



D2.4 IPV market potential and comparative long-term impact scenarios

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SEAMLESS-PV PROJECT

A novel manufacturing process for integrated photovoltaics

Integrated photovoltaics (IPVs) have demonstrated their success and impact in their use as building-integrated photovoltaics. They are also considered promising in several other sectors. Their adaptation to other industries or devices could offer surprising benefits. Unfortunately, the very need for adaptable IPV solutions hinders their expansion as their current manufacturing processes cannot create IPV solutions customised to each sector. The EU-funded SEAMLESS-PV project aims to tackle this by developing revolutionary tools for photovoltaic manufacturing as well as new IPV products that offer improved efficiency, adaptability and integrability while at the same time showcasing their cost-effectiveness in comparison to competitors.

The title of SEAMLESS-PV project is *“Development of advanced manufacturing equipment and processes aimed at the seamless integration of multifunctional PV solutions, enabling the deployment of IPV sectors”*. SEAMLESS-PV is a Horizon Europe Innovation Action started in January 2023 that will continue through December 2026.

More information can be found at:

<https://www.seamlesspv.eu/>

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EXECUTIVE SUMMARY

The present deliverable *D2.4: IPV market potential and comparative long-term impact scenarios*, describes the methodology and results from the market potential assessment of integrated PV (IPV) segments conducted in Task 2.4 of the SEAMLESS-PV project.

This assessment has been performed separately for all four IPV segments: Building integrated photovoltaics (BIPV), Infrastructure integrated photovoltaics (IIPV), Agrivoltaics (AgriPV) and Vehicle integrated photovoltaics (VIPV). A top-down approach is developed, considering characteristics of the IPV market segments previously assessed in WP2, and based on the estimated cost and competitiveness levels resulting from WP1, as well as the project's ambited performances. The potential market deployment of IPV will be estimated, with a short- to long-term vision (up to 2050) and under different scenarios illustrating market and regulatory conditions influencing the adoption of IPV.

The market potential assessment for different IPV segments was conducted using a common methodology, with an approach adapted to the nature of the segments. It is divided into two distinct sections, **technical potential** and **specific market potential** assessments.

The first section follows a multi-step process, starting with a gross technical potential defined according to the nature of the IPV segment, then systematically narrows down the scope through various exclusion hypotheses, in order to obtain a technical potential accounting for realistic parameters and economic feasibility.

The second section factors in the specific characteristics and limitations of the IPV application at hand. Using a back-casting approach, we apply the diffusion of innovations model, a tool used to describe the pattern and speed at which innovations are adopted within the market. Different growth scenarios for the IPV technologies are developed, considering the complex dynamics of the market and the regulatory environment.

The potential of **building integrated PV (BIPV)** has been studied considering its installation to take place during new constructions and renovations of buildings. Starting from building stock data and estimating suitable surfaces for integration, a cumulative serviceable addressable market (SAM) of round 16 GWp was estimated in 2030, possibly reaching a 100 GWp in 2050.

Infrastructure integrated PV (IIPV) was divided into carports and PV noise barriers (PVNB). Carports were estimated to account for a cumulative serviceable addressable market (SAM) of 10-13 GWp in 2030, and between 60 and 100 GWp in 2050. It is expected to be mostly driven by commercial carports on parking lots, a segment that is being pushed by specific policies. PVNBs on the other hand are expected to represent a much smaller market, with under a GWp estimated to be potentially installed by 2050. This is due to the assessment considering integrated PV into noise barriers only, not accounting for other types of linear PV installations exploiting surfaces near roads and railways.

Agrivoltaics (AgriPV) represents by far the largest potential out of the IPV segments studied, due to the significant surface area that agricultural land occupies. While several hypotheses of surface exclusion were performed, a cumulative serviceable addressable market (SAM) of more than 60 GWp is estimated by 2030, even for scenarios illustrating strict policies and regulations on agrivoltaics. One or more TWp could be reached cumulatively by 2050.

The assessment for **vehicle integrated PV (VIPV)** was based on the numbers of vehicles sold up to 2050, with hypotheses made on the adoption of VIPV technology and the evolution of exploited surfaces over time, and per type of vehicle. While a slow take-off is expected, with around 30 MWp estimated by 2030, the cumulative serviceable addressable market of this segment could represent more than 20 GWp in 2050.

Finally, results are discussed in regard to announced climate targets, reviewing the added values generated from environmental, social, and economic points of view. KPIs defined and calculated in T1.1 to T1.4 will serve as main variables for the long-term impact assessment. The goal of this analysis is to demonstrate the potential and attractiveness of IPV and support exploitation activities as well as the go-to-market roadmap, providing useful insights for various stakeholders both internal and external to the SEAMLESS-PV project.

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1 INTRODUCTION

1.1 Description of the deliverable content and purpose

This document contains a detailed description of the market potential assessment that has been conducted for integrated PV (IPV). The four segments of IPV studied in the project – Building integrated photovoltaics (BIPV), Infrastructure integrated photovoltaics (IIPV), Agrivoltaics (AgriPV) and Vehicle integrated photovoltaics (VIPV) – have been assessed, with IIPV further divided into photovoltaic carports and photovoltaic noise barriers (PVNB).

In total, these 5 market potential assessments follow a common general methodology, with approaches and parameters adapted to the nature of the IPV segment studied. The general methodology and its declinations for each segment are described, with the most important hypotheses detailed and discussed. The Market potential estimations results are presented up to 2050 and highlighted for 2030 & 2050. Different scenarios are developed to account for various market and regulatory conditions. The crucial role that IPV can play in achieving binding climate goals will be discussed, in regards of these scenarios. The goal of this analysis is to demonstrate the potential and attractiveness of IPV and support exploitation activities as well as the go-to-market roadmap.

1.2 Reference material

Previous deliverables from the SEAMLESS-PV have been used as reference material for the work conducted in this task, and the writing of this deliverable. Relations between deliverables are described in Table 1.1 in the next section. Previous public deliverables are available on the SEAMLESS-PV project website (<https://www.seamlesspv.eu/>).

In addition, results and hypotheses from “European transport infrastructure as a solar photovoltaic energy hub”, a study on the PV potential alongside roads and railways in Europe by the Joint Research Centre (JRC) of the European Commission [1], were incorporated in this report, as outlined in section 4.2.

Other reference material is directly cited in the text and summarized in Section 9.

1.3 Relation with other activities in the project

Table 1.1 depicts the main links of this deliverable to other activities (work packages, tasks, deliverables, etc.) within the SEAMLESS-PV project. The table should be considered along with the current document for further understanding of the deliverable contents and purpose.

Table 1.1 Relation between current deliverable and other activities in the project

Project activity	Relation with current deliverable
Task 1.1	The cost and competitiveness analyses of IPV solutions conducted in Task 1.1 supported the assumptions made for the deployment of realistic scenarios defined in this work.

Task/Deliverable 2.1	The definition and segmentation of IPV markets employed here was derived from D2.1, which had notably highlighted the split between carports and PVNB within IIPV.
Task/Deliverable 2.2	Regulations and policies encouraging the adoption of IPV solutions covered in D2.2 fed the definition of realistic development scenarios in this work.
WP6	The development of IPV conducted in WP6 contributed to providing a deeper understanding of the types of IPV systems that could be deployed from now up to 2050.

1.4 List of abbreviations

Table 1.2 List of abbreviations

Acronyms	Meaning
AgriPV	Agrivoltaics
BAPV	Building applied/attached photovoltaics
BIPV	Building integrated photovoltaics
BSO	Building Stock Observatory
EEA	European Environment Agency
GIS	Geographic Information System
HNV	High Nature Value
IIPV	Infrastructure integrated photovoltaics
LMI	Land Multi-degradation Index
PVNB	Photovoltaic noise barriers
SAM	Serviceable addressable market
SFH	Single-family houses
SOM	Serviceable obtainable market
SVF	Sky View Factor
TAM	Total addressable market
UAA	Utilized agricultural area
VIPV	Vehicle integrated photovoltaics

2 GENERAL METHODOLOGY

The market potential assessment for different IPV segments was conducted using a common methodology, with an approach adapted to the nature of the segments. It is divided into two distinct sections, **technical potential** and **specific market potential** assessments.

The first section follows a multi-step process, starting with a gross technical potential defined according to the nature of the IPV segment, then systematically narrows down the scope through various exclusion hypotheses, in order to obtain a technical potential accounting for realistic parameters and economic feasibility. While this study does not rely directly on geographic information system (GIS) data, it utilizes data derived from GIS analysis to calculate Europe-wide results. Most data used have a country-level granularity, allowing for precise hypotheses. The technical potential considers all surfaces that could be exploited by PV, not restricting it to IPV in this first step.

The second section factors in the specific characteristics and limitations of the IPV application at hand. Using a back-casting approach, we apply the diffusion of innovations model, a tool used to describe the pattern and speed at which innovations are adopted within market. The analysis is extended up to 2050, in order to provide a short- and long-term vision of its possible evolution. Different growth scenarios for the IPV technologies are developed, considering the complex dynamics of the market and the regulatory environment.

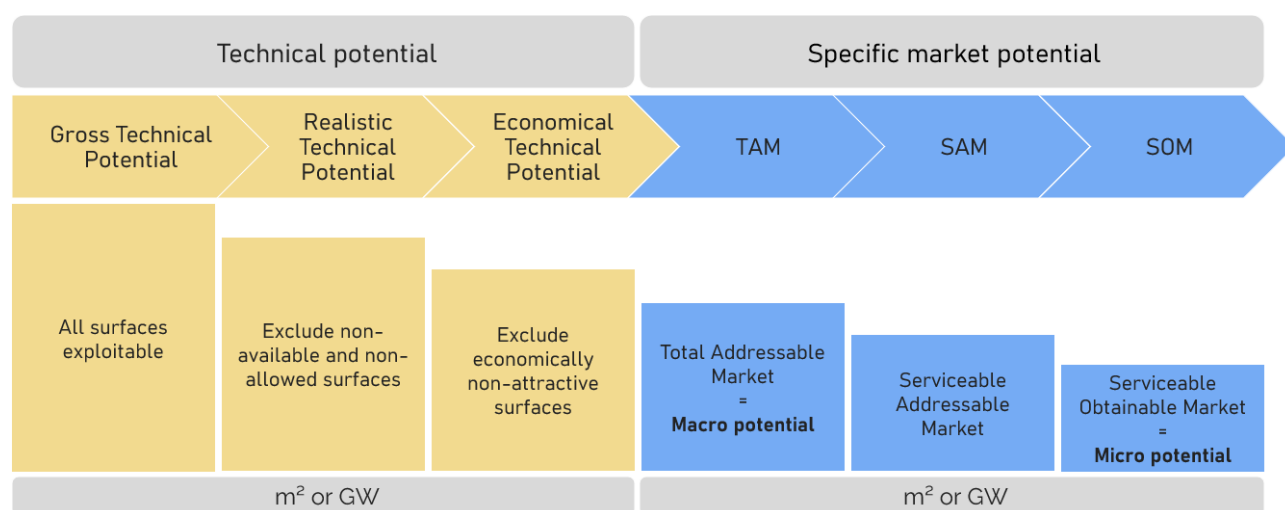


Figure 2.1: General methodology used for the assessment of IPV market potential

The **Technical potential** includes all surfaces where PV can be installed on by 2050, without making a distinction on whether it is an integrated or conventional system:

1. Gross technical potential: all exploitable surfaces for an IPV application are considered.
2. Realistic technical potential: a part of those surfaces is excluded (non-allowed surfaces, surfaces impacted by obstacles and other technical constraints).
3. Economic technical potential: economically non-attractive surfaces are excluded, such as surfaces with low PV yield. Low PV yield refers to surfaces where energy generation is relatively low for the region due to factors such as irradiance, shading and orientation.

The **Specific market potential** considers the specific requirements and limitations of the IPV technology. In other words, it is strictly the potential for the integrated solution, not the conventional counterpart. The diffusion of innovations [2] (S-curve) model is applied in this section to evaluate the potential for a given application under a particular scenario. The diffusion of innovation model dictates that innovations are adopted in stages which are represented by an S-shaped curve, resembling a logistic function (illustrated in Figure 2.2). Adoption starts slowly, as innovators and early adopters experiment with technology. Then, a tipping point occurs where the early majority adopts the innovation, leading to rapid growth. Finally, the later majority and laggards adopt it, which causes a plateau in the curve as the market becomes saturated.

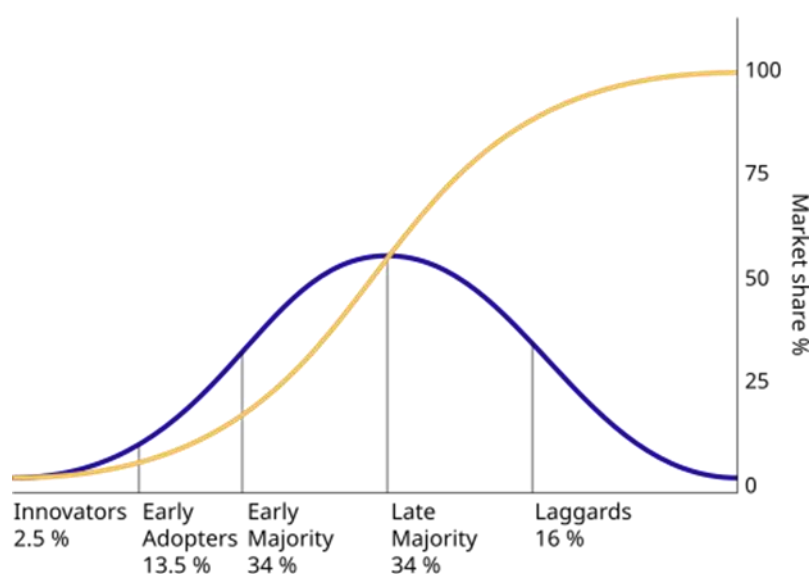


Figure 2.2: Diffusion of innovations model [2] the cumulative market is represented by the yellow line, while the annual market is represented by the blue line.

To use the model, the maximum market potential, as well as the adoption growth rate by a particular IPV application are needed. Here, the Total Addressable Market (TAM), defined below, is used as the maximum market potential.

1. Total Addressable Market (TAM): Refers to the maximum potential for a particular product [3]. It gives a sense of how big the market is for a particular application.
2. Serviceable Addressable Market (SAM): Refers to the portion of the TAM that is accessible and relevant to the application, considering limitations such as regulation, geographic zone, etc [4].
3. Serviceable Obtainable Market (SOM): Share of the SAM that can reasonably be captured by a product or an application. It considers the level of competitiveness of the application in its market.

This methodology integrates both macro and micro level analysis to provide a comprehensive understanding of market opportunities for each of the IPV applications.

The scope of this work extends to the serviceable addressable market (SAM), which is calculated for each IPV segment as a whole and presented in the results. The serviceable obtainable market (SOM), which looks at the type of product or application, will be addressed in the exploitation tasks of the SEAMLESS-PV project.

3 BIPV MARKET POTENTIAL

The assessment of the BIPV market potential in Europe has been conducted following a supply-side approach. Multiple studies have applied this method [5, 6], looking at the available surface in the building stock which can be integrated with PV. This approach considers architectural differences in each building type, construction period and country. By doing so, it provides an estimation for the available surfaces suitable for BIPV technologies. BIPV technologies have been presented in a previous SEAMLESS-PV deliverable [7].

Because BIPV serves as a construction element, it can only be installed when building renovations or new constructions take place. In other words, BIPV installations are constrained by the number of renovations and new constructions that take place every year. In this study, the market potential generated from new constructions and building renovations is included in the gross technical potential by 2050.

Section 3.2.1 presents the results for the technical potential analysis for PV on buildings, without making a distinction on whether the system is BIPV or BAPV.

In section 3.2.2, the total addressable market for BIPV presents the extent of the market that BIPV could apply to, without addressing regulatory and market aspects. On the other hand, the serviceable addressable market is influenced by two factors. First, a regulatory factor, which represents the likelihood of an economically attractive surface being “solarized”. Second, a market factor, which is used to assess competition from other PV technologies, namely BAPV. It represents the likelihood of BIPV being used to “solarize” a given surface.

3.1 Methodology

3.1.1 Technical Potential

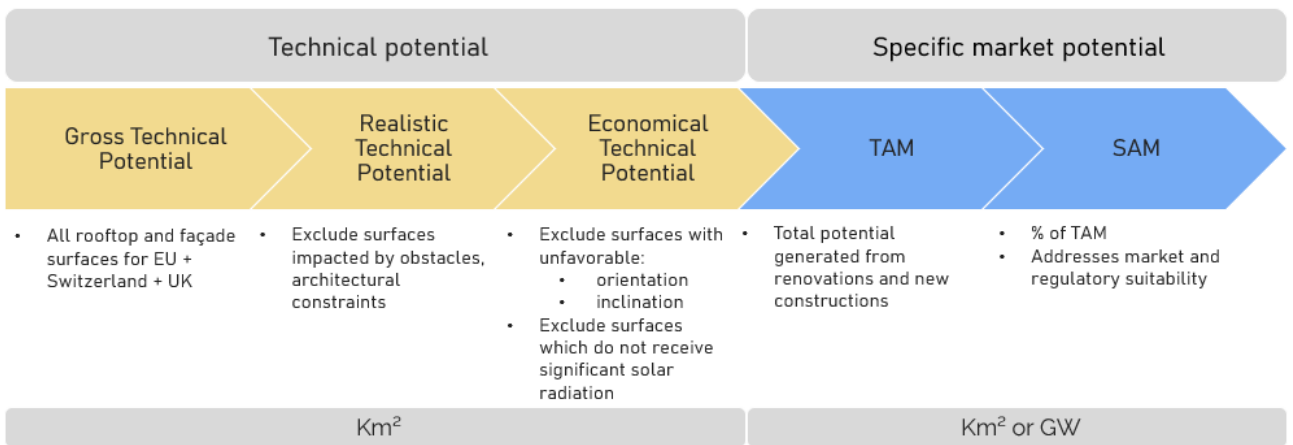


Figure 3.1: Methodology for the assessment of the BIPV market potential

The starting point of this methodology, the **gross technical potential**, includes roof and façade surfaces for each building typology, across the EU + Switzerland and United Kingdom. The constructed floor areas were obtained from the MODERATE project [8], which uses building stock data from 2020, and is the source for this information in the EU Building Stock Observatory (BSO) [9]. These areas were then transformed into roof and façade areas by applying ratios derived from

reference buildings presented in the TABULA-EPISCOPE projects [10]. These roof to ground floor and façade to ground floor ratios of area vary by country, building type and period of construction.

To calculate the market potential generated by the growth of the building stock and renovations up to 2050, annual construction and renovation rates were utilized. The new construction rates for each country were taken from the JRC [11]. For the renovation rates, two scenarios were developed, one considering the renovation wave, which is an initiative to improve energy efficiency in buildings by increasing the number of renovations [12], and the other without considering any major increase in renovation rates. For the Renovation wave scenario, rates were taken from [11]. In the No renovation wave scenario, renovation rates from the European Commission [13] were used and projected until 2050 based on the work by Sandberg [14]. Table 3.1 describes the key distinctions between the two scenarios that were analysed. The renovation rates are applied on a country-level basis for each year, differentiating between residential and non-residential buildings. Whereas renovation rates trend upwards, new construction rates are projected to decrease by 2050 in Europe [11].

Table 3.1: BIPV market potential scenarios

No renovation wave	Renovation wave
Business-as-usual scenario. No major increase in renovations.	Considering a major increase in building renovations
Average renovation rates in Europe 2020-2050. - Residential renovation rate: 1.10-1.19% - Non-residential renovation rate: 1.64-1.72%	Average renovation rates in Europe 2020-2050. - Residential renovation rate: 2.51-2.67% - Non-residential renovation rate: 2.51-2.66%
Source: [13]	Source: [11]
The new construction rates are the same for both scenarios. It ranges from 2.14-4.64% between residential and non-residential buildings in 2020, to 1.63-3.52% by 2050.	
Source: [11]	

The **realistic technical potential** only includes areas on the building envelope in which a PV installation is physically doable. An architectural suitability ratio was used to consider the reduction in the available area for PV due to architectural limitations and obstacles. In the case of roofs, obstacles, such as chimneys, necessary walkways, etc., can limit the area for PV on a roof. A reduction factor of 40% was used, based on [15]. Due to the lack of available information about the architectural suitability for different building typologies, no distinction was made between them when applying these ratios.

For façades, this factor considers areas with insufficient space for PV modules, obstacles, etc. It is approximately 35% that is subtracted from the initial surface [16]. Furthermore, in this study, the potential for BIPV in windows is not considered, and therefore window areas are excluded from the façade areas, based on data from TABULA-EPISCOPE (note that this does not exclude the potential for curtain wall applications). Here too, no distinction was made between different building typologies.

The **economic technical potential** is then obtained by only including areas which receive sufficient solar radiation. Because of the complexity of urbanized areas, with neighbouring buildings, vegetation and nearby objects being possible sources of shading, this was achieved using a solar suitability ratio. For roofs, a solar suitability ratio of 56.5% was considered to exclude unfavourable orientation, inclination and shading from surrounding elements, taken from a JRC 2019 report [15]. For façades, the solar suitability is highly dependent on building height, distance from other buildings and orientation [17]. Chatzipoulka found that the sky view factor (SVF) can be used as a predictor to estimate solar irradiation on building façades [18]. The SVF, is a measure of the portion of the sky visible from a given point on the building surface. Due to lack of available information about the solar suitability in different building typologies, the building typology was not considered when applying the solar suitability ratio. The solar suitability ratio was computed by country, taking into account the repartition of cities, suburbs and rural areas, which affect the average SVF. Using the relationship between the SVF and the solar irradiation on façades, we obtained solar suitability ratios ranging from 14 to 33%, with an average of 27%.

3.1.2 Specific market potential

Because BIPV installations are dependent on the construction of new buildings and/or renovations in the building stock, the **Total Addressable Market** (defined in section 2) for BIPV only includes the areas obtained from new construction and renovations between 2024 and 2050.

The **Serviceable Addressable Market** (defined in section 2) narrows down the scope by accounting for regulatory and market suitability. The TAM is taken as a starting point. Two factors are defined, which are influenced by: country, year, surface type (roof or façade), and building typology:

- **Regulatory suitability factor:** This ratio reflects the impact of regulations, policies and incentives to determine the share of the TAM that would actually be covered by PV. It ranges between 60% of roofs and 3% of façades in 2024, to up to 90% of roofs and 17% of façades in certain countries in 2050. This ratio was estimated based on expert insights gathered by Becquerel Institute, including the analysis of regulatory frameworks related to BIPV performed in the SEAMLESS-PV Deliverable 2.2.
- **Market suitability factor:** This ratio considers the competitiveness and market dynamics of BIPV to determine the share of PV installations on buildings that could be BIPV (and not BAPV). It ranges between 4-15% depending on the country for roofs in 2024, as well as around 85% for façades, to up to 50% of roofs and 96% of façades in 2050 in some countries. This ratio is also based on expert insights and previous publications [5] [19].

From there, the S-curve model was implemented to obtain the adoption trend for BIPV for both scenarios.

3.2 Results

3.2.1 Technical Potential

The European gross technical potential for BIPV amounted to approximately 64 000 km² in 2024 as shown in Figure 3.2

Figure 3.2. This value increases significantly when taken to 2050 because of renovations and new constructions. In the end, after reductions from the realistic and economic technical potential, only

around 12% of the gross technical potential is considered viable for BIPV, which amounts to 16 416 km².

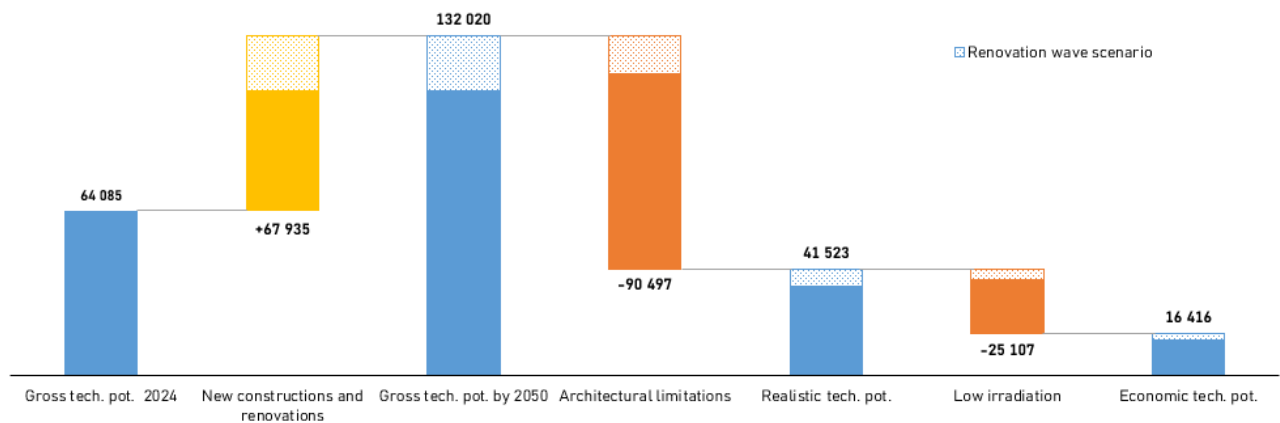


Figure 3.2: Technical potential for BIPV in Europe [km²]. An increase in the total considered value is shown in yellow, while a decrease is shown in orange.

Figure 3.3 shows the distribution of the BIPV market potential in the residential and non-residential sectors, as well as for the surface type, roof or façade. 69% of the potential for PV on buildings comes from the residential sector. 43% of the potential comes from façades, which is a large share, but makes sense considering that buildings usually have a greater vertical area than roof area.

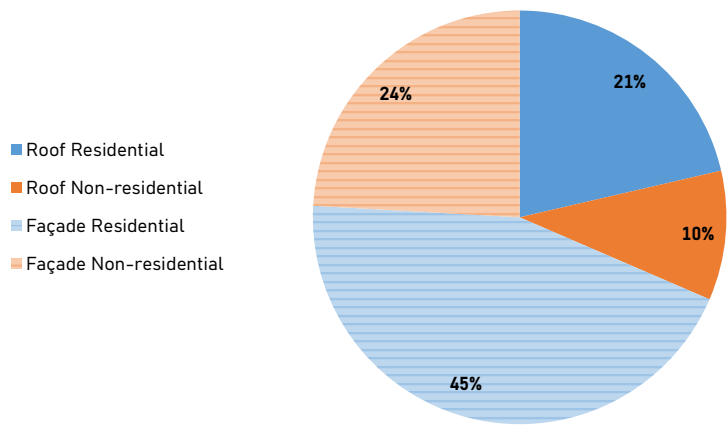


Figure 3.3: Share of façade and roof gross technical potential in 2024 for residential and non-residential buildings

3.2.2 Specific market potential

The installation of BIPV takes place only when a building is being renovated, or in the construction of a new one. So, we assume the BIPV market potential to be limited by the number of renovations and new constructions that take place. An increase in building renovations, like the one described in the Renovation wave [12], would mean a potential increase in BIPV installations. By considering this natural limitation of the BIPV market due to building renovations and new constructions, the

total addressable market (TAM) represents the maximum possible potential this application could achieve in Europe.

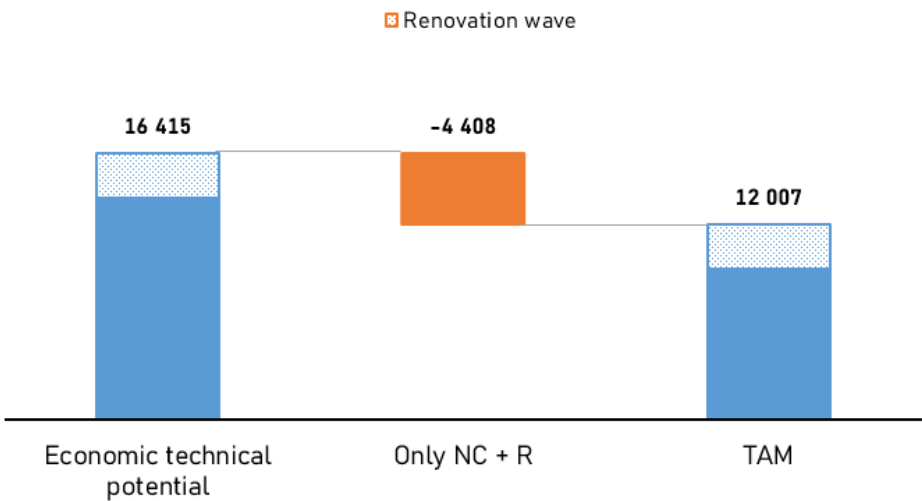


Figure 3.4: BIPV total addressable market by 2050 [km²]

Figure 3.5 shows the share of the BIPV market potential in the residential and non-residential sector, as well as the type of surface, roof or façade. Compared to Figure 3.3, the potential for façades has been reduced notably in the TAM because architectural limitations and low irradiation were more significant in façades than roofs. The increase in renovation rates in the Renovation wave scenario target the residential sector in particular, that is why the share of residential BIPV potential is larger in this scenario. The distribution between roofs and façades is not directly impacted by the scenarios, that is why it stays roughly the same in both cases.

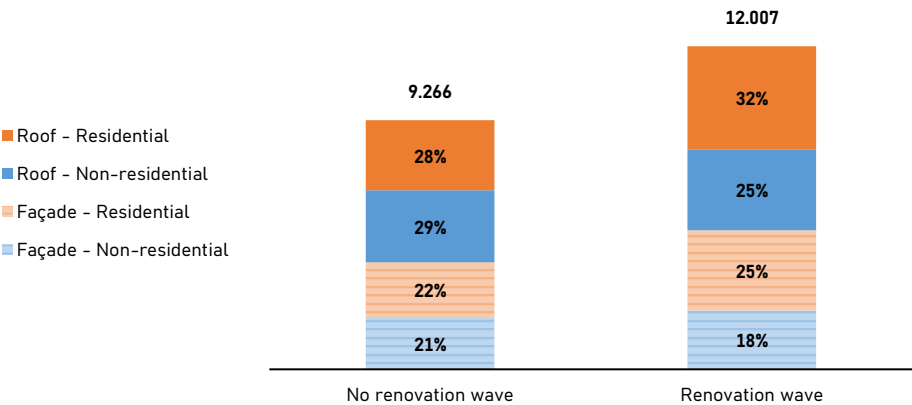


Figure 3.5: Share of residential and non-residential, roof and façade, potential for BIPV by 2050 [km²]

The **serviceable addressable market (SAM)** uses the diffusion of innovations (S-curve) model to represent the way in which the BIPV market would grow, providing an annual and cumulative potential from 2024-2050. It represents the potential for BIPV by considering its regulatory suitability and competition from BAPV. BIPV historical capacity, as well as short-term forecasts made by Becquerel Institute, were used to model the growth rate for BIPV adoption for both scenarios.

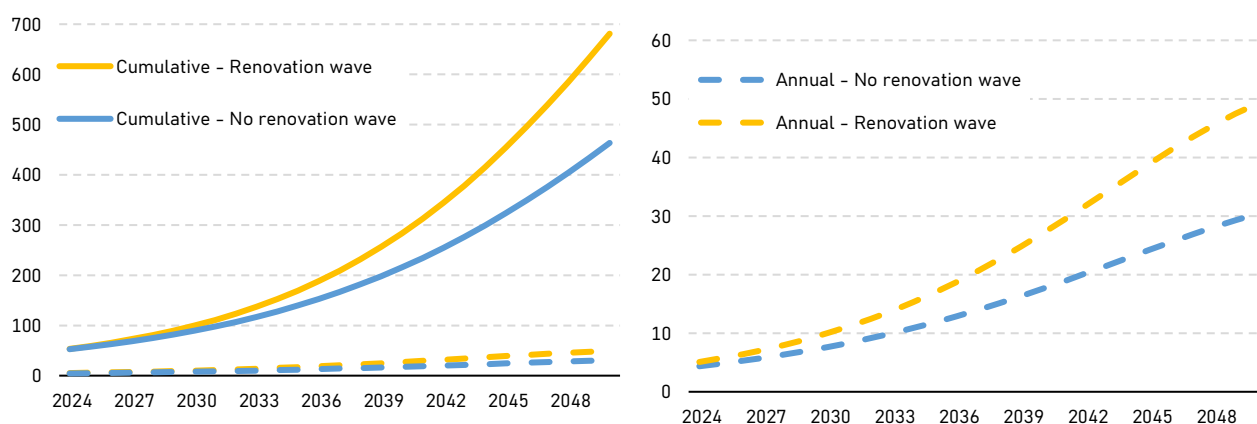


Figure 3.6: BIPV cumulative (left) and annual (right) serviceable addressable market up to 2050 [km²]

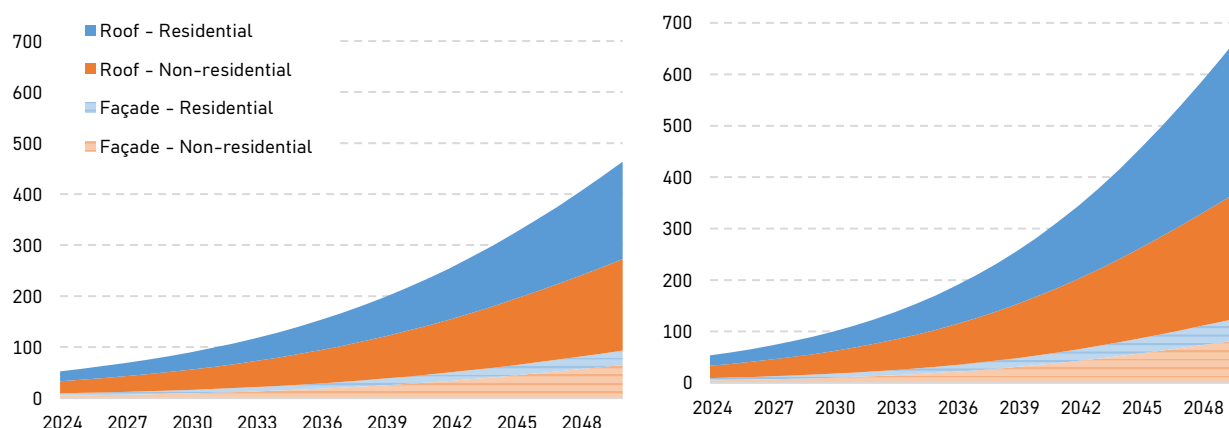


Figure 3.7: Cumulative BIPV serviceable addressable market for the No renovation wave scenario (left) and the Renovation wave scenario (right) [km²]

As shown in Figure 3.6 and Figure 3.7, the Serviceable Addressable Market for BIPV is much lower than the Total Addressable Market, due to the aforementioned regulatory and market factors. The peak annual BIPV installations have not been reached until 2050 in either scenario, which indicates that the BIPV market will continue to grow beyond that. Figure 3.8 shows that over 80% of the potential for BIPV comes from roofs, even though in the TAM, the façade and roof shares were closer to each other. This is because, especially in the residential sector, the energy needs for most buildings will be met by rooftop PV, which reduces the attractiveness of investing in a BIPV façade.

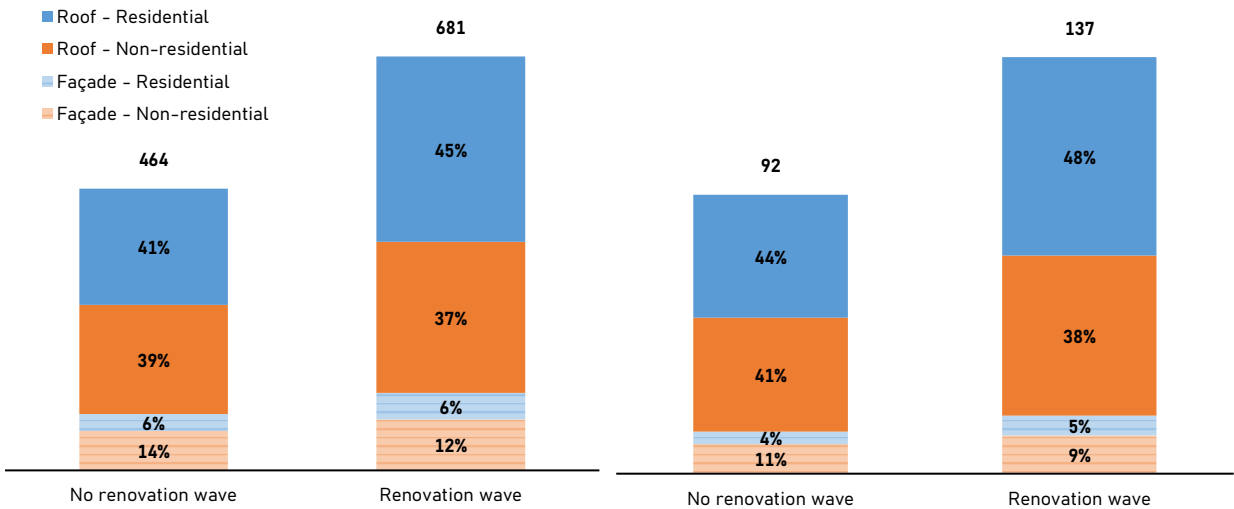


Figure 3.8: Share of residential and non-residential, roof and façade, serviceable addressable market for BIPV by 2050 in km² (left) and GW (right)

The area values were converted to capacity (GW), differentiating between roof and façade surfaces because of the specific requirements and characteristics of the types of BIPV installed in them. The ITRPV 2024 report [20], as well as case studies from multiple BIPV projects were used to estimate the evolution of the power density for BIPV until 2050. The type of cell technology, projected module efficiency, share of semi-transparent modules, and semi-transparency level were considered to make a robust estimation of the potential capacity that BIPV can represent in Europe.

Table 3.2: Power density values [W/m²]

	Façade	Roof
2025	141.3	202.6
2030	145.7	208.8
2040	151.6	216.6
2050	157.1	223.6

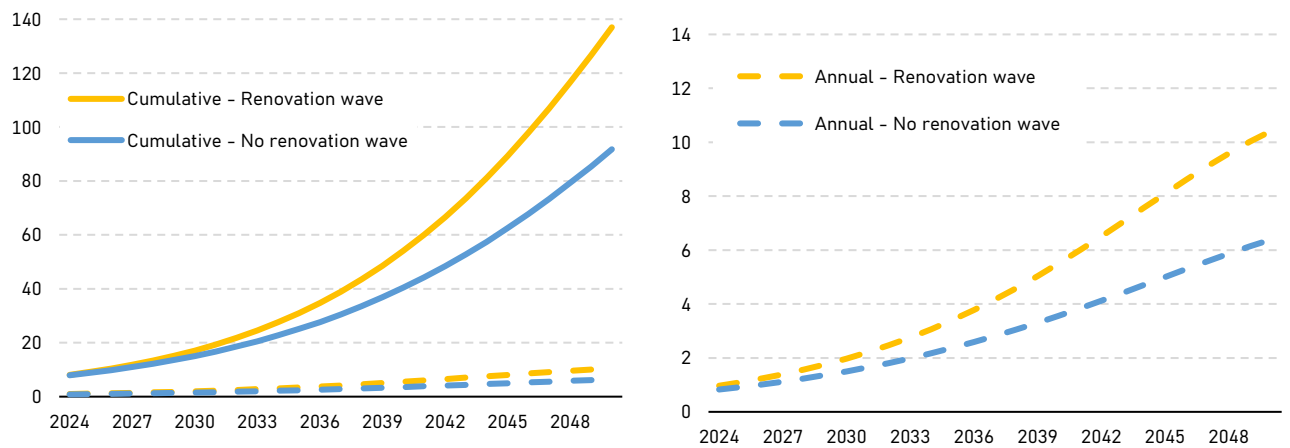


Figure 3.9: BIPV cumulative (left) and annual (right) serviceable addressable market up to 2050 [GW]

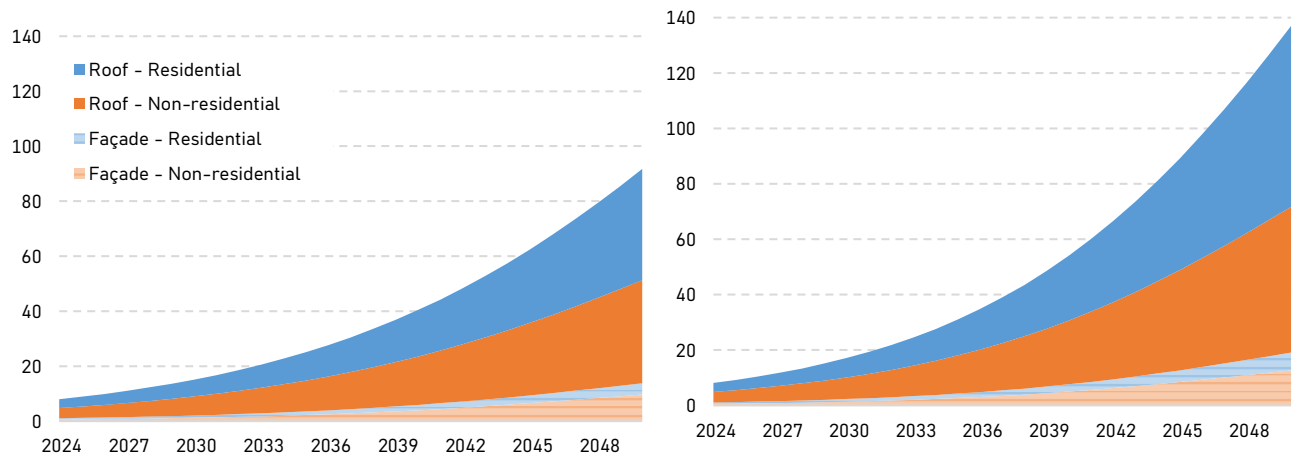


Figure 3.10: Cumulative BIPV serviceable addressable market for the No renovation wave scenario (left) and the Renovation wave scenario (right) [GW]

Table 3.3: Summary of serviceable addressable market (SAM) results for BIPV in Europe [GW]

GW	2030		2050	
Scenario	No renovation wave	Renovation wave	No renovation wave	Renovation wave
Cumulative				
Roof – Residential	6.1	7	40.4	65.3
Roof – Non-residential	6.9	7.8	37.5	52.6
Façade – Residential	0.9	1	4.1	6.5
Façade – Non-residential	1.2	1.3	9.7	12.6
Total	15.1	17.1	91.7	137
Annual				
Roof – Residential	0.6	0.8	3.1	5.6
Roof – Non-residential	0.7	0.9	2.4	3.4
Façade – Residential	0.1	0.1	0.3	0.5
Façade – Non-residential	0.1	0.2	0.7	0.8
Total	1.5	2	6.4	10.4

3.2.3 Comparison with other studies

A study from 2012 [6] estimated the total suitable roof and façade area to 4979 km². The difference with our economic technical potential can be explained by the fact that this study considered only existing dwellings, while we considered new constructions and renovations as well. In this sense, our work considers the potential for BIPV products *sales*, not strictly limited to the possible installed capacity at a given time. In other words, one location could be subject to several BIPV installations over time through renovation or demolition/new construction. The total potential is estimated at 951 GWp by this aforementioned study. In our case, the “final” potential value would, following the surfaces, be much higher. Instead, we have taken the approach of calculating the serviceable addressable market, taking into account regulatory and market factors. This provides a more realistic vision of the expected market dynamics, reducing the cumulative market to around 100 GWp by 2050.

The work conducted [5] in BIPVBOOST looked at the BIPV potential for 7 European countries (Belgium, France, Germany, Italy, Netherlands, Spain, Switzerland). The potential annual market was computed based on a supply-side analysis based on renovation and new construction rates. It estimated an annual market of more than a GWp for both France and Germany, while the revision of the methodology/assumptions performed in this study predicts an annual market of between 1,5 and 2 GWp for the whole of Europe. This discrepancy can be explained by the fact that the BIPVBOOST report was written at a time when the outlook for BIPV was more ambitious than today. Hindsight allows to evaluate that the BIPV market has been evolving slowly and is not expected to reach the GWp mark in Europe just yet.

4 IIPV MARKET POTENTIAL

The IIPV market potential assessment has been conducted on the relevant subsegments found in Seamless 2.1 deliverable [7]; PV noise barriers (PVNB), commercial carports and residential carports. Similarly to BIPV, a supply-side approach was used to analyse the available surfaces for each application.

Although there is existing literature on the potential of PV on transport infrastructure, namely a 2024 JRC study which discovered a massive potential on vertical PV along major highways and railways [1], to the author's knowledge, no previous study has been done on the potential for PV carports and PVNB at a European scale. As a result, several assumptions were made, which will be clarified for each application in sections 4.1 and 4.2.

4.1 Carports

4.1.1 Methodology

Following the methodology described in Section 2, the potential for commercial and residential carports has been split into two sections: technical potential and specific market potential. Sections 4.1.1.1 and 4.1.1.2 outline the steps to calculate these estimates for commercial and residential carports, respectively.

4.1.1.1 Commercial carports

Carport PV is a promising application that has been gaining momentum in Europe, with Germany and France (where they are called “ombrières”) having regulation in place to mandate the installation of PV in parking lots exceeding certain size thresholds or number of parking spaces [21], albeit at different levels of scope. This has been outlined in Deliverable 2.2 (Analysis of regulatory frameworks applicable to IPV systems) of the SEAMLESS-PV project [22]. Other countries, while not having regulations mandating PV installations in parking areas, have undertaken significant projects. For instance, the Netherlands has the world's largest solar car park canopy with a 35 MW capacity [23]. The rapid expansion of electric vehicles further enhances the potential for solar carports, since they can power EV charging stations [24].

A number of studies have assessed the technical potential for PV on parking spaces on a regional scale [25, 26, 27, 28], using geospatial data to estimate the surface covered by parking lots. To the author's knowledge, no study has looked into estimating the potential for commercial carports at European scale. Because of the lack of available information, some assumptions were made which are going to be explained next. Figure 4.1 provides an overview of the methodology that was followed to estimate the potential for PV on commercial carports.

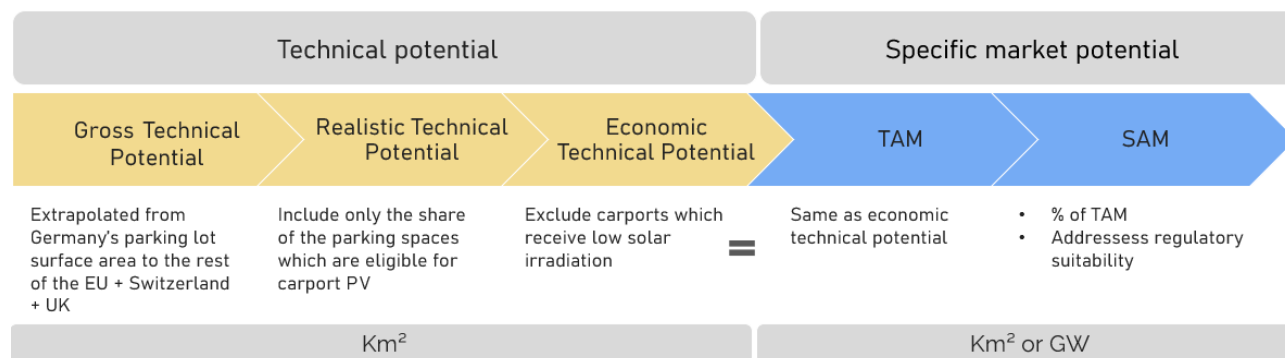


Figure 4.1: Commercial PV carports market potential methodology

The **gross technical potential** is extrapolated from the results obtained by [28] in Germany to the rest of EU countries, UK and Switzerland, according to car ownership rates taken from Eurostat [29]. To account for the growth of carports up to 2050, a growth factor was calculated based on the growth of the number of passenger cars [30] and then applied to the technical potential.

Because in most parking lots, the carport is only installed in the parking spaces, an area coverage factor was used to represent the share of parking spaces in parking lots. Based on the work by Maier, an area coverage factor of 42,2% was used. This results in the **realistic technical potential**.

For this application, the **economic technical potential** and the **Total Addressable Market (TAM)** are the same since they only include areas specific to this application. A shadow factor was used, similarly to [26], to calculate the impact of shadows and reduce the surface area by it.

For the **Serviceable Addressable Market (SAM)** a regulatory suitability factor was applied at country-level to consider the impact of a favourable regulatory environment for the adoption of carport PV. Two scenarios were defined: one optimistic, anticipating regulatory support and growth, and a more conservative scenario, reflecting slower, steady growth influenced by current trends and regulatory environment.

4.1.1.2 Residential carports

To the author's knowledge, no previous study has attempted to estimate the potential for PV in residential carports. Moreover, there is no public data on the spaces covered by residential parking areas. Figure 4.2 describes the methodology used in this study to assess the potential for PV in residential carports. This methodology poses several limitations: it does not consider existing regular carports that would require retrofitting or a complete revamp due to lack of information on the subject. Also, it assumes a single carport size for all single-family buildings, ignoring different carport configurations, or buildings which can't have a carport or have garages instead. The realistic technical potential applies a ratio to consider these factors, but it still remains a rough approximation.

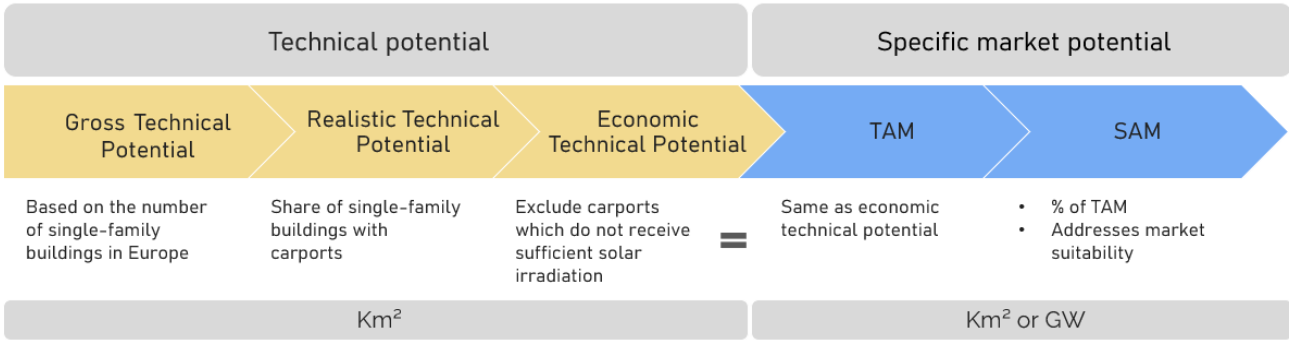


Figure 4.2: Residential PV carport market potential methodology

For the **gross technical potential**, the number of single-family buildings was taken from the MODERATE project [8] for EU countries. For Switzerland, the Swiss Federal Statistical Office was used [31] and, for the UK, the data was obtained from a BRE Trust report [32]. The average area for a carport was set at 15 m^2 , which was determined after looking at some industry cases for single vehicle carports [33] [34]. This potential was then calculated for 2050 by considering the increase in the building stock [11].

As previously mentioned, the **realistic technical potential** aims to keep only the share of single-family buildings that have or can build a carport. Since there is no available information for this, a factor of 35% is applied, in other words, it is assumed that at most 35% of single-family buildings would have a carport. This is evaluated to constitute a conservative assumption.

The **economic technical potential** works in a similar way to the BIPV economic technical potential, by disregarding areas with low solar irradiation. A solar suitability ratio of 56.5% is applied to consider factors such as unfavourable orientation, inclination, and shading from surrounding elements, as outlined in a JRC report [15].

In this case, the **Total Addressable Market (TAM)** is the same as the economic technical potential since the latter is already limited to this niche.

The **Serviceable Addressable Market (SAM)** narrows the TAM by applying a country-level market suitability factor, focusing on the share of the TAM likely to adopt PV carports instead of standard ones. The S-curve model was then used to calculate the annual potential for solar carports, considering two scenarios to reflect more optimistic and less optimistic adoption rates

4.1.2 Results

4.1.2.1 Technical potential

Figure 4.3 and Figure 4.4 illustrate the technical potential and TAM for commercial and residential carports respectively. The Gross Technical Potential is reduced significantly in both cases due to the area coverage factor in the case of commercial carports, and the 35% maximum set for residential. The economic technical potential represents a more significant reduction in the case of residential carports because they generally located in areas prone to shading from nearby vegetation, buildings or obstacles. On the other hand, commercial carports are installed in open areas with significantly less impact of shading.

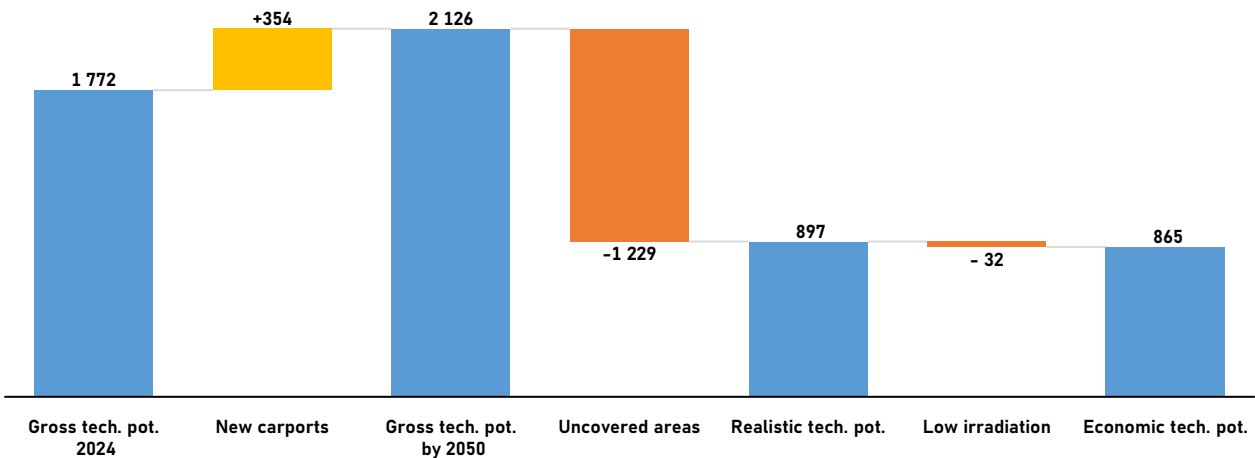


Figure 4.3: Technical potential for commercial carports [km²]

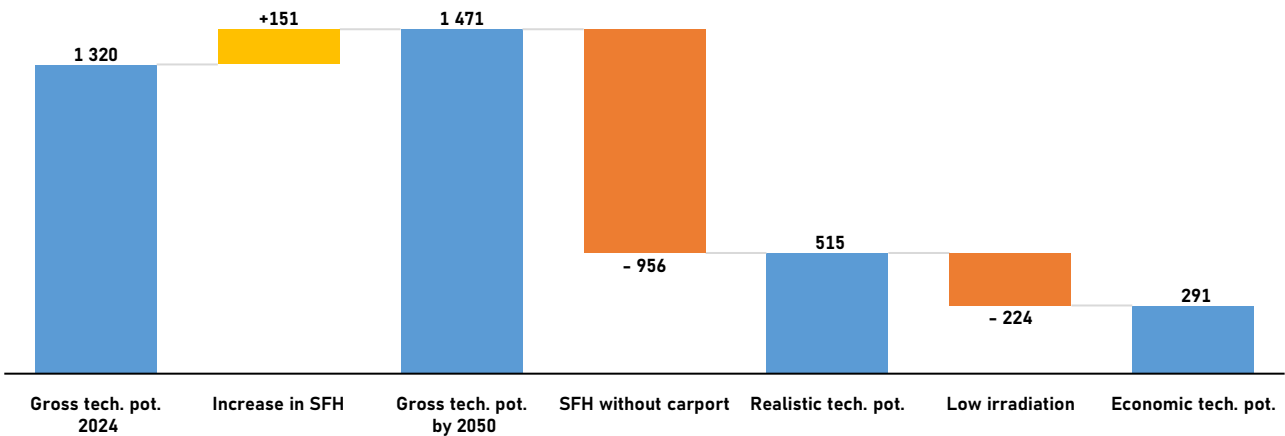


Figure 4.4: Technical potential for residential carports [km²]

4.1.2.2 Specific market potential

Two scenarios were used to illustrate the expansion of PV on carports in both residential and commercial settings. The “High” scenario represents the potential for carports with significant regulatory support, as is the case in France. The “Low” scenario is a more conservative, business-as-usual scenario.

The growth of PV carports in Europe is supported by several key factors: a favourable regulatory environment towards renewables; countries like France, which have already introduced policies mandating the integration of solar PV into carports for large parking areas; and high-profile projects, such as GreenYellow’s Carrefour partnership [35], which serve as industry benchmarks. Additionally, the rapid growth of electric vehicles (EVs) creates a strong synergy with PV carport systems, as these systems can be used as charging stations.

As shown in Figure 4.5 and Figure 4.6, the PV carport segment is projected to grow significantly, even in the Low scenario. The annual installations of commercial carports are projected to peak around 2045 in the High scenario. Residential carports will remain a small part of the carport

market, with their adoption primarily driven by personal preferences rather than regulatory conditions.

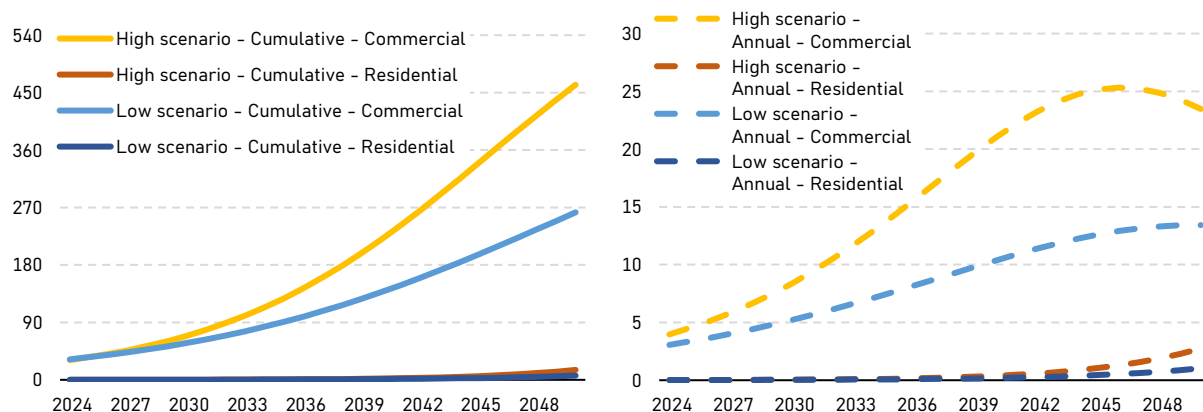


Figure 4.5: Cumulative (left) and annual (right) potential for carports by 2050 [km²]

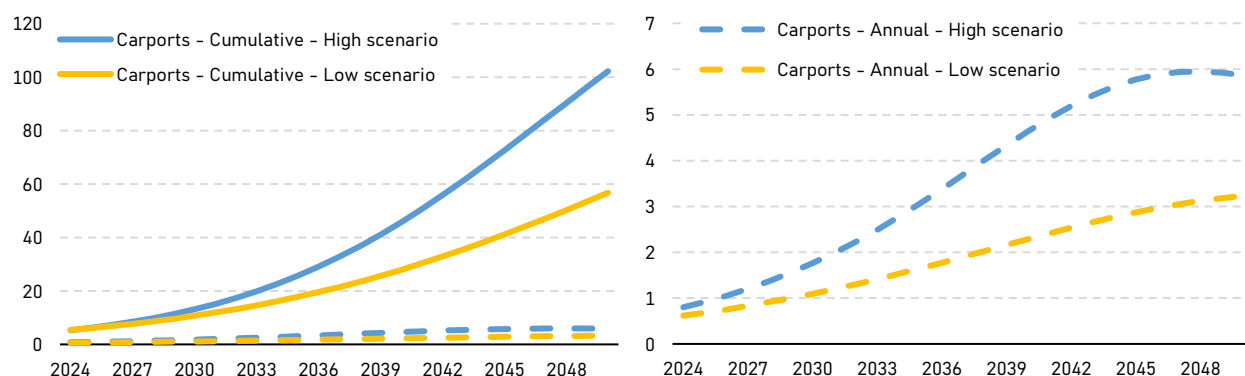


Figure 4.6: Cumulative (left) and annual (right) carport potential capacity by 2050 [GW]

Table 4.1 shows the potential for carports by 2030 and 2050. The difference between the Low and High scenario is significant, indicating the importance of regulatory support in driving the expansion of carport PV.

Table 4.1: Summary of serviceable addressable market (SAM) results for carports in Europe [GW]

GW	2030		2050	
Scenario	Low	High	Low	High
Cumulative				
Commercial	10.7	13.1	55.3	98.8
Residential	0.04	0.05	1.45	3.42
Total	10.7	13.1	56.8	102.2
Annual				
Commercial	1.09	1.75	3	5.25
Residential	0.007	0.01	0.23	0.61
Total	1.1	1.76	3.23	5.86

4.2 PV noise barriers

Although conventional noise barriers are present in many European countries, PV noise barriers are concentrated in only a few. As of 2022, there are 38 PVNB installations in Europe, 20 in Germany, 10 in Switzerland, 3 in the Netherlands, 2 in Austria, 2 in Italy and 1 in France, with a total capacity of 13,7 MW. Only 5 of these have been built on railways [36]. Adoption in other European countries has so far remain limited due to several factors; organizational barriers, technical regulations and design considerations, since the PVNB needs to fulfil its primary role as a noise mitigation structure [37].

Despite these limitations, PVNB have demonstrated their feasibility through successful projects such as the Solar Highways project in the Netherlands [38]. These structures, which serve the dual purpose of reducing noise and generating renewable energy, fit within Europe's broader efforts to achieve decarbonization and tackle environmental noise, as outlined in the Environmental Noise Directive [39]. While the deployment of PVNB is currently concentrated in a few countries, advancements in technology, growing policy support, and increasing awareness of their dual benefits are expected to drive significant growth in PVNB installations across Europe.

4.2.1 Methodology

A recent study by the Joint Research Centre (JRC) found a potential capacity of 403 GWp of vertical PV along highways and railways in the EU using satellite imagery [1]. For their analysis, they excluded any segment that goes through protected areas, secondary and tertiary roads, tunnels, bridges, junctions, trains stations and underground lines. They also considered the PV structures to be orientated perpendicular to the direction of the highway or railway segment.

Although not specific to PVNB, the results from this study are taken as **the technical potential** for PVNB in Europe, as it includes the maximum available length this application could theoretically use (**gross technical potential**), while also excluding restricted areas (**realistic technical potential**). In the case of Switzerland and the UK the lengths of railways and highways were taken from [40] and [41] respectively. A solar suitability factor is not applied in this case, since the studied considered all available segments as suitable for PV installations.

Although the average height of a noise barrier has a height of 4.2 m, an effective height of 3 m was used, since the first metre is often left empty to reduce the effects of soiling, shading and damage from debris [1].

The **Total Addressable Market (TAM)** is defined as the cumulative potential if PV were to be installed in all existing and future noise barriers until 2050. There is no available data on the extent of the noise barrier infrastructure in Europe, only some country reports and objectives. Data from [42], as well as country-level reports were used to approximate the length of noise barriers currently installed in Europe. To obtain future values, an average growth rate for noise barriers was applied to estimate the values for 2050. However, this method relies on generalized assumptions, which may not accurately reflect the actual growth trends in individual countries. Future studies and country-level reports on the length of noise barriers would improve the accuracy of this type of analysis. Table 4.2 lists the sources used for the calculation of the TAM.

Despite the technical potential data being for 2024, the same is assumed for 2050 since it does not directly impact the TAM, it is meant for illustrative purposes only, since it is not for PVNB specifically.

Table 4.2: List of sources used to calculate the PVNB Realistic Technical Potential

Type	Year	Source
Road	2021, 2023, 2024	[43], [44], [45]
Railway	2016, 2023	[46], [47], [48]
Road, railway	1999, 2016	[36], [42], [49]

The **Serviceable Addressable Market (SAM)** applies a country-level, regulatory suitability ratio to evaluate the share of the TAM that could realistically be implemented with PV. This ratio aims to account for each country's regulatory environment regarding PVNB implementation. The S-curve model is applied at this point to illustrate the growth of PVNBs in Europe under two scenarios, a High scenario with favourable regulation and support, and a Low scenario, which represents a business-as-usual scenario.

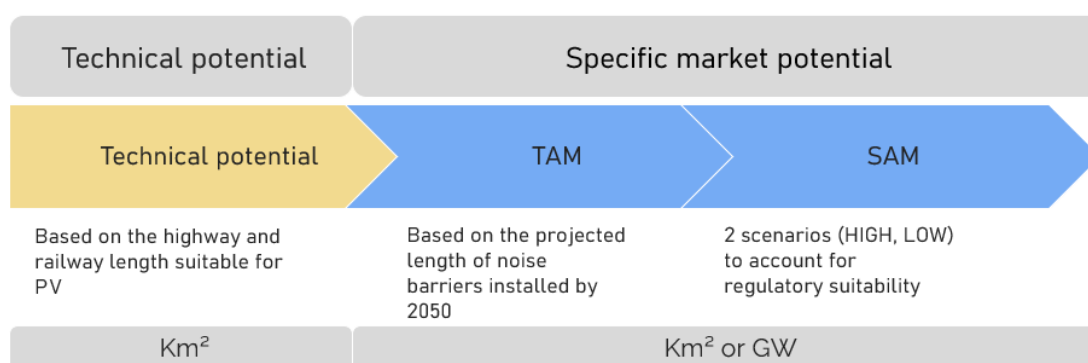


Figure 4.7: PVNB market potential methodology

4.2.2 Results

4.2.2.1 Technical potential

The technical potential comes from the JRC's vertical PV potential on transport infrastructure. It includes motorways, trunk and primary roads, as well as all operational and under construction railways. The researchers disregarded architecturally protected areas and unsuitable surfaces for PV, like tunnels or bridges. A 3 m height is used for PV along the available segments of highway and railway.

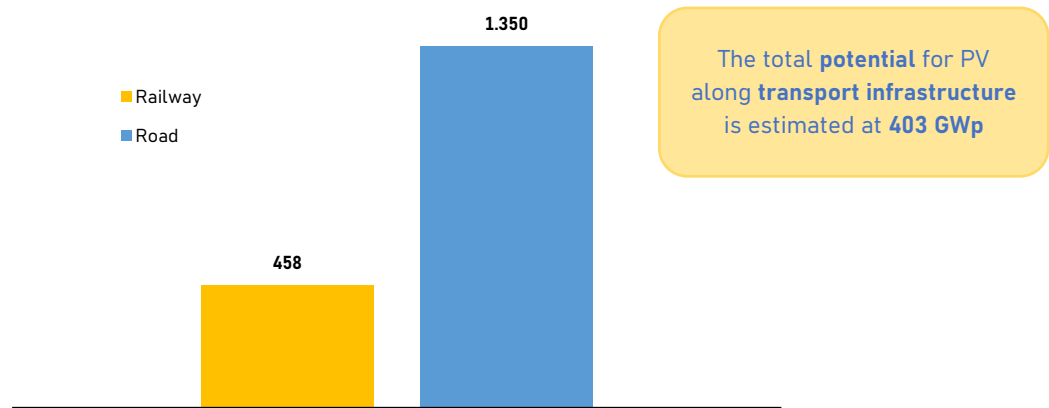


Figure 4.8: Vertical PV potential in transport infrastructure [km²]. Source: [1]

4.2.2.2 Specific market potential

Figure 4.9 shows the estimated surface of noise barriers for 2024 and 2050. It is a very small fraction of the technical potential of PV along transport infrastructure because noise barriers are only present in some built up areas. Noise barriers are projected to increase significantly by 2050 due to ongoing efforts to reduce noise pollution [39]. Noise barriers on roads represent the vast majority of current NB installations,

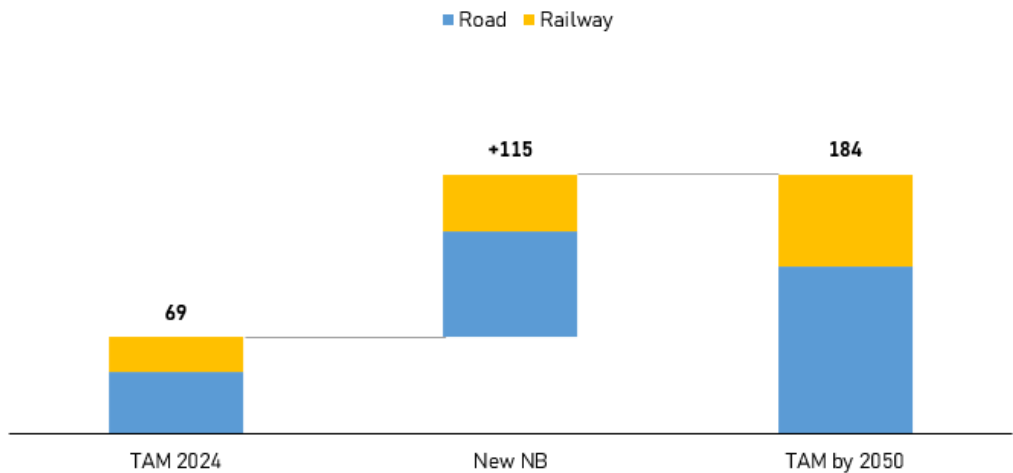


Figure 4.9: PVNB total addressable market [km²]

For the Serviceable Addressable Market (SAM), the current installed capacity was used as a reference point to model the adoption trend for PVNB. Then, two scenarios were developed: a “High” and “Low” scenario. The “High” scenario assumes a strong regulatory push of PV in new installations of noise barriers, while the “Low” scenario reflects a more conservative trajectory. In the high scenario, PVNB installations rise rapidly due to favourable regulatory conditions in more stablished markets as well as new countries incorporating this technology in the short-term. The low scenario, on the other hand, is a business-as-usual case, with PVNB installations growing

consistently but in a slower pace. European countries that currently lack PVNBs take longer to adopt this technology.

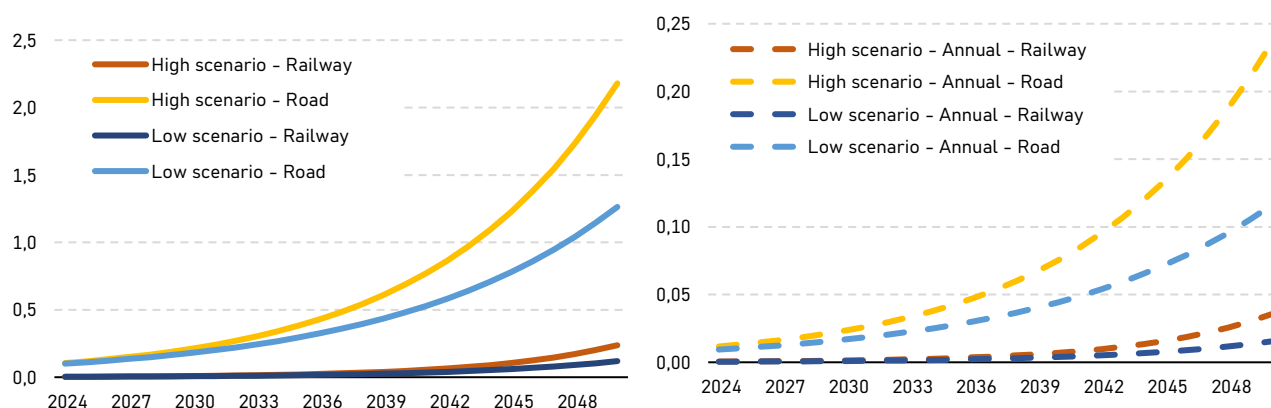


Figure 4.10: Cumulative (left) and annual (right) PVNB market by 2050 [km²]

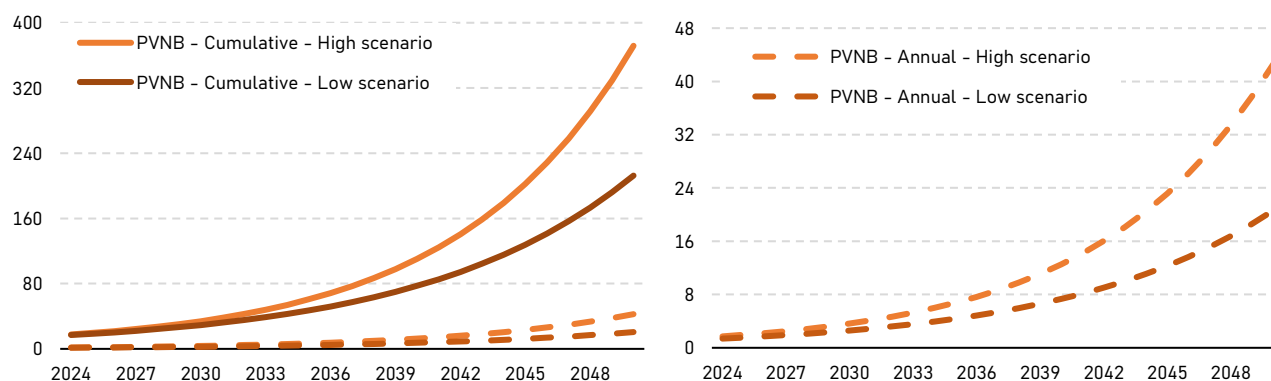


Figure 4.11: Cumulative (left) and annual (right) PVNB capacity by 2050 [MW]

The projected cumulative capacity of PVNB by 2030 and 2050 is presented in Table 4.3. PVNB is expected to grow significantly from the current installed capacity in both scenarios, its impact remains relatively minor compared to other IIPV applications such as carports. While PVNB can contribute to the overall potential of IPV, their impact is limited in scale compared to other more widespread applications. As the JRC demonstrated, the potential for vertical PV on highways and railways is massive, but noise barriers represent only a small percentage of the total transport infrastructure.

Table 4.3: Summary of serviceable addressable market (SAM) results for PVNB in Europe [MW]

MW	2030		2050	
Scenario	Low	High	Low	High
Cumulative				
Railway	1.1	1.4	18.4	36.6
Road	28	32.6	194.1	335.2
Total	29.1	34	212.5	371.8

Annual				
Railway	0.1	0.2	2.4	5.6
Road	2.5	3.4	18.2	37
Total	2.6	3.6	20.6	42.6

5 AGRI PV MARKET POTENTIAL

The potential of PV installations on agricultural land and their contribution to renewable energy targets have received significant attention. PV installations on agricultural land have been present since the early days of PV development. In many cases, agricultural activities have been replaced, redirecting land use towards electricity generation. However, as PV adoption rates increase, competition for land intensifies, leading some countries to restrict the use of agricultural land for PV installations through legislation or stringent conditions in tenders. Agrivoltaics (AgriPV) offer a distinct approach, enabling the dual utilization of land for both food and energy production. PV systems can provide valuable services to farmers by protecting crops and livestock from the increasing frequency of extreme climatic events, while generating additional revenues.

A few studies have already quantified the potential of agrivoltaics. The technical potential of agrivoltaics in Europe has been estimated at 51 TWp by researchers from Aarhus University in Denmark [50]. The Joint Research Centre of the European Commission has assessed the relative land requirement to reach different EU PV installation targets under different hypotheses of density for PV systems. It has estimated that the coverage of 1% of the utilized agricultural area (UAA) in the EU with AgriPV would account for an installed capacity of 944 GWp [51]. Ember has evaluated the technical potential of AgriPV in central Europe countries (Czechia, Hungary, Poland, Slovakia) to reach 180 GWp [52]. These numbers help fuel the high hopes set for agrivoltaics in Europe.

However, as government and developer interest in this segment has grown, so has opposition from farmers' organizations and segments of the public opinion. Concerns have arisen regarding the risks associated with "alibi agriculture" and the necessity for appropriate regulatory frameworks to mitigate conflicts over land use. Legislators face the challenge of striking a balance between achieving renewable energy production targets and safeguarding food production.

In this work, we perform our own assessment of the **technical potential** for agrivoltaics in the EU, using various hypothesis to exclude parts of the total available land. We then go one step further by evaluating the **specific market potential**, which is calculated both cumulatively and annually. The approach for this part of the assessment takes into account the possible impact on regulations affecting agrivoltaics. Several scenarios are defined, illustrating the possible effects of looser or stricter regulations. One objective of this approach is to define a so-called "minimal" potential considering numerous exclusions and limitations which could result from stricter restrictions aiming to maintain the agricultural activity.

5.1 Methodology

The agrivoltaics market potential assessment conducted in this work follows a multi-step process divided into two distinct sections. The first section involves estimating the current **technical potential** for agrivoltaics in Europe, systematically narrowing down the scope to obtain a realistic potential. The second section describes the **specific market potential** using different deployment scenarios, based on the diffusion of innovations' model, which describes the pattern and speed at which innovations are adopted in a market. The granular data for agricultural area is split according to both country and crop type, allowing for filtering during the process.

5.1.1 Technical potential

The starting point of surface area considered is the area in the EU that is actively developing agricultural activities. In the EU, this area corresponds to the utilized agricultural area (UAA), which excludes wooded areas, idle agricultural lands and virtual entities (common land units without a farm manager). The latest available data for the UAA for the 27 countries of the EU, from 2020 (therefore excluding UK), along with data for Switzerland, has been retrieved from Eurostat [53]. This represents the **Gross Technical Potential** of AgriPV. It is assumed that the utilized agricultural area will remain constant until 2050, resulting in a single value for the gross technical potential, valid for 2024 up to 2050.

A portion of this initial area was excluded, through successive exclusion steps, to obtain the **Realistic Technical Potential**:

- **Protected agricultural zones or protected landscape areas** was excluded, based on data from the European Environment Agency (EEA), which assessed the share of protected land across the EU to be 26,1% [54]. This covers both areas designated as Natura 2000 sites, and areas under other complementary national designations. These areas benefit species, ecosystems, and the environment. The EU biodiversity strategy for 2030 sets out a target of protecting at least 30% of EU land by 2030. Here, we assume equal distribution of protected areas both amongst countries and amongst UAA and non-UAA surfaces, as a simplification. The exact computation of this factor could be investigated further in future studies.
- **High Nature Value (HNV) farmland**, which is linked to biodiversity, the continuation of farming on certain types of land, and the maintenance of specific farming systems, has been excluded as well. The concept of High Nature Value (HNV) farming developed from a growing recognition that the conservation of biodiversity in Europe depends, among other, on the continuation of traditional low-intensity farming systems [55]. Country-level data on HNV farmland estimates were retrieved from the European Forum on Nature Conservation and Pastoralism, itself sourcing part of its data from JRC/EEA [56]. The percentage of exclusion is calculated for each country using the (HNV farm area) / (total farm area) ratio.
- **Prohibitive terrain**, with constraints such as excessive slope or frequent flooding, was excluded based on studies conducted in the MAGIC – Marginal Lands for Growing Industrial Crops [57], which computed the area subject to adverse terrain in Europe. 6% of the land was identified as such. Here too, we assume equal distribution of prohibitive terrain amongst countries, as a simplification.

Then, additional factors of exclusion involving economic considerations were introduced in order to reach the **Economic Technical Potential**:

- Surfaces with very low PV yield were excluded, as profitability and synergy with the crops are estimated to be too difficult to achieve. Areas with global horizontal irradiation under 876 kWh/kWp/year were excluded. In practice, only parts of Ireland, Sweden and Finland were excluded.
- Crops that are not suitable for AgriPV were excluded, such as so-called “energy crops” for example. Some of these exclusions are due to physical incompatibilities (due to height, or

indoor farming, for example), other to intrinsic opposition with AgriPV (e.g., energy crops are used solely for the purpose of making fuel. If the energy production was to be optimized at those sites, a regular ground-mounted PV plant would be installed).

In this first part of the methodology, the potential is calculated as a surface area, in millions of ha. The conversion to installed capacity in GWp is performed during the specific market potential stages.

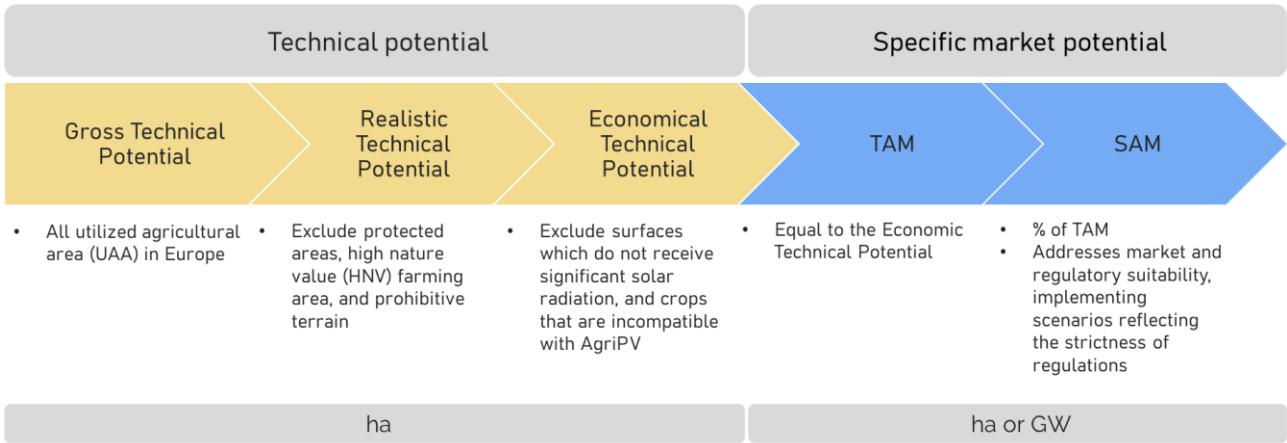


Figure 5.1: Methodology for the assessment of AgriPV market potential

5.1.2 Specific market potential

The **Total Addressable Market (TAM)** for AgriPV in Europe is assumed to be equal to the Economic Technical Potential calculated during the previous section. In other words, all utilized agricultural area that has not been excluded for any of the reasons mentioned above is assumed to be eligible for AgriPV installation.

Additional considerations are included to assess the **Serviceable Addressable Market (SAM)** for AgriPV in Europe. To achieve this, three scenarios were defined, with the aim of representing the possible impact of policy choices and regulations on agrivoltaics. Countries can choose to implement policies favouring certain types of land for development, or to restrict land use through regulations. These regulations usually have the objective of safeguarding the agricultural activity and maintaining its continuity. It can result in less freedom being accorded to the design of AgriPV systems, to accommodate the crops’ needs.

Depending on the scenario, different criteria were considered to illustrate the possible consequence of these policies or regulations. One such criteria is the prioritization of degraded soils, which could be targeted by policies for the development of agrivoltaics. In the “medium regulation” scenario, we excluded a percentage of all areas based on the Land Multi-degradation Index (LMI) [58]. Agricultural lands of LMI class 0 (no degradation) and 1 (very low degradation) were excluded to reflect this choice.

The other criteria included is the crop type selection. Some crop types can be excluded from AgriPV considerations as a result of restrictions on loss of agricultural yield, for example, if they have been shown to be too heavily impacted by the PV plant. The selection of crops applied in this work is to be considered as an example. It can represent the selection that could result from constraining regulations. Here, the “strict regulation” scenario takes this crop selection into account, in addition to the prioritization of degraded soil.

It is important to note here that there is hardly any consensus on the suitability of crops with PV systems, and that this suitability itself is very dependent on the local climate, crop variety and design of the AgriPV system. Agronomical results measuring the behaviour of plants under PV panels must be conducted over several years in order to minimize the effects of yearly or seasonal weather events, diseases, and other punctual elements unrelated to the AgriPV system itself, impacting the results. Given the relative youth of AgriPV technologies, there are only a handful of projects benefitting from sufficiently long lifespans to provide appropriate results. A reflection on the compatibility of crops and PV systems was conducted during our work based on published results. However, due the complexity of this assessment and the lack of available data, we decided to consider the selection of crops applied in this work as one example of selection, not meant to provide a definitive answer on the topic.

The table below summarizes the three scenarios considered. It can be noted that grassland, used for forage or grazing, can in some countries not be eligible for support schemes destined for agrivoltaics. Nevertheless, it has been included in all three scenarios here.

Table 5.1: Scenarios used to calculate the Serviceable Addressable Market (SAM) of AgriPV

	Loose regulation scenario	Medium regulation scenario	Strict regulation scenario
Prioritization of degraded soil	No	Yes	Yes
Selection of crops	No	No	Yes

Furthermore, restrictions such as limits on ground coverage ratio can force the deployment of AgriPV with lesser power densities (in MWp/ha). To reflect this, in addition to influencing the selected surfaces, different levels of PV power density were defined according to the scenario. Three main categories of PV systems used in agrivoltaics were considered: vertical, elevated (with or without dynamic shading/tracking), and ground-mounted (further separated in interrow ground-mounted systems for crops, and ground-mounted systems for pastures, which is more narrowly spaced and resembles regular ground-mounted PV plants). The power density of these systems, as well as the compatibility of these systems with different crop types were estimated based on literature and existing AgriPV projects.

Table 5.2: Power densities (MWp/ha) used to calculate the SAM in terms of installed capacity

	Loose regulation scenario	Medium regulation scenario	Strict regulation scenario
Average density [MWp/ha] (not accounting for crop exclusions)	0.60	0.57	0.54

Here, the power density is set to be dependent on the type of PV system only. In practice, several parameters can influence it, such as the distance between rows of PV, the placement of PV modules, and their power density and design (e.g. the spacing in between PV cells). All those parameters are set according to the irradiation that is required for the crop, and the « acceptable » loss of irradiation. We assume that the choice of PV system is the main factor for the power density. By applying one value of power density to one type of crop, we assume that it could represent several configurations corresponding to this density value.

For each of the scenarios defined above, the cumulative and annual serviceable addressable market (SAM) was computed up to 2050, based on the diffusion of innovations' model, as outlined in the general methodology in section 2 of this work. Furthermore, the results show the distribution of the SAM amongst the three main categories of crops, providing further insight into the nature of the land that is considered to constitute the specific market potential for AgriPV.

- Arable land: land ploughed regularly, generally under a system of crop rotation, used to grow crops such as cereals, root crops, vegetables, etc. [59]
- Permanent crops: land which produces year after year, such as vineyards, orchards (fruit trees), etc. [60]
- Permanent grassland: land used permanently either as pastures for grazing, or producing fodder destined for animal feed. [61]

5.2 Results

5.2.1 Technical potential

The steps operated to obtain the economic technical potential are broken down in Figure 5.2. The gross technical potential for agrivoltaics in Europe accounts for over 155 million ha. Through exclusion of land that is either protected, under high nature value farming recognition, or subject to adverse terrain conditions, a realistic technical potential of just under 78 million ha is calculated. Finally, taking into out areas subject to insufficient irradiation conditions or intrinsically incompatible with agrivoltaics, an economic technical potential of 76,6 million ha is obtained.

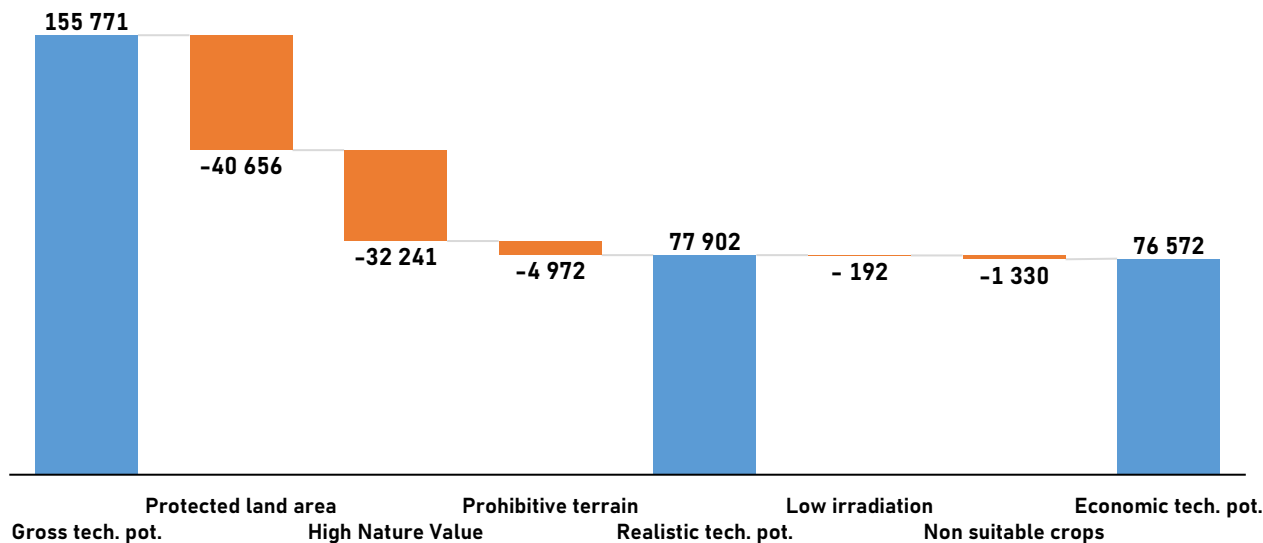


Figure 5.2: Technical potential for AgriPV in Europe [millions of ha]

5.2.2 Specific market potential

The total addressable market, here taken as equivalent to the economic technical potential of 76,6 million of ha, represents a very significant surface area, which will likely not be entirely exploited by agrivoltaics. Instead, the serviceable addressable market (SAM) assessment provides a more realistic vision of the evolution of the area that could be exploited by agrivoltaics. Figure 5.3 shows the evolution of the cumulative and annual SAM up to 2050, in surface units (Millions of ha). The conversion to the installed capacity that this would represent is performed in Figure 5.4, which shows those results in GWp. As this conversion is scenario-dependent, we observe a change in the allures of the curves, with capacity curves for stricter scenarios growing at a relatively slower pace, due to the lesser power densities considered. Although starting slowly, the general growth of the AgriPV market in Europe is expected to take off as we approach the middle of the century, with agrivoltaics increasingly seen as an important part of future PV deployment, especially in the European context where there is competition for land and not many large areas are available for ground-mounted PV plants outside agricultural areas. Despite the limitations defined in the strict regulation scenario, the cumulative installed capacity of AgriPV could reach 1 TWp in 2050 under this scenario, and up to 3 TWp for the Loose regulation scenario. However, to reach this value would require an annual market of more than 50 GWp/year from 2035, meaning more than 100 000 ha would need to be subject to agrivoltaics installations annually.

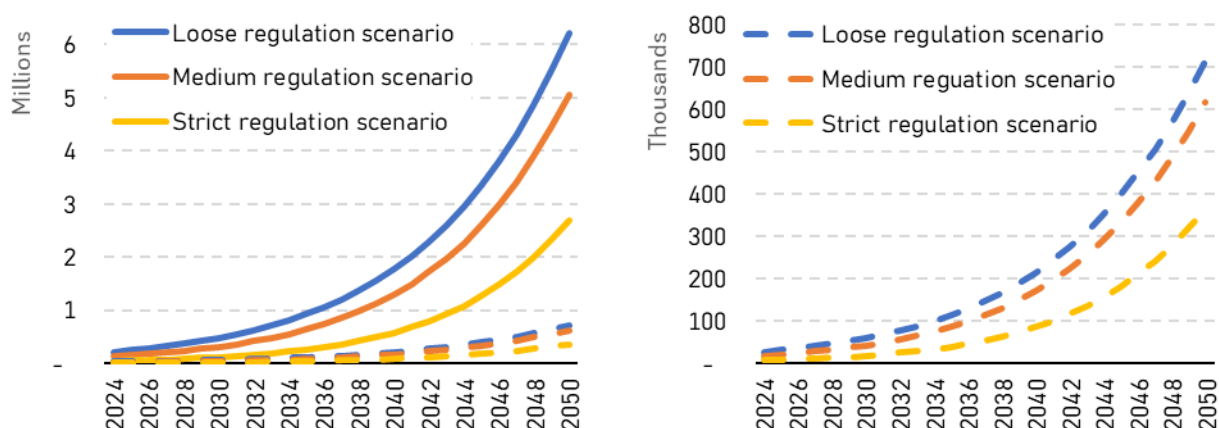


Figure 5.3: Cumulative (left) and annual (right) serviceable addressable market (SAM) for AgriPV in Europe, up to 2050 [ha]

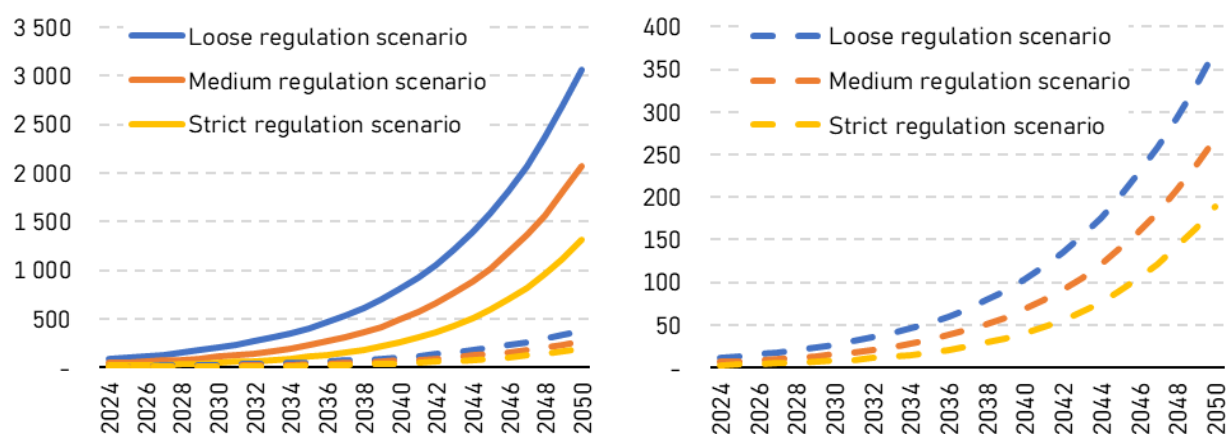


Figure 5.4: Cumulative (left) and annual (right) serviceable addressable market (SAM) for AgriPV in Europe, up to 2050 [GWp]

A closer look at the distribution of this potential among crop categories is provided for each scenario (Figure 5.5 for Loose regulation, Figure 5.6 for Medium regulation, and Figure 5.7 for Strict regulation scenario). We observe that while arable land accounts for a big part of the surface area that constitutes the market potential, its share in the capacity-based potential is much lower, with permanent grassland making up the majority. This can be explained by the fact that the power density assumed for permanent grassland is bigger than that of arable land or permanent crops, due to the type of AgriPV systems considered. Grassland can in some cases be equipped with dense systems, with pastures not being penalized by the loss of irradiation. On the other hand, AgriPV systems deployed on crops, either temporary (arable land) or permanent (permanent crops), tend to be more spaced (at row, module or even cell scale) to allow light to reach the crops. This effect is exacerbated in the case of stricter regulation scenarios, because we consider lower power densities, and because a selection is operated on the crop types, mostly impacting arable land and permanent crops categories, as the majority of permanent grassland types are assumed to be unaffected, or not negatively affected, by agrivoltaics systems.

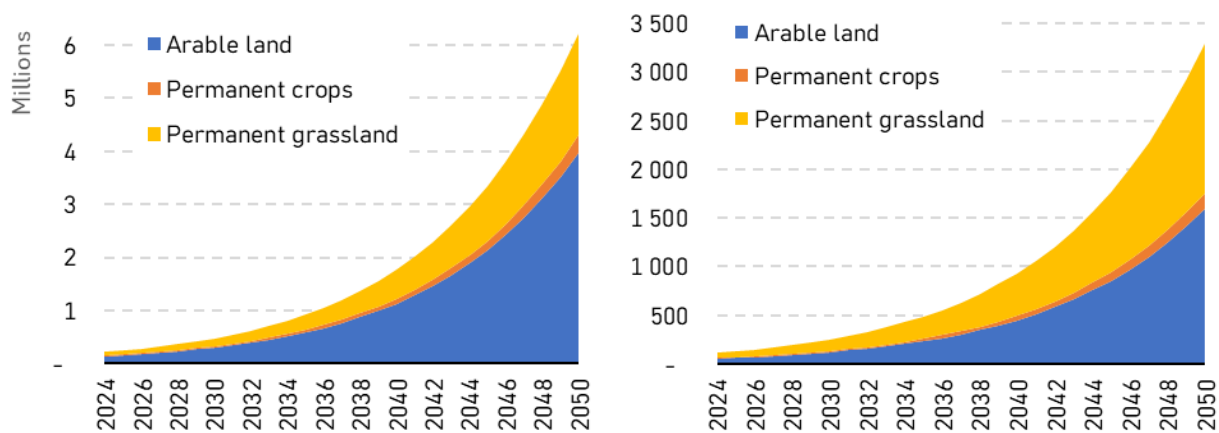


Figure 5.5: Cumulative serviceable addressable market (SAM) for AgriPV in Europe up to 2050, under the **Loose regulation scenario** in [ha] (left) and [GWp] (right)

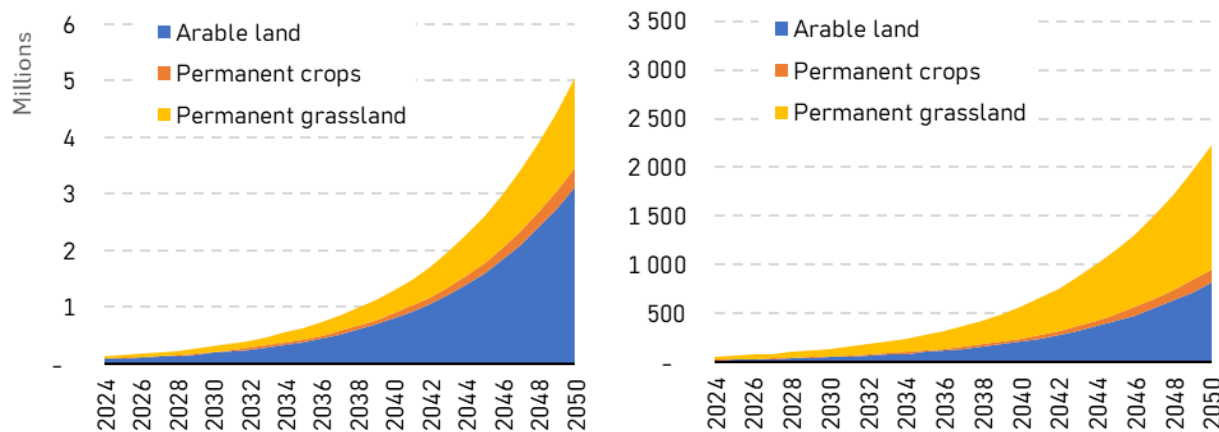


Figure 5.6: Cumulative serviceable addressable market (SAM) for AgriPV in Europe up to 2050, under the **Medium regulation scenario** in [ha] (left) and [GWp] (right)

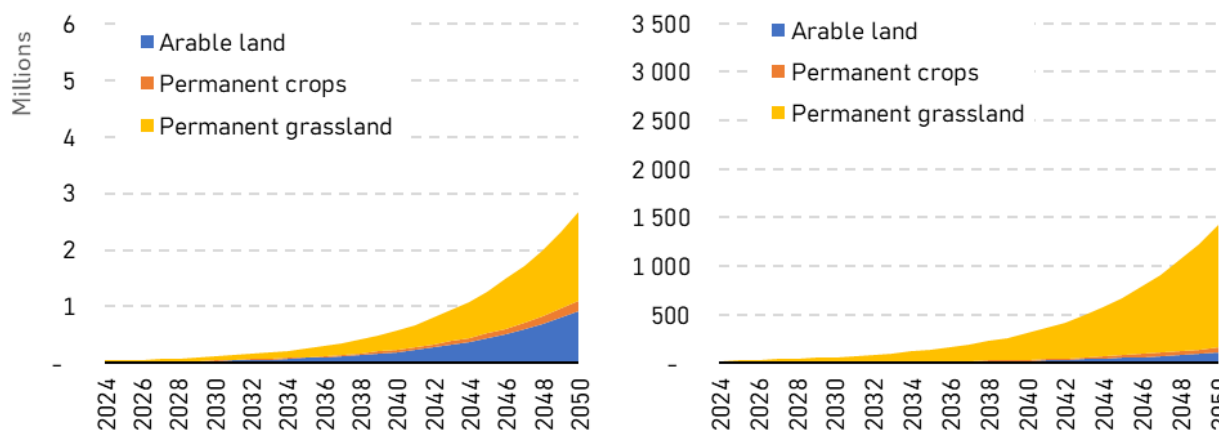


Figure 5.7: Cumulative serviceable addressable market (SAM) for AgriPV in Europe up to 2050, under the **Strict regulation scenario** in [ha] (left) and [GWp] (right)

While the drop-off in market potential between scenarios can seem drastic, especially for arable land and permanent crops, it should be noted that the obtained results remain significant and constitute an enormous potential for installed PV capacity in Europe.

The discussion on scenarios highlights the importance of assessing agrivoltaics in general, and its potential in particular, in combination with its regulatory context. The type of agrivoltaics system that is deployed, and the type of land that is exploited can change depending on policies. Furthermore, the “manner” in which agrivoltaics are developed will also be influenced by regulatory frameworks. While larger projects with bigger power densities may help reach PV installation targets faster, smaller projects showcasing synergies with the agricultural activity might achieve the dual function of AgriPV more sustainably, ensuring the continuity of the agricultural activity and food production.

Table 5.3: Summary of serviceable addressable market (SAM) results for AgriPV in Europe [GWp]

	2030			2050		
Regulation scenario	Loose	Medium	Strict	Loose	Medium	Strict
Cumulative						
Arable Land	122	50	5	1588	819	109
Permanent crops	13	9	2	166	139	56
Permanent grassland	118	78	55	1535	1274	1259
Total	252	137	62	3289	2232	1424
Annual						
Arable Land	15.0	6.8	0.7	182.1	99.8	14.8
Permanent crops	1.6	1.2	0.4	19.1	17.0	7.6
Permanent grassland	14.5	10.5	8.2	176.1	155.3	170.7
Total	31.1	18.4	9.3	377.3	272.1	193.1

While product-oriented analyses will be conducted in the exploitation tasks of this project, some takeaways regarding PV system types in combination with crop types can be highlighted.

- Permanent grasslands are likely to be exploited by regular ground-mounted PV plants, possibly with increased space between rows.
- Existing projects on permanent crops tend to use elevated PV systems, or greenhouses when relevant. Ground-mounted or vertical systems do not seem to be adapted to this type of crops.
- Arable land presents the biggest diversity of PV systems amongst existing agrivoltaics projects. AgriPV on arable land is likely to be divided between ground-mounted interrow, vertical, and elevated PV systems.

5.2.3 Comparison with other studies

The study on AgriPV potential by the JRC [51] estimates a technical potential of 944 GWp, 4 718 GWp, 9 436 GWp using 1%, 5% and 10% of UAA respectively. In our work, the cumulative serviceable addressable market by 2050 was estimated at 3 068 GWp, 2 073 GWp, 1 310 GWp using surfaces of 6,2 Mha, 5,1 Mha, and 2,7 Mha respectively. The total UAA being 155 Mha, this corresponds to 4%, 3,3% and 1,7% of the total UAA in Europe. As a result, our projections seem in line with the findings of the JRC.

Furthermore, the split amongst categories of crop type was the following: Arable land (62%), Permanent grassland (31%), Permanent crops (7%) in the JRC study. In our case the surface-based split was ranging from 34% to 64% for Arable Land, 31% to 59% for Permanent grassland, and 5% to 7% for Permanent crops, depending on the scenario. Arable Land accounts for the highest surface share in the Loose regulation scenario, which is close to the JRC results, while Permanent grassland accounts for the largest share in the Strict regulation scenario.

In terms of installed capacity, since we differentiated the power density depending on the type of crops, the share varies, as opposed to the JRC results which consider a constant power density of 0,6 MWp/ha [51]. Figure 5.5, Figure 5.6 and Figure 5.7 show the share of Permanent grassland in the installed capacity split to increase with the “strictness” of regulations. This is mainly due to part of arable land surfaces being excluded, and the density of systems on arable land and permanent crops being considered to be lower under stricter regulations, while the density on permanent grassland remains higher and constant.

6 VIPV MARKET POTENTIAL

Few studies have quantified the potential of vehicle-integrated photovoltaics (VIPV) at large scale. Studies conducted by Fraunhofer Institute, for example, focus on estimating the yield potential of different types of vehicles under various usage and irradiation conditions [62]. TNO reckons electric vehicles with solar panels could represent 10% of the market in 2030 [63]. TNO counts more than 100 truck trailers already active in Europe, highlighting the existing interest in VIPV for several type of vehicles. In this work, we look at the potential installed capacity of PV that VIPV could achieve from now to 2050 in Europe.

6.1 Methodology

The VIPV market potential assessment conducted in this work follows a multi-step process divided into two distinct sections, just like the other segments covered in this deliverable. The first section involves estimating the current **technical potential**, systematically narrowing down the scope to obtain a realistic potential. The second section describes the **specific market potential** using different deployment scenarios, based on the diffusion of innovations' model, which describes the pattern and speed at which innovations are adopted in a market. The data is split into four different vehicle categories. The analysis projects the growth of global vehicle markets and the adoption of electric vehicles (EVs). The global vehicle market and its respective projections are based primarily on historical data, market trends, and market growth assumptions. The surface of vehicles equipped with PV is projected to grow based on advancements in PV technology. PV efficiency projections rely on conservative extrapolations of current trends, with adjustments made based on historical and forecasted data for existing technologies.

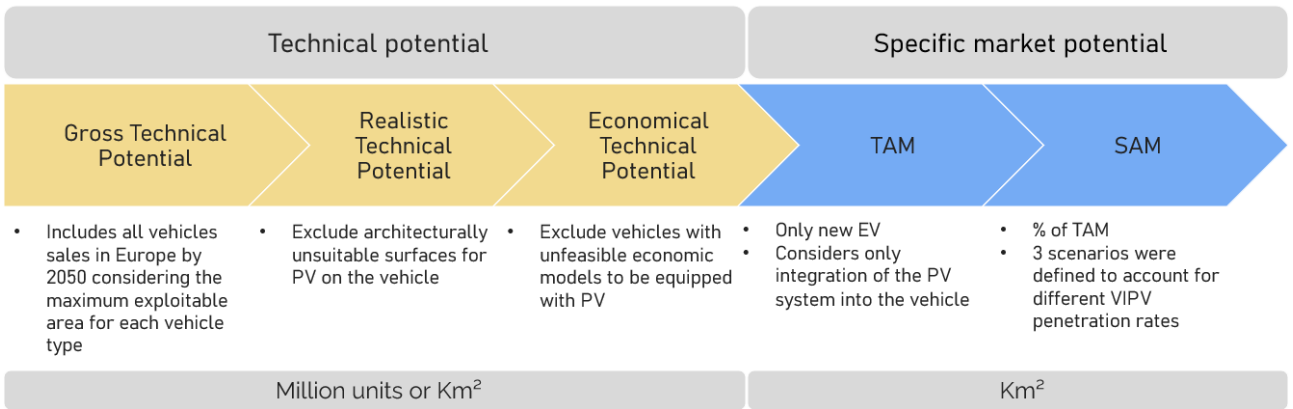


Figure 6.1: Methodology for the assessment of the VIPV market potential

6.1.1 Technical potential

The **gross technical potential** for VIPV was defined as the cumulative number of vehicles (both thermal and EV, existing and new) in Europe by 2050. Vehicle number projections were retrieved from IEA's Global EV Outlook 2024 [64]. Two scenarios were used to obtain EV sales projections, the IEA Stated Policies Scenario (STEPS), and the IEA Announced Pledges Scenario (APS). Vehicles are divided into 4 different categories:

- light vehicles (LV), or in other words passenger cars;
- light commercial vehicles (LCV), corresponding to vans;

- heavy commercial vehicles (HCV), corresponding to trucks;
- and buses.

From that point, the number of vehicles was converted in surface (km²) based on the maximum available exploitable surface estimated for all vehicle types. While these values of exploitable surfaces per vehicle were assumed for 2050, the 2024 starting point was estimated to be lower, to reflect the current state of development and costs of VIPV technologies, which are targeting surfaces most easily exploited on vehicles. The VIPV surface is based on assumptions of existing commercial options [65]. For Light vehicles (LV), limited roof and hood areas (2 m² in 2024) are assumed to gradually expand to 5 m² by 2050 with advancements in lightweight and flexible PV technologies integrating into panoramic roofs and windows. LCVs start at ~11 m², primarily from flat roofs, and grow to 22 m² with PV adoption on side panels and doors. HCVs leverage large trailer surfaces, increasing from 30 m² in 2024 to 69 m² by 2050. Buses start at 27 m² of rooftop PV and reach 46 m² by 2050 with PV integration on side panels. The **realistic technical potential** takes into account this reduction in exploitable surface.

Finally, the **economic technical potential** considers that only a share of vehicles will be subject to feasible economic models to be equipped with PV. This share depends on both the vehicle type (LV, LCV, HCV, Bus), the engine (ICE or EV) and whether the vehicles are new or existing. Generally, new vehicles are more likely to be equipped with PV, but existing vehicles could be retrofitted, or their parts could be replaced with PV-integrated parts. For passenger vehicles, ICE cars are not expected to be equipped with PV, while for commercial vehicles and buses, there could be a business model for PV installation even for ICE vehicles.

The approach used in this section resembles the one applied to buildings in section 3.1, where the economic technical potential included all types of PV installation in buildings, while the total addressable market (TAM) only considered BIPV. Similarly, at this stage no distinction is made between VIPV and vehicle “applied” PV, while the TAM will only consider actual integration (VIPV).

6.1.2 Specific market potential

From the economic technical potential, the **total addressable market (TAM)** for VIPV was defined considering only integration into vehicle body parts (no retrofitting). For this, it was assumed that mostly new, electric vehicles would integrate PV. The penetration rate of VIPV was differentiated amongst vehicle types, with passenger cars (LV) assumed to be the first to deploy PV integration in large numbers. As outlined above, the exploitable surface per vehicle was also differentiated amongst vehicle types and assumed to evolve over time to reflect technological advancements.

The **serviceable addressable market (SAM)** was calculated using the diffusion of innovations model, considering a rather slow take-off for VIPV. As uncertainties remain over the growth of VIPV penetration rates, three scenarios of adoption were defined. In this section, surface values were transformed into installed capacity by making assumptions on the projected module efficiency. The module efficiency of VIPV modules was considered based on the latest data and projection available at the time [66].

6.2 Results

6.2.1 Technical potential

The first half of Figure 6.2 shows the gross technical potential for VIPV in 2024 and by 2050, which includes all vehicles in Europe. By considering only the surfaces in the vehicle which could potentially be used to house solar panels, the realistic technical potential is obtained in km². The economic technical potential considers that only a share of vehicles will have economically viable conditions to be equipped with PV. Only EVs and a small share of regular vehicles are included in this step, as described in section 6.1.1.

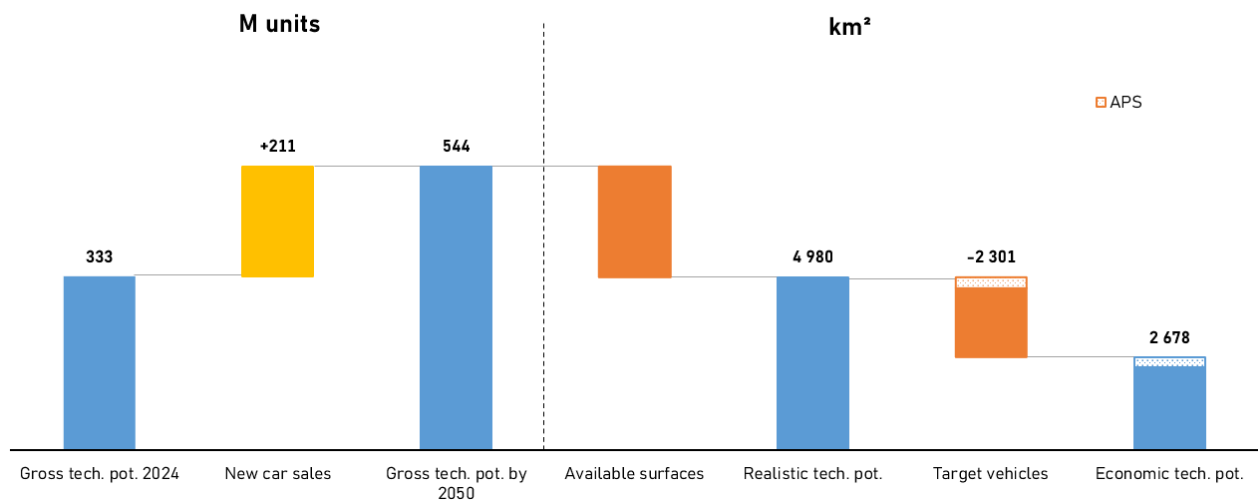


Figure 6.2: VIPV technical potential

6.2.2 Specific market potential

The **total addressable market (TAM)** only integration of the solar system into the vehicle. This is assumed to be the case only on new electric vehicles. Furthermore, the TAM accounts for the gradual increase in the exploitable surface area of vehicles overtime. As previously stated, this growth is driven by technological advancements that would allow for more sections of the vehicle to be exploitable for PV integration. As a results, the TAM presents a more realistic display of the potential for VIPV.

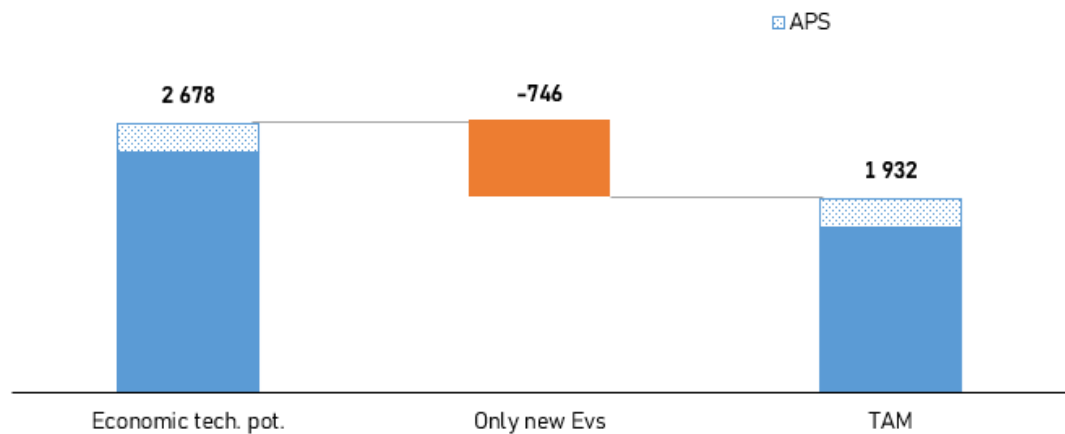


Figure 6.3: VIPV total addressable market (TAM) by 2050 [km²]

In the **serviceable addressable market (SAM)**, three scenarios are used to consider different growth trends for VIPV. The **High** scenario takes the APS EVs projections as its baseline, considering a faster adoption rate, especially for LEVs. The **Medium** scenario uses the average EVs projections from STEPS and APS, as well as taking a more moderate adoption rate. Finally, the **Low** scenario is based on the STEPS EVs projections, and it takes a lower adoption rate.

Despite the strong potential of VIPV, current adoption faces significant barriers. High production costs for specialized solar modules, technical complexity in vehicle integration, and low consumer awareness contribute to a relatively slow market entry in the early years. Maintenance and replacement of the VIPV system should be simple and similar to conventional solutions, as the added complexity could deter adoption [67]. Furthermore, it is true that increases in the energy density of batteries, or the evolution and spread of ultra-fast charging stations could impact the deployment of VIPV, since these innovations reduce the attractiveness of the extra-range created by the PV system. But it can still find its niche in higher-end vehicles, serving as a premium feature. Also, VIPV reduces grid dependency and can be used as a tool for brands to differentiate themselves from the competition.

In the Low scenario, especially, weaker policy support and slower cost declines mean these barriers remain significant for a longer period of time, flattening the initial growth curve.

Conversely, there are also important drivers that can aid in the adoption of VIPV. The accelerating EV market in Europe, boosted by emissions targets and policies in the EU, creates a robust incentive for automakers to integrate PV on their vehicles. As consumers increasingly demand sustainable mobility, VIPV offers the added benefit of extending driving range and reducing grid dependency, while maintaining the aesthetic fixtures of the vehicle. Moreover, economies of scale and improved integration technologies will lower costs, making them more appealing to manufacturers and consumers alike. Together, these factors explain the steep take-off in the early 2040s.

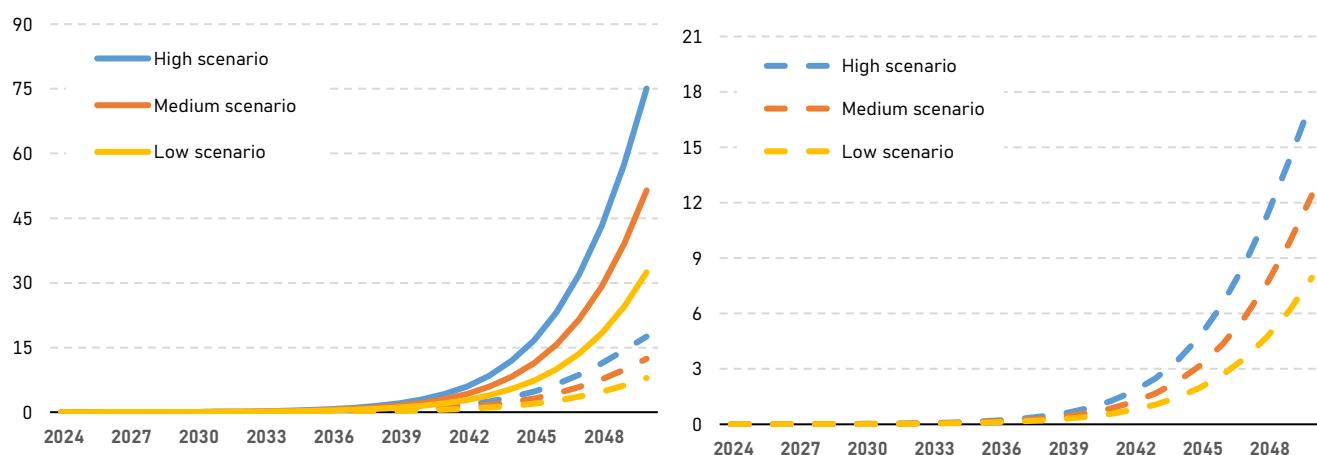


Figure 6.4: Cumulative (left) and annual (right) serviceable addressable market (SAM) for VIPV in Europe, up to 2050 [km²]

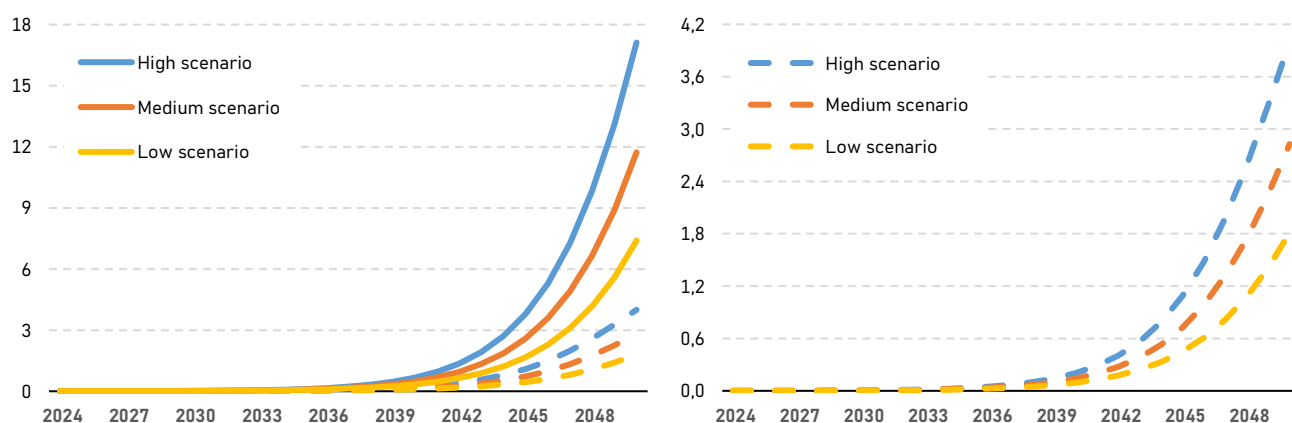


Figure 6.5: Cumulative (left) and annual (right) serviceable addressable market (SAM) for VIPV in Europe, up to 2050 [GW]

The vast majority of the potential, in all scenarios, comes from **LEVs**. This is because it is the segment with the greatest number of vehicles and an already established EV market. [67] notes that VIPV technologies are more attractive in lighter vehicles since their energy consumption is lower, meaning that the energy generated by the PV system has a bigger impact on the overall energy needs of the vehicle. **LCEVs** are the second most promising segment for VIPV, because they have a greater surface area than LEVs and large numbers (at least compared to buses and HCEV) but are not as likely to be integrated. **HCEVs** have the greatest surface area potential out of all fleet types, but fewer numbers, as well as less market incentives to pursue VIPV as opposed to vehicle-applied PV, limit its potential. Lastly, **Buses** represent a niche vehicle type with considerable surface area potential. Although electric buses are becoming mainstream, VIPV solutions are not expected to get significant traction. Instead, conventional lightweight solar panels mounted on the vehicle are more likely to be the preferred alternative.

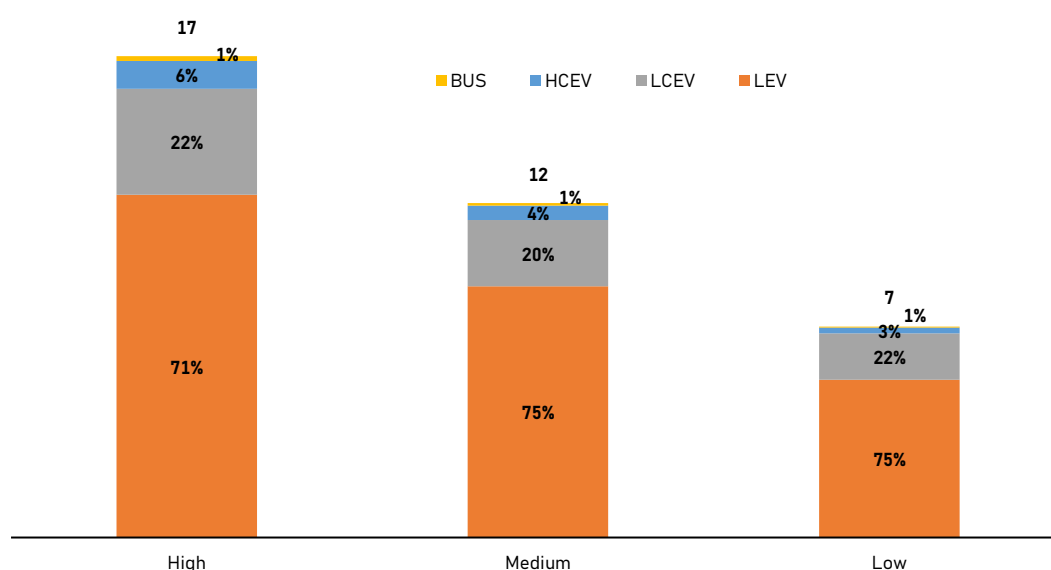


Figure 6.6: Share of vehicle type, serviceable addressable market for VIPV by 2050 [GW]

Table 6.1: Summary of serviceable addressable market (SAM) results for VIPV in Europe [MW]

	2030			2050		
Regulation scenario	Low	Medium	High	Low	Medium	High
Cumulative						
Bus	0.15	0.21	0.28	37.8	90.3	172
LCEV	3.36	3.88	4.63	1 625	2 331	3 718
LEV	6.71	8.09	9.35	5 533	8 808	12 019
HCEV	0.66	0.96	1.28	202	499	975
Total	10.88	13.14	15.54	7 398	11 729	16 885
Annual						
Bus	0.04	0.06	0.09	8.5	21.5	41.3
LCEV	1.04	1.23	1.52	392	567	898
LEV	2.22	2.77	3.27	1 364	2 118	2 778
HCEV	0.20	0.30	0.42	46.5	121	239
Total	3.5	4.36	5.30	1 811	2 827	3 955

7 DISCUSSING THE ROLE OF IPV IN CLIMATE GOALS

Table 7.1 provides a summary of the potential for each segment in the Low and High scenarios. The Renovation wave and Loose regulation scenario fall under the High scenario category, and the No renovation wave and Strict regulation scenario are represented in the Low scenario column.

Table 7.1: Summary of IPV cumulative capacities [GW]

GW	2030		2050	
Scenario	Low	High	Low	High
BIPV	15	17	92	137
Carports	11	13	57	102
PVNB	0.029	0.034	0.213	0.372
AgriPV	62	252	1 424	3 289
VIPV	0.011	0.016	7	17
Total	88	283	1 580	3 545

This section analyses how this potential aligns with European renewable energy targets. Table 7.2 provides a summary of the EU sustainability goals which IPV can contribute to.

Table 7.2: Key European sustainability targets

Target	Source/Organization	Target Year	Segment
Climate neutrality (net zero greenhouse gas emissions)	European Commission / European Green Deal	2050	General
At least 42.5% renewable energy share in final energy consumption	European Commission (REPowerEU)	2030	General
Nearly Zero-Energy Buildings (NZEB) for all new constructions	European Commission (Energy Performance of Buildings Directive)	Since 2021	Buildings
Zero-emission vehicle target	European Commission (Mobility Strategy)	2030	Transport

7.1 BIPV impact on climate goals

Of the 45% renewable energy target under REPowerEU, an indicative target of 600 GW of PV by 2030 is often used. Based on the assumptions in this study, BIPV could contribute modestly to this target, around 2.5–2.8%. In order to achieve the 2050 target of climate neutrality, a large deployment of renewable energy sources is needed, which BIPV can be a part of.

A sustainability assessment conducted in T1.2 looked into the reduction in carbon emissions that BIPV can represent as opposed to electricity from the grid. Preliminary results show a reduction of 81–86% gCO₂/kWh of the carbon footprint of BIPV systems compared to obtaining electricity from the grid. Note that these results are highly dependent on the country's electricity mix and BIPV product in question, as transparency and orientation can significantly impact the energy output.

Also, BIPV positions itself as a key alternative material for the renovation and construction of buildings in order to achieve NZEB targets. The Renovation Wave aims to renovate 35 million buildings by 2030. The potential share of BIPV amongst those renovations could be studied further in future studies. As a very simple estimation not taking into account the nature of the renovation, we could consider 75m² of surface being renovated per building. In this case, the result obtained in this study would evaluate BIPV to potentially represent around 4% of renovations by 2030 under the renovation wave scenario. BIPV's dual functionality offers an aesthetically pleasing alternative to conventional materials, while optimizing the available surface for electricity generation.

7.2 PV carports impact on climate goals

PV carports, in particular commercial ones, contribute to European sustainability and energy objectives. With a projected capacity of 11–13 GW for 2030 and 57–102 GW by 2050, PV carports contribute positively to the decarbonisation of the energy sector by enabling clean electricity generation in urban and industrial areas.

Furthermore, with the EU pushing for a widespread adoption of EVs, PV carports can serve as key infrastructure of the EV charging network, reducing grid-dependency and providing on-site renewable energy.

Finally, by making an efficient use of pre-existing urban spaces, PV carports can contribute to renewable energy production while limiting the need for additional land use.

7.3 PVNB impact on climate goals

PVNB offers dual benefits directly tight to the EU's goals: renewable energy generation and noise pollution reduction. While the projected capacity for PVNB is not as big as other IPV segments (0.034 GW by 2030, 0.372 GW by 2050), its alignment with EU environmental and health targets is significant.

The EU is unlikely to meet its 2030 noise reduction targets under the Environmental Noise Directive [39]. PVNB addresses this by serving as a proven solution to attenuate noise, while at the same time generating renewable energy. Preliminary results from the sustainability assessment conducted in T1.2 have shown, PVNB systems see a 74% gCO₂/kWh reduction of the carbon footprint from electricity generation, compared to obtaining electricity from the grid. As previously

mentioned, these results are highly dependent on the country where the installation takes place, the PVNB design and orientation.

With PVNB, the EU can simultaneously advance its REPowerEU energy targets, noise pollution goals, and carbon neutrality agenda.

7.4 AgriPV impact on climate goals

AgriPV has an unparalleled potential to advance the EU's climate, energy and agricultural objectives. AgriPV could reach 62-252 GW by 2030 and 1,424-3,289 GW by 2050, meaning that AgriPV could potentially cover 42% of the EU's 600 GW target by 2030 under REPowerEU. There is a wide gap between the Loose regulation scenario and the Strict regulation one, highlighting the need for supportive policies to untap the massive potential for this segment.

Preliminary assessments from T1.2 show that AgriPV can represent a 75% reduction of CO₂ emissions, compared to electricity from the grid. The biggest advantage of AgriPV is the optimization of land use. Although that is the case of other IPV segments as well, the importance of this is highlighted by AgriPV since the exploitable surfaces are much bigger, land-use conflicts, a key-barrier to solar expansion, are directly addressed.

As a result of all of this, AgriPV positions itself in the centre of Europe's climate, food and biodiversity goals.

7.5 VIPV impact on climate goals

VIPV advances in efforts to decarbonize transport and promote renewable energy adoption. Though it will remain niche in the near future, with a potential of only 11-16 MW in 2030, but it will increase to 7-17 GW by 2050 as the technology consolidates and becomes widely available. This exponential growth reflects its potential to transition from pilot projects to mainstream adoption, aligning with Europe's long-term climate vision. This aligns with the EU's target of carbon neutrality by 2050.

It supports the Fit for 55 transport targets by enabling self-sufficient mobility and alleviating grid congestion through decentralized, integrated electricity generation. Although modest in scale, VIPV is at the intersection of Europe's plan to decarbonize mobility and promote renewable energy use.

8 CONCLUSIONS

This report provides a comprehensive market potential assessment across four IPV segments: BIPV, IIPV (with a further distinction between carports and noise barriers), AgriPV and VIPV. A general supply-side methodology was followed, although the approach and parameters used varied according to the individual IPV segment studied. The methodology was divided into two sections: technical potential and specific market potential. The technical potential considers all surfaces in each segment that could be exploitable by PV, without making a distinction between Integrated-PV or Applied-PV. Results were calculated by 2050 under different scenarios to account for regulatory and market conditions, reflecting both optimistic and conservative trajectories.

BIPV is currently the most prevalent of the IPV segments studied in this report, and has significant potential, namely 15–17 GW by 2030 and 92–137 GW by 2050. This study also highlights the significant potential of façades, which at the moment remains mostly unused. Its integration into building renovations and new constructions aligns with the Energy Performance of Buildings Directive (EPBD), enabling zero-emission buildings while addressing urban energy needs.

At the same time, the regulatory environment and market readiness play a decisive role in the pace of BIPV adoption. The growth of BIPV will rely on policy support and continued technological improvements, ensuring that BIPV remains a cornerstone of Europe's renewable energy strategy.

The **carport** segment, covering both commercial and residential applications, offers promising opportunities, especially as supportive regulatory frameworks and policies (already in place in several countries) encourage their integration. The synergy with the rapid growth of electric vehicles amplifies their potential, positioning carports as a dual-purpose solution for both energy generation and EV charging. Nonetheless, variations in deployment are expected across markets depending on local regulatory and market conditions.

Residential carports, though smaller in scale, offer households a way to becoming energy self-sufficient. To maximize the impact the potential of carports, continues regulatory support is essential, especially since there is none in most European countries.

PVNB exemplify the EU's vision for multifunctional infrastructure, combining noise mitigation with clean energy generation. While modest in capacity (0.029–0.034 GW by 2030; 0.213–0.372 GW by 2050), PVNB addresses two pressing challenges: urban noise pollution, a priority under the Environmental Noise Directive, and renewable energy generation. Early projects, such as the Netherlands' Solar Highways initiative, demonstrate its feasibility, with systems effectively reducing noise while generating clean energy without using additional land.

Scaling PVNB requires significant policy support for both, for retrofitting existing noise barriers and new ones. So far, this technology is only prevalent in a handful of countries. By embedding PVNB into national noise action plans and spreading awareness of its feasibility, more countries and projects can be involved in the proliferation of PVNB

AgriPV emerges as Europe's most transformative IPV segment, with capacities projected to reach 62–252 GW by 2030 and 1,424–3,289 GW by 2050. This dual-use model could deliver 42% of the REPowerEU 2030 solar target, reconciling energy security with agricultural resilience. It supports crops by shielding them from extreme weather and it also generates revenue for farmers,

Yet, regulatory uncertainty threatens its potential. Strict land-use policies risk missing on its potential, while loose frameworks risk enabling “alibi agriculture.” To properly exploit AgriPV’s potential, inclusive policy support and market awareness are of essence.

VIPV is an emerging segment with its potential projected to grow from 11–16 MW by 2030 to 7–17 GW by 2050. The rapid growth of the EV market, supported by EU-wide policies, could create pathways for VIPV adoption. As the automotive industry increasingly embraces renewable energy.

Current barriers like high costs, low consumer awareness, and a lack of commercially available options hinder its growth at the moment. Innovation in integration technology, increased availability and successful launch of pilot projects can increased VIPV’s role as a contributor to Europe’s environmental targets.

Collectively, IPV segments could deliver 283 GW by 2030 (47% of REPowerEU’s 600 GW target) and 3,545 GW by 2050, positioning IPV as a key enabler of Europe’s climate neutrality goals. These segments do not only contribute to renewable energy targets but also have an important impact on reducing noise pollution, improving energy efficiency in buildings, land-use harmonization and net-zero mobility.

Across all segments, BIPV, IIPV, AgriPV and VIPV, the IPV sector is expected to see exponential growth until 2050, driven by the overall growth of the PV market and their relation to EU’s sustainability goals. While each segment faces challenges, technological innovation, policy support and increased market awareness will boost IPV’s growth.

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