



**COMMISSION NOTICE ON A GUIDANCE
on innovative technologies and forms of renewable energy deployment**

(C/2026/127)

1. Introduction: Why this Commission Guidance and what it contains

The Clean Industrial Deal and the action Plan for affordable energy, adopted in February 2025, have identified the EU's reliance on imported fossil fuels as a major factor contributing to volatile and high supply costs, driving up energy prices. Expanding the fleet of renewable energy sources contributes to the EU's energy security to lower the costs of energy supply, improve the competitiveness of EU businesses and reduce energy bills for European consumers. This acceleration of renewable deployment builds on the revised Renewable Energy Directive (RED), which entered into force in November 2023, increasing the EU's binding renewable energy target from the previous 32% to 42.5% by 2030, with the aim of reaching 45%. In addition, over recent years the EU has adopted a number of regulatory and non-regulatory initiatives to support the growth of renewables in the electricity sector and to ensure that their deployment advances at the required pace. Those initiatives include the 2022 Council Regulation to accelerate the permit-granting process for renewable energy projects and the update of the 2022 recommendation and guidance on renewable energy permitting. Lastly, in the Annex to the 2022 EU Solar Energy Strategy, the Commission indicated it would develop a guidance for Member States to promote innovative forms of solar energy deployment.

Among renewable energy technologies, solar photovoltaics (PV) and onshore and offshore wind energy are growing at the fastest pace and are expected to become the backbone of the energy system according to the Member States' final updated national and energy climate plans (NECPs). In fact, 2023 and 2024 were record years for the deployment of those two renewable energy technologies. Figures from the industry indicate that 56 GW_{DC} solar PV and 16.3 GW wind were installed across the EU in 2023 and 65.5 GW_{DC} solar PV and 13 GW wind in 2024. In addition, in 2024, for the first time wind and solar PV together generated as much electricity in the EU as fossil fuels⁽¹⁾.

While these figures are impressive, further acceleration will be required to achieve the 2030 renewable energy target set in the RED. Forecasts for achieving the EU's renewable energy target indicate that renewable energy installed capacity would need to grow by 2.7 times over the decade between 2020 and 2030, to reach 1 292 GW⁽²⁾. In this context, the Clean Industrial Deal identified the need for annually installing 100 GW of renewable electricity capacity up to 2030. Reaching those levels would require significant increases in annual additions of wind and solar capacities. While two thirds of the capacity of solar PV installations is mounted on rooftops, almost all other solar PV and wind installations require dedicated onshore and offshore sites.

The European Commission recognises the key role and potential of further rooftop deployment. The EU solar Energy strategy put forward the European Solar Rooftops Initiative to unlock the potential of rooftops for solar energy, both PV and solar thermal. Shorter permit-granting procedures for such installations have been included in the revised RED. In addition, the revised Energy Performance of Buildings Directive includes an obligation to install solar energy in certain categories of buildings. It is estimated that rooftop PV installations could theoretically produce 2 000 TWh of electricity annually⁽³⁾, representing three quarters of the EU's total electricity generation in 2023.

Modelling shows that all forms of renewable energy deployment will be required to achieve the EU targets. The deployment of utility-scale projects is already facing challenges such as competition for space with other public goods, long lead times for grid connections or a lack of broad public acceptance. Those challenges could increase if not addressed effectively.

To support the cost-effective roll-out of renewable energy, innovative renewable technologies and innovative ways of deploying renewable energy technologies offer opportunities to exploit further renewable energy resources and thus complement the level of conventional deployment.

⁽¹⁾ European Electricity Review 2024 - Ember.

⁽²⁾ Impact assessment report accompanying the Communication from the commission "Securing our future - Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society" SWD/2024/63 final.

⁽³⁾ Molnár G., Cabeza L.F., Chatterjee S., Ürge-Vorsatz D., Modelling the building-related photovoltaic power production potential in the light of the EU's Solar Rooftop Initiative, Applied Energy, Volume 360, 2024, 122708, <https://doi.org/10.1016/j.apenergy.2024.122708>.

Innovative forms of deployment of existing technologies can also allow space to be optimised by combining multiple activities on the piece of land or water where the renewable energy projects are installed, or exploit synergies in terms of the space needed to install renewable energy projects by integrating them with other structures. Depending on the specific set-up (east-west), they can also bring generation to the electricity system in hours of lower concentration of renewable generation. The distinction between innovative technologies and innovative forms of deployment is not always clear-cut. In some cases, deploying an existing technology in novel ways requires changes that lead to innovation in the same technology.

Both innovative technologies and innovative forms of deployment can help optimise the utilisation of space for renewable energy generation by exploiting synergies with other space uses and untapping potential. This can have a positive impact on the public perception of renewable energy deployment and hence on social acceptance. In addition, promoting those technologies and forms of deployment could incentivise innovation, which Member States are encouraged to do through the indicative target for innovative renewable energy technologies set in the revised RED. The assessment of the final NECPs reveals that 10 Member States have set ambitious targets for the installation of innovative renewable energy technologies, aiming to meet the indicative target. This, in turn, can have a positive industrial impact on specialised manufacturers and on increasing the competitiveness of the EU clean-tech industry in line with the Net-Zero Industry Act. Finally, the technologies and deployment forms can also generate cross-sectoral synergies, e.g. by improving agricultural yield or increasing the energy autonomy of buildings or electric vehicles.

The EU solar Energy strategy set out a list of innovative forms of solar energy technologies deployment, relying either on multiple use of space or on integration with other products, with the potential to mitigate the above challenges, and underlined the importance of promoting their development to reach the EU targets. Member States that signed the 2024 European Solar Charter committed to promote such innovative forms of solar energy deployment, with the support of the Commission.

The technological scope of the innovative forms of deployment in this guidance includes solar energy deployment, covering solar photovoltaic technologies, solar thermal technologies and, combined solar PV/solar thermal technologies. Modularity, flexibility and adaptability are essential characteristics of the technologies that can be deployed using the methods considered in this guidance. Although most of these innovative forms of deployment are applicable to both PV and solar thermal technologies, most systems deployed are PV-based⁽⁴⁾. In addition, this guidance also covers floating offshore wind energy, which can be considered both an innovative renewable technology and an innovative form of wind deployment.

This Commission Notice will focus on innovative technologies that have the highest technology readiness levels (TRLs) and are already being or are close to being commercialised, as those are the technologies that will face barriers to deployment. Ocean energy and offshore floating wind technologies have been identified as the most promising innovative technologies with high TRLs, providing opportunities to reduce the spatial requirements for traditional offshore wind installations and with potential for multiple use of space, including for hybrid projects. Other innovative technologies can benefit from the guidance provided in this document, such as geothermal technologies that are close to market development, i.e. multi-well drilling, closed-loop systems or combined geothermal and lithium extraction. Moreover, this guidance can also be useful to promote the development of other innovative technologies which have a lower TRL and still face innovation challenges, such as airborne wind systems

The list of innovative forms of deployment and technologies covered in this guidance is not exhaustive. As is the case with innovative technologies, others exist. Two examples are the integration of solar PV technologies in textiles or devices such as on clothes or tents, or in shelf labels or other types of labels. Although less modular than solar systems, wind energy technologies can also adapt to new forms of deployment, including on roofs. Such solutions are in the process of being explored. Nevertheless, the selected technologies and forms of deployment are expected to cover the vast majority of the potential for innovative renewable energy technologies deployment in the EU in the coming years.

⁽⁴⁾ This guidance will consider six forms of solar energy deployment. All of them are typically known by a name directly associated to solar PV technologies; in most cases, though, the given form of deployment does not necessarily exclude the use of solar thermal technologies, hence the choice of names that use the word “solar” instead of PV in this context.

Despite their potential, the current role of these innovative technologies and forms of deployment remains limited. This is due to two main factors:

- The first is a price gap with conventional forms of deployment, i.e. ground-based wind and solar, fixed-bottom offshore wind and rooftop solar technologies. The price gap is due, among other things, to the lack of economies of scale in the manufacturing of the innovative technologies/customisation, to higher labour needs and to higher balance-of-system costs, including support structures, customised electronics, cables, etc.
- The second factor is that these innovative technologies and forms of deployment face specific regulatory barriers. In the case of forms of deployment, this is because they combine energy generation with another use of the same land, surface or product, most often an economic use. For example, regulations governing the use of materials in the construction of buildings have not been designed to allow or promote construction elements that, as well as serving as structural elements in construction, also generate renewable electricity. In the case of innovative technologies, regulatory challenges are presented by their novelty and the exploitation of a different renewable resource (the regulations did not provide for the exploitation of tidal or wave energy) or by the technical solutions proposed to deploy offshore wind capacity.

This Commission Notice will focus on the identification of regulatory barriers first (such as barriers related to the complexity of permit-granting procedures or to safety rules or certification procedures). Secondly on non-regulatory barriers (like insufficient awareness of these innovative forms of deployment or the difficulty of participating in support schemes for renewables). And finally on the existing good practices for lifting these barriers. It will also elaborate on the need to have appropriate research, innovation and dissemination policies in place, to promote and further innovation in the field of these renewableenergy technologies or innovative forms of deployment.

The identification of a regulatory barrier to these technologies and forms of deployment does not always imply that the underlying regulation is not justified. Promoting these innovative forms of deployment and technologies will often require striking a balance between competing objectives.

This Commission Notice will focus exclusively on barriers that are specific to one, several or all of these innovative technologies and forms of deployment. It will not refer to barriers that affect renewable energy deployment in general, such as general permitting issues or difficulties in securing grid connections, unless they have aspects that are specific to them.

2. Overview of the innovative forms of solar energy deployment and innovative technologies covered in this guidance

This section will provide a brief snapshot of the innovative forms of solar energy deployment and innovative technologies covered in this guidance. A more detailed overview can be found in Annex I.

It should be noted that the cost-performance of renewable innovative technologies is inherently expected to improve significantly over time, making it crucial to regularly review this classification.

a. Innovative forms of solar deployment

Agrisolar

‘Agrisolar’ refers to the installation and use of solar energy generation in a piece of land that is used for agricultural production. The combination of both activities is at the heart of the concept; whenever one of the two activities ceases, or when the agricultural activity significantly decreases because of the installation and use of solar, there is no longer double use of the land.

Floating solar

‘Floating solar technology’ refers to the installation and use of solar energy equipment on inland water bodies or offshore.

Building-integrated solar

A product can be classified as a building-integrated solar product if it can use radiation from the sun to generate electricity or thermal energy and, at the same time, replace conventional building materials and provide a function as laid down in the EU Construction Product Regulation ⁽⁵⁾ (i.e. roof tiles, facades, bricks, windows).

Infrastructure-integrated solar

'Infrastructure-integrated solar technology' refers to the installation and use of solar generation equipment integrated into transport infrastructure, either in the defined infrastructure corridor or in areas besides the transport infrastructure that cannot be used for other purposes, such as enclosed areas around roadways or airports.

Vehicle-integrated PV

'Vehicle-integrated PV technology' refers to the use of PV panels and their integration into the material of the surface of a vehicle, such as a car, a bus, a truck, a trailer or a train. Vehicle-integrated products can use radiation from the sun to generate electricity and, at the same time, are an integral part of the vehicle.

Plug-in mini solar systems (including balcony PV)

Plug-in systems are very small PV energy systems, usually two or three modules and less than 1 kW in total per installation, which are connected to a micro-inverter and plugged directly into a normal household socket, through which it will feed the house's internal electricity system.

b. Innovative ocean and wind technologies

Ocean energy

'Ocean energy' is a general term covering a range of technologies that harness energy from the ocean to generate renewable electricity or heat. The most advanced technologies belong to the categories of tidal and wave energy, which harness the kinetic and/or potential energy of tidal currents and waves, respectively, to produce electricity.

Floating offshore wind energy

Floating wind is a subcategory of offshore wind technology, which uses turbines to harness the energy of the wind blowing in offshore locations. Unlike fixed-bottom turbines, floating turbines sit on floating structures and are better adapted to deep-sea locations.

c. Relationship with the indicative target of innovative renewable energy technologies in the Renewable Energy Directive

The revised RED introduced a new indicative target at Member State level for innovative renewable energy technology to reach at least 5% of newly installed renewable energy capacity by 2030. This guidance will address how the innovative technologies and forms of deployment covered can help achieve that target.

The revised RED defines innovative renewable energy technology as 'renewable energy generation technology that improves, in at least one way, comparable state-of-the-art renewable energy technology or that renders renewable energy technology that is not fully commercialised or that involves a clear degree of risk exploitable.'

⁽⁵⁾ Regulation (EU) No 305/2011 laying down harmonised conditions for the marketing of construction products. The Commission proposed a review in 2022, on which a political agreement was reached in December 2023.

Deployment in the form of offshore floating wind energy or of ocean energy will help achieve that indicative target because those technologies have not yet reached the stage of commercial deployment and thus qualify as innovative renewable energy technologies.

The innovative forms of solar energy deployment listed above can help achieve the target insofar as they represent an improvement over the state of the art, bring to market products that have not reached yet the stage of commercial deployment, or allow untapped potential to be exploited. As stated above, a new form of deployment will often, but not always, require a degree of innovation in the devices themselves or in the structures holding them.

For instance, depending on the particular situation, infrastructure-integrated solar technology can take the form of traditional ground-based deployment along transport corridors or be integrated into the infrastructure in more novel ways that require new products or solutions, such as integration in sound barriers or vertical panels next to railway tracks. Similarly, agrisolar installations will often, but not always, require innovative products or solutions to adapt the panels to correspond to the agricultural activity.

Products used in building-integrated solar systems are often innovative products that have not fully reached the commercial stage, including solar glass or solar tiles, while the installation of solar systems on water bodies requires adapted panels and the development of specific solutions.

Thus, innovative forms of solar energy deployment would help achieve the indicative target when they introduce a new product or solution. They would not help achieve it when they take the form of standard ground-based or rooftop deployment in spaces where deployment could not take place before, usually for regulatory reasons.

This guidance will proceed to analyse the barriers associated with the regulatory framework affecting these forms of deployment and technologies and good practices to address them (Chapter 3), then those related to the financial framework under which they can take place (Chapter 4) and finally those related to knowledge of and expertise in these forms of deployment and innovative renewable energy technologies (Chapter 5).

3. Addressing permitting barriers to innovative forms of deployment and innovative renewable energy technologies

Key conclusions:

- **Innovative forms of renewable energy deployment and innovative technologies are often not considered in permit-granting processes and relevant legislation.**
- **This problem can be identified in the different regulatory areas governing renewable energy deployment, in particular building codes and regulations, energy law and environmental protection regulations.**
- **A number of Member States have already addressed these barriers and introduced references to some forms of innovative deployment or innovative technologies in the relevant regulations.**

Long and complex permitting processes are one of the main barriers to renewable energy deployment at large. Recent EU legislation, in particular the revised RED, addresses this issue.

Innovative forms of deployment and technologies face specific permitting challenges, often related to the combination of several activities in the same land or product. Since these installations are in most cases not specifically considered in the relevant regulations, it is often difficult to establish what permits are required to proceed with the installation. Investors and then public authorities have to deal with this uncertainty, which can lead to different interpretations regarding which steps of the permit-granting procedures apply, or to longer and more complex permit-granting procedures. Shorter and more streamlined procedures would have a positive impact on the development of these innovative renewable energy technologies and forms of deployment.

Having references or permitting procedures for the technologies in the relevant regulations clarifies the requirements and therefore helps speed up their deployment. In a recent simplification of its general permitting for renewable energy projects, the **Italian government** introduced specific provisions for agrivoltaics and floating PV projects of up to 10 MW. In **Portugal**, tidal and wave energy installations with a capacity of up to 1 MW do not require a full production licence, but they are subject to a notification procedure.

When these innovative forms of deployment are not referred to in the relevant legislation regulating the permit-granting procedures, standard procedures apply. In some Member States, the installation of plug-in mini-solar systems is subject to the same permitting procedures and safety requirements as rooftop PV systems. However, these systems are much smaller and easier to install and their potential impact on grid stability is much lower, especially since they include micro-inverters that regulate the relationship with the grid. Member States could include specific simplified procedures for mini-solar plug-in systems to recognise the differences from rooftop PV systems. **Germany** has recently introduced simplifications for mini-solar plug-in systems. the only requirement is for users to register them online in the Core Energy Market Data Register.

In some cases, the relevant regulations include additional steps in the permitting procedure that appear overly cautious in light of existing academic research data regarding safety or environmental impact and of the frameworks set by other Member States with more experience. For instance, although plug-in mini-solar systems are portable, some Member States require tenants to obtain their landlord's permission or inhabitants of multi-apartment buildings to obtain the permission of the owner's association to install such systems. **Germany** has recently amended its legislation (the Civil Code and the Act on Residential Property and Permanent Residential Rights) to enable tenants and owners in condominiums to install plug-in mini-solar systems on their balconies. In other Member States, installation or certification by an electrician is required, even though the system only need be plugged into a socket. **Austria** allows the installation of mini-solar plug-in systems without the need for certification by an electrician.

a. Building codes and regulations

Building codes and regulations governing the construction of a building cover building and construction laws (including technical requirements relating to building statics, product safety and design aspects), regional and local spatial planning as well as zoning, land use and land designation regulations. From a permitting perspective, compliance with all those regulations is required before permits can be issued by the relevant authorities.

One of the key questions is whether an integrated into the building structure energy device is to be considered as a 'building', element and thus whether building regulations apply.

Member States that apply building regulations to ground-based solar energy installations tend also to apply them to agrisolar installations when they are ground-mounted. Some Member States apply only energy law to such installations, but land use regulations always apply to ground-based installations (see Section 2(c)). In 2023, **Germany** introduced provisions in its Building Code that allow small agrivoltaic installations to undergo a simplified procedure, with a reference to requirements in the Renewable Energy Sources Act.

As floating solar installations are not covered by building codes, it is difficult for authorities to decide whether they should be treated as a 'building' under such codes and regulations or as an 'anchored vessel' under water regulations. This lack of clarity has been noted in various Member States. Moreover, in some cases, water law will supersede building regulations under certain circumstances. As regards land use regulations, floating solar installations often require the land where the water body is located to be redesignated to allow for energy generation activities – a lengthy and complex process. Clarifying which regulations are relevant to floating solar and streamlining the land redesignation procedure would help simplify the process. In the case of **Germany**, a distinction is drawn according to the use of the installation. If the floating solar installation is limited to self-consumption use by an entity that already holds a permit for use of the water body, the procedure to obtain the building permit is faster. If the objective of the installation is to sell electricity through the grid, a building permit will be required.

Little experience has been gained in the field of permitting for offshore floating solar installations. A first generation of such installations is emerging in a hybrid format in offshore wind farms. **The Netherlands** has included innovative PV components in two of its offshore wind installations, Hollandse Kust Noord and West, to exploit the synergies between the two technologies in terms of use of maritime space, complementary generation and grid integration⁽⁶⁾. The permitting process for floating solar installations will thus be integrated into the general process for offshore wind installations.

The question of the application of building regulations to infrastructure-integrated solar installations requires a distinction to be made between two subcategories: (1) if the installation is not integrated into the existing structures of the transport infrastructure and is built separately on the ground, both a building permit and compliance with land use regulations are required in some Member States; (2) if the installation is attached to structures that are part of the infrastructure, such as noise protection barriers, the same permit as for rooftop installations may be required in some Member States. **Nevertheless, Article 16d(1) of the revised RED has simplified these requirements and imposed a limit of three months for issuing the permit.**

In at least three instances, infrastructure-integrated solar installations have been covered by building regulations: **Germany's** Building Code explicitly allows the installation of solar PV in an area along highways and railroads. Similarly, in **France** the Renewable Energy Acceleration Law from March 2023 amended the Urban planning Code to introduce an explicit derogation from the ban on construction within a 100-metre buffer on either side of highways and motorways for solar energy installations. Finally, **the Netherlands' Building Decree** makes a specific reference to electricity facilities that covers infrastructure-integrated PV technology.

The case of the application of building regulations to building-integrated solar installations is specific, since the design and construction of buildings is obviously subject to building permits. The integration of building-integrated solar products into the structure of buildings is assessed against applicable technical regulations, including product safety and fire protection regulations, that generally do not consider the particular characteristics of these products. For instance, fire protection regulations often require minimum distances that are difficult or impossible to comply with for building-integrated solar products. In addition, PV products integrated in glass structures, such as windows or glass facades, are often subject to separate regulations governing the use of glass in buildings.

Finally, there are potential difficulties for the deployment of solar energy in buildings in areas with large historical building stocks, including UNESCO World Heritage Sites. Building-integrated solar technology is one of the means by which these two objectives can be reconciled, as long as building-integrated products are taken into account in local planning regulations. Specific efforts in that direction have been made, for instance, in the city of Évora, in **Portugal**.

b. Energy law

In many Member States, the construction of energy generation facilities, including innovative forms of deployment and innovative renewable energy technologies, is also governed by energy law, requiring a permit. As in the revised RED at EU level, capacity thresholds are generally used by Member States to distinguish the installations to which more stringent requirements are applied. In some cases, the use of the energy generated (self-consumption or sale) is also used to determine whether a permit is required.

The capacity threshold over which a licence to generate electricity is required varies greatly between Member States, e.g. 1 MW in **Poland** and **Romania** or 20 MW in **Bulgaria**. Below that threshold, a simpler permitting procedure is required. In general, higher thresholds are beneficial for – and would help accelerate the deployment of – many forms of innovative deployment and innovative technologies, such as floating solar systems.

The distinction between self-consumer/prosumer and energy producer according to energy law is crucial to some of the innovative forms of solar energy deployment, such as agrisolar, infrastructure-integrated solar or building-integrated solar. A problematic case is when an installation is made for the purposes of self-consumption but is classified as an energy producer, which implies a set of requirements, procedures and charges (including taxes) that make the installation unattractive.

⁽⁶⁾ Dutch Offshore Wind Innovation Guide. Your guide to Dutch offshore wind policy, technologies and innovations - Issue 2024, Netherlands Enterprise Agency, commissioned by the Ministry of Foreign Affairs and International Trade of the Netherlands, 2024.

In the case of building-integrated solar installations, which from an energy law perspective are generally treated in the same way as rooftop installations, the classification as an energy producer can represent a barrier for real estate owners and developers considering such installations some Member States distinguish installations according to their capacities, and over a certain capacity threshold (around 50 kW or less) the installations cannot be considered to be self-consumption installations and cannot enjoy the benefits extended to self-consumers, such as tax exemptions. Capacity thresholds set for rooftop installations can be too low for building-integrated solar systems in large (especially high-rise) buildings, for at least two reasons: (1) these installations can use the building's facade and other constructive elements and are not limited to the roof area; and (2) they generate less electricity for the same peak capacity than rooftop panels. This barrier can be addressed by the general numerical threshold with, e.g. a ratio between the size of the generation installation and the capacity of the building's connection to the grid.

Ensuring that innovative forms of deployment and innovative technologies installed for self-consumption are recognised as such by national energy legislation is therefore key to keeping them attractive to private investors, including the public, and thus contributes to faster deployment and more affordable energy.

c. Environmental protection regulations

As for solar energy installations at large, environmental protection regulations apply to innovative solar energy deployment when it takes place on natural sites, thus affecting in particular agrisolar, floating solar and infrastructure-integrated solar .. In those cases, environmental regulations can require an environmental permit, depending on the specific circumstances. In some Member States, the project needs to be notified to the environmental authority, which can decide if it requires an environmental impact assessment (EIA). Some Member States apply a general capacity threshold over which an EIA is in any case required.

For agrisolar installations, the procedures are similar to ground-based deployment, although the context is different because the land is cultivated. In the case of infrastructure-integrated solar systems, if an environmental permit becomes necessary, it generally takes the form of an amendment to the existing assessment, since in most cases transport corridors require an EIA for construction.

It is in the case of floating solar installations that this procedure can give rise to greater uncertainty. Installations will need to be assessed in terms of their potential impact on nature and specifically water ecosystems, with the Water Framework Directive as the main EU-level legal reference. One of the main obstacles across the EU is that scientific information on this impact may require further research and dissemination efforts, as described in Section 4(a). Until the impact on natural ecosystems has been clearly understood, it will remain difficult for authorities to assess whether floating solar installations need to undergo a full assessment and what mitigation measures can be applied. These circumstances create uncertainty and lengthen permitting procedures, which further deters investment.

Most of the ocean energy projects currently being deployed in the EU are pilot projects. A common barrier is the requirement for project promoters to carry out a full EIA. While more research is needed to understand the potential environmental impacts of projects, in particular of the small number of large-scale projects, this requirement may in some cases be disproportionate, particularly for small pilot projects. In this regard, Member States could consider making use of regulatory sandboxes. To support regulators in their approach to experimentation in the EU, the Commission adopted in 2023 a 'Guidance on regulatory sandboxes, testbeds and living labs in the EU, with a focus section on energy' (7).

Another option could be to incorporate an adaptive management approach, as is the case in **France**. This approach can be burdensome for the developer, as it requires continuous monitoring of the environmental impacts of the project and management adjustments to adapt to them. However, it can also make a substantial contribution to improving knowledge of environmental impacts. This continuous monitoring and adaptation on the basis of environmental impacts can also help increase public acceptance of these projects.

(7) New Commission Staff Working Document sheds light on experimentation spaces for regulatory learning - European Commission.

Floating offshore wind energy projects will generally require an EIA. Although more is being written about – and further experience gained of – the environmental impact of fixed-bottom offshore wind turbines, some of the conclusions drawn are not directly applicable to floating turbines. The first reason is that deep and shallow water environments are different. The second is that mooring systems and platforms supporting floating turbines will have a very different environmental impact from fixed-bottom structures. In addition, some Member States interested in deploying floating offshore wind turbines tend to have little or no experience of fixed-bottom offshore wind environmental assessments. To provide support to developers and authorities, **Spain** committed, as part of its 2022 Roadmap for offshore and marine energy, to adopt environmental and biodiversity guidelines on the implementation of renewable energy in the marine environment ⁽⁸⁾.

As stated above, **Germany's** Renewable Energy Sources Act makes provision for benefits to be extended only to floating solar installations on artificial water bodies, referring to specific typologies defined under the Water Resources Act. In **Spain** the decree regulating the deployment of floating PV installations includes limits on the percentage area that can be occupied by such installations, which can be further reduced to ensure that environmental objectives are met and that pre-existing uses of the water bodies are respected ⁽⁹⁾. **Italy**, on the other hand, does not make this distinction and focuses on the specific impact on the environment. In all Member States, requirements will be more stringent for installations in or near Natura 2000 areas and may require an assessment under Article 6(3) of the Habitats Directive. To simplify the process, authorities in **Belgium** allow building and environmental permits to be bundled in a single procedure.

4. Addressing other regulatory barriers

Key conclusions:

- **A definition of a specific innovative form of deployment or innovative renewable energy technology is an effective way of lifting barriers to its deployment. On that basis, the form of deployment or technology can be signalled as a specific case in the application of a given regulation.**
- **Sector-based regulations are of particular relevance in addressing barriers to the different forms of deployment and technologies:**
 - **Land use regulations often hamper agrisolar deployment, especially where they make dual use of land very difficult.**
 - **Water and mining regulations need to take into account the potential of floating solar installations.**
 - **Construction product certification, including at EU level, remains a barrier to building-integrated solar systems.**
 - **Infrastructure law contains most provisions relevant to the promotion of infrastructure-integrated solar installations.**
 - **Product regulations continue to hamper the deployment of plug-in mini-solar in some Member States.**
 - **The revision of maritime use regulations provides opportunities to promote floating offshore wind and ocean energy.**

The main good practices identified consist of changes and adaptations in the relevant regulations governing the activity involved in that form of deployment to clarify how those regulations would apply to each innovative form of deployment.

⁽⁸⁾ https://www.miteco.gob.es/content/dam/miteco/es/ministerio/planes-estrategias/desarrollo-eolica-marina-energias/enhreolicamarina-pdf_accessible_tcm30-538999.pdf.

⁽⁹⁾ Royal Decree 662/2024.

a. Definitions in the national legislation

A definition is often the first step in promoting a specific innovative form of deployment or an innovative renewable energy technology. On that basis, the form of deployment or technology can be signalled as a specific case in the application of a given regulation. Without that definition, it often becomes difficult to ascertain whether that form of deployment or technology is compatible with the regulation, generating uncertainty.

In the following sections, we will focus on the different categories of regulations in which a definition can be usefully put into practice. In this section, we will focus on the definition itself.

Definitions have become an issue in the case of agrisolar installations as they can help alleviate pressures on land use only if land use regulations specifically allow them, preferably on the basis of a clear definition.

At least four Member States have taken steps to introduce a definition of agrisolar either in legislation or in guidelines, although generally referring to 'Agri-PV' or 'Agrivoltaics' and thus excluding solar thermal installations. **France** included a definition of 'agrivoltaics' in its March 2023 law on the acceleration of renewable energies ⁽¹⁰⁾. **Germany** has not spelled out a precise definition of 'agrivoltaics' but has introduced references to it in the 2023 version of its Renewable Energy Sources Act, while tasking the Federal Networks Agency (the energy regulator) with setting out the related requirements. The Act also refers to technical standards developed at national level by the industry and research organisations (DIN SPEC 91434). **Italy** also lacks a legal definition of agrivoltaics but the Ministry of Environmental Transition has published guidelines on the matter. The guidelines, which are not binding, include a set of criteria to be met by the installations to be considered as agrivoltaic installations and have been complemented by case law. **Czechia** has introduced a Decree on Agrivoltaic Power Generation Facilities, which also lacks a precise definition, but sets out the conditions for agrivoltaic facilities, including the crops on which they can be installed and the percentage of land that must remain in agricultural use.

These efforts to define agrisolar have certain elements in common: (1) solar energy generation and agricultural activities take place at the same time on the same land, with agriculture considered as its primary use; (2) the solar energy installation adopts solutions to ensure the continuity of the agricultural activity; (3) the combination with activity to generate solar energy does not significantly decrease and, ideally, boosts the land's agricultural potential; and (4) the solar energy installation can be removed without damaging the land.

Floating solar is at the intersection of several regulations, including those for energy, water, mining and environmental protection. As such, it would benefit from specific treatment in one or more of these regulations. Without a specific reference in legislation to a floating solar installation, it is often difficult to ascertain whether it requires a construction permit or a water utilisation permit, or both. Nevertheless, Member States have not yet included precise definitions of floating solar installations in their legislation.

Portugal issued a decree in 2021 to regulate support for floating PV, restricting it to a list of seven dam reservoirs and limiting the area that the installations could cover ⁽¹¹⁾. In the 2023 version of its Renewable Energy Sources Act, **Germany** introduced a reference to solar energy on artificial water bodies, referring to specific typologies defined under its Water Resources Act. The exclusion of natural water bodies for the purposes of installing floating solar is linked to environmental requirements. In practice, German legislation excludes from support floating solar installations that cover more than 15% of the water's surface or that don't maintain a distance from the shore of at least 40 metres. In 2022, the country's Bundesrat (Federal Council) submitted a proposal to remove the 15% surface limit.

Thus, three criteria that appear relevant for floating solar are: (1) the characteristics of the water body on which it is installed; (2) the proportion of the surface of the water that the installation can cover; and (3) the minimum distance from the shore.

⁽¹⁰⁾ "Loi n° 2023-175 du 10 mars 2023 relative à l'accélération de la production d'énergies renouvelables".

⁽¹¹⁾ Decreto-Lei n.º 98/2021, de 16 de novembro: Unifica os procedimentos para produção de eletricidade a partir da conversão de energia solar por centros eletroprodutores fotovoltaicos flutuantes a instalar em albufeiras.

The deployment of building-integrated solar, plug-in mini- solar- systems and infrastructure-integrated PV would be accelerated by the adoption of specific technical standards, which should be respected, rather than by creating a general conceptual definition, especially in relation to safety regulations in buildings, product regulation and transport infrastructure.

In the case of infrastructure, in addition to national or regional regulations, rules imposed by the owners or operators of the infrastructure are also an important part of the regulatory context. In the **Netherlands**, Prorail, the government organisation responsible for the maintenance and development of the railway network, has issued a handbook with the technical specification to be respected when installing PV systems along railways or on railway noise barriers ⁽¹²⁾. In **Austria**, an amendment to the Federal Roads Act is under debate. If adopted, it would formally regulate infrastructure-integrated PV, including solar PV installations, in close proximity to roads. Even if innovative renewable energy technologies are, in general, not yet at the commercialisation stage, the introduction of definitions or technical standards can be useful for sending a political signal about the usefulness of the technology in question. In **Germany**, a definition of an airborne wind energy system has been included in the Renewable Energy Sources Act, which also provides important clarifications for their further deployment, such as the information that tenderers must attach to bids for airborne wind turbines.

In conclusion, definitions or technical standards provide a useful basis to revise or implement relevant legislation or measures to support the development of these innovative forms of deployment and innovative renewable energy technologies.

b. Sector-specific regulations

Key conclusions:

- **A definition of a specific innovative form of deployment or innovative renewable energy technology is an effective way to lift barriers to its deployment; on that basis, the form of deployment or technology can be signaled as a specific case in the application of a given regulation.**
- **Sector-based regulations are of special relevance in addressing barriers to the different forms of deployment and technologies:**
 - **National Land use regulations could hamper agrisolar deployment, especially where they make dual use of land difficult.**
 - **Water and mining regulations need to take into account the potential of floating solar.**
 - **Construction product certification, including at EU level, remains a barrier for building-integrated solar.**
 - **Infrastructure law contains most provisions that need to be considered for the promotion of infrastructure-integrated solar.**
 - **Product regulations continue to hamper the deployment of plug-in mini-solar in some Member States.**
 - **The revision of maritime use regulations provides opportunities to promote floating offshore wind and ocean energy.**

Having considered three categories of regulations affecting several or all innovative forms of deployment and innovative technologies, the guidance will now investigate how they are affected by sector-specific regulations.

⁽¹²⁾ Handboek Technische voorschriften voor werken en werkzaamheden op, boven, onder en nabij de spoorweg, ProRail BV.

Agrisolar and land use regulations

Land use regulations, encompassing land designation rules, spatial planning and zoning regulations, have been identified as the key barrier to agrisolar deployment in many Member States, to the point of it being illegal in some of them. Agrisolar represents a combined use of land, for agriculture and energy generation, and it can only take place in jurisdictions where such use of land is facilitated, or at least allowed.

The use of land for agricultural purposes is generally linked to a special land designation, meaning that the land is legally designated to be used primarily or exclusively for that purpose. In such cases, other simultaneous uses of the land are subject to strict restrictions or preconditions. These restrictions can go as far as full prohibition: in some Member States, combined use of land is not possible, and since the installation of solar energy systems would require the redesignation of land to another category, this creates a major barrier for agrisolar installations. Redesignation may also change the tax regime for agricultural activity, for example in relation to inheritance.

In other cases, combined use of land for agrisolar is possible but still requires land redesignation, a lengthy and burdensome process which is only possible under certain circumstances and dependent on decisions made at a local level. In many Member States, land of high agricultural value cannot be redesignated for other purposes. A notable exception in Austria, which is a federal country, is the state of **Styria**, where the local Spatial Planning Act explicitly allows agrisolar installations in grassland areas of up to 0.5ha without land redesignation. In addition, agrisolar is exempted from the general statutory ban that prohibits solar energy installations in so-called 'exclusion zones'.

In general terms, allowing agrisolar under land use regulations will often require a specific reference in those regulations; hence, the importance of developing a definition of agrisolar in the jurisdiction of each Member State, with an accompanying set of criteria, as presented in Section 2a.

Floating solar, water regulations and mining regulations

Floating solar consists of solar system installations on water surfaces. This means that the Member State's water regulations, from navigation or shipping law to water usage regulations, generally apply. Nevertheless, those regulations rarely refer to the possibility of deploying solar energy installations, include a definition of floating PV or set out specific conditions or restrictions on such installations. This creates uncertainty and deters investment.

The right to use water is, generally, strictly regulated in the EU Member States. In many jurisdictions, owners of solar energy installations are not included among the categories of users who must have a contract to use water and pay the related fees. It is, therefore, often unclear whether floating solar will be considered and regulated as needing to have a contract to use water.

Floating solar can conflict with water regulations in several ways. For instance, it can lead to higher water temperatures, potentially leading to impacts on other water users. It can also impact navigation or fishery activities. In addition, the installation and use of electric cables in the water can also create concerns for water authorities, although safety guarantees can be provided. As for other water uses, floating solar can also be restricted in the public interest, such as for flood protection or to safeguard health. These and other factors can lead to rejection of the installation, or the imposition of restrictions and/or the creation of compensation measures for the installation to be approved.

As mentioned in Section 2a, **Germany's** Renewable Energy Sources Act includes a reference to solar systems on artificial water bodies, referring to specific typologies defined under its Water Resources Act, thereby clarifying the applicable water regulation framework, although also limiting its scope. **Portugal** has a clear framework for floating PV on public water bodies, which is only permissible through public tenders that give access to concession permits. This is what the government did in 2021, through the above-mentioned decree, to regulate access and support floating PV limited to installations on a list of seven dam reservoirs. **Spain's** Royal Decree 662/2024 sets out the rules for deploying floating solar on the surface of reservoirs located in hydrographic basins managed by the state.

In addition, in some Member States artificial water bodies related to mining activities (such as quarry lakes) are considered part of the mining facility and regulated by mining law. In those cases, mining authorities will be in charge of authorising the installation of solar energy equipment on the water. In some Member States the authorisation will be linked to the mining activity, meaning that the electricity must be mostly or totally used by the mine itself for self-consumption purposes and that the authorisation will lapse when the mining activity ends. In many cases mining regulations do not consider the possibility of installing energy equipment on the surface of the water, leading to uncertainty.

Encouraging solar installations on water surfaces, particularly on artificial water bodies, where the environmental and landscape impact is likely to be very low, can help to increase the acceptance of this type of project. Where these installations are allowed on natural water bodies, a sound knowledge of the potential environmental impacts, the implementation of effective mitigation measures where necessary, and an approach that minimises the impact on the landscape can also contribute positively to public acceptance.

Building-integrated solar and certification of construction products

Building-integrated solar is based on the integration of solar generation capabilities into construction products. Therefore, the current and generally strict regulations that apply to construction products also apply to building-integrated solar products. There are some exceptions to this, such as **Denmark**, where these products are treated as electrical components. Some Member States clearly treat these products as construction products and have even created additional certification procedures, while in other jurisdictions the situation remains unclear.

Due to these different legal situations and certification needs, building-integrated products cannot be used across the EU under the same conditions. The issue of product certification is particularly important, since certification is routinely requested by authorities before issuing construction permits. The current standard for building-integrated photovoltaic panels (EN 50583-1) has not markedly improved the situation, probably because it focuses on the PV module itself.

The revised Construction Products Regulation (CPR) ⁽¹³⁾, which entered into force in January 2025, will provide opportunities to address this issue through an EU-wide instrument. Nevertheless, this solution can only be envisaged separately for each category of building-integrated solar product, depending on its structural role as a construction product, e.g. solar glass, solar tiles, etc. In addition, the specific products or categories to be covered by the CPR must be part of the work programmes of the CPR, the implementation of which is organised in three-year tranches. The EU-wide instrument to be produced through the CPR could take the form of European Conformity (CE) markings based on harmonised European standards, or of European Technical Assessments, which are voluntary standards issued by technical assessment bodies based on requests from manufacturers.

Infrastructure-integrated solar and infrastructure law

The installation of infrastructure-integrated solar requires compliance with the Member State's infrastructure laws, which often encompass specific regulations for road and railway infrastructure, as well as internal regulations developed by the operators of those infrastructures. In general terms, the planning of motorways and railways is a state monopoly in almost all Member States. Their construction is often contracted to private companies, while their operation is either in private hands through a concession procedure, or is controlled by the state through a monopoly.

⁽¹³⁾ Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products, as amended by Regulation 2024/3110.

In most Member States, all parts of a motorway, road or railway, including noise protection barriers, bridges, tunnels, etc. are considered an integral part of the road or railway and the installation of solar energy equipment needs to comply with the relevant regulations. The main objective of these regulations is to set very high standards for safety and traffic fluidity through technical requirements. In some Member States, the construction and installation of structures within the area of the road or railway land or 'buffer zone' is limited or even not allowed, with a few exceptions that exclude solar energy equipment. In **France**, **Germany** and the **Netherlands**, by contrast, these installations alongside roads and railways are specifically allowed, as explained in Section 2b. Allowing solar installations to be integrated into these existing structures or deployed on these industrial sites alongside infrastructure, rather than focusing exclusively on deploying on greenfield sites, can have other benefits, such as increasing public acceptance of these projects. In most Member States, the adaptability of infrastructure-integrated solar to these standards remains untested and thus an open question. The challenge, then, is to develop a practice of infrastructure-integrated deployment that satisfies these high standards. The infrastructure operator may add requirements to those contained in existing regulations to minimise the risk of liability. The absence of technical criteria to which infrastructure law can refer to establish a clear regime and criteria, remains an obstacle.

In practice, the infrastructure operator is best placed to launch the process to install solar PV in the infrastructure it operates, especially for the purposes of its own consumption, and address the related technical challenges. In **France**, the state-owned railway operator SNCF announced in July 2023 plans to study projects in this area. As mentioned in Section 2a, in the **Netherlands**, Prorail, the government organisation responsible for the maintaining and developing the railway network, issued a handbook for the installation of PV systems along railways or on railway noise barriers.

Plug-in mini-solar and product regulation

Plug-in mini-solar is without doubt the most directly accessible renewable energy technology for the average consumer because of its low capital needs and the ease of installation. Nevertheless, it may raise legitimate safety concerns, for example due to the weight of the installation, or concerns about its potential impact on the grid, which have led some Member States to prohibit their installation.

To overcome these barriers, the setting of minimum requirements for these types of products, for instance in terms of safety, helps ensure that only safe products enter the market, paving the way for bans to be lifted. In this regard, the characteristics of the micro-inverter integrated in the system are particularly important. The **German** testing, inspection and certification association is developing a test specification for balcony systems to ensure their safety. **Belgium** now allows the installation of plug-in mini-solar systems that have a Synegrid certification.

Providing guidelines or advice to users on installing plug-in mini-solar can also increase safety. The **German** association for testing, inspection and certification has published tips for installing and connecting plug-in mini-solar systems⁽¹⁴⁾. Manufacturers of plug-in mini-solar can also provide guidance to users, for instance on how to install the system correctly.

When it is certain that only safe products can reach the market and be deployed, there is less need for burdensome regulations. In addition, it paves the way for simpler permitting procedures, including grid connection procedures. It is important to ensure consistency among these different elements, for instance when capacity thresholds are imposed.

Beyond safety-related issues, the installation of plug-in mini-solar devices can face barriers due to local regulations concerning the facades of buildings, especially when they are installed on balconies, as is often the case.

⁽¹⁴⁾ Balkonkraftwerke: Mit Batterien Sonnenenergie effizienter nutzen - TÜV-Verband.

Floating offshore wind, ocean energy and maritime use regulations

The Maritime Spatial Planning Directive, adopted in 2014, requires Member States to develop maritime spatial plans (MSPs) to coordinate the development of various maritime activities (fishing, navigation, tourism, biodiversity conservation, etc.), including offshore renewable energy. Several Member States, including Germany and Ireland, have dedicated authorities responsible for regulating development and activities in the maritime area. All Member States from the North Sea, the Baltic Sea and the Atlantic area have included offshore renewable energy sources in their MSPs, identifying priority areas for the deployment of these technologies, mainly for bottom-fixed offshore wind. France, Ireland, Spain and Portugal have identified, and pinpointed areas also in each of them for the deployment of floating offshore wind. For example Portugal adopted an Offshore Renewable Energy Zoning Plan in January 2025, which is incorporated into its national MSP, and focuses on the identification of areas suitable for floating offshore wind installations. In a first phase, developers will be granted seabed rights to conduct studies in the area and prepare their bids to the auction to be organised by the state to secure the concession and the contract for public financing. However, no Member State has specifically identified areas for ocean energy technologies. This can represent an obstacle to the development of ocean energy because it must compete with other offshore renewable energy technologies, such as wind offshore energy, which is much more affordable and a more mature technology. The same reasoning holds for the development of offshore floating solar, which could be considered in the Member State's MSP. Offshore wind (floating, but also fixed-bottom), offshore floating solar and ocean energy could also be considered together. In particular, there may be synergies between offshore wind and wave or tidal energy. Considering predictability of ocean energy and complementarity with wind, such a hybrid system could potentially contribute to stabilise the grid, help reduce the need for grid expansion and storage, provide a more programmable supply and support services to the grid and increase the energy yield and reduce overall costs. When revising the maritime spatial plans, Member States could consider designating areas for innovative renewable energy technologies.

5. Financial framework

Key conclusions:

- **Innovative renewable energy deployment and technologies often require customisation and have not reached yet the economies of scale required to drive costs down.**
- **Financial frameworks for the support of renewable energy can be adapted to these specific needs:**
 - **In renewable energy support schemes, there are different solutions to reduce the cost gap with traditional renewable energy deployment, depending on the modality (direct price support scheme, generalised support to renewable self-consumption). Access to the grid is another key factor.**
 - **Where renewable energy deployment is combined with other activities, sector-specific incentives also have a direct impact, in particular agricultural support has an impact on agrisolar, while incentives to renewable deployment in buildings influences the deployment of building-integrated solar.**

Innovative forms of solar energy deployment usually require custom-made products (e.g. roof tiles in the case of building-integrated solar) or balance-of-system components that are not required for ground-mounted or rooftop systems (e.g. mooring systems for floating solar), which, substantially increase upfront costs. Moreover, these systems can require more demanding operation and management, which may also increase their operational costs. The same problem applies to innovative renewable energy technologies such as floating offshore wind energy and ocean energy. Given the technological and financial risks they entail and the need to scale up development to bring prices down, their costs, including capital costs, are also usually higher than those of conventional renewable energy technologies. At the same time, these projects can yield technological breakthroughs with substantial returns down the line, when the technology matures and secures economies of scale. In addition, many of these types of deployment and technologies require a high level of customisation. The

supplier cannot simply make use of standard products and standard installation procedures: a solution adapted to the concrete needs of the installation must be found. This customisation also leads to higher returns at local level, from the manufacture of the product to installation and maintenance, and contributes to the creation of green jobs. Promoting these technologies can therefore have a positive impact on the competitiveness of EU industry and help achieve the manufacturing objectives of the Net-Zero Industry Act and the Clean Industrial Deal. Therefore, taking into account the costs and the potential returns, Member States could consider adapting their financial frameworks to the needs of these technologies and forms of deployment.

The case of plug-in mini-solar systems is different from the other innovative forms of deployment and technologies covered by this guidance. As they tend to be very small installations, the upfront investment is low, even lower than for rooftop PV systems. However, even though they are much more accessible, this does not mean that everyone with a suitable space can afford them, especially vulnerable or energy-poor consumers, who usually lack the necessary financial resources. Member States could consider providing financial support in line with the Commission Notice on the notion of State aid for their deployment in certain cases, e.g. as part of an integrated strategy to alleviate energy poverty or in the context of their social climate plans.

The volume of support dedicated to innovative forms of solar energy deployment and innovative technologies should be carefully tailored to maximise the leverage of public resources, prioritising quality over quantity. Periodic assessment of the results achieved should be carried out frequently to prioritise technologies that demonstrate the fastest improvement and potential for maturity over the medium term.

a. Competition with other forms of deployment and the role of renewables support schemes

There are several ways to reduce the gap between the costs of innovative forms of deployment and innovative technologies and those of conventional forms of deployment. A clear regulatory framework with at least a definition of the technology and a specific process to grant permits can reduce legal uncertainty, drive down financing costs and encourage investment in these forms of deployment. (This issue was discussed in the previous chapter). The design of support schemes can also play a key role in realising projects that integrate these innovative forms of deployment and innovative technologies. Specific support schemes (as for example an offshore site dedicated to floating offshore due to distance to shore and water depth⁽¹⁵⁾) may reduce costs in the medium term by scaling up production and standardising solutions, thus reducing the cost gap, and to further push innovative developments. This is clear for floating offshore wind energy and ocean energy - as innovative renewable energy technologies with great potential for economies of scale and where new research is helping the technologies advance - but is equally valid for some innovative forms of deployment. In the past, renewables support schemes have been the main instrument used to drive down the costs of renewable energy technologies, fostering their development so they can compete on a par with other energy technologies. The same logic can be applied to innovative technologies and forms of deployment to reduce the cost gap with current renewable energy deployment, as some Member States are doing already. How this can be achieved, however, depends on the instrument used.

Direct price support schemes

Direct price support granted through competitive tendering procedures based on price, in particular renewable energy auctions, are unlikely to encourage innovative technologies and forms of deployment if they let them compete with the most advanced renewable energies when an important cost difference exists. The current rules allow small-scale installations and demonstration projects to be exempted from the competitive tendering obligation⁽¹⁶⁾. The rules also provide a number of exemptions that make it possible to conduct technology-specific auctions based, for instance, on the long-term potential of a particular technology, the need to achieve diversification⁽¹⁷⁾, on the fact that these are demonstration projects, or on the existing cost differences between technologies⁽¹⁸⁾.

⁽¹⁵⁾ See State aid decisions SA.100269 and SA.105381.

⁽¹⁶⁾ See Article 4.4 of RED.

⁽¹⁷⁾ See Article 4.5 of RED.

⁽¹⁸⁾ See for instance CEEAG paragraph 96 and 104.

One way to create a niche for novel technologies and forms of deployment is to set out separate baskets for them with indicative budgets, thus letting different innovative options compete with each other. A second way to reward novel technologies and forms of deployment is to introduce a non-price criterion, based on objective and measurable criteria, that attributes more points to projects with innovative components which deliver solutions that go beyond the state of the art; .The Net-Zero Industry Act requires Member States to introduce a set of non-price criteria in 30% of renewable energy auctions, including innovation as one of the possible non-price criteria. In **Spain**, in the tendering process for projects in the maritime territory and ports of national interest, the score is based on several criteria, 30% of which are non-economic factors.

A third option is to create specific tendering procedures for novel technologies and forms of deployment, thus allowing them to compete with each other and leading to the selection of the most cost-efficient options.

The fourth option is to create specific tendering procedures for technologies or forms of deployment. **Germany** and **Portugal** have specific support schemes for floatingPV ⁽¹⁹⁾. **Italy** has recently created two specific support schemes, one for agri-PV and another for innovative technologies ⁽²⁰⁾, including a basket for floatingPV, which will offer incentives for large-scale floating PV projects.

Portugal is also expected to launch a specific auction for 2 GW of floating offshore wind capacity in 2025. Portugal is following in the footsteps of France, which carried out the first commercial-scale floating offshore wind auction, awarding a feed-in tariff to a 250MW project in Brittany in 2024, followed by the award of ContractforDifference contracts to the winners of an auction for two floating wind blocks in the Mediterranean, also in 2024. These price discovery mechanisms revealed lower-than-expected price differentials with fixed-bottom offshore installations, bringing the technology closer to commercial deployment. Member

As already mentioned above when demonstration projects or small scale installations are at stake, Member States can also choose to exempt innovative forms of deployment and innovative technologies from tendering processes, and identify specific areas for their development. In **Spain**, for example, there is an exemption for innovative marine renewable projects with an installed capacity of up to 20MW, provided that they are deployed outside areas with a high potential for offshore wind energy. The MSPs designate priority areas for research, development and innovation in which experimental projects can be deployed.

Generalised support for renewable self-consumption based on excess generation fed to the grid

This kind of generalised support to renewable self-consumption based on excess generation fed to the grid, such as feed-in tariffs or net metering, will generally not provide a basis for innovative forms of deployment and innovative technologies. Since they give compensation for the electricity fed to the grid, they tend to encourage the cheapest installations.

Nevertheless, this kind of support tends to evolve to encourage greater self-consumption by reducing the compensation given for the electricity fed to the grid (i.e. not self-consumed) or by linking it to the market value of that electricity (known also as net billing). In the latter case, forms of deployment that generate electricity at hours in times when there is a lower concentration of renewable generation (e.g. building-integrated vertical installations that generate at sunrise or sunset) can be more attractive.

A more direct way for this support could encourage innovative forms of deployment more directly by introducing additional requirements in that direction or to by providing additional support to consumers that make use of such innovative forms of deployment, in particular building-integrated solar.

⁽¹⁹⁾ Germany's support scheme only covers artificial water bodies.

⁽²⁰⁾ See SA.105880.

It is also useful to clarify the circumstances under which innovative forms of deployment or novel technologies can be considered as self-consumption projects, including self-consumption projects managed by a third party, in line with the provisions of Article 21 of the Renewable Energy Directive. Such clarifications can also help reduce any financial barriers they face. These clarifications can also contribute to exploit synergies between different projects. This is the case, for example, with ocean energy and desalination plants. At the same time, these clarifications can become a barrier if they are too restrictive. For example, in several Member States, mining regulations require floating PV projects to earmark a high percentage of the electricity produced for the mining activity's own consumption, which makes the project dependent on the mining activity and may create legal uncertainty if the mining activity ceases.

Generalised support for renewable self-consumption based on investment aid.

This kind of support is not linked to the generation but to the acquired renewable energy technology. In such cases, the requirements can be set out in such a way as to support innovative technologies or forms of deployment.

As already mentioned above, the case of plug-in mini-solar systems is substantially different. Nevertheless, some Member States have also decided to help this technology penetrate the market by introducing financing support mechanisms. **Austria** has introduced VAT exemptions for solar systems up to a certain threshold, including plug-in mini-solar systems. **Germany** has also followed this same approach. Furthermore, these systems can benefit from the general feed-in tariff for renewable energy projects. In certain German cities and states, there are also specific subsidy schemes for plug-in mini-solar systems. In **Lithuania**, these systems can benefit from CAPEX subsidies for capital expenditure.

Access to the grid

Beyond support schemes, connection to the grid has become a very valuable asset, and innovative technologies and forms of deployment can be greatly encouraged by facilitating it. For instance, reserved grid connection capacity could be among the rights awarded to the successful bidder in a competitive bidding process, as is the case in **Spain** for projects developed in its maritime territory and state-interest ports. In general terms, the rights to develop offshore installations are granted with the associated grid connection, which is a pre-requisite to making them viable.

Innovative forms of deployment could benefit from sharing the grid connection in hybrid renewable energy projects that combine several technologies. An important aspect to consider in this respect is the possibility of sharing a grid connection between several owners. In **Spain, Poland and Portugal** there are examples of floating PV projects developed alongside ground-mounted installations or on the reservoirs of hydropower plants. Other innovative forms of deployment could benefit from the hybridisation of renewable energy projects, such as building-integrated solar, by encouraging the deployment of building-integrated PV-thermal installations.

Member States can also encourage further innovation by enabling and supporting the development of pilot projects. This will be discussed in Chapter 5.

b. Sector-specific incentives

In addition to these general approaches to tackling the price gap for all innovative forms of deployment and innovative technologies, Member States can also set up sector-specific incentives to encourage their development.

Agrisolar

Agrisolar can be promoted under the common agricultural policy (CAP). Support for the development of renewable energy aligns with the broader CAP goals of tackling climate change. Through their CAP strategic plans, which are currently set for five years, Member States can contribute to these objectives in several ways, including by supporting the use of agrisolar. However, many Member States do not address agrisolar in their strategic plans and lack any regulations on this topic, which has been identified as a barrier to its development. The strategic plans of **Germany, Italy, the Netherlands and Slovenia** include references to the promotion of agrivoltaics, but not all contain specific details on this ⁽²¹⁾.

⁽²¹⁾ Chatzipanagi, A., Taylor, N. and Jaeger-Waldau, A., Overview of the Potential and Challenges for Agri-Photovoltaics in the European Union, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/208702, JRC132879.

In the context of the CAP, farmers have the right to receive income support (direct payments), if they fulfil several eligibility conditions. There are some basic rules set at EU level, but Member States enjoy flexibility in implementing them. For example, it is up to Member States to set out the conditions under which agricultural land must be used predominantly for an agricultural activity when there is also a non-agricultural activity on that land, as is the case for agrisolar.

As already mentioned in the section on permitting, the combined use of land is not allowed in every Member State. In such cases, the installation of agrisolar systems on agricultural land typically leads to the land being redesignated, usually as industrial land. This may also lead to the loss of CAP direct payments, depending on how the Member State defines the predominance of agricultural activity. Ensuring that farmers and rural communities can reap the financial benefits of agrisolar projects without losing their direct payments can also increase the public acceptance of these installations.

In Member States where combined land use is allowed, finding a balance between food and energy production is generally a sensitive issue. For example, in **Germany** farmers may continue to receive 85% of their income support from the CAP when they install agri-PV systems if less than 15% of the agricultural land is lost due to the project. However, the eligibility criteria set by Member States sometimes could be restrictive and could hinder the development of agrisolar projects.

Building-integrated solar

Sector-specific incentives are also very relevant to building-integrated solar. Several Member States have created support schemes or sector-specific incentives or obligations for the deployment of solar on buildings. However, these are usually designed specifically for rooftop PV. While accelerating the deployment of rooftop PV is of crucial importance to reach the EU's energy and climate objectives, this approach excludes other important technologies that also have an essential and complementary role to play in decarbonising buildings and the energy system, like building-integrated solar, including PV and heat.

These technologies can be particularly useful in overcoming the challenges associated with deploying rooftop PV, such as the mismatch between generation and production hours, as they will typically have a different orientation leading to a different generation profile. Building-integrated solar systems can also provide a solution if a roof is unsuitable for the deployment of rooftop PV or where there are heritage or conservation constraints. Ensuring that building-integrated solar is included in these sector-specific incentives or obligations is critical to unlocking these potential benefits.

In **Austria**, the state of Vienna introduced a solar mandate that requires a certain amount of installed power per square metre of building surface in a technology-neutral fashion. As the roof area may not be big enough to meet the requirement, the use of building-integrated solar may be not only possible but necessary in some cases.

The recast Energy Performance of Buildings Directive⁽²²⁾ includes a phased obligation to ensure that solar energy installations are deployed in new buildings, existing public buildings and existing non-residential buildings undergoing a renovation that requires a permit. This obligation also extends to new roofed car parks that are physically adjacent to buildings. All suitable solar energy technologies, without limitations as to their form of deployment, are targeted by this mandate, thereby creating a strong incentive for building-integrated solar, including in the case of new roofed car parks. Also, the draft national building renovation plans will include policies and measures on the deployment of solar energy installations on buildings. In 2025, the Commission will issue guidance to Member States on how to implement the provisions that impose obligations related to solar energy installations.

The 23 Member States that signed the European Solar Charter in April 2024 to support the competitiveness of the European PV manufacturing sector committed to several actions, such as the promotion of innovative forms of solar energy deployment or the early implementation of the provisions of the Energy Performance of Buildings Directive on the solar mandate as part of the public procurement of solar energy products.

Member States can also consider other sector-specific incentives or obligations to promote other innovative forms of deployment or technologies. Concessions for the operation of transport infrastructure could integrate obligations for renewable energy deployment, whether or not linked to self-consumption in the operation of the infrastructure.

⁽²²⁾ Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast)

6. Building up expertise in innovative forms of deployment and novel renewable energy technologies

Key conclusions:

- **There is a knowledge gap to be filled regarding innovative technologies and forms of deployment due to their novelty. Three ways to effectively address this gap are:**
 - **Invest in research and innovation, including pilots, which is being done both at EU and national level.**
 - **Ensure adequate coordination and cooperation between authorities at all levels.**
 - **Promote adapted training and capacity building activities.**

As the above novel technologies and innovative forms of deployment are relatively new and differ considerably from conventional ways of deploying renewable energy, there is a considerable knowledge gap to be filled. This applies in particular to innovative renewable technologies, where experience is limited.

For innovative forms of solar energy deployment, the knowledge gap concerns the associated risks and opportunities, including with respect to their potential to attenuating environmental impacts. For innovative technologies it concerns the cost-effectiveness of the various technological pathways and can be addressed through prototypes and pilot projects.

Better and more widely shared knowledge of these novel technologies and innovative forms of deployment is a pre-requisite for extensive deployment. A broader knowledge base will help inform decisions by technology owners, project developers, network system operators, installers and public authorities at national and local level (for e.g. financing and permitting, respectively). It could also have a positive impact on public opinion and on other factors that might discourage their uptake.

There are EU instruments, such as the technical support instrument, that can help Member States overcome some of these barriers. Member States can ask for tailor-made help with designing and implementing key investments and reforms supporting renewable energy deployment.

a. Building up and disseminating knowledge

There are several ways to address this knowledge gap. Member States can encourage continued research on the relevant technologies and forms of deployment, including prototypes and pilot projects, making use of the available EU programmes and funding schemes (e.g. Horizon Europe, LIFE) as well as national research, development and innovation (R&D&I). To speed up deployment, this knowledge must then be disseminated to all relevant public and private stakeholders across the Member States.

Some Member States, such as **Germany** and **the Netherlands**, have carried out national studies on the potential of infrastructure-integrated solar technology ⁽²³⁾. **Finland** has recently launched a research project to investigate the use of agrisolar technology under Nordic weather conditions. At EU level, the European Commission **Joint Research Centre** has already carried out several studies on the potential of innovative forms of deployment and innovative technologies across the EU and their environmental impacts ⁽²⁴⁾. These studies on potential usually precede pilots and can be a key stage in their development.

⁽²³⁾ Elena Chvanova et al, Intermodal exchange of renewable energy, Berichte der Bundesanstalt für Straßenwesen, Reihe V: Verkehrstechnik (364) (2023); Neues Projekt erfasst Photovoltaik-Potenzial an Fernstraßen - Fraunhofer ISE; Potenzialanalyse von Photovoltaik an der Schiene | TÜV Rheinland (tuv.com); Solar Highway: Innovative noise barrier (rijkswaterstaat.nl); Adolf Goetzberger et al, The Potential of PV Noise Barrier Technology in Europe, ResearchGate (2020).

⁽²⁴⁾ Chatzipanagi, A., Taylor, N. and Jaeger-Waldau, A., Overview of the Potential and Challenges for Agri-Photovoltaics in the European Union, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/208702, JRC132879; Georgia Kakoulaki, Nigel Taylor, Sandor Szabo, Robert Kenny, Anatoli Chatzipanagi, Arnulf Jäger-Waldau, Communication on the potential of applied PV in the European Union: Rooftops, reservoirs, roads (R3), EPJ Photovoltaics 15, 2 (2024); reports on wind energy from the JRC's Clean Energy Technology Observatory cover floating offshore wind technologies.

Studies can provide useful input to Member States' policy decisions, including as regards establishing a regulatory framework or providing incentives. For instance, studies by the Fraunhofer Institute for Solar Energy, a research organisation, were key to defining and setting up a regulatory framework for agrisolar in **Germany**. In **the Netherlands**, Wageningen University has developed a solar research programme that, among other aspects, analyses the landscape impact of agrisolar installations ⁽²⁵⁾.

Supporting research can also have a positive impact in terms of public acceptance. For example, research can provide a more accurate picture of potential environmental impacts, whether they are positive, negative or negligible, removing the need for Member States to rely on assumptions or isolated cases. For example, **Spain and Portugal** carried out a project called Wave Energy in southern Europe to collect data on the environmental impacts of wave energy projects. Better knowledge of the potential environmental impacts of innovative forms of deployment and innovative technologies is also essential to be able to design more effective mitigation measures. Member States that have signed the European Solar Charter have committed themselves to exchange good practices in promoting innovative forms of deployment.

Furthermore, on-the-ground pilot and demonstration projects are key to building the knowledge needed to further advance innovative technologies and innovative forms of deployment and adapting them to the specific conditions of each Member State. In this regard, the EU framework for State aid for R&D&I ⁽²⁶⁾ recognises that State aid may be necessary to promote such activities in a situation where the market is unable to develop them. It also sets out the relevant compatibility criteria.

Technological developments in the area of floating offshore wind have largely been based on demonstration projects across EU Member States, including WindFloat Atlantic (25MW) in Portugal, which is the largest, Floatgen (2MW) in France, and DemoSATH (2MW) in Spain, commissioned in 2023. The EU-funded BLOW project is developing a 5 MW demonstrator in the Black Sea ⁽²⁷⁾.

In **the Netherlands**, a pilot infrastructure-integrated PV installation was deployed in 1996 as a noise barrier along a motorway; its performance has been monitored ever since through various research projects. The Dutch government has also funded several research projects on the efficiency of building-integrated PV. **Lithuania** has recently implemented two infrastructure-integrated PV pilot projects along transport corridors, which will be monitored to collect data on the effectiveness of this type of installations. Data will also be collected on the testing of retrofitting to replace existing noise barriers.

In the area of ocean energy, **France** has helped develop the Flowatt tidal turbine pilot farm, one of the world's largest tidal energy installations. **Spain's** 'Renmarinas Demos' programme, financed by the Recovery and Resilience Fund, provides investment aid on a competitive basis for pilot projects, test platforms and infrastructure for marine renewables.

Cooperation between Member States is equally crucial to disseminate knowledge across the Union. Member States can share experiences and align research and innovation (R&I) activities on clean, resilient and competitive energy technologies between policy makers, industry and research centres in the forum provided by the Strategic Energy Technology (SET) Plan.

There are also funding opportunities at EU level for the development of pilot projects for the novel technologies and innovative forms of deployment covered by this guidance. The **Innovation Fund** supports technologies at more advanced technology readiness levels (TRLs) close to the commercialisation phase. Following the 2024 call, two tidal energy projects, one floating PV project and one agri-PV project have been invited to proceed with grant preparation.

Other EU funding programmes promote innovation in novel technologies and innovative forms of deployment at lower TRLs. **Horizon Europe** is the main funding programme for research and innovation, with a total budget of EUR93.5 billion for 2021-2027. It provides funding opportunities for innovative projects via calls for proposals. At the end of 2024, the Commission announced new funding opportunities for energy projects under Horizon Europe's 2023-2024 work programme. One of the calls relates to sustainable, secure and competitive energy supply and covers 13 topics, including critical technologies for future ocean energy farms and PV-integrated mobility applications ⁽²⁸⁾.

⁽²⁵⁾ Wageningen Solar Research Programme - WUR.

⁽²⁶⁾ EUR-Lex - 52022XC1028(03) - EN - EUR-Lex.

⁽²⁷⁾ <https://blow-project.eu/>

⁽²⁸⁾ Calls for proposals | EU Funding & Tenders Portal.

Other sources of EU funding for novel technologies and innovative forms of deployment include the **EU structural funds**, the **Resilience and Recovery Facility**, **InvestEU Programme** or the **LIFE Programme**.

funding . In terms of funding for the development of ocean energy, the **Ocean Energy ERA-NET Cofund** also supported these projects at EU level. At national and regional level, several funding agencies offer aid in the form of grants. These include the Ocean Energy Prototype Development Fund in **Ireland** and the Aid Programme for Investment in the Demonstration and Validation of Emerging Marine Renewable Energy Technologies in the Basque Country in **Spain**. **EuropeWave** is a pre-commercial procurement programme that awards service contracts to R&D providers while at the same time developing solutions funded by EU, national and regional funds aimed at developing wave energy converter systems that can withstand the ocean environment. It is currently in its final phase, i.e. open-sea deployment and testing.

b. Ensuring cooperation between authorities

As already seen in Chapter 2, innovative forms of deployment are governed by rules in various fields, not only energy, as they either allow for multiple uses of space or are integrated with other products. This means that various public authorities, including those in charge of energy, agriculture, environment, housing/building and mining, are involved in drawing up and implementing the regulatory framework. Thus, lifting regulatory barriers to innovative technologies and forms of deployment at national level requires inter-ministerial coordination through a dialogue between the ministry in charge of energy and those in charge of the other policy areas. The objective would be to identify any national, regional or local regulations that stand in the way of deployment and to remove them by, for example, adopting exemptions or laying down specific definitions or technical criteria to accommodate the innovative technology or form of deployment in question.

In federal states such as Spain and Austria, this would also require coordination between federal and regional authorities. As areas such as agriculture and the environment are often the responsibility of the regions in these countries, it would be up to the federal government to draw the attention of regional authorities to any barriers needing to be dealt with.

Local authorities also play an important role, since they are often in charge of issuing permits and are therefore the first entry point for project developers. In the field of building-integrated solar installations, for instance, the municipal authorities that deliver building permits often have insufficient knowledge of the safety features of building-integrated solar products. Industry stakeholders report that this can lead to rejection of building permit applications, delaying projects and discouraging promoters from further attempts to use these innovative materials. National and regional authorities could develop training courses for municipal officers to ensure they have sufficient knowledge of the specific features of building-integrated solar products and of the conditions to be fulfilled by these systems to be able to duly grant or refuse building permits.

Some Member States have created forums for coordination between public authorities at different levels. **Germany** organises annual meetings on agrisolar systems attended by the relevant authorities (agriculture, energy, education and the environment) and **the Netherlands** holds regular coordination meetings and discussions on infrastructure-integrated PV and floating PV systems.

Developers and manufacturers operating in different Member States across the EU often face issues stemming from a lack of standardisation and interoperability, which can result in increased costs, compatibility issues and inefficiencies. These challenges can, in turn, undermine investor confidence. National-level coordination should be combined with efforts to ensure standardisation and interoperability at EU level through the relevant processes.

c. Lack of experience and skills

The authorities in charge of issuing permits tend to be cautious of projects involving innovative technologies because the relevant legislation lacks definitions and a specific permitting procedure, or because there are not enough examples of such projects or a lack of consistent and reliable information on their characteristics and performance. This can lead to delays in the permitting process, sometimes linked to additional and redundant applications for permits, or even to projects being rejected. Legal uncertainty and insufficient information on the rules that apply can also make professionals reluctant to develop novel forms of deployment.

To address this issue, Member States could develop training and capacity-building courses for authorities and professionals involved in innovative forms of deployment on how these can be dealt with under the current rules.

Capacity-building requirements for the relevant professionals already exist at EU level. Under Article 18(3) of the Renewable Energy Directive, Member States must ensure that certification schemes or equivalent qualification schemes are available to installers of various renewable energy systems, including solar photovoltaic and solar thermal systems.

Germany organises training courses for building-integrated PV professions, such as the 'BIPV-Initiative Baden-Wuerttemberg' course, which is tailored-made for architects and planners. The programme provides support for pilot projects and information on relevant issues such as the requirements of the permitting procedure and the technical and architectural aspects to be considered ⁽²⁹⁾. Outside the EU, the Swiss national solar association, Swissolar, organises courses on solar PV and solar heat technologies tailored to professionals in the solar sector (architects, electricians, public authorities, etc.), including modules on PV facades.

Member States could also make use of the opportunities provided at EU level, such as the Pact for Skills, which provides public and private organisations with upskilling and reskilling support, including learning activities such as webinars for members and information on funding opportunities. It also includes a large-scale renewable energy skills partnership, launched in March 2023 with the aim of providing workers with the skills needed to manufacture and manage renewable energy technologies to help achieve the EU's climate and energy objectives. The partnership supports the exchange of best practices and data on skills gaps and needs, and provides guidance and policy recommendations to public authorities. For capacity building of regional and local authorities, "C4T Groundwork" ⁽³⁰⁾ was launched by the European Commission, to support the implementation of sustainability transitions investments funded by ERDF and CF, under Policy Objective 2. The programme provides eligible regions with tailor-made capacity building and advisory support covering areas such as the energy transition, circular economy, water management, climate adaptation or biodiversity.

⁽²⁹⁾ BIPV Initiative (bipv-bw.de)

⁽³⁰⁾ Inforegio - Apply now for C4T GROUNDWORK – the new technical assistance for cohesion for sustainable transitions!

ANNEX I

DETAILED OVERVIEW OF THE INNOVATIVE FORMS OF SOLAR ENERGY DEPLOYMENT AND INNOVATIVE TECHNOLOGIES COVERED BY THIS GUIDANCEa. Innovative forms of solar deploymentAgrisolar systems

'Agrisolar' refers to the installation and use of equipment for solar energy generation in a piece of land that is used for agricultural production. The combination of both activities (farming and energy production at the same time on the same land) is at the heart of the concept; whenever one of the two activities ceases or when the agricultural activity significantly decreases because of the installation and use of solar, there is no longer double use of the land. Likewise, the coexistence of these two activities on contiguous plots of land does not constitute an agrisolar system. Deployment on agricultural-related parts/buildings/spaces/facilities of the farm that are not directly involved in actual farming activities (e.g. warehouse, packaging, drying facilities) is not considered agrisolar. The combination of solar energy generation with grazing can be considered a subform of agrisolar under certain conditions (e.g. lands where animals were grazing and continue to graze without any substantial decrease in livestock density per hectare after the solar energy equipment was installed).

In practical terms, the solar energy equipment can either be part of a closed structure, such as a greenhouse, or it can be combined with open cultivated land, leading to two main categories: closed and open systems. In open systems, the panels can be placed either above the cultivated land (overhead systems) or between rows of cultivated land (interspace systems), with different models depending on the inclination of the panels. The choice of system and the way it is deployed depend on multiple factors, such as the characteristics of the crop (e.g. height and light requirements) and of the land (e.g. irradiation, inclination); soil and climate conditions (e.g. the suitability of a specific crop or type of farming system under existing climate and soil conditions); the business model and objectives of the project (e.g. targeted energy production levels or installation capacity, project pay-off period, number of players involved); access to infrastructure; and legislative and regulatory issues. This highlights the complexity of agrisolar systems.

Agrisolar technologies are recent, as are all innovative forms of solar energy deployment, and standard solutions have not yet been found. Intensive research efforts are taking place and pilot initiatives have proliferated in the EU and elsewhere. At global level, the estimated installed capacity increased from approximately 5MW in 2012 to more than 14GW in 2021.

Estimated TRL: between 3 and 8 (scale 1-9) ⁽¹⁾.

Floating solar systems

'Floating solar technology' refers to the installation and use of solar energy equipment on inland water bodies or offshore. There are many types of inland water bodies on which solar energy equipment can be installed, such as lakes, reservoirs, including hydroelectric reservoirs, mining ponds, industrial and irrigation ponds, water treatment ponds and coastal lagoons.

Installing floating solar systems in existing hydropower reservoirs can create synergies through the use of existing infrastructure, including grid connections. The potential in Europe is huge. Covering just 10% of the total surface of manmade hydropower reservoirs with floating PV installations would produce around 200 GWp ⁽²⁾.

Moreover, installing floating solar systems on water bodies reduces evaporation, bringing additional benefits in particular to areas suffering from water scarcity. In such systems, the solar generation equipment, the associated cables, the supporting floating structure and the mooring system are typically in the water body, whereas the balance of system, including the inverter and the grid connection point, are onshore. However, there are exceptions: in offshore floating solar systems combined with offshore wind in hybrid renewable generation plants, the balance of system can also be offshore.

⁽¹⁾ Source: ETIP-PV - <https://etip-pv.eu/publications/sria-pv/challenge-3/objective-1/roadmap-3/>

⁽²⁾ G. Kakoulaki, R. Gonzalez Sanchez, A. Gracia Amillo, S. Szabo, M. De Felice, F. Farinosi, L. De Felice, B. Bisselink, R. Seliger, I. Kougias, A. Jaeger-Waldau, Benefits of pairing floating solar photovoltaics with hydropower reservoirs in Europe, Renewable and Sustainable Energy Reviews, Volume 171, 2023, 112989, ISSN 1364-0321, <https://doi.org/10.1016/j.rser.2022.112989>.

Floating solar systems on inland water bodies has gained traction over the last 10 years. Estimated capacity at global level is 3 GW and the main markets are in Asia, especially China. The European market is growing, with at least 250 MW installed capacity in 2022, although this figure does not take into account the recent acceleration seen in some Member States.

Offshore floating solar technology is currently between the demonstration and commercialisation stages and is still facing technical hurdles such as corrosion provoked by saltwater and hazards linked to sea turbulence. However, there are examples in the EU of commercial projects being developed in combination with offshore wind. From the perspective of regulatory barriers, this guidance focuses on onshore floating solar, as for offshore floating solar the knowledge gap is greater and still requires further research, including on environmental impacts.

Estimated TRL: 8-9 (scale 1-11) ⁽³⁾.

Building-integrated solar systems

European standard EN 50583 and IEA PVPS Task 15 are currently the main references for the definition of building-integrated solar systems. A product can be classified as a 'building-integrated solar product' if it can use radiation from the sun to generate electricity or thermal energy and, at the same time, replace conventional building materials and provide a function as laid down in the EU Construction Product Regulation ⁽⁴⁾ (i.e. roof tiles, facades bricks, windows).

Thus, traditional solar energy deployment on rooftops, where the equipment is attached to the roof, does not constitute building-integrated solar because the integrity of the building's functionality does not depend on the presence of the solar energy equipment.

Although building-integrated solar technology is not new, it remains a niche market in the EU and elsewhere, with limited and specialised demand and just a handful of producers. This is largely due to regulatory barriers and market fragmentation. It is important to note that areas with little sun exposure may not be optimal for the installation of building-integrated solar systems. A highly innovative sector, building-integrated solar is designing new products and finding new solutions to technical obstacles and aesthetic demands from the market.

Estimated TRL: 9 (scale 1-11) ⁽³⁾.

Infrastructure-integrated solar systems

'Infrastructure-integrated solar' refers to the installation and use of solar generation equipment integrated into transport infrastructure, either in the defined infrastructure corridor (along a highway or a railway track) or in areas besides the transport infrastructure that cannot be used for other purposes, such as enclosed areas around roadways or airports.

In practical terms, an infrastructure-integrated solar installation can, for instance, be integrated into certain sound barriers (depending on e.g. the material or the height of the barrier) or in a canopy over a roadway, or it can be installed on the ground in areas near the corridor that cannot be used for any other purposes. Bifacial solar modules can also be used.

Not all solar energy equipment installed by transport infrastructure operators is considered infrastructure-integrated solar. If, for example, a railway operator installed solar panels on the roof of a functional office or repair workshop building, this would be considered rooftop deployment. Likewise, if it installed panels on unused land which it owns, but that is not an integral part of the railway corridor and could also be used for other purposes, this would be considered traditional ground-based deployment.

Solar installations in recharging stations for electric vehicles in an area that is not an integral part of the transport corridor and can be used for other purposes would not be considered infrastructure-integrated solar deployment. However, if the panels are an integral part of the structure of the building of the recharging station, including its parking lot, the installation would be considered a form of building-integrated solar.

⁽³⁾ IEA - ETP Clean Energy Technology Guide - <https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide>.

⁽⁴⁾ Regulation (EU) No 305/2011 laying down harmonised conditions for the marketing of construction products. The Commission proposed a review in 2022, on which a political agreement was reached in December 2023.

⁽⁵⁾ IEA - ETP Clean Energy Technology Guide - <https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide>.

Infrastructure-integrated solar has huge potential.. Vertical solar panels installed along the EU's major roads and railways alone would produce around 403 GWp ⁽⁶⁾.

Estimated TRL: 6-7 (scale 1-9) ⁽⁷⁾.

Vehicle-integrated PV systems

'Vehicle-integrated PV' refers to the use of PV panels and their integration into the material of the surface of a vehicle, such as a car, a bus, a truck, a trailer or a train. It is comparable to building-integrated solar in that vehicle-integrated products use irradiation from the sun to generate electricity while at the same time being essential to the vehicle's integrity.

The obvious specificity of vehicle-integrated deployment is that, contrary to the other forms of deployment listed here, the product is mobile and not bound to a specific grid connection. As the electricity generated is directly used by the vehicle, vehicle-integrated solar is particularly suited to electric vehicles. Since standard vehicles cannot make direct use of thermal energy, vehicle-integrated deployment does not include solar thermal technologies.

This form of solar energy deployment has considerable potential thanks to the double trend of growing electric vehicle sales and falling prices of high-efficiency PV products, combined with the flexibility and adaptability of certain PV technologies.

As no specific regulatory barriers have been identified, there is no need to elaborate further on this form of deployment. Any future growth in vehicle-integrated PV will mainly depend on industrial developments and innovation.

Estimated TRL: between 6 and 7 (scale 1-9) ⁽⁸⁾.

Plug-in mini-solar systems (including balcony PV)

Several Member States have seen a growing trend in plug-in systems installed on balconies. These are very small PV energy systems, usually two or three modules and less than 1 kW in total per installation, which are connected to a micro-inverter and plugged directly into a normal household socket, through which it will feed the house's internal electricity system. It is plugged directly into a normal household socket, from where it feeds the house's internal electricity system.

Plug-in mini-solar systems are easy for users to install; unlike for rooftop PV systems there is no need for an electrician. This means that they are much less costly than rooftop systems, also because the installed capacity is lower. They can cover a part of a household's consumption and thus reduce electricity bills, especially if the self-generated electricity is self-consumed close to real time. Such systems can help make solar energy more accessible, enabling people to become self-consumers even if they do not own a roof or are unable to install solar PV on their roofs. Because of their capital needs, they are also more accessible to vulnerable customers due to their low price, especially in Member States that promote their deployment through specific support schemes. The accessibility and potential to lower electricity bills of these systems can also help increase public acceptance of renewable energy in general and solar energy in particular.

The revised Electricity Market Directive allows Member States to promote the installation of such systems, including through network tariffs.

Estimated TRL: 9 (scale 1-9) – plug-in mini solar systems are fully available on a commercial basis.

⁽⁶⁾ G. Kakoulaki, S. Szabo, F. Fahl, N. Taylor, A. Gracia-Amillo, R. Kenny, G. Ulpiani, A. Chatzipanagi, K. Gkoumas, A. Jäger-Waldau, European transport infrastructure as a solar photovoltaic energy hub, Renewable and Sustainable Energy Reviews, Volume 196, 2024, 114344, ISSN 1364-0321, <https://doi.org/10.1016/j.rser.2024.114344>.

⁽⁷⁾ Source: ETIP-PV - <https://etip-pv.eu/publications/sria-pv/challenge-3/objective-1/roadmap-5/>

⁽⁸⁾ Source: ETIP-PV - <https://etip-pv.eu/publications/sria-pv/challenge-3/objective-1/roadmap-2/>

b. Innovative technologies:Ocean energy

Ocean energy is a general term covering a range of technologies that harness energy from the ocean to generate renewable electricity or heat. Exploiting this renewable resource helps redistribute the impact of renewables deployment between land and sea. The most advanced technologies are those harnessing the kinetic and/or potential energy of tidal currents and waves, respectively, to produce electricity. While these technologies have reached advanced TRLs, ocean energy installations have not yet reached a commercial scale where they can reap the benefits of cost savings due to scaling up. Other ocean energy technologies are still at the research and development phase, including ocean thermal energy conversion and salinity gradient power. Ocean thermal energy conversion exploits differences in temperature between surface water and deepwater to generate heat, and salient gradient energy is generated by mixing freshwater and seawater, exploiting the difference in salinity. The amount of space required for such installations could be further reduced by integrating them into infrastructure, of which there are already examples.

Estimated TRL: 9 for tidal energy, 8 for wave energy, 5 for ocean thermal energy conversion and 6 for salinity gradient power (scale 1-11) ⁽⁹⁾.

Floating offshore wind

Floating wind is a subcategory of offshore wind technology, which uses turbines to harness the energy of the wind blowing in offshore locations.

Unlike fixed-bottom turbines, floating turbines sit on floating structures and are better adapted to deep-sea locations, especially depths of more than 50 m. Floating offshore wind technology thus makes it possible to exploit wind resources that would otherwise remain untapped.

There are different types of floating offshore wind installation, based on the foundations stabilising the floating turbines. The four main types are barge, semi-submersible, spar, articulated multi-spar and tension-leg platform. The foundations are connected to mooring points (which can be dead weight, drag anchor, etc.) through mooring lines.

As is also the case for fixed-bottom offshore wind installations, the electricity generated is fed into the system through a substation, which can be onshore or offshore.

Estimated TRL: 7-8 (scale 1-11) ⁽¹⁰⁾.

⁽⁹⁾ IEA - ETP Clean Energy Technology Guide - <https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide>.

⁽¹⁰⁾ IEA - ETP Clean Energy Technology Guide - <https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide>.

ANNEX II

SYNOPSIS REPORT ON THE CALL FOR EVIDENCE

A stakeholder consultation was carried out through an online 'call for evidence', which was available on the Commission's 'Have your say' consultation website ⁽¹⁾ for four weeks in preparation for the recommendation and guidance on innovative forms of solar deployment.

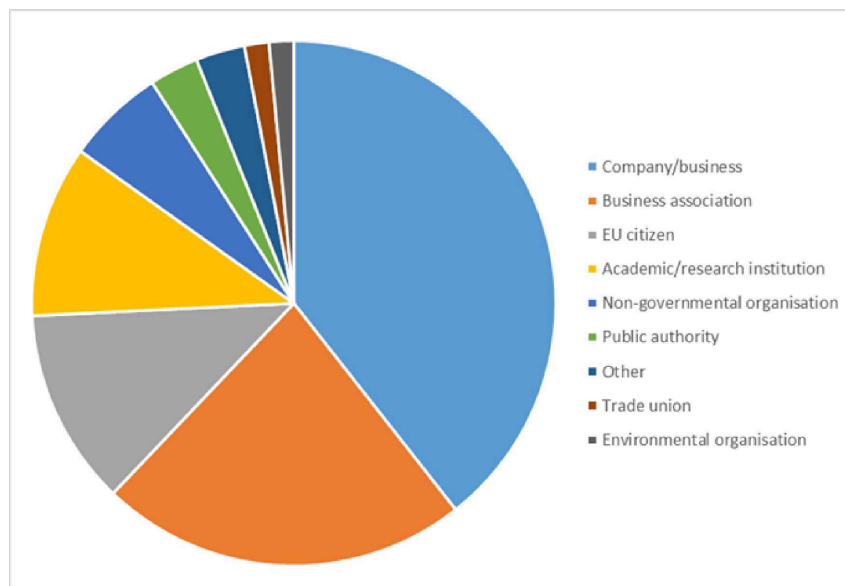
The objective of the consultation was to gather feedback from stakeholders on the proposed scope and content of the initiative. The main stakeholders targeted were public authorities (Member States, regional and local authorities), renewable energy utilities, renewable energy associations, research and innovation associations, non-governmental organisations, representatives of the farming community and the general public.

Replies were received from most of the target groups except Member States and local authorities, and some were received from additional stakeholder groups such as environmental organisations and trade unions (with one contribution each).

The Commission carried out a qualitative analysis of the replies to the call for evidence, including the attached position papers.

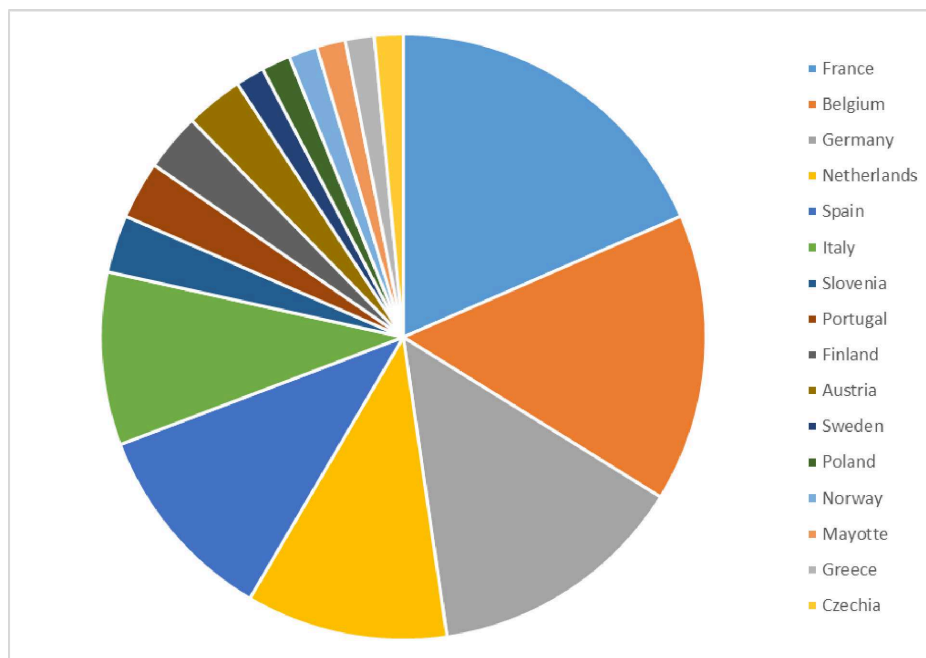
This document is merely a summary of the stakeholder contributions. It does not express the official position of the Commission or its departments and is not binding on the Commission. Also, replies to the consultation cannot be considered a representative sample of the views of the EU population.

The Commission received 66 replies to the call for evidence. The largest group of respondents were companies/businesses (25 replies), followed by business associations (15), individuals (8), academic/research institutions (7) and non-governmental organisations (4). There were also 2 replies each from public authorities and others, and 1 reply each from an environmental organisation and a trade union.



In terms of geographical distribution, there were 13 replies from France, 10 from Belgium, 9 from Germany, 7 from the Netherlands, 7 from Spain, 6 from Italy and less than 2 replies each from 9 other Member States. There was only 1 respondent from a non-EU Member State (Norway).

⁽¹⁾ https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14147-Innovative-forms-of-solar-energy-deployment-recommendation-to-promote-their-development_en.



Most respondents expressed general support for the initiative and agreed with the need to remove barriers to the development of the identified innovative forms of solar energy deployment.

Several respondents called for extending the scope of the recommendation and guidance to also include other solar technologies, in particular solar thermal, that can be deployed in innovative ways – also in combination with solar PV – for example by integrating them into buildings. This suggestion was taken on board and was expanded to also include other non-solar technologies that can be deployed in innovative ways and contribute to reducing land/water use, be it by integrating the technology into other products or by allowing multiple uses of space.

Some respondents were concerned that the development of innovative forms of solar energy deployment would come at the expense of more conventional forms of deployment such as rooftop and ground-mounted PV. However, as explained in the EU solar energy strategy and in this guidance, these innovative forms of deployment are seen as complementary to the more traditional forms.

Some respondents provided examples of barriers and good practices across all the innovative forms of deployment described in the call for evidence, while others focused on just one or a few of them. The innovative form of deployment most commented on by respondents was agrisolar, with lack of access to common agricultural policy support in some Member States cited as one of the main barriers to further development, followed by floating PV, building-integrated solar, infrastructure-integrated PV and vehicle-integrated PV.

Regarding regulatory barriers to innovative forms of deployment in general, many respondents mentioned the absence of definitions and references in the relevant legislation, resulting in lengthy permitting procedures and a lack of standards. In terms of non-regulatory barriers to innovative forms of deployment, many respondents pointed to financing difficulties due to high costs, including when applying for funds under general support schemes, lack of awareness or insufficient knowledge e.g. of the environmental impact, and lack of expertise, especially on part of the authorities issuing permits.

Account was taken of the examples of barriers and good practices shared by respondents, and several of them were incorporated into the recommendation and guidance.