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EU Solar Energy Strategy

{SWD(2022) 148 final}

1. SOLAR ENERGY TO REPOWER EUROPE

Massive, rapid deployment of renewable energy is at the core of the REPowerEU plan - the EU initiative to put an end to its dependency from Russian fossil fuels. Solar energy will be the kingpin of this effort. Panel by panel, the infinite energy of the sun will help 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 320 GW of solar photovoltaic by 2025 (more than doubling compared to 2020) and almost 600 GW by 2030[1]. These frontloaded additional capacities displace the consumption of 9 bcm of natural gas annually by 2027.

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

Solar photovoltaics (PV) and solar thermal technologies can be rolled-out rapidly and reward citizens and businesses with benefits for the climate and their purses.

This is because solar energy costs have decreased spectacularly over time. The EU's renewable energy policies helped bring PV costs down by 82% over the last decade[2], turning it into one of the most competitive source of electricity in the EU. 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 not only creates 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. By creating the right framework conditions, the EU can expand its manufacturing base, building on its vibrant competitive and innovation-driven environment while ensuring that solar products are up to the EU consumer's high standards.

The EU Solar Energy 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**.

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 an abundant skilled workforce to face up the challenge of producing and deploying solar energy all across the EU. In line with the call for

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

stakeholders to establish an **EU large-scale skills partnership** for onshore renewable energy under the Pact for Skills, as part of the REPowerEU plan, this strategy will set out its relevance for the solar energy sector[3]. This partnership will bring together all relevant stakeholders to take action on upskilling and reskilling to fill the gap.

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

2. ACCELERATING SOLAR ENERGY DEPLOYMENT

Solar PV is one of the cheapest source of electricity available[4]. The cost of solar electricity was already well below wholesale electricity prices before the 2021 surge in prices. 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 can 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 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 EU will need to install, on average, approximately 45 GW per year**.

Solar energy 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**.

Rooftops have been the place for most of the solar energy deployment so far, but huge untapped potential remains. It is a low-hanging fruit and the EU and its Member States must join forces to exploit it rapidly as much as possible, given multiple benefits for consumers.

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

[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

European Solar Rooftops Initiative

According to some estimates, rooftop PV could provide almost 25% of the EU's electricity consumption[8] - this is more than the share of natural gas today. These installations – on residential, public, commercial and industrial roofs – can shield consumers from 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 the environment.

The EU-wide European Solar Rooftops Initiative, announced in the Commission's REPowerEU Communication, aims at unlocking the vast, underutilised solar generation potential of rooftops to make our energy cleaner, more secure and affordable. To achieve this swiftly, immediate action is necessary by end 2022

The EU will:

- *Increase its 2030 target for renewables share to 45%.*
- *Limit the length of permitting for rooftop solar installations, including large ones, to a maximum of 3 months.*
- *Adopt provisions to ensure that all new buildings are "solar ready".*
- *Make the installation of rooftop solar energy compulsory for:*
    - *all new public and commercial buildings with useful floor area larger than 250 m^2 by 2026;*
    - *all existing public and commercial buildings with useful floor area larger than 250 m^2 by 2027;*
    - *all new residential buildings by 2029.*
- *Ensure that its legislation is fully implemented in all Member States allowing consumers in multi-apartment buildings to effectively exercise their right to collective self-consumption, without undue costs[9].*

The EU and Member States will work together to:

- *Eliminate administrative obstacles for cost-effective extensions of already installed*

[8] 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

[9] Both the 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 and the Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity contain provisions on collective self-consumption.

systems.

- *Set up at least one renewables-based energy community in every municipality with a population higher than 10 000 by 2025.*

- *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.*

- *Support building-integrated PVs for both new buildings and renovations.*

- *Ensure full implementation of the current provisions in the Energy Performance of Buildings Directive (EPBD) in relation to the nearly zero-energy buildings standard for new buildings, including through dedicated guidance.*

Member States should:

- *Establish robust support frameworks for rooftop systems, including in combination with energy storage and heat-pumps, based on predictable payback times that are 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, giving priority to most suitable buildings for quick interventions (Energy Performance Certificate classes A, B, C or D),*

  - *combine solar deployment with roof renovations and energy storage; this should be implemented through a one-stop shop integrating all aspects.*

The Member States should implement the measures under this initiative as a priority, using available EU funding, in particular the new REPowerEU chapters of their Recovery and Resilience Plans. The Commission will monitor progress in the implementation of this initiative on an annual basis, through the relevant fora, with the sector's stakeholders and the Member States.

If fully implemented, this Initiative, as part of the REPowerEU plan, will accelerate rooftop installations and ***add 19 TWh of electricity after the first year of its implementation*** *(36% more than expected in the Fit for 55 projections). By 2025,* ***it will result in 58 TWh of additional electricity generated*** *(more than double the Fit for 55 projections).*

Financing solar energy deployment

Solar energy technologies have relatively high upfront costs, compared to other sources of energy, but low operational costs. Therefore, attractive financing conditions are crucial for their competitive deployment. Commission analysis indicates that additional investments in solar PVs under REPowerEU would amount to **EUR 26 billion between now and 2027**, on top of the investments needed to realise the objectives of the Fit for 55 proposals.

Most of the financing will be private, but partially triggered by public funding, including from the EU. The **Recovery and Resilience Facility** already dedicated at least EUR 19 billion to accelerate the roll-out of renewables[10]. Other instruments are contributing to this effort: the cohesion policy funds, InvestEU, the Innovation Fund, the Modernisation Fund, Horizon Europe and 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 energy financing programmes, **Member States should also look for synergies with** transport infrastructure or research and innovation programmes, ensuring a coordinated support framework for solar energy across relevant policy areas. In addition, they should use specific technical support provided by the Commission to reduce their dependence on Russian fossil fuels through the **Technical Support Instrument** which *inter alia* supports reforms to enhance the rollout of solar energy. The new **Guidelines on State aid for climate, environmental protection and energy** (CEEAG)[11] have introduced a set of criteria for tailored and proportionate support to renewable energy, including solar. Among other things, this includes contracts for difference, technology-specific tenders or exemptions from mandatory competitive bidding for small projects, including certain energy community projects.

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[12]. 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[13]. **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 frequency of competitive tendering, the related foreseen capacity, the available budget and the eligible technologies[14].

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

[10] Based on the 22 Recovery and Resilience Plans (RRP) adopted by the Council of the EU and the two RRPs of Sweden and Bulgaria endorsed by the Commission on 29 March 2022 and 7 April 2022 respectively.
[11] Communication from the Commission - Guidelines on State aid for climate, environmental protection and energy 2022 (2022/C 80/01)
[12] CEER report (2020): 2nd CEER Report on Tendering Procedures for RES in Europe; AURES II project auction database.
[13] 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)
[14] 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.

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 July 2021[15], and the implementation of the Commission Recommendation on PPAs adopted alongside this communication should allow Member States to boost the number and aggregated volume of the agreements.

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 PV 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, is administrative, in particular long and complex permit-granting procedures. To overcome this obstacle, the Commission has presented a **Recommendation on fast permitting for renewable energy projects** and a **legislative proposal on permitting** alongside this communication.

Go-to areas and multiple use of space

The required expansion in utility-scale projects will increasingly face competing uses of land and public acceptance challenges. 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 impact on other uses of land and preserving environmental protection. In addition, permit-granting procedures for the installation of solar energy equipment in rooftops and other structures created for purposes different than solar energy production should be limited to three months.

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

Multiple use of space can contribute to mitigating land constraints linked to competition for space, including for environmental protection, agriculture and food security.

In particular, under certain conditions, the agricultural use of land can be combined with

[15] Proposal for a Directive of the European Parliament and of the Council amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC on the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 (COM(2021) 557 final)

*solar generation in so-called **agrivoltaics** (or agri-PV). The two activities can establish synergies, whereby PV systems can contribute to crop protection and yield stabilisation[16], with agriculture remaining the primary use of the land area. Member States should consider incentives for the development of agri-PV while designing 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[17]. Ongoing research and innovation efforts are dedicated* inter alia *to developing new mooring solutions, improving the durability of PV panels in marine environment, monitoring and assessing the impact on the environment and reducing maintenance costs. Within the energy sector, the **use of the surface of artificial lakes** created by hydroelectric dams represents a specific potential for PV deployment. Floating PV panels reduce water evaporation and, connected to the dam's electric systems, increase the total output, although the impact on aquatic biomass is still being investigated. Any intervention on water bodies must respect the conditions set out in the Water Framework Directive and the Marine Strategy Framework Directive [18].*

*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 to be replicated in the country's whole system of sound barriers, it would yield enough electricity for 250,000 households[19].*

The Commission will develop **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 accounts for 10%[20].

[16] Barron-Gafford, G.A., Pavao-Zuckerman, M.A., Minor, R.L. et al. Agrivoltaics provide mutual benefits across the food–energy–water nexus in drylands. Nature Sustainability 2, 848–855 (2019). See also research developed by Fraunhofer ISE on the topic: https://agri-pv.org/

[17] 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

[18] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy; Directive 2008/56/EC of the European Parliament and of the Council establishing a framework for community action in the field of marine environmental policy

[19] 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

[20] SolarPower Europe, EU Solar Jobs Report 2021.

There is already a lack of skilled workers. This bottleneck could 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, taking into account the potential to increase women's participation.

At EU level, as part of the REPowerEU plan, the Commission will bring together the relevant stakeholders in the renewable energy sector, including from the solar, wind, geothermal, biomass and heat pumps industries, but also from regional and national permitting authorities, to set up **an EU large-scale skills partnership** for onshore renewable energy, including solar energy, under the Pact for Skills.

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

The Commission will support implementation by the Member States of the Council Recommendation on ensuring a fair transition towards climate neutrality including actions to support workforce reskilling and upskilling and labour market transitions towards growing sectors such as solar energy[21].

In addition, to promote mobility, the revision of the RED proposed in July 2021 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.

2.2. Bringing solar value to citizens and communities

Deploying solar energy on rooftops provides an immediate solution to reduce reliance on natural gas for citizens, but also SMEs and industry. 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 from using 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. Among other things, the new State aid CEEAG guidelines include exemptions from mandatory competitive bidding processes to allocate aid and determine the aid level for small projects, including those below or equal to 1 MW of installed capacity. In addition, the 2021 proposal for the revision of the

[21] COM(2021) 801, SWD(2021) 452 final. Annex 3 provides an overview of funding supporting the fair transition to climate neutrality and the online source "EU funding instruments for upskilling and reskilling"

Energy Taxation Directive continues to allow Member States not to tax electricity of solar origin[22].

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

Better information is key to enhance clarity and predictability on the benefits of self-consumption for 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 the 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**.

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[23], 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[24] apply reduced VAT rates to energy efficient, low emission heating systems, including solar panels, solar water heating systems and heat pumps, as well as to social housing and residential building renovation expenditure[25].

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.

[22] Proposal for a Council Directive restructuring the Union framework for the taxation of energy products and electricity (recast) COM(2021) 563 final

[23] The EU counts nine outermost regions - French Guiana, Guadeloupe, Martinique, Mayotte, Reunion Island and Saint-Martin (France), Azores and Madeira (Portugal), and the Canary Islands (Spain). They are located in the western Atlantic Ocean, the Caribbean basin, the Amazonian forest and the Indian Ocean and are home to 4.8 million EU citizens

[24] 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

[25] See annex III of Council Directive (EU) 2022/543.

Citizens and installers can use it for an instantaneous assessment of the potential to generate solar energy on rooftops.[26]

A balanced allocation of costs and benefits

One of the main barriers to individual or collective self-consumption identified by stakeholders through the public consultation 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 exchanges 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.

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 in securing financing, navigating licencing and permitting procedures or developing sustainable business models. In addition, as they are often initiated by a group of volunteers, they suffer from limited time and lack of access to technical expertise. Cross-border energy communities, which can exploit

[26] https://joint-research-centre.ec.europa.eu/pvgis-photovoltaic-geographical-information-system_en

complementary renewable energy potentials in EU border regions, face additional challenges linked to legal, technical or administrative inconsistencies across borders[27].

To tap into this potential, Member States should **establish appropriate incentives and adapt administrative requirements to the characteristics of energy communities**. An integrated 3-step "learn-plan-do" programme 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 new State aid CEEAG guidelines, including exemptions for renewable energy community projects with installed capacity equal to or below 6 MW from mandatory competitive bidding processes, or to facilitate their participation in such processes.

Collective action can also be organised by consumer organisations, for instance by purchasing of solar energy products. 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 from 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 July 2021 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, can potentially 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.

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

Solar energy and electric vehicles can also be integrated in technologically novel ways.

[27] Report from the Commission "EU Border Regions: Living labs of European integration", COM(2021) 393 final.

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[28]. 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[29].*

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[30] 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. 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 will support interoperability for a wide range of energy consuming, producing and storage devices through a code of conduct for energy smart appliances manufacturers [31].

2.3. Solar value for buildings and industry

The contribution of solar to decarbonising our building stock

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. Through support policies and regulations that **provide a level playing field for all solar technologies** and do not favour one against the other, national and local authorities can promote the most efficient solution for each situation.

When combined, the installation of solar energy and renovation interventions become mutually reinforcing, optimising the building's energy performance. If national support programmes are designed accordingly, they can ensure **swift massive deployment of rooftop solar energy in buildings, giving priority to most suitable buildings for quick interventions** (Energy Performance Certificate classes A, B, C or D). Where appropriate, this effort can be combined with roof renovations and deployment of energy storage and heat pumps.

[28] 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

[29] 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.

[30] 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

[31] 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

As regards new buildings, where technically feasible, the recast of the Energy Performance of Buildings Directive[32] requires that **100% of on-site energy consumption be covered by renewable energy** as of 2030. This transition towards the decarbonisation of buildings' energy consumption will be accelerated by introducing an **obligation to install solar energy equipment** on all new and existing public and commercial buildings above a certain size and on new residential buildings in a gradual fashion, between 2026 and 2029. Where the building is not adapted, renewable electricity can also be acquired through a PPA.

In addition, provisions will be adopted to ensure that **all new buildings are "solar ready"**, i.e. designed to optimise the generation potential on the basis of the site's solar irradiance, enabling the fruitful installation of solar technologies without costly structural interventions.

Greening of energy taxation and the proposed **new emissions trading system for buildings** and road transport can contribute to generating the resources required for these interventions, while setting the appropriate economic incentives. In this context, the proposed **Social Climate Fund** can support measures and investments integrating renewables in buildings, principally to the benefit of vulnerable consumers and micro-enterprises.

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

The opportunities that 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[33]. 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[34]. 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. 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

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

industrial processes is still largely untapped. Two of the main obstacles it faces are administrative hurdles and the gap between the payback times of these investments and the financial requirements of most industrial actors.

Solar electricity can be used in combination with heat pumps or electric furnaces to provide heat, or it can be converted into renewable hydrogen, to be used as fuel or 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 could 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.

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[35] will contribute to the **expansion of cross-border electricity infrastructure and smart grids** and 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 policy funding, including INTERREG or the Recovery and Resilience Fund which already foresees EUR 9.6 billion dedicated to energy networks and infrastructure[36].

Paving the way for Direct Current solutions

[35] 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

[36] Based on the 22 Recovery and Resilience Plans (RRP) adopted by the Council of the EU and the two RRPs of Sweden and Bulgaria endorsed by the Commission on 29 March 2022 and 7 April 2022 respectively.

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. Based on 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 the above-mentioned initiatives accelerating massive deployment of solar energy. To ensure this, the Commission will provide Member States with guidance ahead of the update of their plans in 2023.

3. ENSURING ACCESS TO SUSTAINABLE SOLAR ENERGY

The EU currently imports most of the solar energy products it installs: EUR 8 billion of PV panels in 2020, 75% of which from a single country[37]. Meanwhile, only a small share of global production takes place in the EU. This level of supply concentration diminishes the EU's resilience in case of global or country-specific events. Expanding the EU 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 value added. In addition, the EU will step in to ensure that solar energy products are sustainable and up to the standards demanded by 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, raw materials, water, etc), increased circularity in the use of raw materials and 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

[37] Eurostat - International trade in products related to green energy.

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 to innovative forms of deployment. The upcoming 2023-2024 work programme will include a **flagship initiative to support solar energy research and innovation**, focused *inter alia* on novel technologies, environmental and socio-economic sustainability, and 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 multijunction cells. The Commission will continue to exploit synergies between the space and terrestrial sectors in all initiatives critical for the EU space programme, including research and development.

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, including solar energy. One of the seven large-scale projects selected in the first batch supports innovation in the solar sector. Finally, 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 20 years of operation, today's commercial PV systems can produce almost twenty times the energy needed to manufacture them[38]. However, it is important to continue to reduce the carbon and environmental footprint associated with their manufacturing.

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**. These measures would concern the efficiency, durability, reparability and recyclability of products and systems, to incentivise environmentally sustainable devices. The Commission is also assessing options covering the quality of the manufacturing process and the carbon footprint of PV modules. Apart from their sustainability impact, these measures are also expected to foster innovation and provide a common reference for potential buyers to compare different products.

The Commission also plans to propose a revision of the existing Ecodesign and Energy Labelling regulations for 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.

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

The EU will provide European consumers with guarantees that the products they buy have been made respecting human and labour rights. 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[39].In addition, the Commission has announced a new legislative initiative to **effectively prohibit the placing on the EU market of products made by forced labour[40]**. It will build on international standards and existing EU initiatives in particular due diligence and transparency obligations, and combine a ban with a risk based enforcement.

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[41]. In addition, the manufacturing and installation of all PV modules requires glass, aluminium and steel; copper is used for their connection to the grid. Suppliers from within the EU currently cover a small share of demand for processed materials and depends on international suppliers, often concentrated in one or a 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[42]. EU policy aims at building resilience in relation to critical raw materials, based on access to resources, circular economy 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 has called 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 their 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: a critical point for resilience

[39] 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

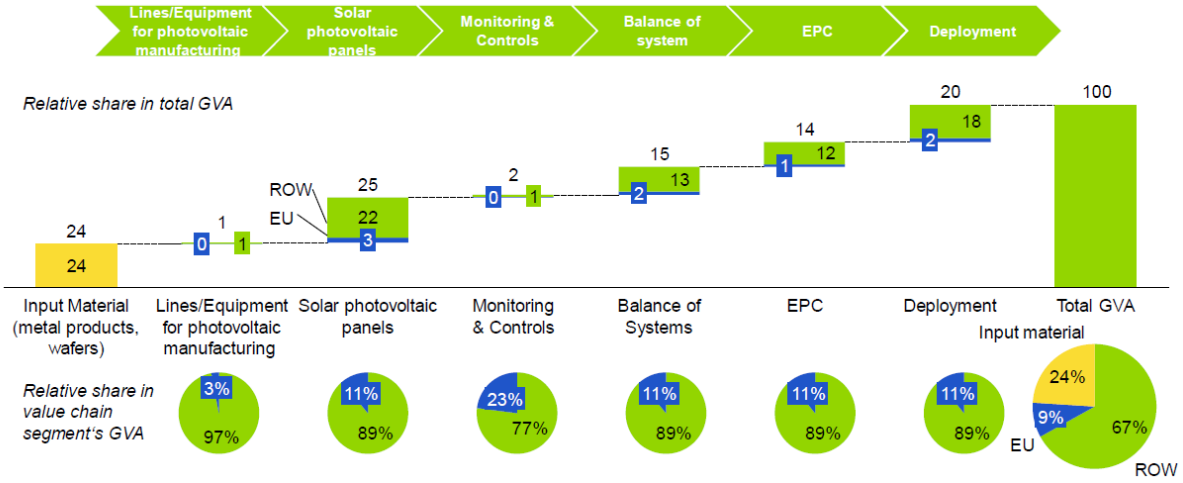
[40] Commission Communication on decent work worldwide for a global just transition and a sustainable recovery (COM(2022) 66 final)

[41] 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).

[42] 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.

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.

Figure: Breakdown of Gross Value Added throughout solar PV value chain[43]



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[44]. 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, diminishes the EU's resilience in case of extensive external supply disruptions[45]. This creates risks for accelerated solar energy deployment.

3.3. An EU Solar PV 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

[43] 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)

[44] 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.

[45] 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

difficult to translate its innovative technological advantages into large scale production and build economies of scale, notably due to high perceived financing risks.

Nevertheless, at least 14 projects have been announced, covering ingots, wafers, cells and modules, although many of them have not yet secured financing. 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.

EU Solar PV Industry Alliance

Securing a diversification of supplies through more diverse imports and scaled up solar PV manufacturing in the EU of innovative and sustainable solar PVs would contribute to mitigate supply risks for the necessary massive deployment of solar energy in the EU. This objective will be supported by an EU Solar Industry Alliance.

The alliance will bring together industrial actors, research institutes, consumer associations and other stakeholders with an interest in the solar PV sector, including the emerging circularity industry. The Alliance will work to identify and coordinate investment opportunities, project pipelines and technology portfolios and establish pathways for the solar industrial ecosystem in Europe.

It will provide a framework for coordinating actions aimed at the development and uptake of new, more efficient and sustainable technologies. It will cover innovation/technology, industrial supply chain, finance, regulation, skills and citizen engagement, and provide advice to the EU and the Member States. The alliance will map the availability of financial support, attract private investment and facilitate the dialogue and match-making between producers and offtakers.

At EU level, the following EU programmes are particularly relevant:

- *InvestEU can provide de-risked financing to private investments channelled via the European Investment Bank and other public finance institutions.*
- *The Innovation Fund can also channel funding towards innovative zero and low-carbon equipment, such as solar panels and their components.*
- *Recovery and resilience and Cohesion policy funds can support relevant projects boosting local development.*

The alliance will include a research and innovation pillar with strong links to Horizon Europe.

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 could discuss potential targets for material recovery rates.

Finally, the alliance will cooperate with the EU large-scale Skills Partnership for onshore renewables to promote the development of a skilled workforce for the solar manufacturing sector.

The Alliance will fully comply with EU competition rules, in particular Article 101 TFEU, in both its setting-up and its activities[46].

The Commission will work on a guidance on permitting procedures for new manufacturing plants.

The Commission will support efforts from Member States to pool their public resources via a potential Important Projects of Common European Interest (IPCEI) focused on breakthrough technologies and innovation along the solar 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[47]. 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.

[46] Competition rules should in particular be safeguarded by reporting on meetings, discussions, information exchanged and agreements reached and making these available to the Commission on request. Furthermore, the members of the alliance will sign a code of conduct including a competition compliance programme.
[47] IRENA statistics

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 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 and to promote transparent and competitive procurement procedures. Promoting a more favourable business environment 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 supply chain resilience in the solar value chain with regard to transparency and sustainability.

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.

Africa, which has the richest solar resources on the planet, installed only 5 GWs of solar PV in 2019. At the same time, in sub-Saharan Africa, 570 million people do not have access to electricity. Last February, during the 6th EU–African Union Summit, the Commission presented 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 assist Africa's efforts to adopt innovative technologies maximising solar energy resources, that is through agri-PV or floating solar on artificial lakes[48]. 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, promote sustainable development and local value in partner countries, the EU is also exploring opportunities to engage with selected countries in sustainable 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.

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

[48] 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

phasing out our dependence on Russian fossil fuels. This strategy proposes to seize the plentiful opportunities offered by energy technologies that run on 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 from taking place.

The **EU large-scale skills partnership** for onshore renewables, including solar energy, 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 the proposed **EU Solar PV Industry Alliance** should help diversify our supply chains, retain more value in the EU and deliver efficient and sustainable products based on next-generation technologies.

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. The Commission invites the European Council, the Council and the European Parliament to endorse this Strategy, including its key initiatives.