REGACE – Crop Responsive Greenhouse Agrivoltaics System with CO2 Enrichment for Higher Yields

Project Deliverable Report

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Executive Summary

The Horizon Europe project, “Crop Responsive Greenhouse Agrivoltaics System with CO2 Enrichment for Higher Yields” (REGACE) addresses the urgent challenges posed by climate change and environmental degradation, with the aim of integrating agrivoltaics (Agri-PV) in greenhouses as a significant component of the European Union's green energy portfolio. This deliverable, named "Recommendations for Improved Regulations" (D7.1), represents the findings of a comprehensive legal analysis conducted by Timelex, the legal partner of the REGACE consortium, about the Agri-PV technology that allows the dual use of land both for food and energy production.

The primary goal of D7.1 is to propose pragmatic regulatory recommendations that facilitate the widespread adoption of project outcomes. The document is the result of an examination of relevant EU and national legislations, identifying gaps and challenges, with attention to key non-EU countries, fostering a comparative analysis that provides recommendations for regulatory harmonization. The deliverable specifically focuses on EU legislation as well as the legislations in Austria, Germany, Greece, Italy and Israel, where project installations and experiments have been made. Furthermore, the deliverable also contains findings about the national legislation of France, an EU Member State which has recently taken significant steps to improve the legal framework for agrivoltaics.

The first important policy-related question analysed in this deliverable concerns the ability or competence of the EU to regulate Agri-PV projects. This informs what recommendations can be made later on. The provisions in the Treaty on the Functioning of the European Union are quite broad where both renewable energy and agriculture are concerned. These are shared competences between the European Union and Member States. Member States are able to regulate how they wish, up to the point when the European Union steps in and implements a harmonizing framework that sets standards for the entire EU. The EU interprets its competency over renewable energy in a broad sense: the EU considers that as long as legislation touched on renewable energy, it is competent to implement these legal instruments. Agriculture is more limited, as there the EU must work within the Common Agricultural Policy (CAP), which consists of two parts, namely direct support to farmers and measures for rural development. Measures in both parts are needed to aid the successful implementation and widespread adoption of Agri-PV systems.

Afterwards, the deliverable looks at different EU legislative initiatives. Among these, there are multiple instruments which provide a more general framework for renewable energy, sustainability and agriculture. Other laws will have a direct effect on the life cycle of Agri-PV. Finally, a third important category of laws are those that will not directly affect Agri-PV installations but will change the way the supply chain of photovoltaic panels functions.

Framework legislation plays a critical role in fostering the development of Agri-PV systems by establishing a cohesive foundation for future, more specific legislation. Although framework legislation does not directly impose binding requirements or provide immediate financial incentives, it creates the necessary legal and policy environment to coordinate action. This deliverable analyses several pieces of framework legislation at the EU level. The Common Agricultural Policy integrates sustainability objectives. Similarly, the EU Solar Strategy highlights the integration of solar energy into agriculture as a priority for achieving energy independence and decarbonization goals. The European Green Deal further underscores the importance of innovative renewable energy solutions like agrivoltaics in meeting ambitious climate targets. Finally, the Regulation on the Governance of the energy union and climate action obliges Member States to implement National Energy and Climate Plans. These plans serve as key instruments for member states to outline their renewable energy trajectories and can incorporate agrivoltaics as a dual-purpose solution for land use. Together, these frameworks enable a

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structured, long-term approach to the growth of agrivoltaics, ensuring alignment with broader agricultural, energy, and climate objectives.

There are also certain pieces of EU legislation which have a more direct impact on Agri-PV systems. The EU can play a pivotal role in overcoming administrative and regulatory barriers, thereby accelerating the deployment of the technology. The Revised Renewable Energy Directive III mandates faster permitting times for renewable energy projects, including Agri-PV systems. This Directive is yet to be transposed into Member States' law. Its provisions aim to streamline bureaucratic processes, reducing delays that often hinder project implementation. Additionally, the Regulation on the Accelerated Deployment of Renewable Energy explicitly recognizes renewable energy projects, such as Agri-PV, as being in the public interest. This designation simplifies the permitting process by lowering the standard of proof required to demonstrate the necessity and benefits of such projects. Together, these legislative measures directly address practical challenges, enabling a more efficient and expedited rollout of Agri-PV systems, while reinforcing their importance in achieving renewable energy and climate targets

The third and final important category of EU legislation are acts that will impact the supply chain and different phases of the Agri-PV manufacturing and deployment process. EU legislation affecting supply chains is increasingly shaping the landscape for Agri-PV systems, addressing issues related to sourcing, sustainability, data access, and cybersecurity. The Corporate Sustainability Due Diligence Directive and the Critical Raw Materials Act will compel the EU to diversify its supply chains, fostering local production and enhancing resilience but potentially increasing short-term costs and complexities. Meanwhile, the Data Act empowers users of connected products to access the data they generate, a provision particularly relevant for advanced Agri-PV systems. This improves operational efficiency and user autonomy but requires robust data-sharing infrastructure. The NIS2 Directive and Cyber Resilience Act mandate stringent cybersecurity standards, fortifying Agri-PV systems against cyber threats but also imposing higher compliance costs and administrative burdens. Upcoming Ecodesign standards will ensure photovoltaic components meet defined environmental criteria, promoting sustainability across the lifecycle of Agri-PV systems. Finally, green finance initiatives like the Taxonomy Regulation, the Green Bond Standard, and Sustainable Project Investment frameworks are instrumental in channelling investments toward Agri-PV projects that align with EU climate and environmental goals. Collectively, these legislative developments are reshaping the Agri-PV supply chain to be more secure, sustainable, and data-driven, while also opening avenue. Chapter 4 investigates the national legal framework for Agri-PV systems in Austria, France, Germany, Greece, Italy and Israel. For each country, the deliverable delves into the general renewable energy framework, eligibility for farmers to receive Common Agricultural Policy direct payment support, rules for taxation, permitting procedure and financing options.

France and Germany have the clearest legal framework on Agri-PV systems, including definitions specifying maximum surface coverage area and minimum yield standards. France balances renewable energy with agricultural priorities, mandating agricultural yields and income protection. However, limited financing, complex permitting, and zoning regulations create barriers. State support for small-scale innovations offers potential, but broader scalability requires regulatory simplification and expanded financial options. Germany integrates Agri-PV into its energy goals but faces regulatory challenges. Permit hurdles, payment uncertainties for support schemes and land-use conflicts limit deployment.

Greece and Italy have a rapidly developing regulatory landscape for Agri-PV. Agri-PV in Greece is emerging, with recent legislative recognition aligning it with energy and climate goals. Challenges include weak grid infrastructure and underdeveloped frameworks. Streamlined permitting, targeted incentives, and infrastructure investment are critical for growth. Italy's fragmented laws slow Agri-PV progress. While farmland protection is prioritized, clear criteria for Agri-PV installations and simplified

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permits are needed. Harmonized policies could accelerate deployment and meet energy targets. However, there is also resistance to Agri-PV in Italy, which is mostly based on misinformation of how the technology works.

Austria has a limited framework for Agri-PV systems. Agri-PV in Austria is hindered by regulatory gaps, fragmented permitting, and limited incentives. Unclear standards in the EAG and CAP exclusions make projects economically unviable for many farmers. Decentralized governance complicates zoning and renewable energy support, confining Agri-PV to small-scale research. Harmonized laws and aligned incentives are needed.

As a non-EU state with a highly regulated land-use system, Israel faces unique challenges in agrivoltaic adoption. Progress in Israel is driven by pilot projects and greenhouse installations, but the research-driven approach has yet to be fully realized. The lack of dedicated legislation and regulatory complexity create significant hurdles for broader implementation. Reducing bureaucracy and ensuring that research findings effectively guide policy will be crucial for advancing Israel's agrivoltaic potential beyond its current stage.

Building on the analysis of EU and national law, the deliverable puts forth recommendations for policymakers, regulators, and stakeholders engaged in the integration of Agri-PV in greenhouses into the EU's green energy portfolio. The insights and recommendations aim to contribute to the regulatory framework supporting the successful implementation of the REGACE project, ultimately advancing the EU's transition to an efficient and competitive economy under the European Green Deal.

The deliverable makes the following key recommendations:

- The Common Agricultural Policy should explicitly ensure that Agri-PV installations do not disqualify farmers from receiving support, and mechanisms should be established to monitor compliance with legal standards;
- Simplifying and shortening permitting procedures for renewable energy projects is crucial. It is necessary to clarify that Agri-PV projects are permissible on agriculturally zoned land;
- States are encouraged to implement dedicated support schemes for agrivoltaics, enhance rural energy grid infrastructure, and provide bonuses for agrivoltaics in tender evaluations;
- Clear tax benefits and guidance on benefit-sharing across the agrivoltaics value chain would further incentivize adoption;
- Finally, stakeholders must actively address misinformation to build public trust and awareness around the benefits of Agri-PV systems.

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Chapter 1 - Introduction

A. Background and Context

Agri-Photovoltaics (Agri-PV) refers to the integration of agricultural activities in the generation of solar energy using a sole piece of land. The combination leads not only to more efficient crop yields but also allows for the production of renewable energy. The dual utilization of land for solar photovoltaic power generation and agriculture holds enormous potential to contribute significantly to the goals outlined in the European Green Deal, like providing more renewable energy, sustainable farming, as well as contributing to climate mitigation and adaptation strategies.[1]

The REGACE project, funded by the European Climate, Infrastructure, and Environment Executive Agency, aims to make Agri-PV a significant contributor to the EU green energy portfolio by combining continuous food production with energy production. The solar panels developed in this context fall within the definition of Agri-PV, since they are meant to be placed in a greenhouse, where plants grow. Through their built-in responsive tracking system, the solar panels determine the plants' needs and adapt by understanding the photosynthetic properties of the plants in real time. This way, the panels adjust themselves in a way that optimizes the amount of light and heat absorbed by the plants. In low-light conditions, the solar panels utilize CO2 to enhance plant growth.

The partners of the REGACE consortium develop and validate an innovative technology to generate large amounts of renewable electricity in greenhouses in all seasons of the year, which enables the constant production of food without energy limitations. There are several benefits to this technology that can be highlighted, specifically with regards to solar panels that are designed for greenhouses and are equipped with a responsive tracking system:

- The dual use of land maximizes the productive use of limited space and is therefore economically advantageous.
- The microclimate of the greenhouse is easier to control using solar panels, which optimizes crop yield. This is especially relevant in the event of extreme weather fluctuations.
- Solar panels can provide the proper amount of shade that is needed by the plants by adjusting themselves, decreasing the cost for artificial cooling during warmer periods.
- The panels can also reduce the evaporation of water by providing shade, which improves the efficient use of water within the greenhouse.
- The generation of electricity through solar panels and the simultaneous cultivation of crops leads to a diversification of income, which can, in return, contribute to the viability of the greenhouse itself.

During the Innovation Action (1/2/2023 - 31/1/2026), the new technology is being tested in six locations with different greenhouse types and crops. Furthermore, several studies are conducted to introduce agrivoltaics solutions to farming communities, regulators, and other stakeholders.

In the context of the green transition, the implementation of Agri-PV systems is contingent upon the possibilities for the dual use of land. Certain regions face the challenge of limited land resources, leading to potential competition between agricultural and PV land utilization, posing threats to either food or energy security.[2] Agri-PV emerges as a solution, integrating agricultural and electricity production on

[1] European Council. (n.d.). *European Green Deal*. Consilium. Retrieved December 18, 2024, from https://www.consilium.europa.eu/en/policies/green-deal/

[2] Chatzipanagi, A., Taylor, N. and Jaeger-Waldau, A., Overview of the potential and challenges for Agri-Photovoltaics in the European Union., EUR 31482 EN, Publications Office of the European Union, Luxembourg, 2023, ISBN 978-92-68-02431-7, doi:10.2760/208702, JRC132879.

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the same land. Furthermore, integrating Agri-PV into greenhouses is anticipated to enhance the stability of agricultural yields in climate-vulnerable regions, offering protection from weather conditions and shading. Additionally, Agri-PV has the potential to contribute to the revitalization of rural economies by providing additional sources of revenue for farmers.[3]

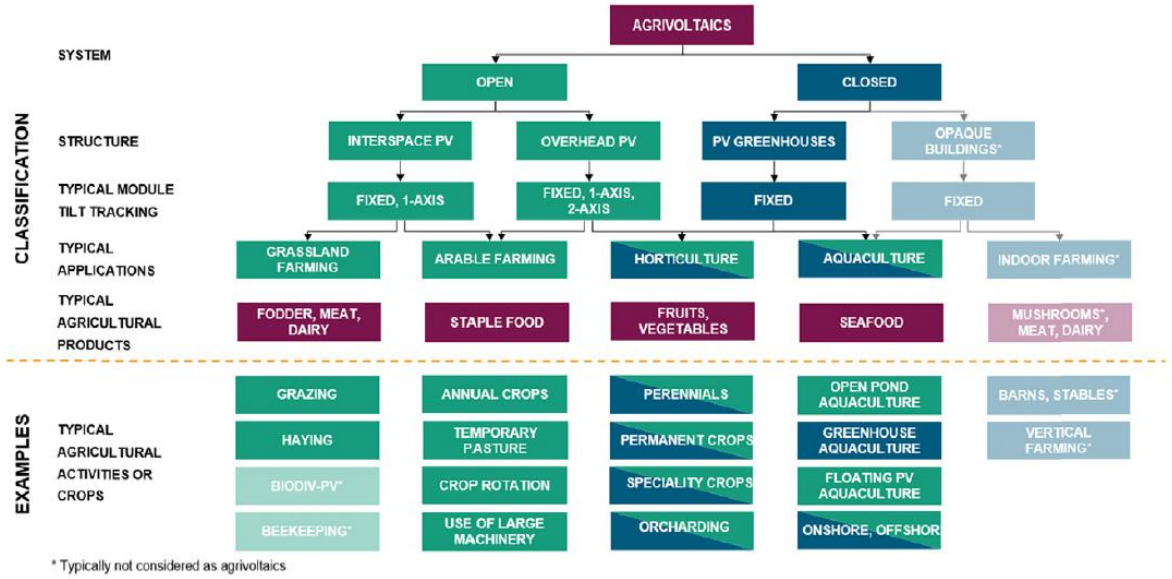


Figure 1: Classification of PV and agricultural colocation approaches[4]

Figure 1 demonstrates the different classes of Agri-PV, distinguishing between open and closed systems. The technology developed by the REGACE consortium falls under PV greenhouses structures in closed systems. The system utilized in REGACE features custom-made bifacial Si PV panels mounted on a tracking system beneath the greenhouse canopy. A programmable logic controller (PLC) connected to sensors regulates the movement of the tracking system, adjusting the angle of the PV panels based on environmental factors such as light, temperature, humidity, and CO2 levels. This responsive approach optimizes electricity production while ensuring adequate shading or light exposure for crops as needed. The feasibility, reliability, and efficiency of the system is assessed using key performance indicators (KPIs) such as ground cover ratio, energy and agricultural yield, and cost per installed kilowatt. Compared to other solutions, this technology is expected to be highly competitive by:

- Providing green energy with a lower cost,
- Providing efficiency also in areas with less sunshine,
- Allowing the dual use of land as well as the dual use of infrastructure,
- Reducing construction and maintenance costs,
- Reducing CO2 emissions,
- Diversifying the energy market.

[3] Asa'a, S., Reher, T., Rongé, J., Diels, J., Poortmans, J., Radhakrishnan, H. S., van der Heide, A., Van de Poel, B., & Daenen, M. (2024). A multidisciplinary view on agrivoltaics: Future of energy and agriculture. *Renewable and Sustainable Energy Reviews*, *200*, 114515. https://doi.org/10.1016/j.rser.2024.114515

[4] Gorjian, S., Bousi, E., Özdemir, Ö. E., Trommsdorff, M., Kumar, N. M., Anand, A., Kant, K., & Chopra, S. S. (2022). Progress and challenges of crop production and electricity generation in agrivoltaic systems using semi-transparent photovoltaic technology. *Renewable and Sustainable Energy Reviews*, *158*, 112126. https://doi.org/10.1016/j.rser.2022.112126

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The overall ambition of REGACE consortium is to demonstrate that agrivoltaics is a year-round solution capable of competing with ground-based alternatives while significantly benefiting both the environment and stakeholders, from farmers to regulators. By cultivating crops with CO2 enrichment, greenhouse agrivoltaics can generate electricity without compromising crop yield.

However, successful implementation of agrivoltaics faces challenges beyond technical aspects. One major concern is the potential conflict between selling electricity and ensuring food security. Regulators are beginning to address this issue. However, it is also important to understand farmers' constraints and attitudes towards Agri-PV systems. To achieve broader adoption of project results, two key factors need to be addressed:

- Determining optimal crop coverage percentages in different climates;
- Reducing mounting structure costs and installation time.

Legal costs are closely related to the second key factor. This includes the time and resources spent on administrative procedures. This deliverable aims to facilitate the broader adoption of project results by investigating the regulatory landscape and policy implications of Agri-PV systems in the European Union and key countries: Austria, France, Germany, Greece, Italy and Israel. For this purpose, the authors reviewed applicable EU legislation and the national legislation of these key countries to conduct an analysis of the gaps, overlaps or contradictions within the current legislation, either at EU level or between the national level and the EU level, and the layout of the Agri-PV scene. Another important aspect is that legislation at all levels on agrivoltaics is rapidly evolving. During the writing of this deliverable, several legislative frameworks at the national level were significantly changed. This creates another form of legal costs: stakeholder involved in Agri-PV installations must ensure their knowledge and resources are up to date to comply with legal requirements.

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B. Methodology

Deliverable D7.1, led by Timelex within Work Package 7, aims to examine the regulatory landscape associated with Agri-PV. The primary objectives are to conduct a comprehensive analysis, identify gaps and challenges in existing regulations, and propose realistic solutions for broad adoption of project results and the integration of agrivoltaics into the EU's green energy landscape.

1. ***Legal Qualification of the Technology:*** Evaluation of the technical properties of the Agri-PV system utilized in REGACE, conducting a factual assessment to determine applicable laws and policies/strategies.
2. ***Examination of the Regulatory Landscape:*** Examination of the existing regulatory frameworks, standards, and guidelines related to Agri-PV in the EU and in key countries to identify gaps and challenges in existing regulations.
3. ***Identification of Practical Challenges:*** Identifying and addressing legal challenges faced by consortium members in relation to Agri-PV systems (i.e., maximizing electricity production while considering biodiversity conservation and avoiding significant impacts on crop yield, permitting and grid connection procedures for Agri-PV projects, …)
4. ***Policy Implications:*** Proposing policy recommendations at EU and national level to facilitate the deployment of Agri-PV systems. Analysis of key EU policies, including those that relate to clean energy, free flow of data, agriculture, biodiversity, and rural development. Providing recommendations for integrating Agri-PV into Common Agricultural Policy (CAP) Strategic Plans, ensuring the eligibility for agricultural subsidies, and proposing capacity targets and financial support mechanisms.

Methodology:

- **Literature Review**
- **Factual Analysis** (technical properties of Agri-PV, considering land coverage, electricity production, and comparison with traditional ground-mounted PV systems)
- **Regulatory & Policy Analysis** (current EU and Member State regulations, standards, and guidelines related to Agri-PV, alignment of Agri-PV with key EU policies, recommendations for inclusion in CAP Strategic Plans and national energy strategies...)
- **Stakeholder Survey** (Engagement with consortium members to gather insights on challenges, opportunities, and the social impact of Agri-PV)

Intended Outcomes:

- A comprehensive understanding of the potential of Agri-PV in greenhouses in the EU.
- Clear recommendations for regulatory frameworks, definitions, and standards for Agri-PV. Insights into policy implications, including CAP Strategic Plans.
- Note: the deliverable does not intend to assess the environmental and social aspects (i.e., with a focus on farmer welfare and public acceptance) as there is another deliverable covering this point.

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C. Relationship with Other Deliverables

The regulatory landscape outlined in D7.1 has synergies with social and environmental deliverables, such as D6.1 (Environment impact report) and D6.2 (Farmer's dialogue report) as well as with business-related deliverables such as D7.2 (Business plan) and D7.3 (Roadmap for achieving TRL9). The regulatory environment significantly influences the feasibility, market entry, and long-term success of innovative projects. In this respect, D7.1 bridges the gap between regulatory requirements and social, economic, and environmental considerations.

D7.1 will also be complemented with key technical deliverables such as D2.2 (CO2 Enrichment Systems), D2.3 (Final design and installation guidelines), D3.2 (Testing results), and D5.3 (System Evaluation). The regulatory recommendations from D7.1 are anticipated to align with data collection and use, research results and overall technical advancements achieved in these deliverables.

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Chapter 2 - Regulatory Landscape Analysis

A. Technical Properties and Potential of Agri-PV in the REGACE project

The technical evaluation of Agri-PV within REGACE is imperative for understanding its capabilities and potential, as well as for determining the applicable legal regime on the technology. This section will delve into the specific technical properties of the implemented Agri-PV system, focusing on aspects such as land coverage and electricity production.

Within the context of the project, location-specific CO2 enrichment systems are being developed and implemented, utilizing different approaches including technical CO2 enrichment, CO2 bags, and organic materials such as manure and green waste. Standardized data collection and evaluation methods are adopted to enable comparison between systems used at different sites.

Furthermore, the integration of CO2 measurement and control systems into cloud-based data collection software allows for continuous recording of measurement data, which is stored locally and, in the cloud, to facilitate data exchange among project partners and minimize the risk of data loss.

The performance and techno-economic feasibility of the systems are evaluated using collected data, focusing on key performance indicators (KPIs) such as PV ground coverage ratio, electric yields, crop yields, and water consumption. Optimal CO2 compensation levels for light reduction in selected crops across different locations are determined, along with estimations of optimal PV module coverage with CO2 enrichment. Data from various sources including internal microclimate measurements, crop quality assessment, CO2 enrichment assessment, water efficiency monitoring, and PV electrical performance evaluation are brought together and analysed for this purpose.

These technical properties play an important role in evaluating whether Agri-PV are meeting the requirements laid out in the legal framework of countries. Multiple countries analysed put forward limitations on the ground coverage of photovoltaics on agricultural land. Furthermore, many initiatives, both at the EU and Member State level offer support for smaller installations with a capacity of a certain amount of kilo Watt peak (kWp). There are significantly less support options available for larger installations. The physical space and technical properties play an important part in applying the different regulatory frameworks.

Table 1: Summary of the Properties of the Agri-PV Deployed in REGACE

Test Site	Location	Greenhouse Type	Dimensions	PV Tracking System	Ground Coverage	Total kWp
University of Thessaly (UTH)	Velestino, Greece	Gothic	25m x 9.6m x 5.0/7.3	240m2	30%	14.4 kWp
University of Natural Resources and Life Sciences, (BOKU)	Vienna, Austria	Ridge and furrow	(1) 6.3m x 6.4m x 3.6m (2) 6.3 m x 3.15 m x 3.6 m	19,8m2 (2 greenhouses)	30%	1.32 kWp
Humboldt University, Germany (HU)	Berlin, Germany	Venlo-type	6m x 6.7m	307m2	10%, 20%, 30%	4.5 kWp

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Bio-Gärtnerei Watzkendorf (BW)	Watzkendorf, Germany	Venlo-type		5000m2	30%	16 kWp
Fattoria Solidale del Circeo (FSC)	Italy	Modified arch	18m x 10m	180m2	30%	5.12 kWp
Israel (AZS)	Kfar Qara	Arched	8m x 17.5 m (2 greenhouses)	140 m2 (2 greenhouses)	30%	12.6 kWp

B. Competence of the EU to regulate

This section aims to clarify to what extent the EU is allowed to regulate matters pertaining to agriculture and energy. Both domains are historically sensitive subjects for Member States, who have been reluctant to delegate their powers to the EU on these topics.[5]

European legislation can take the role of regulations or directives. Regulations are directly applicable law in the national legal system of Member States. Directives on the other hand must be transposed by each Member State's national parliament and lack direct effect.[6] Both types of instruments are legally binding and can be effective at regulating national legal frameworks on a specific matter. However, usually the form of a Directive is chosen when dealing with issues sensitive to the Member States, as the Member States have more leeway when choosing how to transpose a Directive.[7] Generally, this deliverable will focus on the binding and general European framework. These will be mainly relevant directives and regulations. Where relevant, other instruments may be mentioned or analysed.

1. Capacity to regulate agriculture

Agriculture is a shared competency between the Member States and the European Union.[8] This means that Member States may regulate on the parts where the EU has not imposed its own rules. However, once there is an EU legal framework, this takes precedence over the Member States ability to regulate.[9]

Title 3 of Part 3 the Treaty on the Functioning of the European Union (TFEU) clarifies what measures the EU can take with regards to agriculture. In summary, TFEU grants the EU the power to design a Common Agricultural Policy (CAP) and lays the groundwork for agricultural products on the internal market.[10] In light of the REGACE project, the internal market part of this competence is not of major concern, since this primarily allows for regulation on food standards.

The CAP is more interesting for the development of Agri-PV systems and will be discussed further under Chapter 3 A. The CAP provides direct payment support to farmers, aiming to guarantee a liveable wage. Additionally, the CAP allows for regulation and action for the development of rural areas and

[5] See for example the wording of article 39 (2) Consolidated version of the Treaty on the Functioning of the European Union, 2008/C 115/01, European Union, 13 December 2007 (TFEU), which denotes the sensitivity of agriculture to Member States.
[6] See article 288 TFEU.
[7] Craig, P., & de Búrca, G. (2020). *EU Law: Text, Cases, and Materials* (Seventh Edition). Oxford University Press, 139.
[8] Article 4 (2) (d) TFEU.
[9] Craig, P., & de Búrca, G. (2020). *EU Law: Text, Cases, and Materials* (Seventh Edition). Oxford University Press, 114.
[10] Article 38 TFEU. The contents of the CAP will be discussed under section I.A.I.A.

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technical progress to ensure productivity.[11] This is one of the goals of CAP listed in article 39 (1) TFEU. However, in pursuing these goals, the specific nature of agricultural activity must be considered, measures need to be implemented gradually, and the European regulator must always remember how sensitive agriculture is for Member States.[12] Finally, to reach the goals of the CAP, article 41 TFEU lists examples of measures that can be taken. This includes training, research and dissemination of agricultural knowledge.[13]

The provisions on the CAP in the TFEU allow for a broad range of measures that the EU can take. These measures can be regarding the internal market of food products, but also rural development and support for innovation. However, these measures still need to consider the interests of Member States.

2. Capacity to regulate energy

Energy is also a shared competence between the EU and Member States.[14] When taking European action, the regulator must act to accomplish one of the following goals:[15]

- Ensuring the functioning of the energy market;
- Ensuring security of energy supply in the EU;
- Promoting energy efficiency and the development of **new and renewable forms of energy**; and
- Promoting the interconnectedness of energy networks.

Promoting Agri-PV as a source of renewable energy is thus allowed under Treaty law. However, Member States retain the right to determine conditions for exploiting energy resources, their choice between different energy sources and the general structure of their energy supply.[16] This means that the EU cannot obligate Member States to only use renewables, as this would violate Member States' right to choose between different energy sources. Measures that promote renewable energy are permissible if they do not infringe upon this right.[17]

Many measures can be implemented if they relate to renewable energy. For example, within the Renewable Energy Directive III, there are provisions relating to the maximum duration of a permitting procedure for renewable energy projects.[18] Permitting procedures are usually reserved for national law. However, because these permits touch on the development of renewable energy, the EU is competent to regulate in this area. This opens the door for more opportunities for the EU to intervene when national systems are lagging behind to reach green development goals.

[11] Grethe, H. (2008). Agriculture Policy: What Roles for the EU and the Member States?. In *Subsidiarity and Economic Reform in Europe* (pp. 191-218). Berlin, Heidelberg: Springer; Article 39 TFEU.
[12] Article 39 (2) TFEU.
[13] Article 41 (a) TFEU.
[14] Article 4 (2) (i) TFEU.
[15] Article 194 (1) TFEU.
[16] Article 194 (2) TFEU.
[17] See also Talus, K. (2016). *Introduction to EU Energy Law*. Oxford University Press.
[18] See Article 16 Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652.

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Chapter 3 - Examination of Relevant EU Legislation

This section aims to provide an analysis of the key existing EU legislative framework related to Agri-PV. Attention will be given to regulations that impact the deployment of Agri-PV systems and will serve as a foundation for proposing regulatory solutions in alignment with the broader goals of the European Green Deal.

A. Common Agricultural Policy 2023-2027

The current Common Agricultural Policy (CAP) is built around ten social, environmental, and economic objectives that aim to provide a secure and sustainable future for farmers regarding agriculture and forestry[19]. These goals provide a framework for EU Member States to implement national CAP Strategic Plans, tailored to their respective needs, during the period of 2023 to 2027.[20] The CAP is crucial to the business model of farmers. If CAP support is lost when land is used for both agriculture and energy generation, this is a massive deterrent to the widespread adoption of Agri-PV installations.

Within CAP, there are two pillars.[21] The first pillar consists of direct support and market measures. The second pillar is focused on rural development. Both pillars are relevant for the goals of REGACE.

The first pillar is relevant to agrivoltaics because farmers will have to comply with the rules that are a direct consequence of national CAP Strategic Plans. Moreover, certain incentives (such as income support) are established by the CAP to encourage the fulfilment of the objectives. To receive such benefits, farmers must comply with several requirements set by the CAP. The same mechanisms are enabled at a national level, including in the national CAP strategies. Most of the requirements for first pillar CAP support are decided on at the European level. However, Member States are competent for certain crucial provisions. For example, Member States are competent in deciding on the criteria for an 'active farmer', a crucial part of CAP direct payments. From the analysis of national legislation (*infra)* it is clear that certain Member States allow for dual use of land, namely both agriculture and production of energy, without losing CAP direct payment benefits, while in other Member States, combining the two is impossible without losing access to this form of support. Even where Member States allow dual use, the photovoltaic elements will have to comply with the requirements that will stem from national CAP strategies (such as permit regulations that are a direct result of these strategies).

The second pillar of CAP is also important for REGACE, as this pillar provides financing for rural development programs. This pillar is co-financed by the European Union and Member States via the

[19] Key policy objectives of the CAP 2023-27 - European Commission (europa.eu).

[20] Regulation (EU) 1308/2013 of the European Parliament and of the Council of 17 December 2013 establishing a common organization of the markets in agricultural products and repealing Council Regulations (EEC) No 922/72, (EEC) No 234/79, (EC) No 1037/2001 and (EC) No 1234/2007, *O.J.E.U.,* L 347/671, 17 December 2013;
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, *O.J.E.U.,* L 435/1, 2 December 2021.
Regulation (EU) 2021/2116 of the European Parliament and of the Council of 2 December 2021 on the financing, management and monitoring of the common agricultural policy and repealing Regulation (EU) No 1306/2013, *O.J.E.U.,* L 435/187, 2 December 2021.

[21] Council of the European Union. (n.d.). *Common agricultural policy*. Consilium. Retrieved October 22, 2024, from https://www.consilium.europa.eu/en/policies/cap-introduction/.

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European Agricultural Fund for Rural Development.[22] Funding coming from this pillar could be used to launch initiatives spreading Agri-PV technology throughout Europe. These more diverse initiatives are also included in national strategic CAP plans. They can include climate resilience and mitigation measures, which can comprise agrivoltaics initiatives. It is up to EU Member States to consider what initiatives they wish to pursue.

B. EU Solar Strategy & the Renewable Energy Directive

The EU Solar Strategy is part of a larger package (REPowerEU) that aims to end the reliance of the EU on fossil fuels. The objective of the EU Solar Strategy is to increase solar ambition by 43% by 2023 and to speed up the process of solar deployment through several steps: a new framework on permits, a "Solar Rooftops" initiative, the creation of a Solar PV Industry Alliance, and a Solar Skills Partnership.[23]

The Solar Strategy Communication issued by the EU highlights various actions that will be undertaken by the Commission and that Member States are recommended to pursue.[24] For instance, the Commission will develop guidance for Member States in the promotion of innovative solar energy deployment and Member States are encouraged to integrate agrivoltaic incentives in the implementation of their national CAP Strategic plan.[25]

In parallel, the Renewable Energy Directive was revised (EU2023/2413) to reflect the initiatives of the Commission and thereby facilitate the obtention of permits for renewable energy projects, which include solar energy.[26] These frameworks and initiatives are relevant since they will impact the development of national regulations, policies, and incentives, in the fields of solar energy and innovative solar energy deployment. One important aspect of the 2023 revision of the Renewable Energy Directive is that there is now a maximum timeline for the permitting procedure of renewable energy projects. Permits for renewable energy projects will now have to be given out within a two-year deadline. In certain "acceleration zones", permits will have to be granted even sooner.[27] These measures will have noticeable impacts on the development of agrivoltaics and could encourage more investment into the sector as there will be a more rapid return on investment.

C. The European Green Deal

The European Green Deal is a bundle of initiatives that ultimately aim to transform the EU into "a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource

[22] European Parliament. (2024, October 19). *The common agricultural policy – instruments and reforms*. Fact Sheets on the European Union. https://www.europarl.europa.eu/factsheets/en/sheet/107/the-common-agricultural-policy-instruments-and-reforms.
[23] SolarPower Europe. (2022). *EU Solar Strategy Explained*. https://www.solarpowereurope.org/advocacy/eu-solar-strategy.
[24] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: EU Solar Energy Strategy, *O.J.E.U.,* COM 2022/221, 18 May 2022.
[25] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: EU Solar Energy Strategy, *O.J.E.U.,* COM 2022/221, 18 May 2022.
[26] Directive 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652, O.J.E.U., 18 October 2023.
[27] Article 16b Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652.

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use"[28]. Numerous other packages of initiatives are included within the EGD, such as the Fit for 55 package (which translates the considerations of the EGD related to the climate into a series of legislative proposals), the Farm to Fork package (which focuses on shifting towards a sustainable food system), and the EU Biodiversity Strategy for 2030 (which is meant to protect and help recover Europe's biodiversity). Each sub-package of the EGD has its own objectives and environmental concerns. The policies, initiatives, and regulations that stem from the EGD, like the revised Renewable Energy Directive or sustainability reforms in the CAP will have to be assessed individually to determine whether/how they would apply to agrivoltaics.

D. EU State Aid Rules

Articles 107 and 108 TFEU foresee the legal framework for state aid within the EU. Their purpose is to limit state aid that distorts competition on the single market. However, EU Member States can in certain cases legitimately intervene and fulfil specific policy objectives. A number of guidelines and regulations[29] have been adopted by the EU to expand upon state aid within a given context or regarding a particular area. In some situations, these instruments even incorporate policy objectives, notably EGD and the CAP. As such, when Member States provide (or will provide) state aid as part of the implementation of their CAP Strategy, they will have to comply with the framework on state aid set out by the EU. Nonetheless, in light of achieving such ambitious environmental objectives, the regulations are rather inclined to remove state aid barriers for projects that fall under such policies. It will be important for the Agri-PV sector that the technology aligns with the objectives set by EU strategies (like EGD & CAP) to gain access to state aid.

E. Data Act

The Data Act[30] clarifies who can access data generated by connected products and create value from this data, and under which conditions. Following this Regulation, data users will easily and safely be able to access, use, and share data that is generated by connected products. The European Commission highlights the Data Act as an important part of its strategy for solar power, especially where interoperability and data sharing are concerned.[31] The Data Act contains many different provisions, including regulation on data portability, data transfers outside the EU or mandatory data sharing with

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[28] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: The European Green Deal, *O.J.E.U.*, COM 2019/640, 11 December 2019. See also Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law').

[29] Commission Regulation (EU) 2022/2472 of 14 December 2022 declaring certain categories of aid in the agricultural and forestry sectors and in rural areas compatible with the internal market in application of Articles 107 and 108 of the Treaty on the Functioning of the European Union (Text with EEA relevance), *O.J.E.U.*, L 327/1, 14 December 2022; Communication from the Commission Guidelines for State aid in the agricultural and forestry sectors and in rural areas 2022/C 485/01, *O.J.E.U.*, 2022/C 485/1, 21 December 2022; Communication from the Commission – Guidelines on State aid for climate, environmental protection and energy 2022, *O.J.E.U.,* 2022/C 80/1, 18 February 2022.

[30] Regulation (EU) 2023/2854 of the European Parliament and of the Council of 13 December 2023 on harmonized rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 (Data Act), *O.J.E.U.*, 13 December 2023.

[31] European Commission. (2022, May 18). *COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS EU Solar Energy Strategy {SWD(2022) 148 final}*. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022DC0221.

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authorities in cases of emergencies. The most important sections as it pertains to REGACE are the provisions on data sharing for connected devices. As such, this will be analysed in more detail. While the other chapters of the Data Act will have a significant impact on data practices across the EU, they are less relevant to the project at hand.

The Data Act enables users of connected products (like connected cars, medical and fitness devices, but also industrial or agricultural machinery) and related services (i.e. anything that would make a connected product behave in a specific manner, such as an app to adjust the brightness of lights, or to regulate the temperature of a fridge), to access the data that they co-create by using the connected products/related services.[32] The Data Act applies to product data and service data of the connected products and related services. For instance, farmers who use equipment which collects real-time data (such as weather conditions, CO2 levels, temperature, etc.) will have the right to obtain all the data freely in an accessible and secure manner.[33] This will help farmers optimize crop yield, farming strategies, energy consumption, and so on. Not only is this financially advantageous for farmers, but it also fosters sustainable activity.

For a product to be a "connected product" under the Data Act, two key conditions must be met: 1) the product must collect data and 2) the product must have the ability to communicate that data in some manner.[34] Newer solar panels have been designed with built-in responsive tracking systems to collect data (like temperature, plant photosynthesis levels or moisture levels).[35] These types of solar panels collect data and communicate them with controllers which can then cause certain actions to be taken, like rotating the solar panels for optimal shading. These characteristics meet the requirements for connected products in these types of smart photovoltaic installations. These will have to be manufactured and commercialized in accordance with the Data Act, in a way that accommodates the rights of the users (e.g., farmers) to easily access and create value with the data generated by the panels.

A data holder is the entity who lawfully collects the data and has a contract with the user which establishes the basis for such collection. The data holder is typically the company that makes the connected product or that provides a related service. A data holder must have a contract with the user defining the rights regarding the access/use and sharing of the data that is generated by the connected product or related service. The agrivoltaics manufacturer can be considered a "data holder" in that it collects data, if it can be shown that the collected data is then made available to data recipients in the EU.

Chapter II of the Act allows users to access the data that they generate through their use of the connected product or related service free of charge.[36] If the user wishes to share this data with another entity or individual (third party), they can either do so directly or they can ask the data holder to share it with a third party of their choice.

The Data Act empowers farmers regarding the data they generate when using Agri-PV installations. Sophisticated Agri-PV systems like the ones used in the REGACE project gather a myriad of data, like temperature, plant photosynthesis levels, moisture levels, etc., through an in-built responsive tracking

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[32] European Commission. (2024, September 6). *Data Act explained*. https://digital-strategy.ec.europa.eu/en/factpages/data-act-explained.

[33] Article 3 Data Act.

[34] Article 2 (5) Data Act.

[35] See for example Kumba, K., Upender, P., Buduma, P., Sarkar, M., Simon, S. P., & Gundu, V. (2024). Solar tracking systems: Advancements, challenges, and future directions: A review. *Energy Reports*, *12*, 3566–3583. https://doi.org/10.1016/j.egyr.2024.09.038; Bellini, E. (2022, December 13). Novel agrivoltaic array tech for greenhouses. *Pv Magazine International*. https://www.pv-magazine.com/2022/12/13/novel-agrivoltaic-array-tech-for-greenhouses/.

[36] See Article 3 Data Act.

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sensor embedded in the photovoltaic system. Farmers have a right to access all this data free of charge and this must be implemented by default (without the farmer explicitly requesting this). They can then use the data for their own purposes and even share or sell it.[37] This provides further economic incentives for farmers to implement Agri-PV systems. The downside is that Agri-PV manufacturers are less incentivized to develop newer and more sophisticated products, as they now face direct competition from the users of such systems when it comes to selling generated data to third parties.

F. NIS2 Directive

The NIS 2 Directive[38] aims to increase cybersecurity standards in critical industries in Europe. Both aspects of Agri-PV fall under the sectors in scope of NIS 2, those being food production and energy production.

The NIS 2 Directive speaks of "entities". An entity is either a natural or a legal person.[39] When an entity is qualified as either important or essential, they must comply with the cybersecurity standards in the Directive. This includes taking organizational and technical measures to ensure cybersecurity, reporting major incidents to the relevant authority, or evaluating cybersecurity risks.[40]

An entity can be designated as important or essential under several grounds.[41] For operators of Agri-PV installation, the most relevant are the sectoral designations.[42] If an entity is at least of medium size[43] and active in the sectors described in the Annexes of the NIS 2 Directive, it qualifies as an important entity. If it is a large enterprise[44] and carries out activities mentioned in Annex I to the NIS 2 Directive, it qualifies as an essential entity. If, on account of multiple types of business activities, both qualifications are present (important and essential), the entity as a whole will be qualified as essential and thus have to follow more rigid standards and obligations.[45] However, the Directive leaves the door open for sector-specific supervisors at the national level. This means there is the possibility of an entity which is active in multiple sectors having to report to multiple different sectoral supervisors. Finally, Member States are allowed to expand the scope of NIS2 in their national implementation, potentially causing more entities to have to meet the NIS2 standards.

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[37] Article 5 Data Act.
[38] Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union, amending Regulation (EU) No 910/2014 and Directive (EU) 2018/1972, and repealing Directive (EU) 2016/1148 (NIS 2 Directive).
[39] Art. 2 (1) NIS 2 Directive.
[40] Council of the EU. (2022, November 28). EU decides to strengthen cybersecurity and resilience across the Union: Council adopts new legislation. *Consilium*. https://www.consilium.europa.eu/en/press/press-releases/2022/11/28/eu-decides-to-strengthen-cybersecurity-and-resilience-across-the-union-council-adopts-new-legislation/
[41] Art. 3 (1) and (2) NIS 2 Directive.
[42] Art. 3 (1) (a) j. art. 3 (2) NIS 2 Directive.
[43] More than 50 full time employee equivalents or an annual turnover of more than 10 million euro and an annual balance sheet of more than 10 million euro, see Article 2(1) of the Annex to Recommendation 2003/361/EC.
[44] More than 250 full-time employee equivalents or an annual turnover of more than 50 million euro and an annual balance sheet of more than 43 million euro, see Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises.
[45] Centre for Cybersecurity Belgium, *Frequently Asked Questions (FAQ) NIS2 in Belgium*, July 2024, available via https://ccb.belgium.be/sites/default/files/NIS2%20FAQ%20Website%20v1.0%20EN.pdf.

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Relevant sectors for operators of Agri-PV installations are energy producers[46] and food businesses[47]. Since operators of Agri-PV installations can potentially be active in both sectors, they will be in scope of the Directive if they are at least medium sized enterprises, while national legislators can even broaden the scope of the NIS 2 obligations. When the business is of a large size, it will be categorized as an essential entity on account of one of its activities appearing in the Annex I list of sectors.

Once an entity is in scope of NIS 2, several obligations arise. For operators of Agri-PV installations, the main obligations are: 1) taking appropriate cybersecurity risk-management measures[48], 2) involving management in these measures[49], 3) reporting significant cyber incidents[50] and 4) adherence to certification schemes[51].[52] These obligations require a significant review of the digital environment of a business, which can be time and resource intensive.

The NIS 2 Directive introduces notable implications for Agri-PV installations, particularly for larger-scale operators. Many farmers managing small-scale Agri-PV setups are unlikely to meet the thresholds defining medium-sized businesses within the Directive's scope. However, larger operators overseeing multiple or larger installations may have to meet the requirements laid out in the Directive. This is particularly significant for large Agri-PV operations that depend on interconnected systems, like for energy production, monitoring, and agricultural processes. These installations face the risk of becoming the target of cyber threats. Compliance with NIS 2 ensures these operators protect critical infrastructure and maintain operational continuity, though it also introduces significant additional costs and administrative responsibilities. This distinction underscores the Directive's potentially disparate impact. While smaller farmers remain largely unaffected, large-scale operators must navigate significant changes to enhance cybersecurity, ensuring the resilience of their complex, dual-purpose infrastructure.

G. Cyber Resilience Act

In November 2024, the Cyber Resilience Act (CRA) was adopted.[53] This Regulation aims to provide horizontal, technology-neutral, essential cybersecurity requirements for products with digital elements. The horizontal and technology-neutral aspects in its name refer to its aims to apply to all sectors, independently from any specific product. It sets product standards relating to cybersecurity for all

[46] Annex I NIS2, Sector 1. Energy (a) Electricity: "Producers as defined in Article 2, point (38), of Directive (EU) 2019/944". Art. 2 (38) Directive (EU) 2019/944 defines a producer as "a natural or legal person who generates electricity".

[47] Annex II NIS2, Sector 4 Production, Processing and distribution of food: "Food businesses as defined in Article 3, point (2), of Regulation (EC) No 178/2002 of the European Parliament and of the Council (3) which are engaged in wholesale distribution and industrial production and processing.". Art. 3 (2) Regulation (EC) No 178/2002 defines a food business as "any undertaking, whether for profit or not and whether public or private, carrying out any of the activities related to any stage of production, processing and distribution of food".
Only those food businesses which are engaged in wholesale distribution or industrial production and processing are covered by this sector. The definition for energy producers is broader (a person who generates energy) and will cause every Agri-PV operator of medium size to fall under the scope of NIS2, thus imposing high cybersecurity standards.

[48] Art. 21 NIS 2 Directive.

[49] Art. 20 j. 32 (6) NIS 2 Directive.

[50] Art. 23 NIS 2 Directive.

[51] Art. 24 NIS 2 Directive.

[52] Registration is also an obligation for certain entities, but not for Agri-PV operators. The list of entities which must register themselves with a national authority can be found in art. 27 NIS 2 Directive and mainly discusses online infrastructure providers.

[53] Regulation (EU) 2024/2847 of the European Parliament and of the Council of 23 October 2024 on Horizontal Cybersecurity Requirements for Products with Digital Elements and Amending Regulations (EU) No 168/2013 and (EU) No 2019/1020 and Directive (EU) 2020/1828 (Cyber Resilience Act). https://eur-lex.europa.eu/eli/reg/2024/2847/oj.

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products on the EU market. The size of the company making the product does not matter, all products under the scope of the CRA must comply with these requirements.

The CRA applies to "products with digital elements".[54] This includes both hardware and software which include a remote data processing solution and its components.[55] These are similar but not identical definitions to those under the Data Act. For the REGACE project, this includes the photovoltaic units and the devices they are connected to for remote data processing.

The bulk of CRA obligations start applying from 11 December 2027. Starting on this day, manufacturers must ensure all products with digital elements, including sophisticated photovoltaics with sensors, must comply with essential requirements for their cybersecurity.[56] They must also have the appropriate declaration of conformity, CE-marking, technical documentation, etc. Furthermore, the manufacturers of products with digital elements must implement processes for the handling of vulnerabilities in their products which they become aware of.[57]

Whereas the NIS2 Directive is only applicable to certain businesses of a larger size, the CRA applies to every smart product placed on the EU market. This means that any smart product sold in any Member State will have to comply with the requirements. Even if a manufacturer of Agri-PV installations was not in scope of the NIS2 Directive on account of their size, the CRA will ensure that all manufacturers of smart products will nevertheless have to consider cybersecurity in the planning, development and maintenance of these products.

The CRA has important implications for Agri-PV installations and operators. Agri-PV setups rely on products with digital elements for energy management, monitoring, and agricultural automation, especially where innovative and advanced technological solutions are used, like in the REGACE project. This mandates that manufacturers and suppliers of such technologies ensure their products meet cybersecurity standards throughout their lifecycle, including secure design, regular updates, and vulnerability handling. For operators and farmers, the CRA enhances the overall security of their infrastructure but also requires diligence in selecting compliant equipment and maintaining up-to-date systems. While these measures aim to reduce cyber risks and protect interconnected operations, they could also increase costs and complexity for operators, farmers and manufacturers, reshaping the Agri-PV sector's approach to integrating and managing digital technologies.

H. Regulation on the governance of the energy union and climate action

This Regulation[58] is one of the enforcement measures of the Paris Agreement under the United Nations Framework Convention on Climate Change. EU Member States must draft ten-year strategies to achieve energy and climate goals. The current National Energy and Climate Plans (NECPs) span the period of 2021-2030. These ten-year strategies serve as the foundational framework for climate policy, which is

[54] Article 2 (1) CRA.
[55] Article 3 (1) CRA. The Commission is expected to give guidance on what constitutes a remote data processing solution, see article 26 CRA.
[56] Article 6 (a) CRA.
[57] Article 6 (b) CRA.
[58] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council (Text with EEA relevance.), *O.J.E.U.*, L 328/1, 11 December 2018.

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then translated into the national regulations. These more specific regulations will directly affect the development and deployment of Agri-PV installations in Member States.

There are minimum content requirements for the NECPs. Renewable energy is one example of a key point that the NECPs must touch on.[59] In order to achieve the goals set by this Regulation, Member States will have to implement several support structures for renewables to encourage their construction and operation. This can lead to important developments for the Agri-PV sector.

While the EU Regulation mandating NECPs and the plans themselves do not implement specific benefits or detailed regulations for agrivoltaics, they set the stage for the development of tailored legislation at the national level. These national plans are critical for Agri-PV operators as they provide a strategic framework for integrating renewable energy into national energy systems, including the agricultural sector. This framework enables Member States to identify priorities, allocate resources, and establish policies that address the unique challenges of agrivoltaics. By fostering alignment with EU energy and climate goals, NECPs create the necessary conditions for the sector to receive structured, targeted support through subsequent laws and initiatives, ensuring its growth within a coherent policy environment.

For example, the France NECP for 2021-2030 highlights agrivoltaism as an important part of the solar strategy for France.[60] While the French NECP does not directly influence the regulatory framework in France, it is part of a larger strategy to make Agri-PV more accessible. This illustrates the large, though indirect, importance of NECPs.

I. Corporate Sustainability Due Diligence Directive

In 2024, the Corporate Sustainability Due Diligence Directive (CSDDD)[61] was adopted. Member States must transpose it by July 26, 2026.[62] The CSDDD obligates businesses of a certain size to conduct human rights and environmental due diligence within their supply chain. The scope of the CSDDD is large, making businesses consider all adverse human rights impacts on affected stakeholders. This could range from labour rights to human dignity or freedom of expression.[63]

Due to the size requirements for businesses to be in scope of CSDDD, farmers themselves or individual Agri-PV operators are unlikely to be in scope of the Directive.[64] However, the Directive could play an important role in the production process of photovoltaic panels as a whole. Larger businesses who assemble or create solar panel components may need to implement the CSDDD.

Europe imports nearly all of its solar panel components from China.[65] For these components, there are serious concerns about human rights violations in the supply chain, especially where the province of

[59] See article 4 (a) (2) and article 5 Regulation 2018/1999.
[60] Directorate-General for Communication. (2024). France—Final updated NECP 2021-2030 (submitted in 2024 (p. 305). European Commission. https://commission.europa.eu/publications/france-final-updated-necp-2021-2030-submitted-2024_en.
[61] Directive (EU) 2024/1760 of the European Parliament and of the Council of 13 June 2024 on corporate sustainability due diligence and amending Directive (EU) 2019/1937 and Regulation (EU) 2023/2859.
[62] Article 37 CSDDD.
[63] See also article 3 (1) (c) CSDDD.
[64] See Article 2 CSDDD. For a business to be in scope of CSDDD, there is a requirement of having at least 1000 employees and a worldwide turnover of EUR 450 000 000.
[65] Bettoli, A., Nauclér, T., Nyheim, T., Schlosser, A., & Staudt, C. (2022, December 13). Rebuilding Europe's solar supply chain. *McKinsey & Company*. https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/building-a-competitive-solar-pv-supply-chain-in-europe.

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Xinjiang is concerned.[66] These concerns include serious allegations of state sponsored forced labour of the Uyghur population.[67]

Under the CSDDD, there is a requirement to identify adverse human rights and environmental impacts. Once these impacts are identified, they need to be addressed, either by preventing or mitigating potential impacts and by stopping or minimizing existing impacts. In extreme cases, companies are even required to suspend or terminate business relationships with their suppliers. This must happen when there are severe impacts at stake, which outweigh the foreseeable negative consequences of disengagement.[68] In practice, this could lead to a big disruption of photovoltaic supply chains.

Due to the massive reliance on China for the import of solar panel components and connected severe impacts upon human rights, there is a need to shift to a human rights compliant supply chain for the production of photovoltaics in general, including Agri-PV. This is a broader problem for Europe in the transition to renewable energy that should be addressed.[69]

J. Ecodesign Standards

In 2024, the Ecodesign for Sustainable Products Regulation (ESPR)[70] replaced the Ecodesign Directive[71]. Both legal frameworks provide for higher standards to achieve more environmentally sustainable and circular products. This way, the ESPR helps achieve circular economy goals. Under the new ESPR, performance and information standards can be set for almost all categories of physical goods. These standards can improve a product's durability, require it to be more energy efficient, or allow for easier reusing and recycling.[72] The purpose is to gradually remove the lowest performing products from the market. Accordingly, initially the minimum requirements should be met by most manufacturers, and only after a few years will the standards become more stringent.[73]

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[66] Copley, M. (2020, October 22, updated 2024, October 3). Human rights allegations from China's Xinjiang region could jeopardize US solar supply chain. *Business & Human Rights Resource Centre*. https://www.business-humanrights.org/en/latest-news/china-human-rights-allegations-could-jeopardize-us-solar-supply-chain/; Uyghurs: US Senate passes bill to ban Xinjiang imports. (2021, July 15). *BBC*. https://www.bbc.com/news/world-us-canada-57847912.

[67] Wormington, J. (2024, February 29). Xinjiang Abuses Show Need for Robust EU Forced Labor Law | Human Rights Watch. *Human Rights Watch*. https://www.hrw.org/news/2024/02/29/xinjiang-abuses-show-need-robust-eu-forced-labor-law; Reinsch, W. A., & Arrieta-Kenna, S. (2021). *A Dark Spot for the Solar Energy Industry: Forced Labor in Xinjiang*. https://www.csis.org/analysis/dark-spot-solar-energy-industry-forced-labor-xinjiang.

[68] Articles 10-11 CSDDD.

[69] Photovoltaic interest groups ESMC and SolarPower Europe have expressed support for the CSDDD and a proposed ban on import of products made with forced labor by the European Commission. See SolarPower Europe. (2022, May 20). *Position Paper on the EU Corporate Sustainability Due Diligence Directive*. https://www.solarpowereurope.org/advocacy/position-papers/eu-corporate-sustainability-due-diligence-directive; *Statement on European Commission Forced Labour Ban—SolarPower Europe*. (2022, September 16). SolarPower Europe. https://www.solarpowereurope.org/advocacy/position-papers/statement-on-european-commission-forced-labour-ban; Holm, J. (2024, April 26). Due diligence law – Time to End Social Dumping. *ESMC Solar*. https://esmc.solar/due-diligence-law-time-to-end-social-dumping/.

[70] Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products, amending Directive (EU) 2020/1828 and Regulation (EU) 2023/1542 and repealing Directive 2009/125/EC.

[71] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products.

[72] Article 5 ESPR.

[73] Rossi, R. (2023, February 2). PV Sustainable Product Policies: A quick guide on EU sustainability instruments. *SolarPower Europe*. https://solarpowereurope.org/features/pv-sustainable-product-policies-a-quick-guide-on-eu-sustainability-instruments.

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One of the innovations of the ESPR is the Digital Product Passport. This serves as a digital identity card for products. This way information on sustainability and legal compliance of products will be easily accessible to authorities, manufacturers and consumers.[74] The Commission will set up a Digital Product Passport registry to store all data retaining to products placed on the EU market, as well as a publicly accessible search tool for stakeholders to search and compare information in the registry.[75]

It is likely that there will eventually be new standards for photovoltaic panels under ESPR.[76] Currently, the development of these standards is in a very early stage.[77] The EU Joint Research Centre has issued a draft technical report on what products should be prioritized when making the new Ecodesign standards.[78] Solar panels or photovoltaics in general are not included in this report. Due to the lack of prioritization, it could take several years before Ecodesign standards for photovoltaics are released. Eventually, these new product standards could have a significant impact upon the dissemination of Agri-PV installations.

K. Accelerated deployment of renewable energy

To accelerate the construction and operationalization of renewables across Europe, a temporary EU framework was implemented by regulation.[79] This framework was adopted in 2022 for 18 months originally but was extended (at time of writing until 30 June 2025).[80] The framework provides for an easier and shorter permitting procedure for renewable energy projects to meet Europe's climate goals. For starters, renewables are presumed to override public interest during the permitting process, leading to there being less grounds to deny a permit for renewable energy projects.[81] Furthermore, for solar energy, the permitting process may not take more than three months. For small plants, if the competent authority does not answer within a month, they are presumed to have granted the permit.[82] In certain cases, renewable energy installations may also be exempted from an environmental impact assessment.[83]

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[74] Damen, M. A., Stepke-Müller, M., Meyer zum Felde, A., Rubel, H., Turner, J., van Doorne, L., Sukailo, D., Holtorf, M., & Eggert, F. (2023). *The EU DPP shapes the future of value chains—What it is and how to prepare now* (p. 21). World Business Council for Sustainable Development. https://www.wbcsd.org/resources/the-eu-digital-product-passport/.

[75] Article 13 ESPR.

[76] See the initial works on solar photovoltaics Ecodesign, Energy Label, Ecolabel and Green Public Procurement standards: European Commission Product Policy Bureau. (n.d.). *Solar Photovoltaics*. Circular Economy: Environmental and Waste Management. Retrieved October 23, 2024, from https://susproc.jrc.ec.europa.eu/product-bureau/product-groups/462/home.

[77] European Commission Product Policy Bureau. (n.d.). *Solar Photovoltaics*. Circular Economy: Environmental and Waste Management. Retrieved October 23, 2024, from https://susproc.jrc.ec.europa.eu/product-bureau/product-groups/462/home.

[78] Faraca, G., Spiliotopoulos, C. et al. (2023). *Ecodesign for Sustainable Products Regulation—Preliminary study on new product priorities* (Joint Research Centre). European Commission. https://susproc.jrc.ec.europa.eu/product-bureau/sites/default/files/2023-01/Preliminary%20ESPR%20WP%20Report_MERGED_CLEAN_.pdf.

[79] Council Regulation (EU) 2022/2577 of 22 December 2022 laying down a framework to accelerate the deployment of renewable energy.

[80] Council Regulation 2024/223 of 22 December 2023 amending Regulation (EU) 2022/2577 laying down a framework to accelerate the deployment of renewable energy.

[81] Article 3 Council Regulation (EU) 2022/2577 of 22 December 2022 laying down a framework to accelerate the deployment of renewable energy.

[82] Article 4 Council Regulation (EU) 2022/2577 of 22 December 2022 laying down a framework to accelerate the deployment of renewable energy.

[83] Article 6 Council Regulation (EU) 2022/2577 of 22 December 2022 laying down a framework to accelerate the deployment of renewable energy.

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These measures enable a great simplification of the permitting procedure for photovoltaic projects, including Agri-PV systems. Especially small installations are well-served by this regulation which removes permitting bottlenecks.[84] However, the regulation remains temporary, which leads to uncertainty in the long run.

L. Green Finance initiatives

To promote private financing initiatives for sustainable development projects, the EU adopted several initiatives, including the Taxonomy Regulation.[85] This Regulation helps determine whether a business is environmentally sustainable or not. The qualification in the Taxonomy Regulation is relevant for the related Green Bond Standard and for fostering investment in sustainable projects. First, the qualification under the Taxonomy Regulation will be discussed. Afterwards, the Green Bonds Standard and Sustainable Project Investment will be elaborated on.

The Taxonomy Regulation designates businesses of a certain size as environmentally sustainable if they contribute significantly to one of the defined environmental objectives of the Regulation. These six objectives are climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and protection and restoration of biodiversity and ecosystems.[86] Additionally, the economic activity cannot significantly harm any other objectives.[87] There are also minimum social safeguards[88] and businesses are required to comply with performance thresholds.[89] It should be possible for agrivoltaics operators to qualify as environmentally sustainable businesses.

The qualifications from the Taxonomy Regulation are used for the EU Green Bonds Standard. This voluntary standard was adopted in the 2023 Green Bonds Regulation.[90] This Regulation entered into force in December 2024. The main goal of the Green Bonds Standard is to have a standardized green finance product benchmark available. This is based on alignment with the Taxonomy Regulation, robust reporting requirements and independent verification.[91] Once a financial product is labelled a Green Bond, the label will likely appeal to a large and growing segment of investors focused on sustainable

[84] Tomaiuolo, T. (2023, January 16). The Council Regulation (EU) 2022/2577: Accelerate the permitting procedure in view of intensifying the energy transition. *PwC TLS Blog*. https://blog.pwc-tls.it/en/2023/01/16/the-council-regulation-eu-2022-2577-accelerate-the-permitting-procedure-in-view-of-intensifying-the-energy-transition/.

[85] Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088.

[86] Article 3 (a) j. 9-16 Taxonomy Regulation.

[87] Article 3 (b) j. 17 Taxonomy Regulation.

[88] Article 18 Taxonomy Regulation.

[89] Article 3 (d) Taxonomy Regulation. The KPIs and TSCs have been implemented in two delegated acts, see Commission Delegated Regulation (EU) 2021/2178 of 6 July 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by specifying the content and presentation of information to be disclosed by undertakings subject to Articles 19a or 29a of Directive 2013/34/EU concerning environmentally sustainable economic activities, and specifying the methodology to comply with that disclosure obligation; and Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives.

[90] Regulation (EU) 2023/2631 of the European Parliament and of the Council of 22 November 2023 on European Green Bonds and optional disclosures for bonds marketed as environmentally sustainable and for sustainability-linked bonds.

[91] See article 29 Green Bonds Regulation.

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finance. This increases demand and can often lead to more favourable issuance terms.[92] It can also enhance credibility for green projects and proactively contribute to sustainability requirements.[93] Green Bonds can provide a relatively cheap form of capital for agrivoltaics installations, though only larger businesses will have access to this tool.

A third Green Finance initiative at the EU level that will be discussed here is the Sustainable Europe Investment Plan. This plan aims to mobilize EUR 1 trillion to support sustainable investments between 2021-2027.[94] These funds come in large part from the EU budget and secondarily from public and private investors. Through this large amount of spending on sustainable projects, the EU hopes to encourage private investment to follow.

All these Green Finance initiatives provide avenues for agrivoltaics projects to achieve their budgetary goals. For the development and implementation of agrivoltaics, multiple new avenues with a heavy cash-flow behind them are opening. Given the increasing scale at which agrivoltaics operate and the growing market value (see deliverable D7.2), it is key that these new financing possibilities are used intelligently.

M. Critical Raw Materials Act

On April 11th, 2024, the Critical Raw Materials Act ("CRM Act") was adopted.[95] This Act aims to ensure sustainable supply chains of critical metals. These metals are amongst others necessary for the green transition. The goal is to become less reliant on any single third country for critical materials. This way, the EU becomes more resilient to any single supply chain breaking.[96] Recent events have underlined EU strategic dependencies, like the dependency on Russian gas,[97] or the dependency on China for solar panel components (*supra*). As demand for aluminium, copper and nickel are expected to continuously rise for the next thirty years, strategic decisions to guarantee access to resources are needed. The CRM Act intends to make critical metals supply chains more resilient and sustainable.

Some of the key goals of the CRM Act are as follows:

- 10% of the EU annual consumption for critical raw materials should be *extracted* within the EU.
- 40% of the EU annual consumption for critical raw materials should be *processed* within the EU.
- 25% of the EU annual consumption of critical raw materials should stem from recycling happening within the EU.

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[92] Nykvist, A. M., Björn. (2024, April 23). What Can Green Bonds Achieve? *Network for Business Sustainability (NBS)*. https://nbs.net/what-can-green-bonds-achieve/.

[93] Driessen, M., & Groenendijk, N. (2024, January 8). Developments in green bonds: On 21 December 2024 the EU Green Bond Regulation starts to apply. *Stibbe*. https://www.stibbe.com/publications-and-insights/developments-in-green-bonds-on-21-december-2024-the-eu-green-bond.

[94] European Commission. (2020, January 14). *The European Green Deal Investment Plan and JTM explained*. https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_24.

[95] Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020.

[96] See Recital 12 CRM Act.

[97] European Commission. (n.d.). *Critical Raw Materials Act*. Retrieved October 30, 2024, from https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en.

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These non-binding goals should be achieved by 2030.[98] Additionally, not more than 65% of the EU annual consumption of critical raw materials can originate from any single third country.[99] To meet these benchmarks, the CRM Act contains several actions, especially relating to exploration of resources in Europe and circularity. Actions related to trade have also been announced.[100]

These measures will not directly impact the regulatory landscape of Agri-PVs. However, they have the potential to significantly affect the photovoltaic industry across Europe. As discussed under the CSDDD section of this deliverable, Europe imports nearly all of its photovoltaic elements, including critical materials, from China. More resilient and diverse supply chains could drive down prices of critical resources which are necessary for photovoltaics. However, more stringent regulation about the origin of products could also become an extra cost for manufacturers and lead to an overall increase in costs. Especially in a highly volatile market like that of critical raw minerals, it is difficult to predict what the exact impact of the CRM Act will be.[101]

N. Energy taxation

In 2021, the European Commission proposed a revision to the Energy Taxation Directive[102] as a part of the Fit for 55 Package, a package of different pieces of legislation aimed at meeting Europe's clean energy and climate goals.[103] The proposed revisions would base taxation based on the energy content and environmental performance of fuels. The Proposal states that electricity from renewable sources should always be taxed at the lowest rate of energy taxation. This is not a significant deviation from the 2003 Directive. Instead, taxes are raised for non-clean forms of energy. This could lead to increased market competitiveness for renewable forms of energy generation. The proposal for the recast Energy Taxation Directive is currently stalled due to political disagreements, and its future remains uncertain. It is unclear when, or if, it will progress.[104]

[98] See article 5 (1) (a) CRM Act.
[99] Article 5 (1) (b) CRM Act.
[100] European Commission. (n.d.). *Critical Raw Materials Act*. Retrieved October 30, 2024, from https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en; see also Findeisen, F. (2023, October 31). The Club Approach: Towards Successful EU Critical Raw Materials Diplomacy. *Jacques Delors Centre*. https://www.delorscentre.eu/en/publications/critical-raw-materials-club.
[101] Buysse, K., & Essers, D. (2023). Critical raw materials: From dependency to open strategic autonomy? *NBB Economic Review*, *13*. https://www.nbb.be/en/articles/critical-raw-materials-dependency-open-strategic-autonomy.
[102] Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity.
[103] Proposal for a COUNCIL DIRECTIVE Restructuring the Union Framework for the Taxation of Energy Products and Electricity (Recast) (2021). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0563.
[104] See Baert, P. (2024, October 20). *Revision of the energy taxation directive (ETD) | Legislative Train Schedule*. European Parliament. https://www.europarl.europa.eu/legislative-train/spotlight-JD22/file-revision-of-the-energy-taxation-directive; Packroff, J., & Kurmayer, N. J. (2023, May 20). *Energy Taxation Directive: Europe's key climate law stuck in a quagmire*. EurActiv. https://www.euractiv.com/section/energy-environment/news/energy-taxation-directive-europes-key-climate-law-stuck-in-a-quagmire/.

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Chapter 4 - Examination of Relevant National Legislation

This section will explore the regulatory landscape in Austria, France, Germany, Greece, Italy, and Israel concerning Agri-PV systems. The focus will be on identifying national legislation that may impact the integration of agrivoltaics.

This section provides an in-depth analysis of national legislation relevant to agrivoltaics, examining how different countries address key aspects critical to the sector's development. The goal is to highlight both the opportunities and challenges agrivoltaics faces within diverse legislative contexts. Understanding these national-level approaches is essential for identifying best practices and gaps. This can be used to foster a cohesive and effective policy environment for agrivoltaics across Europe. Permits and licenses for such projects are usually granted on a local level. Sometimes, the regional or national levels can get involved, depending on the size of the installations (PV size and plant size), the size of the land covered, and the location of the land.[105]

In this chapter, there is special attention for the following elements of national agrivoltaics legislation. These topics were chosen to give an overview of some of the most important challenges during the lifetime of agrivoltaics installations, from planning to operating.

- **General renewable energy framework:** Agrivoltaics introduce elements of solar power generation to agricultural land and activities. Therefore, it is necessary to see how photovoltaics are regulated in general, and whether or not there are provisions for Agri-PV systems specifically.
- **CAP support:** The extent to which farmers can make use of CAP support for the implementation of Agri-PV systems is an important support mechanism for Agri-PV development. Additionally, there is the crucial question whether or not a farmer can continue to receive CAP direct payments when they install photovoltaic elements on agricultural land.
- **Taxation:** Energy and agriculture are taxed in different ways. It is interesting to research the tax implications for Agri-PV operators and see whether or not there are tax benefits for agrivoltaics installations.
- **Permits and land use:** The farmer must obtain the approval of the relevant authorities with regards to the use of the land (in this case, building a greenhouse and installing solar panels on it). Zoning laws can also prevent the dual use of land and need to be considered when going through the permitting process. As such, they will also be analysed.
- **Financing and state aid:** There are diverse ways for governments to implement aid programs and support the construction of Agri-PV plants. In these financing schemes, there are multiple different approaches possible. The aim is to give an overview of different support schemes to evaluate what is effective.

These categories were all analysed for the selected EU Member States. For Israel, due a different legal context (namely not being an EU Member State and significantly different land use laws), a different approach was chosen, investigating the national conditions to install agrivoltaics.

[105] International Finance Corporation, *Utility-Scale Solar Photovoltaic Power Plants*, 1 January 2015, available at: https://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/2022-03/IFC_Solar_Report_Web__08_05.pdf.

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A. Austria

Austria aims at decarbonizing the energy sector by 2050, with an interim goal to cover 100% of Austria's electricity demand from renewable energy sources by 2030.[106] The photovoltaic sector as a whole has taken massive leaps in the past years.[107] However, due to a lack of legal frameworks and funding programs, Agri-PV is still only a marginal topic and therefore there is no empirical data concerning the impact on agricultural production, plant growth or the impact of other land uses.[108]

The Austrian legal situation currently does not regard PV on agricultural land as dual use, and regulations at the level of the individual federal states do not address Agri-PV in their PV development strategies, leading to Agri-PV only being able to be zoned with special dedications or in combination with grassland.[109] Most existing Agri-PV applications in Austria are therefore rather small-scale plants installed as part of research projects or by energy providers for demonstration purposes. The industry itself is only waking up to the possibilities of larger scale agrivoltaics plants in Austria.[110]

1. Renewable Energy Act

The Federal Act on the Expansion of Energy from Renewable Resources, also referred to as "EAG", regulates the requirements for the promotion of the generation of electricity from renewable sources. The EAG is the transposition of the EU Renewable Energy Directive in Austrian law. The EAG is enacted with the aim of achieving the goals of the Paris Climate Protection Agreement 2015; the goal of the EU to cover at least 32% of the gross final energy consumption of the Union with renewable energy by 2030; as well as achieving the climate neutrality goal in Austria by 2050.

The EAG takes note of Agri-PV installations. It defines "Agri-PV areas" as areas used simultaneously for electricity production using photovoltaics and for agricultural production.[111] This definition is relevant for the subsidy system implemented for photovoltaic installations.

In the EAG, there are two main ways of getting support for solar power projects: auctions and investment subsidies. Auctions are organized by EAG-Förderabwicklungsstelle.[112] This government agency offers a public tender for different types of renewable installations. After verification of the bids, the agency awards chosen projects with funding. Another way to achieve funding is through investment subsidies. These are for smaller plants, with a maximum capacity of 1000 kWp.[113] For these projects, the EAG-Förderabwicklungsstelle organizes at least two funding rounds per year. Most of the aid is granted on a first come first served basis.

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[106] Ressar, K., Muhar, A., & Schauppenlehner, T. (2021). Agrivoltaics in Austria: A stakeholder perspective on the opportunities and constraints of synergetic land use. *AIP Conference Proceedings*, *2361*(1), 020001. https://doi.org/10.1063/5.0054601.

[107] Kurmayer, N. J. (2024, January 8). *Austria boasts Europe's second-greenest power sector in 2023*. EurActiv. https://www.euractiv.com/section/politics/news/austria-boasts-europes-second-greenest-power-sector-in-2023/.

[108] Ressar, K., Muhar, A., & Schauppenlehner, T. (2021). Agrivoltaics in Austria: A stakeholder perspective on the opportunities and constraints of synergetic land use. *AIP Conference Proceedings*, *2361*(1), 020001. https://doi.org/10.1063/5.0054601.

[109] Fechner, H. (2020). Ermittlung des Flächenpotentials für den Photovoltaik-Ausbau in Österreich. *Oesterreichs Energie*, Vienna.

[110] Photovoltaic Austria. (2023). Photovoltaik-Nutzung in der Landwirtschaft – Einblick in die umfangreichen Möglichkeiten der nachhaltigen Sonnenstromproduktion im Agrarsektor. https://pvaustria.at/pvlandschaft/

[111] Section 5 (1) 2 EAG.

[112] Section 19 EAG.

[113] Section 56 (1) EAG.

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To prevent photovoltaic plants from taking over agricultural land, there is a 25% reduction of both auction benefits and investment aid for photovoltaic plants on areas which are considered agricultural or green.[114] However, this reduction is waived "partially or fully" for certain installations. This includes plants on Agri-PV areas which minimally interfere with the agricultural use of the land.

This definition is problematic because it is not precise and likely not effective. When it comes to accuracy, the law does not contain quantitative or qualitative standards for Agri-PV areas. Furthermore, there are no yield reduction standards for minimal interference. There are also doubts as to the efficacy of this measure. Operators of photovoltaics on agricultural land can still receive 75% of the subsidies, which can be significant amounts. This means that photovoltaics operators are potentially not effectively deterred from using agricultural land, which could lead to price speculation for agricultural land and have negative consequences for farmers.

2. Support schemes

In Austria, electricity from renewable sources is granted access to the grid according to the federal legislation on renewable energy and according to non-discriminatory principles.[115] Only the use of the grid by electricity from renewable energy sources is subject to a specific order. When grid capacity is insufficient, grid operators are obliged to give priority transmission to electricity from renewable sources.

Austria has a history of supporting the renewable energy sector through subsidies and feed-in tariffs.[116] In 2022, Austria decided to replace its feed-in tariffs with a market premium scheme. While older feed-in tariffs remain in place[117], new installations are in principle paid market rate prices, with an additional buffer granted by the government.[118] Current feed-in tariffs depend mainly on the type of generating facility. These schemes are paid out by OeMaG, the government agency responsible for the payment of green energy plans.

3. Tax Alleviations

When electricity is fed into the grid, the remuneration for this is qualified as a commercial source of income under Austrian tax law. This means it is subject to the income tax for individuals or the corporate tax for businesses. Individuals do enjoy a tax exemption for the first 12 500 kWh of energy fed into the grid each year, though this is not applicable to businesses. VAT is also applicable to the sale of electricity. There exists a separate transfer tax on each kWh for suppliers of electricity. In general, supplying energy produced by photovoltaic installations is not subject to this tax.[119]

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[114] Section 33 j. section 56 (8) EAG.
[115] Retter, K., Strahberger, H., & Engel, D. (2024). *Generating Electricity from Renewable Sources in the CEE & SEE - Austria*. Wolf Theiss.
[116] European Environment Agency. (2013). *Country Profile—Austria*. https://www.eea.europa.eu/publications/energy-support-measures/austria-country-profile.
[117] Retter, K., Strahberger, H., & Engel, D. (2024). *Generating Electricity from Renewable Sources in the CEE & SEE - Austria*. Wolf Theiss.
[118] Fechner, H. (2022). *National Survey Report of PV Power Applications in Austria*. International Energy Agency Photovoltaic Power Systems Programme. https://iea-pvps.org/wp-content/uploads/2023/12/2023_12_14_NSR-2022_Austria.pdf.
[119] Thorbauer, M., Hayden, T., Grassinger, C., Schachner-Gröhs, B., Statzinger, P., & Egger, S. (2023, February 1). *Photovoltaics: The green energy source. Austrian tax aspects to consider when implementing photovoltaic systems*. https://www.schoenherr.eu/content/photovoltaics-the-green-energy-source-austrian-tax-aspects-to-consider-when-implementing-photovoltaic-systems/.

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4. Permitting Procedures and Land Use Planning

In Austria, urban planning and zoning is a federated matter.[120] As such, each of the nine states has autonomy when deciding on what buildings require a building permit and the procedure for acquiring this permit. This fragmentation has made it so that there is no comprehensive permit for any form of renewable energy in Austria. Depending on the location and size, photovoltaic systems can require permits under the local acts on electricity, nature protection, building codes and trade.[121] Once a greenhouse has been built, there is no additional zoning permit required for Agri-PV installations in any state.[122] It is beyond the scope of this deliverable to give an in-depth explanation of all nine permitting procedures for the construction of greenhouses or renewable energy installations. However, there is a general lack of appropriate zoning types in the spatial planning acts of the federated states that could promote multiple uses of land for AV.[123] This results in an unsatisfactory legal framework that poses numerous legal problems for the implementation of Agri-PV in Austria. The differences in zoning legal frameworks also make it difficult to develop new approaches for achieving the national energy targets.

5. Direct Payments and Agricultural Land Utilization

The Austrian CAP Strategic Plan 2023-2027 states that areas under photovoltaic systems are not eligible for CAP support.[124] This severely limits the possibilities for Agri-PV systems in greenhouses in Austria. This policy choice was made to prevent ground-mounted photovoltaic systems from receiving agricultural support where there is no agricultural activity. While this is effective in achieving its deterring goal, the current wording limits all forms of inventive Agri-PV systems which achieve both objectives of Agri-PV, energy generation and sustainable agriculture. This will be extremely detrimental to the development of Agri-PV systems in Austria, as it requires farmers to take bigger risks and lose a potentially crucial source of income.

6. Analysis

Despite growth in the photovoltaic sector, Agri-PV in Austria remain underdeveloped due to regulatory gaps and limited financial incentives. The EAG acknowledges Agri-PV but lacks clear standards, making the eligibility criteria for subsidies uncertain and potentially ineffective in protecting agricultural land. Austria's support for renewable energy includes both grid priority for renewables and market-based premiums, yet newer Agri-PV installations still face financial and regulatory hurdles. Furthermore, since Agri-PV areas are categorically excluded from CAP payments, many farmers may find Agri-PV economically unviable. This policy landscape, combined with fragmented permitting laws across Austria's federal states, has hindered the development of Agri-PV, relegating it to small-scale

[120] Federal Government of Austria. (2024, January 1). *Baurecht und Bauordnungen*. oesterreich.gv.at - Österreichs digitales Amt. https://www.oesterreich.gv.at/themen/bauen_und_wohnen/bauen/Seite.2260200.html.
[121] ICLG. (2024, September 19). Renewable Energy Laws and Regulations Austria 2025. *International Comparative Legal Guides International Business Reports*. https://iclg.com/practice-areas/renewable-energy-laws-and-regulations/austria.
[122] Ressar, K., Muhar, A., & Schauppenlehner, T. (2021). Agrivoltaics in Austria: A stakeholder perspective on the opportunities and constraints of synergetic land use. *AIP Conference Proceedings*, *2361*(1), 020001. https://doi.org/10.1063/5.0054601.
[123] Damjanovic, D., & Wagner, D. (2022). Legal Barriers and Open Issues for an Effective Implementation of AV in Austria. *AgriVoltaics Conference Proceedings*, *1*. https://doi.org/10.52825/agripv.v1i.536.
[124] Gemeinsame Agrarpolitik Österreich. (2022). *CAP Strategic Plan Austria 2023-2027*. https://info.bml.gv.at/dam/jcr:ea385170-f6ef-437b-8865-782bd6257366/GAP_1_2.pdf.

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research projects rather than commercial application.[125] To advance Agri-PV, Austria would benefit from harmonized zoning laws, clearer definitions, and support frameworks that better align with the dual goals of sustainable agriculture and renewable energy production. This is made more difficult by the fact that some of these competences are at the federal level (like support for renewable energy), while zoning issues are governed by the federated states. This complicates cooperation.

The main issues faced for the development of Agri-PV in Austria are the following:

- **Legal Uncertainty:** The lack of a clear legal framework and restrictive CAP support policies significantly limit Agri-PV development, contributing to a landscape where only small-scale, experimental projects exist.
- **Subsidy Ambiguity**: Regulatory gaps around the criteria for Agri-PV financial support, create uncertainty for investors and may unintentionally incentivize the misuse of agricultural land for PV installations due to a lack of clear standards.
- **Permitting Fragmentation**: The fragmented permitting and land-use planning across Austria's federal states further complicate Agri-PV implementation, impeding progress toward Austria's national renewable energy targets.

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[125] Damjanovic, D., & Wagner, D. (2022). Legal Barriers and Open Issues for an Effective Implementation of AV in Austria. *AgriVoltaics Conference Proceedings*, *1*. https://doi.org/10.52825/agripv.v1i.536.

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B. France

France is integrating Agri-PV into its energy and agricultural landscapes. The policy framework is mostly centred around facilitating Agri-PV while ensuring agricultural activity does not suffer. France's general strategy on photovoltaics is ambitious, yet Agri-PV play a small role in the complete picture.[126] Recent acts by the executive branch of government during 2024 have clarified legal standards for Agri-PV and permitting procedures. This chapter provides an in-depth analysis of France's national laws and requirements concerning the deployment of agrivoltaics in agriculture, encompassing key legislative instruments and policies.

1. Law for the Acceleration of Renewable Energy Production

In 2023, the French legislator enacted the "Loi d'accélération de la production d'énergies renouvelables"[127] ("EnR"). This law implements a legal framework to achieve 40% energy production from renewable sources by 2030 in France, in order to meet the European goal to achieve climate-neutrality in 2050.[128] The contents of the EnR were included in the national Energy Code.

The EnR included provisions that photovoltaics were considered as renewable energy sources and provides a definition of agrivoltaics.[129] The law defines agrivoltaics as an installation for the production of electricity using solar power, where the modules are placed on agricultural land or they contribute to the installation, maintenance or development of agricultural production. It must fulfil at least one of the following purposes:

- Improvement of agricultural yields;
- Adaptation to climate change;
- Protection against hazards; or
- Animal well-being.

If the installation is actively hindering one or more of these goals, it cannot be legally qualified as an agrivoltaics installation. The definition also states that the installation must be reversible and must allow for agricultural activity to remain the principal activity on the land. This definition does not exclude animal farming and herding from the definition of agrivoltaics.

The legislator chose to leave further definitions to the executive power. Accordingly, the French government issued a Décret in April 2024 about the definition and framework for agrivoltaics specifically.[130] This Décret states that the reduction in agricultural yields can amount to maximum 10 percent of the yields on a control plot of land with similar conditions (farmland used for livestock excluded). The Décret also holds that the area of land covered by solar panels must not exceed 40%, except for projects that have "already proven their worth".[131] This amounts to a designation by the French government that certain forms of agrivoltaics are effective in achieving both agricultural yields and clean energy. To receive this designation, evidence-based studies will be crucial. This is especially important for Agri-PV in greenhouses, where a large percentage of the surface area can be covered with

[126] Agence de la Transition Ecologique. (2024). *National Survey Report of PV Power Applications in France 2023*. https://iea-pvps.org/national_survey/national-survey-report-of-pv-power-applications-in-france-2023/.
[127] France, LOI n° 2023-175 du 10 mars 2023 relative à l'accélération de la production d'énergies renouvelables.
[128] Ministère de l'environnement, de l'énergie et de la mer. (2023). *Programmation pluriannuelle de l'énergie: Synthèse*. https://www.ecologie.gouv.fr/sites/default/files/documents/Synthèse.pdf.
[129] Now included in article L. 314-36 Energy Code.
[130] France, Décret n° 2024-318 du 8 avril 2024 relatif au développement de l'agrivoltaïsme et aux conditions d'implantation des installations photovoltaïques sur des terrains agricoles, naturels ou forestiers
[131] Art. R. 314-115 Energy Code.

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photovoltaics. Finally, the Décret states the income from agricultural production must not be lower than the average income before the installation of agrivoltaics.

The contents of the Décret can largely be traced to several rulings by the French Conseil d'Etat (Supreme Administrative Court). This is a judicial body tasked with settling administrative procedures, like permits. In two different cases, the Conseil d'Etat accepted the coexistence of agriculture and photovoltaics, if there is a real agricultural project.[132]

The French regulatory framework is focused on maintaining food security and agricultural income for farmers. The criteria can be quite strict for Agri-PV projects which do not enhance the agricultural yields. These projects will have difficulties meeting the criteria of at least the same income from agricultural products.

Additionally, there are certain gaps in the framework. One important aspect not governed by law is the sharing of the value of energy production between the landowner, the farmer who farms on the land and the Agri-PV operator. In scenarios where these three are different parties, an indication on how value sharing could occur would be beneficial.[133]

2. CAP support

The main advantage of the definition of agrivoltaics in the EnR and Décret relates to CAP support. When an Agri-PV installation meets the criteria of the definition, the farmer remains eligible for CAP direct payments under French law. [134]

Under CAP, direct payments are made to active farmers who meet European standards. However, the definition of an active farmer is up to individual Member States. In France, the definition of an active farmer consists out of two parts: "active" and "farmer", each with their specific meaning. A farmer is a natural or legal person with a farm located in France and engaged in agricultural activity. Agricultural activity refers to the production, breeding or cultivation of agricultural products, including the harvesting, milking, rearing and keeping of animals for agricultural purposes, and/or the maintenance of agricultural land in a condition suitable for grazing or cultivation.[135] Active refers to a person who is not making use of their pension and has the compulsory workplace accident insurance for farmers with ATEXA, the social security organization for farmers.[136]

These definitions were amended under French law to facilitate other activities that were not exclusively agricultural in nature. This means that under current French law, dual use of agricultural land is possible without losing CAP support.

[132] Conseil d'Etat (France), 03/10/2016, 390716; Conseil d'Etat (France), 12/7/2019, 422542.
[133] Connaissance des Energies. (2024, September 13). *Agrivoltaïsme en France: Définition, décret de 2024, rentabilité*. https://www.connaissancedesenergies.org/questions-et-reponses-energies/agrivoltaisme-en-france-de-quoi-sagit-il-et-que-change-le-decret-davril-2024.
[134] Ministère de l'Agriculture et de la Souveraineté alimentaire. (2023). Arrêté du 21 mai 2024 modifiant l'arrêté du 23 juin 2023 relatif aux définitions transversales relatives à l'activité et aux surfaces agricoles, à partir de la campagne 2023 dans le cadre de la politique agricole commune.
[135] Ministère de l'Agriculture et de la Souveraineté Alimentaire. (2024). *Le caractère agriculteur "actif" pour la campagne 2024*. https://www.telepac.agriculture.gouv.fr/telepac/pdf/tde/2024/Exploitation_notice_eligibilite_demandeur_metropole.pdf.
[136] Id.

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3. Tax and price support

Consumers benefit from a beneficial tax scheme for the installation of solar panels, like a lowered VAT and no income tax on photovoltaic energy revenue.[137] However, this is not the case for businesses.

There is also a buyback scheme. The French state will buy energy from solar panels at a fixed rate, thus guaranteeing a minimum price for operators of photovoltaic installation. This buyback obligation only exists for smaller installations of up to 500 kilowatts situated on the mainland of France and for 20 years after installation.[138]

4. Permits and land use

Two different permits are needed for a greenhouse to be built and an Agri-PV installation to be mounted onto it. The first relates to the construction of the greenhouse itself. A separate permit procedure exists for the Agri-PV installation.

a) Greenhouse building permit and zoning

For the greenhouse, a building permit is needed if the construction is taller than 4 meters or has a surface area of more than 2000 m^2. For a greenhouse with a height between 1m80 and 4 meters and a surface area less than 2000 m^2, a prior declaration with the municipality suffices. Finally, for a greenhouse lower than 1m80, no declaration or permit is required.[139]

Under the French Zoning Code, it is principally prohibited to build on agricultural land.[140] New constructions are only authorized in the urbanized zone of a municipality. However, there are exceptions to this. If a building is necessary for agricultural exploitation or for collective equipment, it can be constructed if it is compatible with the exercise of agricultural activity on the plot of land where they are located.[141]

The French Conseil d'Etat, the country's highest administrative court, issued a ruling on the zoning of Agri-PV in greenhouses specifically. The Conseil d'Etat held that Agri-PV mounted on the roof of a greenhouse used for agricultural activity did not detract from the agricultural character of the greenhouse.[142] Thus, this type of Agri-PV was allowed under zoning laws, even years before the French legislator decided to clarify what agrivoltaics were.

b) Agri-PV permit

The permit procedure for Agri-PV largely involves the prefect. This is a governmental body who coordinates energy projects with regards to their permits and can involve different municipalities. They have specific competence in the permit procedure for Agri-PV installations.[143] Once an application has

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[137] Ministère de l'Economie, des Finances et de l"Industrie et Ministère chargé du Budget et des Comptes publics. (2023, August 23). *Installation de panneaux solaires: Vous avez droit à des aides !* https://www.economie.gouv.fr/particuliers/aides-installation-photovoltaiques.

[138] France, (6 October 2021), *Arrêté fixant les conditions d'achat de l'électricité produite par les installations implantées sur bâtiment, hangar ou ombrière utilisant l'énergie solaire photovoltaïque, d'une puissance crête installée inférieure ou égale à 500 kilowatts telles que visées au 3° de l'article D. 314-15 du code de l'énergie et situées en métropole continentale.*

[139] Service Public. (n.d.). *Faut-il une autorisation d'urbanisme pour installer une serre ?* Retrieved October 22, 2024, from https://www.service-public.fr/particuliers/vosdroits/F36780.

[140] Article L 111-3 French Zoning Code.

[141] Article L 111-4 2° French Zoning Code.

[142] Conseil d'Etat (France), 03/10/2016, 390716.

[143] Article R. 422-2 French Zoning Code.

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been filed with the prefect, they inform the mayor and president of the intercommunal cooperation establishment. This indicates both a zoning component and a grid connection.[144]

The application file must include the following elements:[145]

- Proof that the Agri-PV installation is compatible with agricultural activity;
- Proof that installation of greenhouse is necessary for an agricultural activity;
- Physical description of the land used;
- Technical note that the legal definition of agrivoltaics is met;
- Technical note that agricultural production is the main activity on agricultural land;
- Technical note that there is significant agricultural production and that this creates a sustainable source of income for the farmer;
- If required, a description of the control zone;
- An attestation that the farmer is an active farmer in the sense of R. 314-109 Energy Code.

Once the application is complete, it has to be approved by CDPENAF (La Commission départementale de préservation des espaces naturels, agricoles et forestiers). If they do not respond within 2 months on an agrivoltaics file, the answer is assumed to be favourable.[146]

5. Financing

There are two main possibilities to fund Agri-PV in France. Firstly, small-scale innovation projects can rely on the governmental Commission of Energy Regulation (CRE).[147] The second option is private financing. As CRE funding is limited, leading many projects to have to rely on private financing.

The CRE can organize calls for tenders for renewable energy projects. These are exclusively for small installations with an innovative character and a maximum unit power 3 MWp.[148] Once these tenders are granted, the French state commits to buying the produced energy.[149] This buyback obligation ensures that the operators of the agrivoltaics systems will receive a baseline compensation. However, as the tenders are limited in scope and in number, they do not form a structural solution for agrivoltaics financing in France.

When using private financing, the guarantees granted by the CRE do not exist. Private partners do not have the same buyback obligation. A power purchase agreement can be negotiated between parties. However, currently, few power purchase agreements are implemented in France, as only large businesses who are financially extremely stable have been able to buy in so far.[150] One possible avenue are the "Sofergies" (Société de Financement des Économies d'Énergie).[151] These are financial companies that provide debt financing or leasing options for energy efficiency and renewable energy

[144] Article L. 314-39 French Energy Code.
[145] Gossement, A., Ferjoux, F., Vagne, C., & Barré, S. (2024, April 9). Solaire: Le point complet sur le cadre juridique de l'agrivoltaïsme à la suite de la publication du décret du 8 avril 2024 relatif aux installations agrivoltaïques et aux installations agricompatibles. *Cabinet Gossement Avocats*. https://blog.gossement-avocats.com/blog/environnement/agrivoltaisme-1.
[146] Article R. 423-70-2 French Zoning Code.
[147] Agence de la Transition Ecologique. (2024). National Survey Report of PV Power Applications in France 2023. https://iea-pvps.org/national_survey/national-survey-report-of-pv-power-applications-in-france-2023/.
[148] Fraunhofer ISE (Director). (2023, January 12). *Workshop on legal aspects of agrivoltaics in Israel, France and Germany* [Video recording]. https://www.youtube.com/watch?v=Znd9CgANPlE.
[149] Article L. 314-1 and following Energy Code.
[150] Agence de la Transition Ecologique. (2024). *National Survey Report of PV Power Applications in France 2023*. https://iea-pvps.org/national_survey/national-survey-report-of-pv-power-applications-in-france-2023/.
[151] Direction Générale des Finances Publiques (1995). *SOCIÉTÉS AGRÉÉES POUR LE FINANCEMENT DES ÉCONOMIES D'ÉNERGIE (SOFERGIE)*.

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projects by municipalities, social housing organization, commercial companies and agricultural companies. Due to their unique status, they can propose non-market rate financing solutions to projects.

This financing usually happens from the perspective of a project developer for Agri-PV who then negotiates a contract with the farmer for the partial use of their agricultural land.[152] This can happen in short-term leases or longer-term leases (up to 99 years in emphyteutic leases). Farmers can also self-finance or work in a collective to find the necessary funds. There are concerns present that the additional value generated by Agri-PV will increase lease prices for all farmers.[153]

6. Analysis

The current state of Agri-PV in France reflects a framework that aims to balance renewable energy expansion with the protection of agricultural interests. With strict requirements on maintaining agricultural yields and income, alongside a need for better-defined revenue-sharing models and financing options, France has set a high standard that emphasizes sustainability and farmer welfare. However, this ambitious approach introduces challenges, from regulatory and financial complexities to potential increases in land costs. These conclusions highlight both the strengths and areas for improvement in France's Agri-PV strategy, underscoring the importance of innovation and collaboration in advancing dual-purpose land use.

- **Balancing Energy and Agriculture**: The French approach to Agri-PV demonstrates a clear intent to balance renewable energy development with agricultural productivity. By mandating that agricultural activity remains the primary land use and proposing high yield standards, France prioritizes food security and income stability for farmers, which may serve as a model for other countries interested in dual-use land policies.
- **Limited Financing and Structural Challenges**: CRE funding is only available for small-scale, innovative projects, limiting state-supported financial options and forcing many projects to rely on private financing. This constraint could hinder scalability, especially for smaller farms that lack the capital or collateral to attract private investors. The scarcity of power purchase agreements adds to the financial uncertainty.
- **Zoning and Permitting Complexities**: The two-tiered permit process for Agri-PV installations and greenhouse construction, coupled with stringent zoning regulations, adds administrative burdens that may delay projects. While the Conseil d'Etat has offered some leeway by approving Agri-PV on greenhouses in agricultural zones, simplifying these regulatory steps could further encourage project development.
- **Innovation Potential within Constraints**: Despite the hurdles, France's approach opens a unique space for innovative Agri-PV solutions, especially with state support for small-scale projects. This could drive niche innovations, particularly in areas such as climate-resilient greenhouse systems or animal-friendly shading structures, advancing sustainable agricultural practices alongside renewable energy.

[152] Fraunhofer ISE (Director). (2023, January 12). *Workshop on legal aspects of agrivoltaics in Israel, France and Germany* [Video recording]. https://www.youtube.com/watch?v=Znd9CgANPlE.
[153] Fraunhofer ISE (Director). (2023, January 12). *Workshop on legal aspects of agrivoltaics in Israel, France and Germany* [Video recording]. https://www.youtube.com/watch?v=Znd9CgANPlE.

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C. Germany

Germany is integrating Agri-PV into its energy and agricultural landscapes, guided by a policy framework that reflects its commitment to sustainable development and renewable energy.[154] As energy policy objectives are pursued, the utilization of ground-mounted PV systems continues to rise, however, this upward trend presents a challenge in meeting the target of limiting surface sealing to below 30 hectares per day by 2030[155]. In this context, agrivoltaics emerges as a viable solution to reconcile these conflicting interests. Furthermore, Germany has recently taken a significant step towards standardizing Agri-PV systems with the introduction of DIN SPEC 91434:2021-05 by the German Institute for Standardization in May 2021. This chapter provides an in-depth analysis of Germany's national laws and requirements concerning the deployment of agrivoltaics in agriculture, encompassing key legislative instruments and policies.

1. Renewable Energy Act (EEG) and Agrivoltaics

The Renewable Energy Sources Act (EEG), known in German as *Erneuerbare-Energien-Gesetz*, comprises a set of legislative measures initially designed to incentivize the generation of renewable electricity through a feed-in tariff program.[156] It serves as a cornerstone in the energy transition, with provisions encompassing agrivoltaic systems since 2023.[157] Under the EEG, agrivoltaic installations enjoy privileged grid connection, preferential purchase of electricity, and access to feed-in tariffs.[158] Notably, agrivoltaic systems are eligible for tenders, benefiting from a larger area allocation compared to standard ground-mounted systems. Additional incentives, such as premiums for overhead systems, further incentivize the adoption of agrivoltaics within the renewable energy framework. In 2021, Agri-PV gained recognition under German legislation through the revision of the EEG. It was included in a joint tender along with floating PV and PV for parking roofs. The EEG now identifies specific categories for Agri-PV systems, including arable Agri-PV, horticulture Agri-PV, and grassland Agri-PV[159]. Compliance with DIN SPEC 91434 is mandated for participation in these tenders, underscoring its importance in the regulatory framework. [160]

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[154] Trommsdorff, M., & Vollprecht, J. (2023). Current legal framework for agrivoltaics in Germany. *Pv-Tech*, 21; Vollprecht, J., Trommsdorff, M., & Kather, N. (2022). *Legal framework of agrivoltaics in Germany*. AgriVoltaics Conference 2021. https://doi.org/10.1063/5.0103335; Trommsdorff, M. (Director). (2022, December 14). *Workshop on legal aspects of agrivoltaics in Israel, France and Germany* [Video recording]. https://www.youtube.com/watch?v=Znd9CgANPlE.

[155] Deutsche Bundesregierung, (2018). Deutsche Nachhaltigkeitsstrategie, Presse- und Informationsamt der Bundesregierung, Berlin.

[156] Erneuerbare-Energien-Gesetz, 26 May 2023, BGBl. 2023 I Nr. 133.

[157] Before 2023, agrivoltaics were not explicitly listed within the EEG 2021, but they fell under the broader category of renewable energy systems as per § 3(1) EEG, enjoying certain privileges and entitlements outlined within the legislative framework.

[158] Vollprecht, J., & Trommsdorff, M. (2024). New Legal Framework of Agrivoltaics in Germany. *AgriVoltaics Conference Proceedings*, *2*. https://doi.org/10.52825/agripv.v2i.1071.

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

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

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a) Priority Grid Connection and Purchase of Electricity

Operators of agrivoltaic systems benefit from priority grid connection, as mandated by § 8(1) EEG[161]. This provision ensures that grid operators prioritize the connection of agrivoltaic systems, considering the option with the lowest total economic costs. Additionally, according to § 11(1) EEG, operators are entitled to prioritize the sale of generated electricity, with the flexibility to utilize or supply electricity directly, if feasible, before feeding it into the grid.

b) Payment Entitlement and Market Mechanisms

The entitlement to payment for electricity supplied to the grid involves complex considerations outlined in § 20 EEG and subsequent provisions. System operators typically receive payments for a duration of 20 years, with extensions available for systems under certain conditions. For larger systems exceeding 100 kW, participation in tenders or subsidized direct marketing is mandatory, ensuring fair market participation and efficient utilization of renewable energy resources.

c) Location-specific Requirements and Eligibility Criteria

There are specific location requirements outlined within the EEG, with eligibility criteria varying depending on factors such as land use, zoning regulations, and participation in tenders. For instance, installations on buildings or structures primarily used for non-energy purposes may qualify for financial support under § 48(1) EEG[162], emphasizing the concept of dual use. For Agri-PV in greenhouses, it is crucial for this financial support that the initial function retains the focus. Thus, if there are plants present that do not require a greenhouse, the greenhouse would lose its original function and is not eligible for financial support.[163] Similarly, installations on arable land or grassland in designated areas may be eligible for support, when they are dual use and subject to compliance with regional regulations and development plans.

The EEG has tried to prevent the deterioration of arable land by only allowing project tenders to be funded on impervious surfaces, in conversion areas, along highways or railroad tracks, or on constrained land.[164] Nevertheless, large photovoltaic plants are being constructed outside these areas, and on arable land, due to the lower levelized cost of operations of ground-mounted photovoltaic plants compared to more intricate agrivoltaics installations.[165] As a result, the EEG's steering effect which aims to protect high-quality agricultural land appears to have been weakened. With growing land demand, there is a potential for increased competition between agriculture and energy production, potentially leading to economic, ecological, and social conflicts.

d) Innovation Auctions and Special Solar Systems

Innovation auctions present an opportunity for agrivoltaic installations to participate in competitive bidding processes, fostering technological innovation and integration with other renewable energy systems. As outlined in § 16(1) and § 17(2) of the Innovation Auction Regulation (InnAusV)[166], agrivoltaic systems combined with other renewable energy or storage systems can bid for project allocations within specified capacity limits. The regulatory framework aims to promote the deployment

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[161] § 8 EEG 2023.
[162] § 48 EEG 2023.
[163] Vollprecht, J., & Trommsdorff, M. (2024). New Legal Framework of Agrivoltaics in Germany. *AgriVoltaics Conference Proceedings*, *2*. https://doi.org/10.52825/agripv.v2i.1071.
[164] Trommsdorff, M., Gruber, S., Keinath, T., Hopf, M., Hermann, C., & Schönberger, F. (2024). *Agrivoltaics: Opportunities for Agriculture and the Energy Transition* (p. 80). Frauenhofer Institute for Solar Energy Systems ISE. https://www.ise.fraunhofer.de/en/publications/studies/agrivoltaics-opportunities-for-agriculture-and-the-energy-transition.html.
[165] Id.
[166] Innovationsausschreibungsverordnung vom 20. Januar 2020 (BGBl. I S. 106), die zuletzt durch Artikel 8 des Gesetzes vom 20. Dezember 2022 (BGBl. I S. 2512) geändert worden ist.

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of special solar systems, including agrivoltaics, while ensuring compatibility with broader energy transition objectives.

2. Tax Alleviations and Property Status

To address concerns regarding the tax implications of agrivoltaic installations, Germany introduced measures to maintain the agricultural and forestry property status of land hosting agrivoltaic systems. With a decree outlined in the Federal Tax Gazette, agrivoltaic systems of specified categories retain their preferential tax treatment, safeguarding the financial interests of landowners and promoting the sustainable utilization of agricultural land for renewable energy generation.[167]

3. Permitting Procedures and Land Use Planning

While agrivoltaic systems typically fall under the category of ground-mounted photovoltaic systems, the permitting process varies depending on location and land use regulations. Privileged projects, as outlined in the Federal Building Code (BauGB)[168] enjoy expedited permitting procedures, with considerations for public interests and zoning regulations. Moreover, recent amendments have extended certain privileges to agrivoltaic systems[169], particularly along transportation corridors, reflecting ongoing efforts to streamline regulatory processes and promote sustainable land use practices.

The granting of a building permit for agrivoltaic projects is contingent upon various factors, including the location of the land. If the land falls within an area governed by a development plan, compliance with the plan's stipulations is mandatory. Conversely, on land not subject to such plans, permissibility hinges on whether the project is within or outside an urban area. In most cases, agrivoltaic systems are erected on land situated outside urban areas and lacking coverage under a development plan. Within this context, the BauGB makes a difference between privileged and non-privileged projects. Privileged projects, as defined in § 35(1) BauGB[170], are subject to fewer restrictions, with prohibitions arising only in instances of conflict with public interests. Conversely, projects falling under § 35(2) BauGB face more stringent scrutiny, with considerations for potential impacts on public interests outlined in § 35(3) BauGB.

While agrivoltaic systems are not explicitly designated as privileged projects, certain criteria must be met to qualify for such status. According to the Federal Administrative Court (BVerwG), a project must serve an agricultural operation in a manner consistent with prevailing landscape protection imperatives[171]. Notably, systems supplying energy for on-site agricultural buildings are expected to prioritize their own consumption over grid sales. Recent amendments effective since January 2023 have privileged ground-mounted PV systems within specified zones along highways and double-track

[167] Trommsdorff, M., & Vollprecht, J. (2023). Current legal framework for agrivoltaics in Germany. *Pv-Tech*, 21.
[168] Baugesetzbuch In der Fassung der Bekanntmachung vom 23.09.2004 (BGBl. I S. 2414) zuletzt geändert durch Gesetz vom 20.12.2023 (BGBl. I S. 394) m.W.v. 01.01.2024.
[169] Trommsdorff, M., & Vollprecht, J. (2023). Current legal framework for agrivoltaics in Germany. *Pv-Tech*, 21.https://solar-media.s3.amazonaws.com/assets/Pubs/PVTP_34/Current_legal_framework_for_agrivoltaics_in_Germany.pdf.
[170] § 35 BauGB.
[171] Federal Administrative Court, verdict of 3 November 1972, file no. 4 C 9.70. ("a project fulfils this requirement when a reasonable farmer would implement this project with about the same intended purpose, about the same design and configuration and under consideration of the imperative to protect landscapes to the greatest possible extent. Furthermore, the project has to belong to a concrete operation" Vollprecht, J., Trommsdorff, M., & Kather, N. (2022). Legal framework of agrivoltaics in Germany. *AIP Conference Proceedings*, *2635*(1), 050004. https://doi.org/10.1063/5.0103335.

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railroad lines.[172] Because of its privileged status under BauGB, Agri-PV outside urban areas can only be prohibited where they conflict with public interests.

The definition of "agriculture" as outlined in BauGB extends to horticultural production, encompassing operations utilizing greenhouses or cultivating plants[173]. projects falling under § 35(2) BauGB face more stringent scrutiny, with considerations for potential impacts on public interests outlined in § 35(3) BauGB. If agrivoltaic projects face restrictions under § 35 BauGB, stakeholders may explore the option of preparing a development plan, potentially involving partial amendments to zoning maps.

During the development plan process, local authorities are guided by provisions in § 9 BauGB and the Federal Land Utilization Ordinance (BauNVO) [174], limiting the designation of areas to prescribed categories. Expansion of the existing categories or establishment of a specialized "agrivoltaics area" may facilitate integration within development plans. Alternatively, project-specific development plans afford municipalities flexibility in permitting without strict adherence to standard zoning regulations.

When designating areas for agrivoltaic use, the combined agricultural and energy purposes of the land must be considered. Consequently, areas designated for agrivoltaics should be categorized as "supply areas," encompassing facilities for decentralized and centralized generation, distribution, and storage of renewable energy, in accordance with § 9(1) no. 12 BauGB, and as "areas for agriculture," as outlined in § 9(1) no. 20 BauGB.

Alternatively, municipalities may consider extending the existing categories in § 9 BauGB to include a specialized designation for agrivoltaics, facilitating their integration into development plans. Additionally, the adoption of project-specific development plans offers municipalities flexibility in permitting, bypassing the constraints of standard zoning regulations.

Finally, community engagement and stakeholder consultation are integral throughout the permitting process. Early involvement of all relevant parties fosters a conducive environment for project approval and promotes positive reception within the community.

4. DIN SPEC 91434

Germany's permit procedures for agrivoltaic installations have evolved in response to emerging technologies that combine agricultural and solar energy production. DIN SPEC 91434 is a pre-standard that has been introduced in April 2021.[175] This specification sets forth clear criteria for Agri-PV systems to ensure their primary agricultural use. Notably, it stipulates that the agricultural yield post-installation must amount to at least 66% of the reference yield, thereby safeguarding the productivity of agricultural land. Furthermore, restrictions on land loss post-installation, checks on light and water availability, and adherence to agricultural practices are foreseen to maintain agricultural viability along renewable energy generation. Furthermore, the Fraunhofer Institute for Solar Energy has published comprehensive guidelines covering agricultural, technological, and economic aspects of Agri-PV projects in Germany.

[172] Trommsdorff, M., & Vollprecht, J. (2023). Current legal framework for agrivoltaics in Germany. *Pv-Tech*, 21.
[173] Vollprecht, J., Trommsdorff, M., & Kather, N. (2022). Legal framework of agrivoltaics in Germany. *AIP Conference Proceedings*, *2635*(1), 050004. https://doi.org/10.1063/5.0103335.
[174] Baunutzungsverordnung in der Fassung der Bekanntmachung vom 21. November 2017 (BGBl. I S. 3786), die zuletzt durch Artikel 2 des Gesetzes vom 3. Juli 2023 (BGBl. 2023 I Nr. 176) geändert worden ist.https://www.gesetze-im-internet.de/baunvo/.
[175] *DIN SPEC 91434:2021-05, Agri-Photovoltaik-Anlagen_- Anforderungen an die landwirtschaftliche Hauptnutzung*. (n.d.). DIN Media GmbH. https://doi.org/10.31030/3257526.

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These guidelines delve into parameters ranging from crop selection to PV module technologies, and they analyse economic factors.[176]

5. CAP Direct Payments and Agricultural Land Utilization

In the context of EU agricultural policy, direct payments are instrumental in supporting farmers who utilize their land primarily for agricultural purposes. However, concerns often arise among farmers regarding the eligibility of farmland for financial support when integrating agrivoltaics into agricultural practices. The issue of direct payments for land used in agrivoltaic installations has been a subject of debate, influencing the pace of development in Germany.

Since 2023, § 12(5) of the German CAP Direct Payments Regulation (GAPDZV)[177] has clarified the eligibility criteria for receiving direct payments on land hosting agrivoltaic systems. Land used for agrivoltaic installations becomes eligible for direct payments if certain conditions are met. Firstly, the facility must not preclude the cultivation of the area using standard agricultural methods, machinery, and equipment. Secondly, the facility must limit the reduction of agriculturally usable land to a maximum of 15% based on the criteria outlined in DIN SPEC. Meeting these requirements ensures that 85% of the area remains eligible for direct payments.[178]

The EEG also provides various benefits to renewable energy systems, including privileged grid connection, preferential electricity purchase, and regulation of feed-in tariffs. Agrivoltaic systems stand to benefit from these provisions, similar to other renewable energy installations. Notably, eligible agrivoltaic systems enjoy access to a larger area allocation for tenders compared to standard ground-mounted systems, which are typically excluded from agricultural land usage. Moreover, overhead systems, as classified under category I of DIN SPEC, receive additional incentives, such as a premium of 1.2 EUR cents per kWh in 2023 during periods of surcharge[179]. Subsequent years witness a gradual reduction in this premium, contingent upon the timing and extent of the surcharge.

6. Analysis

Germany's integration of agrivoltaics into its energy and agricultural landscapes is aligned with its sustainable development and renewable energy objectives. As Germany progresses towards its energy policy goals, the proliferation of ground-mounted PV systems poses challenges in aligning with targets to limit surface sealing to below 30 hectares per day by 2030. In this context, agrivoltaics emerges as a promising solution to reconcile these conflicting interests, offering a harmonious blend of agricultural productivity and renewable energy generation. However, despite progress, agrivoltaic systems face specific challenges within the legal framework. These challenges are outlined below, referring to relevant articles and percentages where applicable:

- **Room for Improvement of DIN SPEC standard:** While the current DIN SPEC addresses various aspects of Agri-PV, including arable and horticultural land, it may not suit grassland use, especially when it involves biodiversity management. Therefore, there's a need for criteria focusing on species and biotope protection. Additionally, plans are underway to develop a

[176] Trommsdorff, M. et al. (2024). *Agrivoltaics: Opportunities for Agriculture and the Energy Transition* (p. 80). Frauenhofer Institute for Solar Energy Systems ISE. https://www.ise.fraunhofer.de/en/publications/studies/agrivoltaics-opportunities-for-agriculture-and-the-energy-transition.html.
[177] GAP-Direktzahlungen-Verordnung vom 24. Januar 2022 (BGBl. I S. 139, 2287), die zuletzt durch Artikel 1 der Verordnung vom 4. Dezember 2023 (BGBl. 2023 I Nr. 343) geändert worden ist.
[178] § 12 GAPDZV.
[179] Trommsdorff, M., & Vollprecht, J. (2023). Current legal framework for agrivoltaics in Germany. *Pv-Tech*, 21.

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dedicated standard for Agri-PV systems incorporating animal husbandry, reflecting the evolving nature of agricultural practices and sustainability requirements.[180]

- **Permit Challenges:** Agrivoltaic projects often face difficulties in obtaining permits, particularly when located outside urban areas lacking specific development plans. Classification issues exacerbate these challenges. According to § 35(1) BauGB, privileged projects may proceed if they do not conflict with public interests. However, projects outside urban areas are generally prohibited under § 35(2) BauGB, unless they meet stringent criteria outlined in § 35(3) BauGB. While some Agri-PV projects are privileged, not all of them are. This poses an obstacle to agrivoltaic deployment, with potentially severe consequences for project timelines and viability.
- **Land Use Conflicts:** In areas governed by development plans, agrivoltaic installations may conflict with prescribed land use regulations. § 35(1) BauGB permits privileged projects, but conflicts may arise if the proposed land use contradicts existing zoning designations.
- **Payment Eligibility:** Agrivoltaic systems erected on agricultural land may not qualify for payments under the EEG, raising concerns about their economic viability. According to § 12(5) of the German CAP Direct Payments Regulation (GAPDZV), land used for agrivoltaic installations must adhere to specific criteria to remain eligible for direct payments. However, uncertainties persist regarding the impact of agrivoltaics on land eligibility for EEG subsidies, complicating the financial landscape for agrivoltaic projects.
- **EU Direct Payments:** The eligibility of agrivoltaic-affected land for EU subsidies remains uncertain, contributing to delays in project development. Despite the clarification provided by § 12(5) of the GAPDZV, uncertainties persist regarding the compatibility of agrivoltaic installations with EU subsidy criteria. This uncertainty undermines investor confidence and delays the realization of agrivoltaic projects.

However, it is significant to also outline the EEG Advantages for agrivoltaics:

- **Grid Connection and Electricity Purchase:** Agrivoltaic systems benefit from privileged grid connections and electricity purchases under the EEG. According to § 8(1) EEG, operators of agrivoltaic systems are entitled to priority grid connection. Additionally, § 11(1) EEG permits operators to prioritize the sale of generated electricity.
- **Feed-in Tariff Access:** Unlike standard ground-mounted systems, eligible agrivoltaic systems have broader access to tenders for feed-in tariffs. § 48(1) EEG outlines financial support for installations on buildings or structures primarily used for non-energy purposes, emphasizing the concept of dual use. This expanded access enhances the economic viability of agrivoltaic projects and promotes their widespread adoption.
- **Overhead Systems Premium:** Category I agrivoltaic systems, including overhead systems, receive a premium of 1.2 euro cents per kWh in case of surcharges in 2023, as stipulated by the EEG.

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

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D. Greece

In the recent years, Greece is showing a steadily increasing commitment to the use of renewable energy sources. According to official data issued by the Greek Independent Power Transmission Operator (IPTO), 57% of the energy mix in Greece during 2023 was covered by photovoltaics, wind, and hydroelectric power.[181] Greece ranks 28th worldwide in the 2024 Climate Change Performance Index.[182]

Greece has introduced notable changes in its Renewable Energy Sources (RES) regulatory framework, aiming at setting a clearer landscape as regards the authorities responsible for regulation, monitoring and licensing, the simplification of licensing procedures and the financing of RES projects through state aid[183]. Crucial in this aspect is the adoption of the National Energy and Climate Plan (NECP) for the period 2021-2030 that establishes energy efficiency measures to achieve complete independence from fossil fuels[184]. The NECP sets the target to achieve 45% of its total energy consumption from renewable sources by 2030.

1. Overview of the RES regulatory framework[185]

a) Authorities and stakeholders

The Ministry of Environment and Energy sets the national energy policy and issues implementing decisions relevant to, e.g., the production, storage, supply and trade of electricity.

The Regulatory Authority for Waste, Energy and Water (RAAEY, formerly RAE) is a member of the Agency for the Cooperation of Energy Regulators (ACER). It monitors the licensing of RES projects, regulates, and supervises the energy sector in general and has a key role in the promotion of strategic national goals for climate neutrality by 2050.

The Independent Power Transmission Operator (IPTO) is responsible for the balancing market, one of the four separate Electricity Markets, where Renewable Energy Sources (RES) and High-efficiency Combined Heat and Power (HECHP) producers may participate. It also issues Grid Connection Offers (GCO) for the connection of RES plants with a capacity above 8 MW.

The Hellenic Electricity Distribution System Operator (HEDNO) is responsible for the interconnection of RES plants with a capacity of below 8 MW. It further acts as market operator of the non-

[181] Independent Power Transmission Operator. (2024, January 30). *2023 a record year for clean energy in Greece | IPTO*. http://www.admie.gr/en/kentro-typoy/press-releases/2023-record-year-clean-energy-greece.
[182] Climate Change Performance Index. (2024, November 20). *Greece – Climate Performance Ranking 2025*. https://ccpi.org/country/grc/.
[183] Symeonides, R.-M. T., & Maragkozoglou, P. (2023, June 5). Legal framework for increasing renewable energy in Greece. *Lexology*. https://www.lexology.com/library/detail.aspx?g=f3ee6652-b889-43aa-b30b-db462932fc11
[184] European Commission. (2023, December 18). *Assessment of the draft updated National Energy and Climate Plan of Greece.* C(2023) 9619 final. https://commission.europa.eu/system/files/2023-12/SWD_Assessment_draft_updated_NECP_Greece_2023.pdf.
[185] Symeonides, R.-M. T., & Maragkozoglou, P. (2023, June 5). Legal framework for increasing renewable energy in Greece. *Lexology*. https://www.lexology.com/library/detail.aspx?g=f3ee6652-b889-43aa-b30b-db462932fc11; European Commission (2022, December 16). *Study on regulatory barriers and recommendation for clean energy transition on the island – Greece.* https://clean-energy-islands.ec.europa.eu/system/files/2022-12/PUBLIC_IslandSecretariatII_Study%20on%20barriers%20and%20recommendations%20GREECE_20221214%20clean.pdf; Sardelas, P., Fragkos, G., & Mastroperros, A. (2024, September 19). Renewable Energy Laws and Regulations Report 2025 Greece. *Iclg*. https://iclg.com/practice-areas/renewable-energy-laws-and-regulations/greece; Hassan, M. (n.d.). Renewable energy in Greece. *CMS*. Retrieved November 22, 2024, from https://cms.law/en/int/expert-guides/cms-expert-guide-to-renewable-energy/greece.

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interconnected islands and manages the payments of RES producers for the network of Non-Interconnected Islands and the low-voltage network.

The Renewable Energy Sources Operator and Guarantees of Origin (DAPEEP) is a public company responsible for Renewable Energy markets of Greece's National Interconnected System (Transmission System and Distribution Network of Mainland and Interconnected Islands). The company also manages the Guarantees of Origin of Electricity from RES and Combined Heat and Power Units (CHP).

b) Main legislative acts for the generation, transmission, distribution and storage of RES

Law 4001/2011[186] is the main law governing the electricity market and the energy sector in general.

Law 4414/2016[187], revised the support scheme under which RES projects operate through long-term operating contracts or through direct participation in the energy market, in line with the EU Guidelines on State Aid for environmental protection and energy 2014-2020.[188] Furthermore, it promotes the gradual integration and participation of RES and HECHP power plants in the national electricity market in the most cost-effective way for society and end consumers. Said law specifies that the RES producers may opt to participate in the energy market either through the conclusion of an operating aid agreement with DAPEEP or HEDNO, or through the conclusion of Power Purchase Agreements (PPAs), with electricity suppliers or corporate off-takers and in relation to physical or virtual delivery.

Additionally, it establishes the feed-in premium (FiP) mechanism, i.e., a fixed or variable premium paid to RES producers on top of the market price received for the sale of electricity as an incentive for the deployment of renewable technologies in the electricity sector. However, for some small-scale projects (<3 MW wind, <500 kW other RES), the feed-in tariff (FIT) scheme applies to Feed-in tariffs (FIT), i.e., an energy supply policy offering long-term purchase agreements for the sale of RE electricity with a guaranteed, above market price. Paragraphs 7 and 6 of Article 3 of the law are applicable in the context of the program "Photovoltaics in the field" - analysed below - as regards the compensation of energy surplus.

Law 4685/2020[189] concerns the modernization of environmental legislation and transposes Directives 2018/844 and 2019/692 into Greek legislation. It regulates the first phase of the licensing phase of RES typical scale projects (up to the issuance of a Producer's Certificate) through digital and automated procedures. It also replaced generation licenses with generation certificates that significantly accelerate the granting procedure.

Law 4951/2022[190] contains specific rules on the licensing of RES plants. It regulates the second licensing phase of RES following the issuance of a Producer's Certificate until the granting of an

[186] Law 4001/2011 on the Operation of Electricity and Gas Energy Markets, for Exploration, Production and Transmission Networks of Hydrocarbons and other provisions. Climate Change Laws of the World. https://climate-laws.org/documents/law-4001-2011-on-the-operation-of-electricity-and-gas-energy-markets-for-exploration-production-and-transmission-networks-of-hydrocarbons-and-other-provisions_1411.

[187] Law 4414/2016 New support scheme for power plants producing electricity from Renewable Energy Sources and High Efficiency Cogeneration - Provisions for the legal and operational separation of the supply and distribution sectors in the natural gas market and other provisions. https://helapco.gr/wp-content/uploads/N_4414_2016.pdf.

[188]Communication from the Commission — Guidelines on State Aid for Environmental Protection and Energy 2014-2020 (2014). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52014XC0628%2801%29.

[189] Law 4685/2020. https://www.elinyae.gr/sites/default/files/2020-05/92a-2020.pdf.

[190] Law 4951/2022 on Modernization of the licensing procedure for Renewable Energy Sources - Phase B, Licensing of electricity production and storage, framework for the development of Pilot Offshore Photovoltaic

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Operation License. Relevant for the agrivoltaics is the provision of Article 33 that allows for the installation of PV plants with a capacity less or equal to 1 MW without any prior Certificates (e.g., Special Projects' Producer's Certificate) or Production Licenses or other declaratory decisions.

Law 4986/2022[191] transposes Directive 2019/944 into Greek law and provides for the possibility to run programs for the installation of PV plants and storage systems by self-producers (prosumers), including farmers.

Law 5037/2023[192] harmonizes Greek legislation with Directives 2018/2001 and 2019/944 and attributes additional powers to RAAEY, turning it into the single regulatory authority over energy, water, wastewater and waste management issues. It prohibits the issuance of new licenses for electricity production from black coal, lignite, natural gas or petrol products. Additionally, it reinforces the right of end consumers to self-produce energy, to store it and sell any energy surplus, either individually or through aggregators.

There are three important Ministerial Decisions which concern self-producers, a relevant area of law for the REGACE project. The first one of these, Ministerial Decision 3583/31.12.14 establishes the regime of net-metering for energy self-producers. These are energy producers which consume their own energy, targeting mainly small PV installations on building roofs. The net-metering regime allows for the self-producers to in essence use the grid like a battery: when there is a surplus, the electricity is loaded off to the grid, when there is a deficit, the grid supplies energy back. Though the self-producer is not a commercial energy producer, this arrangement allows them to sell energy for the same price they buy it. This regime was extended to virtual net-metering by Ministerial Decision 382/19.02.2019. In 2024, this scheme was abolished and replaced by a net-billing system by Ministerial Decision 5074/05.09.2024. In this net-billing system, self-producers can sell the surplus energy to the grid at a predefined price, determined by the wholesale prices of large producers. This could mean that self-production becomes less interesting for self-producers, as there is no longer a guaranteed fixed income. The risk for the investment of photovoltaic installations is raised for self-producers, as it now has become more market dependent.

c) Law on agrivoltaics

Law 5087/2024[193] is the first ever Greek legislative act to make explicit reference to agrivoltaics. It refers to the need to regulate the combination of agricultural activity and the installation of photovoltaic elements, to ensure the highest comparative advantages of both areas, in accordance with modern trends. The Greek legislator took inspiration from developments happening both scientifically and socially.

Plants and specific provisions for energy and environmental protection. https://www.elinyae.gr/sites/default/files/2020-05/92a-2020.pdf.

[191] Law 4986/2022 on Transposition of Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 concerning common rules for the internal market in electricity and amending Directive 2012/27/EU and other urgent provisions. https://mcusercontent.com/e1bb33f7e1a69178b9d781b78/files/66920129-9627-42eb-8390-0f3da8592aa1/FEK_2022_Tefxos_A_00204.01.pdf.

[192] Law 5037/2023 on Renaming of the Energy Regulatory Authority to the Waste, Energy and Water Regulatory Authority and broadening its scope with responsibilities for water services and urban waste management, strengthening water policy - Modernisation of legislation on the use and production of electricity from renewable sources through the incorporation of EU Directives 2018/2001 and 2019/944 - More specific provisions on renewable energy sources and environmental protection. https://www.elinyae.gr/sites/default/files/2023-03/78b_2023.pdf.

[193] Law 5087/2024 on Strengthening model livestock farming, regulations for fisheries and aquaculture, provisions for plant health, biocidal products and food quality, provisions for stimulating rural development and other urgent provisions. https://www.nomotelia.gr/photos/File/25a-24.pdf.

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Article 36 of law 5087/2024 states that renewable energy plants are allowed on agricultural land if they meet certain conditions. There is no specific definition on agrivoltaics, however, the law states that renewable energy systems of less than 1 MW are on principle allowed on high productivity agricultural land. This can be further regulated by Regional Units. The renewable energy systems may also not cover more than 0,8% of each Regional Unit. Finally, a competent operator must grant the connection offer to the grid. The law delegates further details to the Ministries, like to provide further guidance on the support bases for PV systems, to clarify the obligations relating to the restoration of the land after the dismantling of PV stations or to make a study on the cultivation of plants in combination with renewable energy sources. This study will be used to describe the details, conditions and procedures for the installation of photovoltaic stations and the exercise of agricultural activity.

Article 37 provides a revised definition of the "agricultural holding" to include "*the management of renewable energy sources of less than five hundred (500) KW and the operation of agrotourism units*" along with (amongst others) storage units and processing of agricultural products. This has implications for the taxation of electricity from Agri-PV installations (*infra*).

While law 5087/2024 is a major advancement for Greek agrivoltaics projects, it leaves much to be desired. For starters, it does not provide any specific definitions for Agri-PV installations.

2. CAP Support

The Greek CAP Strategic plan provides support for farmers which install photovoltaics on their farmland.[194] While the exact modalities of this support are not clarified in the CAP Strategic Plan, agrivoltaics are themselves not seen as a bar to receiving CAP support. The Greek definition of 'active farmer', a key component for receiving CAP support, does contain a provision stating that when agricultural activity is insignificant part of a person's income, they cannot be considered as an active farmer.[195] There is uncertainty as to when this applies in the case of agrivoltaics due to the dual use of land. More clarity on this topic would be beneficial for the legal certainty of farmers, who may be more willing to engage with agrivoltaic projects if it is clear they will not lose CAP support.

3. Tax

The Greek tax framework is fragmented, as there is no one legislative act regulating uniform taxation of renewable energy projects. Tax benefits for operators of renewable energy plants do exist, but these are diverse and scattered.

One example of such a measure can be found in the Development Law (Law no. 4399/2016), which decrees that solar plant operators receive an income tax relief when they consume the energy they produce themselves.[196] To be eligible, the operator must have invested a minimum amount into the solar power installation.[197]

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[194] Greek Republic. (2022). *CAP Strategic Plan of Greece 2023-2027 (Έκθεση για το στρατηγικό σχέδιο της ΚΠΠ για το 2021)*. P. 553, 907, 937-938, 974-975. https://www.agrotikianaptixi.gr/wp-content/uploads/2024/03/egkekrimeno_ss_kap_2023-2027.pdf.

[195] European Commission. (2018). *Active Farmer Decisions taken by Member States following the entry into force of the Omnibus Regulation.* https://agriculture.ec.europa.eu/system/files/2018-09/active-farmer-ms-decsions-omnibus-regulation_en_0.pdf.

[196] See art. 9 part. 8 Law 4399/2016.

[197] Art. 5 par. 3 Law 4399/2016.

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Another example of a tax benefit can be found in Article 38 of Law 5087/2024. This provision provides tax alleviations specific to Agri-PV for Producer Groups[198] registered in the National Register of Agricultural Cooperatives and other collective bodies (NRAC). Under Article 22 of Law 4673/2020, it must operate exclusively for the benefit of their members. Such entities fall in the ambit of "agricultural holdings", provided above, and may benefit from VAT exemption as regards their supply with agricultural electricity produced by agrivoltaics.

4. Financing and state aid

The main tools for financial support of solar energy projects in Greece are competitive auctions and a feed-in tariff. The feed-in tariff is a subsidy given to producers of renewable energy projects. However, eligibility for this tariff has been reduced significantly and it is currently predominantly used to support smaller and innovative projects.[199] In its place, there are more competitive auctions which result in contracts for difference.

Contracts for difference (CfDs) are a newer type of renewable energy incentive programs. In short, the parties (government and power plant operator) agree on a stake price. The energy is sold on the wholesale market for market price. If the market price falls below the stake price, the government pays the difference to the operator. However, if the market price rises above the stake price, the operator must pay the difference to the government.[200] This way, a stable income is guaranteed for the energy operator, while the government does not have to buy every Watt of power generated, like in the case of a feed-in tariff. Additionally, the auctions revolve around operators bidding down to obtain a lower stake price, leading to higher competitiveness which could drive down the cost.[201] In other parts of Europe, there is also a shift towards CfDs and away from feed-in tariffs.[202]

In 2024, the Greek Ministry of Environment and Energy launched a support scheme specifically for agrivoltaics. The program, "Photovoltaics in the field", subsidizes farmers for the installation of photovoltaic systems with a capacity of up to 50kW for self-consumption of energy.[203] The strategic objective is to utilize the high potential of RES, thus contributing to the reduction of greenhouse gas emissions, the improvement of energy efficiency through the production of "green" energy, and the simultaneous reduction of energy costs.

The program targets professional farmers, farmers with special status and agricultural enterprises that must have an active agricultural supply and be registered in the Register of Farmers and Agricultural

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[198] These are defined in paragraph 1 of Article 25 of Law 4315/2014 as "*separate legal entities with full legal capacity. They are formed on the initiative of producers of similar products who agree to jointly promote at least 90% of their production and cooperate to create an infrastructure for the concentration and/or promotion of their production. POs shall pursue a specific objective, which may include one or more of the following targets:*
(a) ensuring that production is planned and adapted to demand, in particular in terms of quality and quantity,
(b) concentrating supply and placing on the market the products produced by their members; and
(c) the optimisation of production costs and the stabilisation of producer prices."

[199] Munir, H. (2024, February 22). Renewable energy in Greece. *CMS Expert Guide to Renewable Energy*. https://cms.law/en/int/expert-guides/cms-expert-guide-to-renewable-energy/greece.

[200] This is only the case for two-way CfDs, it is possible to only have the CfD in one direction (the government pays when the stake price is above market price, while the operator accepts windfall if the market price rises).

[201] For more on CfDs, see Ason, A., & Dal Poz, J. (2024). *Contracts for difference: The instrument of choice for the energy transition* (Working Paper No. 34). OIES Paper: ET. https://www.econstor.eu/handle/10419/296661.

[202] Busch, S., Kasdorp, R., Koolen, D., Mercier, A., Spooner, M., & European Commission Directorate-General for Economic and Financial Affairs. (2023). *The development of renewable energy in the electricity market*. Publications Office. https://doi.org/10.2765/411281.

[203] Mezartasoglou, D., & Lapillonne, B. (2024). *Energy Efficiency in Greece Policy Brief* (p. 4). Odyssee-Mure. https://www.odyssee-mure.eu/publications/policy-brief/greece-energy-efficiency.html.

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Holdings during the current year in order to become energy self-sufficient. Moreover, the beneficiary shall not have already put forward any preparatory work or order for the installation of a photovoltaic plant. The selected beneficiaries will receive a 30% subsidy of up to €350 per kW, with the amount of the subsidy not being cumulated with the de minimis aid. If beneficiaries have more than one rural electricity supply, they may apply for the financing of a photovoltaic plant with a capacity of up to 50kW for each of them.

Under this program, the following costs are eligible:

a) supply and installation of PV panels, inverters and accessories (panels, cables, etc.).

b) Supply and installation of a base system.

c) Supply and installation of PV meter.

d) Supply and installation of storage system and accessories (panels, cables, etc.).

e) Fee for design - dimensioning of the system (PV and battery) and installation work

Applications are divided into two priority groups. The first one covers PV systems with a capacity up to 10,8kW and the second one those systems with a capacity between 10,8kW and 50kW. Examination of the first group's applications takes precedence over the second, while within each group applications will be treated according to the time of submission.

The program establishes a dual self-production model with different financing rules:

- For PV systems up to 30 kW, the energy offsetting (net-metering) scheme applies, i.e., an offset function without the possibility of selling any surplus energy produced;
- For PV systems from 31 to 50 kW, the net-billing scheme applies, i.e., if there is surplus energy production, it is compensated with a fixed price by the Renewable Energy Sources and Guarantees of Origin Operator (DAPEEP - as a simple self-producer)

The program is managed and implemented under the supervision of HEDNO.

5. Permits

Greenhouses used for the cultivation of flowers and vegetables are exempted from building permits in Greece when they comply with the requirements imposed by studies done by the Greek government.[204]

6. Analysis

Overall, Greece is gradually modernizing its RES legislative framework, with the clear objective of transitioning to the wide use of RES and achieving a secure and efficient carbon-neutral energy landscape by 2050. By promoting changes in the issuance of licenses and the land planning, Greece has streamlined previously time-consuming procedures to the benefit of end consumers and the society in general.

The regulatory framework for agrivoltaics is rather underdeveloped. Only in 2024 have there been some legislative updates and the promotion of initiatives to ensure the inclusion of agrivoltaics as a vital part of Greece's "green" transition. This development reflects the understanding that investment in environmentally friendly innovation may incentivize youth to get involved in agricultural activities,

[204] ypaithros.gr. (2021, October 13). *ΓΕΩΤΕΕ: Πρόβλημα η εξαίρεση από την έκδοση οικοδομικής άδειας των θερμοκηπίων ανθέων και κηπευτικών*. https://www.ypaithros.gr/geotee-problima-eksairesi-apo-ekdosi-oikodomikis-adeias-thermokipion-antheon-kipeytikon/.

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while reducing the phenomena of desertification and necrosis in the primary sector and rural areas. The Greek government conceives the dual use of land for agrivoltaics as an answer to the energy, food and climate crisis. Furthermore, it increases farmers' self-sufficiency, given that they can protect their crops from extreme weather events, reduce the cost of cultivation, reduce or even eliminate energy costs, earn extra income if they have energy left over, in which case they can sell.

Another important factual issue is the lack of grid connection. In the survey launched as part of the methodology set out for this deliverable, several respondents noted that smaller energy producers have been facing issues connecting to the grid due to lacklustre infrastructure in rural areas in Greece. This prevents agrivoltaics from reaching its full potential within the country, even though renewable energy plants legally have the right to a priority grid connection.[205] While bigger RES units with a capacity of above 1 MW can be connected through private transformers, smaller units cannot connect to the grid.

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[205] This right was included in the original Renewable Energy Directive, see Article 16 (1) – (2) Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

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E. Italy

In Italy, the regulatory landscape for Agri-PV is evolving rapidly to accommodate the intersection of agricultural practices and renewable energy production. At the end of 2021, Italy reached the milestone of 1 million of PV plants installed for a total capacity of 22,6 GW. The National Recovery and Resilience Plan (PNRR) was issued in 2021, in which the Italian government has allocated 1.10 billion euros to the installation of Agri-PV systems aimed at creating a winning combination between agriculture and green energy production. Italy has the objective of installing 2 GW of agrivoltaic capacity and improving the competitiveness of the agricultural sector.[206]

1. Legislative Framework

a) No single legal framework

The Italian Legislative framework on agrivoltaics is fragmented. Recently, there have been improvements. For example, as recently as 2021 legislators did distinguish between standard photovoltaic plants and those installed for agrivoltaic purposes.[207] As a result, there is a significant degree of uncertainty in the sector with regard to both authorization and incentivization.

In the legal framework, Decree Law ("DL") 77/2021[208] provides a definition of Agri-PV. Article 31 of this instrument defines agrivoltaic installations as different to "standard" photovoltaic installations, making them a separate category. The definition of Agri-PV contains the following criteria:[209]

i) The exclusion of ground-mounted plants from state incentives does not apply to agrivoltaic plants adopting innovative and integrated solutions for the installation of fixtures situated above ground which do not jeopardize the continuity of agricultural and pastoral farming activity; and
ii) Access to incentives by agrivoltaic facilities is further conditional upon the simultaneous implementation of monitoring systems designed to assess the impact on crops, water saving, agricultural productivity for different crops and livestock and continuity of the farms concerned.

Installations that meet these criteria are unaffected by the prohibitions of Article 65 of Law Decree No.1/2012[210], which excludes ground-mounted PV plants in agricultural areas from accessing state incentives pursuant to Legislative Decree No.28 of 28 March 2011. These definitions do not include specific criteria for Agri-PV and are vague. Therefore, there is uncertainty about when the rules on Agri-PV apply.

b) Italian Ministry Guidelines

To complement the lacking legal framework on Agri-PV, the Italian Ministry of the Environment and Energy Security published comprehensive guidelines in June 2022.[211] The Guidelines define APV as a "complex system that allows the agricultural activity and the photovoltaic plant operation on the same

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[206] Formolli, M., Croce, S., Vettorato, D., Paparella, R., Scognamiglio, A., Mainini, A., & Lobaccaro, G. (2022). Solar Energy in Urban Planning: Lesson Learned and Recommendations from Six Italian Case Studies. *Applied Sciences*, *12*, 2950. https://doi.org/10.3390/app12062950.

[207] Manenti, T., Sfrecola, L., Vanzaghi, F., & Zago, A. (2022, December 30). Agrivoltaic systems: Practical application and challenges. *Watson Farley & Williams*. https://www.wfw.com/articles/agrivoltaic-systems-practical-application-and-challenges/.

[208] Legislative Decree no. 77 of 31 May 2021 (as converted, with amendments, by Law No. 108 of 29 July 2021- the "Simplification Decree Bis").

[209] See Article 31 Simplification Decree Bis, which integrates article 65 via introduction of four new paragraphs.

[210] This Law Decree was converted into law with amendments by Law No.27 of March 2012.

[211] Ministero dell'Ambiente e della Sicurezza Energetica. (2022). *Linee Guida in materia di Impianti Agrivoltaici* (p. 39). https://www.mase.gov.it/sites/default/files/archivio/allegati/PNRR/linee_guida_impianti_agrivoltaici.pdf.

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area with a volume configuration and proper technological choices for the integration of the agricultural activity and the electric generation, unlocking the productivity potential for both the subsystems and not compromising the continuity of agricultural and pastoral activities."

Furthermore, these guidelines outline specific requirements for Agri-PV projects. A project can be classified if it meets requirements A and B. If it also meets C and D, it can be classified as an advanced Agri-PV plant, which is required to receive access to state incentives on electricity tariffs. If it meets criteria A through E, it can gain access to PNRR funding (*infra*).

- Requirement A: Definition of Agri-PV
  - At least 70% of the surface should be covered with crops.
  - Maximum 40% of the surface area can be covered by PV modules.
- Requirement B: Synergy between Energy and Agriculture
  - Continuity of real agricultural activity:
  - Electricity production by the Agri-PV system may not be below 60% of that produced by a standard PV system.
- Requirement C: The Agri-PV system uses innovative solutions with raised modules
  - This can either happen by having PV modules overhead or between crops.
- Requirements D and E: Monitoring Systems
  - There must be at least monitoring for the following elements: water savings, agricultural continuity, soil fertility recovery, microclimate, and resilience to climate change.

These Guidelines clarified what qualifies as an Agri-PV project in Italy and have been used by other government bodies as qualification criteria (see *infra*).

In December 2023, the Italian Ministry of Environment and Energy Security published a decree concerning innovative agrivoltaics, implementing new support schemes for these installations.[212] This decree has as its goal to create at least 1.04 GW of new agrivoltaic energy systems. It provides a grant of maximum 40 percent of eligible costs financed, as well as an incentive tariff based on the share of net electricity fed into the grid.[213] Similar financing incentives are provided in a ministerial decree on renewable energy communities.[214]

c) The specific incentives provided for in the PNRR

The National Recovery and Resilience Plan ("PNRR") has allocated EUR 2.6bn to Agri-PV projects, divided as follows:

- EUR 1.1 bn for agrivoltaic plants; and
- EUR 1.5 bn for agrivoltaic parks.[215]

For the implementation of these projects, reference is made to the Ministry of the Environment and Energy Security guidelines on Agri-PV. The investments made by agricultural enterprises dedicated to

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[212] Ministerial Decree no. 436 of 22 December 2023.

[213] Ministero dell'Ambiente e della Sicurezza Energetica. (2024, February 13). *Energia: Il MASE pubblica il decreto di incentivo all'agrivoltaico innovativo*. https://www.mase.gov.it/comunicati/energia-il-mase-pubblica-il-decreto-di-incentivo-allagrivoltaico-innovativo.

[214] See Ministerial Decree no. 414 of 7 December 2023; Ministero dell'Ambiente e della Sicurezza Energetica. (2024, January 25). *Energia: MASE, pubblicato decreto CER*. https://www.mase.gov.it/comunicati/energia-mase-pubblicato-decreto-cer.

[215] An agrivoltaics plant refers to the installation of PV systems on top of buildings specifically built for agricultural activities. Italia Domani. (2021). *Piano Nazionale di Ripresa e Resilienza* (p. 273). https://www.governo.it/sites/governo.it/files/PNRR.pdf.

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renewable energy production, if properly implemented, can result in a decrease in their operating costs, which in turn can raise agricultural profitability and improve competitiveness. Self-consumption of the energy produced through the Agri-PV system is therefore seen as a tool to increase farming efficiency.[216]

Agrivoltaic projects that meet all requirements listed under the guidelines (see (2) Italian Ministry Guidelines) are granted the following incentives:

- A direct capital grant of a maximum of 40% of all eligible costs; and
- An incentive tariff on the production of net electricity fed into the grid.[217]

The maximum eligible investment amounts to EUR 1,500/kWp to cover the installation of PV modules.[218]

Through the PNRR, Italy is investing significantly into the Agri-PV sector for installations which actually combine agriculture and energy generation.

d) DL Agricoltura

In May 2024, the DL Agricoltura[219] entered into force. This law prohibits the installation of ground-mounted photovoltaics plants in agricultural areas. However, agrivoltaics are excluded from the scope of this law. The ban also does not affect projects which were already permitted or in the permitting phase. It also leaves the door open for ground-mounted photovoltaics in certain areas of agricultural land, like quarries and mines, or on land close to factories.[220] There is some uncertainty whether all Agri-PV installations are excluded, as only advanced Agri-PV installations are explicitly mentioned. However, Italian administrative law generally does not distinguish between the advanced and basic Agri-PV systems.[221] This uncertainty could be a point of concern for ground-mounted Agri-PV. However, the installations in greenhouses envisioned by REGACE are not ground-mounted photovoltaics and are thus not prohibited. They can still be installed and operated.

The reasoning for ban is fourfold.[222] First, there were concerns the issue that photovoltaics take away farmland which is crucial for food security in Italy. The second concern that ground-mounted photovoltaics can cause desertification. The third reason for the ban is that farmers benefit from a range

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[216] Italia Domani. (2021). *Piano Nazionale di Ripresa e Resilienza* (p. 273). https://www.governo.it/sites/governo.it/files/PNRR.pdf.

[217] United Nations Trade and Development. (2023, November 10). Italy—Adopts scheme to support agrivoltaic installations. *Investment Policy Monitor*. https://investmentpolicy.unctad.org/investment-policy-monitor/measures/4543/adopts-scheme-to-support-agrivoltaic-installations.

[218] Benigni, B. (2022, June 1). Agricultural Solar Park: New resourses for the energetic conversion in Italy. *MGI Vannucci & Associati*. https://www.vannuccieassociati.it/blog/agricultural-solar-park-new-resourses-for-the-energetic-conversion/.
These measures were greenlit by the European Commission. See Ministero dell'Ambiente e della Sicurezza Energetica. (2023, December 22). *Energia: Pichetto firma decreto su agrivoltaico innovativo*. https://www.mase.gov.it/comunicati/energia-pichetto-firma-decreto-su-agrivoltaico-innovativo.

[219] Decree-Law No. 63 of 15 May 2024 (DL 63/2024) on "*Urgent provisions for agricultural, fishing and aquaculture enterprises, as well as for enterprises of national strategic interest*", later converted into Law No. 101 of 12 July 2024, published in the Official Gazette General Series No. 163 of 13 July 2024 and entered into force on 14 July.

[220] Article 5 DL Agricoltura.

[221] Consiglio di Stato, 11 September 2023, n. 8258; Atteritano, A., & Zarra, G. (2024, July 1). Italian "DL Agricoltura": New measures potentially affecting photovoltaic sector's international investors [Hogan Lovells]. *Engage Legal Insights and Analysis*. https://www.engage.hoganlovells.com/knowledgeservices/insights-and-analysis/the-italian-decreto-legge-agricoltura-new-provisional-measures-potentially-affecting-international-investors-in-the-photovoltaic-sector.

[222] Palazzo Chigi (Director). (2024, May 6). *Conferenza stampa del Consiglio dei Ministri n. 80* [Video recording]. https://www.youtube.com/watch?v=ksTGIMygbm0.

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of tax benefits on agricultural land, which Italy does not wish to extend to energy producers. Finally, this measure was taken to stop speculation happening over agricultural lands by investment funds, which were driving up the land prices for farmers.

Overall, the DL Agricoltura notes many of the same points that REGACE wishes to emphasize. It is good that farmers are not priced out of their land due to photovoltaic developers. Agrivoltaics promotes both agricultural progress and a transition to renewable energy. While initial reports about the DL Agricultura were concerning, the Italian government chose to not outlaw agrivoltaics which promote sustainable development between agriculture and energy.[223]

More than anything, the DL Agricoltura and discourse surrounding it teaches that public opinion on Agri-PV matters. Efforts need to be made to ensure that correct information about Agri-PV, and myths need to be dispelled, like the myth that farmers would get expropriated to install more solar panels.[224]

2. Tax

Since 1993, Italy has granted a 10% reduction on VAT for deliveries and services related to investments solar energy installations and investments in grids that distribute this electricity.[225] In the past, different tax benefits also existed but are not active anymore.[226] In 2024, Italy amended its taxation rules, allowing for fiscal credit for photovoltaic projects.[227] The solar panels must be produced in the European Union and must meet certain efficiency standards. Finally, the investment must be made in 2024-2025. If these criteria are met, the fiscal credit amounts to up to 35% of the panel prices, with a limit of EUR 50 million per beneficiary.

3. Authorization Procedures

The framework of Italian legislation on urban and energy planning is characterized by a hierarchical approach stretching from the national level down to the regional, provincial and municipal levels. According to the Constitution, urban planning and energy-related topics are a shared task between the

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[223] Matalucci, S. (2024, May 6). Trovato accordo Pichetto-Lollobrigida: Consiglio dei Ministri approva Dl Agricoltura. *pv magazine Italia*. https://www.pv-magazine.it/2024/05/06/trovato-accordo-pichetto-lollobrigida-consiglio-dei-ministri-approva-dl-agricoltura/; There are concerns the DL Agricultura contains issues with regards to Italy's international obligations to protect foreign investment. This could lead to arbitration disputes against Italy. See for example: Atteritano, A., & Zarra, G. (2024, July 1). Italian "DL Agricoltura": New measures potentially affecting photovoltaic sector's international investors [Hogan Lovells]. *Engage Legal Insights and Analysis*. https://www.engage.hoganlovells.com/knowledgeservices/insights-and-analysis/the-italian-decreto-legge-agricoltura-new-provisional-measures-potentially-affecting-international-investors-in-the-photovoltaic-sector.

[224] Costa, L., Steinhauer, C., Giuliani, M. M., & Biadico, G. (2024, May 23). *Clouds over solar PV in Italy?* https://www.dentons.com/en/insights/articles/2024/may/23/clouds-over-solar-pv-in-italy.

[225] European Environment Agency. (2012). *Country Profile—Italy* (p. 4). www.eea.europa.eu/publications/energy-support-measures/italy-country-profile.

[226] European Environment Agency. (2012). *Country Profile—Italy* (p. 4). www.eea.europa.eu/publications/energy-support-measures/italy-country-profile.

[227] Matalucci, S. (2024, March 5). Italy offers fiscal breaks to PV projects built with EU-made solar modules. *Pv Magazine International*. https://www.pv-magazine.com/2024/03/05/italy-offers-fiscal-breaks-to-pv-projects-built-with-solar-modules-made-in-eu/. Due to the EU origin requirement for the fiscal credit, this measure has been challenged by China before the WTO. See Matalucci, S. (2024, May 3). *Italy's EU-made PV incentives raise specter of Chinese opposition*. Pv Magazine International. https://www.pv-magazine.com/2024/05/03/italys-eu-made-pv-incentives-raise-specter-of-chinese-opposition/.

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State, the Regions, and the autonomous Provinces.[228] Consequently, regional authorities may implement autonomous legislation as long as they do not contradict the general principles and requirements provided by national and EU regulations. The Italian national legislation promoting energy efficiency and the diffusion of RES has been developed as an implementation of the major European directives.[229]

Implementation of Agri-PV projects in Italy can involve different authorization procedures, including Autorizzazione Unica (AU), Procedura Abilitativa Semplificata (PAS), and Dichiarazione di Inizio dei Lavori Asseverata (DILA).[230] These range from a full-scale permit procedure to a simple prior declaration of works.

For construction of a new plant, an AU is required for larger scale projects.[231] The AU request must be granted within 90 days (plus time if there is an obligation to conduct an environmental impact assessment).[232] The regions are competent to issue an AU, which they may delegate to the provinces.[233]

For the construction of smaller scale renewable energy plants, there is the requirement to obtain a PAS.[234] This is the case when the power of the plant does not meet the AU thresholds. Additionally, if the installation is built within 3 km of an industrial, artisanal or commercial area, a PAS is always required (and never an AU).[235] The PAS request must be submitted to the municipality 30 days prior to the start of construction. If the municipality does not reply within 30 days, their consent to the works is assumed and construction can commence.[236]

For modifications of existing plants, a simple declaration (DILA) suffices, and no permit is needed.[237] This declaration must be made to the municipality. Additionally, for works to improve certain safety standards, not even a DILA is required.[238] These works can be done without any notification.

Agri-PV initiatives with a capacity ranging from 20 to 30 GWp are currently undergoing administrative authorization procedures through the national permitting process.[239] Furthermore, the Department of Ecological Transition is actively identifying and assessing appropriate areas for the development of Agri-PV projects.[240]

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[228] Formolli, M., Croce, S., Vettorato, D., Paparella, R., Scognamiglio, A., Mainini, A., & Lobaccaro, G. (2022). Solar Energy in Urban Planning: Lesson Learned and Recommendations from Six Italian Case Studies. *Applied Sciences*, *12*, 2950. https://doi.org/10.3390/app12062950.

[229] See for example the 2011 National Renewable Energy Action Plan, which transposed Directive 2009/28/EC.

[230] Gestore Servizi Energetici. (n.d.). *Autorizzazioni*. Retrieved October 29, 2024, from https://www.gse.it/normativa/autorizzazioni.

[231] Article 12 of Law Decree No. 387 passed on 29 December 2003.

[232] Article 5 of Law Decree No. 28 passed on 3 March 2011.

[233] Gestore Servizi Energetici. (n.d.). *Autorizzazioni*. Retrieved October 29, 2024, from https://www.gse.it/normativa/autorizzazioni.

[234] See Article 6 of Law Decree No. 28 passed on 3 March 2011.

[235] Article 9 of Law Decree No. 17 passed on 1 March 2022, converted into Law No. 34/2022 (known as "Decreto Energia").

[236] Article 6 (4) of Law Decree No. 28 passed on 3 March 2011.

[237] Article 6b of Law Decree No. 28 passed on 3 March 2011. Gestore Servizi Energetici. (n.d.). *Autorizzazioni*. Retrieved October 29, 2024, from https://www.gse.it/normativa/autorizzazioni.

[238] Article 6 of Presidential Decree no. 380 passed on 6 June 2001.

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

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

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Greenhouse construction in Italy is subject to various authorization procedures, including CILA, SCIA, and Permesso di Costruire, depending on factors such as mobility and integration with existing structures.[241]

Municipalities can regulate further on photovoltaics within their municipal building codes. However, experience teaches that these municipal standards only consider the design of buildings in urban areas for photovoltaics.[242] Accordingly, these standards should have little impact for Agri-PV projects.

4. Direct Payments and Agricultural Land Utilization

The Italian CAP plan draws a distinction between Agri-PV and PV installations but does not clarify what the distinction is or how it specifically relates to the CAP strategic plan.[243]

Italy's ministry of Agriculture sets out the criteria for being an "active farmer" for CAP direct payments. In this definition, there is no mention of what the impact of operating Agri-PV installations is on a farmer's ability to receive CAP direct payments.[244] This leads to legal uncertainty and may deter farmers from installing Agri-PV installations, as CAP direct payments can be crucial in a farmer's business model.

5. Support mechanisms

In March 2024, Italy announced its first draft for the RES-X Decree, following up on the 202 FER Decree.[245] This Decree aims to support energy generation from renewables which are close to market competitive. While the text has not been formally adopted yet and is still undergoing revisions during 2024,[246] the Decree has the potential to add substantial support mechanisms for renewable energy projects, including Agri-PV.

Smaller installations (up to 1 MW) would enjoy direct access to the benefits, while having to adhere to a minimum set of obligations. Larger installations would have to enter competitive tenders with the GSE (Gestore dei Servizi Energitici) with certain requirements.

Once the benefits are granted, Italy guarantees that it will buy the energy produced at a minimum price. For 2024, this price would be EUR 80/MWh for photovoltaics.[247]

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[241] See Consiglio di Stato, 15 October 2021, n. 6346.
[242] Formolli, M., Croce, S., Vettorato, D., Paparella, R., Scognamiglio, A., Mainini, A., & Lobaccaro, G. (2022). Solar Energy in Urban Planning: Lesson Learned and Recommendations from Six Italian Case Studies. *Applied Sciences*, *12*, 2950. https://doi.org/10.3390/app12062950.
[243] Formolli, M., Croce, S., Vettorato, D., Paparella, R., Scognamiglio, A., Mainini, A., & Lobaccaro, G. (2022). Solar Energy in Urban Planning: Lesson Learned and Recommendations from Six Italian Case Studies. *Applied Sciences*, *12*, 2950. https://doi.org/10.3390/app12062950.
[244] Lorenzini, S. (2023). *Circular No. 12874 of 22 February 2023—Active farmer—Regulations and controls under Regulation (EU) No 2021/2115*. Agenzia per le Erogazioni in Agricoltura. https://agreagestione.regione.emilia-romagna.it/opendocument/normativa/dettaglio?id=9901&version=1.
[245] Redazione Tecnica. (2024, October 10). *Decreto FER-X: Nuovi incentivi per le rinnovabili*. BibLus. https://biblus.acca.it/decreto-fer-x-incentivi-per-le-rinnovabili/.
[246] Ministero dell'Ambiente e della Sicurezza Energetica. (2024, April 23). *Rinnovabili: Online esiti consultazione pubblica FERX*. https://www.mase.gov.it/notizie/rinnovabili-online-esiti-consultazione-pubblica-ferx.
[247] Redazione Tecnica. (2024, October 10). *Decreto FER-X: Nuovi incentivi per le rinnovabili*. BibLus. https://biblus.acca.it/decreto-fer-x-incentivi-per-le-rinnovabili/.

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Grid operators are also obliged to give priority access to renewable energy plants.[248] They are also obliged to give priority dispatch to electricity from renewable sources. Plant operators can request the grid operator to expand the grid if the connection of a plant requires this expansion.

6. Analysis

Italy's legal framework for Agrivoltaics is poised for further development to foster sustainable energy practices while ensuring agricultural continuity. As Agri-PV projects continue to gain momentum, regulatory harmonization efforts and standardized guidelines will play a crucial role in realizing the full potential of Agri-PV. The following points are the main points of concern when it comes to the agrivoltaics framework in Italy.

Strengthened policy support needed. While significant strides have been made, the fragmented legal framework and uncertainties surrounding incentives and CAP eligibility hinder the growth of Agri-PV. A consolidated legal approach would provide clarity and encourage investment.

Guideline implementation is crucial. Comprehensive guidelines are pivotal for defining Agri-PV systems and accessing incentives. Their successful implementation can unlock Italy's agrivoltaic potential by harmonizing agricultural and renewable energy goals.

Balancing farmland and energy production. Italy has appropriately restricted ground-mounted PV to protect farmland and prevent speculative land pricing. While Agri-PV systems are excluded from this prohibition, there is a lack of clear criteria for Agri-PV installations. This is necessary to foster development of the sector.

Administrative efficiency. There is a need for simplified and harmonized authorization procedures, particularly for smaller projects. This could accelerate deployment and reduce administrative burdens, enabling Italy to meet its renewable energy targets.

Public perception and farmer engagement. The discourse around the DL Agricoltura has clearly taught that it is key to Address misconceptions and educate the public and stakeholders about the benefits of Agri-PV. This is essential to garner support and alleviate fears of land expropriation or environmental harm.

[248] See also Article 16 (2) (c) Directive 2009/28.

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F. Israel

In light of several REGACE project partners being located in Israel, it is important to analyze the Israeli framework for Agri-PV systems. Israel is not a part of the European Union. The country faces different challenges regarding the development of Agri-PV than those discussed earlier in many European states. Israel does not provide state support for farmers in the same way that Europe does with the CAP. This is not an issue for Israeli farmers. However, land use is very heavily regulated. As Israel is a relatively small country with an even smaller area of arable land, the Israeli state wanted to protect its agricultural interests as much as possible. About 93 percent of land in Israel is owned by the state,[249] which is then leased to private actors for a specified purpose for periods of up to 49 years. The land use must comply with the original purpose in the lease, so agricultural land cannot simply be transformed into industrial land. While technological and economic factors have played a significant role in shaping the development of Agri-PV, regulatory frameworks have also influenced its progress, particularly in areas such as energy infrastructure capacity, knowledge gaps about the technology's impact on agricultural productivity, and the costs associated with project implementation.

Israel has no dedicated legislation concerning of agrivoltaics (Agri-PV) systems, but there are research exceptions, particularly within the agricultural and energy sectors, recognizing the potential of integrating renewable energy with agricultural production to enhance land use efficiency and contribute to the country's green energy portfolio.[250] In 2022, the Ministry of Energy and the Ministry of Agriculture and Rural Development teamed up to launch pilot projects for Agri-PV projects throughout the country.[251]

Israel's approach to agrivoltaics is characterized by its focus on research and development, which includes evaluating the environmental and agricultural impacts of agrivoltaic projects, ensuring the compatibility of solar installations with ongoing agricultural activities, and promoting innovative land use strategies. The regulatory framework addresses various aspects such as land lease agreements, planning and land use consents, building permits, environmental permits, grid connection applications, and electricity generation licenses.

The following sections provide a detailed examination of these regulatory requirements, highlighting the critical elements that stakeholders must navigate to successfully implement agrivoltaic projects in Israel. This analysis aims to offer insights into the legislative environment, identify potential challenges, and propose recommendations for harmonizing regulations to facilitate the widespread adoption of agrivoltaic systems.

1. National Master Plan for Agrivoltaic Installations

On 25 October 2020, Israel's government adopted Decision No. 465 to promote renewable energy in the electricity sector, setting a target for 30% of electricity production to come from renewable

[249] Trommsdorff, M. (Director). (2022, December 14). *Workshop on legal aspects of agrivoltaics in Israel, France and Germany* [Video recording]. https://www.youtube.com/watch?v=Znd9CgANPlE.
[250] Bellini, E. (2021). Israeli government wants to boost development of agrivoltaics. *Pv Magazine International*. https://www.pv-magazine.com/2021/02/01/israeli-government-wants-to-boost-development-of-agrivoltaics/.
[251] Ministry of Agriculture and Food Security. (2022, January 11). *The Ministries of Energy and Agriculture & Rural Development will examine the production of electricity from solar energy on active agricultural land of an area of 1,800 dunams in a pilot program*. https://www.gov.il/en/pages/generation_of_electricity_from_solar_energy_in_agricultural_land.

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sources.[252] This decision also included measures to encourage the establishment of renewable energy facilities on built-up land and through dual land use. This decision was reinforced in 2021.[253]

To meet these government targets and to optimize land use while preserving agricultural activity, a national plan was advanced and approved in August 2023.[254] This plan includes the establishment of agrivoltaic research and development sites across the country in areas deemed suitable based on research and planning. The installation of these facilities will enable the examination of their integration with agricultural activity using various research methods and technologies for different crops in diverse geographic regions with varying agricultural and climatic characteristics.

The main objective of the national plan is to allocate land for the establishment of agrivoltaic facilities for research and development purposes. This involves using various research methods and technologies for different crops in diverse geographic areas. The establishment of these facilities will allow for the examination of their integration with agricultural activities and their environmental impact on the land. Key provisions are about designating land for the establishment of agrivoltaic facilities by defining a combined use of "agricultural land with special instructions," ensuring continued agricultural activity, implementing guidelines to minimize environmental and landscape impacts, and establishing conditions for issuing building permits, and providing instructions for setting conditions in permits.

As of the end of 2024, the research facilities approved in this master plan have not yet been constructed; however, more than 50 master plans for agrovoltaic sites in open areas are being advanced or were approved by district planning committees. A National Master Plan for commercial agrivoltaic installations is in preparation.

2. Photovoltaic Installations on Greenhouse Roofs or Façades - Guidelines and Principles for Approval by the Israeli Ministry of Agriculture and Rural Development

On August 7, 2021, the Israeli Cabinet approved Amendment No. 10 to National Outline Plan 10, facilitating the construction of dual-use photovoltaic facilities through a streamlined building permit process. This amendment introduced five new licensing tracks, aligning with the government's renewable energy goals. Among these tracks is the approval route for photovoltaic installations on greenhouse roofs or façades.

The Ministry of Agriculture and Rural Development issued guidelines for photovoltaic installations on greenhouse structures in November 2021, later clarified and amended in March 2023.[255] The current guidelines incorporate these clarifications and further adjustments based on practical experiences with such installations.

Following the amendments, photovoltaic installations on greenhouse roofs or façades require a building permit and Ministry approval. These installations must comply with conditions ensuring they do not interfere with agricultural use or exceed specified dimensions and design requirements. It should be

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[252] Resolution 465 of the government of October 25,2020, on the Promotion of renewable energy in the electricity sector and amendment of government decisions. https://www.gov.il/he/pages/dec465_2020.

[253] Resolution 208 of the government of August 1, 2021, on the Transition to green energy and amendment of a government decision Resolution number 208 of the government. https://www.gov.il/he/pages/dec208_2021.

[254] See Israel Planning Administration. (7 August 2021) *Change No. 10 to TMA 1 – Amendment to the Photovoltaic Installations Chapter.* ((תמ"א 1 - תיקון פרק מתקנים פוטו וולטאיים) 102/10 דמ' 10 לתמ"א 1 - תיקון מס' שינוי)
https://www.gov.il/BlobFolder/reports/sedergov050821/he/Seder_Gov_plan11.pdf.

[255] Ministry of Agriculture and Rural Development. (March 2023). *Photovoltaic installations on roof or facade Greenhouse Guidelines and principles for approval* (מתקנים פוטו-וולטאים על גג או חזית חממה הנחיות ועקרונות לאישור משרד החקלאות ופיתוח הכפר).

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noted that in a strict interpretation of the guidelines, photovoltaic elements can only be installed on the roof of greenhouses. Installing photovoltaic panels inside greenhouses is not permitted, which directly impacts the goals of the REGACE project.

3. Conditions for Approval by the Ministry

Approval conditions for photovoltaic installations on greenhouse roofs or façades are divided into basic principles and technical guidelines.[256]

- The facility must complement agricultural income without replacing it. Agricultural activity must continue alongside electricity production throughout the facility's lifespan. If agricultural activity ceases for over 18 months, the Ministry will report the cessation. The facility must not adversely affect agricultural production capacity or quality. The shading effect must suit the greenhouse crop type.
- The facility must meet safety standards, ensuring it does not pose risks to workers or visitors. The declaration of a structural engineer approval is required for stability.
- The installation must not damage the greenhouse's transparent cover or impede its replacement.
- Applications for photovoltaic installations must follow established procedures, including combined requests for new greenhouses and photovoltaic facilities. Approval requires evidence of agricultural activity in the preceding 18 months.
- Applications for building permits must be submitted to the relevant district at the Ministry of Agriculture and Rural Development, accompanied by necessary documents.

4. Technical Guidelines

- Proof of land ownership or membership in an agricultural association is required.
- Approval will only be granted for facilities on duly established greenhouses with an approved building permit.
- Existing Greenhouses Without Permits must be lawfully approved, possibly through a combined application for both the greenhouse and photovoltaic facility.
- Approval for new greenhouses combined with photovoltaic facilities is possible for active farmers.
- Applications must be submitted through the "Available Licensing" system by a licensed professional, including Ministry approval at the information provision stage.
- The facility area must not exceed 15% of the greenhouse roof area. Panels must be distributed uniformly and placed sequentially. In this respect, it should be noted that REGACE aims at higher coverage rates.
- Panels must be placed along the gutters in compliance with structural guidelines and without causing excess shading.

[256] Id. See also Trommsdorff, M. (Director). (2022, December 14). *Workshop on legal aspects of agrivoltaics in Israel, France and Germany* [Video recording]. https://www.youtube.com/watch?v=Znd9CgANPlE for a discussion on the yield requirements in Israel being not less than 70 percent of the normal yield.

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- Panels must be arranged in specific configurations to the PV system must be "adjacent to the roof," with specific height limitations to ensure structural stability.
- The permit application must include an accurate calculation of the PV facility's area relative to the greenhouse.
- The greenhouse must be structurally adapted to support the PV system's weight and wind loads without causing excess shading.

5. Analysis

While Israel's original aim is advancing agrivoltaics through pilot projects and greenhouse-specific installations experimental sites to evaluate the technology's impacts before commercial implementation, no R&D facilities have been built. Streamlined processes and unified guidelines are needed to scale up and balance agricultural preservation with renewable energy goals. Advancements are continuously being made on the topic, however. The following points are the main takeaways from Israel's journey in Agri-PV legislation.

Facilitating specific Agri-PV applications: Israel has made policy objectives in promoting agrivoltaics by launching pilot projects and simplifying approval processes for certain installations, such as photovoltaic systems on greenhouse structures. However, the current policy does not fully ensure minimal disruption to food production. For open-field Agri-PV, the policy permits up to a 30% reduction in food production, which may not be considered minimal. Furthermore, when it comes to Agri-PV in greenhouses, there are no regulations in place to limit reductions in agricultural production, highlighting the need for more robust guidelines to balance renewable energy integration with agricultural sustainability.

Research-driven implementation. The government's emphasis on research and development demonstrates a commitment to understanding the compatibility of agrivoltaics with agricultural systems. This approach allows for evaluating environmental and operational impacts before scaling up adoption. However, despite this intent, the planned research sites have not been established, and large commercial sites are being approved and constructed without the benefit of prior R&D findings. This gap underscores a missed opportunity to thoroughly assess impacts before scaling up adoption.

Regulatory complexity: Despite progress, Israel's lack of dedicated agrivoltaic legislation and its land use system create hurdles for broader implementation. Current processes require navigating multiple layers of permitting and approvals, which can deter potential stakeholders.

Need for streamlined processes: To facilitate the widespread adoption of agrivoltaics, Israel should refine its regulatory framework. This includes developing clear, unified guidelines for Agri-PV installations and the framework should carefully consider the potential negative impacts of Agri-PV in open fields, such as on food security, landscape quality, and carbon footprint—and ensure safeguards are in place to protect these important aspects.

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G. Conclusions after the national legislation analysis

Chapter 4 has examined the national legal frameworks for Agri-PV systems across Austria, France, Germany, Greece, Italy, and Israel. National legislation plays a pivotal role in shaping the development and deployment of Agri-PV systems, determining how effectively they can address challenges related to land use, food security, and renewable energy generation. This analysis has explored key aspects such as the overarching renewable energy frameworks, farmers' eligibility for CAP direct payment support, taxation rules, permitting procedures, and financing options in each country. The following section provides a brief overview of the main takeaways and analysis. Understanding these national contexts can help policymakers develop better Agri-PV frameworks that align with broader sustainability goals.

France and Germany: Developed Frameworks

Both France and Germany have established comprehensive frameworks for agrivoltaics, addressing the dual objectives of renewable energy development and agricultural preservation. In France, stringent regulations ensure agricultural activity remains the primary use of land, prioritizing food security and income stability for farmers. However, complexities in financing and administrative hurdles in permitting present challenges.

Germany has also integrated agrivoltaics into its energy and agricultural policies, providing benefits under the EEG. However, uncertainties around CAP eligibility, fragmented permitting processes, and classification issues impede progress. Both states emphasize the importance of harmonizing energy and agriculture.

Greece and Italy: Rapidly Developing Frameworks

Greece and Italy are undergoing rapid evolution in their agrivoltaics policies, with frameworks reflecting growing recognition of their potential. In Greece, recent legislative updates aim to streamline licensing and integrate agrivoltaics into the country’s green transition. Benefits such as crop protection, reduced cultivation costs, and income diversification highlight agrivoltaics' potential for farmers, but challenges remain, including grid connectivity in rural areas. Italy has taken steps to protect farmland and prevent speculative land pricing, but fragmented regulations and a lack of clear criteria for agrivoltaic installations hinder growth. Simplified authorization processes and harmonized guidelines are essential for unlocking potential in both countries, with Italy also needing to address misconceptions to build public and farmer support.

Austria: Limited Framework

Austria's agrivoltaic development is stymied by regulatory gaps, limited financial incentives, and fragmented permitting laws across federal states. The Austrian renewable energy framework acknowledges agrivoltaics but provides unclear standards, creating uncertainty around subsidies and the protection of agricultural land. CAP restrictions further limit the viability of agrivoltaics for farmers, while the federal and state-level division of competencies complicates harmonization efforts. As a result, agrivoltaics in Austria is confined to small-scale research projects rather than commercial deployment. To advance, Austria needs harmonized zoning laws, clearer definitions, and supportive frameworks that align energy and agricultural goals. efforts. As a result, agrivoltaic development remains slow in Austria.

Israel: Non-EU Context

In Israel, progress in agrivoltaics is driven by pilot projects and greenhouse installations, but the research-driven approach has yet to be fully realized. The lack of dedicated legislation and Israel’s land-use system create hurdles for broader adoption. Reducing bureaucracy and ensuring research findings guide policy will be crucial for advancing Israel’s agrivoltaic potential beyond its current stage.

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Summary

National approaches to agrivoltaics vary widely, with France and Germany leading with developed frameworks, Greece and Italy catching up through rapid legislative evolution, and Austria and Israel facing unique challenges. Harmonizing regulatory standards, issues with the permitting procedure, improving financing options, and fostering innovation are recurring themes across all contexts. Tailored strategies addressing national and regional administrative, financial, and legislative barriers are essential to unlocking the potential of agrivoltaics and advancing sustainable agriculture alongside renewable energy development.

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Chapter 5 - Policy Recommendations

Based on the research conducted in this deliverable, the authors propose the following recommendations to enhance the policy framework for agrivoltaics, aiming to support the sector's sustainable and equitable growth across Europe. These recommendations address key challenges identified in the analysis. By implementing these measures, policymakers can foster an environment that promotes innovation, safeguards farmers' rights, and maximizes the dual potential of agrivoltaics to advance renewable energy goals while preserving agricultural productivity.

A. CAP

One of the most important issues for farmers is the restriction on receiving CAP support when they commit to Agri-PV projects. **Farmers should still be able to obtain support from CAP direct payments when they install agrivoltaics.** As this deliverable has discussed, certain countries completely bar farmers from receiving CAP support when they install photovoltaics, like Austria. The reasoning behind this can be the fear that photovoltaics on agricultural land will endanger food security. However, this is misguided where Agri-PV systems are concerned, which they aim to guarantee food security, renewable energy generation and sustainability. In other countries there is no absolute restriction on receiving CAP payments when photovoltaic elements are present, but there might be uncertainty on how far this can go before CAP support ends. This is the case in Italy. Finally, even in countries where there are extensive guidelines on the parameters for Agri-PV projects which are still eligible for CAP support, like France or Germany, it is clear that these national standards can differ greatly. For example, France chose to prioritize food security and chose a very high yield standard of 90% of the reference yield of a similar plot of agricultural land. In Germany, this yield standard is much more lenient, at 70%. This creates issues for harmonization.

One way of solving this problem and having farmers continue benefiting from CAP payments, is to **make explicit within the CAP at the European level that agrivoltaics installations do not disqualify a farmer from receiving CAP support**. This provision should be included in the next periodic revision of the CAP, currently scheduled for 2027. This means that there is a need for a definition of agrivoltaics for the CAP, which should align with the definition of agrivoltaics in other areas of law, like zoning law or tax law. This could either be done by writing a definition into the CAP itself, or it can be left to the Member States. From a survey carried out with REGACE consortium members, it is clear that stakeholders want to comply with the legal definition of agrivoltaics, but that there is often a lack of clarity on the exact requirements, leading to difficulties in compliance. Clear standards could include reference to impact on crop yield, ground cover ratio, expert assessments, compatibility with biodiversity or animal grazing, etc.

When writing the definition into the CAP at the European level, this ensures that farmers across the EU can benefit from agrivoltaics. Due to a single definition for the purpose of CAP support, there will be more clarity and legal certainty. In practice, it may be difficult to come to a consensus on what exactly this definition should be. Many EU countries currently do not have a single definition of agrivoltaics. Countries that do have diverging interpretations. In the example of France and Germany, there is a difficulty in finding a middle ground: if the yield standard is lower at the European level, closer to Germany's 70%, this will be at odds with the French requirements which are specifically placed to ensure food security and prevent abuse of CAP funds for solar parks that have little to do with agriculture. On the other hand, if the yield standard is higher and closer to France's 90%, this would suddenly disqualify German farmers who counted on the lower yield standard, planned accordingly and ensured that they would still meet this while investing in renewable energy. Neither scenario is ideal.

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Another way forward could be to leave the definition of agrivoltaics to the Member States. This has precedent within the CAP. While the bigger picture of the CAP is decided upon at the European level, certain eligibility criteria, like the definition for 'active farmer', are left to the Member States to decide. The way forward could be to obligate Member States to provide for an agrivoltaics definition which does not exempt farmers from receiving CAP support in their national CAP strategic plans. This way, each Member State can still set its priorities and retain some of the regulatory space. This could also be an incentive for Member States to further develop the framework for agrivoltaics in other areas of law. The downside is that this will lead to further fragmentation in the regulatory landscape of agrivoltaics. This could cause issues down the line if the European legislator would desire to create harmonization legislation on agrivoltaics at some point in the future.

Regardless of what path is chosen, there will need to be studies on the effects of agrivoltaics on yield, revenue, and similar factors, either at the national level or the European level. These types of studies should consider different types of agrivoltaics. For example, the different REGACE deliverables, like deliverable D3.2 – Testing results, D6.1 – Environment impact report and D6.2 – Farmer's dialogue report, should make it possible to see the effects of this specific technology on agriculture. However, these results will not be representative for agrivoltaics as a whole, where due to spatial or technological limitations different results can occur. These differences need to be taken into account for definitions of agrivoltaics, both at the European and Member State level.

Recommendation: The CAP should include an explicit provision stating that agrivoltaics do not bar a farmer from receiving CAP support.

Once these standards are set, **there should be methods of implementation and following up on the projects**. This is needed to combat fraud and ensure that only agrivoltaics plants which genuinely combine agriculture and energy generation receive CAP support. This also relates to public support, which will be further discussed below. There need to be guarantees for the public that measures exist to ensure agricultural land is not taken over by solar panels.

Recommendation: There should be follow-up mechanisms implemented to ensure agrivoltaics operators are complying with legal standards.

B. Permitting and land use

The research in this deliverable has shown that in several Member States, the permitting procedures are long, obtuse and complex for both the construction of greenhouses as well as the operating of power plants. **Permitting procedures need to be shortened in time.** The European legislator has taken steps to address this issue, like for example in the Renewable Energy Directive III, where the permitting procedure for renewable energy projects was shortened in time. The provisions on permitting from the Directive were supposed to be transposed by July 1st, 2024, yet as of December 2024, only 12 Member States transposed this part of the Directive into national law. Both due to the incomplete transposition and the short amount of time which has passed for the Member States which have transposed the Directive, it is difficult to evaluate whether this type of legislation has the desired effect. One thing is clear, however: the lengthy permitting procedures make the development of agrivoltaics difficult at a larger scale.

Permits pose significant barriers to entry for farmers and developers of agrivoltaics and should be reduced. Another problem is the fact that multiple permits need to be obtained before an agrivoltaics plant in a greenhouse can be built. Obtaining multiple permits for one agrivoltaics project, such as a building permit for a greenhouse and a separate permit for solar panels on the structure, creates significant challenges that can deter investors. The fragmented permitting process results in extended timelines, higher administrative costs, and regulatory uncertainty. Whereas the Renewable Energy

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Directive III implements a maximum timeline for the renewable energy project itself, it does not cover faster permitting for the construction of the greenhouse and infrastructure itself. This discourages investors, who perceive increased risk for their money to disappear if one permit is not obtained. To address this issue, streamlining the permitting process is essential. This is more challenging to organize from a European perspective due to the large role national governments have in deciding on permitting rules. Governments could introduce integrated or unified permits that cover multiple components of renewable projects, establish clear and consistent guidelines, and leverage digital platforms to reduce bureaucratic delays. Additionally, providing financial incentives or expedited review processes for projects with dual benefits, such as renewable energy and sustainable agriculture, could further encourage investment and simplify development.

Recommendation: Permitting procedures for renewable energy should be shortened and simplified.

Closely connected to the issue of permitting is land use and zoning. In certain Member States, photovoltaic installations cannot be put on land designated for agricultural use. This completely prevents any Agri-PV development, even when it does not subtract from the yields of agricultural activity. Member States should **amend their national zoning laws to allow for dual use of land.** This way, the benefits of agrivoltaics to both agriculture and renewable energy targets can be deployed to the fullest. This especially makes sense in the context of photovoltaics combined with greenhouses, as they are present within the REGACE project. Where there is already existing construction and photovoltaic elements do not hinder the cultivation of produce, allowing for the dual use of land is a clear and logical policy choice.

Recommendation: Member States should clearly allow agrivoltaics installations on land zoned for agriculture.

C. National support schemes

Financing agrivoltaics can be difficult due to the many uncertainties that still go hand in hand with the projects. For these reasons, government-funded support schemes are still necessary for the further development of agrivoltaics.

It is important that there is **adequate flexibility** in financing structures, as constant innovation is happening in the world of renewable energy project finance. For example, early support schemes were exclusively based on a feed-in tariff, where the government would commit to buying energy produced by renewable energy sources at a fixed price. Recently, many renewable energy projects have shifted to a contract for difference model, where energy is sold on the wholesale market instead, with additional guarantees from the government. This shift in approach is emblematic of the flexibility and innovation required in renewable energy project finance to effectively address evolving challenges and seize emerging opportunities.

Currently, a significant amount of financing for renewable energy projects happens through tenders. These auctions select the most competitively viable projects to award support to, either in the form of a contract for difference or other support mechanisms. This is problematic for agrivoltaics, as these projects may not be able to compete with the raw energy production or cost-effectiveness of ground mounted photovoltaic plants exclusively focused on producing energy. This means that agrivoltaics projects do not have access to an important source of financing. This can be solved by launching projects specific to agriculture and photovoltaics, like the Greek “Photovoltaics in the field” program. Alternatively, agrivoltaics could be implemented in the tender evaluation criteria. This could mean that when a project qualifies as agrivoltaics, this could be a bonus criterion which would boost its likelihood of receiving support.

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Recommendation: Member States should implement national support schemes specific to agrivoltaics.

Recommendation: States should consider the presence of agrivoltaics as a bonus when evaluating projects for tenders and auctions under national support schemes.

D. Grid connection

Agrivoltaics need a well-developed grid to function well and to ensure produced electricity can actually be sold on the energy market. However, this can still be an issue in practice. Agrivoltaics are usually located in rural areas, where grid connection may be a challenge already. While the Renewable Energy Directive from 2009 already held that EU Member States must give priority grid access to operators of renewable energy plants,[257] there are still many issues today on this. This is exacerbated in Member States with large amounts of land where few people live, like in Greece. These logistical issues need to be solved to enable the full potential of agrivoltaics.

Recommendation: States should further develop their national energy grids, especially in rural areas.

E. Public perception

Agrivoltaics projects aim to genuinely combine agricultural activity and renewable energy generation. However, many renewable energy projects on agricultural land simply consist out of placing photovoltaic elements on this land, without consideration of the agricultural activity, which then ceases. This can have negative consequences for food security if too much farmland goes unused. It can also drive up the price of farmland due to investors speculating, causing farmers to feel pressure to sell their land and cease farming. A third negative consequence is the potential for ecological disruption, as converting farmland into photovoltaic installations can alter local ecosystems, reducing habitats for native species and impacting biodiversity.

These are all valid concerns that the public at large can be very passionate about. **Negative public attention can seriously harm the development of agrivoltaics.** This was seen in the discourse around the Italian DL Agricoltura. This law was specifically created to address the issues listed above. However, what got lost in this discourse was that agrivoltaics inherently respect agricultural activity and aim to address these issues themselves. There is a need for transparent communication about the benefits of agrivoltaics, like preserving agricultural activity, boosting local economies, and contributing to sustainable energy goals. This can help dispel misconceptions that these projects merely replace farmland with solar panels. Highlighting real-world examples of successful agrivoltaics projects and engaging with local communities through educational campaigns and participatory planning processes can demonstrate the mutual benefits for agriculture and renewable energy. By proactively addressing concerns and displaying the potential to harmonize food production and clean energy, stakeholders can ensure public buy-in and minimize conflicts that could hinder the implementation of Agri-PV technologies.

[257] Article 16 (2) (b) Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

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Recommendation: Agrivoltaics stakeholders should proactively combat misinformation about the impact of agrivoltaic systems.

F. Taxation

Agrivoltaics projects face diverse and fragmented tax frameworks across different EU countries, which can either incentivize or hinder their development. The Austrian and French models provide partial support through tax exemptions and buyback schemes, though these benefits often exclude businesses or large installations. Germany's approach of maintaining agricultural property status for agrivoltaic land exemplifies a balance between encouraging renewable energy development and preserving agricultural activities. Meanwhile, Greece's and Italy's frameworks highlight the benefits of targeted tax alleviations and fiscal incentives but suffer from inconsistency and complexity in their application.

These diverse and muddled frameworks make it difficult to find common ground for European harmonization. The European legislator also faces this issue, as the energy taxation measures keep being delayed due to difficulties finding political compromises. For agrivoltaics there is also the difficulty of combining both the tax framework for agriculture and the framework for energy generation, which can face different VAT rates and are subject to different tax exemptions.

In the absence of European legislation harmonizing tax incentives for agrivoltaic projects, Member States can still push ahead and provide necessary benefits. This can be done by streamlining tax codes for renewables, promoting dual-use land tax benefits and expanding tax exemptions to make them accessible to more groups of people.

Recommendation: States should implement clearer and more extensive tax benefits for agrivoltaic installations.

G. Interaction of Agri-PV with Key EU Policies

EU legislation has a big influence on agrivoltaics. There are pieces of legislation that has a direct impact, like the Renewable Energy Directive III mandating shorter permitting periods. This will make a noticeable difference for agrivoltaics operators. However, there are many more examples of legislation that will have an indirect but still significant effect on the agrivoltaics sector. Examples here are, on the one hand legislation which will shake up supply chains for photovoltaic elements, like the CSDDD or the Critical Raw Materials Act. On the other hand, there is important product legislation which will be crucial for the design and manufacturing process of photovoltaics, like the Cyber Resilience Act and Ecodesign standards. Furthermore, new legislation concerning data and organizational cybersecurity such as the Data Act and the NIS 2 Directive will be important for operators of connected devices, like solar panels with sensors.

The diverse range of EU legislation impacting agrivoltaics is not inherently negative. This reflects the multifaceted nature of agrivoltaic projects and their potential benefits across sectors. However, the complexity and volume of these regulations make it nearly impossible for individual small-scale farmers to fully understand and comply with all requirements independently. This regulatory burden thus necessitates partnerships with manufacturers and operators who possess the technical expertise and resources to navigate these frameworks. While these partnerships can bring valuable support and innovation, they may also limit farmers' autonomy and direct control over their land and operations.

This raises the question of how benefits are shared. While operators often provide technical expertise and upfront capital needed to develop agrivoltaic systems, farmers contribute their most valuable resource: land. Without clear agreements and protections, farmers may risk receiving disproportionately small shares of the profits, limiting their economic gains and undermining the potential for agrivoltaics

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to support rural livelihoods. To address this imbalance, the EU could establish guidelines to guarantee farmers' rights in such partnerships. These guidelines could include minimum revenue-sharing thresholds, transparency in contract terms, and mechanisms to ensure that farmers retain long-term control over their land. By taking such action, the EU can ensure fair distribution of benefits while fostering trust and participation in agrivoltaic initiatives.

Recommendation: The EU should adopt guidance on benefit-sharing between different economic operators in the agrivoltaics value chain.

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Conclusion

The legal, regulatory and policy frameworks regarding agrivoltaics are evolving at an unprecedented pace, reflecting the growing recognition of the sector's potential to address both energy and agricultural challenges. Over the course of writing this deliverable, several significant developments occurred, highlighting the dynamic nature of this policy area. Changes include mostly developments in support of agrivoltaics, such as updates to clarify definitions or to create new incentive programs, but also include some agrivoltaics-sceptic evolutions, such as the first case of legislation published to curb agrivoltaics. Despite such setbacks, most of these changes are encouraging. However, the fact that so many changes were registered in such a relatively short timeframe underscores the dynamic and evolving nature of this policy area and the need for continuous monitoring and adaptive policymaking to ensure that frameworks remain inclusive, effective, and aligned with both technological advancements and the needs and interests of various stakeholders.

The growing support for agrivoltaics across several countries, whether explicitly named as such or integrated under broader renewable energy or agricultural initiatives, demonstrates the tangible impact of earlier research on the benefits of agrivoltaics. These advancements validate the foundational work that highlighted agrivoltaics' environmental, economic, and social advantages. The importance of continued advocacy for and research about agrivoltaics should, however, not be underestimated. In order to ensure that stakeholders in the EU and beyond can continue to build on these early successes, and further expand the positive impact of agrivoltaics, it is crucial that research on agrivoltaics continues to be funded and prioritized. Future research should include further developing the evidence base regarding the benefits (and potential downsides) of the different types of agrivoltaics, including energy generation, effects on agricultural yield, the effect on biodiversity and their environmental impact.

Despite significant progress, there remains substantial room for improvement in agrivoltaics policy and in the legal and regulatory frameworks at both the EU and the Member State level. This deliverable has provided some specific suggestions on how to shape future policy that the authors hope will be valuable as a starting point for policymakers in the EU and beyond. One critical area is the establishment of a clear and consistent definition of agrivoltaics, which can serve as a foundation for coherent regulation and policymaking. This definition will play a pivotal role in shaping important decisions, such as which types of agrivoltaics projects to encourage or restrict. It is entirely reasonable for policymakers to determine that certain types of agrivoltaics are not suitable for their specific contexts; however, such decisions must be grounded in research and evidence to ensure they are informed, equitable, and effective. Policymakers can foster a balanced and sustainable development of the agrivoltaics sector through appropriate regulation by prioritizing evidence-based approaches, grounded in solid research findings.

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