EUROPEAN
COMMISSION

Brussels, XXX
[…](2022) XXX draft

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

EU Solar Energy Strategy

1. SOLAR ENERGY TO REPOWER EUROPE

Russia's aggression against Ukraine has brought to light an uncomfortable truth. Whilst the European Green Deal has accelerated Europe's clean energy transition and set ambitious targets, we still depend heavily on Russia's fossil fuels.

Massive, rapid deployment of renewable energy is at the core of the REPowerEU plan - the European initiative to respond to this challenge. Solar energy will be the kingpin of this effort. Panel by panel, the infinite energy of the sun, will reduce our dependence on fossil fuels across all sectors of our economy, from residential heating to industrial processes.

As part of the REPowerEU plan, this strategy aims to bring online over 300 GW [TO BE UPDATED BASED ON NEW SCENARIOS BEING DEVELOPED] of solar photovoltaic by 2025 (more than doubling compared to 2020) and above 500 GW [TO BE UPDATED] by 2030[1].

Solar energy has a number of advantages that make it particularly suitable to meet today's energy challenges.

First, solar photovoltaics (PV) and solar thermal technologies can be rolled-out rapidly, in particular on rooftops. Solar energy enjoys strong public support as it rewards citizens and businesses with benefits for climate and their purses.

This is because solar PV costs have decreased spectacularly over time. The EU's renewable energy policies helped bring them down by 82% over the last decade[2], turning solar PV into the most competitive source of electricity. Solar energy, combined with energy efficiency, protects European citizens from the volatility of fossil fuel prices.

EU citizens appreciate this autonomy to produce their own energy, either individually or collectively. It is a huge opportunity for whole cities and regions, especially those transitioning to a new energy and economic model. The solar sector does not only create renewable electricity and heat; it also creates jobs, new business models and start-ups.

Massive deployment of solar energy is also a chance to reinforce the EU's industrial leadership. We need a plan to retain more economic value from the sector in the EU. By creating the right framework conditions, the EU can expand its manufacturing base, building on its vibrant competitive and innovation-driven environment while solar products must be up to the EU consumer's high standards.

The EU Solar Strategy outlines a comprehensive vision to swiftly reap the benefits of solar energy, and presents four initiatives to overcome the remaining challenges in the short-term.

First, by promoting quick and massive PV deployment via the **European Solar Rooftops Initiative**.

[1] All values on electricity generation capacity refer to alternating current (AC).
[2] See IRENA Data Centre

Second, by making **permitting procedures shorter and simpler**. The Commission will address this issue through the adoption of a legislative proposal, a recommendation and a guidance, alongside this communication.

Third, by ensuring the availability of abundant skilled workforce to face up the challenge of producing and deploying solar energy all across the EU. This strategy will propose an **EU Solar Skills Partnership**, as part of a large partnership for onshore renewable energy under the Pact for Skills, an initiative of the European Skills Agenda 2020[3]. This partnership will bring together all relevant stakeholders to take action on upskilling and reskilling in order to fill the gap.

Fourth, by launching a **European Solar Industry Alliance** that aims at innovation-led expansion of a resilient industrial solar value chain in the EU, in particular in the PV manufacturing sector.

[3] COM(2020) 274 final, 1 June 2020

2. ACCELERATING SOLAR ENERGY DEPLOYMENT

Solar PV is the cheapest source of electricity available[4]. The cost of solar electricity was already well below wholesale electricity prices before the 2021 surge. This advantage has become even more relevant now in the face of the crisis. Solar electricity and heat are key for phasing out EU's dependence on Russian natural gas. Large-scale deployment of PVs will reduce our reliance on natural gas used to produce power. Solar heat and solar power combined with heat pumps, will replace natural gas boilers for heating in residential or commercial spaces. Solar energy in the form of electricity, heat or hydrogen can replace natural gas consumption in industrial processes.

By the end of 2020, the EU reached ca. 136 GW of solar PV installed generation capacity, having added more than 18 GW that year. It delivered around 5% of total EU electricity generation[5]. To reach the 2030 target for renewables proposed by the Commission and the objectives of the REPowerEU plan, we need to radically step up a gear. **Over this decade, the annual installations across the EU need to more than double compared to 2020** [TO BE UPDATED].

Solar systems have long been a low-cost and reliable solution for heating in many European countries[6] but overall solar heat accounts for just around 1.5% of heating needs[7]. To reach the EU 2030 targets, **energy demand covered by solar heat and geothermal should at least triple**.

Solar energy technologies have upfront costs, but lower operational costs. Therefore, attractive financing conditions are crucial for their competitive deployment. More than EUR 50 billion must be invested annually in additional electricity generation capacity to transform the EU's energy system towards 2030[8] with a substantial share of that total channelled towards solar energy installations. This will create employment, reduce the fossil fuel import bill and provide invaluable protection for citizens and business.

Most of the financing will be private, but partially triggered by public funding, also from the EU. The Recovery and Resilience Facility will dedicate at least EUR 18 billion to accelerate the roll-out of renewables. Other instruments are contributing to this effort: the cohesion policy funds, InvestEU, the Innovation Fund, the Modernisation Fund, Horizon Europe or the LIFE programme. Connecting Europe Facility RES and the EU renewable energy financing mechanism will support cross-border cooperation on solar energy projects. Besides dedicated

[4] Estimated at 24-42 EUR/MWh depending on the location within the EU *in* Eero Vartiainen, Gaëtan Masson, Christian Breyer, David Moser, Eduardo Román Medina "Impact of weighted average cost of capital, capital expenditure, and other parameters on future utility-scale PV levelised cost of electricity" – Estimated at 32-74 EUR/KWh depending on the location within the EU *in* Lugo-Laguna, D.; Arcos-Vargas, A.; Nuñez-Hernandez, F. A European Assessment of the Solar Energy Cost: Key Factors and Optimal Technology. Sustainability 2021, 13, 3238. Estimated at an average of 60 USD/MWh in the EU according to IEA World Energy Outlook 2021. Estimated at 75-131 USD/MWh across Italy, Spain, France and Germany according to IRENA Technical Report "Renewable Power Generation Costs 2020".

[5] Eurostat

[6] Competitiveness of the heating and cooling industry and services - Publications Office of the EU (europa.eu)

[7] Solar heat accounted for 38 GW_{th}, primarily in the form of solar heating systems for domestic hot water in residential homes, with 1.6 GW_{th} added in 2019. Eurostat

[8] Commission Staff Working Document - Impact Assessment accompanying the Commission Communication "Stepping Up Europe's 2030 Climate Ambition - Investing In A Climate-Neutral Future For The Benefit Of Our People" (COM(2020) 562 final) (SWD(2020) 177 Final - SWD(2020) 178 Final) 17.9.2020

energy financing programmes, **Member States should support solar energy under programmes** for transport infrastructure, research and innovation or the Common Agricultural Policy in order to ensure an integrated support framework for solar energy across various policy fields.

The revised Guidelines on State aid for climate, environmental protection and energy[9] have introduced a set of provisions allowing for tailored support to solar energy, where needed. It allows for the use of market-based instruments, such as contracts for difference, the possibility of technology-specific tenders or exemptions from mandatory competitive bidding for smaller projects and the ones developed by energy communities.

2.1. Utility-scale deployment and enabling measures

Utility-scale installations

Utility-scale solar installations will be crucial to replace fossil fuels at the required speed. In recent years, competitive bidding has driven growth in this segment. By 2020, 19 Member States had carried out national-level tendering processes, also known as renewable energy auctions[10]. This mechanism has contributed to drive down costs and recent years have seen greater emphasis on auction designs which increase reliance on market-based revenues[11]. **Stable, publicly available schedules for the foreseen auctions increase visibility for project developers and drive up investment**. They should cover at least the following five years, include the amount of support, frequency of competitive tendering, the related foreseen capacity, the available budget and the eligible technologies[12].

Beyond auctions, public procurement can also be leveraged to further promote solar energy deployment, while generating incentives to enhance the sustainability of the equipment. In addition, aggregation of demand for solar energy from large public buyers can reduce investment risks and facilitate innovative business models in the solar energy sector. To this end, the Commission will build on the **Big Public Buyers initiative**, proposing the creation of a community of practice dedicated to the procurement of solar energy. This community will share knowledge and develop best procurement practices for solar energy technologies.

Solar project developers are increasingly relying on a combination of electricity market participation and corporate **renewable Power Purchase Agreements (PPAs)** to ensure a stable income. A swift adoption of the revision of the Renewable Energy Directive (RED), proposed in 2021, and the implementation of the Commission Recommendation on PPAs adopted alongside this Strategy should allow Member States to boost the number and aggregated volume of the agreements.

[9] Communication from the Commission - Guidelines on State aid for climate, environmental protection and energy 2022 (2022/C 80/01)

[10] CEER report (2020): 2nd CEER Report on Tendering Procedures for RES in Europe; AURES II project auction database.

[11] For instance, under a two-way contract-for-difference premium model, the State pays the renewable electricity producer the difference between the actual electricity price and a reference price when the former is lower; vice-versa, the producer pays to the State the difference when the electricity price is above the reference price (see http://aures2project.eu)

[12] Article 6 of Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

As the share of variable renewables increases in the electricity system, **auctions should also support renewables-based technologies that can reduce the cost of ensuring network stability and system integration.** Concentrated Solar Power (CSP) with thermal storage and solar installations with batteries are examples of technologies that can provide these benefits.

The public consultation confirmed that a key barrier holding back utility-scale installations, including solar, are long and complex permit-granting procedures and other administrative barriers. To overcome this obstacle Member States should implement the RED, in force since 2018, and the Recommendation **on fast permitting for renewable energy projects** adopted alongside this communication. The legislative proposal on permitting should be agreed as soon as possible.

Go-to areas and multiple use of space

The required expansion in utility-scale projects will increasingly create competing uses of land and of public acceptance. Member States should undertake a mapping exercise to identify **appropriate locations for renewable energy installations** needed to collectively achieve the revised EU 2030 renewable energy target. They should also **designate the renewable go-to areas** in which permitting will be simpler and faster than elsewhere while limiting the environmental impact.

The repurposing of former industrial or mining land represents an opportunity for solar energy deployment. The Modernisation Fund, as well as the cohesion policy, in particular the Just Transition Fund, can support this kind of economic diversification and reconversion initiatives.

Innovative forms of deployment (1) – Multiple use of space

In a context where land constraints can represent a bottleneck for solar energy expansion, ***multiple use of space*** *provides additional opportunities.*

In particular, under certain conditions, the agricultural use of land can be combined with solar generation in so-called ***agrivoltaics*** *(or agri-PV). The two activities can establish synergies, whereby PV systems contribute to crop protection and yield stabilisation[13], with agriculture remaining the primary use of the land area. Member States should consider incentives for the development of agri-PV while implementing their* ***national strategic plans for the Common Agricultural Policy****, as well as their support frameworks for solar energy (e.g. through the integration of agri-PV in renewable energy tenders). It is also worth noting that, in the agricultural sector, State aid rules allow investment aid to sustainable energy.*

Furthermore, thanks to ***floating PV*** *solutions, the surface of water can be used for solar generation. Offshore solar installations represent a great potential, integrated in the EU Offshore Renewable Energy Strategy[14]. Ongoing research and innovation efforts are dedicated i.a. to developing new mooring solutions, improving the durability of PV panels in marine environment and reducing maintenance costs.* ***Member States are encouraged to integrate floating solar installations in their maritime spatial plans****. Within the energy sector, the* ***use of the surface of artificial lakes*** *created by hydroelectric dams for PV*

[13] See research developed by Fraunhofer ISE on the topic: https://agri-pv.org/

[14] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future COM/2020/741

deployment represents a specific potential. In this framework, floating PV panels reduce water evaporation and, connected to the dam's electric systems, increase the total output. Any intervention on water bodies must respect the conditions set out in the Water Framework Directive[15].

Finally, ***transport infrastructure****, such as highways or railway tracks, presents an unexploited potential for solar energy deployment. For instance, if the installation of solar panels on highway sound barriers in a pilot project in the Netherlands were replicated in the country's whole system of sound barriers, it would yield enough electricity for 250.000 households*[16].

The Commission will develop a **guidance for Member States to promote the development of the innovative forms of solar energy deployment** listed in this strategy.

Rising to the skills challenge

The EU solar PV sector employed 357,000 full-time equivalent (direct and indirect) jobs in 2020 and this figure is expected to at least double by 2030. The installation sector is a particularly strong source of local jobs, representing 80% of the total, while the operation and maintenance sector stands for 10%[17].

There is already a lack of skilled workers. This bottleneck can grow quickly, if unaddressed. Vocational and Educational Training is an important instrument to address this challenge and Member States are encouraged to analyse the skills gap in the solar energy sector and develop training programmes fit for purpose. At EU level, the Commission will bring together the relevant stakeholders in the renewable energy sector (industry, regional and national authorities, social partners, research and innovation institutions, education and training providers) and support them to set up **an EU solar skills partnership**, as part of a large-scale skills partnership for onshore renewable energy under the Pact for Skills, comprising stakeholders from the wind, geothermal, biomass and heat pumps industries, but also from permitting authorities.

The partnership should develop a clear vision of concrete up- and reskilling measures for the solar expansion. This should include training cooperation between companies across the value chain, social partners, training providers or regional authorities. By joining forces, stakeholders can maximise the return on their investment in the partnership. Private, local and national funds can be complemented by EU funding, from the European Social Fund to Erasmus+ and Marie Skłodowska-Curie Actions.

In addition, to promote mobility, the proposed revision of the RED provides requirements for mutual recognition of certification schemes across the EU, based on common unified criteria. It also mandates Member States to publish the list of certified installers to provide guarantees for consumers.

[15] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy.
[16] Solar Highways: solar panels as integrated constructive elements in highway noise barriers. A multifaceted research into the design, construction and yield of a bifacial solar noise barrier. A LIFE + programme project executed by Rijkswaterstaat and TNO. 'Layman's report' Author: Minne de Jong, June 2020
[17] SolarPower Europe, EU Solar Jobs Report 2021.

2.2. Bringing solar value to citizens and communities

Citizens, small businesses as well as the European energy-intensive industry are struggling with high energy prices. Deploying solar energy on rooftops is an immediate solution to dramatically reduce their reliance on natural gas for their energy needs. With every energy consumer turned producer, the acceptance and democratisation of the transition towards a clean and independent energy system is reinforced. Accelerating this transition requires lifting the range of regulatory, financial and practical barriers that still prevent most EU citizens to use the sunshine to increase their independence and reduce their energy bills.

Incentivising prosumers

Prosumers are owners of small, decentralised installations who self-consume part of the energy they produce. Support and enabling policy frameworks for prosumers take various forms: investment subsidies, feed-in tariffs, exemptions from certain taxes or the possibility to sell excess electricity to other consumers or directly in the market. The new State Aid guidelines include exemptions from mandatory competitive bidding processes to allocate aid for small projects, below 1 MW of installed capacity.

The full potential of solar energy for the EU can only be exploited if citizens and communities are provided the right incentives to become prosumers. The public consultation pointed to the persistence of some negative factors, such as the low remuneration for the excess electricity produced or the general lack of awareness.

Better information is key to enhance clarity and predictability on the benefits of self-consumption, potential investors, citizens and SMEs. Investment costs, financial support, increase of property value, network tariffs, generation and consumption profiles and return on investment are all relevant factors impacting investments. **One-stop-shops** in Member States should share such information and give citizens **advice on both energy efficiency measures and solar energy projects** in an integrated manner, from technical requirements to administrative steps and support measures. The best available projections on the above variables should then be used to **design support frameworks that reassure those** deciding on an investment in solar energy, energy storage or heat pumps. This should be done in particular through **a predictable payback period, shorter than 10 years**.

No one should be left behind in this progress. Direct public support, multi-stakeholder approaches and innovative financing models should **facilitate access to solar energy for the energy poor and vulnerable**. This issue deserves particular attention in the most remote regions, i.e. the EU outermost regions, which enjoy a large untapped solar energy potential.

Member States should support partnerships between local authorities, energy communities and social housing managers to facilitate collective and individual self-consumption schemes. Pre-financing shares in energy communities, virtual net-metering schemes (while accounting separately for calculating network charges) or renting out solar PV, energy storage and heat pumps at a fee lower than retail electricity prices can all be used for this purpose. Member States can also[18] apply reduced VAT rates to energy efficient, low emission heating systems,

[18] Council Directive (EU) 2022/542 of 5 April 2022 amending Directives 2006/112/EC and (EU) 2020/285 as regards rates of value added tax

including solar panels, solar water heating systems and heat pumps, as well as to social housing and residential building renovation expenditure[19].

PVGIS, a tool for citizens to evaluate their roof's PV potential

The free and open web-based PVGIS Photovoltaic Geographical Information System tool, developed and maintained by the European Commission's Joint Research Centre, provides information about solar radiation and PV system performance for any location in Europe. Citizens and installers can use it for an instantaneous assessment of the potential to generate solar energy on rooftops.[20]

A balanced allocation of costs and benefits

One of the main barriers to individual or collective self-consumption identified by stakeholders are charges and network tariffs.

Under the current EU legislation, national regulatory authorities (NRAs) have the mandate and exclusive competence to prescribe transparent, non-discriminatory and cost-reflective tariffs. Prosumers have the right to sell their excess production without being subject to discriminatory or disproportionate procedures and charges and should be able to participate in all electricity markets. **These principles are not yet widely implemented across the EU**, especially in multi-apartment buildings.

Member States should avoid discriminatory treatment as regards grid injection tariffs between producers connected at transmission level and those connected at distribution level, such as prosumers and energy communities. Authorities should enable the development of local energy markets to diversify remuneration pathways for prosumers, based on energy sharing and peer-to-peer exchange arrangements.

In the context of collective self-consumption or peer-to-peer exchange within multi-apartment buildings, NRAs should **consider possible cost reductions stemming from the reduced use of the network**. At the same time, such cost-reflective tariffs should not lead to discrimination against those who do not have access to self-consumption. In other words, any discriminatory cost-socialisation of grid-related costs should be avoided. Looking forward, digitalisation, in particular smart meters, can greatly facilitate real-time monitoring of electricity flows and the evaluation of the impact on grid costs.

Time-differentiated distribution network tariffs, especially if flanked by dynamic pricing contracts, would contribute to aligning the choices of prosumers and energy communities with grid congestion management needs and market conditions.

Energy communities and other collective solar actions

Collective solar energy projects provide another avenue to reduce the consumption of fossil fuels and address energy poverty and vulnerability in areas and regions struggling with it.

[19] See annex III of Council Directive (EU) 2022/543.
[20] https://joint-research-centre.ec.europa.eu/pvgis-photovoltaic-geographical-information-system_en

Current legislation already supports **renewable and citizen energy communities**, as well as collective solar initiatives to generate, store, share, exchange, and use energy. However, these communities still face significant barriers, including difficulties to secure financing, navigate licencing and permitting procedures or develop sustainable business models. In addition, as they are often initiated by a group of volunteers, they suffer from limited time and access to technical expertise.

To tap into this potential, Member States should **establish appropriate incentives and adapt administrative requirements to the characteristics of energy communities**.[21] An integrated 3-step "learn-plan-do" programmes could help energy communities build technical expertise and secure access to financing. The assessment and removal of existing barriers would level the playing field with more professionalised and established market participants.

In addition, Member States are encouraged to make use of the flexibility provided by the revised State Aid guidelines to either exempt energy community projects with capacity up to 6 MW from mandatory competitive bidding processes, or facilitate their participation to such processes.

Other types of collective solar energy actions, managed by professionalised and larger actors, should also be encouraged to engage in innovative business models based on collective self-consumption and energy sharing.

Integrating solar energy through the interaction with other devices

To be seamlessly integrated in the energy system at large, the rapid growth of solar energy requires new technological, digital and operational advances.

Energy storage is an important asset to contribute to this integration, especially in the context of heating or transport shifting to electricity. Full system benefits of distributed assets, such as batteries, can only be reaped if they are properly integrated and able to participate in all electricity markets, including balancing and congestion management markets, in a non-discriminatory and homogeneous manner across the EU. At EU level the ongoing work on the **EU network code on demand side flexibility** aims at addressing remaining regulatory barriers and unlocking the potential of such distributed assets as flexibility sources. The proposal for a revision of the RED also includes additional provisions to ensure non-discrimination in the market participation of these assets.

Electric vehicles (EVs) can also serve as energy storage devices and contribute to solar electricity self-consumption, if parked within the premises of the owner or user. Linking the EV's consumption at home while recharging away from home, for instance through the same electricity supplier, has the potential to contribute to a more dynamic system integration of distributed solar energy assets. This may also allow owners and users to use the same contract and data-sharing agreement for their recharging needs.

Off-grid recharging stations equipped with PV panels and energy storage offer the possibility to increase access to EV recharging infrastructure in rural areas and, in general, in those locations with limited grid connection.

[21] As these initiatives are often initiated by a group of volunteers, they are characterised by limited time and access to financial and technical resources.

Innovative forms of deployment (2): vehicle-integrated PV

Solar energy and electric vehicles can also be integrated in technologically novel ways. ***Vehicle-integrated PV*** *presents a high potential to contribute to the reduction of emissions from the transport sector, by increasing the energy autonomy of EVs and partially replacing grid power with solar electricity produced on board[22]. More than other EVs, they can also become an additional source of electricity for the grid while parked, and an energy storage solution contributing to overall grid resilience. The opportunities provided by this technology are being analysed through a pilot project managed by the Commission[23].*

Devices such as batteries and heat pumps can only contribute to the integration of solar electricity into the energy system if they can effectively communicate with each other and with solar energy systems. This interoperability can be facilitated through measures such as standardisation, or open-source solutions for digital connectivity. One of the objectives of the Commission's proposal for a Data Act[24] is to foster a level playing field for energy solutions and services, while putting the user in control of data collection and sharing to third-party service providers. Horizon 2020 research and innovation projects jointly develop interoperability and data sharing solutions, while standardisation organisations are already running activities in this respect. In addition, the upcoming Digitalisation of Energy Action Plan, through a code of conduct for energy smart appliances manufacturers, will support interoperability for a wide range of energy consuming, producing and storage devices[25].

2.3. Solar value for buildings and industry

The contribution of solar to decarbonising our building stock

Buildings are long-lasting assets, with overall high energy consumption, mostly based on fossil fuels and in particular gas. Deployment of solar energy in buildings is more relevant than ever. Solar energy can deliver a substantial part of a building's electricity and heat demand, either through solar heat collectors, solar PV (with heat pumps) or a combination of the two, including hybrid PV-thermal technologies.

National and local authorities should ensure that their support policies and regulations **provide a level playing field for all solar technologies** and do not favour one against the other, while respecting the energy efficiency first principle.

When combined, the installation of solar energy and renovation interventions become mutually reinforcing, optimising the building's energy performance. Member States should set up national support programmes to ensure **swift massive deployment of rooftop solar energy in buildings starting with high energy consumption buildings** (Energy

[22] Thiel, C., Gracia Amillo, A., Tansini, A., Tsakalidis, A., Fontaras, G., Dunlop, E., Taylor, N., Jäger-Waldau, A., Araki, K., Nishioka, K., Ota, Y., Yamaguchi, M.: Impact of climatic conditions on prospects for integrated photovoltaics in electric vehicles (2022). Renewable and Sustainable Energy Reviews, 158, art. no. 112109

[23] Pilot Project – Effect of Energy-efficient and Solar Power Generating Vehicles on Overall Energy Demand in the EU Transport Sector (2022/S 053-136682) – Contract notice published on 16/03/2022.

[24] Proposal for a regulation of the European Parliament and of the Council on harmonised rules on fair access to and use of data (Data Act) COM(2022) 68 final

[25] See the work carried out by the JRC in this area: https://ses.jrc.ec.europa.eu/development-of-policy-proposals-for-energy-smart-appliances

Performance Certificate class D or above). Where appropriate, this effort must be combined with **roof renovations and deployment of energy storage and heat pumps**. The Member States should also mobilise to **install solar energy in all public buildings fit for it**, from administrative offices to schools. Where the building is not adapted, the administration should have the possibility to acquire renewable electricity through a PPA.

Greening of energy taxation and the proposed **new emissions trading system for buildings** and road transport can contribute to generate the resources required for these interventions, while setting the appropriate economic incentives.

As regards new buildings, where technically feasible, the recast of the Energy Performance of Buildings Directive[26] requires that 100% of on-site energy consumption be covered by renewable energy as of 2030. In addition, Member States should ensure that **all new buildings are "solar ready"**, i.e. designed to allow the installation of solar technologies without costly structural interventions, enabling their occupants to easily embrace solar energy.

Innovative forms of deployment (3): Building-integrated PV

The opportunities buildings provide to install solar energy extend well beyond rooftops and parking spaces. ***Building-integrated PV (BIPV)*** *represents a novel form of solar deployment: they constitute a construction product, while at the same time allowing solar electricity generation from additional surfaces. Despite recent cost reductions, the potential of this sector remains to be unlocked through uptake by the construction sector and the related economies of scale. EU-wide deployment would require* ***homogeneous certification*** *for the affected products, as well as customised professional training and university programmes. National governments can also provide* ***guidance to local authorities*** *on how to deal with BIPV in their permitting decisions[27]. Some Member States have introduced* ***specific opportunities for BIPV in their renewable energy support frameworks****. Attaching such support to the construction permit stage can further facilitate the uptake of these products by actors in the construction sector.*

Solar energy for the industrial sector

To meet their electricity demand, companies are already signing direct PPAs with solar energy projects. By 2021, more than 5 GW of solar PV projects had directly signed PPAs with corporate offtakers[28]. However, corporate renewable PPAs still account for a small fraction of the sector's electricity consumption.

Solar energy can also provide industrial heat, which accounts for 70% of industrial energy demand.

[26] Proposal for a directive of the European Parliament and of the Council on the energy performance of buildings (recast) COM/2021/802
[27] JRC Policy Brief (JRC120970): How Photovoltaics can ride the EU Building Renovation Wave
[28] RE-Source platform (2021)

Based on solar collectors or concentrated solar, solar heat can deliver heat for industrial processes from 100 to over 500°C.Nevertheless, the potential of solar heat for industrial processes is still largely untapped. One of the main obstacles it faces is the gap between the payback times of these investments and the financial requirements of most industrial actors.

Solar electricity can be used in combination of heat pumps or electric furnaces to provide heat, or it can be converted into renewable hydrogen, used as a feedstock in industrial processes. Due to declining costs, in particular in places with high irradiation and limited land constraints, it is expected that renewable hydrogen production from solar electricity can become cost-competitive within the next decade.

The Commission is preparing an **EU-wide scheme for carbon contracts for difference** under the Innovation Fund to support innovative solutions for the decarbonisation of industrial energy demand.

European Solar Rooftops Initiative

According to some estimates, rooftop PV could provide almost 25% of the EU's electricity consumption[29] - this is more than the share of natural gas today. These installations – on residential, public, commercial and industrial roofs – can shield consumers against high energy prices, contributing to public acceptance of renewable energy. They can be deployed very rapidly, as they utilise existing structures and avoid conflicts with other public goods like environment.

The EU-wide European Solar Rooftops Initiative, announced in the Commission's REPowerEU Communication, aims at unlocking vast, underutilised solar generation potential of rooftops to make our energy cleaner, more secure and affordable.

To achieve this swiftly, immediate action at EU and Member State level is necessary by end 2022 in order to:

- *Limit the length of permitting for rooftop solar installations, including large ones, to a maximum of 3 months; eliminate administrative obstacles for cost-effective extensions of already installed systems.*
- *Establish robust support frameworks for rooftops, including in combination with energy storage and heat-pumps, based on predictable payback times, shorter than 10 years.*
- *As part of such a framework and where needed to unlock investments, set up a national support programme to ensure as of next year:*
  - *massive deployment of rooftop solar energy in high energy consumption buildings (Energy Performance Certificate class D or above),*
  - *combine solar deployment with roof renovations and energy storage; this*

[29] Bódis, K., Kougias, I., Jäger-Waldau, A., Taylor, N., Szabó, S.: A high-resolution geospatial assessment of the rooftop solar photovoltaic potential in the European Union (2019) Renewable and Sustainable Energy Reviews, 114, art. no. 109309

should be implemented through a one-stop shop integrating all aspects.

- *Install solar energy in all public buildings fit for this purpose by 2025.*
- *Make the installation of rooftop solar energy compulsory for all new buildings.*
- *Ensure that consumers in multi-apartment buildings can effectively exercise their right to collective self-consumption, without undue costs.*
- *Ensure that energy poor and vulnerable consumers have access to solar energy, e.g. through social housing installations, energy communities, or financing support for individual installations.*
- *Set up at least one renewable energy community in every municipality with a population higher than 10.000 by 2025.*
- *Support building-integrated PVs for both new buildings and renovations.*

The EU and its Member States should implement the measures under this initiative as a priority, using available EU funding.

If fully implemented, this Initiative will accelerate rooftop installations and ***add 17 TWh***[TO BE UPDATED] ***of electricity after the first year of its implementation*** *(17% more than expected in the Fit for 55 projections). By 2025,* ***it will result in 42 TWh*** [TO BE UPDATED] ***of additional electricity generated*** *(35% above the Fit for 55 projections).*

2.4. Preparing the energy network for the efficient absorption of solar electricity

Infrastructure investments

Solar energy is abundant, but the energy infrastructure bringing it to the consumer must change to enable a more electrified system powered by wind and solar. In the public consultation, solar industry stakeholders identified grid expansion and grid connection as a key bottleneck for deployment.

The efficient integration of decentralised solar installations will primarily require significant adaptations in distribution networks. These include digitalisation investments, such as smart grids, to enable higher system performance and seize the flexibility opportunity provided by small distributed assets. The forthcoming Digitalisation of Energy Action Plan will highlight the importance of providing clear investment signals to accelerate the digitalisation of the electricity grid.

A trans-European electricity system provides intrinsic flexibility and contributes to lower prices. The updated **Trans-European Networks for Energy** (TEN-E) regulation[30] will contribute to the **expansion of cross-border electricity infrastructure and smart grids** and

[30] Proposal for a regulation of the European Parliament and of the Council on guidelines for trans-European energy infrastructure and repealing Regulation (EU) No 347/2013 - COM/2020/824 final

facilitate integrated infrastructure planning, thus enabling a more efficient transmission and integration of solar electricity produced across the EU.

Member States should use EU funds to remove the bottlenecks to solar expansion in distribution and transmission grids. This could be done through their cohesion funding or the Recovery and Resilience Fund which already foresees EUR 8.5 billion dedicated to energy networks and infrastructure in 17 of the approved national plans.

Paving the way for Direct Current solutions

The introduction of high shares of solar PV and wind has an impact on the way the electricity grid is managed. As renewable power from solar is produced in Direct Current (DC), conversion to Alternating Current (AC) to feed into the grid and then converting back to DC, e.g. to store energy, leads to energy losses. Such conversion losses are currently growing because more devices and system, such as batteries, heat-pumps, data centres, electric vehicles or appliances, operate in DC. Increasing the use of DC technologies could thus be beneficial to the electricity system.

The Commission is investigating how low-voltage DC technologies can enhance the clean energy transition. On the basis of the conclusions drawn from this process, it will **engage with European and international standardisation bodies** for the establishment of the necessary standards and protocols.

*****

The updates of the **National Energy and Climate Plans** are a critical tool for the Member States to adapt and enhance the necessary policies and measures to implement initiatives accelerating massive deployment of solar energy. In order to ensure this, the Commission will provide Member States with support ahead of the update of their plans in 2023.

3. ENSURING ACCESS TO SUSTAINABLE SOLAR ENERGY

While massive deployment of the solar energy increases our independence and its low cost can support competitiveness of our industries, currently the EU imports most of the solar energy products it installs: EUR 8 billion of PV panels in 2020, 75% of which from a single country[31]. Meanwhile, only a small share of global production takes place in the EU. This exposes us to risks linked global or country-specific events. Expanding the role of the EU all along the solar value chain, in particular in the manufacturing stage, on the back of its vibrant innovation and competitive market, will strengthen the sector's resilience, while creating jobs and added value. In addition, the EU will step in to ensure that solar energy products are sustainable and up to the standards of the EU consumers.

3.1. More innovative, sustainable and efficient solar energy products

Supporting innovation in solar energy

The solar energy sector has become a very dynamic and competitive industry, ensuring a constant output of innovative technologies. The EU has one of the strongest innovation environments across all solar energy technologies, from PV to concentrated solar power (CSP). The challenge now is to ensure that a new generation of breakthrough technologies leads to higher conversion efficiencies (which translate into less use of resources, such as space, materials, water, etc), increased recyclability and circularity in the use of raw materials, as well as a more sustainable life cycle, including in manufacturing.

Through Horizon Europe, the EU will continue to support research and innovation to reduce the cost of solar energy technologies, while increasing their energy efficiency and their sustainability, including in the manufacturing stage. These new technologies include heterojunction cells, perovskites and tandem cells, all of which achieve higher efficiencies than commercial technologies. Financial support is also needed for innovation in solar thermal or CSP technologies, as well as products tailored for innovative forms of deployment. The upcoming 2023-2024 work programme will include a **flagship initiative to support solar energy research and innovation**, focused on novel technologies, environmental and socio-economic sustainability, as well as integrated design.

Also under Horizon Europe, the European Partnership for Clean Energy Transition will **crowd in support from Member States, the energy industry and public organisations for research and innovation in solar energy** over the 2021-2027 period. The collaboration with Member States can be further expanded by developing a common solar energy research and innovation agenda in the framework of the European Research Area. This initiative will build on the ongoing work of the Strategic Energy Technology Plan.

The space sector represents an additional innovation trigger. This strategic sector needs the development of high-performance solar cells, including heterojunction cells.

To bridge the gap between research results and commercial development, the Innovation Fund will provide around EUR 25 billion of support over 2020-2030, depending on the carbon price, for the commercial demonstration of innovative low-carbon technologies. One of the seven large-scale projects selected in the first batch supports innovation in the solar sector.

[31] Eurostat - International trade in products related to green energy – data extracted in October 2021.

Finally, from a regional perspective, the European Regional Development Fund supports research and innovation in Member States and regions in priority areas identified through the local smart specialisation strategies.

Fostering the sustainability of PV systems installed in the EU

Over a lifetime of 20 years, today's commercial PV systems can produce almost twenty times the energy needed to manufacture them[32]. Still, it is important to continue to reduce their carbon footprint.

The European Commission plans to propose in the first half of 2023 two mandatory internal market instruments that would apply to solar PV modules, inverters and systems sold in the EU: **an Ecodesign Regulation and the Energy Labelling Regulation**. The measures would concern the efficiency, durability, reparability and recyclability of products and systems, to ensure that the devices deployed are environmentally sustainable. Requirements on the quality of the manufacturing process and on the carbon footprint of PV modules are also being considered as they could foster further innovation in the design and manufacturing stage and promote the use of renewable energy for their production.

These measures would provide a common reference for potential buyers to compare different products. They can also serve as basis for initiatives aimed at stimulating demand for the most sustainable PV products and systems, including through renewable energy auctions.

Nevertheless, there is still a lack of transparency regarding environmental and sustainability criteria in the global value chain of solar PV. The EU calls on international producers of solar panels to strengthen efforts to provide information regarding the sustainability aspects of their products, including their carbon footprint.

The Commission also plans to propose a revision of the existing Ecodesign and Energy Labelling regulations on space and water heaters in 2023. The interaction between heaters and solar energy products is key for the integration of solar energy; these regulations would make their combined benefits more understandable and visible for consumers.

The EU will provide European consumers with guarantees that the products they buy have been made respecting human and labour rights. In particular, the Commission has announced a new legislative initiative to **effectively prohibit the placing on the EU market of products made by forced labour**. In addition, since private actors play a central role in the fight against forced labour, the Commission has put forward detailed reporting requirements covering this and other labour rights aspects in its proposal for a Corporate Sustainability Reporting Directive[33].

[32] Photovoltaics report, Fraunhofer Institute for Solar Energy Systems, February 2022

[33] Proposal for a directive of the European Parliament and of the Council amending Directive 2013/34/EU, Directive 2004/109/EC, Directive 2006/43/EC and Regulation (EU) No 537/2014, as regards corporate sustainability reporting COM/2021/189 final

3.2. Supply chain resilience

Raw materials reliance

The use of raw materials for manufacturing of PV panels depends on the technology used. The market is currently dominated by crystalline silicon cells, which essentially rely on silicon. Thin-film technologies, which represent less than 5% of the global supply, make a more heterogeneous use of raw materials[34]. In addition, the manufacturing and installation of all PV modules requires glass, aluminium and steel; copper is used for their connection to the grid. The EU currently covers a small share of its demand for processed materials and depends on international suppliers, often concentrated in a single or small number of countries.

Although materials intensity is set to decrease over time thanks to technological improvements, silicon demand is expected to increase fourfold by 2030 and then stabilise[35]. The vulnerabilities of the global supply chain on which the EU relies were exposed in 2021, when the price of polysilicon increased by over 350%, impacting the price of PV panels[36].

EU policy aims at building resilience in relation to critical raw materials, based on access to resources and sustainability. Achieving resource security requires action **to ensure that global markets are not distorted and to diversify supply.** Strengthening the sustainable and responsible domestic sourcing of, in particular, silicon metal and polysilicon could also be envisaged.

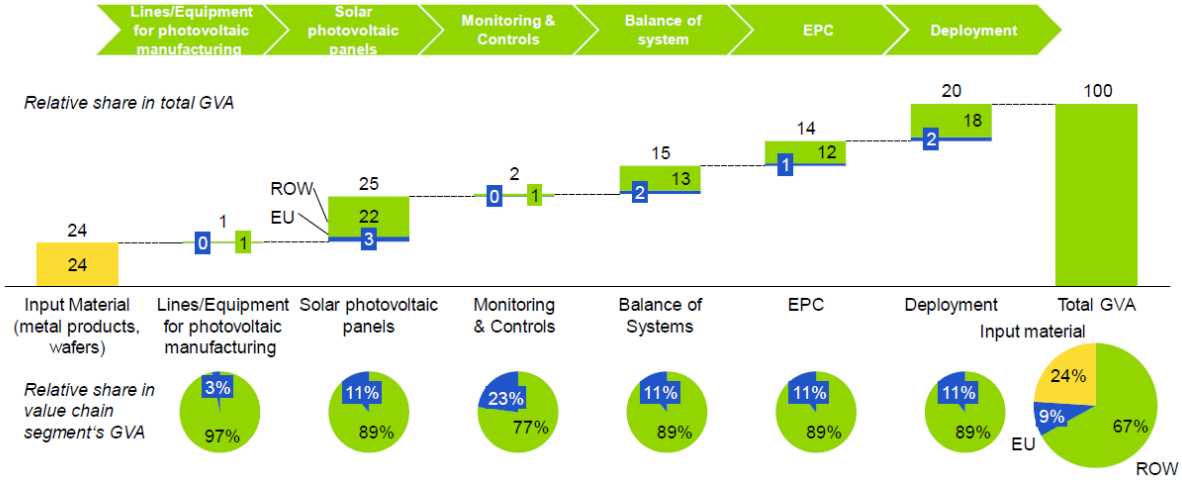
Improving resource efficiency and circularity is equally important to address this challenge. Since 2012 EU legislation calls for the recovery, reuse and recycling of PV modules. The recycling industry today can deliver high levels of circularity but further innovation is still needed. Starting in 2025, the quantity of PV panels reaching its end of life will significantly increase. This will require ensuring reparability and recyclability by design for new equipment and **building up an ecosystem for the efficient recycling of used materials**. The Ecodesign measures for PV systems would include information requirements on these aspects to promote better product design leading to higher long-term energy performance and facilitating recycling and repair.

Manufacturing: the critical point for resilience

The EU industry holds strong positions in several parts of the solar PV value chain, starting with the polysilicon sector, but especially in the downstream segment, including inverter and solar trackers manufacturing or monitoring and control. European companies have also maintained a leading position in the deployment sector. As shown in the figure below, downstream segments represent half of the value chain's gross value added and the EU captures more than 10% of that value.

[34] There are three main categories of thin film solar cells: cadmium telluride (CdTe), copper indium gallium diselenide (CIGS), and amorphous thin-film silicon (a-Si, TF-Si).
[35] JRC, Joint Research Centre (Carrara, S., Alves Dias, P., Plazzotta, B., Pavel, C.), (2020a), Raw materials demand for wind and solar PV technologies in the transition towards a decarbonised energy system.
[36] Bloomberg new Energy Finance, Interactive Dataset, Equipment Manufacturers.

Figure: Breakdown of Gross Value Added throughout solar PV value chain[37]



Source: Guidehouse Insights, 2020

At the same time, the EU is today a small actor in several critical manufacturing and assembly steps in the upstream value chain, including ingots, wafers and cells[38]. If the scarcity of EU-based manufacturing is not remedied, it is poised to reduce the EU's competitiveness in research and innovation, an area in which proximity to manufacturing clusters is often necessary.

The marginal EU contribution in the manufacturing and assembly stages of the supply chain, combined with the quasi-monopolistic role of one country at the components stage at global level, lead to supply risks related to pandemics, extreme weather, country-specific events and geo-political tensions[39]. This creates risks for accelerated solar energy deployment.

3.3. An EU Solar Industry Alliance

Increased EU demand for PVs and rising global transport costs are attracting interest in investments in PV manufacturing in the EU. At the same time, the industry is finding it difficult to secure financing in this highly competitive sector, where large-scale factories are needed to secure economies of scale.

Nevertheless, at least 14 projects have been announced, covering ingots, wafers, cells and modules, although many of them have not secured financing yet. This project pipeline would bring the industry close to achieving a manufacturing capacity equivalent to 20 GW of solar PV at each step of the value chain - an objective set for 2025 by the European Solar Initiative. It is estimated to require more than EUR 8 billion in investments.

---

[37] First published in the European Commission Staff Working Document accompanying the report from the Commission to the European Parliament and the Council "Progress on competitiveness of clean energy technologies" (COM(2021) 950, COM(2021) 952)

[38] European Commission, Report from the Commission to the European Parliament and the Council: Progress on competitiveness of clean energy technologies (COM(2021) 950 final) – (SWD(2021) 307 final). Figures cited cover EU + Norway.

[39] European Commission, Directorate-General for Energy, Guevara Opinska, L., Gérard, F., Hoogland, O., et al., Study on the resilience of critical supply chains for energy security and clean energy transition during and after the COVID-19 crisis : final report, 2021

EU Solar Industry Alliance

Scaling up the production of solar PVs in the EU is a strategic goal. It will be supported through an EU Solar Industry Alliance building on the work of the European Solar Initiative.

The alliance will bring together EU, national – and where necessary - regional and local authorities, industrial actors, research institutes and other stakeholders in the solar PV value chain, including the emerging circularity industry.

It will focus on support to new, more efficient and sustainable technologies, coordinating actions and financial support at national, EU and private levels.

At EU level, a mechanism will be set up to coordinate the potential contribution from relevant EU programs, including:

- *InvestEU will provide de-risking financing to private investments to scale up production, including through equity support channelled via the European Investment Fund to SMEs and Midcaps active in the market.*
- *The Innovation Fund will also channel funding towards EU manufacturing capabilities for innovative zero and low-carbon equipment, such as solar panels and their components.*
- *Cohesion policy funds to support relevant projects boosting local development.*

The alliance will include a research and innovation pillar with strong links to Horizon Europe. It will play a brokering role between producers and offtakers to facilitate the financing of projects.

Circularity and sustainability will also be in its focus. It will promote coordination across the value chain to facilitate higher recycling efficiencies. It will monitor developments in this sector and anticipate possible bottlenecks, in particular with regard to access to safe and sustainable raw materials. It will consider potential targets for material recovery rates.

Finally, the alliance will cooperate with the EU Solar Skills Partnership to promote the development of a skilled workforce for the solar manufacturing sector.

The launch of the EU Solar Industry Alliance will be accompanied by a Recommendation to the Member States on EU Solar manufacturing in order to address bottlenecks to production upscaling, including permitting procedures for new solar PV manufacturing.

The EU and Member States will also seek synergies between their respective financing initiatives in this area, including through a possible Important Project of Common European Interest (IPCEI) focused on breakthrough technologies and innovation along the PV value chain.

The innovative forms of deployment highlighted above, such as product-integrated PV or multiple use of space, also tend to require product innovation and customisation to specific needs. As PV expands beyond the current model of modular rooftop and utility-scale installations, a proactive, innovative EU industry can fill the emerging gaps on the supply side.

In the context of rapid innovation, the EU must strive to maintain its competitiveness in the value-chain segments where it is stronger, such as trackers or inverters, as well as engineering, procurement, and construction.

4. INTERNATIONAL COOPERATION IN THE FIELD OF SOLAR ENERGY

Solar energy is a cornerstone of the global transition to clean energy and net zero emissions. While many of the least developed and most vulnerable countries are the most endowed in terms of potential, a range of factors have hampered the uptake and development of solar in these regions. By the end of 2021, 843 GW were installed worldwide, more than double the capacity installed just four years earlier[40]. And yet, further acceleration in solar energy deployment and integration is still required to achieve the objectives enshrined in the Paris Agreement.

The EU has developed an energy model that creates the incentives to attract investments in renewable energy and integrate them into the grid. Many partner countries in the EU's neighbourhood, such as those belonging to the Energy Community, are interested in replicating this model, backed by regional electricity markets and cross-border cooperation and infrastructure. The EU, via its diplomatic efforts and strategic engagement with third countries will be working on expanding solar energy and other renewables to reduce exposure to fossil fuel volatility and geopolitical risks.

Beyond Europe and its neighbourhood, many countries are firmly committed to solar energy deployment. India is an example and the EU is offering its support through technical cooperation and business-to-business interactions, under the **EU-India Clean Energy and Climate Partnership.** The exponential growth of PV markets also demonstrates the versatility of solar technologies in countries such as Vietnam or Japan.

While solar power is the cheapest source of electricity in most countries today, it is still prevented from competing on equal terms by market distortions, subsidies or advantages to incumbent energy producers. The EU is actively **supporting the phasing out of harmful fossil fuel subsidies worldwide** and the promotion of open, transparent and competitive investment conditions. The EU will also work with its partners to **remove trade and investment barriers** such as local content requirements, which hamper investment and the ramping up of integrated value chains. This will also be an objective of future trade agreement negotiations. In the context of the **EU-US Trade and Technology Council**, both sides are discussing dependencies in the solar value chain, including the transparency, sustainability and diversity of supply chains.

The EU stands ready to support its partners around the world in making use of this technology to accelerate their transition towards universal access to affordable, reliable, and modern energy services, as enshrined in the 7th UN Sustainable Development Goal for 2030. Solar energy's accessibility, modularity and flexibility makes it suitable both for centralised and decentralised grid systems.

In sub-Saharan Africa, 570 million people do not have access to electricity, while the continent has excellent solar energy resources. Last February, the 6th EU–African Union Summit launched the **Africa-EU Green Energy Initiative** to support Africa's green transition in the energy sector by increasing renewable energy capacity and the number of people gaining access to affordable and reliable energy. The EU can support Africa to adopt innovative technologies maximising solar energy resources through i.e. agrivoltaics or

[40] IRENA statistics

floating solar on artificial lakes[41]. As part of the **Global Gateway EU-Africa investment package**, the EU will support the development of regional electricity markets across the five continental African power pools through technical assistance and funding for electricity interconnections and transmission lines. To diversify its suppliers, the EU is also exploring opportunities to engage with selected countries in raw material value chains partnerships to support alternative sources of materials needed for the solar industry.

In cooperation with the **International Renewable Energy Agency**, the EU is also preparing Regional Energy Transition Outlooks for Africa, Latin America and the Caribbean and Europe, providing a thorough analysis of the regions' potential and options in terms of renewable energy, energy efficiency, infrastructure, energy access and cross-border cooperation. The EU is also cooperating with the **International Solar Alliance** to disseminate its experience in solar energy technologies, policies and practices. With the **International Energy Agency**, the EU will also prepare zero-emission energy roadmaps for just and socially fair transitions in countries dependent on coal.

[41] Gonzalez Sanchez, R., Kougias, I., Moner-Girona, M., Fahl, F., Jäger-Waldau, A.: Assessment of floating solar photovoltaics potential in existing hydropower reservoirs in Africa (2021). Renewable Energy, 169, pp. 687-699

5. CONCLUSIONS

EU solar energy has a significant potential to rapidly become a mainstream part of our power and heat systems and a main lever to achieve the European Green Deal objectives while phasing out our dependence on Russian fossil fuels. This strategy proposes to seize the plentiful opportunities offered by energy technologies that run on the sunshine. It sets out a roadmap to achieve this while allowing citizens to directly reap the benefits of solar energy technologies and the EU industry to capture this growth opportunity, creating jobs and added value for the EU.

With the European Solar Rooftops Initiative, the EU will make use of this simple and abundant resource to power our houses, offices, shops and factories, by decisively lifting the barriers that are still preventing that momentous shift to take place.

The EU Solar Skills Partnership, as part of a larger partnership for the renewables sector, will turn the growing bottleneck in the skilled workforce needed to manufacture, deploy and maintain solar energy into an opportunity for new green jobs at the service of the clean energy transition.

On the supply side, through the EU Solar Industry Alliance, next-generation technologies should be brought to factory floors across the EU, seizing this growth opportunity and delivering more efficient products that will accelerate the energy transition.

Amid the energy crisis and geopolitical tensions, the implementation of the Strategy and these key solar initiatives proposed for the EU and its Member States is of utmost urgency.