-call-on-mexicos- government-to-restore-the-countrys-transition-to-clean-energy/).

Philippines

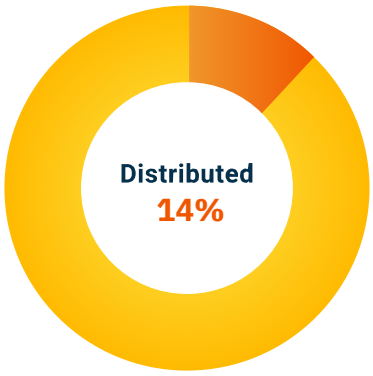
The Philippines' total installed solar PV capacity currently sits at 1.3 GW.

Philippines - PV Capacity (GW)



Of this, 14% comes in the form of rooftop PV projects, or around 182 MW.

Solar PV Capacity Distribution

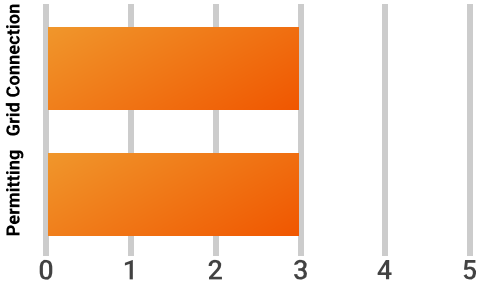


The Energy Regulatory Commission (ERC) has confirmed a sustained growth of net-metering installations.

Permitting and grid Connection

Permitting and grid connection are found to be of equal difficulty, with a rating of 3 out of 5. While it is promising to learn that one is not causing more of a bottleneck than the other, this still skews the overall authorization process toward the more difficult end of the spectrum in terms of time length and complexity, hence there is the need for further simplification.

Philippines - Perceived Complexity

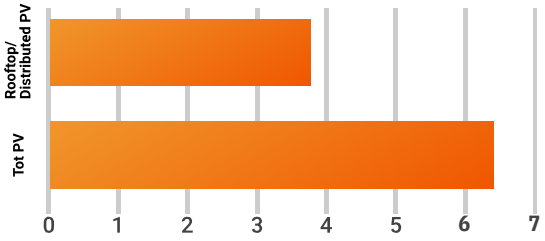


However, authorization of for grid connection and other requirements issued by the authorized governmental agencies in the country are identified as the most complex stages within the whole process.

South Africa

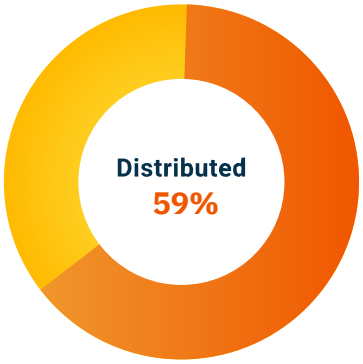
South Africa is the largest solar power market in the African continent, with a current installed PV capacity of 6.3 GW, of which 2.58 GW attributable to medium and large-scale projects deployed through the Renewable Independent Power Producer Programme (REIPPP),[46] and 3.7 GW originated from private sector projects. Around 5% of the total solar installed capacity is off-grid.

South Africa - PV Capacity (GW)



Near 60% (3.75 GW) of the total installed capacity in the country comes in the form of rooftop projects, placing South Africa in the second position for rooftop PV in the examined group, and providing an additional testament to the potential of distributed solar generation. Between 5 and 10% of plants are residential, but none have access to net-metering. In fact, the majority of meters employed is outdated, while very few bidirectional metres in use in the country.

Solar PV Capacity Distribution

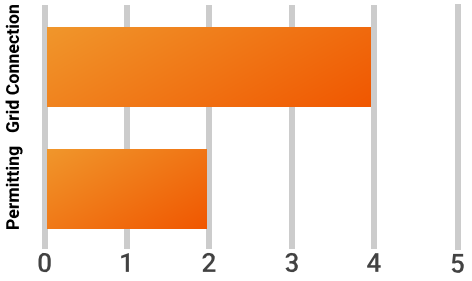


SAPVIA provides an estimate of around 20 GW as the potential capacity for rooftop PV in the country, 15 to 20% of which could belong to the residential segment, while another 10% could generate from commercial buildings and car parks. Currently, the government's Integrated Resource Plan (IRP) has a target to reach 6 GW of distributed capacity, but SAPVIA reports this will soon be at least doubled.

Permitting and grid connection

Permitting in South Africa is considered to be relatively straightforward, with a rating of 2 out of 5 in terms of complexity and length. A significant positive aspect is represented by the fact that commercial and industrial projects up to 100 MW are not required to apply for a license (with this threshold recently increased from 1 MW).

South Africa - Perceived Complexity



On the other hand, the connection to the grid was identified as problematic, with a rating of 4 out of 5. In South Africa, the authorization process is fragmented, differentiated in each municipality. As reported by SAPVIA, several municipalities do not have effective regulations in place to allow for the grid connection of solar PV systems, which is particularly problematic at the residential level. Another factor inhibiting the growth of solar is that a large source of income for the municipalities is represented by the sale of electricity, which has resulted in the active blocking of solar development. This is reportedly the most severe barrier for faster deployment of solar PV.

46. https://www.gov.za/about-government/government-programmes/renewable-independent- power-producer-programme

Policy and incentives

A simplification of the regulatory framework is underway at the national level and will hopefully soon produce positive results. However, today the Department of Minerals Resource and Energy (DMRE) is still focused on coal, gas, and nuclear power generation. A trend that SAPVIA sees as prolonging also due to the influence of strong fossil fuel lobbies and coal mining unions.
\
There are currently no incentives in place for solar PV. But, according to SAPVIA, its benefits, first an d foremost its lower generation costs, are acting as incentives de-facto. The main recommendation offered by SAPVIA to accelerate solar PV's rollout is the establishment of a Feed-in tariff, even if set at lower levels compared with the current prices charged by the state-owned utility company.

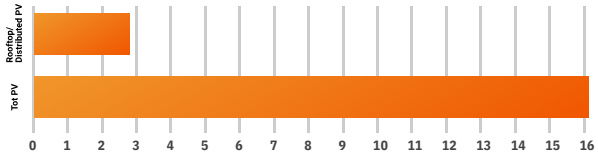
Useful resources

Independent Power Producer Procurement Programme: *https://www.ipp-renewables.co.za/*

Spain

Spain ranked as the second-largest solar market in Europe and top 10 in the world in 2022. The total installed capacity is 16.2 GW,[47] of which 2.7 GW (16.6%) distributed, self-consumption systems.[48]

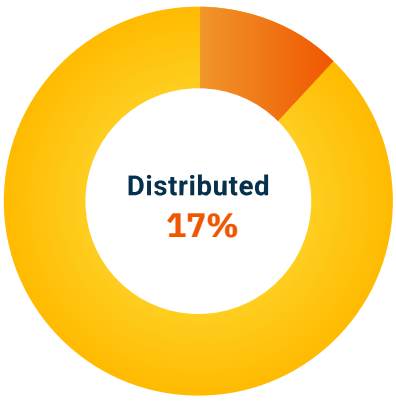
Spain - PV Capacity (GW)



The country's self-consumption rooftop solar market only opened in early 2020 after the abolishment of the Sun Tax, which had kept that segment economically unattractive in the past. But 2021 marked a new era with a 102% year-on-year growth rate.***46***According to UNEF, 1.2 GW of new self-consumption projects were installed in 2021 alone, 32% of which being residential, 41% industrial, 26% commercial, and 1% off-grid.

Spain's national roadmap for self-consumption indicates that the capacity for self-consumption could reach between 9 (in a target scenario) and 14 GW (in a high penetration scenario) by 2030.

Solar PV Capacity Distribution

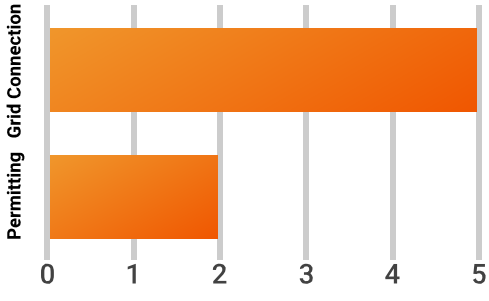


In the target scenario, the roadmap considers that 5,8 GW would be commercial, 1,9 GW collective residential, 0,1 GW individual residential, and 1,1 GW industrial. In the high penetration scenario, the roadmap considers that 7,7 GW would be commercial, 3,8 GW collective residential, 0,9 GW individual residential, and 1,6 GW industrial.

Permitting and grid connection

UNEF provides a 2 out of 5 rating in relation to the difficulty and length associated with the permitting process for solar projects, suggesting a relatively well-structured policy that facilitates the process. The process for grid connection, however, is rated 5 out of 5 in terms of its length and complexity. This, in part, comes as a result of the longer administrative procedures required when a prosumer produces surplus energy and injects it into the grid receiving financial compensation. Furthermore, for installations larger than 15 kW, it is required to request access and connection to the grid. Such a case, in fact, is considered the same as utility-scale installations, a barrier that is identified as the most relevant in the permitting process.

Spain - Perceived Complexity



The national authorization procedure is characterized by some differences at the local level, such as variable planning permission requirements depending on the region. Recently, UNEF's work has led to modification of regulatory frameworks in most of the autonomous communities, removing planning permission requirements for rooftop PV,

47. https://www.ree.es/es/datos/generacion/potencia-instalada
48. At the end of 2021, it has now surpassed 20 GW.
49. EU Market Outlook for Solar Power 2022-2026, SolarPower Europe.

a critical bottleneck. Only one region remains where planning permission is required, the Basque Country.

Policy and incentives

In 2018, the Spanish policy framework changed, establishing the technical, economical, and administrative conditions for self-consumption through solar PV. Alongside removing the Sun Tax for self-consumption and enabling collective self-consumption, the new regulatory framework includes three types of self-consumption depending on the surplus energy:

- Without surplus: in this case surplus energy can not be injected into the grid and the administrative procedure is reduced;
- With surplus injected into the grid: surplus compensation;
- The prosumer receives money for injecting the surplus energy into the grid. This case entails longer administrative procedures.

The new framework propelled the development of self-consumption in Spain, which is sustained also by high electricity prices that are making self-consumption even more profitable, reducing the pay-back time of the projects. However, UNEF identifies barriers still existing in the administrative process, in the access and connection to the grid, and for the development of collective self- consumption and energy communities. According to UNEF, it is essential to reduce these barriers reducing permitting, access and connection to the grid procedures, and simplifying collective self- consumption.

The Spanish national roadmap for self-consumption includes a total of 37 measures to be implemented in order to reach the rooftop PV targets for 2030.

Key measures focus on:

- Reducing permitting procedures, especially related to access and connection to the grid;
- Developing a collective self-consumption manager role that could help to develop this type of installations;
- Improving behind-the-meter energy storage's profitability.

In June 2021, the Spanish government launched grants for self-consumption and energy storage. Incentives were divided into six programs depending on the type of installations.

Implementation of self-consumption facilities, with renewable energy sources, in the service sector, with or without storage.

1. Implementation of self-consumption facilities, with renewable energy sources, in other productive sectors of the economy, with or without storage.
2. Incorporation of storage in self-consumption facilities, with renewable energy sources, already existing in the service sector and other productive sectors.
3. Implementation of self-consumption facilities, with renewable energy sources, in the residential sector, public administrations and the third sector, with or without storage.
4. Incorporation of storage in self-consumption installations, with renewable energy sources, already existing in the residential sector, public administrations and the third sector.
5. Implementation of thermal renewable energy installations in the residential sector.

Useful resources

The Ministry for the energy transition has launched a national roadmap for self-consumption: *https://www.idae.es/sites/default/files/documentos/idae/tecnologias/energias_renovables/OFICINA-de-AUTOCONSUMO/Hoja_de_Ruta_Autoconsumo.pdf*

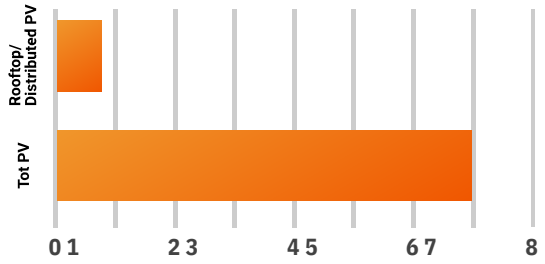
Government grants for self-consumption and storage behind the meter, divided into six programs depending on the type of installations: *https://www.idae.es/tecnologias/energias-renovables/oficina-de-autoconsumo/ayudas-al-autoconsumo*

Government grants for energy communities pilot projects: *https://www.idae.es/ayudas-y-financiacion/comunidades-energeticas/programa-de-incentivos-proyectos-piloto-singulares-de*

Ukraine

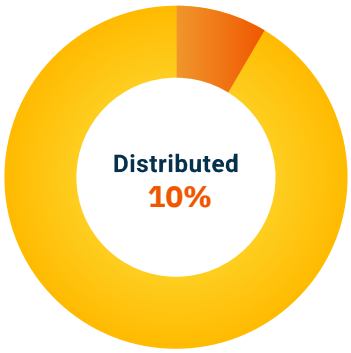
Ukraine currently has an installed solar PV capacity of 7 GW, even though it has suffered extensive damages due to targeted attacks during the ongoing war. The invasion and the need to maintain strategic facilities and communications online, are enhancing the role of distributed generation as solar panels are modulable, transportable, and can very effectively function off-grid. GSC has issued a statement in support of Ukraine and activated a campaign in support of the country.

Ukraine - PV Capacity (GW)



Rooftop solar PV accounts for 10% (0.7 GW). Ukraine has also 25 MW of installations participating in energy communities.

Solar PV Capacity Distribution

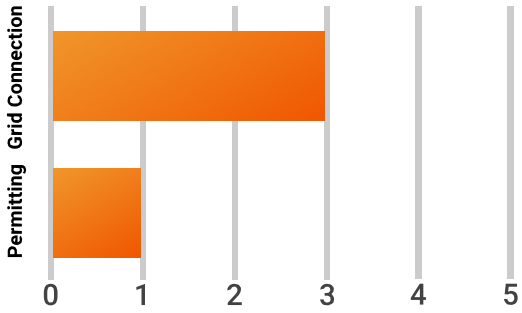


According to ASEU, Ukraine has a potential rooftop PV capacity of 10GW, and a potential capacity for solar parking lots of 200MW.

Permitting and grid Connection

Ukraine has uniform authorization procedures at national level, which lead to faster processing of applications and a more streamlined roll out of solar projects. The permitting process for rooftop solar projects appears straightforward and relatively simple, with ASEU rating it with 1 out of 5. Meanwhile the grid connection process receives a rating of 3 out of 5.

Ukraine - Perceived Complexity



In fact, ASEU specifically indicates the authorization for grid connection as the most complex and time-consuming stage in the overall process.

Policy and incentives

ASEU highlights feed-in tariffs as the principal instruments that has incentivized the origination of distributed solar PV projects in the country. It is recommended to introduce or improve design of renewable energy auctions, feed-in premiums, net billing, and corporate PPAs to facilitate the growth of the market.

Recommendations

Thanks to the involvement of the solar industry's bodies that have participated in this initiative, it is possible to identify a set of key best practices that can be employed to accelerate and simplify the authorization process and boost deployment of distributed solar PV. As a result, a clear sector-specific recommendations arise for policymakers and regulators to stimulate and sustain the development of distributed solar PV markets, and the progress along their countries' energy transition. In particular, the Global Solar Council recommends:

- **Streamlining permitting for rooftop solar PV.** By decreasing mandate requirements of rooftop systems deployment is accelerated and costs are reduced. *Example: Mexico, Chile (PMGD model).*
- **Simplifying the authorization processes providing maximum mandate times, positive silence principle, and simple notification procedure.**
- **Establishing "one-stop shops" for planning and authorization of distributed solar PV.** Simultaneous review of all proceedings (such as municipality planning, environmental authorization, etc.), allows for accelerated implementation of solar power capacity. *Example: France (under evaluation).*
- **Setting out legislation to provide guaranteed grid connection for distributed solar PV systems.** Guaranteeing grid connection for plants under a certain capacity, once created, as well as the purchase of excess power at a fixed price, create a more predictable income stream and certainty of connection when starting the project. *Example: Chile (PMGD model).*
- **Introducing mandates to equip rooftop solar PV for all new constructions and renovated buildings.** Rules should include all buildings of commercial, industrial, public, private use, covered public car parks, as well as extensions or major renovations, defining tailored thresholds. *Example: France.*
- **Homologating the authorization procedures at a national level** to streamline processes and avoid regional bottlenecks;
- **Increasing the clarity and stability of regulatory frameworks** to reduce the perceived risk for investors;
- **Investigating the rooftop PV potential with appropriate studies and setting specific national targets,** designing specific legislation accordingly;
- **Adopting and promoting net-metering and energy communities,** to maximize prosumers' ability to use and share their own electricity;
- **Replicating best practices from other countries,** adapting them to the national markets.

By considering these recommendations, governments can take concrete steps towards incentivising and facilitating the growth of a market that benefits all of its constituents and will serve to improve their citizens' quality of life.

Ideal authorization model for distributed solar PV

The authorization process for constructing photovoltaic plants and related connection works is a crucial step in the development of renewable energy infrastructure. As the world transitions towards a more sustainable future, it is essential that the public authorities facilitate the authorization process for such plants, both to encourage the growth of the photovoltaic industry and to make those systems more accessible for all. Thus, also in accordance with the UN Sustainable Development Agenda, Goal 7, "Affordable and Clean Energy", which identifies as target 7.1 "By 2030, ensure universal access to affordable, reliable and modern energy services" and as target 7.2: "By 2030, increase substantially the share of renewable energy in the global energy mix". In the light of the above, it might be useful to outline the features that make an authorisation procedure for the construction of photovoltaic plants and related connection works 'ideal'.

With specific regard to the process for authorizing connection works of PV plants with the public grid, providing full disclosure from the distributor/grid manager on the power already booked for each connection station could certainly help improve the efficiency of the relevant authorization procedure. This would enable developers to make informed decisions about where to locate their photovoltaic plants and on what size of plant they can install, by planning their projects accordingly and with the aim of reducing the need for costly and time- consuming modifications to the projects or to the grid infrastructure.

At the same time, an ideal authorization process for developing PV plants should take into account, aiming at simplification, the need for a balanced approach that considers both the economic benefits for people using such plants and the potential environmental impact/benefit: however, as opposed to ground-mounted photovoltaic plants, the environmental impact is almost always zero or minimal in case of PV plants on roof.

To facilitate the authorization process, public authorities should provide clear and transparent guidelines, possibly uniform throughout each country. These guidelines should provide a detailed description of the required communications, permits, licenses and certifications, as well as common technical and environmental standards that must be met.

Public authorities could also provide incentives for promoting participation of individuals and communities, such as grants, favourable prices for energy produced and fed into the grid or tax breaks. They could also play the role of aggregator in order to involve individuals and communities in the development of projects. An efficient and timely authorization process, to be completed within a reasonable timeframe, is desirable. In any case, it shall guarantee, at the same time, for a review and an evaluation of the potential impacts of each project.

Considerations on duration and steps of the authorization procedures should not ignore the specific features of each PV project. However, the practise of allowing the construction of PV plants on roof, especially if coplanar and adherent to the roof under a certain threshold of power, subject to simple notification to local authorities (and not to a sequence of procedural steps), could be encouraged.

It should be noted that attempts to outline an ideal time schedule for authorization procedures for solar PV plants are emerging at the regulatory level: for example, with the Council Regulation (EU) 2022/2577, dated December 22nd, 2022 (*"laying down a framework to accelerate the deployment of renewable energy"*), the EU provided for a temporary regulation aimed at accelerating the permit-granting processes for small scale solar installations in all the Member States and at promoting and accelerating the deployment of such small-scale solar installations, including those for renewables self-consumers and collective self-

consumers, such as local energy communities, ***"since those are the options that cost least, are most accessible and have the least environmental or other type of impact for a fast rollout of new renewable installations"***. Article 4 of the Council Regulation (EU) 2022/2577 establishes that *"The permit-granting process for the* ***installation of solar energy equipment*** *and co- located energy storage assets,* ***including building- integrated solar installations and rooftop solar energy equipment, in existing or future artificial structures,*** *with the exclusion of artificial water surfaces,* ***shall not exceed 3 months, provided that the primary aim of such structures is not solar energy production.*** *By way of derogation from Article 4(2) of Directive 2011/92/EU, and Annex II, points 3(a) and (b), read alone or in conjunction with point 13(a) of Annex II to that Directive, such installations of solar energy equipment shall be* ***exempted from the requirement, if applicable, of being subjected to a determination whether the project requires an environmental impact assessment, or from the requirement to carry out a dedicated environmental impact assessment"***.

This provision seems particularly compatible with the case of the distributed solar PV sector, since it is applicable to rooftop and off-grid solar PV systems, where the structures hosting the PV plants are usually not dedicated to energy production only. Overall, this is an example of provision that tries to simplify the permit-granting process and to reduce administrative barriers to entry. Therefore, the maximum duration of authorization procedures indicated therein could be taken as a reference to outline the duration of an "ideal" authorisation procedure.

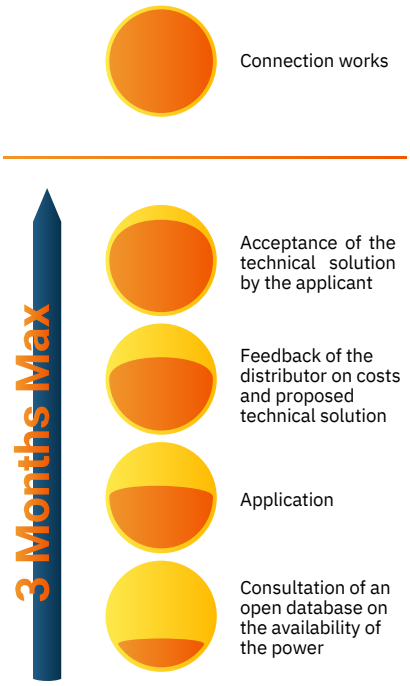
Furthermore, according to article 6 of the same Council Regulation, ***"Member States may exempt renewable energy projects, as well as energy storage projects and electricity grid projects which are necessary to integrate renewable energy into the electricity system, from the environmental*** impact assessment under Article 2(1) of Directive 2011/92/ EU and from the species protection ***assessments under Article 12(1) of Directive 92/43/EEC and under Article 5 of Directive 2009/147/EC, provided that the project is located in a dedicated renewable or grid area for a related grid infrastructure which is necessary to integrate renewable energy into the electricity system, if Member States have set any renewable or grid area, and that the area has been subjected to a strategic environmental assessment"***. This provision can be an example of how upstream planning in the energy sector can avoid downstream complications such as additional environmental authorisations that could be avoided under certain conditions.

In the light of all the above, the key points for approaching the 'ideal' procedure could be those outlined below.

Connection to the grid

Key points for efficient authorization procedures:

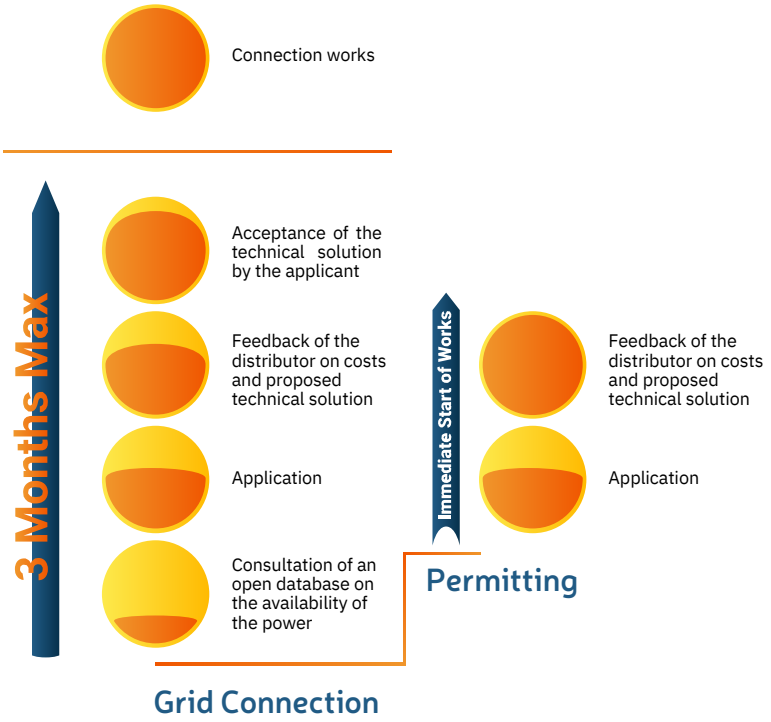
- Uniform procedure in all regions in the same country;
- Consultation of public available database with data on the power already booked for individual stations, to be checked by developers as preliminary step to start the procedure;
- Maximum duration: 3 months, also in case of complex works.



Authorization procedure for PV plants on roofs

Key points for efficient authorization procedures:

- Uniform procedure in all regions in the same country;
- Clear guidelines and planning;
- Power threshold under which a simple communication to the local authorities is sufficient for developing the PV plant;
- Over the threshold, maximum duration of the proceedings should be 3 months.



Energy communities

Energy communities and collective self-consumption, as introduced at the EU level by the Renewable Energy Directive (RED II), can play an important role in the current international context of transitioning towards clean distributed power generation.

Until recently, the production of electricity in the vicinity of the consumption areas has been mainly valued by taking into consideration the energy directly self-consumed by the user to which the solar plant is connected, while in reality, the overall benefits of the plant extend to the community around it.

In fact, the energy that is consumed in the vicinity of where it is produced always remains within the local grid, not requiring transportation via the high voltage networks nor, in many cases, distribution via the medium voltage lines.

Therefore, one of the main objectives of the energy communities is to maximize - and therefore stimulate with appropriate incentives - not only the self-consumption but also the proximity, or collective self-consumption.

If implemented and widespread alongside increasingly sophisticated control systems, energy communities will determine a drastic change in the way energy is produced, with increasingly decentralized systems, but also in the network management, which will progressively tend to local control and balancing services as opposed to the current centralized system.

Beyond their technical utility for the balancing of power grids, if readily implemented by international regulations, energy communities can also have a major social impact. In fact, the ease with which solar PV plants can be built would allow for a large-scale diffusion of such communities, empowering all citizens to self-produce energy for their own needs in synergy with the local community.

This opportunity can lead to new scenarios of energy production and consumption based on cooperation and sharing between people, with strong social implications due to a more widespread distribution of wealth associated with energy production compared with predominantly centralized systems.

Among their advantages, energy communities can generate extensive interest in renewable energy from local administrations and communities, hence supporting the cultural shift in favour of renewable sources.

Conclusion

If the world wants to achieve climate-neutrality and create a sustainable and inclusive future, we need solar PV at all scales. As showcased by this work, distributed solar generation can help significantly in deploying the capacity that is needed, as it is already powering huge decentralized markets. It is important that the development of solar PV capacity is tailored to each country's characteristics and needs, yet with energy production as close as possible to consumption areas, exploiting the benefits of collective self-consumption.

To reach net-zero by 2050, 100 million households need to be equipped with rooftop solar PV by 2030 and 240 million by 2050, up from the current 25 million. The GSC believes more can be achieved on a pathway to 100% renewable electricity with enhanced policy and regulatory support. Indeed, the analysis conducted highlights how, between 2028 and 2035, 11 countries alone have potential to reach around 240 GW aggregated rooftop PV capacity.

Furthermore, it is critical these roofs are spread around the world, for an inclusive energy transition and more equal distribution of the entailed benefits.

Solar PV has the right characteristics, so what is needed is increased political will and accelerated replication of best practices. One of the key aspects highlighted by this report is that a faster transition is possible, and potentially even higher figures are attainable. Considering Brazil can aim for 12 million (around 60 GW) solar PV rooftop systems by 2030, it would take another 10 large countries to undertake a similar commitment to surpass the 2030's target for rooftop PV. Ukraine, Mexico, Spain, France, and South Africa all showcase potential for rooftop solar larger than 10 GW, which frames an optimistic outlook.

Distributed solar generation represents strategic climate action, but it is also capable of unlocking a vast range of positive socio-economic impacts for people around the world, as well as of empowering businesses. In fact, solar PV is the main renewable technology of choice in the private sector. Companies investing in distributed (including rooftop) solar PV installations on their own buildings and premises are responsible for almost 30% of total installed PV capacity as of 2021. [50]

50. Solar PV; IEA.

For said countries to fulfill their solar markets' potential and meet their targets, there is the need for an attitude switch at the policy level and increased financial support, including for the staffing and trainin g of administrations, in order to facilitate the uptake of solar PV projects. This could be done via introducing incentives such as tax breaks, partial grants, favorable loans, feed-in premiums, net-metering, carbon taxes, and others, tailored to each market's characteristics and channeled through effective financial lines. It is critical, to maximize the self-consumption potential, to include specific incentives for energy storage.

In 2022, subsidies worldwide for fossil fuel consumption skyrocketed to more than USD 1 trillion, according to the IEA's latest estimate;[51] by far the largest annual value ever seen, generated by a global energy crisis. These resources should be redirected to finance solar PV's development. The case of South Africa shows how solar PV being consistently more economical than fossil fuels is itself alone encouraging people to make the switch. Yet, depending on the market's maturity, specific incentives can help countries accelerate on their targets.

Awareness of the many benefits solar PV can bring is rising making it the protagonist of people's own energy transition. Indeed, this analysis highlights a tendency to install rooftop PV systems for self-consumption, especially where there are resistances to the grid connection. Although this is regrettable as it limits the potential of solar energy – connecting to the grid can allow for broader exploitation of the power produced, higher financial benefits, and lower payback times – the trend is a testimony to solar PV's unique versatility.

Alongside streamlining the regulatory frameworks, by decreasing the requirements for small-scale plants and reducing the number of entities involved in the permitting, a key aspect is the modernization of the power grids to allow for wider integration of solar power and energy storage. The case of Brazil, where a frenzy market is moving towards charging users for their connection to the grid, might be a major

51. *Fossil Fuels Consumption Subsidies 2022; IEA.*

example of this if the proceedings are employed in strengthening the grid and reinvested into the national energy system with the objective of reaching even higher levels of decentralization with green energy.

Higher volumes of installations can also be unlocked by standardizing authorization procedures at a national level – the cases of France, Mexico, Argentina, and Spain remark on the issues deriving from differentiated procedures across the country – and ultimately by forming a 'one-stop shop' for the whole process. Such homologation and simplification, recommended in all countries, would allow more developers to work on projects in different regions in a streamlined, less risky way, and result in more simultaneous applications.

As the global solar PV stakeholder organization, the GSC promotes the concept of learning from others disseminating and replicating good practices. The Council brought the main outcomes and recommendations from this work at COP 27 in Sharm El-Sheikh, Egypt, in late 2022. Although achieving a historical consensus on reparation for loss and damage suffered by vulnerable countries, COP 27 fell short of ensuring the limitation of further harm caused by worsening climate change through increasing mitigation and adaptation actions. Attempts to increase the ambition of national decarbonization plans and to peak global emissions by 2025, as well as phasing out all unabated fossil fuels have failed, to the benefit of the fossil fuels lobbies.

This is irrational considering that solar and other renewable and clean technologies represent immediate solutions to the energy and climate crises, and can offer great help in facing food and water crises as well. Solar PV in particular is a mature and competitive asset for both mitigation and adaptation. As shown during GSC events at COP27, solar panels are able to keep working even during floods and hurricanes, ensure access to power where grids are disrupted or absent, and help drastically reduce emissions.

This confirms the importance of the GSC's presence at UNFCCC COP alongside the Global Renewables Alliance to influence decisions in favour of solar power and other renewables and clean technologies. With this target, the GSC is committed to stepping up initiatives and ambitions toward COP 28 in Dubai, UAE.

Solar PV is a rational decision. It is the best way forward for people and countries of the world as it makes sense environmentally and economically.

Higher volumes of installations can also be unlocked by standardizing authorization procedures at a national level and ultimately by forming a 'one-stop shop' for the whole process. Such simplification, recommended in all countries, would allow more developers to work on projects in different regions in a streamlined, less risky way.

Annex

Survey structure and objectives

In line with the general objective outlined above, the survey was developed around four clear targets.

- To understand the current state of distributed solar markets across the globe;
- To find out the potential and targets for distributed solar PV of different countries;
- To identify bottlenecks in the development of distributed solar projects;
- To discover the best practices that can help accelerate the deployment of solar PV globally.

For the survey to be comprehensive of the different relevant aspects and coherent with its objectives while providing clarity around the desired results, it was split into four sections.

1. Installed solar PV capacity
2. Potential rooftop solar PV capacity
3. Authorization framework
4. Incentive mechanisms

The GSC Members Survey

Installed solar PV capacity

1. Indicate your country's total current installed solar PV capacity.

2. If available, indicate the share of rooftop solar PV (including residential, commercial, industrial, public buildings).

3. If known, fill up the subdivision of the total installed capacity based on plants size. If data are missing for a specific split, please aggregate the splits:

- under 10kW;
- between 10 kW and 20 kW;
- between 20 kW and 200 kW;
- between 200 kW and 500 kW;
- between 500 kW and 1000kW;
- above 1000 kW.

4. If available, indicate the share of residential plants.

5. If available, indicate the share of plants for self-consumption/net-metering.

6. If available, indicate the share of plants for total grid input.

7. If available, indicate the capacity of plants participating in energy communities/community power.

8. If available, indicate the off-grid total installed capacity and divided by sector (residential, industrial/commercial/agriculture, public).

Potential rooftop solar PV capacity

9. If known, indicate your country's potential capacity for rooftop solar (including all buildings: residential, commercial/industrial/agriculture, public, etc.). Please consider also indicative data or estimates resulting from statistical elaborations, as well as studies regarding specific geographical areas within the country.

10. If known, indicate the share of residential to total potential rooftop capacity. Please consider also indicative data or estimates resulting from statistical elaborations, as well as studies regarding specific geographical areas within the country.

11. If known, indicate the potential capacity of solar parking lots. Please consider also indicative data or estimates resulting from statistical elaborations, as well as studies regarding specific geographical areas within the country.

12. List any relevant used national and international source, document or study.

13. If available, indicate your country's target for rooftop solar PV (alternatively, any other targets put forth for solar PV).

Authorization framework

14. Taking into consideration both complexity and time length, evaluate how difficult the overall permitting procedure to install rooftop solar PV is in your country: 1 to 5 with 1 very easy and 5 very difficult.

15. Taking into consideration both complexity and time length, evaluate how difficult the overall connection to the grid procedure for rooftop solar PV is in your country: 1 to 5 with 1 very easy and 5 very difficult.

16. Describe the type of meters employed (e.g., electromechanical meter or digital meter) and if possible indicate the digital meter substitution rate in residential and industrial/commercial/ agricultural buildings.

17. Describe positive aspects and main barriers (e.g., airport proximity, historical buildings, park area proximity, differentiation based on plants size or on type of consumption) of your country's overall authorization process.

18. Describe the most complex or long stage of permitting in your country (e.g., authorization of rooftop plant, authorization for grid connection).

19. Indicate whether there are uniform authorization procedures at national level or they are differentiated at local level.

20. Indicate any policy instruments currently foreseen or recommended to simplify the authorization process in your country.

21. Indicate any policy instruments currently in place or foreseen that would result in a negative impact for rooftop solar PV installations.

Incentive mechanisms

22. Describe incentive mechanisms in place for installation of rooftop PV, divided by plants size and product sectors (e.g., tax or bills breaks, incentives for energy storage systems, for energy communities).

23. Describe incentive mechanisms in place for power production of rooftop PV, divided by plants size and product sectors (e.g., self-consumption incentives, incentives for energy production, incentives for energy communities).

24. Indicate any incentive mechanisms that have stimulated deployment of installations.

25. Indicate incentives that the government or the industry recommend to further stimulate deployment of installations.

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