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Analysis of barriers for innovative forms of solar PV deployment and associated recommendations

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Abstract

This report presents the findings of the project “Barriers for innovative forms of solar photovoltaic (PV) deployment in EU Member States”, carried out for DG ENERGY, European Commission, between April and December 2023. The report considers Agrivoltaics, Floating PV, Building Integrated PV, Infrastructure Integrate PV and Vehicle Integrated PV, identifying regulatory and non-regulatory barriers to their uptake. The report also shows that several Member States have put in place measures that proved beneficial for the deployment of one or several innovative forms of solar photovoltaic. It concludes that Member States could do more to reduce the most significant regulatory and no-regulatory barriers, and significantly speed up the uptake of innovative forms of solar photovoltaic. The report develops a set of recommendations concerning: the recognition of these innovative forms of PV; permitting procedures; tailored financial support to offset the extra costs of these innovations; measures to address the lack of specific knowledge about these innovative forms of PV; increased cooperation among public authorities and between public and private stakeholders.

1. Executive summary

1.1. What this report is about

This report presents the findings of the project "Barriers for innovative forms of solar photovoltaic deployment in EU Member States", carried out for the Directorate-General for Energy of the European Commission between April and December 2023.

Innovative forms of PV (see below for descriptions of the main categories) aim to **extend the potential deployment of PV, overcoming limitations in the availability of land or rooftop area.** Even in countries where there is sufficient available area for ground- and rooftop-mounted PV, innovative forms can play an important role, maximising PV deployment by exploiting locations that traditional PV cannot reach. Innovative forms of PV systems have existed for numerous years, but their **uptake has been slow or sometimes even inexistent across Member States,** compared to the observed exponential increase in the installed capacity of rooftop and ground-mounted PV.

This report considers five categories of innovative forms of PV deployment:

- **Agrivoltaics**: solar panels installed on agricultural land and that do not disrupt ongoing farming activities;
- **Floating PV (FPV):** solar panels mounted on a structure that floats on a body of water;
- **Building Integrated Photovoltaics (BIPV):** dual-purpose building elements that serve as the outer layer of a structure and generate electricity for on-site use or feed-in to the grid;
- **Infrastructure Integrated PV (IIPV):** solar panels installed on, or in connection to, an infrastructure, such as a road or a railway.
- **Vehicle Integrated PV (VIPV)**: solar modules integrated into the body of an electric vehicle, that contribute to powering the vehicle by recharging its battery.

The project aimed at:

- Identifying the main Identifying main constraints (of a legal, regulatory, technical, economical, environmental, industrial or social nature) to the uptake and deployment of five innovative forms of solar photovoltaic (PV) in Member States;
- Analysing existing and emerging good practices for the deployment of innovative forms of PV in EU Member States and other countries;
- Proposing recommendations to address the identified barriers and to promote good practices, with the aim of increasing the uptake of innovative forms of PV.

1.2. Main findings

The legal framework often **lacks a clear definition of innovative forms of PV**, leading to uncertainty for stakeholders and an often **inefficient and ineffective approval process**. Authorities may also lack

familiarity with the specifics of innovative PV technologies, resulting in permitting procedures which are longer and more complex than necessary. For some applications there is also an absence of accepted technical standards to which national regulations can refer to. Meeting all the requirements (such as compliance with health, safety, environmental and occupational regulations) can be difficult when the overall regulatory framework is unclear. The lack of clarity affects the viability of projects by increasing their risks, costs and development lead time. As some of these technologies are part of wider projects (for example, in the case of BIPV and IIPV), delays in the permitting process for the PV elements risk delaying the entire project, further discouraging potential uptake. In other cases, innovative PV projects may create indirect impacts that affects the overall profitability of the investment, such as fiscal implications of Agrivoltaics.

Beyond regulatory barriers, there are non-regulatory challenges. The business case for all innovative PV technologies is challenging, due to the higher investment costs and risks. While most Member States support deployment of these forms of PV, often this is via incentive schemes developed for traditional PV, which has significantly lower costs and risks. When innovative forms of PV have to compete with traditional ground or rooftop-mounted PV, or must comply with similar requirements, they are in practice excluded from the support measure, or have very little chance of success. Other common challenges concern difficulties in obtaining a grid connection, the lack of appropriate skills in the supply chain, and public acceptance. The latter appears to derive from limited awareness of the benefits of innovative forms of PV deployment, as well as more complex factors specific to each form. Finally, while technical challenges to be overcome are still significant, these often seem to derive from the need to comply with rules and regulations that were developed without fully considering these forms of PV.

Besides common regulatory and non-regulatory challenges, each form of innovative PV deployment considered in this report suffer from its own specific major challenges. For example:

- Agrivoltaics can face conflicts between the farming activity and the energy production activities, from both a technical and regulatory perspective;
- FPV can encounter the imposition of maximum size and technical requirements, which reduce the opportunities of economies of scale and increase cost;
- BIPV can be affected by safety and aesthetic constraints, as solar panels must perform as buildings structural elements and fit with the overall building aesthetic;
- IIPV can increase the complexity and cost in infrastructure projects which are already highly complex and expensive;
- VIPV challenges are related to cost-effectiveness, as current options offer limited benefits compared to their cost.

This report also identifies good practices, applicable to several forms of innovative PV, that successfully address one or more of the barriers mentioned above. Unsurprisingly, these are often found in those countries where innovative forms of PVs have already been deployed, and which are often those countries where land is more scarce, or where significant current investments in infrastructure are taking place.

Among the good practices that target barriers to innovative forms of PV, actions taken to foster collaboration between authorities appear particularly successful for those technologies that fall under multiple regulatory domains, such as Agrivoltaics, FPV and IIPV. The outcome of these

initiatives is often improved by the publication and dissemination of guidance, best practices reports, and by the offer of professional training, which helps developers through the permitting process, provides practical solutions for the most common challenges, and facilitates the construction phase. A related good practice concerns the tailoring and simplification of the permitting process, for example introducing reduced burdens for smaller installations and flexible procedures such as exemption from zoning laws. Finally, targeted financial support measures can help to overcome the higher investment costs of innovative PV forms.

This report also identifies good practices specific to each innovative form of PV. For example:

- Agrivoltaics: when defining the regulatory framework and the conditions to access subsidies for Agrivoltaics, it is important to consider agricultural practices and retaining sufficient flexibility in the parameters used to measure the agricultural activity;
- FPV: similarly, flexible rules and requirements (both for regulatory parameters and during the permitting process) can ensure the environmental integrity of water bodies without compromising positive business cases;
- BIPV: the adoption of common standards for BIPV, without imposing unnecessary additional safety requirements, would speed up its adoption by reducing costs (via economies of scale) and by simplifying the planning and permitting process;
- IIPV: the successful integration of IIPV often depends on the energy-generating elements either providing power directly to the infrastructure or performing an additional function, such as a noise barrier or roof;
- VIPV: the adoption of performance parameters when providing EVs incentives could make VIPV-vehicles more affordable, as technology costs goes down and the number of models on sale increases.

1.3. Conclusions and recommendations

The reasons behind the slow uptake of innovative forms of PV deployment are multiple; they vary by country, by form of deployment, and over time, as regulations, technical aspects, and the economic conditions evolve. Often, the key barriers are related to the dual function that these forms of PV deployment must perform: PV panels are not simply power generating units that must comply with laws and regulation specific to that function, but must also perform as elements of a building, vehicle or piece of infrastructure; or they must integrate with agricultural activities; or must not disrupt the aquatic environment. This means complying with additional laws, regulations and technical requirements which increase the costs and the complexity of the project.

Based on the most common barriers and on the good practices identified, this report provides a series of actions that EU Member States and European authorities could take to increase the uptake and deployment of innovative forms of PV. The full list of recommendations, including those aimed at supporting each specific form of PV deployment, is presented in chapter 0. However, there are a number of actions that are applicable to all forms of innovative PV and for the majority of Member States which are presented here.

To overcome barriers of a regulatory nature, Member States should:

a. Give these innovative forms of PV a clear legal status, officially recognising them in laws and regulations.
b. Where necessary, develop specific permitting processes and authorisation procedures. These should consider the novelty of the technology, the range of possible applications, and (if relevant) include site-specific considerations, rather than set uniform requirements for all possible applications.
c. Where possible, efforts should be made to reduce the complexity of the planning and approval process, in line with broader objectives of the REPowerEU Plan.
d. With particular attention to BIPV and IIPV, adopt harmonised technical standards and avoid imposing additional requirements to those set at European level.

To overcome technical and economic barriers, Member States should:

e. Offer financial support (incentive schemes) tailored to the needs, stage in the development process, and the specific challenges to innovative forms of PV deployment. This support should bridge the gap between the cost and the market revenues that innovative PV technologies can realistically obtain from the market.
f. Fund further research and innovation aimed at increasing cost-effectiveness and the number of potential applications, in particular supporting pilot applications and demonstration projects.

To overcome the challenges of integrating more PV in the power grid, Member States (in particular, energy ministries and regulators) and system operators should:

g. Map grid capacity constraints and deployment potential of these innovative forms of PVs.
h. Identify opportunities for installing PV on the site of, or near, major energy users, to reduce the need for grid reinforcements.

To overcome barriers related to lack of skills and knowledge among public authorities and in the supply chain, as well as public opposition, Member States should:

i. Promote platforms to foster better collaboration between authorities.
j. Disseminate knowledge to the supply chain actors and to the wider public.
k. Consult and involve stakeholders and local communities in the planning process.

2. Introduction

2.1. This project

This is the final report for the project ENER/C1/2022-534 'Barriers for innovative forms of solar energy deployment' under framework contract ENER/2020/OP/0021 on Energy Efficiency and Renewable Energy.

2.1.1. Objectives of the study and content of this report

The overall objective of this assignment is to 'elaborate a set of recommendations capitalizing on good practices to address regulatory and practical barriers to innovative forms of PV in the EU', while the specific objectives are:

- Identify the main constraints – legal, regulatory, economical, environmental, industrial, technical and social – to the uptake, promotion and deployment of 5 selected PV technologies within Member States: Photovoltaic (PV) modules used with agriculture ("Agrivoltaics"), Floating-PV (or "FPV"), Infrastructure-PV ("IIPV"), Building-Integrated PV ("BIPV") and Vehicle-Integrated PV (or "VIPV").
- Identify existing or emerging good practices among European Member States and beyond Europe in selected countries.
- Propose recommendations to address the identified barriers and promote those innovative technologies.

The report contains four main chapters:

- Chapter 3 – Presents the regulatory framework governing the selected innovative forms of PV and the potential barriers. This chapter gives an overview of potential barriers affecting all or some of the four innovative forms of PV: Agrivoltaics, FPV, BIPV and IIPV.
- Chapter 4 – Provides an in-depth analysis of regulatory framework and barriers from a selection of up to ten Member States on four innovative forms of PV: Agrivoltaics, FPV, BIPV and IIPV.
- Chapter 5 – Provides an in-depth analysis of the non-regulatory barriers from a selection of Member States on 5 innovative forms of PV: Agrivoltaics, FPV, BIPV, IIPV and VIPV.
- Chapter 6 – Contains a consolidation of the identified good practices and our recommendations to address the identified barriers and to promote each of these innovative forms.

This report contains three Annexes:

ANNEX A - REGULATORY FRAMEWORK AND BARRIERS presents the legal framework of selected Member States, identified via the desk research. Also, it presents a long list of potential barriers identified in relation to the regulatory framework of the selected Member States.

ANNEX B – TASK 3 DESK RESEARCH presents the different documents analysed.

ANNEX C – LIST OF INTERVIEWED COMPANIES PER EU MEMBER STATE presents the organisations interviewed in the course of this study.

2.1.2. Scope of the study

The study focuses on:

- five innovative forms of PV deployment across Europe Member States:
  - Agrivoltaics: solar panels installed on agricultural land and that do not disrupt ongoing farming activities;
  - Floating PV (FPV): solar panels mounted on a structure that floats on a body of water;
  - Building Integrated Photovoltaics (BIPV): dual-purpose building elements that serve as the outer layer of a structure and generate electricity for on-site use or feed-in to the grid;
  - Infrastructure Integrated PV (IIPV): solar panels installed on, or in connection to, an infrastructure, such as a road or a railway.
  - Vehicle Integrated PV (VIPV): solar modules integrated into the body of an electric vehicle, that contribute to powering the vehicle by recharging its battery.
- both regulatory and non-regulatory (technical, economic, practical) barriers to their deployment.

In terms of geographic scope, the study covers all EU Member States. However, good practices from both EU and non-EU countries are considered, and for some tasks a selection of Member States is made (see below).

2.2. Approach and limitations

2.2.1. Overarching approach

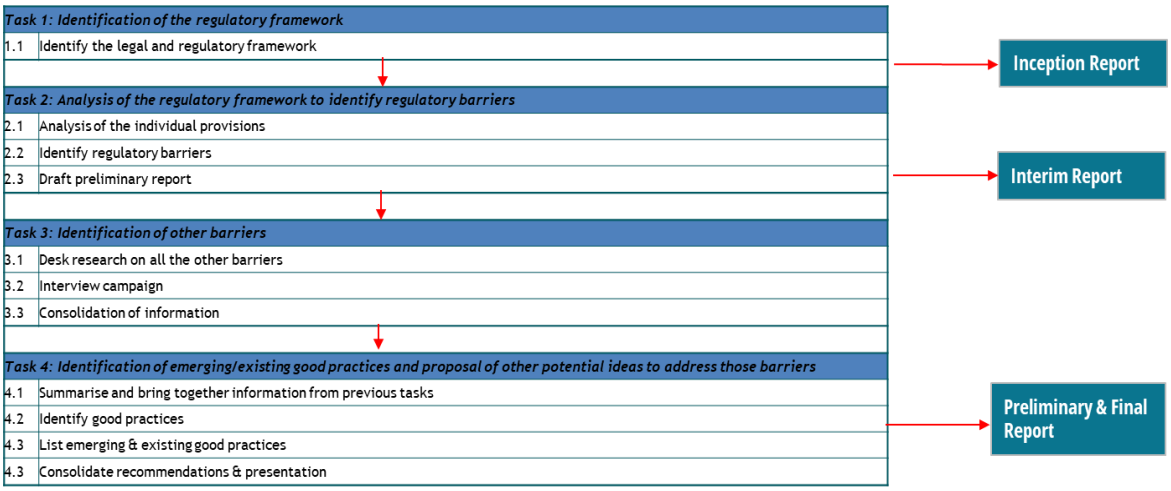
The project consisted of four tasks:

- Task 1 – We identified legal and regulatory barriers to the uptake, promotion and deployment of innovative forms of solar energy deployment, both globally and at EU level, and for each of the four innovative PV technologies (we excluded VIPV, which is country-agnostic and less affected by regulatory barriers, and which was analysed under Task 3 and 4).
- Task 2 – We conducted a detailed analysis of the legal provisions for selected countries (around 10 countries, where these innovative forms have potential for a significant uptake or are already deployed to some extent) with the aim to identify legal and regulatory barriers to the uptake, promotion and deployment of innovative forms of solar energy deployment. We focused on selected countries where the four innovative PV technologies are the most developed.

- Task 3 – We investigated non-regulatory barriers to the deployment of innovative PV, via desk research and an interview campaign across Member States.
- Task 4 – We concluded by providing a set of best practices and options that effectively promote the deployment of innovative forms of solar energy. We also provided recommendations on the need to adapt the EU regulatory framework, in order to provide a level playing field among the Member States.

Figure ***Error! No text of specified style in document.****-1* presents an overview of the analytical tasks carried out as part of this project.

Figure ***Error! No text of specified style in document.****-1 Overview of project's tasks and sub-tasks*



2.2.2. Methodology for Task 1 –Identification of the regulatory framework governing the selected innovative forms of solar energy deployment

The legal frameworks of the majority of the Member States have been studied by national legal experts. To identify the relevant legal and regulatory framework in each Member State, as well as the provisions which allow prospective generators to establish a viable business case, national legal experts investigated five main topics common to all or most of the innovative forms of deployment. In addition, the national legal experts studied specific topics related to each of the innovative forms of deployment. These topics included inter alia: (i) permitting, (ii) energy law, (iii) environmental law, (iv) water law and (v) the impact on the status of agriculture. The input provided by national legal experts was analysed and used to draw conclusions on legal and regulatory frameworks as well as barriers to these innovative forms of solar deployment in Member States.

Methodology for Task 2 – Analysis of the regulatory framework to identify regulatory barriers

The work under Task 2 also relied on national experts and focussed on ten selected Member States. The national legal experts conducted a thorough investigation of the legal and regulatory framework applicable to the respective innovative PV forms. The focus of the desk research was on the provisions which are potential barriers to the deployment of innovative PV. National legal experts investigated up to three main topics: (1) permitting, (2) energy law and (3) a technology specific topic such as water law, status of agriculture or infrastructure law. The national legal experts drafted a report for each innovative form of deployment per Member State and this report was then analysed

and barriers to the deployment identified. Based on the report conclusions on the legal and regulatory framework and the barriers to these innovative forms of deployment were drawn and are reflected in the tables below.

Methodology for Task 3 – Identification of other barriers

In Task 3, we conducted a large literature review of practical barriers hindering the five innovative forms of PV deployment, categorising them into technical, economic/financial, environmental, industrial and social/behavioural barriers. We complemented the desk research with 37 stakeholder interviews from 19 EU Member States and three countries outside the EU. This allowed us to identify both regulatory and non-regulatory barriers, as well as good practices.

Methodology for Task 4 – Identification of emerging and existing good practices and proposition of other potential ideas to address those barriers and promote those innovative solutions

Task 4 aimed at arriving at a set of recommendations by summarising and bringing together information collected in previous tasks, and by identifying and assessing existing and emerging good practices. To develop a set of recommendations, we first prioritised the barriers to innovative forms of PV deployment identified in Tasks 1, 2 and 3. We then prioritised the best practices identified in Task 3 and other best practices that our experts and stakeholder brought to our attention. This allowed us to develop policy recommendations for Member States and European authorities, accompanied with examples of how these can be implemented in practice. The recommendations were discussed and validated during a workshop with several stakeholders from the European Commission and other organisations.

Limitations

While care was taken to present a correct and comprehensive picture of the issues presented in this report, it is worth considering the following limitations:

- It was not possible to survey and analyse the legal and regulatory frameworks of all Member States. Latvia, Estonia, Cyprus and Malta are not included in the analysis presented here;
- While the literature review covered an extensive list of sources, it is possible that some relevant aspects (for example, **specific provisions at local level)** were not identified, given the breadth of the scope in terms of geography, technologies and potential issues;
- We conducted 37 interviews with organisations from 19 EU Member States and some countries outside the EU. However, the supply chain and potential stakeholders of the five technologies covered are much more extensive; therefore, the list of findings may miss some important aspects which are beyond the knowledge of the interviewees.

2.3. The various forms of innovative PV

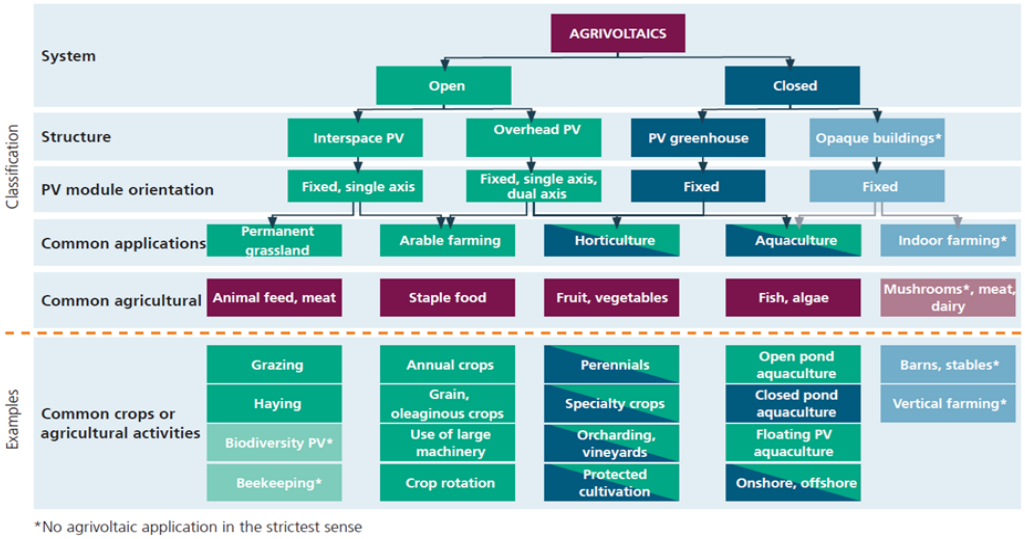
Agrivoltaics

Agrivoltaics offers the possibility of installing large PV systems on open land while keeping the ground clear for food production. This dual land use of land for agriculture and photovoltaics can be particularly beneficial for areas that are good for farming due to their fertile soil and temperate

climate and are a suitable location for ground-mounted PV systems because they receive high levels of solar radiation.

The technical solutions for integrating PV into farming are as diverse as farming itself. They can be broadly categorized into open and closed systems (see *Figure* ***Error! No text of specified style in document.****-2*).

Figure ***Error! No text of specified style in document.****-2 Segmentation of Agrivoltaics*



Source: Fraunhofer ISE, Agrivoltaics: Opportunities for Agriculture and the Energy Transition, April 2022

Closed systems mainly cover PV greenhouses, while open agrivoltaic systems can be broken down into ground-level, interspace PV and overhead PV. PV modules in overhead systems are mounted at least 2.1 meters above the ground. With overhead systems, the land under the PV modules is used for farming, whereas with interspace systems, it is usually the land between PV modules that is farmed.

In recent years, Agrivoltaics has experienced a very dynamic development and spread in almost all regions of the world (see *Figure* ***Error! No text of specified style in document.****-3*). The installed capacity increased from approx. 5 MWp in 2012 to more than 14 GWp in 2021, with government subsidy programs in Japan (since 2013), China (approx. 2014), France (since 2017), the USA and Korea (both since 2018) as well as Israel, Germany, and Italy (since 2021). There are several factors that suggest Agrivoltaics will continue growing in the future, such as land scarcity, the need to expand renewable energies, decreasing PV module and agrivoltaic-system costs, and the need to increase resilience in agriculture to weather extremes and water scarcity. However, despite existing agrivoltaic systems showing promising results and the agricultural and solar industries showing more and more interest in the technology, many regions lack policies to expand agrivoltaics.

Figure ***Error! No text of specified style in document.****-3 Selected milestones in the development of agrivoltaics*

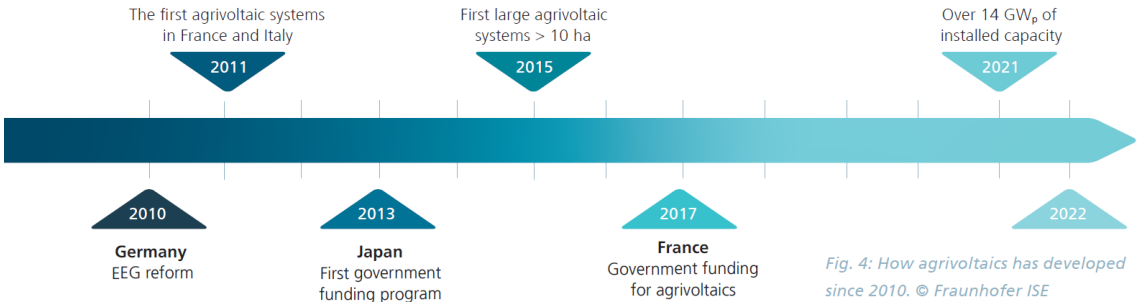


Fig. 4: How agrivoltaics has developed since 2010. © Fraunhofer ISE

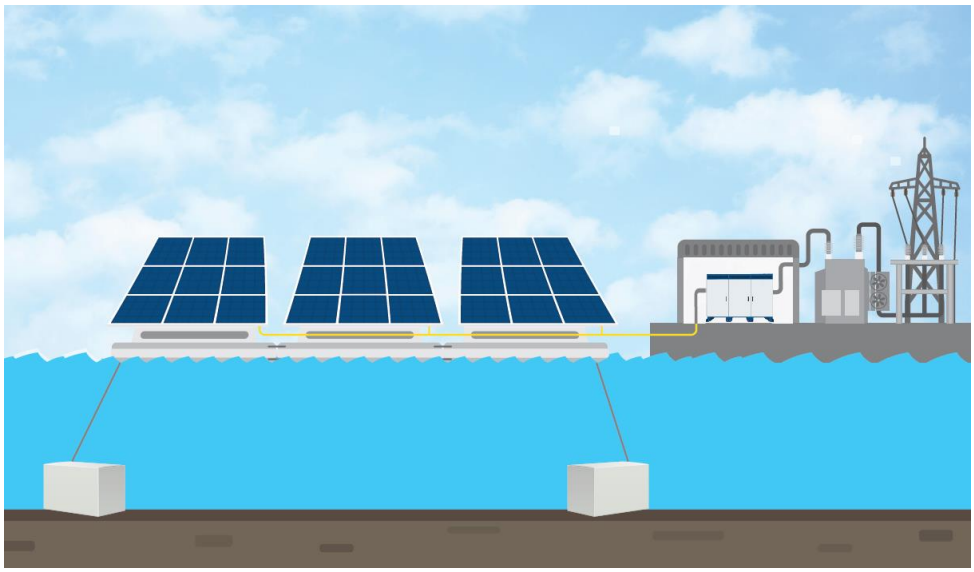
Source: Fraunhofer ISE, Agrivoltaics: Opportunities for Agriculture and the Energy Transition, April 2022

2.3.1. Floating PV (FPV)

According to the World Bank[1], the term "floating PV" (FPV) may be used to refer to any type of PV system installed on water bodies, such as lakes, reservoirs, hydroelectric dams, mining ponds, industrial and irrigation ponds, water treatment ponds, and coastal lagoons.

An FPV system (see *Figure* ***Error! No text of specified style in document.****-4*) comprises the ensemble of components part of a solar PV installation on a water body used for collecting, converting and transmitting energy into a Point of Connection ("POC", e.g. grid or load), including PV modules, supporting structure, station keeping, balance of system up to the POC[2].

Figure ***Error! No text of specified style in document.****-4 Illustration of floating PV installation*



Source: DNV, the future of Floating Solar, 2022

[1] World Bank and SERIS - Floating Solar Market Report **- Executive Summary, 2019.**

[2] Derived from DNV, RP-0584 Design Development and Operation of Floating Solar Photovoltaic Systems.

FPV is considered an attractive option as it has some advantages over 'traditional PV'. However, there are also several challenges for this solar PV application, these are summarised in *Table **Error! No text of specified style in document.**-1*.

*Table **Error! No text of specified style in document.**-1 Advantages and Challenges of FPV*

Advantages	Challenges
Reduced land usage Faster installation Higher power density Potential for higher yields Hybridisation with hydropower and other assets	Increased costs Design, installation and Operation &Maintenance (O&M) entail more complexities Increased corrosion of metallic components Fluctuating water levels Safety

There are two main categories of FPV: (1) inland FPV, which is developed and mature in multiple countries; and, (2) near-shore or off-shore PV (sea based) which is still under development. This report covers only FPV on inland water bodies.

Inland FPV. The first recorded FPV projects were built in 2006-2007, with pilot installations, mainly for research purposes or for self-consumption in California, Spain, Italy and Japan. The size of these projects ranged from 10 to 100 kWp. Inland FPV has started to gain greater traction in the past decade. *Table **Error! No text of specified style in document.**-2* shows the current estimated installed capacity worldwide. The Asian market is largely dominating the FPV scene, with both local and international companies being involved. The scarcity of reliable information on the Chinese domestic market may lead to uncertainties in estimations, but it can be estimated that more than 2.7 GW have been installed in Asia, with China leading with close to 2 GW installed. The European market is rapidly consolidating the role of second biggest market for FPV after Asia, already counting more than 200 MW installed capacity in the Netherlands only, with France, UK, Germany, and Belgium jointly adding more than 50 MW to the total. Not recorded in the table, it is understood that during 2020-2021, Israel also experienced a fast growth in the number of FPV installations, mainly supplied by Chinese manufacturers, for a total installed capacity estimated to be more than 150 MW.

*Table **Error! No text of specified style in document.**-2 Estimated FPV installed capacity worldwide, by continent* [3]

Continent	FPV installed capacity (in MWp)
Asia	> 2 700
Europe	> 250
North America	> 10
South America	1 to 5
Africa	< 5
Oceania	< 1

Near- or Off-shore FPV. The IEA ranks floating solar PV on open sea at a Technological Readiness Level of 8 (on a scale of 9), i.e. at "demonstration level – first of kind commercial"[4]. It is not yet fully

[3] Source: DNV, as of February 2022.

commercial due to technical barriers. Indeed, having floating structures on sea environment is extremely challenging considering the climatic hazards (e.g. turbulent sea) and the required resistance to the highly corrosive saltwater environment. Furthermore, the connection to the grid can also be a challenge and additional cost. All this leads developers to focus first on inland photovoltaics. Therefore, whilst there are trials around the world, no commercial development of near or offshore floating PV was identified. This assessment was validated by industry experts, our research, and interviews, with the conclusion that FPV is not mature enough to be commercially adapted to the open sea.

[4] https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide.

Advantages	Challenges
Reduced land usage Faster installation Higher power density Potential for higher yields Hybridisation with hydropower and other assets	Increased costs Design, installation and Operation &Maintenance (O&M) entail more complexities Increased corrosion of metallic components Fluctuating water levels Safety

2.3.2. Building Integrated PV (BIPV)

The current European standard for BIPV (EN 50583) distinguishes between modules (part 1) and systems (part 2). The definition for BIPV modules in EN 50583-1 is similar to that from IEA PVPS Task 15[5]: "BIPV photovoltaic modules are considered to be building-integrated, if the PV modules form a construction product providing a function as defined in the European Construction Product Regulation CPR 305/2011. Thus, the BIPV module is a prerequisite for the integrity of the building's functionality. If the integrated PV module is dismounted (in the case of structurally bonded modules, dismounting includes the adjacent construction product), the PV module would have to be replaced by an appropriate construction product."[6]

Photovoltaic systems are considered to be building-integrated if the PV modules they utilize fulfil the criteria for BIPV modules as defined in EN 50583 Part 1 and thus form a construction product providing a function as defined in the European Construction Product Regulation CPR 305/2011.

There are multiple other names for PV modules mounted on buildings including "Building Applied PV", "roof-top", etc; which may not comply with above mentioned technical norms. EN 50583 provides not only a definition for "Building-attached Photovoltaic Modules" but also a clarifying negation: "The integrity of the building functionality is independent of the existence of a building-attached photovoltaic module."

Status

The "PV in buildings" sector is hampered by an absence of scalable solutions. At the regulatory level, there is a lack of harmonization between PV and building sector regulations and there is conflict about the optimal allocation of the building envelope area among PV, windows and 'green façade' elements. A positive trend over the past decade is that many technological options for aesthetic and functional integration of solar PV into buildings has been developed. Recently, the research focus has moved towards integrating PV with building systems using building information modelling (BIM), aided by progress in techniques to acquire and process data.

[5] One of the key working groups from the IEA, focused on BIPV, see here https://iea-pvps.org/research-tasks/enabling-framework-for-the-development-of-bipv/

[6] https://iea-pvps.org/wp-content/uploads/2020/02/IEA-PVPS_Task_15_Report_C0_International_definitions_of_BIPV_hrw_180823.pdf.

2.3.3. Infrastructure Integrated PV (IIPV)

Infrastructure-Integrated PV (IIPV) refers to the installation of solar PV equipment on structures that are integrated in terrestrial transport infrastructure, such as sound barriers or canopies over highways, or on the ground, such as land at railway tracks. This also includes the areas besides the transport infrastructure such as areas enclosed by roadways (e.g., at highway intersections) or areas within the defined corridor for infrastructure. IIPV is sometimes also referred to as road integrated photovoltaics (RIPV).

There are no major technical barriers to install PV on railways, motorways and canals. However, permission procedures are laborious as Infrastructure-Integrated PV is regulated by laws and regulations affecting infrastructure and the use of the land surrounding it, including safety aspects, for instance requirements on accessibility of the fire brigade. This may extend to internal regulations created by the organisations that own and exploit the infrastructure. A real-life case from the Netherlands illustrates the latter: the injury risk profile of passenger cars accidently colliding with a highway's guardrail needs to be reassessed when PV modules are installed on the guardrail.

2.3.4. Vehicle Integrated PV (VIPV)

VIPV refers to installation of PV panels on the surface of a vehicle: car, bus, truck, train, etc. To the contrary of Vehicle Applied PV, which refers to panels attached (glued or bolted) to the vehicle, VIPV integrates the PV panel to the material of the vehicle and is not meant to be dismounted. As such, it' s part of the vehicle structure.

Most advanced VIPV development is for cars and electric cars in particular. The rapid growth in the number of electric vehicles (EV) provides scope for new technologies like VIPV which could mutually accelerate the growth of photovoltaics and EVs. In 2023 EVs (BEV, PHEV and HEV) were 48% of the total EU passenger car sales, or approximately 5.1 million vehicles[7].

The rapid development in recent years of the PV industry has led to more developments in VIPV as shown in *Figure* ***Error! No text of specified style in document.****-5*. This sudden increase in projects from 2015 can be attributed to the decline in PV module price and growth of electric vehicles [8]. With further developments in solar cell efficiency and vehicle surface area it is expected that integrated photovoltaics will be used more often to extend the travel range of vehicles[9].

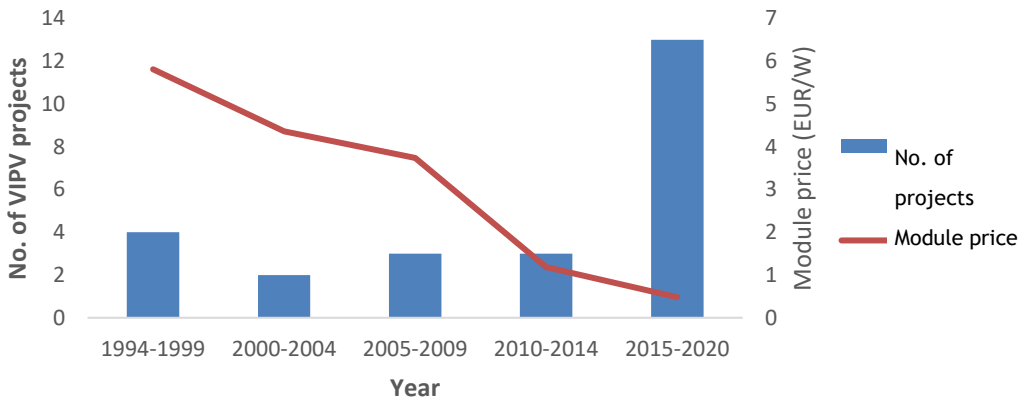
Figure ***Error! No text of specified style in document.****-5 Trends in VIPV projects for passenger cars*[10]

[7] ACEA (2024) Economic and Market report: Global and EU auto industry: Full year 2023

[8] *Overview and Perspectives for Vehicle-Integrated Photovoltaics*; Commault, B. et al; Applied Science 2021.

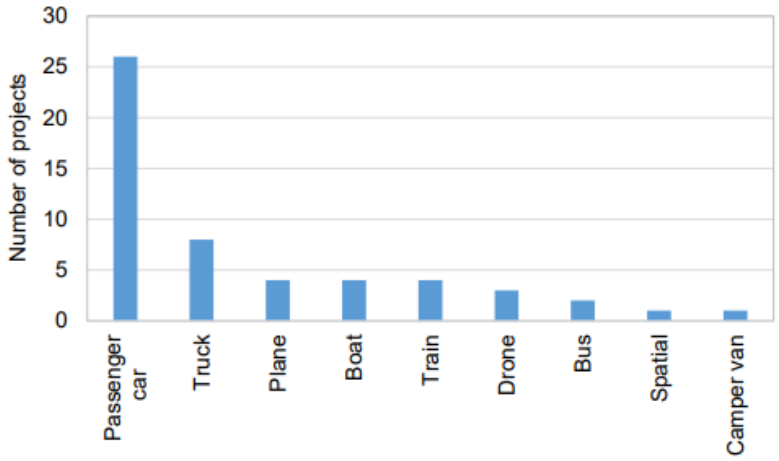
[9] *Potential and Challenges of Vehicle Integrated Photovoltaics for Passenger Cars*; Heinrich, M. et al, 37th EUPVSEC 2020.

[10] Our World in Data, Sept. 2022.



Like passenger cars, other vehicle segments (trucks, buses…) are also experiencing some developments as shown in *Figure* ***Error! No text of specified style in document.****-6* .

Figure ***Error! No text of specified style in document.****-6 Development projects in VIPV for different segments*[11]



There are certain reasons which have led to the developments in VIPVs over the past few years. However, there are also important challenges which prevent their uptake in the market, these are summarised below in *Table* ***Error! No text of specified style in document.****-3*.

Table ***Error! No text of specified style in document.****-3 Advantages and challenges of VIPV*

Advantages	Challenges
Avoid grid transmission losses	Insufficient PV power for EV fast charging
Provide surplus PV energy	Irradiance mismatch
Increased battery life	Complex battery management system
Reduced charging times	Transformation losses
Higher mileage gain	Recyclability

[11] *State-of-the-art and expected benefits of PV-powered vehicles.* IEA - PV Power Systems. *IEA-PVPS;* Araki, K. K.-D., 2021.

3. Regulatory framework governing innovative forms of PV and potential barriers

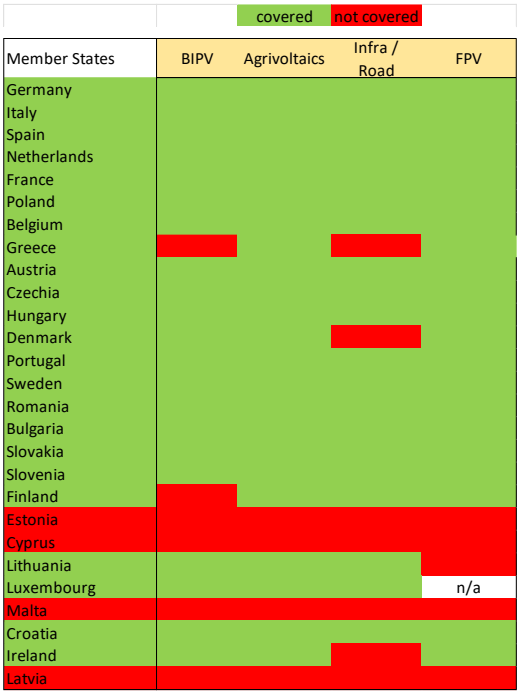
3.1. Scope and objectives

This chapter presents the key aspects of the legal and regulatory framework for four of the innovative forms of PV deployment across EU Member States. It analyses the legal and regulatory framework governing each of these forms and gives an outlook on potential regulatory barriers identified.

3.2. Methodology and topics coverage

Mapping the legal and regulatory framework across each Member State was done by national experts filling a guidance paper, on each of the four innovative forms of PV (Agrivoltaics, Floating PV, BIPV, IIPV). This guidance paper guided experts in their review of key law domains affecting the form of deployment (such as construction law, environmental law, etc., and depending on the form of deployment: agricultural law or water law). Each guidance paper helped to identify barriers and categorize them. A summary paragraph for each form of innovative PV deployment with relevant country examples is provided in the next paragraphs. Topics covered in this first task are summarized in below Figure Error*! **No text of specified style in document.**-7*. It indicates which innovative forms have been considered in each country.

*Figure **Error! No text of specified style in document.**-7 Innovative forms of PV covered by Member States*



It was not possible to cover the following countries: Cyprus, Malta, Estonia and Latvia. Further, the lack of coverage of innovative forms over some countries is related to two aspects:

1. The inadequacy of the form of deployment over a given country: e.g. Floating PV cannot be used in Luxembourg as there are no water bodies there. Another example is cold countries where trials of floating PV have so far demonstrated that the technology is unlikely to offer any significant deployment potential, given the many technical challenges encountered.
2. No land scarcity in the country, making technologies less attractive economically than ground mounted or standard rooftop PV less popular. It is the case of Greece with BIPV, Lithuania with Agrivoltaics and generally with IIPV (complex regulations/process vs. benefits).

Finally, interviews carried out as part of this assignment (Task 3) confirmed the above assumptions.

3.3. Barriers common to all or some innovative forms of PV deployment

Our desk research on regulatory frameworks has shown that all four innovative forms of PV deployment (Agrivoltaics, FPV, BIPV and IIPV) share some regulatory aspects and encounter similar barriers. In this chapter, the most common barriers to all innovative forms of deployment are set out to avoid repetition.

3.3.1. Summary of barriers common to all or some innovative forms of PV deployment

Table Error*! No text of specified style in document.-4* below shows the barriers common to all or some innovative forms of deployment and the respective Member States in which they were identified by the national experts.

*Table **Error! No text of specified style in document.**-4 Summary of barriers common to all or some innovative forms of PV*

Barrier	Description	Member State[12]
Competition with other forms of solar PV deployment	Agrivoltaics is not addressed in the support scheme.	CZ, BG, FI, FR, HU, LU, PL, SE, SK,
	Specific support scheme for agrivoltaics / FPV /IIPV sets very strict eligibility criteria	AT, DE
	FPV is not addressed in the support scheme	CZ, BE, HR, HU, IT, PL, RO, SK, SI
	BIPV is not addressed in the support scheme	AT, CZ, DE, HR, HU, LU, RO, SK, SI
	Specific support schemes for BIPV abolished	FR (2018), IT (2013)

[12] Only Member States for which the national experts have reported a barrier are included in this table.

	IIPV is not addressed in support scheme	CZ, BE, BG, DE, ES, HR, HU, LU, PT, RO, SK, SI
Lack of definition	Missing definitions for agrivoltaics cause delays in land re-designation procedures and leads to legal uncertainty	PL, LU, SI
	Missing definition of FPV causes confusion regarding applicable legal framework	AT, CZ, BE, BG, FI, HR, HU, IT, RO, SK, SL
	Lack of technical specifications for modules for BIPV and IIPV	All Member States
Lack of experience of the authorities	Authorities lack expertise and know-how	AT, CZ, BE, BG, HR, HU, FI, FR, NL, PL, RO, SK, SL
Compliance with HSE and labour protection regulation	HSE rules do not take the specifics of agrivoltaics into account	AT, CZ, FR, PT, RO, SE
	Very stringent HSE rules on electricity and water	CZ, BE, FI, FR, PL, RO, SL
Compliance with energy law	Numerous obligations for electricity undertakings or energy suppliers	IT, HR, HU, PL, SK, SL
	Energy permit requirements	CZ, PT, RO, SK
	Challenging grid connection process	HU, LU, PL, RO

3.3.2. Competition with other forms of solar PV deployment

All innovative forms of deployment can be assessed in light of their competition with standard forms of solar PV deployment, including traditional ground-mounted solar PV. The development and operational costs for innovative forms of PV are normally higher than for traditional forms. The design of the national support schemes for renewables (if any) is therefore crucial for enabling the innovative forms of PV to enter the market. Only a few Member States specifically address the four innovative forms of deployment discussed in this study, summarised in *Table **Error! No text of specified style in document.**-5* below. Also, specific (regional or local) subsidies or other financial support may vary from one region to another within a Member State. In some Member States the local government or the municipality may provide subsidies for certain forms of deployment (e.g. agrivoltaics) or solar PV in general.

*Table **Error! No text of specified style in document.**-5 Support scheme by innovative form of PV by Member States*

Innovative form	Member State	Support scheme
Agrivoltaics	Austria	Addressed in the national support scheme.
BIPV	Bulgaria	Support schemes are mostly drafted as recommendations
BIPV	France (until 2018), Italy (until 2012)	Addressed in the national support scheme
FPV	France	Financial bonus as FPV on certain sites (former mining sites) qualifies as “degraded land”
FPV	Germany	Only on artificial water bodies.

IIPV	Austria	Addressed in the national support scheme.

Potential barriers

In many Member States the national support scheme stipulates a competitive auction for renewable energy technologies. In case a competitive auction is part of the support scheme, innovative forms of deployment may be subject to a competitive disadvantage as the investment and operational costs of the four innovative forms of deployment considered in this study are still higher than for traditional solar PV technologies (e.g. simple ground or roof mounted PV). Thus, with the current legal framework, innovative forms of deployment will likely not be awarded support in the respective auction and support scheme without specific provisions or allowances made for innovative PV. This has been reported a potential regulatory and economic barrier in many Member States (see summaries in *Table **Error! No text of specified style in document.**-4*).

In some Member States the national support scheme does address (some) innovative forms of deployment but, very strict eligibility criteria are set, which sometimes restricts the access to the support scheme, for example in the FPV measure in Germany in *Table **Error! No text of specified style in document.**-5*. Moreover, in some Member States such as Bulgaria, the eligibility criteria (for BIPV) are drafted as recommendations only and are not included in the legal bases of the support scheme addressing innovative forms of deployment. This leads to legal uncertainty and a reluctance to invest in innovative forms of deployment.

3.3.3. Lack of definitions for innovative forms of PV deployment

The lack of clear, tailored definitions and rules addressing all four innovative forms of PV deployment complicates the permitting processes in most of the Member States. It also leads to a disadvantage compared to standard PV installations, since these in general do not face this issue. In all Member States the legislator has introduced clear, tailored definitions and rules addressing standard PV installations. However, these "general" definitions and rules for PV usually are not sufficient to cover all variations and provide legal certainty for innovative forms of deployment. This leaves project developers with a very challenging situation and makes the installation and operation of innovative forms complicated.

Potential barriers

A lack of definitions makes it hard to plan a project and the permitting process becomes challenging – for applicants and the competent authority. The lack of specific provisions that regulate the installation and operation of innovative forms of PV deployment create confusion about responsibilities, permitting processes, and technological applications allowed.

For Agrivoltaics, this is especially relevant in spatial planning law, in view of the entirely different spatial impact of agrivoltaics compared to standard PV installations. For example, in Poland, a clear statutory basis for the re-designation of land for agrivoltaics is missing. As a result, the change of a local zoning plan may take years and the authority is not obligated to make the requested changes. A lack of specific rules for agrivoltaics in the national spatial planning and local zoning laws make a required re-designation even more complicated. In Luxembourg, the lack of specific regulation leads to legal uncertainty among public authorities and legal advisers as to whether agrivoltaics fall within the exceptions of permitted constructions in protected areas.

Due to missing definitions and specific provisions on the categorization of FPV it remains unclear whether FPV qualifies as a building or not. It is also unclear whether a special land designation is necessary or not. In Romania for example, PV plants are not expressly included among the categories of users subject to water usage/exploitation subscriptions and related water usage/exploitation fees. The same is true for Austria where, at the time of this study, it is unclear if all types of FPV fall under the water law regime.

For BIPV and IIPV there is also a lack of technical specifications that ensures that the modules have the right safety specifications within the regulatory framework. This lack of safety specifications further complicates the permitting process.

No Member State has yet introduced a definition of IIPV. However, in a very recent draft of the revision of the federal roads act in Austria, a reference to PV in close proximity of the road is included.

3.3.4. Lack of experience of the authorities

Common to all innovative forms of deployment is that they are (relatively) new and even though in some Member States the authorities have gained some experience over the past years with some innovative forms of deployment, in most Member States the authorities are lacking experience with these innovative forms of PV deployment. The lack of specific expertise across the competent authorities, can lead to the situation whereby overarching regulations may allow for the installation of an innovative form of deployment, but the competent authorities reject the application in order to avoid any risks as they do not understand it well enough.

Potential barriers

The water protection authorities are not yet familiar with FPV and their potential impact on water conditions and the aquatic ecology. In many Member States, this may cause material delays in permitting and may result in a refusal of permits.

The lack of know-how around BIPV and around the participation on the energy market hinders the development of BIPV. In Slovakia the lack of experience of local network operators in connecting solar PV (including BIPV) to the grid hampers development.

Given the novelty of the innovative form of PV deployment, a lack of specific expertise across the competent authorities has been reported from almost all Member States. This means that, even when the overarching regulation may allow for the installation of IIPV, the competent authorities may tend to reject the application in order to avoid any risk, e.g. for related to safety of the traffic.

3.3.5. Compliance with HSE and labour protection regulations

HSE regulations are, inter alia, aimed to protect employees against work-related hazards. All forms of innovative PV deployment must be compliant with HSE-related regulations. Protection rules apply to all workers and employees, including those related to all four innovative forms of deployment.

However, for agrivoltaics and FPV HSE regulations may pose bigger challenges due to (i) either the risks for farm workers working with heavy machinery close to PV installations or (ii) the combination of water and electricity. Compliance with HSE-related regulations is typically relevant in the permitting process and is usually reviewed during the operation period by national authorities.

Potential barriers

HSE standards developed for electricity-related workers regularly do not consider explicit risks deriving from the four innovative forms of deployment in question. HSE standards developed for working with electricity often do not explicitly consider the risks deriving from the four innovative forms of deployment in question. This lack of specific regulation at national level might result in legal uncertainties for authorities and investors/operators who need to ensure that operations are done in compliance with national HSE regulations. Some technical specifications regarding safety (worker protection) could discourage investments in the four innovative forms of deployment.

The HSE standards developed for farmers and agricultural workers typically do not take into account the risks arising from agrivoltaics, but rather from photovoltaics in general (working with electricity, working at heights, breakable glass, higher risk for fire incidents, etc.). This lack of specific regulation might result in legal uncertainties for authorities and farmers who need to ensure that the agricultural operation is in compliance with HSE regulations.

For FPV (e.g., during maintenance operations in or under water) HSE-related regulations may be of particular relevance. In Poland for example, there are legal provisions governing underwater works with stringent protective measures.

3.3.6. Compliance with Energy law

In some Member States, the construction of energy generation facilities, including innovative forms of deployment, is governed by energy law. The main reason for this is that, as a general rule, the larger the project the more relevant the energy-specific construction and operational aspects become, and these aspects are primarily addressed by energy law rather than general building law. Hence, innovative forms of deployment may be subject to permitting and/or notification requirements under national energy laws. Moreover, energy law applies when it comes to the construction of electricity network connection lines and public grid access. In some Member States, the production of electricity for the purpose of generating financial profits triggers the legal status of an electricity undertaking which leads to more complicated rules to comply with.

Potential barriers

The qualification as an electricity undertaking or energy supplier comes with various regulatory obligations and may deter real estate owners and developers from investing in innovative forms of deployment. In Poland for example, for the energy produced in renewable energy source installations, which is not a micro-generation plant or small – generation plants (meaning over 50 kW up to 1,000 kW), a license to generate electricity from renewable energy sources is required and the producer has to be registered with the Register of Energy Producers in Small Generation Plants. This comes along with the requirement to meet certain conditions regarding your financial status, technical capacity, and qualifications. In Romania, a setting-up authorization is required for all RES-technologies.

Moreover, grid connection processes may be challenging. In Poland, for example, the network operators are responsible for setting out the conditions and the process for connection to the grid. However, there are no established practices for innovative forms of PV deployment, no clear and consistent criteria for investors which are to be met to obtain a required connection.

3.4. Agrivoltaics

3.4.1. Introductory remarks

The construction and operation of agrivoltaics can be legally assessed from two different main angles:

1. Permitting

   Agrivoltaics can be assessed from a permitting perspective since the deployment of agrivoltaics is regularly subject to special permits and licenses. National permit regimes may provide for regulations and limitations that can either promote or hamper the deployment of agrivoltaics. Also, the lack of specific permitting regulations for agrivoltaics can represent a barrier, as this creates legal uncertainties for investors, who need to know exactly which permits are required, which documentation needs to be prepared to successfully obtain the permits, and the timeframe of the permitting process. It can also create uncertainties for competent authorities that need to judge if the permit requirements are met.

2. Impact on the status of agriculture

   Agrivoltaics can be assessed against their potential impact on the legal status of agricultural activities. This aspect is very important because the status of agriculture is regularly linked to various financial benefits and government support payments for farmers. There is a risk that the use of agricultural land for other purposes than agriculture results in a loss of the farmer status and, as a result, a loss of financial benefits.

3.4.2. Summary of barriers to Agrivoltaics over EU Member States

The following main barriers specific to agrivoltaics have been identified. Other (general) barriers, such as a lack of definitions in the national legal framework as well as a lack of experience of the national authorities, also affect agrivoltaics. They have been discussed above in chapter 2.3.

Table Error! No text of specified style in document.**-6 Main regulatory barriers for agrivoltaics**

Barrier	Member States	Description
Dual land use ban	BG, CZ, LU, SK, SI	Complete ban of dual land use – land redesignation required
Dual land use restriction	AT, HU, HR, DE, NL, PL, RO, SE	Special land designation required
Loss of tax benefits	AT, BE, LU, NL, PL	Farmers lose tax benefits for agricultural land
Loss of direct payments	DK, FI, EL, HR, HU, LT, PL, PT,	No specific rules on CAP

under CAP	RO, SK	direct payments for agricultural land used for agrivoltaics

3.4.3. Permitting

Building law (including spatial planning, land use and zoning regulations)

The term "building law" includes all regulations that govern the construction of a building, facility or installation. It primarily comprises building and construction laws, regional and local spatial planning as well as zoning, land use and land designation regulations. A project needs to comply with all those regulations, otherwise a building permit would be refused by the competent authorities. In Austria, Croatia, Italy, France, Bulgaria, Hungary, Romania some form of definition or mentioning of agrivoltaics can be found[13] in the building laws (federal or national). However, in most other Member States, the building codes do not provide a general definition of agrivoltaics. With or without a specific definition, an agrivoltaic plant regularly qualifies as a "building facility" which is fixed to the ground.

The construction of such a building facility requires a construction permit (building permit) or construction notification under the applicable national building laws. In general, the construction permit grants the right to construct the building facility in accordance with the building application and building conditions imposed by the competent building authority. To obtain a construction permit, the project needs to be in line with the technical building regulations (which regularly address building statics, safety, and design aspects) and applicable spatial planning as well as land use / zoning regulations.

In some Member States, energy generation installations are exempted from the building regulations and governed by an alternative regime (e.g. energy law), however, land use and zoning regulations may still be applicable under the alternative regime. Based on our research we can therefore conclude that the deployment of agrivoltaics is regularly subject to national building law and associated land use regulations.

Potential barriers

Our research revealed that the use of land for agricultural purposes is regularly linked to a special land designation. This means that the agricultural land is legally designated for being used primarily or exclusively for agriculture purposes. In some of the Member States there is a special land use category for agriculture, whereas in other Member States agricultural activities can be performed on lands that are not specifically designated for being used for other purposes. The latter is regularly categorized as "green land" or "grassland". In any case, if a land is designated and used for agricultural purposes, other land uses are regularly subject to rather strict statutory restrictions or prerequisites. In other Member States the use of agricultural land for any other purposes is totally prohibited. For example, in Bulgaria, a re-designation of the agricultural land to another land category is required and thus agrivoltaics is not possible. Whereas in Luxembourg, agrivoltaics are excluded from any "green area" land.

[13] More details on this can be found in ANNEX A – REGULATORY FRAMEWORK AND BARRIERS.

From a legal perspective, the use of agricultural land for energy production results in a "dual land use" of agricultural land and this might be in breach or conflict with the applicable spatial planning, land use and zoning regulations. This conflict can occur in different ways: In some of the Members States, such as Bulgaria, Czech Republic, Slovakia or Slovenia, there is a ban on dual land use of agricultural land and this ban practically excludes agrivoltaics from the market. In other Member States, such as Hungary, there is no ban on dual land use at all if the construction and operation of agrivoltaics does not interfere with the primary use of the underlying land as agricultural land. In some Member States, there is no strict ban on dual land use, but the land would have to be re-designated to allow for the construction and operation of agrivoltaics. For example, in Austria and Croatia, the use of agricultural land for other purposes, such as agrivoltaics, requires a special designation in the spatial planning.

Redesignation of land is usually burdensome and linked to a lengthy administrative procedure. Some Member States make the possibility of redesignation dependent on the location and size of the relevant land. This is the case for example in Austria. Moreover, landowners and/or developers usually do not have a statutory right to re-designation. The deployment of agrivoltaics thus depends on the political will of local decision makers and their favourable use of discretion. For example, in Hungary, even though the Hungarian Act on the Protection of Agricultural Land includes an authorization to provide specific rules on agrivoltaics, the legislator has not yet made use of this authorization. Therefore, in Hungary, neither the regulatory authorities nor potential developers can properly assess the requirements for agrivoltaics.

In many Member States it is not allowed to redesignate and use agricultural land for agrivoltaics if the land is of high agricultural value (see **Table** Error! No text of specified style in document.**-7**). In some Member States such as Austria, the deployment of agrivoltaics is promoted by exempting them from land use restrictions that apply to "conventional" ground-mounted PV. In Romania, for example, re-designation of agricultural land for dual land use is possible, but only outside the built-up area and on a surface of up to 50 ha. However, such contradicting legislation limits the general possibility for re-designation to agricultural land of lower quality. Moreover, the competent authorities apply a very restrictive interpretation of the provided legal exceptions, resulting in less possibilities for dual land use.

Table Error! No text of specified style in document.**-7 Agrivoltaics - Dual land use restriction by Member States**

Dual land use restriction	Member States
Strict dual land use restriction (total prohibition)[14]	BG, CZ, LU, SK, SI
Medium level of dual land use restriction / Protection of agricultural land of high quality	AT[15], HU[16], HR, DE, PL, RO, NL, SE
No dual-use restriction	BE, EL, ES, IT, FR, PT, FI, DK, LT

[14] The use of agricultural land for any other purposes is totally prohibited. A redesignation of agricultural land to another land category is required and thus agrivoltaics is not possible.

[15] Except for the province of Styria.

[16] Allowed if the construction and operation of agrivoltaics does not interfere with the use of the land as agricultural land.

The development of agrivoltaics is further complicated by the fact that building law is highly fragmented in the Member States and there may be several different laws (especially in Member States with federal structures), depending on the state, region and even municipality. This is even more true since the authorities in charge of granting the respective permits often lack relevant experience with the development of agrivoltaics. Our research has shown that the lack of experience at administrative level is one of the most common barriers to agrivoltaics.

Romania and Bulgaria impose restrictions on the acquisition of agricultural land by non-residents, which in the worst-case blocks' foreign investment in agricultural projects. Investors in such cases may therefore be forced to look for local partners who already own or can acquire agricultural land. This makes investments in agrivoltaics more complex and arguably more expensive due to the involvement of (intermediary) services provided by other stakeholders.

Environmental law

As per definition, agrivoltaics are constructed on agricultural land and they are therefore typically located on natural sites and outside of urban areas, and will have an impact on the environment, on protected animals and plants (species), (ground)water and landscape. For this reason, agrivoltaics are regularly subject to environmental protection regulations. These regulations can provide the requirement to obtain an environmental permit for the construction of agrivoltaics. Such a permit would for example be necessary in Austria. In some jurisdictions the project needs to be notified to the environmental authority which then needs to decide if the project must run through an Environmental Impact Assessment (EIA). In other Member States, such as for example Croatia, a preliminary assessment of the requirements for an EIA must be carried out for certain (usually smaller) projects. In this context, in some Member States, the authority also assesses whether the project in question has a chance of a positive EIA, makes proposals to the applicant for changes to the project or for mitigation measures to make it approvable, and in the worst case classifies the project as doomed to failure from the outset. Occasionally, Member States' (e.g. Italy) environmental regulations also require that the maintenance of primary agricultural use of an area as well as the quality and fertility of the soil be monitored.

Potential barriers

We have not identified any regulations deriving from environmental law specifically tailored to agrivoltaics. However, agricultural land is regularly seen as cultural heritage which significantly shapes the landscape and the external appearance of the surrounding area. Agrivoltaics can amend the agricultural landscape and this impact is sometimes perceived negatively from a landscape protection perspective. In general, it appears that the more agrivoltaics negatively affect the primary agricultural use of an area, the less likely it is to be successfully deployed from an environmental perspective. Moreover, our research revealed that landscape protection regulations are sometimes fragmented and inconsistent within Member States, and that there is largely a lack of knowledge and experience in assessing potential environmental impacts of agrivoltaics. In many Member States there is no established practice how to identify and evaluate potential environmental impacts from agrivoltaics. This particularly includes impact on soil, fauna, flora, and habitats. This lack of evaluation standards and experience may delay permitting procedures. For example, in Luxembourg, the lack of specific regulation leads to legal uncertainty among public authorities and legal advisers as to whether agrivoltaics fall within the exceptions of permitted constructions in protected areas.

3.4.4. Impact on the status of agriculture

The use of agricultural land for other, non-agricultural purposes, such as energy generation, bears the risk of losing the legal status as a "farmer" or agricultural operator. As a comprehensive steering and financing instrument, the CAP is of fundamental importance for agriculture, forestry, and rural areas. The dual land use of agricultural land may also have implications for agricultural subsidies law.

Tax regulations

Agricultural activities are regularly subject to special tax regimes that provide tax benefits to farmers.

Potential barriers

Our research revealed that in some of the Member States (such as for example Austria, Belgium, Luxembourg, the Netherlands, or Poland) the use of agricultural land for other, non-agricultural purposes such as energy generation through agrivoltaics is linked to the risk of losing the legal status of a "farmer" or agricultural operator. This can result in a loss of tax benefits under tax regulations applicable to the agricultural sector.

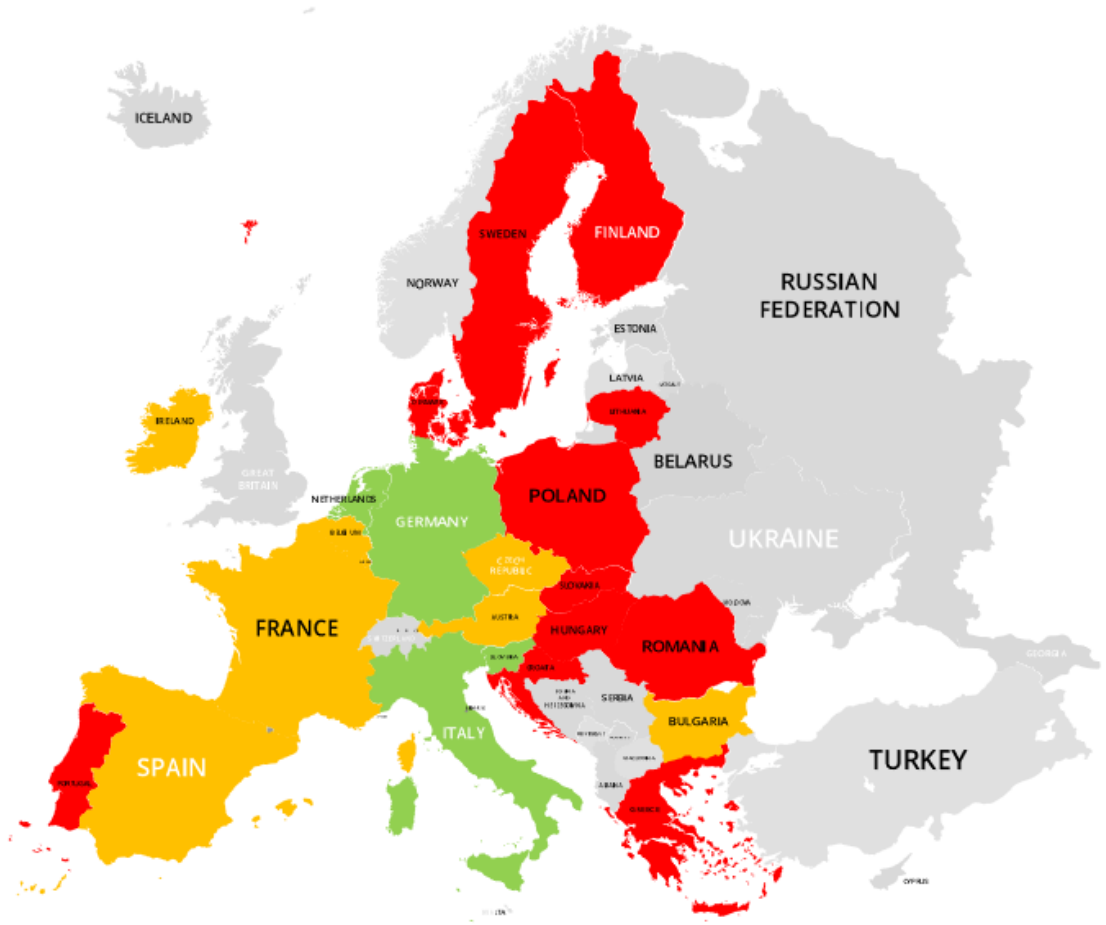
Agricultural subsidies law

Farmers regularly benefit from direct payments under the CAP. The EU grants direct payments for areas that are primarily used for agriculture.

Potential barriers

The national CAP legislation (national CAP strategy) regularly defines the (strict) criteria that need to be fulfilled to qualify as a land or area that is primarily used for agriculture and is therefore eligible to receive direct payments under the CAP. For example, in Poland the current practice of the authorities indicates that land used for agrivoltaics should be excluded from the classification as agricultural and thus would no longer qualify for the CAP. A more favourable approach is taken in France and Germany, where specific criteria have been set for the evaluation of agrivoltaics. In addition, most Member States agrivoltaics are not addressed in the CAP Strategy at all and it is therefore unclear if and under which conditions agrivoltaics can be deployed without being exposed to the risk of losing the right to receive direct payments under the CAP. Our research has shown (see *Figure **Error! No text of specified style in document.**-8*) that the lack of regulation regarding agrivoltaics under the CAP is especially an issue in Spain, Romania, Hungary, Croatia, or Austria. Only in Germany, Italy, the Netherlands, and Slovenia agrivoltaics is addressed in the national CAP plans.

*Figure **Error! No text of specified style in document.**-8 Status of CAP and PV/agrivoltaics by country*



No reference to either solar PV or agrivoltaics in the national CAP strategic plans

Reference to solar PV in the national CAP strategic plan

Reference to agrivoltaics in the national CAP strategic plan

3.5. Floating PV (FPV)

3.5.1. Introductory remarks

The construction and operation of FPV can be legally assessed from three different perspectives:

1. Permitting

FPV can be assessed from a permitting perspective since special permits/concessions are regularly required for FPV installations. National permit or concession regimes may provide for regulations and limitations that can either promote or hamper the deployment of FPV. The lack of specific permitting regulations for FPV can represent a barrier, since such lack goes along with legal uncertainties for investors, who need to know what permits are exactly required and what documentation needs to be prepared to successfully obtain the permits, as well as for national authorities that need to assess the permit requirements.

2. Water specific regulations

FPV are PV systems located on the surface of different water types (e.g., lakes, rivers, sea). Therefore, FPV can be legally assessed with respect to water specific regulations (e.g., water protection law, water use acts). In almost all Member States assessed, water related authorities need to be included in the permitting process and/or must give their approval for installing FPV. In this context, it is mainly relevant which water body is selected for the FPV project.

3. Potential environmental impact and nature protection regulations

FPV can be legally assessed with respect to their impact on nature and water related ecosystems. Nature protection laws are typically rather strict when it comes to interferences with (natural) water bodies. This aspect is essential for the deployment of FPV. In this context, it is particularly relevant to consider what type of water body is to be used for FPV plants (natural or artificial waters, public or private waters). Artificial water bodies are generally subject to less strict nature protection restrictions than natural water bodies and less stringent rules may apply to privately owned water bodies compared to public ones. Operators/investors usually face FPV-project rejection by the public authorities or additional permit conditions/measures, and in general, a lengthy permitting process if an FPV plant is to be located on a public and/or natural water body.

3.5.2. Summary of barriers to Floating PV over EU Member States

The following main barriers specific to FPV have been identified. Other (general) barriers, such as a lack of definitions in the national legal framework as well as a lack of experience of the national authorities, also affect FPV. They have been discussed above in chapter 2.3.

Table Error! No text of specified style in document.**-8 Main regulatory barriers for FPV**

Barrier	Member States	Description
Land (re-)designation requirements	AT, BG, CZ, IT, FI, PL, RO	Special land designation required for FPV. Complicated and lengthy land re-designation process.
Lack of specific provisions in building law	AT, BE, BG, CZ, ES, HU, PL, PT, SE, SK, SI	It remains unclear whether FPV is considered a building or not.
Lack of specific regulations in mining law	IT, HR, HU, SK,	Mining regulation does not take FPV into account. Unclear situation regarding permitting.
Lack of specific regulations in water law	AT, BE, BG, CZ, FI, IE, HU, PL, PT, RO, SK, SI, SE	Unclear situation with regard to permitting under water regulations and the applicability of water regulations for FPV
Concession required for public waters	IT, PT	For the installation of FPV on public water bodies a concession is required
Conflicting environmental laws	All Member States	Conflicting environmental/nature protection regulations and interests for FPV

3.5.3. Permitting

Building law (building codes and spatial planning)

For a common definition of building law please refer to chapter 3.4.3.

Since most of the FPV are fixed to the water ground or watersides (banks) by using anchoring and mooring systems, national construction / buildings laws are usually applicable. Therefore, it is regularly questionable if the installation of FPV is in line with spatial planning and land use designation regulations (zoning plans). In general, the construction permit grants the right to construct the building facility in accordance with the building application and building conditions imposed by the competent building authority. In order to obtain a construction permit, the FPV project needs to be in line with the technical building regulations (which regularly address building statics, product safety and design aspects) and applicable spatial planning as well as land use / zoning regulations. In some Member States, energy generation installations are exempted from the building regulations and governed by an alternative regime (e.g., water, mining and/or energy law). However, land use and zoning regulations may still be applicable under the alternative regime. Based on our research we can therefore conclude that the deployment of FPV is regularly subject to national building law and associated land/water use regulations. Depending on the type of water body selected for the FPV facility, the applicable national building code may vary or be legally displaced by other national laws.

Potential barriers

Our research revealed that the use of natural water bodies for FPV is regularly linked to a special land designation to obtain the construction permit. In many Member States, the construction needs to be in line with spatial planning and land designation (as provided in the local zoning plans). The land containing the water body must be legally designated for the energy production with FPV (special land use designation). Redesignation of land is usually burdensome and linked to a lengthy administrative procedure. Moreover, landowners and/or developers usually do not have a statutory right to redesignation. Therefore, FPV deployment is highly dependent on the political will of local decision makers and national authorities. A lack of definitions of FPV in the building codes of many Member States leads to legal uncertainty whether FPV is considered a building or not. In Bulgaria for example, it is not clear to stakeholders whether the authorities have legal grounds to issue permits for FPV.

Mining law

In some Member States artificial water bodies related to mining activities are legally not declared as natural waters but are classified as part of the mining facilities. This is the case for example in Austria. Therefore, FPV placed on these waters usually fall under national mining law. In many Member States, the utilization and modification of such artificial water bodies are subject to mining regulations and may require a special permit by the mining authority. Mining regulations in some Member States require that the energy produced by FPV on such waters must be used (at least partly/predominantly) for mining activities (self-consumption) and cannot be fed into the power grid entirely. In addition, the use of FPV is linked to the mining operations and therefore time limited. As soon as material mining ends, the water body is no longer a mining facility and may be subject to other national regulations (e.g. building law and/or water law).

Potential barriers

In many Member States, national mining regulations do not explicitly consider the use of water bodies related to mining to produce energy through FPV. This lack of specific regulation at national level might result in legal uncertainties for authorities and investors/operators who need to ensure that FPV operations are done in compliance with national mining regulations.

3.5.4. Water specific regulations

Water law

FPV is per definition a PV plant installed on the water surface. Therefore, the most important area of law to be examined at national level are water law and water-related regulations (e.g. navigation law or shipping law). Even though water-related regulations play an important role when establishing FPV, national water regulations rarely directly refer to FPV. In Romania for example, PV plants are not expressly included among the categories of users subject to water usage/exploitation subscriptions and related water usage/exploitation fees. The same is true for Austria: it is, at the time of this study, unclear if all types of FPV fall under the water law regime. FPV can conflict with national water regulations in different ways. For instance, a FPV plant may impact the water temperature, which result in conflicts with existing water rights of third parties. Moreover, FPV regularly produce shadow, which can also negatively impact the water and aquatic ecosystem. In addition, conflicts with other types of water use by third parties may arise. Such as hydropower, drinking or cooling water withdrawal, public navigation (ships) and fishery. FPV systems can also conflict with existing water rights of third parties and with different public interests (e.g., flood protection and public navigation or tourism). In Poland for example, FPV are in potential conflict with regulations centred around flood protection and the broader health-centric safeguards. Any conflict of FPV in Poland with such regulations will lead to the outright refusal of a water permit. In other Member States, in case of such conflicts, the water permit will be typically refused by the national authorities. Moreover, the installation and use of electric cables for transporting the electricity to the next substation might trigger concerns by national water authorities. FPV, as constructions, regularly contain chemicals and hazardous substances which can trigger concerns from a surface, groundwater and drinking water protection perspective. In general, a water related permit will be refused at national level, if FPV plants potentially cause a deterioration of the water body in terms of the EU Water Framework Directive. In some cases, an exemption permit can be obtained. For the use of public waters typically a license or concession is needed.

Potential barriers

In most Member States, installing FPV is legally subsumed as a form of water utilization/use. Thus, a special water use permit is required at national level to install/operate FPV. The construction of physical fixture in water bodies is regularly subject to a special construction permit under water law. Our research revealed that the use of water bodies for energy generation through FPV is linked to the need of a special water permit or exemption permit due to potential conflicts with national water protection regulations. In Belgium for example, the federal water protection legislation sets rules for pollution prevention and for the protection of certain species as well as prohibitions to install FPV in areas where animals are hibernating or migrating to. Additionally, water protection authorities are not yet familiar with FPV and their potential impact on water conditions and the aquatic ecology. In many Member States, this may cause material delays in permitting and may result in a refusal of permits.

*Table **Error! No text of specified style in document.**-9 Water law regulation vs. FPV by Member States*

Water law regulations	Member States
Restrictions for FPV on most (natural) water bodies	BG, DE
Special construction permit required (under water law)	IT, HU, SK
Water use permit required	CZ, DE, HR, PL
Concession requirement for public waters	IT, PT
Lack of specific definitions in water regulations[17]	AT, BE, BG, CZ, FI, IE, HU, PL, PT, RO, SK, SI, SE,

3.5.5. Potential environmental impact and nature protection regulations

FPV are regularly subject to environmental protection regulations. These regulations can provide the requirement to obtain an (additional) environmental permit for the construction of FPV. Environmental law regularly includes special protection rules for the use of water bodies (e.g., water birds protection regimes, landscape protection). As per definition, FPV are placed on the surface of water bodies, and they therefore regularly are located on natural sites and outside urban areas. This goes along with the fact that FPV might impact the water related environment, in particular concerning protected animals and plants (species), (ground)water and landscape. For this reason, FPV are regularly subject to environmental protection regulations. These regulations can provide the requirement to obtain an environmental permit for the construction of FPV. In Spain, for example, an Environmental Impact Assessment (EIA) is mandatory for all FPV, regardless of the size of the installation or the capacity installed. In some jurisdictions such as in Poland and Hungary for example, the FPV project needs to be notified to the national environmental authority which then decides if the project must run through an EIA. The problem in these cases is that neither the regulatory authorities nor the potential developers can properly assess the permitting requirements.

Potential barriers

Environmental protection is one of the main issues in conjunction with the deployment of FPV in Europe. Usually, an environmental permit will be refused by the national authorities if a potential negative impact on the environment (e.g., on protected species) is identified. Such a "green on green" conflict has been identified in all member States. Moreover, our research revealed a lack of knowledge and experience regarding the assessment of potential environmental impacts of FPV. In many Member States, there is no established practice how to identify and evaluate potential environmental impacts from FPV (e.g., concerning microplastic release and shock hazards related to electricity and water with power wire installations going through water). This lack of evaluation standards and experience may delay permitting procedures.

[17] Lack reported by national experts. In other MS a definition might be missing, but it was not raised by the national experts.

3.6. Building Integrated PV (BIPV)

3.6.1. Introductory remarks

BIPV can be assessed from a permitting perspective since the deployment of BIPV can be subject to special permits and licenses. National permit regimes may provide for regulations and limitations that can either promote or hamper the deployment of BIPV. Also, the lack of specific permitting regulations for BIPV can represent a barrier, since such lack goes along with legal uncertainties for investors, who need to know what permits are exactly required and what documentation need to be prepared to successfully obtain the permits, as well as for competent authorities that need to judge on the permit requirements. Moreover, there are additional costs involved in the certification of the product to comply with the respective national standards which delay the permitting procedure.

Although many legal requirements on building-integrated photovoltaic modules and installations must also be met by building-attached photovoltaics, the scope of this research is restricted to BIPV.

3.6.2. Summary of barriers to BIPV over EU Member States

The following main barriers specific to BIPV have been identified. Other (general) barriers, such as a lack of definitions in the national legal framework as well as a lack of experience of the national authorities, also affect BIPV. They have been discussed above in chapter 2.3.2.

*Table **Error! No text of specified style in document.**-10 Main regulatory barriers for BIPV*

Barrier	Member States	Description
Conflicting regulations	AT, BE, FR, HR, HU, LT, PL, SK, SI	Conflicting regulations for the deployment of BIPV due to land- and townscape protection and preservation regulation

3.6.3. Permitting

Building law (including spatial planning, land use and zoning regulations)

For a common definition of building law please refer to chapter 3.4.3.

The design and construction of buildings are subject to a building permit in accordance with the provincial (local) buildings laws. Also, amendments to existing buildings regularly require a building (amendment) permit. Therefore, the permissibility of BIPV needs to be assessed against its compliance with applicable building laws and technical regulations, including product safety and fire protection regulations. The design of the building needs to comply with local land-and townscape protection rules.

Potential barriers

In most Member States there is no definition of BIPV and therefore no specific regulations for BIPV. According to our research, a definition of BIPV can be found in Austria. This leads to having to apply regulations to BIPV that do not consider their specifics. In Bulgaria for example, the lack of technical standards and norms leads to uncertainty about the specific requirements for BIPV and thus, to delays and refusals by the municipal authorities. In some Member States, e.g. in federal states such as Austria or Belgium, the legal provisions in the federal states differ from each other and thus have different permitting or notification procedures. Our research revealed further that, apart from the general technical regulations which set standards for building constructions, including the installation of PV, BIPV is also regularly subject to regulations governing the use of glass in buildings. This increases the complexity of design works. BIPV can conflict with townscape protection regulations and also face very strict regulations (e.g. in Austria, Poland, Belgium, Slovakia and France) especially in towns with large historical building stock. This might result in a denial of building permits or delays in permitting. Another potential barrier is the fact that in some jurisdictions the neighbours are granted the status of a legal party in building permit proceedings, which leads to a slowdown in proceedings. In Croatia and Lithuania there is even a prohibition of installing solar panels in protected cultural heritage zones.

3.7. Infrastructure Integrated PV (IIPV)

3.7.1. Introductory remarks

The deployment of IIPV can conflict with infrastructure regulations since those regulations restrict the use of infrastructure for other purposes than the original one. The technical safety rules that have been established for transport infrastructure may include provisions that prevent IIPV from being integrated into infrastructure elements.

The construction and operation of infrastructure integrated PV (IIPV) can be legally assessed from two different main angles:

1. Infrastructure Law

IIPV can be assessed from the infrastructure regulation point of view, since in most Member States the solar power plant will become part of the infrastructure and thus must follow the respective rules and regulations. Also, the lack of specific permitting regulations for IIPV within the legal framework applicable to infrastructure can represent a barrier, since such lack goes along with legal uncertainties for investors, who need to know what permits are exactly required and what documentation need to be prepared to successfully obtain the permits, as well as for competent authorities that need to judge on the permit requirements.

2. Permitting

IIPV may also be assessed from a permitting perspective. Even though in most Member States infrastructure laws will have the main impact on IIPV, building permits and other special permits may be needed. National permitting regimes may provide for regulations and limitations that can either promote or hamper the deployment of IIPV.

3.7.2. Summary of barriers to IIPV over EU Member States

The following main barriers specific to IIPV have been identified. Other (general) barriers, such as a lack of definitions in the national legal framework as well as a lack of experience of the national authorities, also affect IIPV. They have been discussed above in chapter 2.3.

*Table **Error! No text of specified style in document.**-11 Main regulatory barriers for IIPV*

Barrier	Member States	Description
Conflicting regulations	All Member States	Conflicting regulations for the deployment of IIPV due to very high technical standards and safety concerns.
Lack of specific provisions on the question whether additional permits, such as building permits, environmental permits, etc. are required for IIPV.	All Member States	Missing regulation on the question whether additional permits, such as building permits, environmental permits, etc. are required for IIPV.
Complex permitting process	All Member States	The complexity and risks involved lead to a lack of interests from developers, also concerning engagement with regulators to understand and regulate the innovative form of PV.

3.7.3. Infrastructure law

According to our research, no Member State has yet introduced any provisions explicitly regulating IIPV in the motorway / road or railway regulation. However, several projects of IIPV have already been implemented throughout the Member States. The construction and operation of motorways and other (public) roads is regulated in specific road regulation acts. Whereas the construction and operation of railway tracks is regulated in specific railway or infrastructure regulation acts.

In almost all Member States, the construction and planning of motorways and railways is a state monopoly and strictly regulated, although with some exceptions. In some Member States, in addition, private railway infrastructure is permitted. There, private operators may also build private railway infrastructure, subject to the approval of the Ministry of Transport, and the endorsement of the local authorities and the Ministry of National Defence. It is, however, unclear whether an additional permit for IIPV on private railway infrastructure is necessary.

In most Member States, such as in Austria, Belgium, Bulgaria, Croatia, Czech Republic, France, Poland, Romania, Slovakia, and Slovenia the construction of motorways either requires a license or a special permit issued to constructing and/or operating entity. In Hungary, in addition, a concession must be obtained through a public procurement procedure. In Italy, the construction is usually given to a private company via concession, but the initial planning is performed in a state monopoly. In Luxembourg, also an authorization for the use of public space by the local competent authority is required. For railway infrastructure, usually a concession system is applied in the Member States. In some Member States, such as Romania, Hungary or Poland, all or most railways are constructed and operated directly by the state.

In most Member States all parts of a motorway or road including noise protection walls, bridges, tunnels, etc are or become a part of the road. IIPV installed on parts of the motorway or road (e.g. on noise protection walls) would therefore have to follow the road regulations as well. The same is true for railway infrastructure. Due to the missing legal framework, the status of IIPV in the Czech Republic is not clear and for now it is not possible to determine, whether IIPV would become part of the infrastructure or not. Due to the restrictive exceptions in the Roads Act, it is likely that IIPV is not permitted in Slovenia.

In Member States with a federal structure such as Austria or Belgium, the planning and construction of motorways and other roads is usually divided between the respective administrations of the federal state or the provinces. In some Member States, such as for example Austria, Italy, Luxembourg, Poland, or Romania, the municipalities are competent for the local roads or streets within the city limit.

Many Member States such as Austria, Bulgaria, Czech Republic, Hungary, Poland, Romania, or Slovakia, have rules on the use of motorways and roads for other purposes (special use). Depending on the type of IIPV and the exact location of the power plant, an additional permit for the special use of the infrastructure may be required. Usually, a permit is required for special use, which is granted by the competent local, provincial, or federal authority. In Romania, an authorization by the infrastructure authorities is required. In Austria, Bulgaria, the rules on a special use permit list for example gas stations, restaurants, hotels, advertisers, etc. However, IIPV is not (yet) explicitly regulated.

In some Member States, such as Austria, Slovenia, and Spain, the construction and installation of structures within the road or railway land or so called "buffer-zone" is limited and except for an exhaustive list of measures (e.g. structures aimed at traffic control, safety, road management) not permitted. IIPV is not (yet) included in those exhaustive lists. In France, a recent amendment to the French Urban Planning Code makes installations within 100m of motorways and railways possible. The depth of the buffer zone varies, depending on the road – larger buffer zone for motorways, smaller buffer zone for local streets. Since IIPV is not explicitly regulated yet in the motorway and railroad road regulations of the Member States, the approval of IIPV within the buffer zones may not be possible or may be complicated.

Motorway and road as well as railway regulations set a very high standard for safety. The main objective of the safety rules is always the safety and the fluidity of the traffic. All construction and structures usually have to either (i) be for the benefit of the safety and fluidity of the traffic, or (ii) at least do not pose any threat to the safety and fluidity of the traffic. IIPV would thus need to meet these very high safety standards. For example, in Finland, all railway construction requires a separate usage permission from the traffic safety authority. Moreover, road regulation in the Member States has very strict technical standards. Since IIPV usually becomes part of the road or the railway, the PV-plant would need to comply with the strict technical standards e.g. on glare, fire safety, etc. Even if a permit is granted for IIPV, the infrastructure operator has to take account of major liability risks due to the very high technical standards and safety concerns. In Croatia, the railway operators may impose specific conditions for the installation of a PV plant in addition to the general legal requirements with regard to buildings and landfill that may cause air pollution, make the air flammable or explosive. In the Czech Republic, these standards are so high, that a permit for IIPV would most likely not be granted. As in many Member States, in Hungary, it is currently not possible

to assess whether IIPVs which are installed by solar roofing on motorways are possible with regard to safety standards, due to missing specific provisions or IIPV in missing regulatory framework.

In some Member States, the construction of railroads is limited to certain zones. In Croatia, no construction (including IIPV) is possible in some zones and in other zones a special permit is necessary.

Potential Barriers

Our research has shown that in most Member States, the use of motorway or railway infrastructure (including the land surrounding it) is restricted to a specific purpose. This purpose is best described as the safety and fluidity of the traffic. The use of motorways and railways for different purposes (such as energy generation, advertisement, food services, etc) is either restricted or requires a special permit. For example, in Romania, the infrastructure authority requires a prior authorization for the use of motorway and road infrastructure for a different purpose. We have identified a certain reluctance of the authorities in Romania to grant such an authorization for the use of motorway and road infrastructure for a different purpose, due to safety concerns. In some Member States, the use of roads for a different purpose (such as energy generation, advertisement, restauration, etc) does not seem to be possible at all.

As set out above, in most Member States the IIPV becomes a part of the infrastructure and thus an amendment to or re-issuing of the existing infrastructure permit or concession could become necessary. This is a major barrier, as it is costly and sometimes impossible to obtain. Moreover, in Croatia, Hungary, Poland, Slovakia, the installation of IIPV by a third party is subject to the consent of the infrastructure operator. Thus, third party installation would be more complex.

*Table **Error! No text of specified style in document.**-12 Infrastructure related barriers to IIPV*

Infrastructure related barriers	Member States
Purpose restriction of motorway / railway infrastructure	AT, BG, CZ, HU, PL, RO, SI
Restricting buffer-zones	AT, ES, SI

Public Procurement

Since in most Member States, roads and railways are part of public infrastructure, the construction falls within the public procurement. However, in most Member States, there are no specific rules on the integration of IIPV in the public procurement legislation.

Potential Barriers

The lack of specific rules on the integration of IIPV in the public procurement legislation complicates the process for developers, legal advisers, and authorities. So, for example in Bulgaria, the question whether IIPV would even be possible, cannot be answered (yet), since IIPV is not included into public procurement.

3.7.4. Other Permitting regimes

Building law (including spatial planning, land use and zoning regulations)

For a common definition of building law please refer to chapter 3.4.3.

A PV plant regularly qualifies as a "building facility" which is fixed to the ground. However, IIPV, integrated into motorways, road or railway infrastructure would most likely not be regarded as a "separate" building facility, since it becomes part of the road or railway. In case an IIPV is not integrated into the road or railways, but built separately, a construction permit might become necessary. To obtain a construction permit, the project needs to be in line with the technical building regulations (which regularly address building statics, safety, and design aspects) and applicable spatial planning as well as land use / zoning regulations. In Finland, a construction permit would be required, in case the PV panels have a significant impact on the cityscape or the environment. The same is true for France, where the Urban Planning Code requires a building permit in certain cases. In Hungary, a construction permit is required for the construction of solar power plant of more than 50 kVA. In the Netherlands, it is not entirely clear whether IIPV would qualify as structure under the Housing Act and whether it would require a permit or not.

In some Member States, a special urbanistic permit is required for roof mounted PV. IIPV attached to e.g. a noise protection wall might be considered "roof mounted" PV and as such could also trigger the urban permit requirement. Since there are no explicit rules on IIPV or jurisprudence in the Member States, it is unclear whether the competent authorities would qualify IIPV on noise protection walls as "roof mounted". In Croatia, IIPVs require a permit for "ground mounted" solar panels. However, due to the lack of a legislative framework it is questionable whether IIPV would be considered as a simple building or as ground mounted solar panel. The permitting regime varies significantly and less permits are required for simple buildings. On the contrary, ground-mounted PV in Sweden does not require a building permit. Only if considered a "building" a building permit would be required. Our research has shown that the classification of IIPV under construction law is not (yet) established in the Member States.

In some Member States, IIPV needs to be in accordance with the zoning and spatial planning. For example, in the Czech Republic, Slovakia, and Slovenia, IIPV must comply with the respective zoning and spatial planning rules. However, up to this date there are no specific rules on IIPV in the zoning and spatial planning regulations of the Member States. It thus remains unclear, whether IIPV would need to follow general PV zoning and spatial planning rules or those for motorway, road, or railway infrastructure.

Potential Barriers

Our research has shown that there are no specific rules or regulations on IIPV in the Member States. The lack of definitions in building and zoning law, as well as other relevant legislation, is a potential barrier for IIPV. On the one hand, it is not clear whether IIPV is excluded from building law or whether it requires a building permit. On the other hand, authorities and consultants lack experience and may not be able to give clear answers to interested parties.

Environmental permit

Infrastructure projects such as motorways, roads and railways regularly require an environmental impact assessment and an environmental permit. Since IIPV is mostly not included in the original infrastructure project, an amendment to the existing environmental permit may become necessary, depending on the size of the IIPV, the location and other factors (e.g. nature conservation areas, Natura 2000, etc.). In some Member States, a specific environmental permit is required for IIPV. In Finland, such a permit or a notification would be required if the IIPV is installed in an area belonging to the Natura 2000 network. This usually includes the prior approval of the respective authority and sometimes the municipality council. In France, for example, the requirements are set by the local authorities, meaning that there is no uniform approach to landscape protection. In Slovenia, an environmental permit could be refused if IIPV would be assessed to have a negative impact on the environment. In Belgium, an impact-assessment on the fauna and flora is required, since the IIPV usually is installed outside a city in the green land or close to a forest.

Potential Barriers

We have not identified any barriers specific to IIPV deriving from environmental regulations. In many Member States, there is no established practice on how to identify and evaluate potential environmental impacts from IIPV. This particularly includes impact on soil, fauna, flora, and habitats. This lack of evaluation standards and experience may delay permitting procedures.

4. Regulatory framework and barriers in selected Member States

4.1. Introduction

Having identified the legal and regulatory framework for innovative forms of PV deployment in the previous chapter, this chapter contains a detailed analysis of the individual provisions with the aim to identify legal and regulatory barriers to the uptake, promotion, and deployment of innovative forms of solar energy deployment. A "barrier" is defined as a circumstance that prevents or hampers the deployment of innovative solar energy. Typical examples for legal barriers are:

- Legal provisions that prohibit certain activities which need to be conducted to deploy innovative solar energy.
- Special deployment requirements and conditions that are difficult to fulfil for innovative solar energy.
- Permitting obstacles and requirements.
- Legal and regulatory gaps (including legal uncertainties regarding the deployment of innovative solar energy).

The detailed analyses focus on selected countries where the four innovative PV technologies are the most developed. A such, this task focuses on a selection of states and not all EU 27 Member States, as illustrated in Table Error! No text of specified style in document.-13 below.

Table Error! No text of specified style in document.-13 Key Member States per innovative form of PV

	Countries investigated
Floating PV	Austria, Belgium, Romania, Croatia, France, Italy, Germany, Portugal, Poland, and the Netherlands
Agrivoltaics	Austria, Bulgaria, Croatia, France, Germany, Italy, Poland, Romania, and the Netherlands
BIPV	Austria, Belgium, Bulgaria, Croatia, France, Germany, Italy, Poland, Romania, and the Netherlands
Infra PV	Austria, Belgium, France, Germany, and the Netherlands

4.2. Status on agrivoltaics on selected Member States

The countries studied in this section are: Austria, Romania, Bulgaria, Croatia, Poland, France, Germany, Italy, and Netherlands. The following table gives an overview over the legal framework applicable to agrivoltaics and the potential issues and barriers detected for the selected Member States. More detailed information on the regulatory framework applicable to agrivoltaics and the identified barriers in the selected Member States can be found in *Annex A – Regulatory framework and barriers*.

*Table **Error! No text of specified style in document.**-14 Regulatory framework and barriers for Agrivoltaics*

Agrivoltaics	EU Member States								
Building Law	**AT**	**BG**	**HR**	**FR**	**DE**	**IT**	**PL**	**RO**	**NL**
Re-designation of the land required		X							
Definition of agrivoltaics			X	X	X	X[18]			
Strict requirements set by definition				X	X				
High technical standards and safety						X			X
No uniform building regulation	X				X				
Building permit required	X			X	X	X[19]	X	X	X
No (uniform) legal definition of agrivoltaics	X[20]	X				X[21]		X	X
Agrivoltaics must be beneficial for				X	X[23]				
Treated as conventional ground mounted PV	X[24]				X	X[25]	X	X	
Special land (re-) designation required	X		X[26]				X	X	
No uniform rules on land re-designation	X			X			X		
Designated zones for solar PV / agrivoltaics	**PV**		**Ag**					**PV**	
Building Law Barriers	**AT**	**BG**	**HR**	**FR**	**DE**	**IT**	**PL**	**RO**	**NL**
Dual land use restrictions	X[28]						X	X[29]	X
Without a special designation for the use of	X		X				X	X	
Agrivoltaics requires a re-designation of the			X						

[18] Definition only in guidelines of the Ministry of Environmental Transition.

[19] Usually, only a declaration required.

[20] Definition and preferential treatment regarding special land designation (*Eignungszone*) in the province of Styria.

[21] Defined only in guidelines.

[22] Agrivoltaics must be beneficial or "necessary" for the agricultural activity, a close relationship between the PV plant and the agricultural activity is required by law or regulation (or indirectly via a subsidy regime). Agrivoltaics may e.g. provide shading to plants or protect against water evaporation.

[23] Small agrivoltaic systems that comply with the definition in the EEG are privileged if functionally related to agricultural activity.

[24] Only in case of no specific provision, depending on the province.

[25] Depending on the type.

[26] Only if not in designated areas for the construction of agrivoltaics.

[27] Exceptions in the province of Styria – specific land designation (*Eignungszone*) is possible also within exclusion areas.

[28] All provinces except Styria.

[29] Limited to low quality land and limited in surface.

Lack of designations for agrivoltaics in							X		
Missing definitions / specific legislation	X					X[30]		X	
Fragmented regulation	X				X				
Lack of (implementing) regulation to definition of agrivoltaics				X		X			
Lack of experience of regulatory authorities	X		X		X		X	X	X
Complete ban on dual land use (the use of agricultural land for energy generation is not permitted)		X							
Long and political land re-designation			X				X	X	
Cost and time intensive permitting				X	X				
Lack of case law and administrative practice				X					X
Energy Law[31]	**AT**	**BG**	**HR**	**FR**	**DE**	**IT**	**PL**	**RO**	**NL**
No uniform energy law or specific legislation	X								
Energy permit required	X[32]		X						
Definition of agrivoltaics					X				
Same benefits as conventional ground					X				
Innovative tenders	X				X				
Energy Law Barriers	**AT**	**BG**	**HR**	**FR**	**DE**	**IT**	**PL**	**RO**	**NL**
Lack of precedents					X				
Combination of technologies in one tender causes disadvantage for agrivoltaics					X				
Lack of specific regulation	X								
Lack of implementing regulation on				X					
Without a special land designation an energy permit will be rejected	X								
Status of Agriculture	**AT**	**BG**	**HR**	**FR**	**DE**	**IT**	**PL**	**RO**	**NL**
Preferential taxation on agricultural activities	X						X	X	
Agrivoltaics has no impact on taxation					X				
Definitions of agricultural activity in tax	X								
National CAP regulation requires principal	X				X[33]	X		X	
National CAP legislation does not refer to	X							X	

[30] No legally binding definition, only in guidelines by the Ministry of Environmental Transition.

[31] This table only indicated the legal framework (and barriers) for those Member States which have reported specific issues for agrivoltaics regarding energy regulation.

[32] Above a certain threshold an energy permit is required.

[33] 85% is considered eligible.

No regulation for implementation on CSP			X	X					
Agricultural activity required for certain years after purchase of land							X		
Status of Agriculture Barriers	**AT**	**BG**	**HR**	**FR**	**DE**	**IT**	**PL**	**RO**	**NL**
Dual land use may lead to loss of tax	X						X	X	
Lack of specific legislation/jurisprudence on "principal agricultural use of land" with regard to agrivoltaics	X						X	X	X
Loss of CAP payments for permanently	X							X	
Lack of regulation addressing agrivoltaics in regulations governing agriculture			X						
Missing regulation on eligibility areas				X					
Missing regulation on CAP Strategic Plan			X						
Maximum surface for agrivoltaics per farm						X[34]			
Lack of experience of regulatory authorities regarding the qualification of agrivoltaics							X		
Risk that land re-designation is necessary, which would trigger (i) payment of a fee and (ii) loss of subsidies							X		
Conflicting regulation: land fund law and agricultural subsidies law								X	
Approval required for exclusion of agricultural land for other activities							X		

4.3. Status on Floating PV (FPV) on selected Member States

The countries analysed in this section are: Austria, Belgium, Croatia, France, Germany, Italy, Poland, Portugal, Romania, and Netherlands. The following table gives an overview over the legal framework applicable to FPV and the potential issues and barriers detected for the selected Member States. More detailed information on the regulatory framework and the identified barriers in the selected Member States may be found in *Annex A – Regulatory framework and barriers*

*Table **Error! No text of specified style in document.**-15 Regulatory framework and barriers for FPV*

FPV	**EU Member States**									
Building Law	**AT**	**BE**	**HR**	**FR**	**DE**	**IT**	**PL**	**PT**	**RO**	**NL**
Not clear whether building law applies	X					X			X	X
Building related permit required	X	X	X	X	X[35]			X	X	X
Lack of clear criteria for land designation	X						X			

[34] 10% of the agricultural area.

[35] If FPV is used for sale of electricity, easier process for self-consumption in combination with existing water use permit.

Special rules for water bodies used for	X				X					
No uniform building regulation	X	X			X	X				
Permit requirements set on municipality		X								
Definition of land for FPV			X							
Same procedure as conventional solar PV				X						
Concession required								X		
Building Law Barriers	**AT**	**BE**	**HR**	**FR**	**DE**	**IT**	**PL**	**PT**	**RO**	**NL**
Lack of experience at administrative level	X		X	X	X	X	X	X	X	
Lack of FPV-specific regulations and	X	X	X	X		X	X	X	X	X
Long permitting process	X				X					
Different levels of administrative competence at regional level		X								
Highly fragmented legal system concerning building law	X	X			X	X	X			
Conflicting jurisdictions on artificial water						X				
Time-consuming permitting procedures	X				X		X	X		
Lack of jurisprudence / precedents	X								X	X
Lack of legal certainty due to inaccessible information on permitting									X	
Energy Law[36]	**AT**	**BE**	**HR**	**FR**	**DE**	**IT**	**PL**	**PT**	**RO**	**NL**
No uniform energy law	X									
No specific legislation	X									
Energy permit required			X				X		X	
Support scheme specific for FPV					X					
Requirements regarding the size of the FPV					X					
Long and time-consuming procedures							X			
Energy Law Barriers	**AT**	**BE**	**HR**	**FR**	**DE**	**IT**	**PL**	**PT**	**RO**	**NL**
Lack of specific regulation	X		X				X		X	
Support scheme only for artificial water					X					
Time-consuming permitting procedures							X			
Lack of experience with regulation of FPVs at service provider's and grid operator's level	X						X		X	
Water Regulation	**AT**	**BE**	**HR**	**FR**	**DE**	**IT**	**PL**	**PT**	**RO**	**NL**

[36] Only selected MS are represented in this table, due to the fact that not all national legal experts reported legislation or issues specific to FPV.

No definition of FPV	X		X						X	
Unclear whether water law is applicable	X					X			X	
Water law permit required	X		X		X		X	X	X	X
Fragmented legal framework		X								
Water Act not applicable to FPV				X						
Restrictions towards the size and location of					X					
Concession required for public water bodies								X		
Water Regulation Barriers	**AT**	**BE**	**HR**	**FR**	**DE**	**IT**	**PL**	**PT**	**RO**	**NL**
Lack of FPV-specific regulations	X		X	X		X	X		X	
Lack of jurisprudence on FPV	X		X	X					X	X
Potential legal conflict due to other public and private interests	X								X	
Lack of regulatory experience at		X			X	X	X		X	
Complex administrative permitting		X			X					
Highly fragmented legal framework		X			X					
Conflicting regulation (water law vs nature						X	X			
Lack of regulation for use of private water								X		
Lack of joint administrative procedures /										X
Nature Protection Regulation	**AT**	**BE**	**HR**	**FR**	**DE**	**IT**	**PL**	**PT**	**RO**	**NL**
Environmental permit/approval required	X	X	X			X	X	X	X	X
Fragmented legal framework	X	X		X	X					
Environmental impact assessment required	X		X	X			X	X	X	
Nature Protection Regulation Barriers	**AT**	**BE**	**HR**	**FR**	**DE**	**IT**	**PL**	**PT**	**RO**	**NL**
Lack of FPV-specific regulations	X	X	X		X	X	X		X	X
Conflicting regulation due to environmental protection (green on green conflict)	X		X		X	X				
Lack of regulatory experience at environmental expert and administrative	X	X		X	X	X	X	X	X	
Extensive use of administrative formalities			X				X			
Highly fragmented legal framework				X						
Time consuming permitting procedures			X				X			

4.4. Status on Building Integrated PV (BIPV) on selected Member States

The countries studied in this section were: Austria, Belgium, Bulgaria, Croatia, France, Germany, Italy, Poland, Romania, and Netherlands. The following table gives an overview over

the legal framework applicable to BIPV and the potential issues and barriers detected for the selected Member States. More detailed information on the regulatory framework applicable to BIPV and the identified barriers in the selected Member States can be found in *Annex A – Regulatory framework and barriers.*

*Table **Error! No text of specified style in document.**-16 Regulatory framework and barriers for BIPV*

BIPV	EU Member States									
Building Law	AT	BE	BG	HR	FR	DE	IT	PL	RO	NL
Building permit	X	X	X		X	X		X	X	X
Compliance with technical standards	X		X			X	X	X	X	X
Compliance with land- and townscape	X	X		X	X	X	X	X	X	X
Fragmented building law	X	X				X				
Compliance with rules on use of glass	X					X				
Compliance with fire protection regulations	X		X				X			X
Building Law Barriers	AT	BE	BG	HR	FR	DE	IT	PL	RO	NL
Conflicting regulations regarding BIPV	X								X	
Restrictive permitting practice	X					X	X			X
Different administrative procedures throughout the Member State	X	X				X				
Complex and fragmented legislation		X				X			X	
Lack of specific definition and regulation			X			X	X	X	X	
Lack of regulatory experience at			X		X			X	X	X
Lack of jurisprudence			X					X		
Lack of joint administrative procedures					X					X
Complex administrative procedures			X		X					
Energy Law	AT	BE	BG	HR	FR	DE	IT	PL	RO	NL
No uniform energy law	X									
No specific legislation	X									
Energy permit required				X					X	
Same regime as rooftop PV						X				
Energy Law Barriers	AT	BE	BG	HR	FR	DE	IT	PL	RO	NL
Lack of specific regulation	X			X	X	X	X	X		
Lack of experience of the DSO/TSO with			X							
Lack of regulatory experience at						X				

4.5. Status on Infrastructure Integrated (IIPV) on selected Member States

The countries studied in this section were: Austria, Belgium, France, Germany, and The Netherlands. The following table gives an overview over the legal framework applicable to IIPV and the potential issues and barriers detected for the selected Member States. More detailed information on the regulatory framework applicable to IIPV and the identified barriers in the selected Member States can be found in *Annex A – Regulatory framework and barriers.*

*Table **Error! No text of specified style in document.**-17 Regulatory framework and barriers for IIPV*

IIPV	Member States				
Infrastructure Law	**AT**	**BE**	**FR**	**DE**	**NL**
IIPV becomes part of the	X			X	
Infrastructure regulation applicable	X			X	
Infrastructure permit (amendment)	X	X		X	X
Lack of definition	X		X		
No uniform competence		X			
Possibility to install IIPV in close proximity to infrastructure	X		X		
Fragmented legal framework				X	
Stringent safety requirements	X			X	
Instructions given in handbook					X
Infrastructure Law Barriers	**AT**	**BE**	**FR**	**DE**	**NL**
Lack of specific regulation	X	X	X	X	
Lack of jurisprudence	X	X	X	X	
Building Law	**AT**	**BE**	**FR**	**DE**	**NL**
Building law not applicable	X				
No uniform competence		X		X	
Building permit required		X		X	X
Concession company			X		
Building Law Barriers	**AT**	**BE**	**FR**	**DE**	**NL**
Lack of specific regulation	X	X	X		
Energy Law	**AT**	**BE**	**FR**	**DE**	**NL**
No uniform energy law	X	X			
Energy permit required			X		
Environmental permit required		X			
No specific subsidy for IIPV				X	

Complex technical feasibility regarding grid connection					**X**
Energy Law Barriers	**AT**	**BE**	**FR**	**DE**	**NL**
Lack of specific regulation	**X**	**X**	**X**	**X**	
Interpretation of complex regulation					**X**

5. Non-regulatory barriers in selected Member States

Further to the previously discussed regulatory barriers, the five innovative forms of PV studied in the scope of this report are all facing various technical, economic, environmental, industrial, social or adoption factors. They are still considered in 2023 as emerging technologies among most EU Member States. The objective of this chapter is to provide an overview of the barriers that affect the deployment of all these innovative forms of PV in many Member States. The key barriers have been selected among the ones investigated through desk research (see ANNEX B – TASK 3 DESK RESEARCH) and interviews (see ANNEX C – LIST OF INTERVIEWED COMPANIES PER EU MEMBER STATE), then categorised by type of barrier. This work helps to ensure that the most adequate recommendations to overcome them can be formulated.

5.1. The different categories of barriers to innovative forms of PV

There are many barriers faced by the different actors involved in the deployment of innovative forms of PV, covering both regulatory and non-regulatory barriers. The latter have been classified into the following categories:

- Technological barriers, which refer to any factors that prevent larger adoption of the innovative form of PV. They can be, for example, the requirement of a more complex implementation for proper operation, e.g. the anchoring system in floating PV plant.
- Economic and financial barriers, which refer to any factors that affect the competitiveness of the innovative form compared to ground-mounted or rooftop PV. They can sometimes be coupled with legal constraints, that can, for example, increase the cost of the innovative form of PV and as such slow or prevent its adoption. These may stem from regulatory choices as identified in Chapter 3 and 4.
- Environmental barriers, which refer to any environmental factor that can affect the operation of the PV plant or restrict its installation. They can be, for example, a natural barrier, e.g. floating-PV in very cold regions where freezing can cause potential damage to the floating structures.
- Industrial barriers, which refer to manufacturing or economy of scale factors that prevent the scale-up of the innovative form of PV. They can be, for example, the lack of automation in the manufacturing of BIPV panels, which lead to more expensive products and lower market adoption.
- Social and behavioural barriers, which refer to the social, cultural or behavioural aspects of market players, that hinder the development of innovative form or prevent them (rejection). They can, for example, the installation of BIPV panels in traditional villages or cities, affecting visually the scenery.

A barrier can affect a single form of innovative PV or several ones; therefore, we categorized barriers which are common to several innovative forms of PV and barriers which are specific only to a single form of innovative PV.

Also, the methodology aimed at reaching good coverage of the EU-27 while focusing resources on a selection of representative countries for each innovative form. We also added few non-EU countries: Albania, Israel, Switzerland. This approach is illustrated in below **Table Error*! No text of specified style in document.*-18**.

*Table **Error! No text of specified style in document.**-18 Countries investigated for non-regulatory barriers*

Form of innovative PV	Key EU Member States	Potential EU Member States	Non-EU Member States
Floating PV	France, Germany, Italy, Netherlands	Austria, Belgium, Czechia, Greece, Ireland, Lithuania, Poland, Portugal, Spain	Albania, Israel
Agrivoltaics	Austria, France, Germany, Italy, Netherlands	Belgium, Czechia, Denmark, Greece, Ireland, Lithuania, Poland, Portugal, Spain	Israel
Building Integrated PV	Austria, France, Germany, Italy, Netherlands	Belgium, Denmark, Hungary, Ireland, Lithuania, Sweden	Switzerland
Infrastructure Integrated PV	Netherlands, Germany, France	Belgium	Switzerland

Note: for Vehicle Integrated PV, no country-specific barrier was identified, so the VIPV market from the perspective of selected industrial market players (located in the Netherlands, Germany and Sweden) was investigated.

5.2. Non-regulatory barriers common to several innovative forms of PV

*Table **Error! No text of specified style in document.**-19* provides an overview of the three main barriers categories that apply to several forms of innovative PV in Member States.

*Table **Error! No text of specified style in document.**-19 Non-regulatory barriers common to several innovative forms of PV*

Title of the barrier	Description	Member States[37]	Actors affected
Technical barrier			
Difficulty to connect PV power plant to the grid	Access to a grid connection for innovative forms (Agrivoltaics and Floating PV in particular) is often an issue. Such installations are often far from the electricity grid. This involves extra cost to deploy electricity lines and often there is a lack of transformer capacity, which are usually located in more populated areas. An associated issue is the lack of grid capacity from the DSO/TSO to take in additional injections to the network, whether at national level or locally. The grid is often unable to accept PV projects in general, so the same issue applies to innovative forms as well.	BE, CZ, DK, ES, EL, FR, IE, PL, SE	Project Developers
Economic & financial barriers			
Higher initial	Innovative forms of PV are more expensive compared to	BE, DK, ES,	Project Owners and

[37] Examples of EU Member States, non-exhaustive, based on EU country codes.

Title of the barrier	Description	Member States[37]	Actors affected
cost of innovative forms	standard PV. Beside the extra CAPEX cost, they also involve more complex O&M and as such additional OPEX cost. For example, a project developer mentioned that a FPV project is "25% to 30% more expensive than a ground mounted project".	EL, IT, LT, NL, PL, PT, SE	Developers
Lack of dedicated support schemes	While most Member States have in place subsidies to support renewables (usually Feed-in-Tariffs and sliding premiums, such as Contracts for Differences), the design of these support schemes is rarely suited for supporting innovative forms of PV deployment. This is because these instruments generally aim at reducing the support cost by targeting the most popular technologies, or by enforcing competition among participants, which clearly favours cheaper technologies. In some cases, Member States have provided support to innovative technologies by implementing dedicated schemes or by ringfencing part of the budget for them. However, these schemes have now been discontinued (e.g., France, Italy).	BG, CZ, ES, EL, FR, IT, LT, IE, PL	
Social and adoption barriers			
Complex permitting process	Permitting typically involves lengthy, complex procedures, often aggravated by a lack of experience and training of staff that has to deal with it, and lack of appropriate internal processes. For example, in some Member States there are several entities (national water authority, regional water authority and local communities) that can decide on some aspects of a FPV project, but there is no process to support a coordinated approach. It is similarly the case for IIPV. This explains, in combination with other factors, why some innovative forms of PV have shown significant potential when tested, but never followed by deployment at scale (Agrivoltaics or FPV in Spain, BIPV in France, etc.)	BE, CZ, ES, EL, IT, PL, PT	Project Owners and Developers
Land availability for ground-mounted PV projects	The availability of land for ground-mounted solar projects plays a crucial role in determining the feasibility of three innovative forms of photovoltaics: Agrivoltaics, Floating PV (FPV), and Integrated PV (IIPV). o In regions where there is sufficient land available for ground-mounted projects, there is usually limited interest in these alternative forms of deployment. This is primarily due to their relatively higher cost compared to traditional ground-mounted PV systems. For instance, in Spain, where ground-mounted PV development is already widespread, the growth of innovative deployment methods is seldom pursued. o Similarly, in developing PV markets (countries with installed capacity below 1 GW such as Ireland, Slovakia, Slovenia, and the Baltic states) ground-mounted PV remains the dominant choice. o In countries with limited available land, or those with already high rooftop PV penetration, innovative forms of PV, such as Agrivoltaics, FPV, and IIPV, are more actively supported. For example, because of land constraints and very high deployment of rooftop PVs, the Netherlands recognises and actively support alternative deployment methods, such as floating PV. Similarly, Switzerland and Israel were found to have a more favourable environment for innovative PVs.	NL	Project Developers
Public	This applies to standard PV and to all the innovative forms of	DE, FR, EL,	All

Title of the barrier	Description	Member States[37]	Actors affected
opposition/ reluctance to any PV installations	PV, except VIPV. Multiple factors are behind such resistance. This is typically due to aesthetic and usage reasons. For example, PV may be considered to "steal" part of the natural environment from other activities: e.g. FPV on top of natural water bodies versus leisure or bird-watching activities; BIPV versus green grass for rooftop. It can also lead to complications in the usual use of the land: e.g. in Agrivoltaics, the installation needs to be adapted to vehicles or animals.	IE, PL	
Lack of knowledge of the PV form and all its implications	Lack of knowledge can affect multiple players: public officers, architects, designers, but also end users or neighbours of the installation. A typical consequence is to delay the permitting process but it can also impede actors e.g. for architects (BIPV), farmers (Agrivoltaics), water organisations or dam operators (FPV), etc choosing the innovative PV form from the beginning.	BE, DE, EL, FR, LT, SE	All
Industrial barriers			
Reliance of EU industry on imports	An barrier often mentioned by European manufacturers is the fact that a large part of the supply chain of crystalline silicon is in China (for ingots, wafer & cells), so European panel manufacturers often buy their cells from China. In case of a supply crisis, such as the one during Covid-19, the European BIPV industry would suffer and would struggle to find alternatives.	n/a	Product Manufacturers
Lack of support to European producers	Taking into account the protectionist measures introduced by government support in China or the USA (via the Inflation Reduction Act), European BIPV manufacturers consider that European policy-makers are not supporting them enough to build a solid supply chain.	n/a	Product Manufacturers

5.3. Non-regulatory barriers for Agrivoltaics

Table Error***! No text of specified style in document.***-20 provides an overview of the three main barriers categories that apply specifically to agrivoltaics in Member States.

*Table **Error! No text of specified style in document.**-20 Non-regulatory barriers for Agrivoltaics*

Title of the barrier	Description	Member States	Actors affected
Technical barrier			
Absence of dedicated standard	Germany is the sole country to have defined a standard for Agrivoltaics (DIN SPEC 91434). As highlighted in a JRC report[38], the absence of a dedicated standard is seen as a major barrier to the development of Agrivoltaics. Some countries (FR, IT) defined guidelines, which represent a softer standardisation effort.	Most EU Member States except DE	Project Developers
Heavy technical requirements	In some countries, technical requirements are burdensome	IT, NL	
Economic barriers			
Lack of suitable business model for farmers	The lack of a proper balance between farming and PV-based electricity generation poses a significant challenge for agrivoltaic projects. While many farmers express interest in PV systems due to their potential to enhance profitability of their land, they must deal with the fact that regulations often hinder this possibility, even when the agricultural activity is preserved. Furthermore, there are instances where regulatory guidelines, defined with excessive granularity, inadvertently hinder the realization of win-win	BE, DE, PT, NL, IT	All

[38] Overview of the Potential and Challenges for Agri-Photovoltaics in the European Union, 2023.

Title of the barrier	Description	Member States	Actors affected
	scenarios (e.g. IT). Moreover, in order to establish a viable business model, it is necessary to establish a mutually beneficial relationship between the farmer and the PV developer.		
Resistance from farmers due to potential taxation/loss of subsidies	Designating agricultural land for PV deployment has consequences on farmers' income, and these are often unclear and vary across Member States. For example, the extent to which CAP subsidies are affected, and the taxation of the revenues from these activities. Other economic consequences for farmers may arise as a result of land price speculation happening in areas surrounding the one that has been designated for PV deployment (see chapter 3.4.4). Due to these risks, farmers in some Member States are reluctant to engage in this activity.	BE, DK, IE	
Split ownership or lack of ownership of the land	In some Member States, farmers do not own the land they farm, or own only a part of it. As such, they need to negotiate with the landowner the construction of an agrivoltaic plant on the land. On the other hand, landowners that lease land to farmers and that may want to install a PV system may also have to negotiate the process with the farmers. This makes the development of the agrivoltaic project more complex.	CZ	Project Owners and Developers
Social or Adoption barriers			
Visual aspect of PV installation on the farming area	Visual impact is often mentioned as an issue in countries where agricultural activity is part of cultural heritage and as such protected: particular regions of Italy or Portugal are concerned. As such, the regulator may prohibit any installation of PV on land in these regions. Also, there are cases (e.g. DK), where the law requires to hide the agrivoltaics installation behind a tree fence ("green fence") within 3 to 5 years from installation. This can be a challenge when systems are high as it requires to plant trees that grow fast to heights of 5 meters or more. However, this phenomenon may give rise to shading issues on the PV installation, leading to a reduction in energy production.	IT, PT, DK	Project Developers
Local acceptance	Securing local agreements is essential for PV projects, and it necessitates consultation with influential stakeholders. For example, acceptance from key agricultural bodies (e.g., local chamber of Agriculture) was identified as a key issue in France. Opposition from environmentalists has also been observed, although more rarely.	FR, PL	All

5.4. Non-regulatory barriers for Floating PV

Table Error***! No text of specified style in document.***-21 provides an overview of the three main barrier categories that apply specifically to Floating PV in Member States. It is important to distinguish the water body on which the FPV is installed, as barriers can vary substantially according to this element. For example, different provisions apply to public water reservoirs or dams, public or private irrigation reservoirs, industrial water reservoirs (quarry lakes), etc.

*Table **Error! No text of specified style in document.**-21 Non-regulatory barriers for FPV*

Title of the barrier	Description	Member States[39]	Actors affected
Technical barriers			
Stability of the floating plant on water	The fluctuation of water levels in water bodies occurs throughout the year, such as in the case of dams, reservoir droughts, or water freezing. These fluctuations impose technical constraints on the installation, necessitating additional equipment or	BE, LT	Engineering & Construction companies (EPC)

[39] Example of EU MS, non-exhaustive, based on EU country codes.

Title of the barrier	Description	Member States[39]	Actors affected
	protective measures. In some cases, they may even render FPV installations unfeasible. An example of these issues is provided by the failure of an FPV plant situated on a pumped hydro storage lake in Lithuania[40]: during a severe winter, the freezing of water led to the destruction of the floating PV installation, causing it to sink and become entrapped in the pumped hydro system. Such incidents have dissuaded several European northern countries and mountainous regions from considering FPV installations on water bodies		
Economic barrier			
Need of strong balance sheets for developers	FPV projects tend to benefit from economies of scale and require investments of a significant size. However, the number of finance providers comfortable with this type of investments, and the number of developers with large balance sheets and interested in the technology, is rather limited.	All EU Member States	Developers
Environmental barriers			
Potential impact of fauna	A common environmental impact is bird habitats, where new installations on water can disturb the habits of birds, such as nesting and feeding grounds. It has also been observed that birds mistake panels with the water body, and can get injured landing on them.	BE, IT, LT	All
Lack of evidence of positive effects	As FPV has seen a rather low deployment to date, there is a general lack of experience with the analysis of environmental impacts of FPV installations[41,42], both negative and positive (for example, FPV may help to reduce water evaporation and algae growth). According to interviewees, there is still an insufficient number of studies on the impacts of FPV.	BE, EL	All
Social or Adoption barriers			
Opposition from local stakeholders [43]	The deployment of FPV systems can have noteworthy implications for water bodies. By diminishing the available water surface area and altering its aesthetic characteristics, FPV can engender conflicts among various stakeholders regarding water usage. These conflicts may, in turn, provoke opposition to FPV projects. Notably, such conflicts are more pronounced in the context of freshwater bodies and dams, where competing uses of the water resource are likely to arise. In contrast, former industrial sites (such as quarry lakes) experience these conflicts less frequently as the activity is discontinued and FPV becomes the new principal activity. This nuanced understanding of FPV's impact on water bodies is crucial for informed decision-making and sustainable project implementation.	FR, DE, EL, IE	All
Visual impact	The aesthetic or visual impact of FPV plants on water bodies is frequently cited as a challenge or obstacle. The concern revolves around how FPV installations alter the natural visual landscape of water bodies, potentially affecting their overall appeal and harmony with the environment.	BE, IT, DE, EL, LT	All
Relations with hydro dam	Relationship with hydroelectric dam operators can be a barrier. Implementing FPV on a dam has technical and economic	ES, PT, IT, LT	Developers

[40] Lithuanian Radio & Television article, February 2021 (in Lithuanian).

[41] World Bank and SERIS - Floating Solar Market Report**, 2019.**

[42] "**Environmental impact of floating solar" from Sacha de Rijk at the 3rd annual FPV Forum in Amsterdam, 2023.**

[43] This issue has been mentioned in relation to other forms of innovative PV, but it has a more significant effect on the deployment of FPV.

Title of the barrier	Description	Member States[39]	Actors affected
operators	dependencies and proper collaboration with operators of hydroelectric installations (which are often public companies) is necessary. This barrier can be addressed by having the hydroelectric plant operator run the FPV plant, but when this is not possible developers must strike a complex deal with the dam operator, for example in order to share infrastructure: a key advantage of collocating FPV and hydroelectric power plants is the possibility to profit from the existing connection to the grid (which often is a barrier to most innovative forms of PV deployment).		
Difficulties when dealing with public owners of water bodies	Public authorities tend to be less inclined to develop FPV systems compared to private owners, especially in the context of natural water bodies. Public authorities encompass both national and regional entities. In the case of the latter, policies towards innovative forms of PV may exhibit significant variation. Conversely, it has been reported that owners of private artificial water bodies, such as irrigation reservoirs or quarry lakes, are more favourable to building FPV. For this reason, developers tend to favour such water bodies.	IT, LT	Developers
Industrial barrier			
Not enough experienced/ reliable suppliers	There are few cases where the reliability and experience of FPV systems, or FPV components' suppliers and installers, was identified as a barrier to the development of FPV plants. This is mainly due to technological challenges (e.g. on anchoring and mooring of the floating structure) and lack of experience from multiple installations.	IT, EL	Developers, Engineering & Construction companies (EPC)

5.5. Non-regulatory barriers for Building Integrated PV

BIPV is one of the oldest forms of innovative PV deployment, but it still encounters a large number of barriers, in particular of technical nature. BIPV is a combination of an electricity-generating element and a building element; this is often complex to deal with for construction professionals.

Table Error***! No text of specified style in document.***-22 provides an overview of the three main categories of barriers that apply specifically to BIPV in Member States.

*Table **Error! No text of specified style in document.**-22 Non-regulatory barriers for BIPV*

Title of the barrier	Description	Member States	Actors affected
Technical barriers			
Lack of unified/enforced labelling/certification in EU	Currently, there exists no consensus among EU Member States regarding the classification of BIPV as "building products". Consequently, their inclusion within the purview of the EU Construction Product Regulation and compliance with Building Code requirements remain subject to varying interpretations. Different examples of BIPV classification can be identified in Member States: • In Denmark, BIPV is flourishing despite its non-recognition as a formal building product. Danish practice treats BIPV as an electrical component, exempting it from permitting considerations except for local aesthetic requirements. However, this approach warrants scrutiny, as BIPV products should ideally meet safety standards	BG, BE, DE, FR, HU, SE, LT	Product Manufacturers, Architects, Developers, Installers

Title of the barrier	Description	Member States	Actors affected
	applicable to conventional building materials. • France & Germany have established additional certification procedures specific to BIPV. Even if BIPV products bear European-level labelling (e.g., EN 50583-1), French regulations necessitate an extra certification step (e.g., ATEC[44]). • Lithuania and Hungary lack explicit legal definitions for BIPV. Consequently, stakeholders in the construction industry struggle to deal with BIPV, preventing larger adoption of the technology.		
Rigidity of product certification rules	The European standard EN 50583-1 requires requalifying a BIPV product any time a manufacturer changes a component of the equipment, even when minor changes are made (change of supplier, slightly different chemicals/materials, change of colour, etc.). The re-certification is a costly and lengthy process.	All EU Member States	Product Manufacturers
Fire codes incompatibilities with BIPV	Fire codes[45] can conflict with the installation of BIPV products due to incompatibilities of technical specifications between the BIPV product and the requirement of the code, or because the code does not foresee such elements. For example, in Sweden, BIPV products are aligned on BAPV (Building Applied PV) products, which require spacing between the panels and the roof or façade. This is in contradiction to the way BIPV is intended to be implemented (without spacing).	IT, SE, PL	x
Economic barrier			
Warranties responsibility between trades	BIPV products, being simultaneously electrical and building products, fall within the scope of responsibility of several different trades[46]. There can be disagreement about which of the involved building trades (electrician, roofer, etc.) is responsible for guaranteeing the quality and performance of the BIPV installation or for subsequent maintenance work, including mandatory warranties. Such unclear allocation can be a hurdle, as the required building trades are unwilling to work on such projects.	All EU Member States	All
Social or Adoption barriers			
Integration into the urban landscape	The adoption of BIPV panels, especially on facades, can present challenges in terms of aesthetic integration within the urban landscape. While some companies are beginning to provide BIPV panels in various colours, aiming to mimic traditional building colours and elements such as white walls and red roof tiles, these offerings remain niche products. The majority of BIPV panels available for purchase are black or dark, potentially impacting the aesthetic harmony of the urban landscape when installed. This issue is particularly relevant for historical towns and city centres, which usually adopt strict planning policies in order	BE, BG, DK, IT, LT, SE	**All**

[44] ATEC or "Avis TEChnique".

[45] Set of standards established and enforced by a government or a dedicated body for the purpose of fire prevention and fire safety.

[46] "BIPV overview of Barriers and Opportunities", 2023, THERMAL SCIENCE Vol. 27, no. 2B.

Title of the barrier	Description	Member States	Actors affected
	to preserve the character of the area.		
Training of installers and building planners	The traditionally separate construction trades are not well adapted to the installation of BIPV products, which is a combination of electrical and building elements. Professionals often need specific interdisciplinary training to deal with BIPV products. The professional able to bridge the gap between different trades is often the architect, but that also requires him/her to be well-informed about the possibilities for incorporating BIPV into buildings.	BE, SE, LT	All

5.6. Non-regulatory barriers for Infrastructure Integrated PV

Table Error***! No text of specified style in document.***-23 provides an overview of the four main barriers categories that apply specifically to IIPV in Member States.

*Table **Error! No text of specified style in document.**-23 Non-regulatory barriers for IIPV*

Title of the barrier	Description	Member States	Actors affected
Technical barriers			
Complex systems	There are multiple IIPV systems (i.e. combining the PV panel with the mounting structure and other elements) but all require complex setups to fulfil infrastructure and security requirements; combined with the implementation in a limited area, it leads to limited economies of scale	BE, FR, NL	Developers, Operators
Necessity to implement anti-glare systems in some cases	The requirement of the implementation of anti-glare functionality into PV panels of IIPV projects presents both technical and economic challenges. As PV panels from IIPV systems may reflect sunlight or other artificial lights, precautions need to be taken in order to avoid that users of the infrastructure are blinded by the reflected light. The necessity for such requirements prompts either modifications to existing panels or the development of specialized, more expensive versions.	BE, FR, NL	Manufacturers, Installers, Operators
Incidents to circulation as a related to events on PV panels	In the event of a fire, PV panels can break and glass can be scattered on the road thus causing a hazard for users[47,48]. Infrastructure operators are always wary of such risks and try to avoid glass as much as possible near highways.	NL	All
Restrictions due to safety standards	Another major (potential) barrier to IIPV is the lack of specific technical regulations. Weather, noise, and vibration due to the use of the infrastructure could generate risks to the IIPV, but also in turn to the users of the infrastructure. The safety requirements may be too general and without specific rules adapted to the technical specificities of IIPV, authorities may be inclined to either deny the installations due to general, non IIPV-specific safety concerns or include a long list of requirements to be met. In addition, IIPV may be in conflict with technical regulations for motorways and other roads. Thus, custom-made PV modules may be required.	CZ, FI, HR, HU, LU, RO	
Economic barriers			
Identify profitable business cases	Given the high cost, technical challenges, and gaps in relevant regulations, identifying a successful business case is complex, as the risks often appear to surpass the potential benefits, and alternative	NL	Developers

[47] "Verkehrsträgerübergreifender - Austausch von Erneuerbarer Energie", 2022.

[48] Modular E-cover for Smart Highway, 2020.

Title of the barrier	Description	Member States	Actors affected
	options appears more convenient. For example, in the Netherlands, after having experimented in the recent years, RWS concluded that solar PV ventures purely focused on noise barrier mounting never reached a positive business case[49]		
Theft of PV modules	PV modules mounted on road infrastructure are easily accessible and transportable, so PV module theft is a concern by IIPV plant operators	NL	Installers, Operators
Public financing of IIPV projects	The authority to install PV systems on public infrastructures typically rests with public authorities or the governmental bodies that own the infrastructure. When public budgets are under strain, other public investments will take the priority, especially as the budget for IIPV may directly compete with budget for other improvements to infrastructure.	BE	Developers
Environmental barrier			
Potential biodiversity impact	IIPV includes projects that are developed in the surrounding area of an infrastructure, for example alongside roads or railroads. In doing so, the IIPV installation extends the land area affected by the project, and contributes to increasing its environmental impacts. This may involve, for example, impacts on wastelands and humid areas found alongside roads.	FR	Developers, Land owners
Industrial barrier			
Industrial feasibility of the IIPV projects	The organisation of an IIPV venture is relatively complex: involving multiple stakeholders, both from the public and from the private sectors, often with diverging interests. The organisation of an IIPV venture requires a concerted approach which must take into account that profits from the operation are likely to be limited[50]. IIPV requires the collaboration of actors from the solar and infrastructure sectors, which have limited knowledge of each other and limited experience working together. This leads to long development processes with chances that market players drop out of the project for profitability reasons.	All EU Member States	Developers

5.7. Non-regulatory barriers for Vehicle Integrated PV

Table Error! *No text of specified style in document.*-24 provides an overview of the four main barriers categories that apply to specifically to Vehicle Integrated PV in Member States.

*Table **Error! No text of specified style in document.**-24 Non-regulatory barriers for VIPV*

Title of the barrier	Description	Member States	Actors affected
Technical barriers			
Lack of unified regulation in Europe	There is currently a lack of unified regulation in Europe to promote VIPV on cars or on electric semi-trailers.	All EU Member States	Vehicle Manufacturers
Lack of certification specific to VIPV	The biggest barrier for VIPV is the current lack of certification specific to VIPV, e.g. something similar to WLTP - Worldwide Light vehicles Test Procedure standard[51]. Specific certification would contribute to define and prove the additional range of a VIPV vehicle.		
Limited area for	This barrier is critical for cars and to a lower extent for buses or		

[49] https://sun-projects.nl/innovatie/zon-op-snelwegen, 2019.

[50] The Potential of PV Noise Barrier Technology in Europe, 2020.

[51] Information on WLTP test standard.

Title of the barrier	Description	Member States	Actors affected
installation of solar cells	trucks. Further for cars: the curvature of the vehicle is an additional technical complexity[52] to integrate solar cells. The most efficient photovoltaic cells for energy yield are those made of rigid crystalline silicon. However, they must be adapted to curvature through specific industrial processes, which adds extra cost. Flexible cells can also be used but they have a lower yield. For trucks and buses, flat area for installation is available and is often large and well exposed to sun. The second consideration is the ratio between the power generated by the vehicle and the vehicle's own electric needs, which is also largely correlated with the vehicle's surface.		
Environmental barrier			
Recyclability	Automotive products have a 95% recyclability obligation at the end of vehicle's lifetime. Integrating solar PV cells into the surface of the vehicle presents a significant challenge due to the tight bonding of the cells to the support material. This strongly reduces the recyclability of these elements or adds extra cost to the recycling process. This recyclability requirement is even higher than the requirements applied to conventional PV.	All EU Member States	Vehicle Manufacturers
Social or Adoption barriers			
Complexity to prove the concrete benefit to end-users	The need to prove the concrete benefit of VIPV, i.e. a significant additional range for the EV, is crucial for its adoption. The electricity produced by the VIPV, estimated in the range of 2 to 5% of the total mileage's range of the vehicle[53],[54] varies largely according to the location, orientation of the vehicle and potential shading. As such, it is hard to provide a concrete number to end-users.	All EU Member States	Vehicle Manufacturers
Non-mobilization issue in case of damage to PV panels	In particular for professional vehicles such as trucks or buses, a potential crash or other damage to the PV structure can lead to non-mobilization of the vehicle for substantially more time than a conventional vehicle, leading to the loss of utility or revenue.		
Industrial barriers			
Hard to align with automotive industry security requirements	There are two strong requirements that are hard to match: - crash test (for vehicles produced > 1 000 units) that requires flexibility of the hood to absorb shocks and thus prohibit rigid materials such as crystalline silicon cell and glass, which are the most popular and lowest cost solar manufacturing products. - scratch resistance that is incompatible with glass, typically used on top of standard cells.	All EU Member States	Vehicle Manufacturers
Automotive makers acceptance of different material & production processes	Automotive makers acceptance of different material & production processes (integration of solar cells on the body of the vehicle): - Material costs for automotive company. - Optimized production life which is the main driver for automotive company to ensure a decent margin. The added complexity of VIPV is consequently not well accepted.		

[52] Potential and challenges of vehicle integrated photovoltaics for passenger cars, 2020.

[53] Application of photovoltaic panels in electric vehicles to enhance the range, 2022.

[54] Yield potential of vehicle integrated photovoltaics on commercial trucks and vans, 2021.

6. Good practices and Recommendations

This chapter presents a list of good practices linked to the barriers analysed in previous chapters, identified in Member States and third countries. We analyse good practices that allow to reduce or eliminate both regulatory and non-regulatory barriers.

6.1. Good practices common to several forms of innovative PV

This section presents good practices that are relevant to more than one form of innovative PV deployment.

*Table **Error! No text of specified style in document.**-25 Summary of good practices common to several innovative forms of PV*

Good practice details	Regulatory / Non-Regulatory (NR)	Seen in
Customised and simplified approval processes	Regulatory	Italy, Germany
Financial support tailored to innovative forms of PV	Non-regulatory – Economic	Germany, France, Italy
Mapping of grid capacity and deployment potential	Non-regulatory – Technical	Spain, France, Poland, Greece, etc.
Platforms to foster better collaboration between authorities	Non-regulatory – Adoption	Germany
Knowledge building and stakeholders management	Non-regulatory – Adoption	Netherlands, Denmark, Germany

6.1.1 Customised and simplified approval processes

Delays in the planning and approval process are one of the key factors slowing down the uptake of renewables in the EU, as recognised by the *Commission Recommendation on speeding up permit-granting procedures for renewable energy projects and facilitating Power Purchase Agreements*[55] and by several other key publications since.[56] For innovative forms of PVs, the approval process is further complicated by interactions with concurrent approvals from additional authorities, as described in chapter 3 and 5, and by the fact that often the technology is not explicitly recognised in official regulations. Our research shows that this can be a significant issue for 4 of the 5 innovative forms of PV considered (VIPV is less affected, given the early stages of deployment).

[55] Commission Recommendation on speeding up permit-granting procedures for renewable energy projects and facilitating Power Purchase Agreements.
[56] European Commission, Enabling framework for renewables.

While speeding up the approval process is necessary for all renewables, some Member States have developed targeted process to speed up the approval of one or more of the forms of PV deployment considered in this review, or have explicitly allowed some forms of innovative PV within the simplified procedures. For example:

- The Italian government has set up a general simplified procedure for renewables (PAS – Municipal Simplified Procedure), which includes explicit provisions for Agrivoltaics and FPV (for projects up to 10 MW)[57].
- Since early 2023, small agrivoltaic installations in Germany are also included in the list of technologies that can obtain the approval faster and at lower cost, according to paragraph 35 of the German Building Code (BauGB)[58]. The German code requires the facility to meet the requirements for a special solar facility according to the EEG[59]. Additionally, the project must be in a spatial-functional connection with an operation according to § 35 (1) number 1 or 2 of the BauGB, the base area of the special solar facility must not exceed 25,000 square meters, and with only one facility operated per farm.
- Also in Germany, the building law distinguishes between specific types of use of the electricity. Floating photovoltaic systems are treated as a privileged project according to article §35 of Federal Building Code (Baugesetzbuch, BauGB), and some provisions simplify the permitting process and requirements in cases where the electricity is used for self-consumption, or for specific types of end-use. For example, if FPV is installed on an artificial water body belonging to a mining facility, and the electricity is used directly for mining activities, the facility can benefit from a simplified permitting process. For this exception to apply, at least 50% of the electricity produced needs to be used directly for the mining activity.

Such initiatives address one of the key barriers slowing down the planning and approval process of innovative forms of PV, namely gaps in the regulatory framework. When the regulatory framework explicitly addresses these forms of PV, local planners can proceed with the approval without facing the risk of later appeals.

6.1.2 Financial support tailored to innovative forms of PV

All Member States have implemented one or more renewable support schemes, with the aim of bridging the gap between the cost of renewable installations and the revenues that generators can expect to earn by selling in the energy market. In recent years, Member States have moved towards competitive allocation of subsidies, so that only the most cost-effective projects are awarded support. Member States are also moving towards the use of two-sided contracts-for-differences in order to address the revenue risk of the projects for mature renewable energy technologies while reducing or even eliminating net support throughout the lifetime of the projects. This however penalises more innovative technologies that have not yet achieved the cost reductions observed for established ones.

[57] Rinnovabili.it (2023) Decreto Siccità, ok a semplificazioni per il fotovoltaico galleggiante, AmbienteSicurezzaWeb.it (2023) Impianto Agrivoltaico : si puó ricorrere alla Pas?.

[58] § 35 (1) sentence 1, number 9 of the BauGB.

[59] Detailed requirements of the EEG are specified by the Federal Network Agency (BnetzA) and the aforementioned DIN SPEC.

To support promising, but not yet cost-effective, technologies some Member States have put in place dedicated support schemes or have reserved a part of the scheme budget for them. For example:

- The Italian Ministry for Environment and Energy Security has recently launched a support scheme dedicated to Agrivoltaics.[60] The operational rules are set by the System Operator (also in charge of managing the scheme), and provide further clarity for applicants and administrators in charge of approving planning requests.
- For BIPV, a practice found in several countries such as France[61], Italy[62] was the implementation of dedicated Feed-in Tariffs for BIPV, but this practice disappeared several years ago.
- For FPV, there are some incentives in Germany and Portugal[63].

Having dedicated support schemes has a number of beneficial effects on the viability of these technologies, on the supply chain and on the planning and approval process:

- Developers interested in specific forms of innovative PV deployment know that they can have access to support tailored to their technology. This is more likely to ensure a viable business case.
- The supply chain actors receive a clear signal from the government that these technologies are explicitly recognised and supported, reducing the risk of suppliers and installers that want to develop capacity and skills to offer these products.
- Administrators in charge of the planning and approval process have additional legal references necessary to guide them in their assessment of development applications.

These practices are also linked to those associated with the simplification of the planning and approval process: explicitly considering innovative forms of PV (both in the planning process and as part of support schemes) fosters their uptake by reducing barriers related to the supply chain and to the authorities in charge of approving the installations.

6.1.3 Mapping of grid capacity and deployment potential

A technical barrier that innovative (but also traditional) forms of PV face is related to challenges to integrate new generation capacity in the power grid, due to aspects such as grid connection procedures and the capacity of the distribution network to accommodate the new flows (for transmission-connected installations the latter is less often a concern, but does arise in e.g. the Netherlands[64], and may become more relevant in the future with increased RES penetration and electrification of end-uses). In practical terms, this barrier results in delays in the connection process, frequent curtailments, a connection that is unable to accommodate the full capacity of the new installation (an undersized connection capacity offered by the grid operator), or an outright rejection of the connection request. Networks of some Member States may also be facing challenges to meet new offtake connection requests.

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[60] MASE (2024) Decreto Agrivoltaico.

[61] BIPV was supported in France with a FiT called "Intégration au bâti" between 2006 and 2018 https://librairie.ademe.fr/energies-renouvelables-reseaux-et-stockage/5439-etat-du-photovoltaique-en-france-2020.html.

[62] BIPV was supported in Italy with a FiT called "Conto Energia" between 2006 and 2013.

[63] Portuguese government (2022) Leilão solar flutuante regista preço de energia mais baixo do mundo.

[64] TenneT – Grid capacity map.

Issues related to injection connection requests affect mostly agrivoltaics and floating PV which, unlike BIPV or IIPV, are more often located far from the transmission grid and can reach significant sizes. However, grid integration issues have also been observed in relation to BIPV in Germany, where applications for BIPV installations were rejected by the system operator on the ground of local capacity constraints.

A good practice being implemented in several Member States concerns the publication of information concerning the current grid constraints and plans for grid reinforcements. For example:

- RED Eléctrica, [65] is the Spanish electricity TSO. It provides easily accessible information about the connection nodes location and capacity.[66]
- RTE (France's electricity TSO) publishes maps and data covering current future constraint to the transmission of electricity.[67] Further, Réseaux Énergies[68], a project promoted by GRTgaz (one of the two gas TSOs) and RTE collects and publishes data concerning energy production, energy consumption, storage, mobility, infrastructures and other aspects of France's energy system. The portal allows to access several datasets that cover the transmission and distribution system, including new RES projects being developed.
- Netbeheer Nederland is the Dutch association of national and regional power network operators. It has set up a congestion map of the high- and medium voltage grid and the map is publicly available on its website. The map shows both capacity and congestion status, identifying areas that more congested, and thus signalling to potential developers where there are increasing constraints for the deployment of large-scale wind and solar power plants.[69,70] The electricity TSO TenneT publishes a complementary grid capacity map for the transmission level.[71]

This practice allows renewable energy developers to locate their project where the grid is less congested, which is likely to result in shorter connection time and less risk of curtailment orders to ease local congestion. Recognising the value of the practice, the obligation for system operators to provide more information on the availability of grid connection capacity is included in the provisionally agreed energy market reform: *Transmission system operators shall publish in a clear and transparent manner, information on the capacity available for new connections in their respective areas of operation with high spatial granularity, while respecting public security and data confidentiality, including the capacity under connection request and the possibility of flexible connection in congested areas. The publication shall include information on the criteria used to calculate available capacity for new connections. Transmission system operators shall update that*

[65] RED Eléctrica (2024) Conoce la capacidad de acceso.
[66] RED Eléctrica (2024) Capacidad de acceso a la red.
[67] RTE, Publication des études de contraintes.
[68] ODRE Open Data.
[69] Netbeheer Nederland, 2023 Capaciteitskaart elektriciteitsnet (netbeheernederland.nl)
[70] TenneT, 2023 Grid capacity map - TenneT.
[71] TenneT – Grid capacity map.

information on a regular basis, at least monthly.[72] See also paragraph 51 of the December 2023 proposal from the Commission for a Regulation to improve the Union's Electricity Market Design.[73]

Information over available network capacity can be complemented by information concerning the potential for the deployment of innovative forms of PV, such as a national database on water bodies. The Spanish government, Ministry for the ecological transition (MITERD) has developed a national database of artificial water bodies and the respective water quality[74]. This database gives developers visibility on the surface area potentially available for each location.

6.1.4 Platforms to foster better collaboration between authorities (agrivoltaics)

Innovative forms of PV often require the close collaboration of many stakeholders, both on the supply chain side and on the administrative side. On the latter, there exist regulatory and practical limits that hinder a more efficient and coordinated process. Regulatory limits, as explored in chapter 3, are usually related to the lack of explicit provisions that the responsible body can refer to during the approval and permitting process, as well as unclear perimeter of responsibility, in some circumstances. This barrier becomes more consequential because of the lack of open communication channels among the interested authorities (which is not surprising, as the need for close collaboration may have not been present in the past). This has been observed across four of the innovative forms of PV explored in this research: Agrivoltaics (conflicts between agricultural provisions and requirements to access generation support schemes), IIPV (conflicts between transport regulation, infrastructure-related provisions and technical requirements of the PV installation), FPV (conflicts related to environmental protection and the technical requirements of the PV installation) and BIPV (conflicts between the building codes, planning laws, and availability of suitable materials for the PV installation).

In order to overcome these barriers, several Member States have set up formal coordination platforms or fora; these bring together institutional actors with the aim of fostering collaboration and finding practical solutions to the barriers imposed by the regulatory framework (or by the lack of adequate provisions). The regular and semi-formal character of these initiative ensure a wide participation and effectiveness of the meetings, as institutional actors develop the relationship over time. For example, on IIPV or FPV, in the Netherlands coordination initiatives, such as meetings and discussions are regularly held[75] between different public authorities both at national and local level. In Germany, there is an annual meeting[76] on agrivoltaics between agriculture, energy, education and environment authorities where the topic is discussed from different viewpoints and cross-ministry implications.

There are a number of limitations to the effectiveness and potential replicability of this practice:

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[72] See Proposal for amending Regulations (EU) 2019/943 and (EU) 2019/942 as well as Directives (EU) 2018/2001 and (EU) 2019/944 to improve the Union's electricity market design - Analysis of the final compromise text with a view to agreement, changes to Article 50: *4a.*

[73] ibid, page 37.

[74] MITERD (2021) Masas de agua PHC (2015-2021).

[75] Deelnemers (zonopwater.nl) and Agenda (zonopinfra.nl).

[76] "Ressortgespräche Agri-PV" meetings, organized by Bundesministerium für Bildung und Forschung (BMBF), taking place within this project: SynAgri-PV – Synergetic Integration of Photovoltaics in Agriculture as a Contribution to a successful Energy Transition - Fraunhofer ISE.

a. While an open discussion will help solve issues related with coordination and "grey areas" of the regulatory framework, administrative bodies have to follow the official laws and regulations. If these hinder certain forms of deployment, administrators may have limited options to bring the process forward.
b. Often, the bottleneck of the planning and approval process are local administrations, which may lack resources and knowledge to facilitate these initiatives. Involving all of them in a single forum could pose significant practical challenges.

The limitations listed above however offer some important opportunities:

a. The platform could play a part in identifying the main issues of the regulatory framework and become an active part in the policy-making process. The insights gained by the administrators directly involved in the process would ensure that inputs provided to the legislator (or to the regulatory body) is already sufficiently developed.
b. The platform could play an important part in creating and disseminating knowledge on the subject. This would support smaller (and less well resourced) administrations in understanding the subject and how to deal with it by providing resources and practical guidance (rather than providing access to the platform directly). Complementarily, local coordination platforms led by local institutional actors could be incentivised, and be focused on the issues that cannot be talked at national level because they are dependent on the local environment.

While the focus on this project is on innovative PV, these platforms could also cover other renewable technologies, bearing in mind the risk of diluting too much the discussion if too many issues are brought at the same table.

6.1.5 Knowledge building and stakeholder management

The lack of a trusted source of information for these innovative forms of PV deployment is a rather common barrier that affects the potential deployment (not only of innovative PV but also of other innovative renewable technologies) in different ways:

- Potential buyers may be discouraged because they are unable to find reliable and consistent information on the advantages and disadvantages of the technology;
- Planning administrators may struggle to properly assess planning applications submitted;
- Project developers may struggle to communicate the benefits of their project, and fail to win the approval of local administrators and local communities. Similarly, the supply chain may have difficulty in communicating the benefits of their technology to planners, architects and final clients.

A good practice found in several countries (Netherlands[77], Denmark[78], Germany among others) involves the creation of an independent body, which acts as an information repository and supports different stakeholders in solving the problems identified above. As an alternative, these functions can be assigned to an existing body with an aligned remit, such as an energy agency. The main role of the independent body may include issuing fact sheets (summarizing key information about innovative PV technologies, materials, and applications); the publication of reports and guidelines that delve deeper into specific aspects (such as emerging trends, best practices, and expert advice);

[77] Milieu Centraal started in 1998 on the initiative of the then Ministry of Environmental Management (VROM).
[78] The Danish Energy Agency.

and the management of a list of accredited suppliers and installers. Such an entity is likely to have a wider remit than only innovative PV, and may also serve as a hub to foster collaboration among stakeholders by:

- Supporting the supply chain in identifying potential partners, considering factors like expertise, industry alignment, and shared goals. Potential partners could be other companies, research institutions, or individual experts.
- Encouraging collaboration by promoting common initiatives, part- or fully-funding these when feasible.
- Supporting public authorities in assigning public funds to research projects or product development.
- Organising networking events, workshops, and matchmaking between potential partners.

6.1.6 Recommendations

Based on the barriers and good practices identified, we propose a series of actions to support the deployment of all innovative forms of PV.

1. Member States, National Regulatory Agencies, and other authorities involved in the planning, approval, and implementation of innovative forms of PV deployment, as well as those responsible for setting up financial support schemes, should:
    a. **Explicitly recognise and address these forms of innovative PV deployment within the regulatory framework.** While the judgement of whether these forms of PV should be incentivised or financially supported remains a policy decision that should be based on national objectives and circumstances, the legal status and planning rules applicable to innovative forms of PV should be defined as clearly as possible at national level.
    b. **Consider whether these innovative forms of PV deployment should be regulated under a dedicated policy framework** in relation to other innovative forms of renewable generation, and in relation to more established forms of PV deployment, such as rooftop and ground-mounted installations. Such a framework may involve different planning and approval process, and a different fiscal regime.
    c. Noting the additional benefits provided by these innovative forms of PV deployment, their higher cost, and specific barriers they face, Member States should consider:
        i. **targeted support measures of a regulatory nature**. These could include a simplified / prioritised permitting process, or enhanced support during the early development phase.
        ii. **dedicated financial support schemes** (where innovative PVs do not have to compete with traditional PV), with the aim of developing the supply chain and lower their cost over time. While the majority of innovative PV forms can be financed with the more common support measure design types (e.g., feed-in tariffs, CfDs), other forms will require other common measures of support, such as development grants (for example, for BIPV and for VIPV).

2. Member States should **promote the development of cooperation platforms to bring together key actors involved in the deployment of innovative forms of PV**, including relevant

ministries, national authorities, and planning bodies. The primary objective of these fora would be to increase coordination, ensure a clearer division of responsibilities, identify gaps in the regulatory framework and find solutions to fill these gaps. These platforms should encourage regular sessions among established participants, so that working relationships are developed and strengthened over time.

3. Energy agencies, or equivalent bodies, could play a key role in **creating a link between the platforms suggested under the previous recommendation and other key stakeholders**. They could support:
    a. Local administrations, for example by providing learning resources and support during the application process;
    b. One-stop-shops, by handling requests related to these innovative forms of PVs.

    Further, energy agencies or equivalent bodies should consider the organisation of information campaigns aimed at disseminating knowledge about innovative forms of PV deployment. Such campaigns would provide neutral and objective information to the supply chain actors and the wider public. As part of these campaigns, authorities could setup national, regional and provincial-level initiatives and consultation meetings to increase acceptance among the wider public, as well as gather further feedback on specific challenges and barriers encountered by developers.

4. To support innovative forms of PV deployment (primarily, but not exclusively, Agrivoltaics and FPV), Member States should consider:
    a. **Mapping suitable areas**, or identifying criteria for the identification of suitable areas, for agrivoltaics and FPV.
    b. Encouraging **system operators to comply with the new transparency requirements** of the provisionally agreed EU electricity market reform ahead of time. When developing maps and indicators to represent capacity available for new connections, system operators should ensure this dataset can be linked to the one developed at point *a* above.
    c. Explicitly **identifying the conditions for the inclusion of these forms of PVs within the Renewable Acceleration Areas** defined by Article 15c of Directive 2023/2413 (Renewable Energy Directive), taking into account the designation criteria included in that Article.[79] The mapping exercise referred to in point *a* could be included in the preparatory work necessary for the setup of acceleration areas.

6.2. Agrivoltaics

This section presents a list of good practices for the promotion of Agrivoltaics, and a list of recommendations to support its deployment.

*Table **Error! No text of specified style in document.**-26 Good practices identified for Agrivoltaics*

Good practice details	Regulatory / Non-Regulatory (NR)	Seen in …
Fiscal rules and aid to farming	Regulatory	Germany
Flexible regulation focussed on benefits	Regulatory/ Economic	France, Germany

Exempt agrivoltaics from (certain) zoning requirements	Regulatory	Austria (Styria)

6.2.1. Fiscal rules and aid to farming

Farming activities across Europe often benefit from advantageous tax treatments and aid payments, such as those distributed as part of the Common Agricultural Policy. The installation of Agrivoltaics may put these financial benefits at risk because of the way the national schemes for supporting agricultural activities are designed. For example, they may exclude land subject to dual use, or the revenue from energy generation may affect the way in which support payments are calculated. Stakeholders in Austria, Belgium, Luxembourg, Netherlands and Poland explicitly expressed concern with this issue, but it is likely that such a risk applies to most Member States to some extent.

To overcome this barrier, paragraph 12(5) of the German CAP Direct Payments Regulation (GAPDZV) considers land used for agrivoltaic installations eligible to receive direct payments if:

- (1) the facility does not exclude the cultivation of the area using usual agricultural methods, machines, and equipment;
- and if (2) the facility reduces the agriculturally usable area by a maximum of 15 percent based on the DIN specification 91434. If those conditions are fulfilled, as a lump sum, 85 percent of the area is considered eligible to receive CAP payments.

With this provision, the German legislator manages to address the problem (providing certainty to farmers), while at the same time imposing sensible limits to the extent the agricultural activity has to be sacrificed for the production of energy, and thus avoiding abuses (for example, installing PV systems that do not allow for the use of machinery, and thus significantly reducing the agricultural value of the area).

The German legislator also addresses the issue related to taxation, with a decree, published in the Federal Tax Gazette[80], that establishes that areas concerned with Agrivoltaics installations maintain their status as agricultural land or forested area, with the associated tax benefits.

6.2.2. Flexible regulation focussed on benefits

While the clarity offered by the German legislator in the previous example provides certainty to potential developers, a regulation with too strict parameters can also represent a barrier, as it may exclude otherwise suitable business models. An example was identified for Italy, where the Guidelines for Agrivoltaic Installations[81] define a fixed "Land Area Occupation Ratio" (between the *total footprint of the agrivoltaic system* and the *total surface area occupied by the agrivoltaic system*), requiring that at least 70% of the surface is intended for agricultural activity, in compliance with agricultural best practices. When the farming land is highly fragmented, as it may happen in some parts of Italy, achieving the threshold is challenging and may make the business case more complicated.

[80] "Bundessteuerblatt (BStBl) I 2022, page 1226, “Gleich lautende Erlasse der obersten Finanzbehörden der Länder”, “Zurechnung und Bewertung von Agri-Fotovoltaik-Anlagen", 15th of July 2022.

[81] MASE (2022) Linee Guida in materia di Impianti Agrivoltaici.

Another example could be “green fences” required around agrivoltaic installations. The Danish regulator requires PV installations to be hidden behind trees or bushes of appropriate height. However, trees need 3 to 5 years to reach the required heights, and once they reach it, they may cast their shade on the panel, reducing the output of the installation.

Stakeholders interviewed as part of this research have highlighted the need for regulation that is sufficiently precise but that, at the same time, allow market players to develop innovative business models. With the law 2023-175 of March 2023[82], the French government provides a new framework for the installation of Agrivoltaics, "while keeping the priority given to food production", and thus reconciling the issues of food sovereignty and energy autonomy.[83] According to stakeholders[84] and experts consulted as part of our interview campaign, the new law offers sufficient flexibility while at the same time preserving the nature and scope of traditional agricultural activities. For example, rather than setting strict coverage parameters, the new law focuses on the agronomic result, while allowing a certain flexibility based on the specific conditions of the installation.

6.2.3. Exempt agrivoltaics from (certain) zoning requirements

Zoning requirements, i.e. the parameters that set which activities can be performed in a certain area, are a significant challenge for Agrivoltaics, given that, by definition, this technology is implemented on areas dedicated to agriculture. Dual-use restrictions, land re-designation requirements, and limits to where PV can be installed (so-called “photovoltaic eligibility areas”) have been reported as a regulatory barrier to Agrivoltaics in several Member States (see chapter 4.2 of this report). Besides instances where the dual use is expressively prohibited, when this is allowed there are lengthy and complex planning procedures to overcome, which discourage potential developers.

A good practice to address such barriers has been introduced in the Austrian province of Styria, which expressly defines Agrivoltaics in the Styrian Spatial Planning Act[85], and addresses the barriers listed above. The Act explicitly permits the construction of agrivoltaics in a grassland area of up to 0.5ha without the need for a special land redesignation. In addition, Agrivoltaics is promoted by exempting it from the general statutory ban that prohibits PV installations in the so-called “exclusion zones”[86]. These provisions mean that no special land re-designation – which is mandatory in the rest of Austria in these cases – is required for small Agrivoltaics installations. Moreover, Agrivoltaics can be established within existing exclusion zones, significantly extending the areas where the technology can be applied.

The exemption from the land re-designation requirement and other preferential treatment in the planning process for Agrivoltaic is broadly similar to the measures taken by other Member States at national level concerning smaller installations (see for example Italy, with a simplified procedure for installations of small size). Exemptions for smaller installations offer a good balance between supporting the deployment innovative forms of PV deployment without compromising too much on the objectives and interests that regulations and planning laws are protecting, such as environmental conservation, landscape protection, rural economies, and the rights of the local population.

[82] Journal officiel "Lois et Décrets": JORF n° 0060 du 11 mars 2023 - Légifrance (legifrance.gouv.fr).

[83] Ministère de l’agriculture et de la souveraineté alimentaire.

[84] See for example the communication from FNSEA, the National Federation of Agricultural Operators’ Unions.

[85] Steiermärkisches Raumordnungsgesetz 2010, StROG, LGBl Nr 49/2010.

[86] Exclusion zones (*Ausschlusszonen*): zones defined by the local or provincial government in the local development plans. In such exclusion zones PV installations are usually banned.

6.1.4 Recommendations for promoting the deployment of Agrivoltaics

Based on the barriers and good practices identified, we propose a series of actions to support the deployment of Agrivoltaics.

1. Concerning the issue of tax status and CAP payments:
    a. Member States should **clarify the parameters and limitations that Agrivoltaics installations must meet in order not to affect CAP payments and tax benefits**. In doing so, they should aim to be as consistent as possible with the definition of Agrivoltaics that is used as part of the planning and permitting process.

    b. The European Commission should examine this aspect as part of the next assessment of the CAP Strategic Plan regulation[87] in 2025 and should **consider whether is necessary to develop stricter EU guidelines on this issue**. For example, the Commission may consider issuing an official definition of Agrivoltaics for the purpose of CAP payments and set some general criteria to guide Member States in defining thresholds and parameters at national level.

2. Member States should **setup an appropriate regulatory framework that aims to maximise outcomes and synergies between energy generation and agricultural activities**. The framework should be:
    a. sufficiently robust to avoid unsustainable practices and the loss of agricultural land;
    b. able to support innovative business models, which are fit for the specificities of each region and different farming activities;
    c. able to accommodate further innovation in Agrivoltaics technologies, as well as the transition to more sustainable farming practices (for example, considering that the move to organic farming may reduce yield).

    Revenues from energy generation could play an important part in supporting rural livelihoods and reduce the burden of CAP payments, but agricultural best practices, sustainable farming and nature conservation must be explicitly addressed and protected by the framework.

[87] Regulation (EU) 2021/2115 of the European Parliament and of the Council of 2 December 2021 establishing rules on support for strategic plans to be drawn up by Member States under the common agricultural policy (CAP Strategic Plans) and financed by the European Agricultural Guarantee Fund (EAGF) and by the European Agricultural Fund for Rural Development (EAFRD) and repealing Regulations (EU) No 1305/2013 and (EU) No 1307/2013.

6.3. Floating PV (FPV)

This section presents a list of good practices for the promotion of Floating PV, and a list of recommendations to support its deployment. In December 2023, Solar Power Europe has published an extensive report dedicated to Best Practice Guideline for Floating PV[88]; this report aims to complement this work drawing on those practices more related to the barriers we identified.

*Table **Error! No text of specified style in document.**-27 Summary of good practices in FPV*

Good practice details	Regulatory / Non-Regulatory (NR)	Seen in …
Flexibility in the permitting process	Regulatory	Netherlands Belgium, Germany
Develop hybrid installations to lower costs	Non regulatory – Economic	Poland, Spain

6.3.1 Flexibility in the permitting process

The installation of PV on water bodies is often hindered by a complex permitting process, due to the need to ensure the protection of the water body and its surroundings. Lakeside environments are often rich in biodiversity and rely on delicate water cycles, which an FPV installation may disrupt. A traditional permitting approach for energy installations requires that an application must meet all requirements to avoid being rejected. For technologies such as FPV, for which there is little practical experience, and whose impacts are highly dependent on the specific location chosen for their installation, such an approach poses a significant barrier. This section elaborates on the general good practice described in 6.1.1 (simplified approval process), with examples specific to FPV.

A good practice to mitigate such issues is opting for a more flexible permitting process, which allows the applicant to modify some parameters after the initial submission. In the Netherlands, the permitting authorities have the possibility to request modifications to the proposal submitted (rather than issuing a flat-out rejection); the requests may concern the attainment of some minimum requirements, or modification to specific details of the FPV project (for example, its size, location, technical aspects). This helps to speed up the permitting process and allows to reach a positive conclusion more often. Further, the Dutch Foundation for Applied Water Research – STOWA – has issued guidelines and tools for developers interested in floating PV projects across the Netherlands. The analysis tool allows developers to visualise the possible effects of solar panels on water quality (measured by several indicators), with the possibility to tailor the analysis to the characteristics of the concerned water body and the design of the FPV system[89].

More focused examples of flexibility have been observed in other countries. These can be found, for example, in the revised regulation for PV in Germany and in the Netherlands, in respect to the mitigation of ecological impacts. Disruption to local habitats is inevitable when an FPV plan is installed and during its operations. For example, habitats would be affected by the equipment used

[88] SolarPower Europe (2023) Floating PV Best Practice Guidelines.

[89] Commissioned by STOWA (Foundation for applied research on water management) and Rijkswaterstaat (organization of Ministry of Infrastructure and Water Management) and made available by Deltares and Colibri Advies. https://www.pv-magazine.com/2019/02/27/the-promised-land-of-floating-pv-now-has-guidelines-for-proper-deployment/.

for the installation, by the anchoring infrastructure and cabling, and by the shadow cast by the panels on the water. As some of these disruptions are inevitable, developers can propose options to install “compensation” measures. One of these is the installation of "bio huts", which are boxes or cages placed under water: these solid structures allow plants to form strong roots and provide shelter to smaller fish and invertebrates. If these measures are identified with experts and in consultations with the local community, the risks of unintended consequences due to these actions is mitigated. This measure has been observed both in Germany and in the Netherlands.

Also in Germany, other flexible approaches to FPV regulation have been discussed in recent years:

- A key parameter used to mitigate the impacts of FPV on water bodies is to limit the size of the PV plant in relation to the size of the water body (specifying the maximum ratio between PV surface and lake surface). However, when this is done without consideration for the specific project characteristics and impacts, it leads to viable projects being rejected without valid environmental reasons. An alternative is to also consider the size and type of water body, as done in Germany. The Bundesrat, which represents the 16 federal German states, has submitted a proposal to remove the 15% area limit for floating photovoltaic (PV) plants on artificial lakes.[90] However, this would be balanced with a restriction that floating PV systems should be installed only on artificial lakes or already developed water bodies, such as quarry ponds, in order to prevent negative ecological effects on natural environments. However, the Bundestag has not included the measure in the revised Renewable Energy Sources Act (EEG 2023)[91] and the Water Resources Act (WHG)[92].
- A similar limitation, found regularly in national regulations across Europe, concerns the minimum distance to the shore for the FPV installation. Similarly, to the case of size ratios, the German Water Resources Act includes a minimum threshold that requires installations to be placed 40 metres from the shore. An alternative approach would see the minimum distance vary with the type of water body, and the characteristics of the lake shore. Such an approach may, for example, consider differently shallow sandy shores, steep rocky cliffs, or densely vegetated sides, evaluating the risks to the natural environment (habitat degradation, biodiversity loss) and the risks to the FPV installation (strong currents, fall of boulders from high lake shores).

A similar approach can be found in Israel, where a significant number of water bodies suitable for FPV exists, while land availability is a constraint. The Israeli regulator categorises water bodies according to their type:

- “dirty water bodies” (handled by the Ministry of Health) with defined clear limits on FPV area versus water body area according to water quality
- “rain or flood reservoir”: FPV can cover 100% of the surface area

[90] Germany's Bundesrat approves removal of 15% area limit for floating PV plants (renewablesnow.com)
[91] Erneuerbare-Energien-Gesetz.
[92] Wasserhaushaltsgesetz.

- Most reservoirs are artificial, so there are no environmental restrictions applying, a situation quite opposite to Europe.

The permitting process is managed by water companies and is carried out according to construction law, as FPV are considered equivalent to rooftop installations. Construction law defines the criteria to be respected by the reservoir and by the FPV installations. The permitting process is usually fast (<6 months), largely because FPV are exempted from the more stringent environmental requirements found in Europe. For example, FPV can be installed without the need for a zoning plan.

Due to the novelty of the technology, there is only very limited evidence to fully understand the impact of an FPV plant on different types of water bodies, and the risks to the integrity of the FPV installation. While the 15% and 40 meters limit (imposed by the German Water Resources Act) seems reasonable as a no-regret option, providing distinctions based on the ecological value of different water bodies and the specific risks to the FPV plant, together with an elaborate guidance (such as the one provided by STOWA in the Netherlands), seems to be a more effective approach. As seen for the Agrivoltaic decree in France, adopting a flexible approach that consider the specificities of the installation and its surrounding often leads to increased deployment with limited environmental risks.

6.3.2 Develop hybrid installations to lower costs

High installation costs are one of the main barriers for the development of innovative PVs, in particular FPV (investment costs of FPV are usually 15-30% higher than for ground-mounted PV). An effective way to reduce the overall project cost per MW installed is to opt for hybrid installations, where FPV share some of the infrastructure with other installations.

In Poland, there are examples of FPV developed alongside ground-mounted PV. This approach lowers the overall development cost, mostly due to the sharing of some equipment and fixed costs, such as grid connection costs. Further, some projects managed to complement the production from FPV and ground-mounted PV, as they have been installed with different orientations and therefore are able to provide power with an extended and smoother profile during the day.

Similar benefits could be achieved by the co-location of FPV in artificial water bodies where a hydroelectric dam already exists. This practice provides multiple advantages:

- The water body is artificial and the natural environment has already been affected by the construction of the dam;
- An active hydroelectric dam has a grid connection, and often of significant capacity. Accommodating additional generation from FPV would usually not be a problem;
- There would be other infrastructure that can be shared between the two installations, further reducing the cost of the FPV.

Projects where the dam operator is the one in charge of the FPV plant clearly pose less challenges, while co-location may present some coordination challenges in case the dam operator and the operator of the FPV plant are not the same entity. In particular, the dam operator may have limited interest in collaborating, or may prioritise the safe operation of the dam versus the limited benefits it can gain from sharing infrastructure.

6.3.3 Recommendations for promoting the deployment of FPV

Based on the barriers and good practices identified, we propose a series of actions to support the deployment of Agrivoltaics.

1. Member States should **define guidelines and rules for FPV which are flexible and tailored to the different types of water bodies** found in their country. The national framework should:
    a. Define a methodology and/or criteria for FPV that vary with the nature of the water body, its location, and the potential for environmental damage - considering more lenient criteria for artificial water bodies and water bodies with limited biodiversity or depending on location. For example, avoid imposing requirements related to snow and ice for FPV located in areas with minimal snowfall.
    b. Avoid relying on too rigid parameters to define the extension, location and characteristics of FPV plants.
    c. Define guidelines that consider the specificities of the water bodies, as well as the potential benefits that an FPV installation can bring. For example, requiring the installation of features that benefit the local wildlife.
    d. Support developers to identify the most suitable approach to develop FPV, for example by adopting a more flexible permitting process, issuing early opinions and advice on how certain issues can be addressed.

2. The European Commission should consider **issuing a set of guidelines to support Member States in defining the methodology** discussed at the previous point. According to the EU Water Framework Directive, the ecological potential of an Artificial or Heavily Modified Water Body should not be deteriorated, but this poses the risk of excluding large water areas with limited biodiversity from the opportunity to develop FPV.

3. Due to the complexity of interacting factors and impacts of FPV and the environment, the European Commission and Member States should **develop guidelines and assessment tools to support the identification of environmental impacts** (including potential benefits); complementary to these, Member States should provide tools to support developers in navigating the permitting process.

6.4. Building Integrated PV (BIPV)

This section presents a list of good practices for the promotion of Building Integrated PV, and a list of recommendations to support its deployment.

*Table **Error! No text of specified style in document.**-28 Summary of good practices in BIPV*

Good practice details	Regulatory / Non-Regulatory (NR)	Seen in …
BIPV product certification	Regulatory	Austria, Denmark, Switzerland, etc.
Obligation for on-site generation	Regulatory	Switzerland, Austria
Knowledge and skills	Non-regulatory - Adoption	Switzerland, Germany, France

6.4.1 BIPV product certification

In order to be usable as a building element, BIPV needs to undergo a stringent certification process. This is to comply with the legal requirements related to the CE marking, which cover safety, health, and environmental protection requirements. PV panels to be used as part of a building need to comply with the following directives[93]:

- Construction Products Regulation (CPR) 305/2011, which defines harmonized rules for the marketing of construction products in European Union.
- Low Voltage Directive (LVD) 2006/95/EC, which ensures that electrical equipment within certain voltage limits provides a high level of protection for European citizens and benefits fully from the Single Market. It also implies compliance with the harmonized standard EN 61730: "Photovoltaic module safety qualification".
- Electronic Electromagnetic Compatibility (EEC) Directive 2014/35/EU, which ensures that electrical and electronic equipment does not generate, or is not affected by, electromagnetic disturbance.

The standard EN-50583[94] applies to photovoltaic modules used as construction products. The standard references the European Construction Product Regulation CPR 305/2011 and the applicable electro-technical requirements, as stated in the Low Voltage Directive 2014/35/EU or CENELEC standards. EN-50583-1:2023 is the revision of the 2016 standard currently in force, which includes significant improvements that make it closer to a building standard. The process to convert it into a mandated, harmonised product standard according to the CPR is also in progress.

However, according to manufacturers, the certification process is too demanding and costly. A recent paper published by Irena[95] considers this in more detail, analysing the cost and benefits of certified quality assurance process at every step in the value chain; it concludes that, overall, the benefits of high-quality components and processes outweigh the costs both for project owners and for the supply chain. However, some Member States (such as France and Germany), pose a high number of requirements on BIPV modules, which discourages potential applications and increase their cost. Other Member States have put in place simpler processes for the certification process of BIPV:

- In Austria and Switzerland, conformity of BIPV modules with EN 50583 is included in the technical regulations but is not mandatory.
- In Spain, EN 50583 is not included in the technical regulation.
- In Denmark, BIPV panels are considered as "electrical parts" and not as a building element. While this particular practice is debatable, this allows manufacturers to sell their products at lower costs and allows them to offer a wider range of innovative options.

While the less regulated approach for BIPV found in several Member States may simplify their adoption and incentivise its use in the short term, having products that conform to an established standard, and having the building regulations refer to such standard, facilitates the work of planners, engineers and authorities in charge of approving the construction project. Further, the official

[93] Also described in this document (D1.2 Regulatory framework) on BIPV from PVSITES project, 2016 BIPV.

[94] Link to standard: Standards.iteh.

[95] Irena (2017) Boosting Solar PV Markets: the role of quality infrastructure (irena.org).

recognition in technical guidelines would remove safety and other concerns that the public may have over these products.

As compliance with the standard is not required everywhere in Europe, manufacturers may choose not to seek certification and target the less regulated markets. This may have some advantages, for example allowing manufacturers to test innovative products at scale, and further improve them before having to invest in expensive certification. However, if EN 50583 had the status of a mandated, harmonised product standard, its adoption into Member States' building codes would be mandatory, which would facilitate harmonisation and favour the safest and more robust BIPV products that managed to obtain certification.

6.4.2 Obligation for on-site generation

The provisionally agreed recast Energy Performance of Buildings Directive (2010/31/EU)[96] defines new and ambitious efficiency targets that new and refurbished buildings in the EU must meet, via definitions such as "nearly zero-energy building" and "zero-emission building". Achieving these performance levels requires, in the majority of cases, the installation of on-site generation, usually PV. However, where roof space is not sufficient, BIPV may become the only feasible solution to achieve the needed target.

For example, some Member States or regions have gone further by defining specific requirements for the amount of building electricity use to come directly from PV panels located on-site. For example, the Austrian state of Vienna requires that 1 kW of PV panel must be installed for every 150 m^2 of building surface, equivalent to 6,6 W/m^2. In Switzerland, buildings with a total floor area above 300 m^2 are required to have 10 W/m^2 of PV panel installed. In many cases, this may be achievable only with the use of BIPV, as the roof space may not be sufficient to meet this obligation.

6.4.3 Knowledge and skills

Compared to Agrivoltaics and FPV, which can be considered stand-alone, purpose-built installations, BIPV are an element (often a minor one) in a much broader building project. BIPV therefore must be integrated in the construction process, posing new challenges in the planning and execution phase. During the latter, close coordination between builders and electricians is needed; while this is a well-established practice in any construction project, experts and practitioners highlight significant new challenges. These are generally related to the novelty of the technology, and the fact that it often blurs the perimeter of responsibilities between the builder and the electrician. Further, planners and architects must bridge a knowledge gap, and play a significant role in promoting social acceptance.

In order to solve the problem, countries such as Germany and Switzerland have established training courses dedicated to BIPV professionals. As an example, the *BIPV-Initiative Baden-Wuerttemberg* is an information programme primarily addressed to architects and planners, which provides guidelines (covering issues related to technical/architectural aspects and requirements of the planning process) and hand-on support to pilot projects[97]. In Switzerland, the national solar association (Swissolar) organises training courses on PV for planners, public authorities, and professionals. As part of its offer, several modules are targeted at BIPV, such as application to façades[98].

6.4.4 Recommendations for promoting the deployment of BIPV

Based on the barriers and good practices identified, we propose a series of actions to support the deployment of BIPV.

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[96] 'Fit for 55': Council and Parliament reach deal on proposal to revise energy performance of buildings directive

[97] BIPV-Initiative Baden-Württemberg.

[98] Swissolar, Formation continue.

1. The European Commission should **mandate prEN 50583-1:2023 as a Harmonized Product Standard under the Construction Product Regulation (CPR)**; EU-wide recognition that BIPV modules are building products, and thus fall within the scope of the CPR, would clarify that BIPV installations fall under building code requirements and as such are subject to building permitting processes. At present, this is not the case in some Member States, which means manufacturers may have to comply with different provisions across the EU. A mandate to recognize the revised standard EN 50583-1 as a harmonized product standard would also allow simplify the procedures for permitting, reducing the cost and time needed to install the technology. Additionally, the compliance with the requirements of testing standards (external review or on-site documentation) should be documented, using the procedure currently applied for laminated glass as a guideline.[99]

2. **Member States should not require additional certification for BIPV modules** but should rely on the revised version of EN 50583, as its scope addresses all essential requirements of the Directive 89/106/EEC for construction products. This would simplify approval procedures for international manufacturers. Further, the proposed fire-safety product classification in prEN 50583-1:2023 should be in in each Member State's building code as the basis for addressing fire safety of BIPV installations.

3. In order to reach the targets sets by the revised EPBD, Member States should **consider defining specific thresholds for a minimum amount of PV based on the size of the building**. This obligation may apply to new medium to large buildings, and over time be extended to existing buildings undergoing major renovation. Based on the identified best practices, the obligation could concern buildings larger than 150 m2, and may require the installation of least 6 W/m2 of PV per m2 of floor area.

4. Member States should **work with relevant national institutions and professional bodies to promote professional training on BIPV**. The training offer should be targeted to the entire supply chain, with a particular focus on building professionals (architects, builders, and installers).

6.5. Infrastructure Integrated PV (IIPV)

This section presents a list of good practices for the promotion of IIPV, and a list of recommendations to support its deployment.

*Table **Error! No text of specified style in document.**-29 Summary of good practices in IIPV*

Good practice details	Regulatory / Non-Regulatory (NR)	Seen in …
Assess potential, develop business models, and build knowledge	Regulatory and non-regulatory – Adoption	Netherlands, Germany, Austria, Switzerland
Fill in the regulatory voids and develop	Regulatory / non regulatory	Austria, Netherlands

[99] The authors submitted this recommendation to the National Mirror Committee to CENELEC TC 82 on 1 February 2024, during the call for comments on prEN 50583-1

guidelines		

6.5.1 Assess potential, develop business models, and build knowledge

IIPV can be integrated on many different types of infrastructure (roads and parking spaces, railways, water infrastructure), in different ways (for example, on the side of bridges, alongside roads, as pavement on cycling routes), and perform different functions (provide shading, act as a noise barrier). However, IIPV can present technical challenges and often increases substantially the cost of already expensive infrastructure. In order to improve the feasibility of IIPV projects, including identifying an appropriate location and an appropriate business model, requires comparing the many different options, and identifying the ones that offer the best opportunity. To do so, authorities should first aim to identify the potential for IIPV development in their area by funding dedicated studies.

Countries where IIPV has been deployed, such as the Netherlands, Germany and Switzerland have all commissioned several pieces of research in the past. For example:

- *The potential of PV noise barrier technology in Europe (2000)*[100] presents the potential of PV noise barriers along highways in six different European countries. The study that was funded by the European Commission, DG Energy (DG XVII at the time) and the Swiss Federal Office for Education and Science.
- *Business feasibility of a solar ribbon along the Betuweroute*[101] *(2013).* The study addresses the opportunities for having solar power generation along a long rail/highway track (more than 100 km and with the installation of south-facing noise barriers in part of the track) from a business perspective. It outlines three business models and details four corresponding business cases. The feasibility study was funded by the Dutch Province of Gelderland, initiated, and executed by a private advisory firm in The Netherlands.
- *Verkehrsträgerübergreifender Austausch von Erneuerbarer Energie (2022)*[102]. The study was published by Germany's Federal Highway Research Institute (*Bundesanstalt für Straßenwesen*). It covers solutions for the increased generation and use of renewable energies along road, rail and waterway infrastructure.
- *Potenzial für Photovoltaik an Bundesfernstraßen (currently running)* [103]. The study investigates the overall capacity and yield potential in the main road network in Germany and is funded by Germany's Federal Highway Research Institute (*Bundesanstalt für Straßenwesen*).
- *Potenzialanalyse von Photovoltaik an der Schiene (currently running)*[104]. This study is funded by the *Deutsches Zentrum für Schienenverkehrsforschung* (DZSF) and assesses the potential yield from PV installations at the German railway network.
- *The Solar Highway project (currently running)*[105] is investigating the technical and economic feasibility of integrating double-sided solar panels into noise barriers along motorways.

Based on these and other studies, several successful IIPV projects have been implemented:

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[100] Goetzberger et al. (2000) The Potential of PV Noise Barrier Technology in Europe.

[101] DNV KEMA, March 2013.

[102] BAST: Verkehrsträgerübergreifender Austausch von Erneuerbarer Energie.

[103] Fraunhofer ISE (2022) Neues Projekt erfasst Photovoltaik-Potenzial an Fernstraßen.

[104] TUV Rheinland: Potenzialanalyse von Photovoltaik an der Schiene.

[105] Rijkswater: Solar Highway: Innovative noise barrier.

- Switzerland was the first country demonstrating so-called "PV noise barriers". Along the A13 highway, the Swiss Authority installed a 100 kWp PV power array in 1989. After 24 years of operation its yield was still 85% of the original value, while its panels have never been cleaned.
- Use of solar panels at the entrance of tunnels[106], found in Switzerland and Austria: the entrance of road tunnels is often a vertical façade developed to some extent as part of the road facility. Adding PV panels to the facade and surrounding ground allows the generation of electricity that is then used to illuminate and ventilate the tunnel. Given that generation and use of electricity happens in the same place, there are significant cost savings, which enhance the economic viability of the project.
- Switzerland was also the first country to install photovoltaics along railways; in 1992 at the rail station of Gordola, and in 2008 with bifacial PV modules at the rail station of Münsingen.
- In the Netherlands, along the A27, a solar array was installed in 1996 as a noise barrier, and it has been monitored since in several research programs. The installation is still present today, although the yield is current reduced due to nearby trees causing significant shading. Limited panel theft was also reported. This approach has been replicated along other stretches of the Dutch road Network, including the ongoing the Solar highway project, where a 400-meter-long sound barrier was erected on the eastern side of the A50 in Uden. The construction was concluded in February 2019, and since its completion it has been able to supply around 40 to 60 households with local green electricity.
- One of the biggest railroad PV installations today is found in Antwerpen (Belgium): 3.4 km long and 17 meter wide, on the rooftop of a rail tunnel, which was built to protect the railway from nearby trees. The installation required a total investment of € 15.7 Million in 2011, resulting in a high CAPEX per MWh compared to other PV installations, but it allows to generate power in the middle of a forest with limited environmental impacts.

As demonstrated by the examples, often a successful IIPV project requires the PV panels to play an active role in the infrastructure project: provide power to the infrastructure, act as a noise barrier, protect from trees and debris. While the investment can be substantial, the PV structure performs an active function, which means it generates additional benefits beyond power generation. In the cases where the power generated is directly used in the infrastructure, it is also necessary to consider the benefits to the energy system, as this reduces the need for investment in the power grid to transport and distribute the electricity.

As more practical experience is gained from these projects, and as new research opens up new opportunities, it is important to ensure that knowledge is organised, retained and shared. For example, Rijkswaterstaat and ProRail (NL), the Autobahn GmbH (Ger) and FEDRO (CH) have made significant investments in knowledge and capacity-building programs in recent years, setting up dedicated budgets and resources. Besides the publication of diverse material, they have also organized conferences, seminars and workshops to facilitate exchanges and to involve other actors such as universities, administrations and the general public.

[106] Kanton Graubunden (2022) Erste Photovoltaikanlage für Tunnelstromversorgung in Betrieb. Example of IIPV (28 kWp, 130 m2) on Trin tunnel entrance in Switzerland.

6.5.2 Fill in the regulatory voids and develop practical guidelines

As for other innovative forms of PV, the lack of dedicated provisions in laws and regulations is a key barrier for the supply chain and for administrators that have to assess and approve the project. Further, as per other forms of PV deployment, the overlap between different legislative domains generates further uncertainty. The rules over infrastructure procurement are often very strict, due to safety risks and the high cost for the public budgets. However, in those countries where IIPV has been pioneered, such as in the Netherlands and Germany, the legislator and regulator have been successful in defining the framework for the use of IIPV in public and private infrastructure projects. More recently, an amendment to the Austrian Federal Roads Act formally introduces IIPV and the terms for their regulation. This amendment also clarifies that PV installations installed in close proximity to roads are considered part of the road, and thus the Federal Roads Act is applicable.

Besides the formal recognition under the legal point of view, it is necessary to translate the possibilities and limits defined by the law in operational instructions that infrastructure owners and planners can put in practice. This has been attempted by several infrastructure authorities and operators across Europe, such as Dutch rail companies:

- The Dutch rail company ProRail (publicly owned organisation responsible for the maintenance and extension of the national railway network infrastructure) issues and regularly updates a Handbook[107] which provides specific instructions and prescriptions for installing PV systems along railways or on railway noise barriers (covering also other technologies such as wind). The Handbook specifically addresses the current law and regulations, identifying key documentations and requirements that have to be fulfilled in order to install IIPV along the rail infrastructure.
- the '*Handboek Zonnepanelen Spoor*'[108] is a collaboration between Bureau Spoor-bouwmeester, ProRail and NS, the main Dutch railway operator. It provides principles for the integration of solar energy systems into the rail landscape, including general design and aesthetic considerations for ground-mounted solar panels in the railway environment. The handbook also aims to guide the design on third-party land in the vicinity of the railway, helping to take into account not only the interests of local residents, but also of train passengers. In addition, the handbook provides spatial frameworks that can be used to determine whether a location is suitable for developing a solar park and provide directions for the design and integration of solar energy systems in the area, as well as discussing financial principles, safety, technology and ecological considerations.

6.5.3 Recommendations for promoting the deployment of IIPV

Based on the barriers and good practices identified, we propose a series of actions to support the deployment of IIPV.

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[107] Technische voorschriften voor werken en werkzaamheden op, boven, onder en nabij de spoorweg; ProRail BV, version 2 in July 2022.

[108] Spoorbeld (2021) Handboek Zonnepanelen Spoor.

1. Public infrastructure authorities have a pivotal role in successfully developing IIPV projects. In many countries, these infrastructure authorities are the unique acting bodies with the necessary mandates to install and operate PV systems at or along infrastructure works. Therefore, Member States:
    a. should define the potential for IIPV development in their territory by commissioning technical and economic studies aiming at identifying suitable infrastructure, regulatory approaches, and grid integration. In particular, these studies should identify the most viable options for using IIPV to perform an active function in the infrastructure and generate additional benefits.
    b. Recognise IIPV in infrastructure regulation and in procurement guidelines for public infrastructure.
    c. mandate infrastructure authorities to consider IIPV integration in their medium and long-term infrastructure development plans, setting up ambitious targets and, if necessary, giving these authorities access to dedicated funding.
    d. Facilitate capacity-building and knowledge sharing among authorities and operators, requiring them to set appropriate budget and resources for this purpose.

2. Infrastructure authorities and operators should:
    a. Identify concrete technical options for the integration of IIPV.
    b. Collaborate with the supply chain and investors to identify suitable business models.
    c. Translate laws and regulations into practical guidelines, developed in collaboration with experts and the supply chain actors.
    d. Promote pilot projects and monitor their impact over time, involving research organisation, universities and other authorities in the process.

6.6. Vehicle Integrated PV (VIPV)

This section presents a list of good practices for the promotion of VIPV, and a list of recommendations to support its deployment. Contrary to the other form of PV deployment explored in this study, VIPV is still significantly behind in the technology lifecycle, and most of the applications are in the pilot phase. Further, VIPV is less dependent on the regulatory framework of individual Member States, as vehicles standards tend to be more harmonised at EU level.[109] Nonetheless, Member States could play a significant part in creating the economic case for IIPV through incentives and obligations.

*Table **Error! No text of specified style in document.**-30 Summary of good practices in VIPV*

Good practice details	Regulatory / Non-Regulatory (NR)	Seen in
Efficiency standards and fleets	Regulatory and non-regulatory	Netherlands

[109] The revised Renewable Energy Directive (Directive 2023/2413) includes a definition of solar-electric vehicles in Article 2 and clarifies that the production of energy by the VIPVs may be counted as fully renewable (article 27).

6.6.1 Efficiency standards and fleets

While most Member States have introduced measures to support the uptake of EVs, few consider the efficiency of the vehicle as a parameter, for example in terms of km per kWh, which would support the inclusion of VIPV. Even fewer have explicit provisions aimed at supporting VIPVs, or other innovations aimed at reducing the overall demand that EVs exert on the electricity network.

Technological innovation is allowing VIPV to increase the yield per m^2 and its range of potential application, thanks to the use of new materials and process. This means that new passenger and commercial vehicles can significantly extend their range if fitted with BIPV. For example, the Lightyear One, a luxury vehicle created by the Dutch company Lightyear, in cooperation with Siemens and NXP is equipped with than 5 m^2 of integrated solar cells. These generate up to 1,250 Wp, which under optimal conditions, extend the range of the 60 kWh battery by up to 200 km.[110] While the idea was technically successful, the high cost of the vehicle resulted in the failure of the venture, and currently a cheaper model is being developed.

Equipping commercial vehicles with onboard PV panels may prove more economically advantageous and is now being tested by several manufacturers. Compared to passenger vehicles, trucks and large commercial vehicles often have a large flat roof area, which is ideal for the installation of solar panel. Further, the safety risks of BIPV modules installed on the roof of the cargo space are significantly less than BIPV installed on the roof of passenger vehicles.

However, the number of large electric and hybrid commercial vehicles on the road is still limited, due to the significant cost and limited range of the battery. As the efficiency of electric drivetrain and batteries increases, and their costs further reduces, it is likely that electric and hybrid trucks will become more common, and VIPV will be a cost-efficient feature to include in the vehicle.

To accelerate technological development, the Dutch government has in the past funded projects to increase the efficiency of BIPV[111], and it has recently drafted a public proposal to support the production of innovative PV technologies, including building- and vehicle-integrated PV panels, with a total fund of €70 million.[112]

6.6.2 Recommendations for promoting the deployment of VIPV

Based on the barriers and good practices identified, we propose two main actions to support the deployment of VIPV.

1. The European Commission and Member States should target financial support to:
    a. found studies aimed at quantifying the potential benefit of VIPV deployment in Europe, considering aspects such as energy system benefits (grid

[110] Photovoltaic – European Technology & Innovation platform: Vehicle-integrated Photovoltaics (VIPV) as a c ore source for electricity in road transport.
[111] RVO (2021) Electric Vehicle Reduction in Charging Frequency through Enhanced Integrated Photovoltaics.
[112] RVO (2024) Nieuwe subsidie versnelt klimaatneutrale economie in eigen land.

integration), types of vehicles to be targeted by support measures, and overall economic benefits.

b. Further **develop the technology and its range of application via research grants** (aimed at technical improvements) and supporting pilot projects;
c. Explicitly **targeting vehicle efficiency as part of EV financial support measures**, for example by providing higher support to vehicles with lower electricity consumption per km. This performance factor should consider the energy potentially generated from the PV panel.
d. Consider **support measures for BIPV-equipped commercial fleets**, starting with fleets owned by public bodies. As many authorities are currently converting their fleet of service vehicles (buses, waste collection trucks, maintenance vehicles) to electric ones, specific provisions should be made to support BIPV. This would align with the principle of exemplary role of the public sector, set by Article 5 to 7 of Directive 2023/1791 (Energy Efficiency Directive).

2. The European Commission and Member States should consider the **introduction of performance standards specific for EVs**, for example defined in kWh/km. When doing so, energy generated from BIPV should be appropriately considered in the calculation. This would incentivise the purchase of vehicles that have a lower impact on the power grid and reduce the system integration cost of EVs. As part of this process, European authorities should update current road tests procedure"[113] to better take into account VIPV benefits into the calculation of the overall efficiency of EV. This should include, for example, considerations over the periods when the vehicle is stationary, based on observed trends.

[113] E.g. Worldwide Harmonised Light Vehicles Test Procedure or WLTP.

Annex A – Regulatory framework and barriers

6.7. Introduction

This Annex is the basis for the tables in chapter 4. Having identified the legal and regulatory framework for innovative form of PV deployment in chapter 3, this Annex contains a detailed analysis of the individual provisions with the aim to identify legal and regulatory barriers to the uptake, promotion, and deployment of innovative forms of solar energy deployment. The detailed analyses focus on selected Member States where the four innovative PV technologies are the most developed.

6.8. Status on agrivoltaics in selected Member States

The countries studied in this section were: Austria, Romania, Bulgaria, Croatia, Poland, France, Germany, Italy, and Netherlands.

6.8.1. Permitting

Building Law

As set out above in chapter 3, the term "building law" does include all regulations governing the construction of a building, facility, or installation. It primarily comprises building and construction laws, regional and spatial planning as well as zoning, land use and land designation regulations. Compliance with all the regulations is usually a requirement for the issuance of a building or construction permit.

Austria

Agrivoltaics in Austria is considered a "building facility" and therefore require a building permit or building notification in accordance with the relevant building laws, including spatial planning and local land use regulations. To obtain a building permit, it is mandatory to comply with the spatial planning and land use regulations. Austria has nine different building and spatial planning laws, each of them adopted on provincial level. There is no uniform building regulation of agrivoltaics in Austria. There is also no uniform legal definition of agrivoltaics. Depending on the applicable building law, agrivoltaics remains either entirely undefined or they are defined in different ways.

Whenever there are no specific provisions for agrivoltaics in the provincial building law, agrivoltaics is treated the same way as conventional ground-mounted solar PV installations, especially when it comes to the legal requirement to comply with applicable spatial planning and land use regulations. For example, it is not allowed to install ground-mounted PVs on grassland, including agricultural land, which has not been specifically designated for PV. This practically means that agricultural land needs to be re-designated for the purpose of energy production from PV, otherwise the application for a building permit would be rejected.

It is important to note that the land re-designation rules of the individual provinces are inconsistent. In principle, however, re-designation requires an appropriate decision by the respective municipal council since local spatial planning is a municipal matter under Austrian law. Consequently, regional peculiarities must also be taken into account, which may make re-designation impossible or difficult (e.g. in the case of areas in nature reserves). In addition, existing neighbours must always be heard.

Generally, the land re-designation rules provide rather restrictive rules by, for in-stance, excluding many grassland areas from agrivoltaic deployment, including those on which agricultural activities are currently performed. Moreover, in some of the provinces, the re-designation of land can only take place if the respective land is located in a so-called "photovoltaic eligibility area" ("*PV-Eignungszone*") which needs to be established by a separate legal act under the applicable spatial planning law. Notably, only a very little number of such areas have been established to date and most of the provinces have not defined such areas at all. One of the rationales behind those restrictions is the protection of agricultural land of high quality. Such land should be maintained for agricultural purposes.

An exception is the province of Styria, where agrivoltaics is expressly defined in Section 2 para 2 (1) of the Styrian Spatial Planning Act (S*teiermärkisches Raumordnungsgesetz 2010* – "STROG"). Moreover, under the STROG, the construction of agrivoltaics with an area of up to 0.5ha is expressly permitted in grassland without the need for a special land designation. In addition, the "Development Program for Renewable Energy – Solar Energy", which was adopted based on the STROG and which came into force on June 7, 2023, promotes agrivoltaics by exempting them from the statutory ban to establish PV installations in so-called "exclusion zones" (*Ausschlusszonen*). This means that the aforementioned PV eligibility areas, which must be established in order for local municipalities to convert existing grasslands and allow for the deployment of agrivoltaics, can be established within existing exclusion zones – including high quality agricultural lands. In addition, the province of Styria has regulated that PV eligibility areas of more than 10 hectares can only be designated for agrivoltaics.

In the other provinces of Austria, the legal situation is entirely different and rather disadvantageous for agrivoltaics. For example, the province of Burgenland designated agrivoltaic areas in its PV eligibility area planning act, but the spatial planning act does not provide any regulatory exemptions in favour of agrivoltaics. As a result, even small agrivoltaics can only be constructed in specially designated eligibility areas and therefore agrivoltaics are legally treated in the same way as conventional ground-mounted PV plants. The latter are subject to rather strict limitations, especially if they are located on grassland or agricultural land. The same applies for most other provinces, where agrivoltaics also require a special land designation. Same as conventional ground-mounted plants, the designation of land for agrivoltaics is subject to extensive regulatory restrictions stemming from spatial planning and land use regulations that are aimed to protect agricultural land from non-agricultural uses.

Apart from the legal and regulatory restrictions, our desk research revealed that the competent building authorities do only have limited experience in dealing with agrivoltaics. This is mainly because agrivoltaics is not well deployed in Austria yet.

Barriers:

- *(Dual) land use restrictions in almost all provinces.*
- *Without a special designation for the use of solar PV, a building permit will be rejected.*
- *Missing definitions or specific legislation – the general rules on ground-mounted PV in green land or grassland apply.*

- *Lack of experience of competent authorities in dealing with agrivoltaics.*

Bulgaria

In Bulgaria the protection and development of agricultural land is regulated by the Protection of Agricultural Land Act (*Закон за опазване на земеделските земи* "PALA") and the Regulation for Application of PALA (*Правилник за прилагане на Закона за опазване на земеделските земи*).

Under art. 2, para. 4 of PALA, construction on agricultural land without changing its designation can be carried out for greenhouses, for linear objects of technical infrastructure (e.g. cables) and for objects whose functions are related to the agricultural purpose of the land - under conditions determined by an ordinance of the Minister of Agriculture and the Minister of Regional Development and Public Works. This is Ordinance No. 19 of 25.10.2012 on the construction on agricultural land without changing of the designation ("Ordinance 19"). Thus, currently, **agrivoltaics projects are not possible in Bulgaria** because the land may not have dual purpose – either the designation of the land is changed for electricity generation, i.e. the land is no longer used for agricultural activities, or the designation remains for agricultural purposes with limited options for construction of a PV installation for own consumption only.

Barriers:

- *Dual land use restriction – the use of agricultural land for energy generation is not permitted.*

Croatia

Under Croatian law, there are various permits required to construct and operate agrivoltaic power plants. The relevant permitting regime for agrivoltaics stems from spatial planning law, energy law, environmental law, and building law. The term of agrivoltaics has been introduced into Croatian legislation for the first time this year (July 2023). The intention of the amendments throughout the spatial and energy legislation is a facilitation of the development of agrivoltaics. The initiative is commendable but there are still many loopholes and obstacles the farmers must overcome until the full operation of their agrivoltaic power plant.

The Croatian Spatial Planning Act (Official Gazette No. 153/2013, 65/2017, 114/2018, 39/2019, 98/2019, 67/2023; "***CSPA***") defines in particular the **areas for construction of agrivoltaics** as areas that have been designated as agricultural areas by the spatial plan of any level (municipal, county or state level), through the establishment of permanent agricultural plantations entered in the records of agricultural land use (ARKOD) or on which, in addition to the existing farming area or greenhouses, the installation of an *agrosolar* power plant (*Cro. agrosunčana elektrana*) will achieve the goals of agricultural activity development, while retaining the purpose of the agricultural land, except in national park and nature park areas. According to CSPA solar power plants may *inter alia* be constructed on "*areas designated by the spatial plan as the agricultural land marked as P3, and in direct contact with a separate construction area outside economic and business purposes settlements in which existing economic or business buildings are located provided that the same area does not exceed 50% of that economic and business zone, and the obtained electricity is used for the needs of*

these buildings". Even though agrivoltaics have now been included in the spatial planning act, the possibilities are limited by the rather narrow definitions. Moreover, if an agrivoltaic power plant is intended to be installed on land that does not meet the above criteria, an amendment to the relevant spatial plan is required, in order to have the concerned area adequately designated. The spatial plan amendments process is rather political and can last anytime from several months to a couple of years.

Apart from the legal and regulatory restrictions, our desk research revealed that the competent authorities do only have limited experience in dealing with agrivoltaics. This is mainly because the concept of agrivoltaics has only recently been introduced into the legal framework.

Barriers:

- *Development of agrivoltaics requires a re-designation of land unless it is on specifically defined (agricultural) areas.*
- *Lengthy and politically driven land re-designation process.*
- *Without a special designation for the use of solar PV or agrivoltaics, a building permit will be rejected.*
- *Lack of experience of competent authorities in dealing with agrivoltaics.*

France

French law is beginning to specifically regulate agrivoltaics and allows dual land use of the agricultural land. A definition of agrivoltaics is contained in article 54 of law n°2023-175 of 10 March 2023. Agrivoltaics is defined as "*an electricity production facility that uses the sun's radiative energy and whose modules are located on an agricultural plot where they make a lasting contribution to the establishment, maintenance or development of agricultural production*".

This definition is completed by a set of criteria characterizing the agrivoltaic status of the installation, which must (i) be reversible, (ii) preceded by a rooftop installation on existing farm buildings (where possible), (iii) allow agricultural productivity to be the main activity of the land and guarantee significant agricultural production and income from the latter, (iv) provide improvement of the agronomic potential and impact, adaptation to climate change, protection against hazards, improve animal welfare. The implementing decrees for this law have yet to be published. There is no case law.

Under French Law, permitting procedures are mainly regulated by building law (French urban planning Code) and environmental law (Environmental code). One may also need to comply with landscape regulations and preservation of cultural heritage. Projects must be linked to and necessary for agricultural activity. They must be dimensioned and located according to the needs of the farm. They must be carefully integrated into the landscape. A detailed inventory must be carried out on the characteristics of the concerned areas and an analysis of the consequences of the project on agriculture. Measures must be taken to reduce and compensate for any impact on agricultural production. The terms and conditions for obtaining land rights (acquisition, lease, etc.) must be specified. These elements must be included in the environmental impact study. France is a rather centralized country in terms of legislation, but this does not mean that specific provisions in terms of

urban planning or preservation of cultural heritage do not apply. Fragmented regulation and local planning rules may still be the reality and an obstacle for agrivoltaics.

Barriers:

- *Lack of implementing regulations.*
- *Lack of established case law and administrative practice with regard to agrivoltaics.*
- *Long and costly procedures.*
- *Different legal competences at regional level.*

Germany

In the German building law, agrivoltaics generally belongs to the category of "ground mounted" PV systems and is considered as a "building facility" and therefore requires a building permit or building notification in accordance with the relevant building laws, including spatial planning and local land use regulations. A building permit is granted if – among other things – the specifications of the German Construction Act (*Baugesetzbuch, BauGB*) are fulfilled. The specifications heavily depend on the location of the affected plot of land. According to Section 35 (1) BauGB, ground-mounted photovoltaic systems (agrivoltaics) are privileged in a 200 m wide strip of agricultural land on both sides of highways and at least double-track railroad lines. As a privileged project, the process to obtain a building permit is more streamlined.

Moreover, small agrivoltaic systems that comply with the definition of agrivoltaics as set in the German energy law (EEG) are also privileged if the area does not exceed 2.5 ha and they are spatially and functionally related to an agricultural or forestry operation or to an operation for horticultural production pursuant to Section 35 (1) No. 1 or 2 BauGB.

Generally, agricultural buildings according to the rules of good agricultural practice are privileged in the German building law. Currently, agrivoltaic systems are not considered as buildings according to the rules of good agricultural practice and, hence, are not generally privileged. This can considerably increase the effort required to justify the classification of agrivoltaics as special status projects. Privileging agrivoltaic systems might speed-up the market launch in Germany, however, such a regulation might negatively affect social acceptance towards the form of deployment as it restricts the power of local communities.

Barriers:

- *Fragmented regulation.*
- *Complex and time-consuming administrative procedures*
- *Typically, low capacities and knowledge of local authorities to deal with the complexity and rising number of agrivoltaics projects.*

Italy

PV projects (including agrivoltaics) need to be compliant with building requirements. Depending on the type of facility, a permit for agrivoltaics may be necessary. Only minimum impact installations may be "free to build" without a permit. Such projects require only a declaration with the competent authority. Ground-mounted PV on agricultural land (hence agrivoltaics) are regarded as minimum impact installations and thus only require a declaration.

Even though there is no legal definition of agrivoltaics in Italy, the Ministry of Environmental Transition has published guidelines on agrivoltaics. It defines agrivoltaics as PV systems that adopt solutions to preserve the continuity of agricultural and pastoral cultivation activities at the installation site. The guidelines set a set of criteria agrivoltaics must comply with, such as (i) enhancing the productive potential of both agricultural and energy generating activities, (ii) not compromising the continuity of agricultural and pastoral activities, (iii) installation of innovative solutions with elevated modules and (iv) have monitoring equipment installed (monitoring water, cultivation, microclimate, soil fertility, etc.). It is not clear from the non-binding guidelines how the monitoring system needs to be set up and what information should be transmitted and to whom.

However, it is clear from case law, that an agrivoltaics system must be designed and operated in such way as to ensure the continuity of agricultural cultivation as productivity and not vice versa. Therefore, the agrivoltaic system must adhere to the technical specifications of the electrical system but also comply with the requirements of the activities of cultivation, food production and livestock breeding.

Barriers:

- *No legal binding definition of agrivoltaics*
- *Lack of regulatory provisions on agrivoltaics*
- *Burdensome technical requirements*

Poland

Agrivoltaics in Poland is (depending on the construction) considered a "building facility" and therefore require a construction permit (or notification on construction) in accordance with the Building Law (Polish: *Prawo budowlane*). Moreover, the agrivoltaic installations must also adhere to the spatial planning and development regulations specified in local zoning plans (Polish: *miejscowy plan zagospodarowania przestrzennego*).

To obtain a building permit, it is mandatory to comply with the spatial planning and land use regulations, since any deviation will lead to the dismissal of the construction permit application.

Although Building Law and the Act on Spatial Planning and Development (Polish: *Ustawa o planowaniu i zagospodarowaniu przestrzennym*) are binding nationwide, local zoning plans and studies of conditions and directions of spatial development (which will be replaced by municipal general plans by the end of 2025) are adopted for every municipality and may differ on the permissibility of agrivoltaics location. Neither the building law nor the Act on Spatial Planning and Development provide any specific provisions for agrivoltaics. As a result, agrivoltaics are treated the same way as conventional ground-mounted solar PV installations, especially when it comes to the legal requirement to comply with applicable spatial planning and land use regulations.

On 24 September 2023, an amendment to the Act on Spatial Planning and Development entered into force. Since then, the construction of (i) any photovoltaics on good quality soils (group I-III), (ii) photovoltaics with a capacity over 150 kW on poor quality soils (IV), and (iii) photovoltaics with a capacity over 1000 kW on other lands than above indicated can solely take place based on local zoning plans. The amendment to the Spatial Planning Act leads to the situation that the construction of photovoltaics with the parameters specified above is excluded from individual zoning decisions, which were until then issued for specific construction in the absence of a local zoning plan upon investor's request. The issuance of zoning decisions allowing for the construction of photovoltaics is now abolished.

Since local zoning are adopted for every municipality and usually there are many local zoning plans within one municipality, the permissibility of the installation of solar PV can vary. Changing a local zoning plan and its associated spatial development study is a lengthy process that can span over years. Authorities are under no obligation to adjust zoning plans upon request. However, the mentioned amendment offers a streamlined process for modifying local zoning plans when the intent is to incorporate photovoltaic installations.

Polish regulations on zoning and planning do not provide a basis for agrivoltaic land use. It is worth pointing out that dual use of the land is permissible. Local zoning plans may provide dual land use described as for example agricultural land and energy production through photovoltaic or area of electro power, however functions cannot be conflicting. The interpretation of conflicting functions has changed in polish court judgements, for example the Supreme Administrative Court allowed a combination of wind turbines and agricultural use of land. It is also possible to specified percent share of each function (permissible use) in local zoning plan.

Dual land use in relation to combination of agricultural use and energy production in photovoltaic plant is not popular in local zoning plans, since agrivoltaics is a new concept and most of the local zoning plans were adopted many years ago when renewable energy was not in use. Also, there is a risk that due to the lack of experience on administrative level authorities or administrative courts will consider those two functions as conflicting.

Barriers:

- *Special land designation in the zoning plan necessary for solar PV on agricultural lands.*
- *Lack of designations for agrivoltaics in zoning plans, mostly due to the lengthy and politically driven land re-designation process.*
- *Dual land use restrictions due to missing specifications in the local zoning plans.*
- *Lack of experience on the administrative level authorities.*

Romania

Renewable energy projects, including agrivoltaics are qualified as "constructions" in Romania and therefore they must obtain a building permit in accordance with the relevant construction laws, including local urban planning and land use regulations.

Typically, the issuance of a building permit is subject to ensuring compliance with the local urban planning and land use regulations. A conflict with those regulations regularly results in a delayed issuance of the building permit or, in a worst-case scenario, the rejection of the application for a building permit. A risk of annulment of the building permit also exists, where the building permit is issued in breach of the applicable urban planning and land use regulations. Nevertheless, recent amendments to the constructions and urban planning legislation, entered into force in June 2023, authorise the issuance of building permits for renewable energy facilities without a prior approval of the urbanism and spatial planning documentation. Agrivoltaics is not defined in the legislation and is treated the same way as conventional ground-mounted solar PV installations. Hence, agrivoltaics also benefit of the aforesaid exemption from the obligation to obtain urban planning documentation before obtaining a building permit.

Furthermore, the installation of renewable energy projects (including agrivoltaics) on agricultural lands located outside the built-up area of municipalities is limited to land that is (i) not arable and has a low quality (i.e. quality classes 3 to 5); (ii) has a total surface of max 50 ha; and (iii) is re-designated for the purpose of energy production from renewable energy sources.

In principle, the re-designation of lands located outside the built-up area of municipalities requires an appropriate decision by the county agricultural authorities which must be preceded by (i) the performance of pedological studies, ascertaining the low-quality class of the respective lands; (ii) the endorsement from the county authorities for land improvements; and (iii) the endorsement from the specialty department within the Ministry of Agriculture. For agricultural lands located inside the built-up area of municipalities, the re-designation is typically performed via the issuance of the building permit, subject to obtaining a prior endorsement from the county agricultural authorities and the endorsement from the county authorities for land improvements.

The Romanian land fund law (*Legea Fondului Funciar nr. 18/1991*) explicitly allows for a dual land use re-designation of agricultural land for the development of renewable projects if the land is (i) located outside the built-up area and (ii) has a maximum surface of 50 ha. In case such dual land use re-designation is issued, the respective lands may be used both for agricultural activities and to produce renewable energy. The removal from agricultural use only effects the surfaces occupied by the renewables, the remainder is keeping its agricultural use.

The dual land use re-designation is conditional upon the filing of various documents and information, including the project's technical design, the type of the investment objective, the location of the project, the degree of land occupancy, the indication of surfaces used both for energy and agricultural production. The legislation does not provide a definition of agrivoltaics and there are no technical specifications based on which the respective PV installations would be recognized by the authorities to qualify for agrivoltaics and benefit of dual land use re-designation of agricultural lands (e.g. minimum height of PV panels, positioning, etc.). Due to the lack of dedicated regulations, a degree of incertitude remains regarding the criteria based on which the authorities will decide on the dual land use re-designation for various PV projects and how they will differentiate between conventionally ground-mounted PVs and agrivoltaics when granting the dual land use land re-designation.

Barriers:

- *(Dual) land use restrictions for agrivoltaics – limited to low quality land, limited in surface, re-designation for RES required.*
- *Without a special designation for the use of solar PV or agrivoltaics, a building permit will be rejected.*
- *Lack of specific legislation for agrivoltaics leaves uncertainty regarding the re-designation process.*
- *Lengthy and complicated land use re-designation process.*
- *Lack of experience on the administrative level authorities.*

The Netherlands

According to Article 2.1 of to the Environmental Law General Provisions Act (*Wet algemene bepalingen omgevingsrecht*) an environmental permit is to be issued by the respective authority (*Bevoegd Gezag*) for the building of a structure (*het bouwen van een bouwwerk*).

The Building Decree under the Housing Act provides a collection of technical building regulations that all buildings in the Netherlands must comply with. Agrivoltaics is neither defined in the Dutch Building Decree nor the Housing Act. It is thus not entirely clear whether agrivoltaics qualifies as a construction (*Bouwwerk*) under the respective legal acts.

Our research has shown that the technical standards and safety measures set by the Construction Law(s) affect agrivoltaic systems in the field of safety more than 'traditional solar PV' is affected on this aspect. Since farmers continue their (mechanized) agricultural business efforts on a daily basis having PV installations in their fields/yards, farmers' (electrically) safe operation should be ascertained and, in return, the integrity of the PV installation should be maintained over its agreed lifetime while heavy agricultural machinery is rolling around.

Installing solar PV on agricultural land may not be in accordance with the (existing) usage categories of the respective zoning plans.

Barriers:

- *Dual-use restrictions*
- *Lack of jurisprudence / precedents / case law.*
- *Lack of joint administrative procedures / mechanisms.*
- *Lack of experience of the administrative authorities.*

Common barriers identified

Building law is highly fragmented in the Member States and there may be several different laws (especially in Member States with a federal structure, such as in Austria), depending on the state, region, and even municipality, complicating the development of agrivoltaics. Zoning plans and spatial

planning is usually performed at a municipal level. This adds another layer of complexity for project developers and legal advisers likewise. The individual practice of the municipalities varies and, in most Member States the process of changing the spatial planning acts and especially the zoning plans is highly political, and individuals usually do not have the power to request a change of the respective legal act.

A lack of relevant experience with the development of agrivoltaics by the authority in charge granting the respective permits is one of the most common barriers to agrivoltaics. This is closely linked to the lack of clear, tailored definitions and rules specifically addressing agrivoltaics. The lack of specific regulation not only complicates the permitting procedures in the Member States, but also leads to a disadvantageous treatment of agrivoltaics compared to other "classical" PV installations.

Moreover, the lack of specific regulations is the most common reason for dual land use restrictions. Dual land use restrictions make agrivoltaics practically impossible. The reason behind such restrictions is usually the protection of agricultural land in general or agricultural land of high quality. However, this is redundant in the case of agrivoltaics since the whole purpose of agrivoltaics is to maintain the agricultural activities on the respective land. Only the introduction of specific language addressing agrivoltaics in the respective spatial planning and land use acts will be able to lift this barrier.

Energy law

In some Member States the construction of energy generation facilities (including agrivoltaics) is (also) governed by energy law. This is particularly the case for larger agrivoltaics which exceed a certain capacity threshold. The rationale behind this is that for larger projects, the relevance of energy-specific construction and operational aspects is prevailing.

Austria

In Austria, similar to building law, electricity law is standardised in nine different provincial electricity laws, here, however, in addition to a nationwide electricity ("basic") law (called *Elektrizitätswirtschafts- und -organisationsgesetz 2010* – "ElWOG"). Solar PV above a certain capacity threshold requires an electricity law permit. However, there is no uniform approach in Austria. Each province sets their own capacity threshold. In some provinces solar PV is completely exempted from the permit requirement. Agrivoltaics are only explicitly addressed in the Lower Austrian Electricity Act (*NÖ Elektrizitätswesengesetz 2005* - "NÖ ElWG"), where, in the context of the operator's obligation to notify the competent authority of the start of the decommissioning and its arrangements upon decommissioning, it is stipulated that, in the event of the decommissioning of a PV plant on agricultural land, the authority must in any case order the removal of the above-ground parts.

Overall, the electricity permit must comply with the regulations in force at the planned location of the PV plant, this includes spatial planning and zoning laws. In this context, it should be noted that the experience of the authorities with regard to the approval of agrivoltaics seems to be very modest.

Barriers:

- *Lack of specific regulations on agrivoltaics in most provinces.*

- *Without a special designation for the use of solar PV, an energy permit will be rejected.*

Croatia

The energy approval is an approval issued by the Croatian Ministry of Economy (as the ministry currently in charge for the energy; the "***CMoE***") based on which the project developer can construct a new energy facility or upgrade the capacity of the existing one. The main purpose of the energy approval is to provide information to the CMoE about the energy projects under development. The energy approval is issued either through the tendering process administered by the CMoE or upon a request of the project developer. The energy approval is issued without the tendering process for agrivoltaics under the new energy law. The request for the issuance of the energy approval for agrivoltaics must be accompanied, along with other required documents, with evidence of the establishment of permanent agricultural plantations entered in the records of the agricultural land use (ARKOD) or location information about the farms and greenhouses areas.

CMoE will issue the energy approval within 90 days of receiving a duly filed request. The fee for the issuance of the energy approval must be paid to Croatian Electricity Market Operator ("***HROTE***") within 15 days as of the enforceability of the decision on the issuance of the energy approval in the amount of 8.327 EUR/kW of the connected power of the production facility for which the energy approval has been obtained (different formula applied in case of upgrade of the existing facility) plus the VAT if applicable under the regulation governing the VAT. The project developer/investor is also obliged to pay an annual fee to the local government unit where it plans to build the production facility.

No barriers specific to agrivoltaics have been identified.

France

As set out above, a new definition of agrivoltaics has been introduced into the French regulatory framework. The definition introduced by the new law is complex, the criteria set out by the law may not be met by the installation (and hence, authorization may not be granted). No implementing regulations have been adopted yet. Thus, the implications of the new definition on energy law cannot be assessed yet.

Barriers:

- *Lack of implementing regulations.*

Germany

According to the Renewable Energy Act (EEG), agrivoltaic systems generate electricity from solar radiation energy and are thus to be classified as systems for the generation of electricity from renewable energies within the meaning of § 3 No. 1 EEG 2023. Hence, agrivoltaic systems enjoy the same benefits as ground-mounted PV e.g. the right for connection to the grid, the mandatory purchase of electricity from the grid operator, and a financial support by receiving feed-in tariffs for the produced electricity

Regarding feed-in tariffs, operators of facilities with an installed capacity of more than 100 kW are obliged to market the electricity to a third party (so-called mandatory direct marketing). Still, in the case of subsidized direct marketing, the system operator is entitled to the so-called market premium

from the grid operator in accordance with Section 20 EEG 2023. This is the difference between the so-called "value to be applied" and the annual market value for solar energy. Since the electricity is sold to the third party and the third party pays the agreed price to the system operator, the operator receives the market premium and the price agreed with the direct marketer for the electricity fed into the grid.

Another possibility to receive feed-in tariffs is a participation in PV tenders of the first segment of the EEG (for systems with a maximum capacity of 20 MWp)[114]. Operators of agrivoltaic systems with an installed capacity of more than 1,000 kW must successfully participate in the tender according to §§ 29 et seq. in conjunction with §§ 37 et seq. § 37 ff. or 38c ff. EEG 2023. An exception from the obligation to tender may apply if the agrivoltaic system is operated by a so-called "*Bürgerenergiegesellschaft*" in the sense of § 3 No. 15 EEG 2023: In this case, the limit above which participation in a tender is required is increased to 6,000 kW.

Within the tenders, though, most agrivoltaics projects are not able to compete with ground-mounted PV systems due to higher costs. Also, a participation in PV tenders is only possible for PV projects in certain areas. Generally, agricultural areas are not included in these areas. Exceptions are stripes along both sides of highways and at least double-track railroad lines and agriculturally disadvantaged areas. With the last amendment of the EEG from 26.7.2023, agrivoltaic facilities that comply to the DIN SPEC 91434 can participate in tenders with access to all agricultural areas except certain natural conservation areas. In case of conformity with the category I DIN SPEC (e.g. a minimum vertical clearance of 2.1 meters), the EEG provides a premium of 1.2 Eurocent per kWh to increase competitiveness of agrivoltaics. The premium gradually melts down to 0.5 ct/kWh until 2028. Eligible application areas for agrivoltaic system are set in § 37 Abs. 1 Nr. 3 lit. a to c with:

- lit. a arable farming,
- lit. b permanent and perennial crops, and
- lit. c permanent grassland.

Accordingly, agrivoltaic systems like PV greenhouses or aquaculture PV cannot participate in the EEG tenders.

Beneath the regular tenders, agrivoltaic systems can also participate in the innovation tenders of the EEG. However, the obligation to be coupled with a storage system or one or more renewable energy systems imposes a restriction in terms of content that can hardly be justified for the agrivoltaic systems to be funded.

The tendering process involving agrivoltaic systems is being planned together with floating PV systems and PV parking lot canopies as the so called "special solar facilities". This establishes direct competition and if the other system types offer a more affordable option, agrivoltaic systems will not be given a chance.

In addition, interspace agrivoltaic systems have a less complex substructure, which gives them a clear competitive edge that is likely to have a strong influence on the composition of the projects awarded. As a result, overhead systems allowing crops to be grown between the PV module rows are not likely to be awarded funding.

[114] Due to the war in Ukraine and the resulting energy crisis, the limitation to 20 MWp was temporarily increased to 100 MWp in the year 2023 (see "*Beschleunigungsgesetz*").

Barriers:

- Combination of technologies in one tender cause disadvantages for agrivoltaics.[115]
- *Lack of precedents*.

Common barriers identified

We have not identified any major potential barriers which derive from energy law, and which are specifically relevant for agrivoltaics.

6.8.2. Impact on the status of agriculture

Agricultural activities are regularly subject to special tax regimes that provide tax benefits to farmers. The use of agricultural land for other, non-agricultural purposes, such as energy generation, bears the risk of losing the legal status as a "farmer" or agricultural operator. As a comprehensive steering and financing instrument, the CAP is of fundamental importance for agriculture, forestry, and rural areas. The dual land use of agricultural land may also have implications on agricultural subsidies law.

In some Member States agricultural activity is regulated and protected by specific legislation. Agrivoltaics is usually not (yet) included in the respective legislation, which causes difficulties for the authorities, farmers and project developers.

Austria

Tax regulations

Income from agriculture and forestry can be determined on a flat-rate basis (*pauschalierte Einkommensermittlung*). However, energy generated by solar power is not a primary product (*Urprodukt*) within the meaning of Section 21 of the Income Tax Act (*Einkommensteuergesetz 1988* - "EStG") and therefore, the production of energy does not constitute an agricultural or forestry activity. In case no more than 50% of the energy produced on the own land is fed into the grid, the activity qualifies as an agricultural and forestry subsidiary - *land- und forstwirtschaftlicher Nebenbetrieb*) and receives preferential treatment.

However, if the land is transferred to a third party for the operation of a photovoltaic system, the remuneration received for this transfer will be considered as (preferential) income from agriculture and forestry only if the land in question continues to be part of the agricultural and forestry assets. Land only constitutes agricultural and forestry business assets if it is used primarily for agricultural purposes. This is defined in detail in Austrian regulation, stipulating for example, primary agricultural purpose as areas with underride modules mounted at a height (of at least 4.5 meters) such that the entire area underneath can still be safely used by agricultural vehicles and can thus be used for agricultural purposes[116]. In cases not covered by the respective criteria, the land concerned is removed from the

[115] This barrier is expected to be solved within the upcoming amendment of the EEG. The respective law draft was published on August 16, 2023.

[116] Moreover the following is considered primary agricultural purpose:

agricultural and forestry assets. The land in question is then valued as real estate and the consideration for its transfer gives rise to income from rentals and leases. In addition, the change in valuation can also have serious consequences regarding the amount of property tax and property transfer tax in the event of a possible transfer of the farm. Therefore, when transferring land for the operation of photovoltaic systems, special care must be taken to ensure that the land in question continues to serve a primary agricultural purpose as described above. This, in turn, leads to higher installation costs for agrivoltaics and thus generally reduces the attractiveness of agrivoltaics for farmers and investors.

CAP Strategic Plan for Austria

The focus of the Austrian CAP Strategic Plan is the preservation of an area-wide agriculture through largely stable direct payments.

In this context, for example, the Austrian ordinance on the application of the CAP strategic plan ("GSP-AV"), which lays down, in particular, rules on the support measures covered by the CSP and the procedures to be applied, stipulates that the eligible land on which direct payments are based must be agricultural land used for an agricultural activity or, if the land is also used for non-agricultural activities, that it is mainly used for agricultural activities. These activities include the production of agricultural products and the maintenance of agricultural land in a condition suitable for grazing or cultivation. Agricultural products are essentially those listed in Annex I TFEU. However, these "products" do not include electricity. The "principal agricultural use" referred to above is when the intensity, nature, duration, and timing of the non-agricultural use does not limit the agricultural activity on the land.

Therefore, it can be assumed that the eligibility of an area used for agrivoltaics also depends on whether it continues to be used primarily for agricultural activities. However, this is purely conjecture since this ordinance does not provide any specific information on whether and to what extent the use of agrivoltaics actually affects eligibility for support (even if primary agricultural use is guaranteed). In any case, according to the ordinance, the ineligible areas include elements of photovoltaic systems permanently anchored in the ground, which in any case reduces the eligible areas and thus the direct payments.

Although the current legal situation provides indications on the eligibility of land for support in the case of simultaneous use for agrivoltaics and agriculture, no conclusive statements can be made on the

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- Livestock farms that graze areas equipped with PV modules in a sustainable and profit-oriented manner for primary production, e.g. at least 1,650 pullets/fattening chickens, at least 1,460 fattening ducks, at least 660 laying hens/fattening turkeys per hectare of PV area (fenced area). The keeping of other animals (especially sheep) is generally not considered to have a primary agricultural purpose (this is because poultry is considered to be sustainably and commercially grazed, whereas sheep, cows, etc. are considered to be more agricultural "caretakers" of the land);
- Areas with special crops (e.g. viticulture, orcharding, soft fruit), where the PV-modules serve e.g. as roofing or as a substitute for hail protection nets;
- Areas where the modules are mounted at a height of more than 2 meters (lower edge) or are mounted vertically (like a fence) and the area between the module rows is tractor-accessible (normal standard agricultural technology, minimum clear width of 6 meters). If the modules are mounted at a height of 2 meters or less - except in the cases covered above - or if the distance is less than 6 meters clear width, the land is only considered agricultural and forestry business assets if the module area does not exceed 25% of the area of the total plant (this is the module area plus the spaces between them and a small "border"). In the case of tracked systems (which follow the position of the sun), the horizontal position must be considered.

possibility of receiving support in the form of direct payments in the absence of concrete regulations for non-agricultural use of land for agrivoltaics. Therefore, it remains largely unclear whether and under what conditions agrivoltaics can be deployed without running the risk of losing entitlement to direct payments under the CAP.

Barriers:

- *Dual land use of agricultural land may result in the loss of tax benefits under income tax regimes.*
- *Lack of specific legislation and jurisprudence on agrivoltaics regarding the evaluation of the principal agricultural use of land for payments under CAP.*
- *Loss of CAP payments for agricultural land with permanently anchored PV systems.*

Bulgaria

Since agrivoltaics are not possible in Bulgaria, there are no implications on tax law or agricultural subsidies law. Moreover, there is no public consensus in Bulgaria whether agrivoltaics will be beneficial to the agricultural sector. There are still opinions that if the legal regime would allow for the development of agrivoltaics, large amounts of agricultural land would be turned into regular PV plants without any agricultural activities.

Croatia

Tax regulations

No known implications regarding agrivoltaics.

Agricultural subsidies law

The focus of the Croatian CAP Strategic Plan is on the preservation of an area-wide agriculture through largely stable direct payments. However, Croatia still has not enact regulation for implementation of the CSP goals. Since the agrivoltaics have been just introduced into Croatian legislation, the whole set of regulation governing the agriculture, agricultural support and agrotechnical measure will have to be amended to catch up with the reality of agrivoltaics.

Barriers:

- *Missing implementation regulation on CSP goals.*
- *Lack of regulations specifically addressing agrivoltaics in the regulations governing agriculture, agricultural support and agrotechnical measures.*

France

Agricultural subsidies can be granted for land used for farming.

As dual land use of agricultural land is not prohibited by French law, as long as the energy production activity does not call into question the agricultural use of the plot, and the agricultural activity can be carried out without being significantly hampered by the intensity, nature, duration and timing of the energy production activity.

The French national strategic plan, which implements the common agricultural policy recommended at European level for the period 2023-2027, simply states that the eligibility of areas covered by photovoltaic panels for agricultural subsidies will be specified in national regulations at a later date. No such regulations have been published yet; thus, the implications cannot be assessed.

Barriers:

- *Missing regulation on eligibility areas.*

Germany

Tax regulations

According to a change of the Federal Tax law agrivoltaic systems have no impact on the tax status. Thus, all tax benefits for agricultural and forestry remain in place for the respective area.

Agricultural subsidies law

Farmers benefit from direct payments under CAP. The German laws define the eligibility criteria that must be met to receive funding. According to them, the facility must (i) not exclude the cultivation of the area using agricultural methods, machines, and equipment; (ii) reduces the agriculturally usable area by a max of 15 percent based on the DIN SPEC 91434. If those conditions are met, as a lump sum, 85% of the area is considered eligible.

No barriers specific to agrivoltaics detected.

Italy

Agricultural subsidies law

Farmers benefit from different direct payments under CAP. The national implementation law defines the eligibility criteria that must be met to receive funding.

Some Italian regions grant local incentives for energy production from renewable sources, which may also include agrivoltaics. Since 2021 agrivoltaic facilities will only be able to receive incentives if they cover no more than 10% of the agricultural area of the individual farm. This limit reduces the possibilities of farmers to invest into agrivoltaics.

Barriers:

- *Maximum surface for agrivoltaics per farm.*

Poland

Tax regulations

There are no specific regulations concerning taxation of the land on which agrivoltaic is located. For the land used for agricultural purpose an agricultural tax (favourable for the owner) is due. On the other hand, a much higher property tax is due when the land (even agricultural land) is used for business activity. Taking current regulations into account, areas covered by agrivoltaics will most likely be subject to property tax instead of agricultural tax, which will cause significant increase of taxation. Our desk-research has not identified any legal disputes or existing case law concerning the basis of the taxation in case of agrivoltaic, therefore this issue cannot be confirmed.

Agricultural law

As a rule, according to the Act on Shaping the Agricultural System (Polish: *Ustawa o kształtowaniu ustroju rolnego*) only individual farmers are permitted to acquire agricultural land with an area of 10,000 sq. m. or more, whereas other entities are required to obtain a permit of the state authority. The buyer of the agricultural land is obligated to run an agricultural activity on the purchased land for at least 5 years. Since agrivoltaics is a new concept, there is no experience at administrative levels. It therefore remains unclear whether the use of land for these two purposes (energy production and agriculture) will be treated as complying with the obligation to carry out agricultural activity.

According to the Act on Protection of Agricultural and Forests Lands (Polish: *Ustawa o ochronie gruntów rolnych I leśnych*), agricultural land used for non-agricultural purposes must be excluded from agricultural production. Exclusion from agricultural production is carried out by the decision of the competent authority, additionally the exclusion of good quality soils (group I-III) necessitates the approval from the Ministry of Agriculture and a change of the land use in the local zoning plan. Only the exclusion of poor-quality soils (soils of mineral origin from group IV, V, VI) does not require an approval in this matter. In every case however, the owner is obligated to pay a fee for exclusion from agricultural production. The fee depends on the class of the land and ranges from PLN 87,435.00 for every 10,000.00 square meters to PLN 437,175.00 minus the value of the property.

There is no clear regulation concerning the exclusion of land from agricultural production in case of agrivoltaics. The current practice of the authorities indicates that the land should be excluded from agricultural production in case of construction of solar PV power plants on the agricultural land. However, in our opinion, since the land will be still used for agricultural production, there should be no obligation to obtain a relevant consent and pay the fee for the exclusion. The lack of specific regulations and missing jurisprudence on the matter makes a precise answer impossible.

Agricultural subsidies law

Subsidies are based on the EU regulations, which means that legal permissibility of subsidies in case of agrivoltaics depends mostly on the EU bodies, however execution of those regulations is performed by the Polish authorities. Since agrivoltaics is a new and unknow concept to the national authorities there is a risk that due to the lack of experience on administrative level, the refusals concerning payments will be issued. In our opinion, such a refusal does not have a basis since the land is mostly used as agricultural land. However, considering the possibility of exclusion from agricultural production as set out above, a refusal concerning payments seems probable. Our desk-research has not identified any case law on that matter; thus, a final assessment is not possible.

Barriers:

- *Risk of loss of preferential taxation due to a lack of specific regulation on agrivoltaics under agricultural tax laws.*
- *Lack of experience of administrative authorities on the qualification of agrivoltaics as agricultural activity.*
- *Risk that exclusion from land for agricultural production is necessary, which would (i) trigger the payment of a fee and (ii) would result in the loss of agricultural subsidies.*

Romania

Tax regulations

At this stage there are no specific references in Romanian tax legislation with respect to tax treatment of incomes from operating PV systems, including agrivoltaics. Agricultural activities may benefit of certain favourable tax treatments, which likely do not apply to income from operating a PV system on own agricultural land.

An individual obtaining revenue from agricultural activities is liable to pay income tax of 10% on a flat taxable basis irrespective of the income obtained. This flat taxable basis is computed as a fixed amount per ha/per animal, etc. No accounting records are necessary for such activities (as opposed to the case of independent activities).

The income from agricultural activities includes: (i) cultivation of vegetal agricultural products; (ii) the exploitation of vineyards, fruit trees, fruit bushes and similar; (iii) breeding and exploitation of animals, including the sale of animal products, in a natural state.

The income tax due for carrying out independent activities (which in general includes any activities from economic activities, thus also the incomes from operating a PV system on own agricultural land) is computed at 10% on the realized net income. The net income is determined as difference between total revenues obtained and expenses incurred for realizing the activities, adjusted with non-deductible/non-taxable items (if the case).

The Application Norms state that if an individual carries out agricultural activity (for which the income tax is determined based on the flat taxable basis) and an independent activity (for which the income tax is computed on the net realized income), that individual is liable to pay income tax specific to each activity. Thus, the income from operating a PV system on own agricultural land is likely not to benefit of taxation regime for incomes from agricultural activities.

CAP Strategic Plan for Romania

The national CAP strategic plan ("**CSP**") was approved by the Commission Implementing Decision no. C (2022) 8.783 of 7 December 2022 and replaces the previous rural development programs (in Romania: National Rural Development Program 2014-2020) as the funding instrument for rural areas in the funding period 2023 to 2027.

In this context, the Government Decision on the general framework relating to the CAP strategic plan ("**GD 1571/2022**"), stipulates rules on the implementation of interventions relating to the vegetal and zootechnical sectors covered by the CSP and the procedures to be applied. The GD 1571/2022 stipulates that the eligible land on which direct payments are based must be composed of agricultural surfaces used for an agricultural activity or, if the agricultural surface is also used for non-agricultural activities (e.g. energy production through agrivoltaics), the intensity, nature, duration of the non-agricultural activities must not hinder the agricultural activities, as per the CPS criteria. As per the CPS criteria, the non-agricultural activities must not (among others) interfere with the usual agricultural activities for a period exceeding 120 days. Where the 120-day period is exceeded, assuming the respective non-agricultural activity does not entail the degradation of soils and ground cover, the respective land may nevertheless remain eligible for agricultural subsidies if the delays are objective and justified. The required conditions are to be further specified in the national implementation regulations.

Against this background, it results that the eligibility of agricultural lands used for agrivoltaics largely depends on whether they continue to be used primarily for agricultural activities. For the moment, no further specifications are provided in the national regulations regarding the conditions under which the use of agrivoltaics on agricultural lands may impact the eligibility of the respective lands for agricultural incentives. Hence, until such detailed regulations are enacted, it remains uncertain to what extent agrivoltaics shall reduce the surface of eligible agricultural lands (even where the dual land use is recognized).

Our desk research has revealed that currently, the provisions of the land fund legislation (allowing dual land use) and the agricultural subsidies legislation contradict each other. In order to resolve this contradiction and provide legal certainty to farmers, the agricultural subsidies legislation needs to include language expressing that in case of agricultural lands designated for dual land use, the land surfaces which are occupied by agrivoltaics continues to benefit the agricultural incentives and thus remain eligible agricultural lands.

Barriers:

- *Risk of loss of preferential taxation due to a lack of specific regulation on agrivoltaics under agricultural tax laws.*
- *Lack of specific legislation and jurisprudence on agrivoltaics regarding the evaluation of the principal agricultural use of land for payments under CAP.*
- *Conflicting regulation: The land fund law and agricultural subsidies law lack common definitions. This may result in a conflict when determining the application of the respective legislation to agrivoltaics.*

The Netherlands

CAP Strategic Plan

Farmers benefit from direct payments under CAP. The installation of PV panels on agricultural land (thus agrivoltaics) may cause the loss of the agricultural land criteria and therefore, farmers could not benefit from the support schemes anymore.

Barriers:

- *Lack of specific legislation and jurisprudence on agrivoltaics regarding the evaluation of the principal agricultural use of land for payments under CAP.*

Common barriers identified

Preferential taxation of agricultural activity and agricultural subsidies law usually has the purpose of incentivizing agricultural activities. Any restrictions and the loss of preferential treatment in case of the performance of other, non-agricultural, activities aim at the protection of agricultural activities. However, this concern is easily dismissed regarding agrivoltaics since the whole purpose of agrivoltaics is to continue the agricultural activity and protect agricultural land. The lack of specific language in the respective tax and subsidies regulations is a common barrier to the deployment of agrivoltaics since it leaves famers and authorities with legal uncertainty.

6.9. Status on FPV in selected Member States

The countries studied in this section were: Austria, Belgium, Croatia, France, Germany, Italy, Poland, Portugal, Romania, and Netherlands.

6.9.1. Permitting

Building/Construction Law

Building and construction law includes all regulations governing the construction of a building, facility, or installation. It primarily comprises building and construction laws, regional and spatial planning as well as zoning, land use and land designation regulations. Compliance with all the regulations is usually a requirement for the issuance of a building or construction permit.

Austria

Under Austrian law, various permits are required for the installation and operation of FPVs. Which permits are needed for the specific FPV system planned, depends on the type of water the system is floating on (e.g., private, or public, natural waters or artificial water bodies used or created for mining activities).

The Austrian law does not clearly define whether FPVs are subject to construction law since the construction laws mainly refer to the use of PV on solid ground / soil rather than the use of water surfaces or bodies. Moreover, it needs to be noted that water law supersedes construction law in certain circumstances (e.g., when the FPV is legally qualified as a plant for "water use"). Then a special construction permit under water law and not building law is required. As it is unclear whether FPV qualifies as "water use" under water law, it cannot be finally assessed if construction law is applicable to all types of FPV.

If the planned FPV does fall under building law, a building permit or notification in accordance with the local building code and spatial planning is required. As already set out above, Austria has a highly fragmented building law due to the different regulations at provincial level. The main issue is that there are no clear provisions in Austria which state whether special land designation for the construction of FPVs are required. There are no statutory (clear) criteria based on which it is decided to establish required land designation for FPVs (leading to an unlimited discretion of the competent authority). In practice, this dedication requirement considerably complicates the (rapid) implementation of FPVs, because a building permit will be refused if the land designation does not allow the placement of FPVs.

The authorities in charge of spatial planning and land designation are not yet familiar with FPVs (at least at the time this study was conducted). The same applies to authorities in charge of permitting of FPVs. The lack of expertise at administrative level may cause delays during the permitting procedure and legal uncertainties for FPV operators / investors.

In case the FPV is planned to be installed on an artificial water body created for mining activities, the specific mining regulations apply to the permitting procedure. A special mining law permit is required for the use and modification of such waters. In addition to the mining authority, the water authority may also be responsible for approving/permitting FPVs on waters connected to a mining facility. For example, if the FPV plant may affect the quality of water bodies outside the mining area (e.g., nearby rivers or groundwater). However, the Austrian mining law does not clearly define under which circumstances it is legal to install FPVs on water bodies which are subject to mining regulations. Thus, Austrian mining law contains a high level of legal uncertainty, which potentially delays the permitting process.

Barriers:

- *Legal uncertainty due to the lack of FPV-specific regulations and definitions.*
- *Highly fragmented legal system concerning building law and therefore different regulations applicable to FPVs at provincial level.*
- *Lack of experience at administrative level concerning FPVs.*
- *Potential delays in the permitting process due to a high level of legal uncertainty for FPVs placed on artificial water bodies created for mining activities.*

Belgium

It should be first noted that Belgium is a federal state. It means that it is divided into three regions and communities that have their legal provisions. Within the regions there are local authorities, provinces, and municipalities that can impose additional rules relevant for FPVs. Depending on the location where the FPVs are supposed to be installed, different laws can apply. Therefore, for each FPV-project, a case-by-case assessment is required. The following analyses only gives an overview of the various regulations that may apply to FPVs.

Each region is competent to decide what acts and works are required for a building and urban planning permit. In all three regions, an urban planning permission is required for the establishment/installation of PV panel fields (meaning the installation of more than one PV panel) (*D.IV.22 link ; art. 98 CoBAT*). The Belgium legislation neither defines PV panels fields nor contains a definition of or any language on

FPVs. However, there is also no indication that FPVs would not fall within the scope of this requirement.

An urbanistic permit is issued by the competent authority on local level. Since the municipality has the authority to decide on the required documentation for an urbanistic permit and there are more than 500 municipalities in Belgium it is not possible to state the respective requirements.

Floating PV parcs already exist in Belgium. Thus, it is possible to obtain the authorization in order to install such floating PV. Moreover, in 2022, a budget of 2 million euros was granted for the installation of a floating PV park in the North Sea.[117] Therefore, we can consider that there is a positive approach towards floating PV in Belgium. In regional waters, some projects have also already been allowed (e.g., Tertre, Dessal). However, environmental permits may be refused if FPV has negative impact on the environment (including impact on protected animals such as water birds, micro-climate, and landscape).

Barriers:

- *Lack of specific and harmonized regulations concerning FPVs.*
- *Different legal competences at regional level.*
- *Different levels of administrative competences.*

Croatia

Under Croatian law, there are various permits required to construct and operate FPV power plants. With the most recent legislative amendments, water surfaces have been recognized as the areas for construction of solar power plants for the first time. However, other laws regulating inland waters should follow the most recent spatial law amendments to make the development of FPVs a reality.

The Croatian Spatial Planning Act (Official Gazette No. 153/2013, 65/2017, 114/2018, 39/2019, 98/2019, 67/2023; "***CSPA***") defines areas for construction of solar power plants and includes water surfaces. Those areas are defined as lakes created by the exploitation of mineral raw materials, as well as ponds and other aquaculture farms on the mainland, with the consent of the concession grantor/lease grantor if that area is subject to the concession/lease.

A location permit may be required for FPV. According to the Regulation on space interventions that are not considered construction (Article 2, paragraph 1, points 2 and 4) such permit is required for permanent installation, mooring, or anchoring of vessels on inland waters such as ships, floating objects (pier, jetty, swimming pool, house on the water, houseboat, pontoon bridge, floating catering facility, floating dock, etc.) and scaffolding. For the installation of the FPVs water related conditions would likely be imposed by the competent authority (*Hrvatske vode*). Should the development of the FPV include some mining works or installation of submarine, underwater cables, special conditions of the relevant mining authority could also be imposed. A location permit is issued within 60 days as of the duly filed request (and after meeting all specific construction conditions, OPUO/PUO, conceptual design, etc.). The location permit is valid for two years and it can be extended for additional two years

[117] https://www.rtbf.be/article/deux-millions-d-euros-pour-un-projet-de-panneaux-solaires-flottants-en-mer-11031467. However, that FPV on or offshore FPV is not in the scope.

provided that the spatial conditions based on which the location permit has been issued remained the same.

Generally, the building permit is required for development of solar power projects. However, it is questionable whether the building law would apply to FPVs. The Croatian Construction Act (Official Gazette No. 153/2013, … 125/2019; "***CCA***") defines the building as building is an assembly (*Cro. sklop*) created by construction and connected to the ground, made of purpose-connected construction products with or without installations, an assembly with a built-in plant, an independent plant connected to the ground, or an assembly created by construction. It is questionable whether FPVs fall within the definition of the buildings and therefore the application of the CCA to the FPVs remains questionable. However, given that the installation of underwater/ground cables are necessary for connecting the FPV to the grid, the building permit would be required for installation of the cables.

Barriers:

- *Legal uncertainty due to the lack of FPV-specific regulations and definitions.*
- *Lack of experience at administrative level concerning FPVs.*

France

Under French Law, permitting procedures are mainly regulated by building law (French urban planning Code) and environmental law (Environmental code). One may also need to comply with landscape regulations and preservation of cultural heritage. French law does not define FPVs, so it is not clearly stated that FPVs are subject to building law since the building laws refers to the use of PV on solid ground / soil rather than the use of water surfaces or bodies. However, in some local government studies, it is clearly stated that an application for a building permit is require.

Under building law, solar power plants are subject to an authorization regime under the Town Planning Code ("*Code de l'urbanisme"*) which may differ depending on the capacity installed, the location and the maximum height above ground level of the device. The capacity installed is particularly important as it determines whether an environmental assessment of the project is required. The installation of a solar power plant on a water surface (natural or resulting from an artificial reservoir) has no specific consequences on the planning procedure, which will be carried out according to the same criteria as a conventional power plant. In the case of use of the public domain, the application file must include a document expressing the agreement of the domain manager (R. 431-13 CU). Depending on the type of project and the location, a permit application (building permit, development permit, etc.) or a prior declaration of works is required.

A building permit is a type of urban planning authorization. When the project is the subject of a building permit, environmental studies must be included. A preliminary declaration ("*déclaration préalable"*) is a type of planning permission required for certain types of work for which a building permit is not required. In general, no formalities are required for structures less than 12 meters high, with a footprint of less than 5 m2.

Barriers:

- *Lack of FPV-specific regulations and definitions.*
- *Lack of experience at administrative level concerning FPVs.*

Germany

In Germany, there are different permitting procedures, which depend mainly on two aspects. The essential first difference is whether there are any activities on excavation taking place on the water body. The second difference is the purpose for which the FPV is implemented. If it is mainly for self-consumption of a company which has already the usage permits for the water body, permit can be granted quite quickly. If the FPV is used for sale of electricity through the grid a "normal" building permit must be granted through "*Bauleitplanung*".

In this matter, the FPV project is being approved via the German Land Use Plan procedure. Therefore, a development plan is required, a respective land designation is needed, and the land zoning plan must be changed. Once the FPV developer receives the resolution from the competent authority, the construction permit can be requested. In addition to the construction permit, the approval of the water authorities must be obtained.

Notably, Germany has a highly fragmented building law. Each federal state has its own building code. The building permit typically is endorsed through the land use plan procedure (*Bauleitplanung*). There are two different, but equally important procedures in the Land Use Planning: the so-called "*Flächennutzungsplanänderung*" (change of zoning plan) and "*Bebauungsplanänderung*" (change of development plan). The municipalities must draw up urban land use plans if it is necessary for the planning concept or for the urban development and order. There is no legal limit to the period of validity.

At the time of this legal study, FPV projects have been implemented in five different German federal states. For Germany, a lack of information concerning the regulatory aspects at the beginning of FPV projects can be flagged as a potential barrier, since this often causes insecurity and delays.

A permit under the Federal Mining Act in Germany (*Bundesberggesetz, BBergG 1980*) is typically required, when FPVs are placed on waters connected to active mining sites (e.g., mining of mineral quartz). This is the case if a FPV is a facility serving or intended to serve mining and thus falls under mining law. Therefore, the operator must prove that a certain amount of percentage of the energy produced will be used for self-consumption of the mining activity (e.g., at least 50% in the FPV project in Haltern am See, Germany).

Barriers:

- *Highly fragmented legal system concerning building law and therefore different regulations applicable to FPVs at provincial level.*
- *Lack of experience at administrative level concerning FPVs.*
- *Potential delays in the permitting process due to a high level of legal uncertainty for FPVs placed on artificial water bodies created for mining activities.*

Italy

So far, only two FPV facilities have been installed in Italy: one offshore, and the other built on the waters of a reservoir in the mountains. Due to missing legislation, it is unclear whether the construction legislation is applicable or not. However, a permit under the framework of energy generating facility is

required. Construction laws mainly refer to the use of onshore ground / soil rather than the use of water and no specific regulation is in force that specifically addresses the construction of FPVs. Therefore, it remains unclear whether FPV is subject to construction law or not. In any case, water law supersedes construction law in certain circumstances.

In case construction law would be applicable to FPV, it must be noted that it is highly fragmented. Construction law is regulated at local level which means that there are at least 20 local building codes potentially applicable to FPV. The authorities in charge of spatial planning and land designation are not familiar with FPV. Same applies to authorities in charge of permitting of FPV. In the case of old mines and quarries, a clearance from the mining authorities is required to proceed with the project. Clearance involves closure procedures of mining activities that are difficult, long and costly to finalize.

As an energy production facility, FPV are required to secure a building permit from the municipality for plants under 10 MW and from the region if plant is larger than 10 MW. The lack of local competences on the municipality level force developers to revert to regional authorities for FPV building permits, even though the municipality is the competent authority.

Barriers:

- *Legal uncertainty due to the lack of FPV-specific regulations and definitions.*
- *Highly fragmented legal system concerning building law and therefore different regulations applicable to FPVs at provincial level.*
- *Lack of experience at administrative level concerning FPVs.*
- *Conflicting and competing jurisdictions on artificial water bodies.*
- *Lack of FPV experience and competences on municipality level.*

Poland

In Poland, the deployment of FPVs faces regulatory challenges, especially concerning construction permits. The placement and construction of FPV systems are informed by a tapestry of legislative sources, including the Act on Spatial Planning and DevelopSiment (*Ustawa o planowaniu i zagospodarowaniu przestrzennym*), the Construction Law (*Ustawa Prawo Budowlane*), and the local zoning plans (*Miejscowe plany zagospodarowania przestrzennego*) and local studies of conditions and directions of spatial development (*Studium uwarunkowań i kierunków zagospodarowania przestrzennego,* which will be replaced by municipal general plans by the end of 2025).

In September 2023 an amendment to the Act on Spatial Planning and Development entered into force. Since then, the construction of:

- any PVs on the good quality soils (group I-III),
- PVs with capacity over 150 kW on poor quality soils (IV),
- PVs with capacity over 1000 kW on other lands than above mentioned

can take place solely on the basis on the local zoning plans.

Those changes mean that the construction of the FPV with the parameters specified above is excluded from the zoning decisions, which were before issued for specific construction in the absence of a local zoning plan upon investor's request. Since September 2023 issuance of zoning decision allowing for the construction of photovoltaics will be excluded.

Since local zoning plans as well as studies of conditions and directions of spatial development are adopted for every municipality and usually there are many local zoning plans within one municipality, the permissibility of placement of PV can vary (fragmented regulations).

At the moment, since the new legislation is in force, issuing of zoning decisions in relation to construction of photovoltaics will be excluded, therefore new investments will be based exclusively on provisions of local zoning plans.

The change of the local zoning plan and the study of conditions and directions of spatial development can take a few years and the authority is not obligated to change the local zoning plan as requested. The mentioned amendment to the Act on Spatial Planning and Development provides a simplified procedure of change of the local zoning plans if the change is being carried out to include localization of the photovoltaics in the local zoning plan.

Barriers:

- *Highly fragmented legal and regulatory framework applicable to FPVs.*
- *Lack of experience at administrative level.*
- *Barriers through extensive use of administrative formalities / time-consuming procedures.*

Portugal

According to the General Regulation for Urban Buildings (RGEU), a construction licence is required from the relevant municipality. Examples show that the requirements for a construction license are not well defined, and they depend on the insights of each municipality. This results to hurdles in the project development process, especially in cases where FPV projects were awarded in a national tender. An exception from the construction license issued by the municipality is made for power plants constructed and operated under a concession (e.g., a concession is required for FPVs located in coastal or river areas, which are not covered by this study). According to wording of the requirement of construction licences, FPV on public domain are subject to concession are not subject to a construction licence. FPVs on private waters are not mentioned in the exception to the permit requirement and thus fall under the activities that require construction licence from the competent authority.

Barriers:

- *Legal uncertainty due to the lack of FPV-specific regulations and definitions.*
- *Permitting and administrative procedures are slow due to lack of sufficient and qualified administrative staff.*

Romania

According to the Romanian legal system, the relevant permitting regimes for FPV plants are stated in different laws, such as, constructions law. As per Romanian Construction Law (*Legea autorizarii lucrarilor de constructii nr. 50/199*1), the construction works regarding installations/facilities which are fixed into the ground, including PV installations, typically require the prior issuance of building permits.

The Romanian law does not provide clear regulations as to whether FPVs are subject to the obligation to obtain a building permit. The construction law mainly refers to the use of PV on solid ground/soil and/or on other constructions, but not to the use of water surfaces or bodies or underwater ground.

Furthermore, as a rule under the Romanian construction law, the issuance of the building permit is conditional upon holding "real" (in rem) rights (e.g., ownership, superficies, concession rights) over the lands/constructions affected by the authorized construction works. No reference is made in the legislation to the rights required to be obtained for constructions erected on water surfaces or bodies or anchored into underwater ground.

Lacking express indication of the rights required to be secured for building FPV (e.g., concession rights over the water surface and/or concession or other rights over the waterbed) may trigger delays in the permitting of FPVs and/or inconsistent implementation of the permitting proceedings at the level of various local authorities.

Barriers:

- *Lack of uniform definitions and lack of regulations for FPVs, which can lead to delays in the permitting process.*
- *Lack of experience at administrative level.*
- *Lack of jurisprudence / precedents.*
- *Lack of legal certainty due to inaccessibility of legal information concerning the permitting requirements for FPVs.*

The Netherlands

According to Article 2.1 of the Environmental Law General Provisions Act (Wet algemene bepalingen omgevingsrecht) an environmental permit is to be issued by the respective authority (Bevoegd Gezag) for the building of a structure (het bouwen van een bouwwerk).

The Housing Act provides provisions on public housing and rules to promote the construction of good homes and other structures.

Art. 1a Housing Act reads: “The owner of a structure, open yard or site or the person who is authorized to make provisions for it on other grounds shall ensure that the state of that structure, open yard or site does not pose any danger to health or safety arises or continues.” For the purposes of this Act, construction also includes the installations forming part of it. The Building Decree is an Order in Council (Dutch: *AMvB*) under the Housing Act. The Building Decree provides a collection of technical building regulations that all buildings in the Netherlands must comply with. Chapter 6 of the Building

Decree provides further rules on installations. Art. 6.8 of the Building Decree stipulates that "An electricity facility complies with technical standards: NEN 1010 at low voltage, and NEN-EN-IEC 61936-1 and NEN-EN 50522, at high voltage.

According to technical experts it could be that the Construction Law(s) affect FPVs (other than 'traditional solar PV' is affected on this aspect), because the NEN 1010 (update 2020) addresses PV systems as a separate special type of installation. FPV systems are not specifically addressed in NEN 1010. Even more, FPV systems are excluded from NEN 1010 in article 11.3 clause c) where moveable and fixed units on water, such as offshore platforms, are excluded from NEN 1010. This has been confirmed by the NEN 1010 technical committee and means that NEN 1010 is not enforced by law on FPV systems in the Netherlands. Projects may still strive to comply tot NEN 1010 as much as possible to achieve a similar level of safety.

Barriers:

- *Legal uncertainty due to the lack of FPV-specific regulations and definitions.*
- *Lack of jurisprudence / precedents / case law.*

Common barriers identified

Building law is typically highly fragmented in the Member States and there may be several different laws (especially in Member States with a federal structure, such as in Austria), depending on the state, region, and even municipality, hamper the development of FPVs. Zoning plans and spatial planning are usually performed/changed at a municipal level. This adds another layer of complexity for project developers and legal advisers. The individual practice of the municipalities varies and, in most Member States the process of changing the spatial planning acts and the zoning plans is highly political, and individuals usually do not have power to request a change of the respective legal act.

Energy Law

In some Member States the construction of energy generation facilities (including FPV) is (also) governed by energy law. This is particularly the case for larger FPV-projects which exceed a certain capacity threshold. The rationale behind this is that for larger projects, the relevance of energy-specific construction and operational aspects is prevailing.

Austria

In Austria, similar to building law, electricity law is standardized in nine different provincial electricity laws, here, however, in addition to a nationwide electricity ("basic") law (called *Elektrizitätswirtschafts- und -organisationsgesetz 2010* – "ElWOG"). Solar PV above a certain capacity threshold requires an electricity law permit. However, there is no uniform approach in Austria. Each province sets their own capacity threshold. In some provinces solar PV is completely exempted from the permit requirement.

Overall, the electricity permit must comply with the regulations in force at the planned location of the PV plant, this includes spatial planning and zoning laws. In this context, it should be noted that the experience of the authorities with regard to the approval of agrivoltaics seems to be very modest.

Barriers:

- *Lack of FPV-specific regulations.*
- *Lack of experience at service provider's and grid operator's level.*

Croatia

An energy approval is an approval issued by the Croatian Ministry of Economy (as the ministry currently in charge for the energy; the "***CMoE***") based on which the project developer can construct a new energy facility or upgrade the capacity of the existing one. The main purpose of the energy approval is to provide information to the CMoE about the energy projects under development. The energy approval is issued either through the tendering process administered by the CMoE or upon a request of the project developer. The CMoE does not specify FPV as a project for which an energy approval is issued without a tendering process, FPV-projects would have to undergo the tendering process unless some additional specific requirements for the issuance of the energy approval without the tendering have been met.

The energy approval is valid for a period of 7 years and this period cannot be extended. The project developer must construct the production facility within that period and obtain and deliver to the CMoE an enforceable certificate of occupancy.

After CMoE issues energy approval to the project developer, the CMoE will register the project with the Register of Renewable Energy Sources and Cogeneration and Eligible Producers ("***OIEKPP Registry***") kept by the CMoE.

Barriers:

- *Lack of FPV-specific regulations.*
- *No FPV-specific exceptions from the tendering process.*

Germany

In Germany, the Renewable Energy Source Act (*Erneuerbare-Energie-Gesetz, EEG*) establishes a support scheme for PV, including FPVs. The EEG provides a privileged grid connection, the privileged purchase of electricity, and the regulation of feed-in tariffs for FPVs. However, only FPVs according to the Water Resources Act receive the EEG subsidy. This regulation also is transferred to commercial projects for self-consumption and therefore restricts the size of FPV systems. Please note that the German subsidy scheme implemented is limited to FPVs constructed on artificial water bodies. This restriction has been stated due to natural conservation considerations (with reference to the requirements of the EU Water Framework Directive). Thus, FPVs on natural waters (e.g., natural lakes) are not subsidized in Germany. The German EEG stipulates that tenders for solar systems in Germany shall only be submitted for PV plants that are placed on an artificial water body within the meaning of section 3 number 4 of the German Water Resources Act (*Wasserhaushaltsgesetz, WHG*) or a heavily modified water body within the meaning of section 3 number 5 of the WHG.

Furthermore, the German support regime does not address the fact that the investment and operating costs for FPVs are typically much higher than for regular PV systems. This leads to a lack of competitiveness in national public auctions in Germany.

Barriers:

- *Support scheme only for FPVs on artificial water bodies.*

Poland

For the energy production in renewable energy source installation, which is not a micro-generation plant (*Mikroinstalacje*) or small – generation plant (*Małe instalacje*) (over 50 kW up to 1,000 kW), a license to generate electricity from renewable energy sources (*Koncesja na wytwarzanie nergii elektrycznej z OZE*) is required.

In case of energy production from 50 kW up to 1,000 kW, a producer should obtain an entry to the Register of Energy Producers in Small Generation Plants (*Rejestr Wytwórców Energii w Małej Instalacji*). For installations exceeding the mentioned value, a license to generate electricity from renewable energy sources should be obtained.

Under the provisions delineated within the Energy Law (*Prawo energetyczne*), connecting to the electricity grid necessitates the submission of a detailed application to the designated network operator, followed by the finalization of a formal connection agreement. Connection of renewable energy sources has a priority over other energy sources.

The investor firstly applies for conditions for connection to the grid, which includes information of real property and information necessary to provide technical and operational requirements for equipment to be connected to the network as well as an excerpt from the local zoning plan or zoning decision and documents confirming title to the property. Depending on the technical specifications of the installation, conditions for connections should be issued within 21-150 days. A Connection over 1kV requires an advance payment for connection fee.

It is worth noting, from an investment and operational perspective, that grid connection currently represents the most uncertain stage within the renewable energy investment lifecycle.

Barriers:

- *Lack of FPV-specific regulations.*
- *Barriers through extensive use of administrative formalities and therefore a time-consuming procedure.*
- *Lack of FPV experience and lack of established practice at network level.*

Romania

In Romania, the so-called "setting-up authorization" (*Autorizatia de infiintare*) is the regulatory permit which authorizes, along with the building permit issued by the local administrative authorities, the

construction of the renewables, such as FPVs. The rules for the issuance of the setting-up authorization apply uniformly, regardless of the type of electricity production technologies.

The setting-up authorization represents the administrative deed issued by ANRE[118], which grants to applicants the permission to construct/refurbish power production facilities with total installed capacities of at least 1 MW.

As stated above, the construction or refurbishment of electricity production capacities concerning facilities with an installed capacity of up to 1MW do not require a setting-up authorization. Hence, FPVs having less than 1MW installed capacity will generally benefit of the exemption from the obligation to obtain a setting-up authorization.

As per Romanian Energy Law, "electricity producer" means the natural or legal person having as specific activity the production of electricity, including the production in co-generation. By means of exemption, the operators of energy generation capacities with a total installed capacity of less than 1 MW do not need an operating license. Hence, FPVs having less than 1MW installed capacity will generally benefit of the exemption from the obligation to obtain an operating license.

FPVs which fall under the obligation to obtain a setting-up authorization and an operating license shall acquire the status of licensed energy producers, which is accompanied by various regulatory obligations.

The setting-up authorization, licensing and operating fees and costs, as well as the above-mentioned obligations could act as a deterrent for potential investment in FPVs exceeding 1MW installed capacity.

Departing from the general grid connection regulations, the secondary legislation enacted by ANRE provides nevertheless dedicated and simplified grid connection proceedings for certain categories of renewable self-consumers (i.e., local public authorities and renewable self-consumers with installed capacities of up to 400KW), which may also be a benefit to FPVs.

For example, as per the Procedure for connection to the grid of prosumers (ANRE Order no 19/2022) renewable self-consumers with installed capacities of up to 400KW (FPVs implicitly included) benefit of simplified grid connection proceedings, being exempted, among others, from the obligation to obtain and provide the grid operator with a building permit and/or land book excerpts ascertaining their title over the lands/premises where the self-generation plants are built.

Barriers:

- *Lack of FPV-specific regulations.*
- *Lack of practical experience at service provider's and grid operator's level.*

Common barriers identified

We have not identified any major legal potential barriers which derive from energy law, and which are specifically relevant for FPVs.

[118] Romanian Grid Connection Regulations (ANRE Order no. 59/2013).

HSE and labour protection regulation

In all Member States revised under this section the employees and workers must be protected against hazards during their work. The general legal framework for HSE and labour protection applies also to FPV-projects. No Member State has introduced any specific legislation addressing FPVs specifically.

The legislative framework in the Member States assumes practical implications in the FPV projects. Given that the installation, and subsequent maintenance, of FPVs inherently involves activities both on and below the water's surface, the mandates articulated in the above statutes come to the fore. Specifically, any tasks necessitating underwater interventions, often referred to as "diving", obligate employers to ensure stringent protective measures for their personnel and to ensure that those engaged possess the required diving qualifications.

The HSE-regulations may conflict with FPV-projects due to strict employee protection regulations. The lack of FPV-specific regulations and the lack of experience at administrative level concerning FPVs in all Member States may pose difficulties in the permitting process and while operating FPVs. However, we have not identified any major potential legal barriers which derive from HSE and labour protection regulations, and which are specifically relevant for FPVs.

Water specific regulations

FPVs are per definition placed on the water surface. Therefore, the most important area of law to be examined at national level is water law and water-related regulations. FPV systems can also conflict with existing water rights of third parties and with different public interests (e.g., nature, health, and flood protection or tourism).

Austria

In Austria, the use of public and private water bodies is primarily regulated by the Federal Water Act 1959 (*Wasserrechtsgesetz, WRG 1959*). When installing a FPV system, the first question is whether installing the FPV plant is subsumed as a "use of water" and therefore a water use permit as defined in the WRG is required.

Austrian water law does not define FPVs. Although, the legal term "water utilization" refers to the use of surface waters. This is, for example, the use of the motor power of water for direct power transmission or for the generation of electrical energy, or for the use of its chemical or physical properties (e.g., for heat generation or cooling purposes, mineral, medicinal and thermal water use).

Due to the lack of explicit regulations concerning FPVs, it is – at the time of this study – unclear if FPVs fall under the water law regime. Floating PV systems are usually technically anchored to the shore and/or the bed of the lake or pond. Because both the bank and the bed are part of the water body, the use of waters as defined in WRG can be assumed. Thus, for implementing FPVs, usually a permit pursuant to WRG is required. Due to this legal uncertainty, delays in the permitting process are expected. A clarification by the Austrian legislator would be advisable to overcome this legal obstacle.

Barriers:

- *Lack of FPV-specific regulations and lack of jurisprudence concerning the different types of FPVs and the requirements for a permit under water law.*

- *Potential legal conflicts due to other public interests and third-party water rights protected by water law regulations.*

Belgium

Belgium is a federal state, divided in three different regions (Walloon region, Flemish Region, and Brussels Region). Therefore, different legislations are applicable depending on where the plants will be located. Due to the different legal frameworks and different levels of competent authorities, FPV-projects are faced with a very fragmented legal framework. The regional and local authorities are competent for local waters. Therefore, depending on the location of the FPV, different rules apply to the project regarding water use and potentially required permits and authorizations under water law. The lack of experience at administrative level and the complex administrative procedure are expected to hamper the deployment of FPVs in Belgium.

Barriers:

- *Highly fragmented legal framework.*
- *Lack of experience at administrative level.*
- *Complex administrative procedures for FPVs.*

Croatia

Croatian Water Act (Official Gazette No. 66/2019, … 47/2023) does not define FPVs but provides that the use of (standing or flowing) waters for installation of floating objects is subject to a water use permit issued by Hrvatske vode (state - owned company managing inland waters). Should the installation of FPVs cause deterioration of the water bodies, Hrvatske vode can terminate the water permit.

Article 170 of the Water Act provides that the water permit is not required, among others, for the use of waters for installation of floating objects except for performance of catering or other commercial activity. Giving that the installation of FPV would likely have a commercial connotation, the water permit would be required for installation of the FPV.

Lack of specific regulation is the most significant barrier along with the grid connection. Although the FPVs could be brought under the floating objects regime, a whole spectrum of regulation is needed to facilitate the FPV development especially in terms of the regulation application by the competent authorities.

Barriers:

- *Lack of FPV-specific regulations and lack of jurisprudence concerning the question of the requirements for a permit under water law.*

France

Articles 214-2 et seq. of the French Environment Code ("*Code de l'environnement*") set out an authorization regime for certain types of activity in water.

The provisions of articles L. 214-2 to L. 214-6 of the Environment Code apply to installations, structures, works and activities carried out for non-domestic purposes by any natural or legal person, public or private, and resulting in the withdrawal of water from surface or groundwater, whether or not restored, a change in the level or flow of water, the destruction of spawning grounds, nursery or feeding areas for fish, or direct or indirect, chronic or episodic discharges, run-off, discharges or deposits, even if non-polluting.

However, FPVs do not necessarily fall under this special authorization regime. In fact, the impact studies carried out for certain photovoltaic parks in inland water bodies clearly state that, given their characteristics, the projects in question are not subject to the Water Act, which has integrated these articles into the Environmental Code.

Barriers:

- *Lack of FPV-specific regulations and lack of jurisprudence concerning the question of the requirements for a permit under water law.*

Germany

A recent amendment to the EEG affects the PV system application FPV. In the amendment a change of the Water Resources Act (WHG) is foreseen so that a solar park may not be built and operated (i) on and above a body of water which is not man-made or heavily modified (ii) in and above an artificial or heavily modified body of water if the PV plant covers more than 15% of the water surface or the distance to the shore is less than 40 meters.

Generally, a permission is required for the use of water bodies. Such a permission grants entitlement to use a body of water for a specific purpose. It follows a building permit, meaning that a water use permit will only be issued in combination with a respective building permit. Water use permits are limited in time and will only be granted if a specific plan of the water use and a purpose have been established in the application documents. Moreover, any installation must be operated in such a way that no harmful changes to bodies of water are to be expected.

The main difficulty is that the building and water authorities must both work on the project proposal, but one authority has to be the responsible one. This differs from province to province and often is agreed after applicants have submitted their proposal.

The German Federal Environmental Agency (*Umweltbundesamt*) categorizes “sur-face water bodies" (*Oberflächenwasserkörper*) as “running waters” (*Fließgewässer*), “lakes and dams” (*Seen und Talsperren*), and “transitional, coastal and marine waters” (*Übergangs-, Küsten- und Meeresgewässer*). Surface water bodies can be either natural, heavily modified, or artificial. Surface water bodies count as heavily modified when the water structure has been altered to such an extent that their original reference condition can no longer be used as an assessment standard. Dams in impounded rivers, for instance, represent "heavily modified" bodies of water because the damming of the body of water leads to a change in its category: from a flowing water body to a lake. Artificial water bodies are bodies of water that were man-made in places where no water existed before. In Germany, these are mainly open pit lakes, which were created in connection with the open-cast lignite mining, and quarry lakes as well as canals and drainage ditches. In the case of heavily modified and artificial bodies of water, the environmental objective is not the "ecological status" but the "ecological potential". According to the lake categorization in Germany by the Federal Environmental Agency can be found in Appendix. All types until no. 14 are natural lakes. The type 99 “Special type of artificial lake (e.g., excavation lake)” (Sondertyp künstlicher See (z.B. Abgrabungssee)) is the type of artificial bodies of water where FPV

installations float currently are assigned to. Accordingly, the compilation of regulatory frames is linked with these bodies of water as the use of other types for floating PV are up to now not foreseen in Germany.

Barriers:

- *Highly fragmented legal framework.*
- *Lack of experience at administrative level.*
- *Complex administrative procedures for FPVs.*

Italy

Due to the lack of specific regulations and the experience at administrative level, it is unclear whether the installation of FPV qualifies as a type of water use which is subject to a water use permit.

In general, the use of public waters for a private purpose requires a public concession (permit to use that territory for a specific purpose). Such concessions are granted only limited in time. When the concession comes to an end, the non-removable works, constructed on the state-owned area, shall remain property of the State, without any compensation or reimbursement, without prejudice to the right of the authority grantor to order their demolition with the restitution of the property State property in its pristine state.

Water bodies are not clearly attributed to the specific government jurisdiction. As such, regional and national agencies dispute the right to issue a permit to access water bodies and enforce regional or national requirements.

Barriers:

- *Lack of regulation.*
- *Conflicting regulations.*
- *Lack of experience at administrative level.*

Romania

Romania is a country with a high number of inland water bodies usable for FPVs (e.g., natural lakes and artificial water facilities). In Romania, the use of public and private water bodies is primarily regulated by the National Waters Administration Act (*EGO no. 107/2002*) and the Waters Act (*Law 107/1996*). As per the National Waters Administration Act and the Waters Act, the various categories of water users (including agri-zootechnical, industrial and other operators) owe money contributions to the water authorities, payable based on subscription agreements for water usage and exploitation.

When installing a FPV system, the first question is whether installing the FPV plant is qualified as "water usage and exploitation" and therefore water usage and exploitation permit and subscription are required.

PV plants are not expressly included among the categories of users subject to water usage/exploitation subscriptions and related water usage/exploitation fees. However, considering the non-exclusive list of water users obliged to pay such fees, local water authorities will arguably construe that FPV operators

fall within the categories of operators obliged to enter water usage/exploitation subscription agreement and pay water usage/exploitation fees. Nevertheless, lacking dedicated regulations, it remains uncertain the way the respective water usage/exploitation fees will be computed for FPV projects. This is also since it is unclear if FPVs qualify as "water exploitation" under National Waters Administration Act, subject to specific water exploitation fees.

Furthermore, as per the Waters Act, the construction works and/or the activities which are performed on water bodies or which have a connection to water bodies, require the issuance of water management approvals and water location permits as a condition for the issuance of the building permit, as well as a water management authorization, as a pre-requisite for their operation.

The issuance of the water management approval is typically conditional upon the prior performance of water impact assessment studies, which may evidence potential conflicts of FPVs with existing water usage rights, interests of operators and existing hydrotechnical constructions (dams, levees), in which case the water management approval, the water location permit and/or the water management authorization may be subject to implementation of compensation measures (at operators expense), relocation of the projects or (in a worst case scenario) they may be denied, where no satisfactory compensation measures are available.

The local authorities in charge of urbanism planning and land redesignation are not yet familiar with FPVs. The same applies to authorities in charge of permitting of FPVs. For example, water management authorities are not familiar with FPVs and their potential impact on water bodies, aquatic ecology, and existing water rights. This may entail delays in permitting and refusals to issue water management approvals/authorizations and cause legal uncertainties for FPV operators / investors.

Barriers:

- *Lack of FPV-specific regulations and lack of jurisprudence on FPV-projects.*
- *Lack of experience at administrative level and unpredictable legal decisions.*
- *Conflicting regulations with existing water usage rights and public interests, regulated within the national water law.*

Poland

Based on the provisions of the Water Law (*Prawo wodne*), the installation of FPV within waters necessitates the acquisition of a specialized water permit. Such a permit, once granted, remains valid for up to 30 years. Polish law identifies the state as the custodian of flowing waters, whereas standing waters, given they are not interlinked with flowing water bodies, can be under private ownership.

Water permits are issued only if there is no incongruence with other existing regulations, such as local zoning plans or environmental protection guidelines.

Water protection authorities are not familiar with FPVs and their potential impact on water conditions, aquatic ecology and existing water rights. This causes material delays in permitting and may result in a refusal of permit.

One significant concern arises from the potential conflicts between FPV installations and established regulations, particularly those centred around flood protection and the broader health-centric

safeguards. These existing regulations, when in conflict with proposed FPV projects, possess the authority to result in the outright refusal of a water permit application. Compounding these operational complexities is the current lack of experience of the water protection authorities in permitting process concerning FPVs. Their limited familiarity with the nuances of FPVs, coupled with potential uncertainties regarding their impact on water conditions, aquatic ecosystems, and the pre-existing water rights, becomes a material impediment. This lack of experience may not only delay processing of the permit application but also amplifies the risk of permit denials.

Barriers:

- *Lack of FPV-specific regulations.*
- *Conflicting regulations due to water protection provisions and nature preservation aspects.*
- *Lack of experience at administrative level.*

Portugal

Law No. 58/2005 establishes the bases and the institutional framework for sustainable water management. According to Law no. 50/2006 the use of water resources constitutes utilization titles issued by competent authorities. FPVs fall into the scope of the above-mentioned water regulation. Under water regulation a title for the use of the water body is required. Portuguese water regulations provide for three types of water resource use titles. An authorization is required for private water resources. This is granted without a time limit. A license is required for some uses of public and private water resources limited to 10 years with some exceptions. The access to public water domain is granted through a public tender. A concession is required for uses of public water resources. The concession is granted under the terms of a contract. The choice of concessionaire is made by decree. It is unclear if FPV on private waters requires an authorization or a licence.

The regime is clear and well-defined for FPV on public water bodies. They are only accessible through public tenders that give concession permits. However, there are no regulations or identification of requirements for private and artificial water bodies.

Barrier:

- *Lack of clear regulation for the use of private waters (authorization or license).*
- *Lack of regulation regarding the use of artificial water bodies.*

The Netherlands

The Water Act (W*aterwet)* regulates the management of water systems. A water system can be surface water, flood defences and engineering structures such as a dock. A 'water permit' is required when the construction and operation of an FPV is not deemed to be in line with the intended function of the water system and an environmental permit is required. The Water Act will be active until the '*Omgevingswet'* enters into force on January 1st, 2024.

The competent authorities for the water systems in the Netherlands are quite experienced with permitting processes for activities categorized as other (typical) functions; however, they lack experience with FPVs. Typical functions that are considered are water safety (flood risk), recreative

swimming, fishing and shipping. According to national experts FPV may also be considered an "other function".

Barriers:

- *Lack of jurisprudence / precedents / case law.*
- *Lack of joint administrative procedures / mechanisms.*

Common barriers identified

FPVs are usually addressed by national water legislation. The installation of an FPV is sometimes considered a form of "use" of the water. A lack of clear definitions of FPV under water regulation is common to the Member States. It therefore is often left for the discretion of the competent authority to decide whether FPV is a form of water "use" or not. If considered water use, a special water use permit is required. The national water protection authorities are not yet familiar with FPVs. In many Member States, this can lead to significant delays in issuing permits and result in the refusal of permits required for FPVs.

Potential environmental impact and nature protection regulations

Austria

Depending on the relevant Austrian province, FPV may qualify as a "technical construction" (=building) in terms of nature protection law and therefore requires – in addition to the permits mentioned above – approval by environmental authorities. Austria has nine different nature protection laws, one for each province / federal state. Notably, none of the nature protection laws provide any specific regulations on FPVs.

Furthermore, floating PV systems are subject to a permit requirement under nature conservation law, as this may involve an intervention in a body of water that is relevant from a nature conservation point of view. Surface water bodies can provide habitats for protected species. Existing species protection rules might therefore conflict with FPV. Austrian species protection rules prohibit deliberate disturbances of protected species. The Austrian law (e.g., the Vienna Nature Conservation Act, *Wiener Naturschutzgesetz, Wr NSchG 2021*) does not clearly define whether FPV qualifies as a technical construction in terms of nature protection laws. It is therefore questionable if FPV is subject to environmental permit.

Austrian authorities refuse environmental permits or impose compensatory measures / conditions if FPV has negative impacts on the environment (e.g., impact on protected animals such as water birds, microclimate, and landscape). This can be identified as a typical "*green on green conflict*" which can hamper the deployment of this innovative form of deployment. For most FPV projects, it is to expect, that environmental impact assessments are required, as a basis of evaluating permissibility. The lack of knowledge and experience as regards environmental impact of FPVs leads to legal uncertainties in Austria and likely delays in permitting.

Barriers:

- *Lack of FPV-specific regulations.*
- *Conflicting regulations due to environment protection provisions ("green on green conflict").*
- *Lack of experience at environmental expert and administrative level.*

Belgium

On federal level in Belgium, specific legislation protects certain species. In order to install FPV in an area where protected species reside, some specific conditions apply. An authorization will only be granted in case the FPV-project is not disturbing the animals during reproduction times, hibernation or migration, no deterioration or destruction of their reproduction sites or resting areas. It also sets rules regarding the protection of the environment such as pollution prevention, environmental impact assessment. However, environmental permits can be refused if a FPV plant will have a negative impact on the environment. In some cases, the installation of FPV may be prohibited as such.

Depending on the relevant region, the applicable legislation is different (Walloon Environmental Decree, Flemish Environmental Decree, Brussels Landscape Management Codex). However, in all regions, the installation/operation of FPVs requires an environmental permit. The specific requirements to obtain the permit are determined by the municipalities. Since a building permit is also required for FPVs, a combined procedure is available in all regions. A single permit, which is a combination of a building permit, and an environmental permit may be issued for FPV-projects. However, the procedure is quite time-consuming, since various documents are required, public inquiries must be conducted, and the opinions of experts must be included.

Barriers:

- *Lack of specific and harmonized regulation.*
- *As it is not yet a common form of deployment, a lack of experience at environmental expert and administrative level can be expected.*
- *Lack of experience at administrative level.*

Croatia

Prior to obtaining the location permit as set out above, the project developer must obtain the decision on acceptability of the project for the environment and for the ecological network.

Depending on the type of the project and the environmental intervention either an assessment of the need for environmental impact assessment (Cro. *ocjena o potrebi procjene utjecaja zahvata na okoliš*; "***OPUO***") or a mandatory assessment of the environmental impact assessment (Cro. *obvezna procjena utjecaja zahvata na okoliš*, "***PUO***") will have to be carried out. Provided that the FPV is designed as a stand-alone solar power plant, OPUO will be required. Depending on the outcome, a PUO may be required. For FPVs with an installed capacity above 100 MW, a PUO is always required. Moreover, a PUO is generally required for any intervention that could have a meaningful negative impact on the environment. Since inland waters provide habitat for numerous protected species, it is likely that the PUO is required for installation of FPVs on inland waters.

In addition to a OPUO or PUO an assessment of acceptability for the ecological network may be required. This is a procedure that evaluates the impact of a strategy, plan, program, or intervention, alone or with other strategies, plans, programs and interventions, on conservation goals and the integrity of the area of the relevant ecological network (***ENIA***). This procedure is conducted for projects that may have a significant impact on conservation goals and the integrity of the ecological network area. It is not crucial whether the planned project is located inside or outside the area of the ecological network, but whether the project will have impact on the ecological network. The ENIA procedure consists of three main stages: (i) pre-assessment (screening), (ii) main assessment, and (iii) establishment of imperative reasons for overriding public interest (IROPI) with approval of compensatory measures. According to our knowledge, no such decision (on establishment of IROPI) has been rendered for any RES project.

Barriers:

- *Lack of specific legislation and jurisprudence on FPVs concerning environmental law.*
- *Conflicting regulations due to nature protection provisions ("green on green conflict").*
- *Barriers through extensive use of administrative formalities and time-consuming permitting procedures.*

France

The protection of the biodiversity is very crucial during the phases of both public consultations on these projects and in case of litigation, the French Council of State ("*Conseil d'Etat*") has jurisdiction according to Article L. 311-13 of the Code of Ad-ministrative Justice).

"Plan Biodiversité" (2018) and law "Climat et resilience" have defined an objective of zero net artificialisation. To avoid any usage conflict, most of FPV projects are installed on "degraded sites".

Further, an Environmental Impact Assessment (EIA) is mandatory for any PV plant above 250 kWc and subject to environmental authority approval.

Landscape legislation is regulated on a local level (regions) and requirements will vary depending on the area the project is being developed in.

Barriers:

- *Highly fragmented legal framework.*
- *Lack of experience at administrative level.*

Germany

The nature and landscape protection regulation are fragmented in Germany. The competent authorities in Germany lack experience with FPV regarding natura conservation law. Since no standards for the technical evaluation of FPV projects have been developed in Germany, uncertainties regarding the compensation measures that have to be taken for the intervention in nature and landscape when deploying FPV remain an issue. Likewise, there are no empirical values for FPV installations regarding effects on resting birds and the impact on the water body. Due to this lack of

scientific data regarding the impact of FPVs on water bodies, the permitting process can be delayed, and the competent authority may require additional measures (e.g., to monitor and provide data concerning the water quality).

Please note that the German subsidy scheme according to the EEG (see chapter 2.3 above) is limited to FPVs constructed on artificial water bodies. This restriction has been stated due to natural conservation considerations (with reference to the requirements of the EU Water Framework Directive).

Barriers:

- *Lack of specific legislation and jurisprudence on FPVs concerning environmental law.*
- *Conflicting regulations ("green on green conflict").*
- *Lack of experience at environmental expert and administrative level*

Italy

The Italian environmental act provides standards for the protection of the environment; in particular, the ability of water bodies to maintain natural processes of self-purification and to support large and well-diversified animal and plant communities.

In Italy, there are three different procedures for construction, which exempt from the requirement of an environmental permit. FPV is not mentioned in this law, so it is not clear if one of these procedures could possibly apply or if FPV must follow the classical procedure which implies applying for a separate environmental permit.

Natural and artificial water bodies have the same level of requirements of FPV regardless of the specificities of these two different waters bodies. A permit may be refused if the FPV has a negative impact on the environment. The lack of knowledge and experience as regards environmental impact of FPV might trigger legal uncertainties and cause delays in permitting. Surface water bodies can provide habitats for protected species. Existing species protection rules might therefore conflict with FPV.

Environmental permitting requirements for FPV are not defined making it subject to arbitrary and stringent individual perspective of the permitting personnel. Visual impact and distance to shore are very unclear and subjective resulting in blockage or limited potential of FPV.

Barriers:

- *Lack of specific regulations.*
- *Conflicting regulations.*
- *Lack of experience at environmental expert and administrative level.*

Poland

According to the Act on Sharing Information on the Environment and its Protection and Public Participation in Environmental Protection and Environmental Impact Assessment (*Ustawa o o*

udostępnianiu informacji o środowisku i jego ochronie, udziale społeczeństwa w ochronie środowiska oraz o ocenach oddziały-wania na środowisko), decision on environmental conditions is issued for investments which may always or potentially impact the environment. A catalogue of investments which may impact the environment is listed in the Regulation Concerning Projects That Might Significantly Influence the Environment (*Rozporządzenie w sprawie przedsięwzięć mogących znacząco oddziaływać na środowisko*).

Photovoltaic plants (such as FPVs) covering an area of 10,000 square meters are deemed as projects with potential environmental impact, necessitating an environmental decision.

For FPVs situated within protected areas (e.g., in a NATURA 2000 national park, or in a landscape protection zone), even those spanning an area of 5,000 square meters will require an environmental decision. Should the project have a significant adverse impact on the environment within Natura 2000 regions, the authorities will deny approval for its implementation. If the negative impact of the FPVs on the environment (including impact on animals, plants, soil, microclimate, and landscape) is significant, the authority will change the scope of designed construction or refuse to issue an environmental permit.

Lack of knowledge and experience as regards environmental impact of FPVs triggers legal uncertainties in respect to the permissibility of the FPV project, applicable regulations, and cause delays in permitting.

Given the relative novelty of FPV systems, there is a significant lack of comprehensive data on their environmental interactions. These void fosters legal uncertainties, potentially culminating in delays in processing permit applications or even permit rejections. Moreover, in cases where a project is deemed to negatively impact environment, authorities might mandate developers to conduct compensation measures, such as undertaking compensatory ecological initiatives on their own cost.

Barriers:

- *Lack of specific legislation and jurisprudence on FPVs concerning environmental law.*
- *Conflicting regulations due to nature protection provisions ("green on green conflict").*
- *Barriers through extensive use of administrative formalities and time-consuming permitting procedures.*

Portugal

The Environmental Impact Assessment (EIA) regime (RJAIA) applies to all projects likely to cause significant impacts on the environment. To this end, it defines a set of project typologies, listed in Annexes I and II of Decree-Law no. 151-B/2013, of 31 October. FPV are subject to one of two environmental approval schemes, the EIA or the Environmental Incidents Assessment AIncA. In general, power plants in the special regime, such as decentralised production (for self-consumption or small production) may benefit from simplified licensing. The Ecological Flow Regime (CERs) must be guaranteed in all bodies of water. Only projects over 1 MVA[119] are subject to a specific environmental approval.

[119] Volt Ampere are used for AC power, whereas Watts are for DC power, the difference is reactive power. For inverters, it is assumed that 1 VA = 0,8W.

There are two competent bodies responsible for the environmental approvals the Portuguese Environment Agency (APA) and the Coordination Regional Development Commissions (CCDR) without clear distinction on their respective responsibilities in the approval process. There are power plants not subject to an EIA, for which only a favourable opinion is required. However, there is no specific legislation on FPVs and thus no information weather certain FPVs with small size could qualify for this category. Additionally, we identified a lack of experience at the level of environmental and administrative authorities, which can hamper the deployment of FPVs in Portugal.

Barriers:

- *No information about applicability of simplified procedures for FPV.*
- *Lack of experience at the level of environmental and administrative authorities.*

Romania

The construction of technical installations (including FPVs) requires the issuance by the country environmental authorities of an environmental permit or, respectively, a decision ascertaining that the respective project may be development without an environmental permit (in case the authorities establish that the respective project does not have the potential for a significant environmental impact).

Furthermore, where projects are in the vicinity of, or are overlapping with Natura 2000 protected areas, a distinct Natural 2000 permit may be required in view of constructing the respective projects.

Depending on the size of the FPV project (and its potential environmental impact, its construction may also require obtaining an environmental permit and respectively, Natura 2000 permit, which requires undergoing a full environmental permitting procedure (*Environmental Impact Assessment Law no. 292/2018*), consisting in the performance of lengthy environmental impact assessment proceedings and appropriate environmental assessment proceedings as per the Protected Areas Act (*GEO no. 57/2007 on the regime of protected natural areas*) (in case of Natura 2000 sites). Alternatively, leaner, and less time-consuming proceedings will be required in case the authorities decide that the project does not have a significant environmental and that the construction may be authorized without requiring an environmental permit or a Natura 2000 permit.

Notably where Natura 2000 sites are or may be affected by the respective projects, developers need to provide evidence that the respective projects (including FPVs) do not conflict with the protected areas protection regulations. Moreover, the respective environmental procedures may require lengthy bird/animal population monitoring, as well as the involvement of various environmental associations with attributions in the preservation of the protected areas.

Against such background, we note that, due to the lack of FPVs in Romania and dedicated legislation, environmental authorities are not familiar with FPVs and their potential impact on water bodies, aquatic ecology, and existing water rights. Such limited knowledge and practical experience regarding the environmental impact of FPVs could cause delays in, or (in a worst-case scenario) prevent the permitting of FPV projects, notably considering that numerous surface water bodies are prone to fall under Natura 2000 protection regime for providing habitats for protected species. Such protection rules might therefore conflict with FPVs and prevent permitting or require mitigation measures.

Barriers:

- *Lack of FPV-specific regulations.*
- *Lack of experience at environmental and administrative authority level.*

The Netherlands

The Environmental Management Act (*Wet Milieubeheer*) is most important environmental law. This law determines which legal tools can be used to protect the environment. The most important instruments are environmental plans and programs, environmental quality requirements, permits, general rules and enforcement.

It is expected that the Environmental Management Act does not cause any new/different barriers to FPV, other than to ground mounted and rooftop PV.

According to the Dutch Nature Conservation Act (*Wet Natuurbescherming*) a permit or an exemption may be required for FPVs. Sometimes an environmental permit is required for the construction of a solar farm (including FPV). This is relevant when a solar farm is located in or near a Natura 2000 area. The permit is required if the development of a project could significantly harm or degrade the natural habitat of the flora and fauna in the area. A permit will not be issued until it is certain that the project will not have an adverse effect on the natural features of the Natura 2000 area. If it is impossible to provide such certainty, an environmental permit may only be obtained in the absence of any other feasible alternative. In addition, there must be a compelling reason in the general interest and compensation measures will have to be adopted for the area.

In addition, during the construction of a solar farm, it may be necessary to obtain an exemption, to contravene any prohibition to kill, wound or disturb birds or other animals. Examples include disturbing the breeding season.

Barriers:

- *Lack of specific legislation and jurisprudence on FPVs concerning environmental law.*

Common barriers identified

Potential legal conflicts due to environmental protection regulations were identified as a common barrier in all Member States. This leads to a so-called "green on green conflict". This is particularly the case for FPVs on natural waters or waters in rural areas or close to a nature conservation area. The lack of long-term experience with the installation of FPVs typically delays the permitting process for FPVs.

6.10. Status on BIPV in selected Member States

The countries studied in this section were: Austria, Belgium, Bulgaria, Croatia, France, Germany, Italy, Poland, Romania, and Netherlands.

6.10.1. Permitting

Building Law

As set out previously, the term "building law" does include all regulations governing the construction of a building, facility, or installation. It primarily comprises building and construction laws, regional and spatial planning as well as zoning, land use and land designation regulations. Compliance with all the regulations is usually a requirement for the issuance of a building or construction permit.

EU-wide recognition that BIPV modules are building products, and thus fall within the scope of the Construction Product Regulation, would clarify that BIPV installations fall under building code requirements and as such are subject to building permitting processes. At present, this is not the case in some EU member states. A mandate to recognize the revised standard EN 50583-1 as a harmonized product standard for BIPV modules under the CPR is urgently needed as a first step toward this clarification. A detailed discussion on this topic can be found in chapter *5.5 Non-regulatory barriers for Building Integrated PV*.

Austria

In Austria the design and construction of buildings are subject to a building permit in accordance with the provincial (local) buildings laws. Also, amendments to existing buildings regularly require a building (amendment) permit. The permissibility of BIPV needs to be assessed against its compliance with applicable building laws and technical regulations, including product safety and fire protection regulations (OIB directives, building technology regulations, OVE directives, Austrian Standards (*ÖNORMEN*)). Furthermore, the design of the building needs to comply with local land- and townscape protection rules. It is important to note that neighbours are granted the status of a legal party in building permit proceedings.

Building law in Austria is a matter for the federal states in terms of legislation and a municipal matter in terms of enforcement. As a basic rule, a building permit or building notification for the construction of a PV plant is generally only required if no permit under electricity or trade law is required. However, in Styria, unlike in the other federal states, no exemptions from the construction permit requirement in accordance with Styrian Building Law ("*Steiermärkisches Baugesetz*", *Stmk BauG 1995*) are provided for PV systems that (also) require a permit under the Styrian Electricity Industry and Organization Act 2005 ("*Steiermärkisches Elektrizitätswirtschafts- und -organisationsgesetz*", *Stmk. ElWOG 2005*). Thus, in Styria both systems are fully applicable to PV plants. Furthermore, in Vienna, also in contrast to other federal provinces, there is a requirement for a permit under the Vienna Building Code ("*Bauordnung für Wien*", *Wr BauO*) even though the PV system is subject to an electricity law permit or notification requirement under the Vienna Electricity Industry Act 2005 (*WelWG 2005*).

Apart from the general technical regulations which set standards for building constructions, including the installation of PV, BIPV is also regularly subject to regulations governing the use of glass in buildings (Austrian Standards). This increases the complexity of design works. PV installations, including BIPV, are considered as a construction with increased risk of fire incidents according to Austrian Standards. The fire protection regulations continuously conflict with BIPV, since fire protection regulations regularly require a minimum distance and other safety measures that are difficult to be complied with in case of BIPV. Moreover, BIPV are subject to OVE Directive R 11-3 which regulates the protection from glare caused by PV. It is not clear if the Directive directly addresses BIPV. According to our research it cannot be ruled out that the protection requirements will be a barrier for the deployment of BIPV, considering that neighbours have the right to participate in building permit proceedings and raise the issue of non-compliance with glare protection rules.

Furthermore, BIPV can conflict with townscape protection regulations, especially in towns with large historical building stock. This might result in a complete denial of the building permit or delays in permitting. Many construction or building codes in Austria foresee a requirement to install a PV system for new buildings. However, this requirement is usually waived for protected zones or old town areas worthy of preservation and other listed buildings. For example, according to Section 66a (4) Lower Austria Building Code (*Niederösterreichische Bauordnung*, NÖ BO), the obligation to install PV systems only applies if the compliance with the obligation does not conflict with the objectives of the protection zones, old town areas worthy of preservation or listed buildings. In Styria there is an exemption from the obligation to install solar energy systems in new residential buildings with a gross floor area of more than 100m^2 for buildings if the requirement would lead to the denial of a building permit, because of the protection of the local image or the Graz Old Town Preservation Act.

Barriers:

- *Conflicting regulations regarding BIPVs.*
- *Restrictive practice of the permit issuing authorities (regarding townscape protection rules).*
- *Different administrative procedures in the federal states.*

Belgium

It should be first noted that Belgium is a federal state. It means that it is divided into three regions and communities that have their legal provisions. Within the regions there are local authorities, provinces, and municipalities that can impose additional rules relevant for BIPVs. Depending on the location where the BIPVs are supposed to be installed, different laws can apply.

In all three regions, an urbanistic permit is required for the establishment of PV panels fields (meaning the installation of more than one PV panel) (*D.IV.22 Code du développement territorial ; art. 98* CoBAT). PV panels fields are not defined by the legislations. BIPVs are therefore not directly mentioned in this legislation and there is no indication either that it would not fall within the scope of this requirement. An urbanistic permit is issued by the competent authority on local level. Since the municipality has the authority to decide on the required documentation for an urbanistic permit. There are more than 500 municipalities in Belgium, so it is not possible to state the respective requirements.

BIPV panels are integrated into the building's architecture and design, and their installation must comply with aesthetic considerations. Some building regulations impose restrictions on the appearance and visual impact of buildings, including the integration of solar panels. Compliance with these regulations may limit the design options or require additional design approvals.

Furthermore, BIPVs may conflict with townscape protection regulations, especially in towns with large historical building stock. In case of conflict the urbanistic permit may be denied, or this might result in delays in permitting. According to regional legislations, such as the Walloon Codex of patrimony (art 25, 27 à 30) or the Brussels Landscape management codex (CoBAT) and the Flemish Environmental Decree), works on classified buildings can be allowed but more authorizations and conditions are required such as:

In Wallonia the submission of a prior declaration to the AWaP (Agence Wallonne du Patrimoine – Walloon Agency of Patrimony) describing the purpose and characteristics of the planned works is required for maintenance or emergency conservation works or an application to the AWaP and the

holding of two heritage meetings prior to the submission of an application for a planning permission issued by the local authority of the municipality in which the property is located or by the Planning Officer (FDU) is required. These heritage meetings are organized by the AWaP and attended by the applicant, the FDU, the local council and the Royal Commission for Monuments, Sites and Excavations. They enable the various parties involved to learn about and discuss the project, and to help the applicant prepare the planning application.

In Brussels the applications for planning permits for properties that are part of the protected heritage are examined by the regional delegate officer and, in certain cases, are subject to the opinion of the Royal Commission for Monuments and Sites.

In Flanders any modification to a listed building, which is a classified building, that has been considered historical and is therefore protected to be conserved, or one situated in a protected area typically requires planning permission. This also applies to the installation of solar panel. If the building is listed or protected, the consent of the monument conservation service is also required. They will evaluate the application based on the impact of the solar panels on the historical value of the building.

Barriers:

- *Different administrative procedures in the three regions.*
- *Complex and fragmented legislation – requirements set at municipality level.*

Bulgaria

In Bulgaria the design and construction of buildings are regulated in the Spatial Development Act (*Закон за устройството на територията* "SDA"). The SDA is applicable in the entire country while the competent bodies to issue the relevant acts and permits in most cases are the municipal authorities where the property is located – the mayor, the municipal council, and the chief architect. The SDA does not explicitly regulate BIPV and there is no legal definition for BIPV in Bulgaria. However, since BIPV is integrated in the structural elements of the building, it should be possible to construct BIPV if the investment designs for the building also include the designs of the integrated PV modules. The investment designs are the main documents in the development process and include multiple drawings, sketches and explanatory notes. The scope of the investment designs, depending on the type, designation, size and location of the designed objects, may include the following parts: (i) architecture and construction; (ii) installations and networks of technical infrastructure; (iii) geodesic; (iv) technological; (v) fire safety, and others. The construction part of the investment designs contains a description of the characteristic elements and details of the construction, as well as information for the technical parameters and used materials. Thus, according to our research, BIPV should be permitted through the approval of the investment designs for the building and the subsequent issuance of a construction permit for the entire building by the chief architect of the municipality. We note that this conclusion is based solely on our interpretation of the law as there is no publicly available administrative or court practice on this matter.

The issuance of a construction permit for a building is subject to compliance with multiple technical norms and regulations. The following steps are required in order to obtain a construction permit.

First, at the stage of urban planning, the detailed zoning plan for the land plot should reflect that the building will incorporate a PV plant and respectively the land plot will be used for electricity generation

activities as well. The detailed zoning plan is subject to public announcement and may be appealed by the owners of the neighbouring properties.

Second, at the stage of the preparation of the investment designs, the PV system must be designed in accordance with the provisions of Ordinance No. 14 dated 15.06.2005 on technical rules and regulations for the design, construction and use of sites and facilities for the production, conversion, transmission and distribution of electrical energy ("Ordinance 14"). Ordinance 14 does not contain any specific regulations for BIPV. Generally, Ordinance 14 should not restrict the development of BIPV but if there are any technical specifics of BIPV compared to a conventional PV plant, such specifics should be introduced in the legislation to facilitate the development of BIPV.

Third, the development of BIPV must comply with fire safety regulations under the Ordinance No. Iz-1971 of 29.10.2009 on construction and technical rules and norms for ensuring safety in case of fire ("Ordinance No. Iz-1971"). Ordinance No. Iz-1971 does not regulate explicitly the possibility to use PV modules as an integral part of the construction. Thus, BIPV must be assessed on a case-by-case basis depending on the type of building, the fire danger category, and the applicable fire safety regulations for the respective fire danger category.

Finally, considering that the PV modules in BIPV are qualified as construction mate-rials, the BIPV must comply with Ordinance No. RD-02-20-1 of 02.05.2015 on the terms and conditions for placing construction products in construction sites in the Republic of Bulgaria. Generally, if there is a harmonized EU standard for the respective construction product, such product should meet the Bulgarian construction law requirements and may be used in buildings.

Barriers:

- *Complex administrative procedures due to a lack of regulations that apply specifically to BIPVs.*
- *Lack of experience at administrative level.*
- *No publicly available administrative or court practice on BIPV.*

Croatia

BIPVs are the PVs that encounter the least stringent permitting regime under the Croatian regulatory framework and are considered the easiest to develop.

BIPVs, if installed on an existing building, are considered to be simple buildings in terms of the Regulation in the Official Gazette No. 112/2017,…, 74/2022; "Simple Building Regulation". According to Article 5, paragraph 10, 11, and 14 of the Simple Building Regulation, the works can be carried out without a building permit, and in accordance with the main project on an existing building (i) connected to the power grid for the purpose of electricity production with the associated distribution cabinet and a system for connecting to the public grid for transferring energy to the grid; (ii) for the purpose of electricity production for the needs of that building without the possibility of the electricity export to the grid; and (iii) on the part of the building where the equipment intended for charging electric vehicles is installed, without or with the associated canopy with the photovoltaic modules for the production of electricity for vehicle charging.

Apart from a building permit, there is no need for the inclusion of the location into the spatial plan, no need for the location permit and no need for the certificate of occupancy (provided that the existing building holds the certificate of occupancy) or for an energy approval in accordance with Article 19, paragraph 4 of the Regulation on the criteria for conducting a public tender for the issuance of an energy approval not the conditions for the energy approval issuance (Official Gazette No. 70/23; "Energy Approval Regulation").

BIPVs can conflict with townscape protection regulations, especially in towns with large historical building stock. Special permission of the conservationists' administration could be required for installation of BIPVs on the buildings within cultural-historical complex. On historical buildings and buildings within the heritage sites, conservationists' administration can prohibit the installation of BIPVs altogether. This has been recognized as one of the most burdensome barriers for development of BIPVs within cultural historical units in the Croatian cities.

Barrier:

- *No major barriers for BIPV have been detected.*

France

France already has started on the implementation of BIPV and several legal sources may apply, the main legal regulation comes from urban planning regulations and electricity market laws. France has recently adopted a new law (LAW no. 2023-175 of March 10, 2023, on accelerating the production of renewable energy) which aims to boost and increase renewable energy. This law makes it easier to install solar panels on land that has already been developed or where there are no major environmental issues. This includes buildings. On new or heavily renovated non-residential buildings (warehouses, hospitals, schools, etc.), the minimum solar roof coverage will gradually increase from 30% in 2023 to 50% in 2027.

Under French Law, permitting procedures are mainly regulated by building law (French urban planning Code) and environmental law (Environmental Code). Different authorization procedures may apply, depending on the size and power of the plant, and its location (protected or not). The installation of a BIPV requires, depending on the case, a building permit (permitting duration 2 months) or a prior declaration (30 days duration of the process). There are two possible scenarios:

1. If BIPV is to be installed on an existing building a prior declaration is required. However, if the building is listed as a historical monument, the project owner must apply for a building permit.

2. In case of a new building, it is generally preferable to include the photovoltaic installation in the building permit application.

In both cases, the project owner will have to check the compatibility of his project with the local urban planning document (*POS*[120], *PLU*[121], *PLUI*[122]) if the municipality has one, and with the National Building Regulations (*RNU*[123]) if the local municipality does not have one. In some cases, a special hydraulic study may be necessary for BIPV if the area is located (i) in a housing estate (ii) on any territory of a

[120] "Plan d'Occupation des Sols".
[121] "Plan Local d'Urbanisme".
[122] "Plan local d'Urbanisme intercommunal".
[123] "Règlement National d'Urbanisme".

commune subject to PPRI (*Plan for the Prevention of Natural Flooding Risks*) (iii) on any territory of a commune with a Zoning of Rainwater. This depends on the respective local urban planning regulations.

A prior declaration or building permit must be submitted to the town hall of the municipality where the project is to be implemented. The "*Architectes des Bâtiments de France*" (Architects in charge of protecting French Historical Buildings) must be consulted when the project is located within a 500m radius of a classified or registered monument. Depending on the co-visibility of the BIPV-project and the protected monument the competent authority either must comply with the respective opinion or has the possibility to disregard it.

Since landscape protection is under the jurisdiction of the local authorities, there is no uniform regulation applicable to BIPV on a national level.

Barriers:

- *Lack of joint administrative procedures / mechanisms*
- *Lack of experience at the administrative level*

Germany

In Germany the design and construction of new buildings are subject to a building permit in accordance with the State (local) building code. To obtain a permit, a building application must be lodged by a qualified person, such as an architect or a civil engineer, to the local council, which then forwards it to the building inspection authority that is responsible for that region. Changes to existing buildings also regularly require a building (modification) permit, particularly if safety aspects such as fire safety are affected. The permissibility of BIPV needs to be assessed against its compliance with applicable building code and technical regulations, including the local State version of the MBO (*Musterbauordnung* – model building regulations) and the MVV TB (*Musterverwaltungsvorschrift Technische Bestimmungen* – model administrative technical regulations). Each of the 16 German States has its own version of the building code that is based on the model building regulations; for example, in the State of Baden-Württemberg this is the "*Landesbauordnung für Baden-Württemberg* (LBO)" (State Building Code for Baden-Württemberg) in the version of 5th March 2010. In addition, building technology regulations and DIN standards must be observed. There are no special provisions for BIPV products and thus, they are treated the same way as any other building component in this respect.

There is no specific law governing glare from BIPV installations but there are often stricter glare requirements on energy-related installations than for optically similar glazing installations. Furthermore, BIPV systems (like all PV systems) are addressed by the "Bundes-Immissionsschutzgesetz - BImSchG", which covers disturbing "emission of light" (i.e. glare). Conventional architectural glazing does not fall under the scope of this law.

The design of the building needs to comply with local landscape and urban planning protection rules. BIPV can conflict with urban planning regulations, especially in towns with a large historical building stock. For example, in the State of Baden-Württemberg, the Gesetz zum Schutz der Kulturdenkmale (DSchG – Law to Protect Cultural Heritage) requires in §8(1) 2 that "*Ein Kulturdenkmal darf nur mit Genehmigung der Denkmalschutzbehörde in seinem Erscheinungsbild beeinträchtigt werden*" (The appearance of a cultural heritage object may be compromised only with the permission of the Cultural Heritage Authority.) This can result in denial of building permits or delays in permitting. It is important

to note that neighbours are granted the status of a legal party in building permit proceedings and may raise objections during the permitting process, which may further delay or complicate the permitting.

Barriers:

- *Regionally and even municipally different regulations.*
- *Lack of special provisions regarding BIPV.*
- *Restrictive granting of permits through authorities (regarding townscape protection rules in historic town centres).*

Italy

The national construction code d.P.R. 6 giugno 2001, n. 380 gives general recommendations in Part 1, including building permission procedures, whereas Part 2 is the framework for local regulations, including technical requirements. The permissibility of BIPV needs to be assessed against its compliance with applicable building laws and technical regulations, including structural safety (D.M. 17 gennaio 2018 - Aggiornamento delle «Norme tecniche per le costruzioni») and fire protection regulations (D.M. 3 agosto 2015 – "Approvazione di norme tecniche di prevenzione incendi"). The design of the building needs to comply with local landscape and urban planning protection rules ("Piano Regolatore Generale Comunale"). As in all EU Member States, basic requirements for building products are defined in Annex I of the European Construction Products Regulation (EU-CPR). The corresponding standard specifying requirements on BIPV modules and systems is EN 50583, Parts 1 and 2, respectively.

The standards for building constructions defined by general technical regulations must be observed. This increases the complexity of design works compared to free-standing PV plants. The fire protection regulations targeting PV may limit the installation of BIPV. Moreover, not only specific PV fire protection regulations have to be observed in the case of BIPV but also the specifications applying to other building components.

BIPV can conflict with urban planning regulations, especially in towns with a large historical building stock. This might result in denial of building permits or delays in permitting.

Barriers:

- *Lack of specific BIPV regulations and definitions.*
- *Restrictive granting of permits through authorities (regarding townscape protection rules).*

Poland

The installation and implementation of BIPVs in Poland are governed by a series of regulations, including the Act on Spatial Planning and Development (*Ustawa o planowaniu i zagospodarowaniu przestrzennym*), Construction Law (*Ustawa Prawo Budowlane*), the Regulation on the Technical Conditions to be met by Buildings and their Location (*Rozporządzenie w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie*), and the Construction Products Act (*Ustawa o wyrobach budowlanych*).

Within the framework of these laws, several critical requirements have been laid down for the design and construction of buildings. Firstly, the initiation of any building project necessitates the obtaining of a construction permit or submission of notification on construction. This rule extends to modifications to existing structures, which often require a construction permit, notification on construction or amendment permit depending on the scale of modifications and characteristic of the building/construction itself. Moreover, the initiation of construction projects involving PV systems with a capacity exceeding 50 kW is contingent upon the obtaining of a construction permit. For construction projects involving PV systems with a capacity between 6,5 kW and 50 kW there is an obligation to consult the project with a fire protection expert for compliance with respective fire protection requirements. The fire protection regulations stipulate minimum distance requirements and safety protocols, potentially conflicting with the practical aspects of BIPV implementation. Furthermore, the use of glass in buildings often envelop BIPV projects, consequently amplifying the complexity of design works.

The obligation to obtain a construction permit may result from other (than construction of the PV with relevant capacity) parameters of the building like height or size of the building. For most single-family-homes, a notification (instead of construction permit) will be sufficient.

It is noteworthy that non-free-standing devices are exempt from the requirements outlined in studies of spatial development conditions or local zoning plans, irrespective of their installed capacity. The lack of clear statutory criteria regarding the classification of BIPV as non-free-standing devices, together with limited experience at administrative level, may result in interpretative issues and inconsistent practice. This leads to the conditioning of the consent for the non-free-standing installations on fulfilment of the requirements set out in studies of spatial development conditions or local zoning plans. Based on the available interpretations and information, BIPV should be interpreted as non-free-standing devices in the same way as photovoltaic solar panels located on the roofs of the buildings.

However, the implementation of BIPV is not possible without its regulatory assessments. It is imperative to evaluate the admissibility of BIPV systems against existing building law and technical regulations. These evaluations encompass various aspects including, but not limited to, product safety and compliance with fire protection regulations. Additionally, the building's design should be in harmony with local land and townscape protection regulations. BIPV systems might clash with townscape protection regulations, especially in regions with a significant stock of historical buildings. This clash could manifest in delays or outright denial of building permits.

Barriers:

- *Lack of regulations regarding BIPV.*
- *Lack of experience at administrative level.*
- *Lack of jurisprudence and precedents that lead to interpretative issues.*

Romania

In Romania the design and construction of buildings are subject to a building permit in accordance with the relevant constructions law. Also, amendments to existing buildings typically require obtaining a new building permit. The permissibility of BIPV needs to be assessed against its compliance with applicable constructions laws and technical regulations, including product safety, technical norms and fire protection regulations (Constructions Law, its related norms, the Constructions Quality Law, the

Constructions Energy Performance Law, technical instructions, norms and guidelines regarding the design and construction of buildings). Furthermore, the design of the building needs to comply with local urban planning regulations.

The Constructions Law ("*Legea autorizarii lucrarilor de constructii*", Legea 50/1991) typically requires a building permit for all building structures, including PV systems and BIPV. However, as of 2020, the Constructions Law exempts the installation of PV systems for the generation of electricity by renewable self-consumers (solar being the form of deployment predominantly used by renewable self-consumers) on buildings, on outhouses/dependencies and on land from the obligation to obtain a building permit.

Although not entirely clear due to a lack of detailed secondary legislation, it appears that this exemption from the obligation to obtain a building permit applies only to rooftop and/or ground-mounted PV panels and not to BIPV. As per the definition provided by IEA PVPS task 151, BIPV are a pre-requisite to the integrity of the respective building and hence, they are covered by the construction technical design and permitting proceedings required in view of obtaining the building permit.

The lack of regulations addressing specifically BIPV permitting matters and the lack of practical experience could trigger delays in the permitting of BIPV, notably in case of administrative disputes/litigation proceedings between developers and administrative authorities.

Apart from the general technical regulations which set the standards for building constructions, including the installation of PV, BIPV is also subject to the regulations enacted by the Constructions Energy Performance Law (*Legea 372/2005 privind performanta energetica a cladirilor*). According to said regulations, in case of new buildings/building complexes, the urbanism certificate (*certificatul de urbanism*) issued by the local authorities (which represents the information document listing the required approvals/permits/studies for obtaining the building permit) will provide on the one hand, the obligation to observe the minimum energy performance requirements and, on the other hand, will require the performance of a study to assess technical, economical, and environmental feasibility of integrating high-efficiency alternative systems in the respective buildings, including the decentralization from the energy generation, by using renewable energy sources (BIPV implicitly included).

Furthermore, BIPV can conflict with national and/or local urban planning regulations, especially in areas with large historical building stock. This might result in a lengthier and more complex permitting process or, in a worst-case scenario, in a denial of building permits.

Barriers:

- *Lack of (consistent) regulation regarding BIPVs.*
- *Lack of experience at developers and administrative level.*
- *Barriers through constructions restrictions being imposed for historical buildings and areas.*

The Netherlands

According to Article 2.1 of the Environmental Law General Provisions Act (*Wet algemene bepalingen omgevingsrecht*) an environmental permit is to be issued by the respective authority (*Bevoegd Gezag*) for the building of a structure (*het bouwen van een bouwwerk*).

It could be that the Construction Law(s) affect BIPV systems (other than 'traditional solar PV' is affected on this aspect).

Traditional rooftop PV in the same plane of the roof, and flat roof PV away from street-level view, are usually exempted from the need for an environmental permit. Due to the architectural nature of some BIPV systems, permits may be required for application of these systems. During the permit application, the regulatory commission (Dutch: *welvaartscommissie*) will verify if the changes to the building do not negatively impact the cohesion of a zone.

The Housing Act provides provisions on public housing and rules to promote the construction of good homes and other constructions.

Art. 1a Housing Act reads: "The owner of a structure, open yard or site or the person who is authorized to make provisions for it on other grounds shall ensure that the state of that structure, open yard or site does not pose any danger to health or safety arises or continues."

For the purposes of this Act, construction also includes the installations forming part of it.

The Building Decree is an Order in Council (*AMvB*) under the Housing Act. The Building Decree provides a collection of technical building regulations that all buildings in the Netherlands must comply with.

Chapter 6 of the Building Decree provides further rules on installations including solar PV.

Art. 6.8 of the Building Decree stipulates that "*An electricity facility complies with technical standards: NEN 1010 at low voltage, and NEN-EN-IEC 61936-1 and NEN-EN 50522, at high voltage*."

NEN standard 1010 (update 2020) addresses PV systems as a separate special type of installation.

The construction of BIPV systems is a more complex process than traditional solar PV, due to the large variety in building architecture requiring custom solutions. NEN standard 7250 provides guidelines for the construction of aspects of the integration of solar energy installations in roofs and facades. NEN 7250 is currently not included in the building decree, and also states that BIPV-elements functioning as glass ("*uitgevoerd als beglazingselementen*") are not included in the standard.

The NEN 7250 standard addresses fire-safety in article 7, but a more elaborate standard is currently still in development. Recently in the Netherlands, public concern regarding fires involving PV systems has risen. The absence of fire-safety regulation might hamper the deployment of BIPV systems.

The Heritage Act describes, together with the Spatial Planning Act, how to preserve and protect Dutch cultural heritage. Recently, guidelines have been published for PV-systems on monuments and heritage sites. The placement of PV systems is not necessarily forbidden, but each case is treated separately. There should always be the focus to place PV elements "away from the public eye". It could be that the Heritage act affects BIPV systems as BIPV bears the potential to be accommodated significantly to the architecture (other than 'traditional solar PV' is affected on this aspect). Any alteration to monuments or heritage sites is subject to permitting granted on individual cases. BIPV elements that are intended for placement in visually accessible places might not be permitted for monuments and heritage sites.

Barriers:

- *Lack of joint administrative procedures / mechanisms*

- *Lack of experience of the administrative authorities*
- *Restrictive granting of permits through authorities (regarding townscape protection rules)*

Common barriers identified

Building law is fragmented in the Member States and there may be several different laws (especially in Member States with a federal structure, such as in Austria, Germany or Belgium), depending on the state, region, and even municipality, complicating the development of BIPV. Land zoning and spatial planning are usually performed at a municipal level. This adds another layer of complexity for project developers and legal advisers likewise. The individual practice of the municipalities varies and in most Member States, the process of changing the land planning acts and especially the zoning plans is highly political, and individuals usually do not have the power to request a change of the respective legal act.

A lack of relevant experience with BIPV by the authority in charge of granting the respective permits is one of the most common barriers to BIPV. This is closely linked to the lack of clear, tailored definitions and rules specifically addressing BIPV. The lack of specific regulations not only complicates the permitting procedures in the Member States, but also leads to a disadvantageous treatment of BIPV compared to other "classic" PV installations. The lack of a harmonized EU standard for the respective (BIPV) construction products adds to the complexity of the permitting process.

For historical buildings and towns with a large historical building stock, the rules on their protection lead to lengthier and more complex permitting processes and the risk of the denial of building permits. These regulations regularly try to protect the cultural heritage of the city and protect old historical structures. It is not yet widely known or recognized that BIPV systems can provide a more aesthetically acceptable solution than standard PV modules attached to a building skin.

There is no widely recognized definition for BIPV or any specific mention of BIPV. The same rules should apply as for e.g. normal architectural glazing. However, due to the lack of harmonized standards, the authorities are confronted with individual authorizations for the respective BIPV building components, which makes the authorization process more complicated. Even though there might not be any visual difference between BIPV components and e.g. normal glass, the authorities apply stricter standards to BIPV components. Harmonized standards including BIPV would improve the situation and give authorities the basis for uniform permitting decisions.

Energy Law

In some Member States, the production of electricity for the purpose of generating financial profits triggers the legal status of an electricity undertaking which leads to more complicated rules to comply with. The same goes for the sale of electricity by building owners that can qualify as an energy supply activity. In some Member States, the construction of electricity generation facilities, including BIPV, is governed by energy law. Electricity producers generating electricity from renewable sources including BIPV may qualify for support schemes/subsidies.

Austria

In general, the production of electricity for the purpose of generating financial profits triggers the legal status of an electricity undertaking. Additionally, the sale of energy by building owners can qualify as an energy supply activity (especially if the energy is sold to end-consumers). The qualification as

electricity undertaking, or energy supplier goes along with various regulatory obligations and may prevent real estate owners and developers to invest in BIPV.

In Austria there are special support schemes for PV systems as well as special subsidies according to the Investment Subsidies Regulation-Electricity ("*EAG Investitionszuschüsseverordnung-Strom", EAG-IZV*). However, there is no separate investment scheme for BIPV that addresses its peculiarities.

Barriers:

- *Lack of (specific) regulations for BIPVs.*

Bulgaria

Pursuant to the Bulgarian Energy Act ("*Закон за Енергетиката*"), a license for the generation of electricity is required only if the installed capacity of the PV plant exceeds 20MW. Thus, BIPV should not fall within the licensing requirements as BIPV are usually installations with much smaller capacity.

As there are no special provisions on BIPV, the building owner must follow the general legal regime for grid connection as a regular PV producer. Under Bulgarian law, there are separate connection procedures for consumers and producers of electricity and since buildings with BIPV are both consumers and producers of electricity the investor will have to apply for two separate connection procedures with the respective grid operator. There is no unified procedure for prosumers. The grid operators will have to apply the law under a new practical scenario, so delays and differences in the administrative practices could be expected.

Barrier:

- *Lack of (specific) regulations regarding BIPVs.*
- *Lack of experience of the DSO/TSO with BIPV.*

Croatia

In general, an energy license is required for the performance of energy activities such as electricity production. The license is awarded by Croatian Energy Regulatory Agency ("HERA"). An electricity production license is issued for a period of 1 to 30 years and can be extended.

As stated above in Chapter 1, BIPVs are seen as simple buildings, meaning the works can be carried out without a building permit. The so-called "eligible producer" status is not required for production facilities that fall under the simple building concept according to the Simple Building Regulation. However, even power plants considered to be simple buildings would have to obtain the eligible producer status if they intend to participate in the guarantees of origin schemes or in the supporting schemes.

According to Article 36 paragraphs 2 and 3 of the Regulation on the use of renewable energy sources and high-efficiency cogeneration (Official Gazette No. 28/2023, "RES Regulation") for the BIPV (simple buildings) the status of the eligible producer is acquired based on the evidence that the production plant has achieved the right to permanent connection to the grid.

Barriers:

- *Lack of (specific) regulations regarding BIPV.*

France

There is no regulation specifically applicable to BIPV. The general rules apply. No specific barriers have been detected by the national (legal) experts.

A special support scheme for BIPV has existed but it ended in 2018 and has not been replaced by a specific support scheme.

Barriers:

- *Lack of (specific) regulations regarding BIPV.*

Germany

In Germany according to the Renewable Energy Source Act (*Erneuerbare-Energien-Gesetz*, *EEG 2023*) and the changes effective as of 1.1.2023 there are some benefits applicable to rooftop PV and implicitly also to BIPV. According to our research, BIPV falls under the general category of "PV on buildings" as there is no special scheme addressing BIPVs. Those benefits are:

- Feed-in tariff increased for rooftop PV (both for complete feed-in or partial feed-in in combination with self-consumption)
- Simplified grid connection procedure for PV systems smaller than 30 kWp.
- 70% feed-in limit abolished[124]
- No sales tax applies for new private (residential) PV systems
- For PV systems up to 30 kWp, no income tax is due on income generated by selling generated electricity

These recent changes represent a significant reduction in previous barriers to the uptake not only of conventional rooftop PV but also BIPV. However, further reductions specific to BIPV are still needed. One example: the limit of 30 kWp (installed power rating) for a tax exemption on income derived from selling generated electricity should be higher for façade-integrated BIPV systems, which usually generate fewer kWh/kWp than roof-mounted systems.

Barriers:

- *Lack of specific regulations for BIPV.*

[124] **In the past the amount of electricity that could be fed into the grid from PV "on buildings" was limited to 70 % of the rated power of an installation in an attempt to prevent overloading of grids that were designed for supply of electricity from a few central power stations, rather than many distributed ones. The remainder could be consumed within in the building, but only if the system had been designed to allow this.**

- *Lack of experience of competent authorities.*

Italy

There is no regulation specifically applicable to BIPV. The general rules apply. No specific barriers have been detected by the national experts.

A special support scheme for BIPV has existed but it ended in 2013 and has not been replaced by a specific support scheme.

Barriers:

- *Lack of specific regulations for BIPV.*

Poland

Drawing from Polish Energy Law (*Prawo energetyczne*), several key principles and guidelines emerge regarding the electricity market and its associated activities. Central to this discourse is the concept of a prosumer (self-consumers), a term that designates individuals who play a dual role in the energy market: both consuming and producing electricity. Considering the premise of the BIPV as part of the building, we are assuming that its use will classify energy producers as prosumers. Self-consumption can only take place in micro – generation plants (*mikroinstalacje*) (up to the 50kW) in case of a renewable energy prosumer. Additionally, it is important to note that energy production cannot be the main business activity of self-consumers (neither in case of renewable energy prosumer nor in case of renewable energy collective prosumer).

Barriers:

- *Lack of regulations and definitions regarding BIPVs.*

Romania

As per Romanian Energy Law (*Legea energiei si a gazelor naturale nr. 123/2012*), "electricity producer" means the natural or legal person having as specific activity the production of electricity, including the production in co-generation.

Electricity producers must obtain from ANRE the operating licence (*licență de exploatare comerciala a capacitatilor de producere a energiei electrice*) before starting the production activities.

By means of exemption, the operators of energy generation capacities with a total installed capacity of less than 1 MW do not need an operating license. Hence, considering that BIPV will typically have less than 1MW installed capacity, BIPV will generally benefit of the exemption from the obligation to obtain an operating license.

Nomajor barriers for BIPV have been detected.

The Netherlands

There is no regulation specifically applicable to BIPV. The general rules apply.

No specific barriers for BIPV have been detected.

Common barriers identified

In most Member States no specific support mechanisms for BIPV have been introduced. There is also no specific language or definition of BIPV in the respective energy regulations or electricity laws. This lack of regulation may lead to a prolonged approval process for electricity permits, grid connection or a disadvantage regarding subsidies and support schemes.

The qualification as an electricity undertaking or energy supplier goes along with various regulatory obligations and may prevent real estate owners and developers from investing in BIPV. Such a qualification comes along with the requirement to meet certain conditions regarding your financial status, technical capacity and qualifications. The lack of know-how and experience concerning BIPV and participation in the energy market hinders the development of BIPV. Furthermore, the lack of regulations regarding BIPV leads to uncertainty around their deployment and thus to a hampered development of BIPV.

6.11. Status on IIPV in selected Member States

The countries studied in this section were: Austria, Belgium, France, Germany, and The Netherlands.

6.11.1. Infrastructure regulation

Austria

Motorways and federal roads are governed by the Austrian Federal Roads Act (*Bundesstraßengesetz*). According to this act, not only those parts of the road directly used for traffic (roadways, parking spaces) are considered a road, but also other parts not directly used for traffic. Those parts include inter alia the boarders of the road, parts regulating traffic, controlling traffic, toll infrastructure, tunnels, bridges, road embankments, roadside ditches, undeveloped land, and construction used as protection against traffic impacts (e.g. noise protection walls). IIPV is not explicitly mentioned as being part of the road. However, following the logic of the Austrian Federal Road Act, the installation of PV on any of the parts of the road will most likely have to follow the road regulations as well.

In general, the construction of new motorways or federal roads or parts of it, as well as the other extension measures require a permit of the Federal Minister for Climate, Environment, Energy, Mobility, Innovation and Technology. Other extension measures may be the building of a noise protection wall. It has to be noted, that IIPV is not explicitly mentioned in the Austrian Federal Road Act and thus also not listed in the exceptions to the permit requirement. Thus, in case IIPV is planned from the beginning of the construction of a road or noise protection wall, then the original permit will already take IIPV into account and no separate permit should be required. However, if IIPV is installed afterwards, an amendment to the original permit may be required. For such an amendment a simple notification to the competent authority is sufficient in case the neighbours to the construction are not negatively impacted and no additional protection measures will be required by the amendment. Emission neutral state of the art adjustments, or emission neutral changes in the technical implementation or

construction do not require a notification. Whether IIPV is considered as such an emission neutral adjustment, technical implementation or construction is not clear since there has not been any jurisprudence on the question of IIPV and it is not explicitly mentioned in the road regulation.

Provincial and local roads in Austria are regulated in nine different road acts, each of them adopted on a provincial level. There is no uniform regulation on IIPV in Austria. There is also no legal definition of IIPV. Provincial and local roads in Austria generally follow the system of federal roads as described above. However, a construction permit and any amendment to it, is granted by different authorities depending on the road. The construction and amendment of provincial roads requires a permit of the regional administrative authority, or the provincial government and municipal roads require a permit by the respective major of the municipality. No permit is required for amendments of existing roads and parts of roads which do not touch upon the rights of the parties involved (neighbours, landowners, etc) or in case the involved parties have explicitly accepted the amendments.

In Austria, the railway tracks and the surrounding infrastructure are governed by specific legislation, the Austrian Railroad Act (*Eisenbahngesetz*, EisbG). Rail roads are a federal competency. Most of the railways are constructed and operated by the state-owned company Österreichische Bundesbahnen AG (ÖBB).

The construction of installations for railroad energy in power plants, converters, or production plants in whole or in parts and the construction of transmission grids always requires a permit. Thus, it depends on the IIPV project, whether the exception to the building permit is applicable or not. However, it has to be noted that IIPV is not explicitly mentioned in the Austrian Railroad Act. Moreover, even though some IIPV-projects already exist in Austria, the authorities may not be familiar with the concept, which could lead to delays in the permitting process and legal uncertainty for the construction of IIPV.

Barriers:

- *Lack of specific regulations regarding IIPVs.*
- *Lack of jurisprudence regarding IIPVs.*

Belgium

The use of parcels that are of public domain and next to roads is the competence of the Regions. Therefore, depending on the location of the IIPV panels, the applicable legislation is not the same. It is also possible to have stricter rules depending on the municipality.

An authorization must be asked for to the competent authority. The application for the authorization must also contain a copy of the urbanistic permit, a certificate of conformity to the general regulation on electric installations and the positive opinion of the officer competent for the specific rescue zone (art. 3 Walloon decree (Décret du 19 mars 2009 relatif à la conservation du domaine public régional routier et des voies hydrauliques), art 8 Flemish decree (Décret du 3 mai 2019 sur les routes communales), art 7 Brussels Ordinance (Ordonnance générale de police)).

It is up to the competent authority, based on the specific requirements of the relevant municipality, to decide, considering the interests of the public domain, its users or its environment, the principle of equality or other general interests, whether or not to grant the authorisation requested, to grant it

subject to certain conditions, to grant it by means of a unilateral act or a contract, or to grant it for a fixed or indefinite period.

In Flanders, the prior approval of the municipality council and an environment permit are required (art 69 Flemish Decree (Décret du 3 mai 2019 sur les routes communales)). An impact-assessment study regarding road security shall be conducted (art 6 Brussels Ordinance (Ordonnance générale de Police).

Barriers:

- *Lack of specific regulations regarding IIPVs.*
- *Lack of jurisprudence regarding IIPVs.*

France

Under French law, transport infrastructure is mainly regulated by the French Highway Code (highways and routes) and French Transportation Code (railways).

Motorways and federal roads are governed by the French Highway Code and Route Code. IIPV is not explicitly mentioned as being part of the road and the public road is defined by the French Highway Code as the domain that comprises all public property owned by the State, sub-regions ("départements") and municipalities and used for land traffic purposes, with the exception of railroads. A literal interpretation of this provision leads to conclusion that IIPV are not part of the road. Unfortunately, there is currently no case law or doctrine to shed any light on the subject.
IIPV is not explicitly mentioned in the French Codes and thus also not mentioned in the permit requirements.

Until recently, the French urban planning code prohibited installations within 100m of highways and train tracks. France has recently adopted a new law (LAW no. 2023-175 of March 10, 2023, on accelerating the production of renewable energies) which aims to boost and increase renewable energy. This law makes it easier to install solar panels on land that has already been developed or where there are no major environmental issues. Such law authorizes the creation of a solar cadastre to take into account "surfaces that have already been artificially developed". This includes land bordering roads and freeways (e.g. rest areas or freeway ramps), railroads and waterways, as well as existing outdoor parking lots over 1,500 m2.

It can be therefore considered that the installation of IIPVs is now authorized, although this is not specifically regulated in any text.

In France, the railroad network is managed by the SNCF (*Société Nationale des Chemins de Fer*). The French Transport Code governs railway infrastructure, which is a state responsibility. Plans have been made public in July 2023 to study implementation of PV fields in the land SNCF owns around the railways in order to balance its power consumption. This could amount up 1 000 hectares (10 km2) by 2030-2032 and 10 000 hectares (100 km2) by 2040-2050 [125].

[125] https://www.lemonde.fr/economie/article/2023/07/06/le-pdg-de-la-sncf-jean-pierre-farandou-nous-allons-creer-sncf-renouvelables-pour-produire-de-l-electricite_6180771_3234.html.

IIPVs are not mentioned in the legislation, but the definition of railway infrastructure is broad enough to cover IIPVs. Construction work is subject to authorization by the competent authority (Ministry of Ecological Transition), notably on condition that a safety report has been drawn up by a risk analysis assessment body within the meaning of EU law (Commission Regulation 402/2013 of April 30, 2013).

Barriers:

- *Lack of specific regulations regarding IIPVs.*
- *Lack of jurisprudence regarding IIPVs.*

Germany

The development of projects for the use of renewable energies along roads touches on many legal issues. Infrastructure law in Germany is divided between different legal acts and competent authorities. The Federal Highway Act (*Bundesfernstraßengesetz*) regulates the construction, operation, and maintenance of federal highways, including the German motorways. It includes provisions related to safety, design, and infrastructure requirements, which could impact the installation of solar modules.

> According to Section 1 (4) of the Federal Highway Act federal highways include the body of the road, in particular bridges, tunnels, embankments and noise protection facilities. In addition, accessories, such as traffic facilities and installations of all kinds, as well as ancillary facilities, are also part of the highway components. According to the legal definition, ancillary facilities are those facilities that predominantly serve the tasks of the road construction administration of the federal trunk roads, e.g. road maintenance depots, equipment yards, warehouses, storage areas, extraction points, auxiliary operations, and facilities. Unmanaged rest areas without service operations (usually toilet facilities, as well as parking and recreation areas) are included in the road body in such a way that they form a dependent unit with it and thus also count as ancillary installations.
>
> The construction of a renewable energy (RE) plant is a measure that must meet the requirements of according to the Federal Highway Act. In order to determine whether and, if so, which prerequisites must be met for the construction of a RE plant on the "road" mode of transport, the dedication and purpose of the federal highway must first be determined. A determination of the common use is not possible without any doubt. If it is assumed that the construction of a RE plant is a special use, this special use must be authorized by the road authorities in accordance with Section 8 (1) Federal Highway Act (so-called special use permit). The competent authority decides on the granting of the special use permit at its due discretion and in doing so weighs up the requirements of public use on the one hand - in particular safety and ease of traffic - and on the other hand the public interest of the special use.
>
> Structural installations on federal highways are subject to certain prohibitions on construction. Section 9 (1) Federal Highway Act prohibits the erection of buildings of any kind within a distance of up to 40 meters for federal highways and up to 20 meters for federal roads, in each case measured from the outer edge of the paved roadway (the so-called no-building zone). This means that PV systems are also likely to be structural construction within the meaning of Section 9 Federal Highway Act. If such installations have not already been taken into account in the planning procedure, there is a within the 40 m strip (in which noise walls and noise barriers are usually located, as well as parking lot areas) a

ban of construction. Furthermore, a construction restriction zone applies for a 100 m strip measured from the outer edge of the paved roadway (also important for open space installations). Section 9 (7) of the Federal Highway Act, however, also provides an option for overcoming the restriction of construction. Furthermore, the Federal Highway Authority may, under the requirements of Section 9 (8) of the Federal Highway Act grant exemption from the ban on construction.

The constituent elements of both alternatives represent indeterminate legal concepts with room for assessment by the administration and are therefore doubtful. Nevertheless, for PV installations on noise barriers, noise protection walls, bridges, tunnels and traffic sign installations - which are part of the road body within the meaning of Section 1 (1) Federal Highway Act and are therefore not structural installations with - in the meaning of Section 9 Federal Highway Act - it should also be the case that the ban on construction does not apply and these can be erected without restrictions.

Barriers:

- *Lack of specific regulations regarding IIPVs.*
- *Lack of jurisprudence regarding IIPVs.*

The Netherlands

The Road Traffic Act 1994 (*Wegenverkeerswet* 1994) is the basis of all traffic legislation. The law regulates safety and traffic flow on the road, and the prevention of damage and nuisance caused to others by traffic.

According to Article 19 of the Dutch Railway Act (*Spoorwegwet*) a permit from the Minister of Infrastructure and Water Management required for the use of the main railways and the adjacent lands in order to carry out installations or place objects on, in, under, above or next to the main railway line or have or store highly flammable substances. Thus, a permit is needed to install PV systems along railways or on railway noise barriers.

The Dutch rail infra company Prorail issued a Handbook (*Technische voorschriften voor werken en werkzaamheden op, boven, onder en nabij de spoorweg;* version 2 in July 2022) providing specific instructions/prescriptions for installing PV systems along railways or on railway noise barriers (resp 15 and 16 each). The instructions/ prescriptions in the handbook are clear and pragmatic. Even though the instructions limit PV system deployment (given the requirements for the functionality of the railways) the handbook may serve as a good practice example, since it provides clear guidelines for developers and authorities.

No specific barriers related to IIPV.

Common barriers identified

Infrastructure regulations are highly fragmented in Member States with a federal structure, such as in Austria, depending on the state, region, and even municipality, complicating the development of IIPVs. This adds another layer of complexity for project developers and legal advisers likewise. The lack of clear definitions for IIPV leads to legal uncertainty with regard to the qualification of IIPV. The main issue in this regard is whether IIPV is a "special use" of the motorway or railway infrastructure, requiring a specific authorization or permit or not. Although the deployment of renewable energy systems - such as a photovoltaic system on a noise protection wall – is considered to be a use that does not relate to

the use of highways, this should not be an issue, since IIPV do not contradict the intended purpose of the highway in general and the purpose of the noise barrier in particular (esp. the functionality of the noise barrier is not impaired).

A lack of relevant experience with the development of IIPVs by the authority in charge granting the respective permits is one of the most common barriers to IIPVs. This is closely linked to the lack of clear, tailored definitions and rules specifically addressing IIPVs. The lack of specific regulation not only complicates the permitting procedures in the Member States, but also leads to a disadvantageous treatment of IIPVs compared to other "classical" PV installations.

6.11.2. Building permits

Austria

As set out above in chapter 3.3.1 a building permit is required for buildings under Austrian building law. However, in Austria, IIPV, integrate into motorways, road or railway infrastructure is generally not be regarded as a "separate" building facility, since it becomes part of the road or railway. In case an IIPV is not integrated into the road or railways but build separately a construction permit might become necessary. In order to obtain a construction permit, the project needs to be in line with the technical building regulations (which regularly address building statics, safety, and design aspects) and applicable spatial planning as well as land use / zoning regulations.

Barrier:

- *Lack of specific regulations regarding IIPVs.*

Belgium

In Belgium, the different Regions are competent to decide which construction projects require a building/urban permit.

An authorization is needed, issued by the competent authority. The application for the authorization must also contain a copy of the urban permit, a certificate of conformity to the general regulation on electric installations and the positive opinion of the officer competent for the specific rescue zone (art. 3 Walloon decree (“*Décret du 19 mars 2009 relatif à la conservation du domaine public régional routier et des voies hydrauliques*”), art 8 Flemish decree (“*Décret du 3 mai 2019 sur les routes communales*”), art 7 Brussels Ordinance (“*Ordonnance générale de police*”).

Therefore, in all three regions (Flemish Region, the Brussels-Capital Region and the Walloon Region), an urban permit is required for the establishment of PV panel fields (meaning the installation of more than one PV panel) (*D.IV.22 Code du développement territorial; art. 98 CoBAT*). PV panel fields are not defined in the legislation. IIPV are therefore not directly mentioned in the legislation but there is also no indication that they would not fall within the scope of this requirement.

Barrier:

- *Lack of specific regulations regarding IIPVs.*

France

The construction of a freeway is entrusted by the State to a concession company. This company works closely with the government during the design and construction phases. For every project three levels of design can be distinguished and, on each level, studies have to be prepared for the project. First-level studies are sanctioned by a ministerial decision approving the main characteristics of the operation, taken after the file has been examined by specialized external technical services. Second- and third-level studies are the sole responsibility of the concessionaire and are therefore not subject to ministerial approval. However, in the case of non-standard engineering structures, the preliminary design is submitted to the authorities for approval. IIPVs not being a standard installation, they need to be submitted for approval.

Barrier:

- *Lack of specific regulations regarding IIPVs.*

Germany

The Building Code (*BauGB*) regulates the construction of buildings and structures. It includes provisions related to building permits and zoning requirements, which can impact the integration of solar modules around roads. Section 35 BauGB explicitly defines that in the non-urban area PV projects are permissible on an area along highways or railroads of the superordinate network. According to Section 2b of the General Railway Act, installations on railroads with at least two main tracks must be at a distance from them of up to 200 meters, measured from the outer edge of the roadway. All installations may only be constructed if public interests are not opposed, and a sufficient development is ensured. Each German state has its own building regulations that provide detailed requirements for construction projects. These regulations may include provisions related to noise barriers, building materials, safety, and structural requirements.

No specific barriers related to IIPV have been detected.

The Netherlands

According to Article 2.1 of to the Environmental Law General Provisions Act (*Wet algemene bepalingen omgevingsrecht*) an environmental permit is to be issued by the respective authority (*Bevoegd Gezag*) for the building of a structure (*het bouwen van een bouwwerk*).

The Housing Act provides provisions on public housing and rules to promote the construction of good homes and other structures.

Art. 1a Housing Act reads: "*The owner of a structure, open yard or site or the person who is authorized to make provisions for it on other grounds shall ensure that the state of that structure, open yard or site does not pose any danger to health or safety arises or continues*." For the purposes of this Act, construction also includes the installations forming part of it. The Building Decree is an Order in Council (Dutch: *AMvB*) under the Housing Act. The Building Decree provides a collection of technical building regulations that all buildings in the Netherlands must comply with. Chapter 6 of the Building Decree provides further rules on installations. Art. 6.8 of the Building Decree stipulates that "*An electricity facility complies with technical standards: NEN 1010 at low voltage, and NEN-EN-IEC 61936-1 and NEN-*

EN 50522, at high voltage". According to national experts, IIPV is categorized as such an installation, regardless of what form of deployment is used.

No specific barriers related to IIPV have been detected.

Common barriers identified

Building law is fragmented in the Member States and there may be several different laws (especially in Member States with a federal structure, such as in Austria), depending on the state, region, and even municipality, complicating the development of IIPVs.

The main issue with regard to IIPV is the lack of specific regulation and clear, tailored definitions in the respective building legislation. Without such tailored definitions is remains unclear whether IIPV is regarded as "construction" and thus requires a building permit or not. The lack of specific regulation not only complicates the permitting procedures in the Member States, but also leads to a disadvantageous treatment of IIPV compared to other "classical" PV installations.

6.11.3. Energy law

In some Member States the construction of energy generation facilities (including IIPV) is (also) governed by energy law. This is particularly the case for larger IIPVs which exceed a certain capacity threshold. The rationale behind this is that for larger projects, the relevance of energy-specific construction and operational aspects is prevailing.

Austria

In Austria, similar to building law, electricity law is standardized in nine different provincial electricity laws, here, however, in addition to a nationwide electricity ("basic") law (*Elektrizitätswirtschafts- und -organisationsgesetz 2010 - El-WOG*).

IIPV is not explicitly addressed in the electricity market regulation in Austria.

Furthermore, operators of IIPV are not explicitly covered by the provisions on electricity companies, and there are no provisions in the ElWOG that are specifically tailored to operators of IIPVs. Therefore, it can be assumed that the rules generally applicable to operators of PV plants described above can also be applied to operators of IIPVs (which is, of course not ideal, since this entails the risk of legal uncertainties and associated implementation difficulties).

Barrier:

- *Lack of specific regulations regarding IIPVs.*

Belgium

In addition to a construction permit, an environmental permit may be required for certain activities – one of them is electricity production. Environmental permits differ in Belgium, depending on the relevant region. In all three regions, only the activities that contain one or more of the following so called "classified" installations are subject to an environmental permit:

Electricity production with a static transformer connected to an electrical installation with a rated power equal to or greater than 100 kVA and less than 1 500 kVA or a static transformer connected to an electrical installation with a rated power equal to or greater than 1,500 kVA.

In Wallonia, if the installation contains at least one static transformer, linked to the electric installation with a nominal power equal or superior to 1.500 kVA, it is subject to a unique permit ("*Permis unique*"). A unique permit consists of an urban and an environmental permit.

Barrier:

- *Lack of specific regulations regarding IIPVs.*

France

Plants with a capacity of over 50 MW require an operating permit. Plants with a lower capacity are deemed to be authorized, and no administrative procedures are required.

With regard to connection to the public electricity grid, a connection request is required for all new installations. This is done by contacting the network operator, de-pending on the voltage range.

The contract comes into effect on condition that the producer provides his co-contractor with a certificate attesting to the electrical compliance of his installation with the applicable regulations within three years.

Barrier:

- *Lack of specific regulations regarding IIPVs.*

Germany

The Renewable Energy Sources Act (*Erneuerbare-Energien-Gesetz, EEG*) promotes the generation of electricity from renewable energy sources, including solar power. It governs feed-in tariffs, market integration, and legal requirements for renewable energy installations. There is no specific subsidy for IIPV but Section 37 EEG includes bids in the tenders for solar plants of the first segment to be submitted for plants that are to be erected which meets the requirements specified in BauGB or, if these requirements are not met, which are located along highways or railroads at a distance of up to 500 meters measured from the outer edge of the roadway.

No specific barriers related to IIPV have been detected.

Netherlands

The Electricity Grid Code (*Technische Codes*) contains all regulations for grid operators and grid users in 3 areas (functioning of the networks; connecting customers to the grids; transmission of electricity over the grids). In general, the Electricity Grid Code does not cause any new/different barriers to IIPV uptake in the power system, other than the ones 'traditional solar PV' faces. However, since the Dutch railway operator considers applying PV modules along its railways feeding power into their own power grid, the technical feasibility is more complex. The Grid Code (and Measuring Code) need to be interpretated in their details. This may cause delays for the IIPV-project.

Barriers:

- *Interpretation of complex regulation required.*

Common barriers identified

The qualification as an electricity undertaking or energy supplier goes along with various regulatory obligations and may prevent real estate owners and developers to invest in IIPV. Such a qualification comes along with the requirement to meet certain conditions regarding your financial status, technical capacity, and qualifications. Depending on the infrastructure operator, the complex obligations may deter infrastructure operators from investing in IIPV. However, railroad infrastructure operators may already have experience with these obligations since they usually produce their own electricity in conventional power plants for their own use.

A lack of relevant experience with the development of IIPVs by the authority in charge granting the respective permits is one of the most common barriers. This is closely linked to the lack of clear, tailored definitions and rules specifically addressing IIPVs. The lack of specific regulation not only complicates the permitting procedures in the Member States, but also leads to a disadvantageous treatment compared to other "classical" PV installations.

Annex B – Task 3 desk research

Form of PV	ID	Title of paper / study	Authors	Published in	Reference	DOI	Country covered
Agri-PV	A1	Does agrivoltaism reconcile energy and agriculture? Lessons from a French case study.	Carrausse, R., Arnauld de Sartre, X.	2023	Energ Sustain Soc 13, 8 (2023)	https://doi.org/10.1186/s13705-023-00387-3	France
Agri-PV	A2	A First Investigation of Agriculture Sector Perspectives on the Opportunities and Barriers for Agrivoltaics	Pascaris, Alexis S.; Schelly, Chelsea; Pearce, Joshua M.	2021	Agronomy (Online), 12, 10	https://doi.org/10.3390/agronomy10121885	USA
Agri-PV	A3	Driving and restraining forces for the implementation of the Agrophotovoltaics system technology – A system dynamics analysis	Daniel Ketzer, Peter Schlyter, Nora Weinberger, Christine Rösch	2020	Journal of Environmental Management,Volume 270,2020	https://doi.org/10.1016/j.jenvman.2020.110864	Germany
Agri-PV	A4	Overview of the Potential and Challenges for Agri-Photovoltaics in the European Union	Chatzipanagi, A., Taylor, N. and Jaeger-Waldau, A.,	2023	Publications Office of the European Union, Luxembourg, 2023	doi:10.2760/208702, JRC132879	Europe
Agri-PV	A5	Social acceptance of dual land use approaches: Stakeholders' perceptions of the drivers and barriers confronting agrivoltaics diffusion	Gabriele Torma, Jessica Aschemann-Witzel	2023	Journal of Rural Studies 97 (2023) 610–625	https://doi.org/10.1016/j.jrurstud.2023.01.014	Europe
BIPV	B1	Status, barriers and perspectives of building integrated photovoltaic systems	Rafaela A. Agathokleous, Soteris A. Kalogirou,	2020	Energy,Volume 191,2020,116471,ISSN 0360-5442	https://doi.org/10.1016/j.energy.2019.116471.	Global
BIPV	B2	The adoption of building-integrated photovoltaics: barriers and facilitators	Hans Christoph Curtius	2018	Renewable Energy Volume 126, October 2018, Pages 783-790	https://doi.org/10.1016/j.renene.2018.04.001	Europe
BIPV	B3	BUILDING INTEGRATED PHOTOVOLTAICS Overview of Barriers and Opportunities	Mladen BOŠNJAKOVIĆ, Marko KATINIĆ, Ante ČIKIĆ, and Simon MUHIČ	2023	THERMAL SCIENCE: Year 2023, Vol. 27, No. 2B, pp. 1433-1451 1433		Europe
FPV	F1	STATE OF THE ART OF THE FRENCH FPV MARKET	Harold MEURISSE	2023	Presentation a 3rd ANNUAL FLOATING SOLAR PV FORUM 2023, AMSTERDAM		France
FPV	F2	Environmental impact of floating solar	Sacha de Rijk	2023	Presentation a 3rd ANNUAL FLOATING SOLAR PV FORUM 2023, AMSTERDAM		Europe
FPV	F3	MARINE LIFE A THREAT TO FLOATING PV	Pratikshya Prusty	2023	Presentation a 3rd ANNUAL FLOATING SOLAR PV FORUM 2023, AMSTERDAM		Europe
FPV	F4	The impact of floating photovoltaic power plants on lake water temperature and stratification	Konstantin Ilgen	2023	Nature	https://www.nature.com/articles/s41598-023-34751-2.pdf	
FPV	F5	Floating Solar Handbook for Practitioners	World Bank and SERIS	2019	World Bank Group, ESMAP and SERIS. 2019. Where Sun Meets Water: Floating Solar Handbook for Practitioners. Washington, DC: World Bank.	-	Global
FPV	F6	Enabling Floating Solar (FPV) Deployment: Policy and Operational Considerations	NREL, Sika Gadzanku	2022			Global
FPV	F7	Where Sun Meets Water FLOATING SOLAR MARKET REPORT	World Bank Group, ESMAP and SERIS.	2019	World Bank Group, ESMAP and SERIS. 2019. Where Sun Meets Water: Floating Solar Market Report. Washington, DC: World Bank.		Global
FPV	F8	Floating-Photovoltaik und der herausfordernde Weg zur „Schwimmerlaubnis"	Gölz, Sebastian & Zuber, Beatrice	2023	PV Magazine	https://www.pv-magazine.de/2023/05/11/floating-photovoltaik-und-der-herausfordernde-weg-zur-schwimmerlaubnis/	Germany
Infra PV	I1	Verkehrsträgerübergreifender Austausch von Erneuerbarer Energie	Elena Chvanova Birgit Haller, Uwe Leprich et al.	2022	Berichte der Bundesanstalt für Straßenwesen, Verkehrstechnik, Heft V 364		Germany
Infra PV	I2	Zon-op-Snelweg	Wilma Eerenstein	2019			The Netherlands
Infra PV	I3	Handboek Zonnepanelen Spoor	Gerald Olde Monnikhof, Mariette van Rooij, Jan-Willem Jehee, Rudi Treffers, Eric Luiten, Jos van den Hende	2021			The Netherlands
Infra PV	I4	Modular E-cover for Smart Highway	R. A. Bezemer, K. E. Sewalt, E. M. B Heller, D. A. Roosen, V. de Waal, M. Arnoldy	2020			The Netherlands
Infra PV	I5	Zonnepanelen op wegdek -pilot resultaten N401 & A2	RWS Sunday Conference	2019			The Netherlands
Infra PV	I6	THE POTENTIAL OF PV NOISE BARRIER TECHNOLOGY IN EUROPE	Adolf Goetzberger, Thomas Nordmann, Andreas Froelich, Gerhard Kleiss, Georg Hille, Christian Reise, Eo Wiemken, Vincent van Dijk, Jethro Betcke, Nicola Pearsall, Kathleen Hynes, Bruno	2000	16th European Photovoltaic Solar Energy Conference and Exhibition		Europe
VIPV	V1	Application of photovoltaic panels in electric vehicles to enhance the range	Illia Diahovchenko, Lubov Petrichenko, Ihor Borzenkov, Michal Kolcun	2022	ScienceDirect		Global
VIPV	V2	Potential and challenges of vehicle integrated photovoltaics for passenger cars	Martin Heinrich, Christoph Kutter, Felix Basler, Max Mittag	2021	Fraunhofer Insitute for Solar Energy Systems		Global
VIPV	V3	Master Thesis on "Use of Solar Energy in Battery-electric Commercial Vehicles"	Arafat Nawid Safi	July 2023	Technische Universität Berlin		Global
VIPV	V4	Yield potential of vehicle integrated photovoltaics on commercial trucks and vans	Christoph Kutter, Luis Eduardo Alanis, Dirk Hogler Neuhaus, Martin Heinrich	2021	Fraunhofer Insitute for Solar Energy Systems		Europe

7. Annex C – List of interviewed companies per EU Member State

Country \ Innovative PV form	BIPV	Agrivoltaic	Floating PV	IIPV	VIPV
Austria	Sunovation	Next2sun			
Belgium	TechLink	TechLink, Equans	TechLink, Equans	TechLink	
Czech Republic		Solarniasociace	Solarniasociace		
Denmark	Green Power DK, Danish Solar Energy	Green Power DK, European Energy			
France	R2M solutions	Lightsource			
Germany	Sunovation	Next2sun	BayWa		Sono Motors
Greece		HELAPCO	OceanSun, Okeanis, BayWa, Terna		
Hungary	Terran				
Ireland	ISEA	Alternus, ISEA	ISEA		
Italy	EURAC, R2M solutions	Lightsource	Laketricity		
Lithuania	Fetek, LSEA	LSEA	LSEA		
Netherlands		Equans	Equans, Baywa	RWS	Lightyear
Poland		Alternus, Polish PV	Scatec		
Portugal		Galp	Isigenere		
Spain		Baywa RE	Isigenere, Acciona		
Sweden	Midsummer				Midsummer, Scania
non EU					
Albania			OceanSun		
Israël			SolarEdge		
Switzerland	SUPSI			TNC	

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