

INITIAL PROJECT REPORT

D4.13

April 2013



Main Authors

Paolo Michele Sonvilla, Edoardo Binda Zane, Anna Poblocka and Robert Brückmann (eclareon GmbH)

Michel Vandenberg (DERlab)

Disclaimer: The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information contained therein.

Table of contents

INITIAL PROJECT REPORT	1
D4.13	1
1 EXECUTIVE SUMMARY	4
2 INTRODUCTION	8
3 ASSESSMENT OF NATIONAL FRAMEWORKS FOR PV DEVELOPMENT	9
3.1 Research on National Administrative Frameworks	9
3.2 Barriers to PV System Development and Operation	10
3.3 Summary of National Frameworks	12
4 ENHANCING PV HOSTING CAPACITY IN DISTRIBUTION GRIDS	29
4.1 Prioritising Technical Solutions for PV Integration	29
4.2 Preparation of Normative and Regulatory Recommendations	33
5 PV GRID CONSORTIUM	36
6 GLOSSARY	39

1 EXECUTIVE SUMMARY

PV GRID is a European project operating in the framework of the Intelligent Energy Europe Programme, started in May 2012. The project consortium is composed by 21 partners covering 16 European countries, coordinated by the German solar industry association, BSW-Solar.

The overall goal of the PV GRID project is to address the regulatory, administrative and technical requirement barriers hampering the integration of PV into the electricity distribution grids in Europe through two main actions:

- **assessing national frameworks for PV development** in the participating countries;
- **enhancing PV hosting capacity in distribution grids** by favouring the adoption of available technical solutions.

Assessment of national frameworks for PV development

Over its first year of activity, the PV GRID consortium has taken over the legacy of the previous PV LEGAL project by redesigning and extending its research activity to 16 European countries.

Procedures and Indicators

The results of this initial research activity are available in the online PV GRID database that offers, utilising a practical step-by-step approach, a description of administrative procedures and other requirements necessary to authorise, build, connect to the grid and operate a PV system in each of the participating countries. The information is presented with the aid of intuitive flowcharts, and is organised in three separate market segments: residential, commercial, and industrial ground-mounted PV systems.

The description of procedures and requirements is also complemented by quantitative indicators, obtained by measuring the hands-on experience of PV developers by means of an extensive interview campaign. An overview of the most significant indicators in each of the participating countries is offered in the following figures.

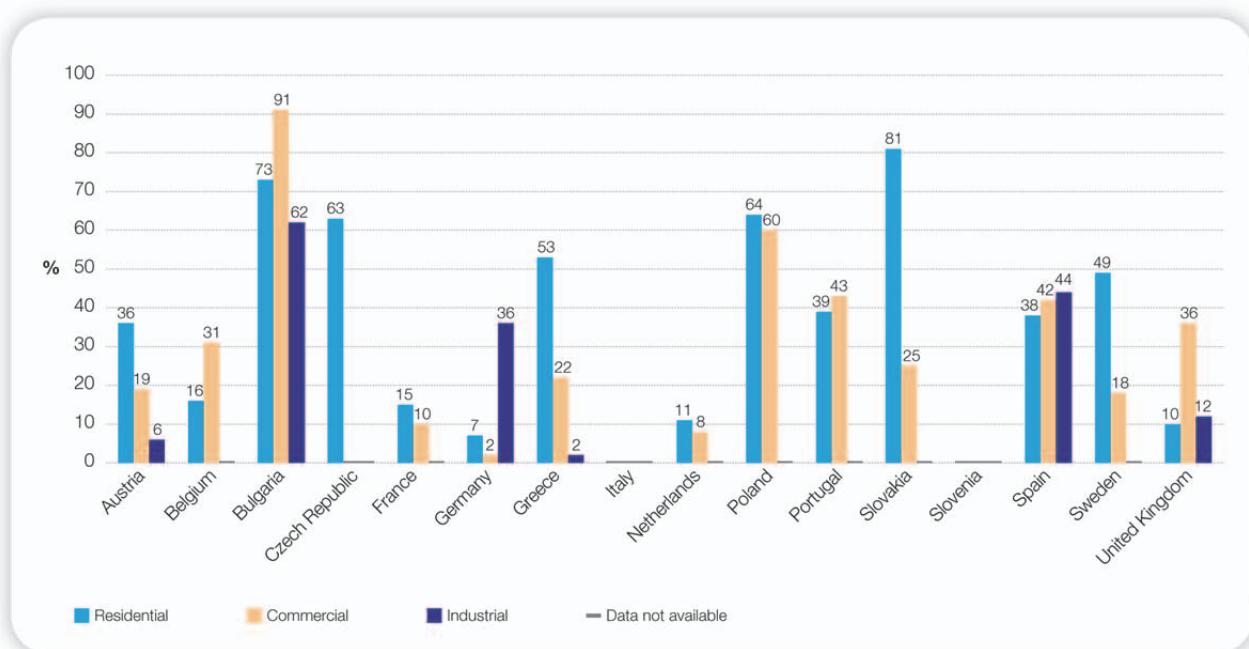


Figure 1.1 - PV project development: Legal-administrative Cost Share

The share of legal-administrative costs over total project development costs (excluding PV equipment and other materials, Figure 1.1) can provide an idea of the economic burden that project developers have to bear in order to secure the authorisations needed to build and connect a PV system. This burden is normally reflected in national PV system prices.

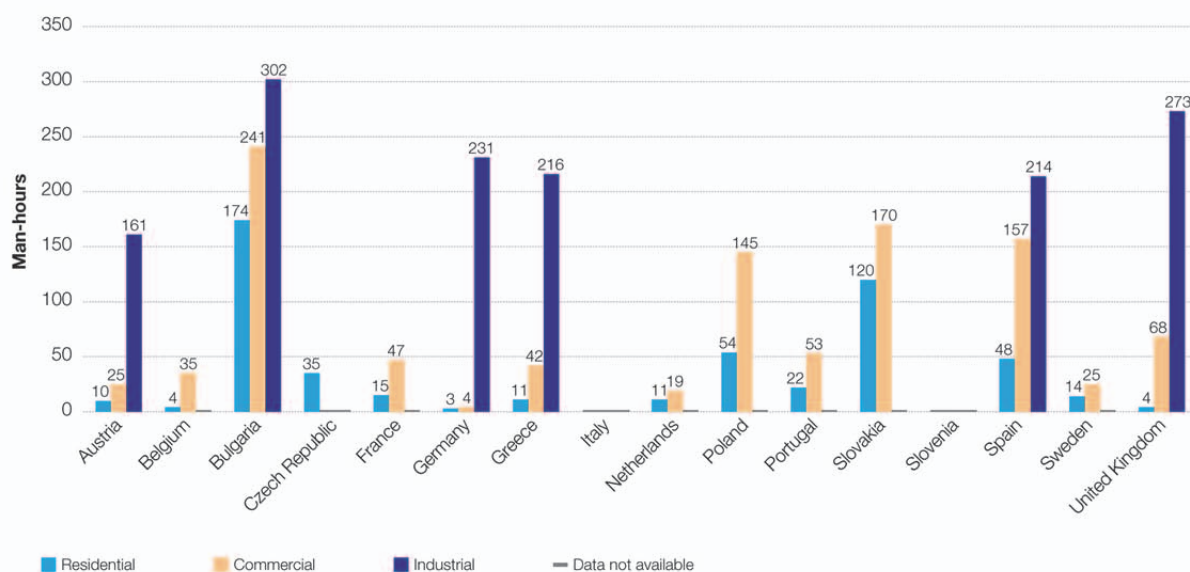


Figure 1.2 - PV project development: Legal-administrative Labour Requirements

The total labour required for accomplishing the permitting and grid connection procedures (Figure 1.2) can instead serve as a measure of the complexity and lack of transparency hidden within these administrative procedures.

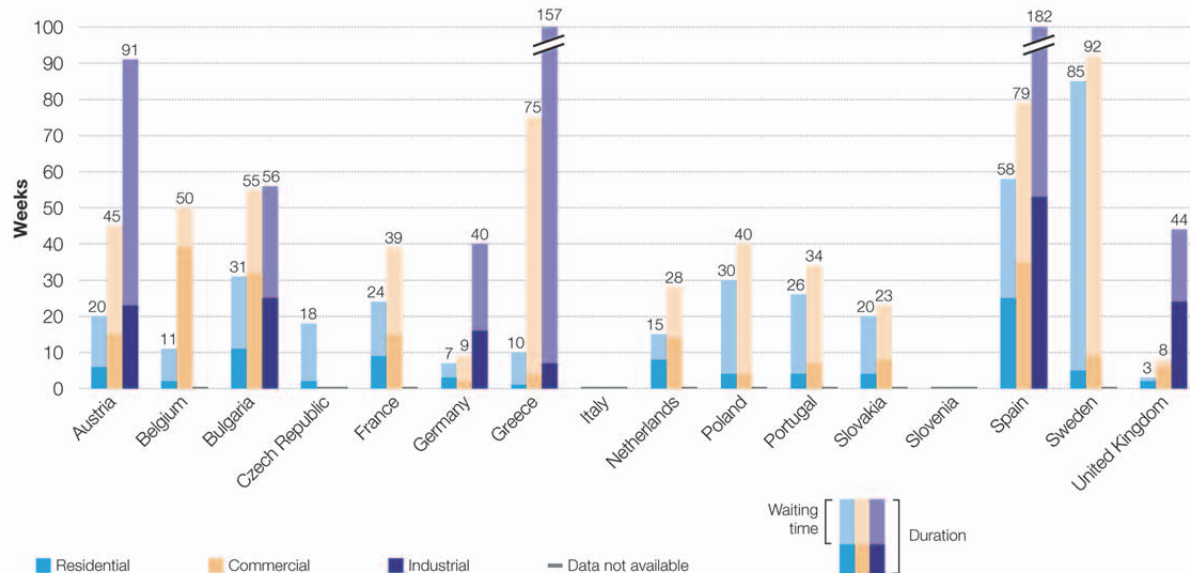


Figure 1.3 - PV project development: Duration and Waiting time

The total duration of the development process for a PV project (Figure 1.3) is another measure of the economic risk faced by investors: the more it takes to build and connect a PV system, the longer investors are financially exposed without earning revenues. Additionally, the waiting time spent uselessly by a developer waiting for an answer from an authority or a grid operator can be a measure of the inefficiency shown by such parties in dealing with their tasks.

Barriers

A relevant part of the research carried out in PV GRID deals with the assessment of barriers encountered in the development and operation of PV systems. These barriers have been identified and verified by means of qualitative research and direct communication with PV system developers active in national markets.

Even though the focus of PV GRID research activities is on administrative frameworks, it is natural that national industry associations and other interviewed stakeholders also tend to highlight barriers that are not purely administrative, but rather deal with technical requirements, regulatory matters and economical profitability issues. This information cannot be discarded and it is therefore also recorded in this report.

Following a review of the collected body of information, these barriers have been grouped in four main categories:

- **Permitting Procedures**, including barriers involved in those administrative processes necessary to authorise the construction of a PV system: e.g., building permits, environmental impact assessments, electricity production licenses;
- **Grid-related**, including barriers linked to the accomplishment of the grid connection procedures and those dealing with technical grid requirements, grid access or grid capacity issues;
- **Support-related**, including barriers related to regulatory instability and the (arguable) shortage of support schemes;
- **Operation & Maintenance**, including those barriers arising from the instability of support schemes and from administrative or technical requirements for the operation of PV systems.

The analysis of barriers found during the initial research activities will continue over the remainder of the project. In particular, the information on grid-related barriers will be fine-tuned and passed to the project partners that are responsible for the other main activity of PV GRID, the analysis of normative and regulatory barriers hindering the large-scale integration of PV on distribution grids.

Enhancing PV hosting capacity in distribution grids

To integrate higher shares of PV and other distributed energy resources (DER) in saturated distribution grids, voltage and congestion limitations need to be overcome by technical measures.

In the first phase of the PV GRID project, the most appropriate technical solutions have been identified. The suitability of these technical solutions has then been analysed by involving the expertise of distribution grid operators (DSOs) and other experts. Based on these results, in a second phase the PV GRID consortium will investigate those normative and regulatory actions that may allow a swifter and economical adoption of the identified solutions. For the PV industry it will be essential to examine all the identified technical solutions in the light of potential investment barriers arising from their complexity or their consequences on revenue generation for PV system operators.

Identification of Technical Solutions

In order to increase the hosting capacity for PV generators, firstly voltage rise mitigation and secondly congestion reduction should be addressed in distribution grids.

The list of technical solutions for enhancing the grid capacity for PV integration illustrated in Table 1.1 has been identified in the literature and within the PV GRID consortium as the most relevant for current and future electrical distribution grids.

Depending on where they can be implemented, the technical measures are categorised in DSO, PROSUMER and INTERACTIVE solutions.

- **DSO** solutions are installed and managed on the grid side and do not require any interaction with the consumers or the PV plants;
- **PROSUMER** solutions are installed beyond the point of common coupling and react on loads or generation units, without any communication need with the DSO;
- **INTERACTIVE** solutions require a communication infrastructure linking the hardware located in different grid locations.

Category	#	Technical solution
DSO	1	Network Reinforcement
	2	On Load Tap Changer for MV/LV transformer
	3	Advanced voltage control for HV/MV transformer
	4	Static VAr Control
	5	DSO storage
	6	Booster Transformer
	7	Network Reconfiguration
	8	Advanced Closed-Loop Operation
PROSUMER	9	Prosumer storage
	10	Self-consumption by tariff incentives
	11	Curtailment of power feed-in at PCC
	12	Active power control by PV inverter P(U)
	13	Reactive power control by PV inverter Q(U) Q(P)
INTERACTIVE	14	Demand response by local price signals
	15	Demand response by market price signals
	16	SCADA + load control
	17	SCADA + PV inverter control (Q and P)
	18	Wide area voltage control

Table 1.1 - Summary of technical solutions for congestion management and voltage quality issues

Prioritisation of Technical Solutions

The qualitative approach for the evaluation of technical solutions is based on a country-wise assessment by DSOs from Italy, Spain, Germany and Czech Republic and the assessment of the involved PV industry associations. However, technical solutions might not be applicable in every grid situation. This methodology was chosen to point out fundamental needs for action in terms of existing technical barriers and the surrounding regulatory framework.

Technical solutions have been evaluated considering two grid types - low voltage (LV) and medium voltage (MV) - against the following five criteria:

- Investment costs
- Impact on voltage
- Impact on congestion
- Technology readiness
- Applicability within existing regulations

Several performance indicators have been calculated from these criteria. The results obtained by ranking the technical solutions have been complemented by multi-stakeholder workshops.

The final results are two priority tables, respectively for low voltage (LV) and medium voltage (MV) grids, discussed in Section 4.

2 INTRODUCTION

Foreword

Energy imports currently contribute significantly to the trade deficit of the EU. A vigorous expansion of renewable energies is currently a recognised way to confront the dependency on energy imports. European fossil fuel resources diminish steadily and have an extremely negative CO₂ balance. Therefore, the development of photovoltaic (PV) and other renewable energy sources (RES) is not only environmentally, but also economically a valid alternative.

The PV GRID project aims to indicate how the integration of large amounts of PV and RES in the energy supply system may be facilitated, and aims to point at obstacles that hinder the development of RES. Since PV has arguably the greatest potential among renewable generation, this project focuses on this technology without entirely neglecting other RES.

PV GRID

PV GRID is a transnational collaborative effort in which sixteen national and European solar industry associations, three distribution system operators, a policy consultancy, a technical consultancy and a regulatory research institute collaborate within the Intelligent Energy Europe Programme. The project is coordinated by the German solar Industry association, BSW-Solar.

The overall goal of the PV GRID project is to address the **regulatory, administrative and technical requirement barriers** hampering the integration of PV into the electricity distribution grids in Europe through two main actions:

- the **assessment and comparison of national frameworks for PV development** in the 16 participating countries;
- the prioritisation of technical solutions available for **enhancing PV hosting capacity in distribution grids** and the formulation of regulatory and normative recommendations for their adoption.

Assessment of National Frameworks for PV Development

The assessment and comparison of national frameworks for first developing and then operating PV systems in 16 European countries is achieved by means of an **extensive research activity** involving fifteen national industry associations and coordinated by the policy consultancy eclareon GmbH, based in Berlin, Germany. The results of this assessment are mainly disseminated through the online PV GRID database and a series of national forums that will take place in each of the participating countries during the spring and summer of 2013.

The initial results of this assessment are documented in section 3 of this report.

Enhancing PV Hosting Capacity in Distribution Grids

The objective of enhancing PV hosting capacity in distribution grids is pursued by an initial **prioritisation of available technical solutions**, analysed by involving distribution grid operators (DSOs) and other electricity sector experts. This task mainly leverages on the experience of three DSOs: ENEL Distribuzione (Italy), RWE (Germany) and Lumen (Czech Republic) and is coordinated by DERLab, an association of laboratories and research institutes in the field of distributed energy resources based in Kassel, Germany.

Starting from the most favourable solutions identified and the barriers to their large-scale application, the project consortium will proceed to **formulate European-wide regulatory and normative recommendations**. This second step of the action will be led by the IIT research institute of the Comillas Pontifical University based in Madrid, Spain. The results of this process will be mainly disseminated in the aforementioned national forums and in an additional series of national and European workshops targeted at DSOs, regulators and policy-makers taking place in 2014.

The initial results of this process are documented in section 4 of this report.

National and European Level Communication

The national and European level communication activities for the dissemination of project results are coordinated by EPIA, the European PV Industry Association based in Brussels, Belgium.

3 ASSESSMENT OF NATIONAL FRAMEWORKS FOR PV DEVELOPMENT

3.1 Research on National Administrative Frameworks

The research activity within PV GRID focuses on the administrative frameworks for PV system development and operation in 16 European countries. The research tasks are carried out by the participating national solar industry associations coordinated by the eclareon GmbH consultancy. This activity builds upon the legacy of the PV LEGAL project, which ran from 2009 to 2012 and allowed to build the core of the PV GRID consortium.

The primary research objective is to describe, both qualitatively and quantitatively, the procedures and requirements involved with the permitting, installation, connection to the grid, and operation of a PV system. As a consequence, the research allows also identifying those barriers that investors and project developers face when setting up a PV project. Furthermore, the research is aimed at providing results in a standardised format, making them comparable across countries.

National PV markets are analysed focusing on three PV market segments: **residential systems** (PV systems up to 1 kWp in size), **commercial systems** (up to 1 MWp in size) and **industrial ground-mounted systems** (over 1 MWp in size). For the purpose of the analysis, the PV project development lifecycle is broken down in ten standard processes, which are then analysed both qualitatively and quantitatively.

Processes and Requirements

As mentioned, within PV GRID a set of ten standard processes is used to break down the development and operation of a PV system:

1. **Site Selection:** the acquisition of the project site and any other action needed to make it legally suitable for further project development activities;
2. **Electricity Production Licence:** all actions necessary in order to obtain the license to produce electricity. This license may have different names, such as electricity generation license or exploitation authorization;
3. **Administrative Process:** all necessary administrative authorisation activities - such as the application for building or environmental permits - that need to be completed before the construction of the PV installation may start;
4. **Grid Connection Permit:** the formal procedure to obtain the permission to connect the PV installation to the grid;
5. **Support Scheme(s):** the formalities that must be done in order to receive the most important support schemes for PV installations such as a feed-in tariffs or quota systems;
6. **PV System Construction:** The physical installation of the PV system and any administrative requirements associated with this process;
7. **Grid Connection and Commissioning:** The phase of realising the PV system's physical connection to the grid and its initial conformity verification;
8. **Financing:** The steps to be taken to acquire the necessary capital, equity or financing for the realisation of the PV installation;
9. **Corporate Legal-Fiscal:** All actions necessary to incorporate (if this is legally required), to become member of a certain association, to become liable for taxation, or to become exempted from it;
10. **PV System Operation:** The requirements and other activities involved with the operation of a grid-connected PV system over its 20 to 30 years of operational lifetime.

Qualitative and Quantitative Analysis

The initial phase of qualitative research is focused on all the permitting, grid connection and operation provisions that a PV system has to withstand and leverages on the market experience of national solar industry associations and their members. For all covered countries, each standard process is thoroughly analysed and described by means of a succession of simple steps. The barriers within each process are identified, and possible legal solutions to such barriers are also researched.

In a successive step, selected stakeholders (mainly PV project developers) are interviewed in each country. The aim of this phase is twofold. It allows verifying and refining the previously researched descriptions of processes, barriers and

legal solutions, but most of all it is aimed at quantifying the involved in each process. The quantitative data gathered in each country is reviewed and corrected in order to provide significant and consistent statistics both a national level and across countries.

Indicators: Costs, Time and Labour

In PV GRID, the statistics gathered by assessing the practical experience of PV project developers are described making use of the following indicators:

- **Duration:** the total time (measured in weeks) needed to complete a specific process or the sequence of all processes (for the Overall Project);
- **Waiting time:** the total idle time (measured in weeks) spent waiting for authorities, administrations or grid operator feedback or action, thereby blocking further action in the process;
- **Legal-administrative Cost Share:** the average share of legal-administrative costs in total project development costs, excluding PV equipment (measured in %);
- **Barrier severity:** the qualitative assessment of the gravity of market barriers hampering or blocking PV system development;
- **Legal-administrative Labour Requirements:** the amount of time (measured in man-hours) invested for complying with legal-administrative requirements during a process;
- **Non Legal-administrative Labour Requirements:** the amount of time (measured in man-hours) that needs to be invested for a process, excluding the time spent complying with legal-administrative requirements.

PV GRID Database

The outcome of the research methodology outlined above is a database illustrating with a practical step-by-step approach the procedures necessary to develop and operate a PV system in 16 European countries, complemented with a set of quantitative indicators that allow comparing across countries the lead times and administrative burdens faced by PV project developers and investors.

The PV GRID database is accessible online at <http://www.pvgrid.eu/database/>.

3.2 Barriers to PV System Development and Operation

A large part of the research carried out in PV GRID relates to the assessment of barriers encountered in the development and operation of PV systems. As previously outlined, these barriers have been identified and verified by means of qualitative research performed by national solar industry associations and further investigated with interviews to national stakeholders, principally taking into account the perspective of PV system developers and operators.

During the remainder of the project, the research results on barriers will be further discussed with those project partners (especially the DSOs) that are responsible for the other main activity of the PV GRID, the analysis of normative and regulatory barriers to the large-scale integration of PV on distribution grids.

In total, more than 200 barriers have been identified. Even though the focus of the research is on administrative frameworks, it is natural that both national industry associations and interviewed stakeholders also tend to highlight barriers that are not purely administrative, but rather deal with technical requirements, regulatory matters and economical profitability issues. This information cannot be discarded and it is therefore also recorded in this report.

Following a review of the collected body of information, these barriers have been grouped in 4 main categories:

1. Permitting Procedures
2. Grid-related
3. Support-related
4. Operation & Maintenance

Below, a description of the four barrier categories is provided, along with some examples.

Permitting Procedures

Administrative permitting procedures affect PV projects quite differently, depending on the market segment and on the regulations that apply to systems belonging to that segment.

In the **residential segment**, the administrative permitting process is in most cases simple and requires only a building permit or a simple notification to the municipality stating that the PV system will be installed. In the **commercial segment**, the administrative permitting process can become more challenging. Planning permissions and environmental impact assessments are more frequent and in some countries an electricity production license may also be required. In the **industrial ground-mounted segment**, the administrative permitting process is usually complex and time consuming. Given the typical large size of these plants, compliance with local land or urban development plans needs to be ensured. Furthermore it is commonly necessary to undergo an environmental impact assessment and to verify the acceptance of the new plant by the local communities. The administrative lead times are normally in the range of a year or more.

Examples of barriers encountered at this stage include:

- **Presence of restrictions on the land:** the chosen location of the PV plant may be subject to specific limitations due to land use plans, e.g. the chosen area could be a special protection zone, or the zoning of the land would not allow the construction and operation of a PV plant. Often, overcoming such requirements is not straightforward and may be extremely time-consuming;
- **Environmental impact assessment requirements:** it is not always clear under what criteria an environmental impact assessment may be required. This assessment is usually time- and cost-intensive and can thus pose a strong barrier to the development of a PV project;
- **Regional regulations:** there may be relevant regulations that exhibit changes across regions, and this may prove challenging in case investors wish to develop plants in more than one location or in case the connecting line would pass through different regions. In such cases, there would be additional administrative burdens for the developers, as they would need to deal with two or more sets of requirements.

Grid-related

Grid-related barriers represent, together with those in permitting procedures, one of the two main groups of barriers that have been identified in the PV GRID research. Such barriers appear in the grid connection permit and in the grid connection and commissioning process.

These processes may vary largely in the three market segments, in terms of requirements and in terms of administrative procedures, going from a mere notification for **residential systems** to a more complex procedure for **commercial systems**. Often, barriers are encountered in the case of larger plants, given the additional complexity involved.

In general, for **industrial ground-mounted systems**, the grid connection process consists in an initial request phase, during which a request for a connection point is sent either to the competent distribution or transmission system operator. After internal consultations and the opportune technical verifications, the grid operator will reply to the system developer confirming the access point and presenting an offer for the realisation of the connection works, or refusing the access point request. In the latter case, the grid operator is normally required to provide an alternative access point and connection works offer. Once the PV system developer accepts a connection offer, a provisional connection contract is signed between the two parties, a deposit is paid to the operator and usually the works for installing the PV systems can start. Once the PV system construction and installation has been finally completed, the PV developer will contact the grid operator and request that the connection works are executed. Finally, after a brief test and commissioning phase, the PV system will be connected to the grid and will begin feeding electricity into it. At this point, the PV system owner and the grid operator generally conclude the process signing a connection contract.

The main barriers encountered at this stage include:

- **Grid connection costs:** in case a developer wishes to connect his or her plant in an area where the existing grid is relatively weaker, there may be a need to reinforce the grid so that all generated electricity can be fed in and transported. Depending on the regulatory framework, the grid operator may have the possibility of charging the plant operator with the grid expansion costs, which can be extremely high;

- **Grid access:** In certain countries RES access to the grid is today not guaranteed in practice, often due to grid capacity issues that are strongly questioned by the RES sector stakeholders;
- **Long waiting times:** developers are sometimes put in the position of having to wait a long time before they can start feeding electricity in the grid. Due to the impossibility of generating revenues, developers can be faced with difficult financial situation and in extreme cases be forced to abandon the project.

Support-related

Although the goal of PV GRID is not specifically to analyse and report on support schemes, administrative requirements linked to this issue are considered relevant in the context of project development, and as such are assessed in this project. Regardless of the market segment, these issues are relevant in two contexts: administrative requirements and financial aspects. The first two barriers outlined below relate to the former area, whereas the third one relates to the latter.

The main barriers encountered with respect to support schemes include:

- **Complex and long procedures:** complex procedures for accessing a support scheme may be particularly daunting for smaller developers. This kind of barrier in fact impacts on the project developer mainly in terms of labour, and whereas this could be a minor amount with respect to the total labour required for a larger plant, it could be a relatively large one if the project is relatively small and managed by a smaller company;
- **Market caps:** a limitation to the support scheme, for example in the form of a capacity cap or budget cap, may be used to control the deployment of PV systems in a country. This situation has been identified in five countries among the covered ones;
- **Regulatory Uncertainty:** refers to a situation in which there is a high frequency of changes in the support scheme framework. These include changes in the technical requirements, in the tariff, in the type of support scheme offered or in the eligibility of a plant. Under these conditions, investors may perceive an unstable environment and be less willing to invest in a PV system.

Operation & Maintenance

A minor group barriers identified in PV GRID relates not to the development of the installation itself, but rather to its operation. There may be certain regulatory changes or existing requirements that create particular difficulty in terms of the day-to-day management of the installation.

The main barriers include:

- **Unforeseen costs or diminished revenues:** there are cases in which the instability of conditions for support schemes has been reported. Ideally, conditions for a support scheme (economic and administrative) should remain unchanged through the entire period in which support is received, as the investor is basing the economic viability of his investment on the stability of such conditions. Situations have been identified in which changes with retroactive impacts have been implemented, strongly impacting the stability of the PV system sector.
- **Administrative requirements:** this barrier refers to a number of situations in which certain activities have to be performed or pieces of information have to be provided in order to receive the support scheme or in order not to incur in fees or penalties. Such requirements are not uncommon, however in some cases their specifics have been reported as inappropriate and demanding.

3.3 Summary of National Frameworks

In this section, we present a summary of the situation of administrative frameworks and of the national PV markets in each of the 16 participant countries, offering a glance at the main PV GRID indicators, the situation in each market segment and the major current market barriers.

This collection of information is based on the research carried out by national solar industry associations, complemented with interviews with national PV system developers and operators.

More detailed and up to date information can be found online in the PV GRID database at:

<http://www.pvgrid.eu/database/>.

Austria

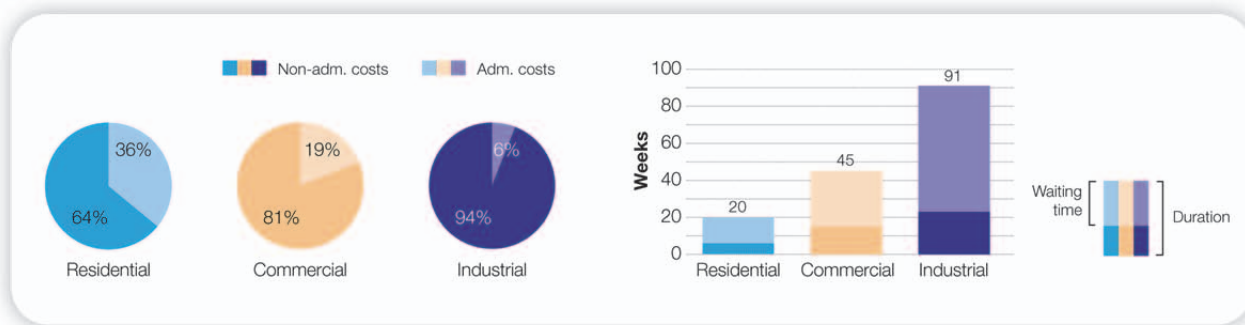


Figure 3.1 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

In the Austrian legal-administrative system, the overall framework is set at national level, whereas implementation takes place at federal level. As a result, there are 9 different federal Electricity Management and Organization Acts and a number of implementation rules, released either by single network operators or by all federal network operators in a harmonized common document. In this context, the main barriers appear to be uncertainties about costs for the grid connection, the limited budget for the promotion of PV systems and the long and costly approval procedures.

The large majority of PV systems in Austria are **residential systems**. According to a market report for 2011¹, 77% of the overall installed capacity is represented by systems smaller than 5 kWp.

Commercial systems (around 50 kWp) represent a market share of about 20%. When a PV system is planned and operated in the context of a commercial property, specific approval procedures apply, which may represent a barrier for PV system planners, even for the most experienced ones.

As regards **industrial ground-mounted systems**, plants with a capacity above 1 MWp are rather uncommon in Austria. There are a few projects either in operation or in phase of construction that were initiated under the promotion policies of earlier editions of the Green Energy Act (GEA). As the actual release of the GEA does no longer support projects with capacity above 500 kWp, there are actually no new large projects being developed. A growing number of projects below 500 kW are developed by local communities and financed by a public participation scheme.

Barrier Type	Name	Process	Description
Permitting Procedures	Electricity production licence	Electricity Production	The Federal Electricity Acts requires electricity permit procedure. Whether an electricity permit is necessary, depends on the peak power of the PV system and on the federal limits. For small-scale plants a simple procedure is allowed without an on-site approval meeting. Larger systems need to be approved within an on-site negotiation meeting. Sometimes also several expert are required which cost money and cause delay.
Permitting Procedures	Request of green power feed-in tariff and limited promotion budget	Support Scheme(s)	Project applicants can apply for a green power feed-in tariff on a dedicated website. Due to the limited overall promotion budget of 8 million €, not all project applicants can be supported. Request for feed-in tariff support has to be entered very quickly in order to get properly queued. Because of this, the speed of handling of this web interface is a crucial success factor.
Grid-related	Grid capacity constraint	Grid Connection Permit	According to the Electricity Management and Organization Act, network operators are obliged to connect PV systems with priority to the grid. Upon verification of the grid capacity, the network operator either approves by sending a contract, or makes it dependent on successful commissioning. If sufficient grid capacity at the nearest possible connection point is not available, the network operator claims to reinforce the grid at the cost of the project applicant.

Table 3.1 – Most severe market barriers in Austria

¹ Innovative Energietechnologien in Österreich Marktentwicklung 2011, Biermayr et. al. (BMVIT) 2012

Belgium²



Figure 3.2 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

The larger part of the PV market in Belgium is composed of residential and commercial systems. Industrial ground-mounted systems are not present.

Residential systems in Wallonia (maximum 10 kVA) and in Brussels (maximum 5 kVA) are well developed and growing. These systems represent 97% of PV systems in Wallonia and 50% of those in Brussels and are mostly installed on rooftops and sometimes on the ground (in gardens). Administrative procedures are simple. Benefiting from the sale of green certificates and net-metering support, these PV systems allow for a return on investment of less than 7 years. The main obstacle in Wallonia is the investment capacity. A revision of the system and the level of support could reduce the financial attractiveness and introduce obstacles. The main difficulties for this sector in Brussels are the urban and historical contexts of the city.

Commercial systems represent about 3% of total installed PV power in Wallonia and 50% of total installed PV power in Brussels, and these values are gradually increasing. Also for this segment, the urban and historical contexts of the city of Brussels may create some barriers.

Industrial ground-mounted systems are present neither in Wallonia nor in Brussels. There is no support scheme for PV systems larger than 250kVA. Moreover, the dense urban character of the Brussels region makes it very hard for this sector to develop.

Barrier Type	Name	Process	Description
Permitting Procedures	Urban permission rejection	Administrative Process	Regarding classified buildings, there are no clear and specific criteria to give or reject an authorization for PV system installations. This mainly depends on the opinion of the officers responsible for this decision.
Permitting Procedures	Inappropriate procedure	Administrative Process	Municipal officials are not always experienced with this difficult law (CWATUPE). It has been reported that sometimes a longer procedure – not necessarily the simplest or fastest one – is being asked for by the authority to be on the safer side.
Support-related	Support level conditioned to 50% self-consumption	Support Schemes	Up to a PV system capacity of 250 kWp it is possible to receive four green certificates per MWh produced, with the condition that the self-consumption of electricity is at least equal to 50% of the production every three months.

Table 3.2 – Most severe market barriers in Belgium

² Not including Flanders

Bulgaria

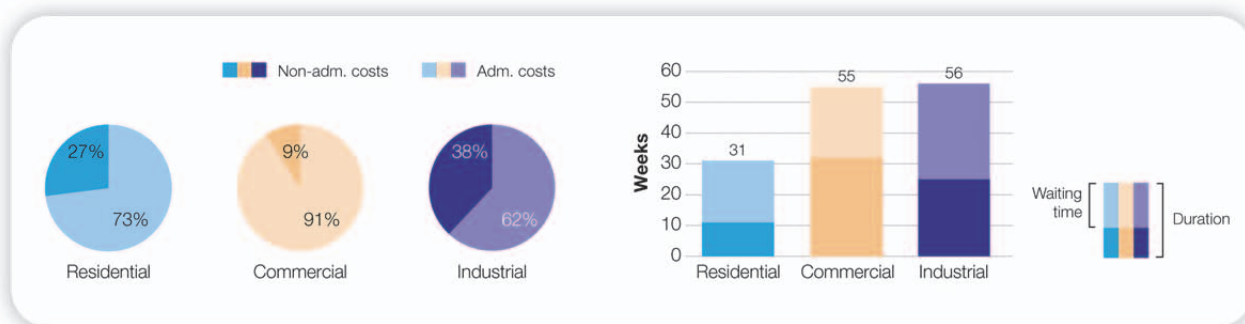


Figure 3.3 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

The development of PV systems in Bulgaria is facing several barriers that impede the development of the overall sector. In general, an unclear political framework prevents foreign investments. Disproportionate requirements hamper in particular the sector for small systems, while large ground-mounted systems are affected by recent changes of the legal-administrative framework.

The installation of **residential systems** on buildings is mainly hampered by numerous complicated procedures. A simple notification of construction is not allowed; instead developers have to undergo a full building permit process. Some DSOs apply rules that are meant for large and middle-sized systems, thereby creating additional burdens.

Burdensome processes also impede the development of the **commercial systems** segment. Building permits are required and entail the need for a supervision company to monitor the construction of the PV system and of the required architectural, electrical, static and other designs, subject to special approval by the municipal administration. A recent transitional provision of the RES Act implements the rescheduling of the grid connection of large and middle scale PV plants after 2016. DSOs tend to interpret this rule very broadly, which affects the investment stability of many projects.

The **industrial ground-mounted systems** segment suffers in particular from recent legal reforms, among others an early interconnection fee, the change of the grid connection procedures, including postponement of the connection of all projects after 2016 and annual determination of available capacities for new RES initiatives. In 2012 there was no grid capacity available for ground-mounted systems. Moreover, rescheduling of grid connection procedures and retroactive grid access fees in practice block the sector.

Barrier Type	Name	Process	Description
Grid-related	Rescheduling of grid connection procedures	Grid Connection Permit	A decision of the National Electricity Company for rescheduling the grid connection of large and middle scale PV is broadly interpreted and currently applied to all segments. DSOs are postponing the time of grid connection for small installations after 2016 or blocking the grid connection procedure.
Grid-related	Grid access fee	PV System Operation	The retroactive introduction of a grid access fee has created the danger of bankruptcies, as many of the producers were caught by surprise and currently cannot pay their bank credits.
Grid-related	Temporary restriction	Grid Connection Permit	There is a temporary restriction for development of new RES projects caused by the annual decision for maximum available grid capacity for RES projects. The decision for 2012 provided no available capacity. Thus, no new PV projects will have access to the electricity grid until the next decision of the Regulator due in July 2013.

Table 3.3 – Most severe market barriers in Bulgaria

Czech Republic



Figure 3.4 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

The Czech PV market has undergone quite strong changes in the past years. At present, smaller systems appear to be still developing, but larger ones seem to suffer from the current situation. In fact, there is no economic support scheme for PV systems above 30 kWp, and support for system below 30 kWp could cease in 2014.

Residential rooftop systems represent the only segment that is still in development. At present, there are more than 10,000 systems in the country. The installed capacity has reached 65 MWp by the end of 2011 (PV systems under 20 kWp) and preliminary results for the growth in 2012 are between 55 and 110 MWp (this includes all the plants under 30 kWp). The main barriers for this market segment relate to the attitude of the grid operators, which may hinder obtaining the connection permit and commissioning, and the technical difficulties, which tend to delay, or even block, higher grid penetration.

The installed capacity of **commercial rooftop systems** reached 107 MWp by the end of 2011. There are currently about 2,400 commercial rooftop installations. This segment is strongly influenced by the lack of support and the difficulties in grid connection outlined for residential rooftop systems.

Installation of new **industrial ground-mounted systems** has stagnated from March 2011. At the end of 2011, 1,600 licences were granted to PV plants above 100 kWp, for a total capacity of more than 1,800 MWp. These numbers were almost the same as in 2010. The most significant changes of the legal framework that came into effect since 2011 were the cancellation of the 5-year tax exemption, the introduction of a special taxation on production, the amendment of support (resulting in more than 5% decrease of FiT per year), the extension of the depreciation period to 20 years and the introduction of recycling fees. Obtaining the connection permit and the concrete commissioning for a large PV system is rather unlikely. A special authorisation from the Ministry of Industry and Trade is required for PV systems above 100 kWp.

Barrier Type	Name	Process	Description
Grid-related	Refusal to connect lacking substantial explanation	Grid Connection Permit	There is a risk that grid operators refuse the connection approval. It is often not clear what the true reasons are, although the operator usually argues they are of purely technical nature. Usually, distributors argue there is insufficient grid capacity in the respective location and thus another generation plant with non-linear production could cause a serious damage to it.
Operation & Maintenance	Retroactive changes of the support scheme	Support scheme	The support scheme is unstable and there has been a retroactive reduction of the FiT as well as the introduction of new taxes and fees.
Grid-related	Heterogeneous approach to the applicants	Grid Connection Permit	DSOs show a non-standard approach towards applicants, applying different requirements without justification.

Table 3.4 – Most severe market barriers in Czech Republic

France

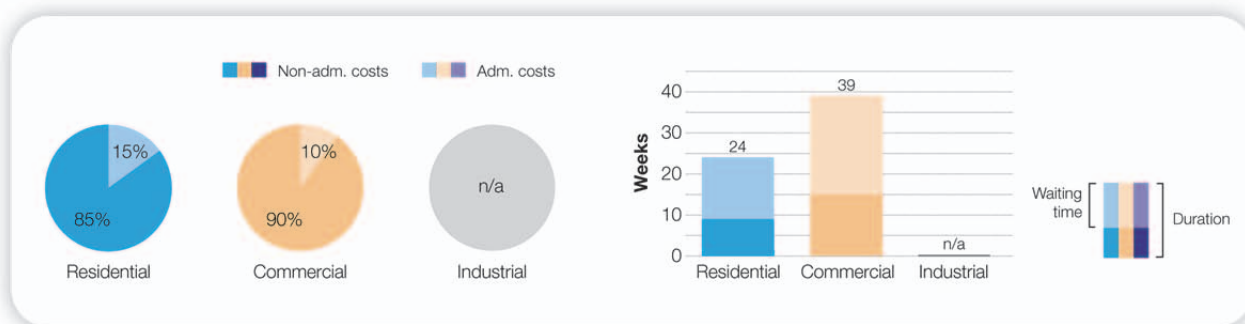


Figure 3.5 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

The largest part of the market in France is composed of residential and commercial PV systems, whereas industrial ground-mounted systems are less developed, also due to the fact that the feed-in tariff is not very attractive for larger systems and that the regulatory framework is quite restrictive and laborious to respect.

Most of the French PV market in the **residential systems** segment is made up of rooftop installations of less than 3 kWp in size. These installations are supported by the tax credit and the feed-in tariff. Building integrated PV installations on residential houses up to 9 kWp are eligible for the highest FIT level. The main barriers to the development of these kinds of PV projects are related to obtaining the administrative permissions and to the grid connection costs.

Commercial rooftop systems with a capacity up to 100 kWp are essentially supported by the feed-in tariff. The main obstacles for the development of this segment are the grid connection procedure and the vagueness of certain regulations. A call for tenders is available every four months for rooftop PV projects between 100 and 250 kWp.

The feed-in tariff is attractive only for installations less than 100 kWp in size, thus not covering large industrial PV system on roofs or **industrial ground-mounted systems**. This is severely limiting the profitability of bigger installations. This segment is practically undeveloped at the time being, even if a call for tenders has been opened in 2011 and a new one is opened from the March to September 2013. The most severe barrier regarding this sector is the administrative procedure.

Barrier Type	Name	Process	Description
Grid-related	Grid capacity constraint	Grid Connection Permit	Often, technical constraints exist relatively to the grid integration capacity in some areas. If the installation is too far from the grid, or if the grid is overloaded, sometimes, specific grid expansion works must be made by the DSO.
Grid-related	Waiting times	Grid Connection Permit	Waiting times in for obtaining the permit may be extremely time-consuming.
Grid-related	Grid connection fees	Grid Connection Permit	Since a December 2010 law, producers have to pay 100% of the grid connection fees, instead of 60% (previously, the remaining 40% were born by the DSOs). Additionally, since 2013 owners of PV systems above 36 kWp have to pay a share of a dedicated grid connection fee applicable to RES, which aims to finance specific investments on the grid necessary due to RES penetration.

Table 3.5 – Most severe market barriers in France

Germany

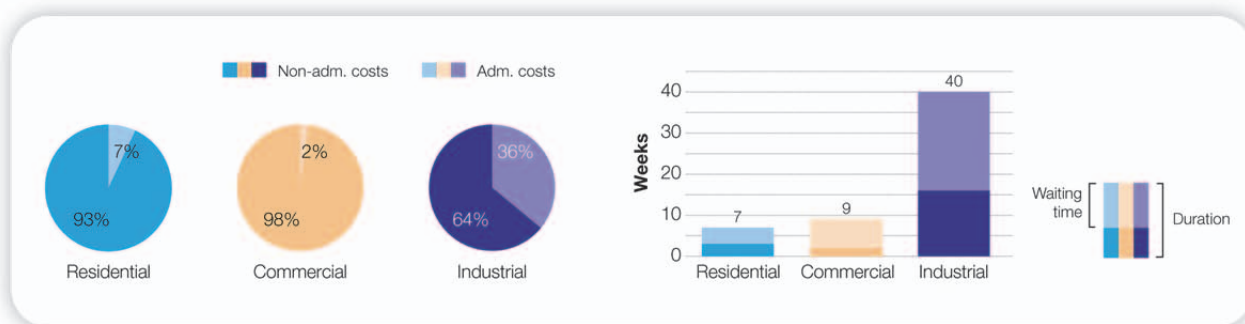


Figure 3.6 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

Residential systems up to 10 kWp in size are usually installed on building rooftops and in most cases benefit from an exemption from planning permissions. For installations up to 30 kWp it is legally defined that the connection point of the plot with the grid is regarded as the most favourable connection point. When applying for grid connection, the experiences with the individual grid operators differ. The application is often easy and quick. Sometimes, however, PV system developers report that the process takes too long and involves high connection fees.

The segment of **commercial systems** up to 1 MWp in size represents the highest share of the German PV market. The grid connection application is often a significant obstacle. For systems with power of more than 30 kWp the grid connection point is defined in EEG (section 5 para. 1 sentence 1). This paragraph stipulates that the network operator has to connect EEG generators immediately and with priority to the grid connection point which is suitable in terms of the voltage and which is at the shortest linear distance from the location of the installation if no other grid system has a technically and economically more favourable grid connection point. The definition of the systems up to 30 kWp is therefore more precise than the definition for systems of more than 30 kWp. Thus, more disputes between the PV system developer and the grid operator occur with respect to the grid connection point of installations higher than 30 kWp. In the PV system developer's point of view, the process takes too long and involves too high connection fees.

The eligibility of **industrial ground-mounted systems** larger than 1 MWp in size has been restricted in the past years. Whether the criteria are met is not always obvious. Drafting or amending a land development plan and urban development plan is necessary in most cases in order to be granted feed-in tariff payments. The involved proceedings are slow and expensive. The application of a connection point often turns out to be a major obstacle. The allocation of the technically and economically most favourable connection point by the grid operator is often disputed.

Barrier Type	Name	Process	Description
Permitting Procedures	"Change of use" induced by the installation of a PV system on a building	Administrative Process	The exemption of PV systems from the requirement to obtain planning permission does not cover the possible change of use of non-commercial buildings induced by the installation of a commercially used PV system on the building. In that case, the developer has to apply for permission for change of use of the building.
Grid-related	Technical grid connection conditions	Grid Connection Permit	The relevant technical connection conditions for PV systems are created by a committee (FNN), in which the grid operators have the majority. The connection conditions contain regulations that make the connection of renewable energy systems difficult. Moreover, the value of the FNN standards as recognised rules of technology is in part criticised by planners, installers and operators.
Permitting Procedures	Difficulties finding locations for ground-mounted systems	Site Selection	Suitable areas for PV ground-mounted systems have become rare and require the approval of municipalities. Project developers must invest a lot of time to identify areas and subsequently negotiate with the owners of the areas and the municipalities in order to implement a project.

Table 3.6 – Most severe market barriers in Germany

Greece

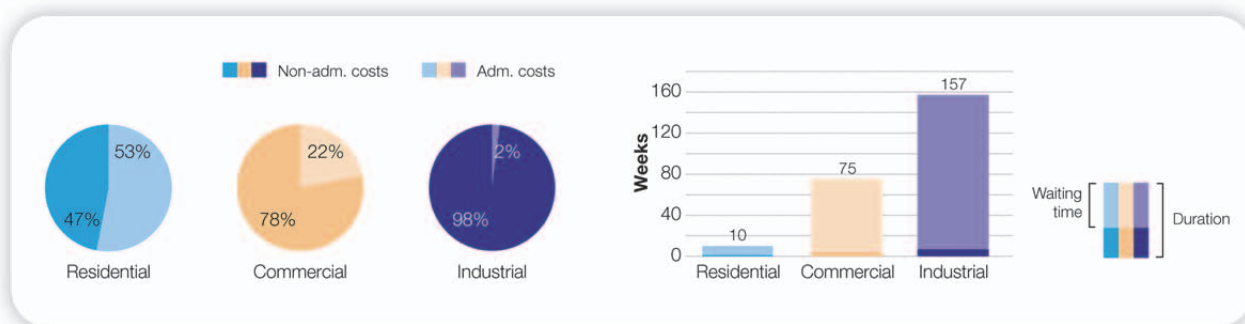


Figure 3.7 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

The PV Market in Greece is currently mainly composed of residential and industrial ground-mounted systems, whereas commercial systems are facing some difficulties in deploying.

Thanks to a program for the installation of **residential systems** up to 10 kWp on building rooftops, most barriers have now been lifted for this segment, which is now a very dynamic one. The current annual market for residential systems is in the order of 100 to 150 MWp.

The installation of **commercial systems** follows a relatively easy process, especially since mid-2010 when new legislation came into force removing most of the existing barriers. The most severe barrier in this segment is the delayed response of the grid operator to applications for grid connection offers. As of August 2012, there was a suspension of new applications for this segment. The market in commercial rooftops is still small and unless the authorisation suspension is lifted, this market segment will not develop considerably.

Since 2010 the permitting procedures do not constitute a barrier for the **industrial ground-mounted systems**. Until August 2012, when a suspension on new licensing of this segment was introduced, the key bottleneck was the grid connection offer. This segment in mid-2012 represented one-third of all installed capacity.

Barrier Type	Name	Process	Description
Permitting Procedures	Suspension of new applications	Grid Connection Permit	Suspension of new applications commercial systems segment is the major barrier as of August 2012.
Grid-related	Grid connection bottleneck	Grid Connection Permit	Since mid-2010, the grid connection process has become a serious barrier in the commercial and industrial segments due to the long waiting time for file to be processed.
Permitting Procedures	Exclusion of prime agricultural land for PV installation.	Site Selection	New installations of ground-mounted systems (having filed an application to the Grid Operator after 21-9-2011) are not allowed on prime agricultural land. This barrier was not in place in the period June 2010 - Sep. 2011.

Table 3.7 – Most severe market barriers in Greece

Italy

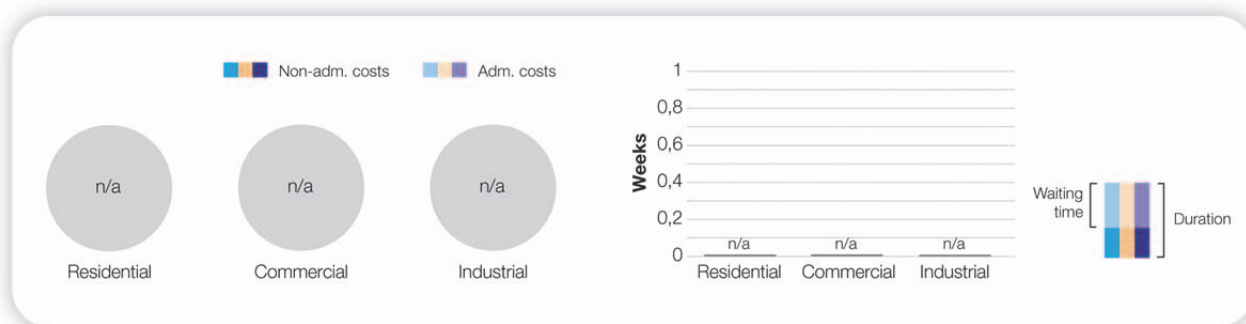


Figure 3.8 - PV project development: share of administrative costs, duration and waiting time³

Summary of market status

The 5th revision of the *Conto Energia* support scheme (DM 5 July 2012), which entered into force the 27 August 2012, represented a major change in the Italian PV policy, replacing once more the existing rules and increasing the instability of the sector. The main changes have been the introduction of registries for smaller systems (above 12 kWp) and a lower feed-in tariff level.

Residential systems are typically installed on rooftops. Authorization procedures are simple enough, even though there can be differences at regional level. In some cases, restrictions that require longer procedural steps are possible. These installations are better positioned than bigger systems, in terms of lighter authorization procedures and of an exemption from the registry system.

Commercial systems have been highly penalized in 2012 by the introduction of the registries for all systems above 12 kWp. Authorization procedures are also relatively simple, even though also in this case there can be differences at regional level or restrictions that might require longer procedural steps. These systems are probably the ones mostly affected by the new registry system.

Under this support scheme, the installation of **industrial ground-mounted systems** is still possible, but there is a larger uncertainty and risk involved with respect to the past. The lower tariffs, the registry system and a generally unclear framework greatly affected this segment. On the other hand, the lowering of PV equipment prices makes it possible to work outside of the *Conto Energia* incentives with "Grid Parity" business plans, especially in the southern zones of the country. A new era for PV seems possible, but a clear and appropriate legal and fiscal framework, as well as political will and commitment will be fundamental.

Barrier Type	Name	Process	Description
Permitting Procedures	PV system registry	Administrative Process	The PV system registry, in those cases when it is required, greatly discourages the installation of PV systems.
Permitting Procedures	Lengthy permitting process	Administrative Process	Restrictions relating to protection of the environment, landscape and historical/artistic heritage can be imposed by various administrations. The permission from regional Superintendencies, when necessary, can lead to considerable delays. The conduct and waiting times can vary according to the territorial offices concerned.
Permitting Procedures	Electricity Production Licence (PV systems larger than 20 kWp)	Electricity Production	For the Electricity Production Licence request, procedures and paperwork might differ a lot according to the territorial offices involved. The legal-administrative as well as the technical workload may not be uniform. Long waiting times and difficult communications with the relevant authority (Ufficio Tecnico di Finanza - UTF) are reported.

Table 3.8 – Most severe market barriers in Italy

³ Results for Italy are not available at the time of publishing. Please check the PV GRID database for up to date information.

The Netherlands



Figure 3.9 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

Residential systems have seen a boost in the Netherlands over the last year, thanks to their economical attractiveness in comparison with prices of electricity from the grid and the many collective PV system purchasing initiatives. The organisations behind these initiatives have achieved this success by offering a 'one-stop-shopping' service, easing the legal and administrative barriers for the buyers. Presently, the most important barriers for this market segment result from the financial support scheme and the grid connection administrative process. These barriers require improvement, but their severity is not as such that these block the development of the market, contrarily to the restrictions for a rooftop system on a listed building or in an area of monumental protection.

The market for **commercial systems** has started to develop in the last few years, thanks to the increased awareness amongst other created by the original SDE support scheme. In the revised 2011 version of the SDE support scheme (SDE+) some of the earlier administrative barriers were reduced. Unfortunately, the financial stimulus was reduced as well, in terms of accessibility and tariff level: in 2012 only 16% of the applicants were able to secure a grant. Because of this, the realisation of a PV project in this segment is not always competitive with purchasing electricity from the grid. New commercial initiatives are expected to bypass some of these concerns and may give this segment a boost over the coming years.

The market segment for **industrial ground-mounted systems** is almost non-existing in the Netherlands. With the SDE+ and the inclusion of solar in some regional urban development plans, projects have started to appear. So far, only a small number of systems of relatively small size have been realised. An increase can however be expected in the future.

Barrier Type	Name	Process	Description
Permitting Procedures	Denied approval of land development plan amendment	Administrative Process	A Municipality may eventually decide to not make an amendment to the land development plan (or not issue an exemption to the plan) in favour of a planned PV project. The reasons for such decision can be manifold.
Permitting Procedures	Lack of designated land for solar usage	Site Selection	As the segment for ground-mounted systems is new for the Netherlands, and notwithstanding the goodwill of regional authorities, the practical reality is that land designated for solar is scarce.
Operation & Maintenance	Potential impact of changes in net-metering conditions	PV System Operation	As with support schemes, it is likely that the economical conditions for net-metering will change over time, or that net-metering will be replaced by a different mechanism. This will have an impact on the return on investment of the PV system. Today, the volume of electricity that can be net-metered does already differ depending on the competent Electricity Retailer.

Table 3.9 – Most severe market barriers in the Netherlands

Poland

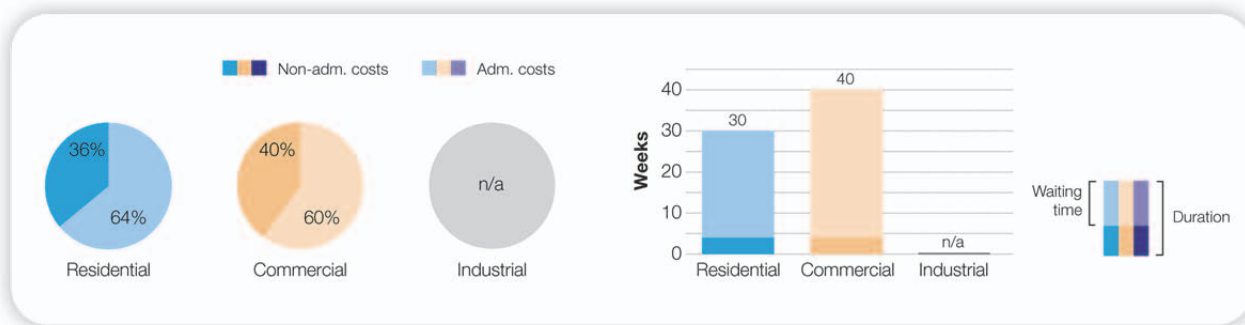


Figure 3.10 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

The Polish PV market is hardly developed, as there are only a few systems above 10 kWp. Furthermore, from the administrative and grid connection point of view there is no segmentation: all PV systems, regardless of their size are treated in the same way.

Residential systems are poorly developed in Poland. **Commercial systems** on rooftops may instead become the fastest developing segment of the market. In fact, larger system developers have greater administrative resources, allowing them to overcome barriers with greater ease. The procedures required for these two segments are in principle identical. A problem arising on regional level may result from municipal zoning plans and unnecessary requests for application for building permit. For example, in Krakow PV systems on buildings are treated as electrical equipment so a simple notification is enough, while in Warsaw local authorities require building permits. Aside from that, a serious burden is the need for monthly green certificate applications and the lack of experience of DSOs in connecting PV systems to the grid.

As for **industrial ground-mounted systems**, there is only one 1 MWp system in Poland. Unfortunately the data of its operation is not available. This segment of the market will not grow quickly due to the low incentives offered by state. The procedures applying to this type of systems are in principle the same as in the residential and commercial segments. The problem on the regional level may arise from municipal zoning plans.

Barrier Type	Name	Process	Description
Grid-related	Lack of established procedures for small PV systems	Grid Connection Permit	As DSOs do not have experience or established procedures suited to PV systems, they typically attempt to delay the issuance of grid connection permits.
Grid-related	Unwillingness of electricity utilities to participate in grid connection costs	Grid Connection and Commissioning	The Energy Law places an obligation on the DSO to cover 50% of the connection costs for RES under 5 MWp. Nonetheless, DSOs attempt to force the costs of grid connection onto the developers (the entire cost of grid connection is reported as higher than it is in reality). It has also occurred that payment of the entire cost has been demanded to the developers.
Permitting Procedures	Need to establish a company	Electricity production	Because only companies can obtain concessions to produce electricity using renewable sources (not individuals), the person wishing to install even a small PV system is forced to establish a company (if they do not already have one), which is a complicated and lengthy process.

Table 3.10 – Most severe market barriers in Poland

Portugal

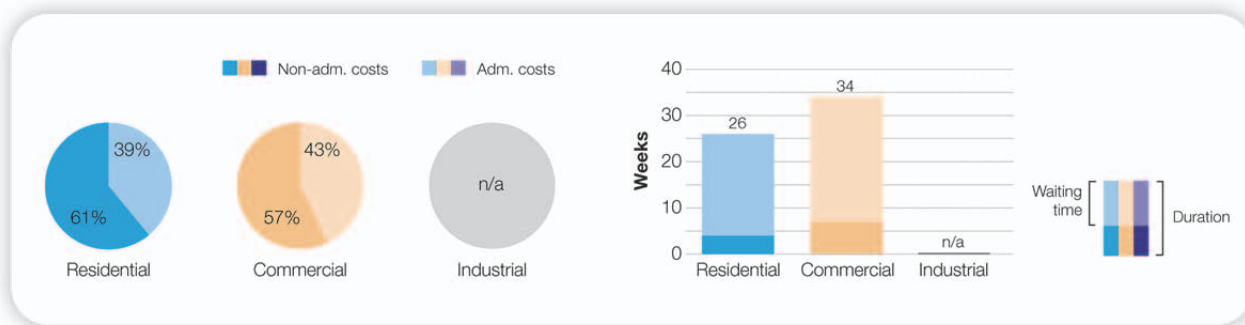


Figure 3.11 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

Despite favourable conditions, Portugal being one of the sunniest countries in Europe, the PV market has not reached its actual potential. This is mainly due to a support scheme with a market control mechanism.

Residential systems on buildings are allowed with a maximum capacity of 3.68 kWn (nominal inverter capacity). Each consumer may install a PV system, but there are grid connection capacity restraints and an annual market cap in place. Until 2012, the annual cap was 25 MWn, which represents approximately the requested capacity but was then limited to 10 MWn. This restriction has created serious problems for the PV sector, as the demand for licenses goes well beyond it. Another serious barrier is the application of technical requirements, which creates high costs for the upgrade of existing grid connections.

In the **commercial systems** segment, installations are relatively small and range from 20 to 100 kWn inverter capacity. The annual quota for this segment is 30 MWn. Again, this limit has created serious problems for the PV sector since it limits market demand consistently.

At present, the segment for **industrial ground-mounted systems** is inactive. The decree that used to support this PV segment (DL 312/2001) assumes as mandatory the attribution of a specific kind of license (PIP - Project of Public Interest) that is blocked since 2006. As a consequence, it is theoretically possible to develop a plant of more than 250kWn. However, since the Government blocks the licenses, the legal framework does not apply. Regardless the law from 2006, there was an open public tender of a total of 150 MWn. This was however an exceptional situation and it isn't expected to happen again in the next years.

Barrier Type	Name	Process	Description
Support-related	Resilience of electricity suppliers	Support Schemes	Several electricity suppliers do not respect the law and do not accept contracts for the support of small systems. There is a new legislation, since January, that obliges the last resource commercialization to buy all the production in mini and Microgeneration.
Grid-related	Technical barriers in construction and connection phase	PV System Construction	The technical guidelines are not adequate for a PV installation. The required installation is much more expensive and the labour costs increase significantly. The technical support by the utilities is insufficient.
Grid-related	Regional differences in interpretation of grid connection requirements	Grid Connection	As there are various certifying companies in the country's regions, there are also various interpretations of technical rules. Thus, it may happen that a technical solution is accepted in one region and refused in another. Although it does not happen very often, some technical rules are subject to change without notice.

Table 3.11 – Most severe market barriers in Portugal

Slovakia



Figure 3.12 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

The PV market in Slovakia is currently not thriving due to excessive administrative burdens, lack of governmental support and lack of competitiveness on the electricity market.

Residential systems represent the smallest share of PV systems installed in Slovakia. The only support scheme is the feed-in tariff, reviewed in July 2012. Due to its relatively low levels (0.119 €/kwh), it results in a long investment return period. In addition, the legal-administrative and regulatory framework is unstable, changing a few times a year and involving excessive bureaucracy: as a consequence, the development process may take up to 10 months. The expectation for the near future is a decrease of new installations due to a lack of profitability and the complications resulting from the legal-administrative framework.

Commercial systems on building rooftops in Slovakia are allowed up to 100 kWp in size and this limit will be lowered to 30 kWp as of July 2013. The administrative process is the same as for small residential rooftop systems and therefore involves a large amount of bureaucratic barriers. The FiT value is the same as for residential rooftop systems. Also in this segment, the expectation for the next 5 years is a decrease of new installations.

The **industrial ground-mounted systems** segment had seen a period of expansion in 2010 and 2011, when about 480 MWp were installed. Since early 2011, large systems are not anymore allowed by the Slovakian legal-administrative framework: it is not possible to build a PV plant larger than 100 kWp, not even in an off-grid system.

Barrier Type	Name	Process	Description
Support-related	Long waiting time for support contracts	Support Scheme(s)	A long time is needed for finalising FiT and Green Energy contracts, mainly due to the parallel presence of inefficient procedures in the authority and a high workload to deal with such contracts.
Permitting Procedures	FiT certificate validation	Support Scheme(s)	The regional distribution system operator in central Slovakia (SSE-D) requires the validation of the FiT certificate. It means that once the producer gets the FiT certificate and signs the contract with the regulatory office, the regulatory office notifies the Ministry of Economy and both the producer and the ministry have 40 days to disclaim the contract. After this period the producer has to apply to the regulatory office to validate the FiT certificate. This step is uselessly prolonging the whole process.
Permitting Procedures	Bureaucracy	Administrative Process	It has been reported there is an inappropriate amount of documentation and steps required by the regulatory office, such as the final inspection of the building where the PV system is installed, even in the case of small systems.

Table 3.12 – Most severe market barriers in Slovakia

Slovenia

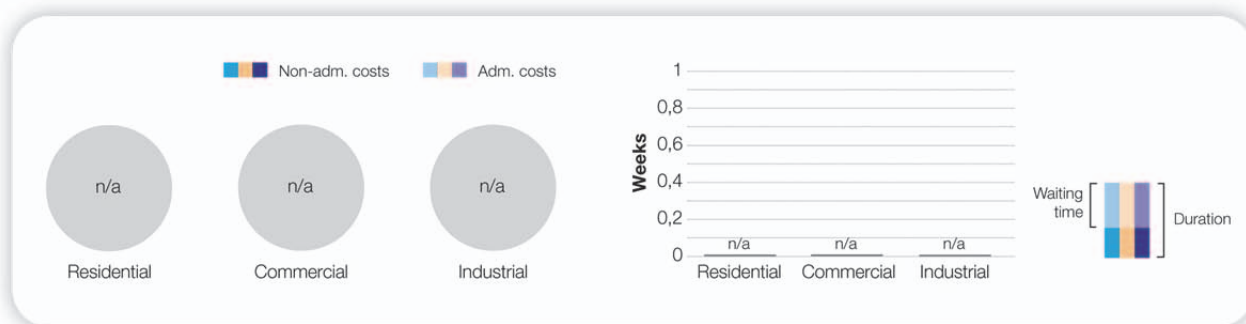


Figure 3.13 - PV project development: share of administrative costs, duration and waiting time⁴

Summary of market status

All three market segments appear to be developing quite strongly in Slovenia, although some regulatory issues still prove to be challenging for developers.

Residential systems on rooftops are developing relatively well and fast. The main obstacle encountered in this area is the fact that small PV systems are more expensive per kWp in comparison to larger ones and thus their return is not as attractive. Due to tax legislation, it is often also necessary to start a commercial entity linked to the installation: while individuals can sell electricity from PV systems freely, due to VAT regulations individuals are in a weak position as taxpayers. Furthermore, it appears that current legal provisions do not sufficiently regulate DSO activity and as a result the cost and time horizon of an investment are highly influenced.

Commercial systems on rooftops fall under the same laws of residential rooftop systems and are also in sharp ascent, though some issues have been identified. In addition to the ones outlined for the residential segment, there is some difficulty in accessing support schemes after grid connection. This process may take up to 3 months and only on completion of the process the FiT will be decided. Because the tariff regresses on a monthly basis, this may lead to consistent losses.

Industrial ground-mounted systems are facing strong barriers to their development because of the 5 MWp cap for the FiT support system. Investors tend to split PV installations larger than 5 MW into groups of smaller ones. Furthermore, these systems are not considered simple constructions and thus the administrative authorization process may prove demanding.

Barrier Type	Name	Process	Description
Support-related	Annual cap for ground mounted PV systems	Support Scheme(s)	There is a 5 MWp yearly cap on ground-mounted PV systems up to which <i>Borzen</i> (power market operator) can provide the feed-in tariff. Currently, the yearly cap is already filled up to the end of 2014.
Grid-related	Unfair competition from electricity distributors	Grid Connection Permit	Some electricity distributors are building their own PV systems and are delaying the issuing of approvals and contracts to other providers.
Permitting Procedures	Land designation	Site Selection	Problems in choosing a land plot can arise either through an incorrect classification of land (if it is building land) or through the designation of "local interest" as municipalities themselves have use of the land plots. The plot's designation can be changed every 5 years when the municipalities change their urban plans. If the land plot is not suitable for construction an investor may wait up to 5 years for the application for the changing of the designation to be processed.

Table 3.13 – Most severe market barriers in Slovenia

⁴ Quantitative analysis of the Slovenian framework is not within the scope of the project.

Spain

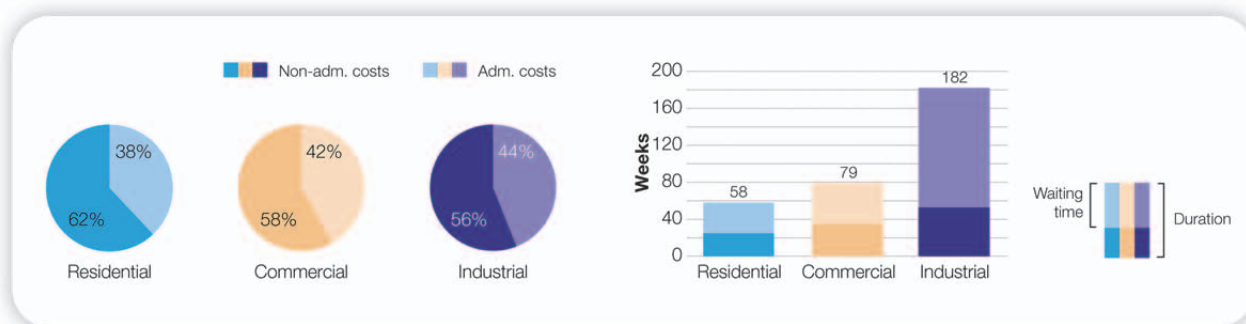


Figure 3.14 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

Currently in Spain the support schemes for PV installations (and RES-E generation in general) are suspended due to decree RDL 1/2012: the allocation of feed-in tariffs is blocked also for those systems that are waiting in the pre-registry allocation queue.

Residential systems (up to 10 kW) installed on buildings are assigned lighter permitting and grid connection procedures, as provided by the RD 1699/2011 decree. This piece of legislation also allows for the self-consumption of all generation for PV installations up to 100 kW connected to the low voltage grid, therefore including the **commercial systems** segments. However, both segments are having difficulties in accessing financial support. Another limiting requirement PV system operators need to fulfil is to have an electricity contract for a capacity equivalent to at least 25% of the installed PV power. These segments appear, in any case, to have a promising future in Spain, thanks to electricity self-consumption and net-metering, expected to come into force within the near future.

Within the last 3 years, **industrial ground-mounted systems** have seen their total yearly PV market share decreasing from nearly 100% to only 33%, mainly due to the introduction the pre-registry regime, the decrease and the suspension of feed-in tariffs. However, PV systems still have the possibility to sell the electricity to the grid at pool prize and this option is expected to become more and more profitable, especially at very large system sizes. At local level, urban planning and environmental matters prove to be tough obstacles to overcome, resulting in difficult and expensive system development processes.

Barrier Type	Name	Process	Description
Permitting Procedures	Pre-registry regime	Support Scheme(s)	Inclusion in the pre-registry depends on the quantity of systems on a waiting list, and this creates serious uncertainty on cash flows. For ground-mounted systems the waiting list currently lasts three and a half years.
Permitting Procedures	Permitting fees	Support Scheme(s)	Before accessing the pre-registry, and without knowing if it is going to be obtained, it is necessary to forward consistent payments for the building permit and a financial guarantee.
Grid-related	Lack of information	Grid Connection Permit	DSOs tend not to provide transparent information with regards to the grid capacity evaluation. Grid data and calculation tools are not available to connection point applicants.

Table 3.14 – Most severe market barriers in Spain

Sweden



Figure 3.15 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

The Swedish PV market is still underdeveloped, mainly due to a support scheme with a market limitation mechanism.

The market for **residential systems** has existed just since July 2009 when a new investment subsidy was introduced. The subsidy has recently been prolonged until 2016. However, its total budget is limited to €7 million per year in 2012-2013 and to €6 million per year in 2014-2016. Due to these limitations the number of residential installations is still relatively small. The government has launched an investigation, to be completed in June 2013, evaluating the implementation of net-metering. If net-metering will be allowed, in combination with decreasing system prices and increased awareness of the possibilities with PV, from 2014 this segment may grow much faster. Grid operators and electricity supplier companies are showing a growing interest for PV and in 2012 some electricity suppliers started to offer turn-key residential PV systems.

The market of **commercial systems** is also mainly driven by the above mentioned investment subsidy. However, from February 2013 there is a subsidy limitation of 140.000 € per property that sets an upper limit (of roughly 200 kWp) to the PV system size. The possible implementation of net-metering may not have a strong effect on this segment.

There is no market for **industrial ground-mounted systems** in Sweden, due to the inapplicability of the support system for large installations. Also, the production cost of PV electricity without subsidies is higher than the Nord Pool electricity spot market price.

Barrier Type	Name	Process	Description
Support-related	Incongruous trading conditions of electricity certification system	Support Scheme(s)	The electricity certification system is not adapted to residential PV systems. The requirement of hourly production measurements forces the producer to buy a service that is too expensive to make any profit from the certificates. The producer can get certificates without cost for excess electricity fed into the grid, but this give certificates only for a limited part of the full production. In addition, the value of certificates is too low to promote the market development.
Support-related	Cap of investment subsidy budget	Support Scheme(s)	Total government budget of investment subsidy is in 2012 limited to approximately €7 million (60 MSEK), of which €0.3 million (2.5 MSEK) used to cover administration costs of the authorities. The budget is too low to allow for funding to all applicants.
Support-related	Electricity certificate value	Support Scheme(s)	The value of electricity certificates is set by the market and is too low to promote the market development. Even with electricity certificates, the production cost of PV electricity will not be lower than the Nord Pool electricity spot market price. Statistics for historical values of the electricity certificates are available at the website " <i>Cesar elcertifikat</i> ".

Table 3.15 – Most severe market barriers in Sweden

United Kingdom

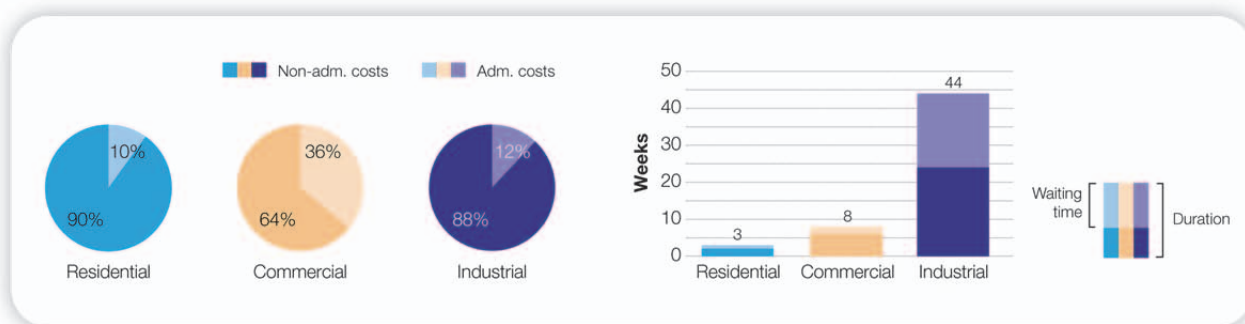


Figure 3.16 - PV project development: share of administrative costs, duration and waiting time

Summary of market status

The latest estimations by the Department of Energy and Climate Change (September 2012) of the amount of installed PV power in the UK indicate that there is about 1.4 GWp of installed PV capacity in operation, mainly concentrated in the residential and commercial market segments. In April 2013, data from the Microgeneration Certificate Scheme showed that in these 2 segments there are about 445,000 PV installations. Larger installations are also present, but to a lesser extent.

Residential systems can count on a quite swift procedure with minor and relatively few barriers in the installation process, as it takes between 2 and 4 weeks to complete the whole process.

Commercial systems show slightly larger values in terms of overall process time and labour invested, but the segment appears to be in relatively good health. Installation of a commercial system takes 8 weeks on average. The biggest legal and administrative barriers occur at the site selection and grid connection stages of the process. These are not insurmountable, but the process could be made easier.

The project lifecycle of **industrial ground-mounted systems** takes 44 weeks on average and cases of processes lasting up to one year have been recorded. About half of this time is calculated as waiting time, that is time spent waiting for an answer from authorities. Usually, operators of industrial ground-mounted systems make use of the renewables obligation quota system instead of the feed-in tariff, following a drop of the latter in 2011.

Barrier Type	Name	Process	Description
Support-related	PV does not qualify for Enhanced Capital Allowances	Financing	Unlike some other renewable technologies, solar PV does not qualify for Enhanced Capital Allowances. This means that solar PV is not treated as favourably as other technologies with regard to corporation tax.
Grid-related	Cost of grid upgrade	Grid Connection Permit	Costs of grid upgrades charged on developers can be prohibitive.
Permitting Procedures	Change of land use	Administrative process	There may be objections to changing the use of the land e.g. from agriculture to power generation, leading to consistent lead times.

Table 3.16 – Most severe market barriers in the United Kingdom

4 ENHANCING PV HOSTING CAPACITY IN DISTRIBUTION GRIDS

As discussed in the introduction, PV GRID consists of two main actions. In parallel to the assessment of national frameworks for the development of PV installations described in the previous section, PV GRID also focuses on the challenges linked to the integration of high shares of PV electricity into the distribution Grid infrastructure. The main goal of this second action is to prepare the grounds for large-scale integration of PV systems on distribution grids across Europe.

Organised in three working groups, PV GRID project partners and external experts collaborate in researching and analysing the issues and discuss solutions on a trans-national level. The main tasks of the working groups are to:

- Review and evaluate the **most appropriate technical solutions for integrating PV systems** on the distribution grid infrastructure
- **Recommend normative and regulatory solutions** that allow for swifter and economic implementation of these solutions

The **normative recommendations** will address administrative barriers and other obstacles that either DSOs or PV operators have to face when implementing technical solutions that would instead allow for higher grid hosting capacity, such as long permitting times and inappropriate grid codes.

The **regulatory recommendations**, on the other hand, will address the framework in which DSO and PV systems owners economically operate. For instance, a certain national regulatory framework may not allow a DSO to recover the costs of necessary grid-enhancing investments. Also, a PV system operator may not be correctly incentivised (by means of network fees for instance) to make an efficient use of the distribution grid.

4.1 Prioritising Technical Solutions for PV Integration

Technical Problems and Barriers to PV Integration

In order to identify technical solutions for increasing the hosting capacity of distribution grids towards the integration of high shares of PV, the initial step has been to frame the problems a power system has to cope with in such a context. The problems can be grouped under 4 categories: **frequency stability, voltage quality, fault conditions and congestion management**.

It has been clarified that some of the technical solutions related to fault conditions and frequency stability are dealing with system security aspects. However, dealing with these aspects would require a full system picture also including the transmission grid level, which is out of the PV GRID project scope, whose main focus is instead on the distribution grids. Therefore, only those technical solutions having an impact on **voltage quality** and local **congestion management** will be considered in the work of PV GRID.

Technical Solutions for PV Integration

For the purpose of assessing the state of the art, a document repository was established. Several documents were collected by all partners participating in the project consortium. The sources for documents were mainly national, European and other international projects, grid codes and standards. The collection process was finalised at the end of June 2012.

The collected documents were classified in three categories:

- Regulatory and normative framework;
- Technical framework;
- Both technical and regulatory framework.

Two working groups have then been set up for the purpose of evaluating the documents:

- **WG1 (SMART GRIDS)**: Discussion of technical issues and solutions on the network and consumer side;

- **WG2 (SMART PV):** Discussion of technical issues and solutions on the PV system side.

The initial findings of the working groups were detailed in two internal discussion papers that were the basis for a discussion that took place in the first of a series of three consultation workshops, participated both by project partners and external experts. External experts were selected amongst stakeholders of the European electricity sector: representatives of TSO, DSOs, inverter and storage manufacturers. Following the recommendations of the first consultation workshop, a short list of technical solutions was proposed. The solutions variants and combinations were discussed more in depth and the list was further refined through the following workshops in order to reach a large consensus between stakeholders.

The results of this process are listed in Table 4.1. The table presents a list of technical solutions that potentially can increase the hosting capacity in distribution grids. As already mentioned, only those technical solutions having an impact on voltage quality and local congestion management have been considered in the remainder of this work.

Category	#	Technical solution
DSO	1	Network Reinforcement
	2	On Load Tap Changer for MV/LV transformer
	3	Advanced voltage control for HV/MV transformer
	4	Static VAR Control
	5	DSO storage
	6	Booster Transformer
	7	Network Reconfiguration
	8	Advanced Closed-Loop Operation
PROSUMER	9	Prosumer storage
	10	Self-consumption by tariff incentives
	11	Curtailment of power feed-in at PCC
	12	Active power control by PV inverter P(U)
	13	Reactive power control by PV inverter Q(U) Q(P)
INTERACTIVE	14	Demand response by local price signals
	15	Demand response by market price signals
	16	SCADA + load control
	17	SCADA + PV inverter control (Q and P)
	18	Wide area voltage control

Table 4.1 – Summary of technical solutions for congestion management and voltage quality issues

As some of these technical solutions may be applied for both voltage quality and congestion management problems, it was decided to reclassify them according to the following 3 categories:

- **DSO** solutions that are implemented within the grid operator infrastructure and require no communication with the consumer (or prosumer);
- **PROSUMER** solutions which are implemented within the consumer (or prosumer) infrastructure and require no communication with the grid operator;
- **INTERACTIVE** solutions that are implemented within both the grid operator and the prosumer infrastructures and where the different components react based on signals exchanged via a communication infrastructure.

DSO solutions

- **Network reinforcement** - Further grid hosting capacity is provided by additional cable and transformer capacity installations.
- **On Load Tap Changer (MV/LV transformer)** - The OLTC device is able to adjust the lower voltage value of an energized transformer.

- **Advanced voltage control (HV/MV transformer)** - This solution includes new control methods for existing HV/MV transformers with already installed OLTC.
- **Static VAR Control** - Utilizing Static VAR Compensators (SVC) enables to provide instantaneously reactive power under various network conditions.
- **DSO storage** - Storing electricity with a central storage situated in a suitable position of the feeder enables to mitigate voltage and congestion problems.
- **Booster Transformers** - Boosters are MV-MV or LV-LV transformers used to stabilize the voltage along a long feeder.
- **Network Reconfiguration** - Revising network operational conditions by reconfigurations, in particular the boundaries between feeders in MV networks, is a method to enhance the voltage profiles in distribution networks.
- **Advanced Closed-Loop Operation** - Two feeders are jointly operated in a meshed grid topology controlled by a Smart Grid architecture to decrease the circuit impedance while increasing the short circuit power.

Prosumer solutions

- **Prosumer Storage** - Storing electricity at prosumer level enables to mitigate voltage and congestion problems if a reduction of the feed-in peaks can be ensured.
- **Self-consumption by tariff incentives** - With a fixed tariff structure (e.g. feed-in price lower than consumption price), the prosumer is motivated to shift its electricity consumption in order to reduce its injected PV energy. A maximum feed-in power based tariff (e.g. kWh price set to zero or to negative values above some feed-in power limits) could further help in reducing injected PV peak power.
- **Curtailement of power feed-in at PCC** - The meter at the customer's site controls that the feed-in power is never above the contracted maximum power or above a fixed value (e.g. 70% of the installed PV capacity as implemented in the German Renewable Energy Act). This solution requires the meter to be able to control down the PV production or to activate a dump load.
- **Active power control by PV inverter $P(U)$** - Voltage and congestion problems can be solved by curtailing the PV feed-in power. Contrary to the fixed power curtailment as described in previous solution the LV grid voltage is used as an indicator for the grid situation and for the curtailment level.
- **Reactive power control by PV inverter $Q(U)$, $Q(P)$** - Providing reactive power as a function of the local voltage value [$Q=Q(U)$] or as a function of the active power production [$Q=Q(P)$], limits the voltage rise caused by distributed generators.

Interactive solutions

- **Demand response by local price signals** - Demand response is triggered by local price signals available only to consumers located in feeders that experience voltage and/or congestion problems.
- **Demand response by market price signals** - Demand response is triggered by electricity market price signals, which are identical for consumers wherever they are located.
- **SCADA + direct load control** - In critical grid situations, DSOs or energy aggregators are allowed to remotely activate (or curtail) dedicated consumer loads, based on agreed contract.
- **SCADA + PV inverter control (Q and P)** - The level of reactive power provision and the active power reduction of dedicated PV inverters are remotely controlled by a feeder supervisory control system.
- **Wide area voltage control** - All controllable equipment (like transformers with OLTC, static VAR compensators, dedicated loads and PV inverters) are coordinated to optimize voltage and power factor in the whole DSO area. Smart grid technologies are applied to measure the voltage and power factor at several points, controlling the equipment, coordinating and optimizing the generation and load.

Prioritisation of Technical Solutions

Once different possible technical solutions for increasing the grid hosting capacity were identified, the following objective was to define a list of "most wanted" technical solutions at European level, by involving the expertise of DSOs, PV associations and other stakeholders. These results are going to be the basis for the further investigation of

normative and regulatory actions that will allow a swifter and more economical implementation of the most promising technical solutions.

Multi-criteria analysis and stakeholder dialogue

Due to the many different situations in the European distribution grids (e.g., PV penetration level, feeder characteristics, load profile, load density), comparing the benefits and costs of the different possible technical solutions for increasing the grid hosting capacity for PV is not an easy task. An initially foreseen approach to the prioritization of the technical solutions was to perform simulations on generic representative distribution grids for the four focus countries, i.e., Germany, Spain, Italy and Czech Republic. However, the assessment of the effort and resources necessary for this solution lead to the decision that the simulations' required effort could not be justified within the activities of the PV GRID project.

Taking into account the aforementioned considerations, it was decided to apply an iterative method based on a multi-criteria analysis, discussed and agreed during the aforementioned consultation workshops.

Initial National Assessment by DSOs

Initially, the different technical solutions have been evaluated against common criteria (e.g. cost, technology readiness, impact on grid hosting capacity, applicability within existing regulations) for four grid type categories (rural low voltage (LV), suburban LV, rural medium voltage (MV) and suburban MV grids) in each of the four focus countries. This task was performed by the DSOs participating in PV GRID (RWE, ENEL, LUMEN), supported by Comillas Pontifical University and Iberdrola for Spain.

During the evaluation process, the distinction between rural and suburban grids was evaluated as not very relevant and only two grid categories (LV and MV) were kept.

Performance Indicators

In a second step, utilising the evaluation results obtained in the first step, two multi-criteria performance indicators were defined for assessing both the techno-economic and the regulatory priority for each solution:

- **techno-economic indicator**, based on the three criteria: investment cost, impact on voltage and impact on congestion, opportunely weighted in order to represent the current priorities for DSOs;
- **regulatory priority indicator**, which indicates if the implementation of a technical solution is facing a regulatory barrier and how urgent it is to remove this regulatory barrier. This indicator is defined as in Table 4.2.

Regulatory Priority Index	Technology available?	Regulation needed?	Recommendation
1	YES	YES	Urgency to adapt regulations to an available technology
2	NO	YES	Urgency for regulatory changes depends on technology availability
3	NO	NO	Technology is not mature
4	YES	NO	Should be applied where problems occur

Table 4.2 - Regulatory priority indicator

Finally, the results of the techno-economic indicator for the different countries have been combined in order to define a ranked list of technical solutions at European level for two grid types (LV and MV).

Final Stakeholder Consultation

Before moving on to the analysis of barriers for the preference list of solutions, an additional consultation with the PV industry and other stakeholders involved in the electricity sector was organized during a final consultation workshop. These stakeholders were represented by PV and solar industry associations participating to the project and invited external experts selected from research institutes, DSOs, TSO, inverter and storage manufacturers.

Based on the outcome of this last consultation round, the ranking of technical solutions was finally adjusted. The results for the techno-economic indicators were aggregated in two preference lists (one for each voltage level) with three priority categories in order to better reflect the position of all stakeholders. These preference lists are illustrated in Table 4.3 and Table 4.4.

4.2 Preparation of Normative and Regulatory Recommendations

In order to build the regulatory and normative recommendations, a third working group has been set up in early 2013.

While working groups 1 and 2 have identified the technical solutions that could enable a higher integration of PV, working group 3 will analyse the regulatory and normative barriers that can hamper the implementation of such solutions, taking into account the peculiarities of the 4 focus country of the project: Czech Republic, Germany, Italy and Spain. Working group 3 is formed by members of the PV GRID project consortium and external experts. External experts have been selected so that their experience on administrative and regulatory questions will complement that of the project consortium.

The tasks of working group 3 has been organised in three successive steps. First, the barriers in the regulatory, administrative, standard and grid codes frameworks will be analysed at a European level. In a second step, each focus country will be extensively analysed with reference to the high priority solutions identified and the barriers insisting on each of them. Finally, a problem-oriented analysis will be used, starting with the technical solutions and identifying the barriers for each solution, taking into account the result of each country case study performed in the previous step.

The problems identified in the focus countries will be grouped in clusters to identify general characteristics, problems and recommendations valid not only for the focus countries, but also at European level.

The activities of working group 3 are underway, and its recommendations will be published in a European Advisory Paper scheduled in late 2013. The recommendations will then be discussed during early 2014 in a series of national workshops involving national stakeholders amongst authorities, policy-makers, energy regulators, and representatives of transmission and distribution grid operators.

In late 2014, the recommendations will be discussed at European level in a final forum organised in Brussels.

Prioritisation results for LV grids

Table 4.3 presents the final evaluation results based on the stakeholder consultation. The list of high priority solutions includes two DSO solutions (the classical network reinforcement and the new product OLTC for MV/LV transformers) and four PROSUMER solutions (storage, reactive power provision by PV inverters and the 2 curtailment variants of PV power). No regulatory barriers have been identified for the DSO solutions (green colour in table). On the contrary, regulatory barriers are present for PROSUMER solutions. In the low priority category are gathered the solutions based on electricity price signals, the sophisticated closed loop operation and solutions less relevant to this voltage level.

Priority	Technical solution	CZ	DE	ES	IT
HIGH PRIORITY	Curtailment of power feed-in at PCC				
	Network Reinforcement				
	Reactive power control by PV inverter Q(U) Q(P)				
	Active power control by PV inverter P(U)				
	Prosumer storage				
	On Load Tap Changer for MV/LV transformer				
NORMAL PRIORITY	SCADA + direct load control				
	Network Reconfiguration				
	Self-consumption by tariff incentives				
	Wide area voltage control				
	Static VAr Control				
	Booster Transformer				
	SCADA + PV inverter control (Q and P)				
	DSO storage				
LOW PRIORITY	Demand response by local price signals				
	Advanced voltage control for HV/MV transformer				
	Demand response by market price signals				
	Advanced Closed-Loop Operation				

Table 4.3 - Priority list of technical solutions for LV grids

Regulatory priority index - Legend
Urgency to adapt regulations to an available technology
Urgency for regulatory changes depends on technology availability
Technology is not mature
Should be applied where problems occur

Prioritisation results for MV grids

Table 4.4 presents the final evaluation results based on the stakeholder consultation. The list of most wanted solutions includes three DSO solutions (the classical network reinforcement, OLTC for HV/MV transformer and network reconfiguration), three PROSUMER solutions (un-supervised reactive power provision by PV inverters and curtailment variants of PV power) and one INTERACTIVE solution (supervised control of PV active and reactive power). No regulatory barriers have been identified for the DSO solutions (green colour in table). On the contrary, regulatory barriers are present for PROSUMER solutions. (red colour in table, with exception of un-supervised reactive power provision in Germany). In the low priority category are gathered the solutions based on electricity price signals, the sophisticated closed loop operation and solutions less relevant to this voltage level.

Priority	Technical solution	CZ	DE	ES	IT
HIGH PRIORITY	Network Reinforcement	■	■	■	■
	Reactive power control by PV inverter Q(U) Q(P)	■	■	■	■
	Curtailment of power feed-in at PCC	■	■	■	■
	Active power control by PV inverter P(U)	■	■	■	■
	Network Reconfiguration	■	■	■	■
	SCADA + PV inverter control (Q and P)	■	■	■	■
	Advanced voltage control for HV/MV transformer	■	■	■	■
NORMAL PRIORITY	Static VAr Control	■	■	■	■
	SCADA + direct load control	■	■	■	■
	Self-consumption by tariff incentives	■	■	■	■
	Wide area voltage control	■	■	■	■
	DSO storage	■	■	■	■
	Prosumer storage	■	■	■	■
LOW PRIORITY	On Load Tap Changer for MV/LV transformer	■	■	■	■
	Booster Transformer	■	■	■	■
	Demand response by local price signals	■	■	■	■
	Demand response by market price signals	■	■	■	■
	Advanced Closed-Loop Operation	■	■	■	■

Table 4.4 - Priority list of technical solutions for MV grids

Regulatory priority index - Legend
Urgency to adapt regulations to an available technology
Urgency for regulatory changes depends on technology availability
Technology is not mature
Should be applied where problems occur

5 PV GRID CONSORTIUM

Coordinator

Bundesverband Solarwirtschaft e.V. (BSW-Solar)
Quartier 207
Friedrichstraße 78
10117 Berlin - Germany
Jörg Mayer: mayer@bsw-solar.de
www.solarwirtschaft.de



WP Leaders

eclareon GmbH
Giesebrechtstraße 20
10629 Berlin - Germany
Paolo Michele Sonvilla: pms@eclareon.com
www.eclareon.com



DERLab e.V.
c/o Fraunhofer IWES
Königstor 59
34119 Kassel - Germany
Michel Vandenberg: michel.vandenberg@der-lab.net
www.der-lab.net



European Photovoltaic Industry Association
Renewable Energy House
63-67 Rue d'Arlon
1040 Brussels - Belgium
Marie Latour: m.latour@epia.org
www.epia.org



Partners

APESF
Avenida da República, n.6, 7º esquerdo
1050-191 Lisboa - Portugal
Leonor Barradas: info@apesf.pt
www.apesf.pt



ASSOSOLARE
Piazza Luigi di Savoia n.2
20124 Milano - Italy
Andrea Zanolla: andrea.zanolla@assosolare.org
www.assosolare.org



BPVA
2 Nikolay Haitov, Entrance G, off. 36A 2
1113 Sofia - Bulgaria
Rumen Petrov: rpetrov@bpva.org
www.bpva.org



CZEPHO
Americká 17
12000 Prague - Czech Republic
Zuzana Musilova: zuzana.musilova@czepho.cz
www.czepho.cz



edora
Allée des Artisans 26
4130 Tilff - Belgium
Frank Gerard: fgerard@edora.be
www.edora.org



ENEL Distribuzione
Via Ombrone 2
00198 Roma - Italy
Mariangela Di Napoli: mariangela.dinapoli@enel.com
www.enel.it



ENERPLAN
515 Avenue de la Tramontane, Le Forum B
13600 La Ciotat - France
Sylvain Roland: sylvain.roland@enerplan.asso.fr
www.enerplan.asso.fr



HELAPCO
Vouliagmenis Ave, 224 & Ag. Dimitriou 1
173 43 Ag. Dimitrios, Athens – Greece
Stelios Psomas - info@helapco.gr
www.helapco.gr



Holland Solar
Korte Elisabethstraat 6
3511 JG Utrecht - Netherlands
Arthur de Vries - adevries@celstar.nl
www.hollandsolar.nl



Lumen
Nemanická 2722
37010 České Budějovice – Czech Republic
Martin Muller: martin.muller@lumen.cz
www.lumen.cz



PTPV

ul. Pralatońska 5/50

03-510 Warsaw - Poland

Stanisław M. Pietruszko: pietruszko@pv-poland.pl

www.pv-poland.pv



PV AUSTRIA

Neustiftgasse 115 A/19

1070 Wien - Austria

Vera Liebl: office@pvaustria.at

www.pvaustria.at



RWE DEUTSCHLAND

Kruppstrasse 5

45128 Essen - Germany

Carmen Calpe: Carmen.Calpe@rwe.com

www.rwe.com



SAPI

Bajkalská 5/B

831-04 Bratislava - Slovakia

Veronika Galeková: info@sapi.sk

www.sapi.sk



Solar Trade Association

25 Eccleston Place - London SW1W 9NF

United Kingdom

Paul Barwell: pbarwell@solar-trade.org.uk

www.solar-trade.org.uk



Svensk solenergi

Torsgatan 12

11123 Stockholm - Sweden

Jan-Olof Dalenbäck: Jan-Olof.Dalenback@chalmers.se

www.svensksolenergi.se



UNEF

Velazquez18, 7ª izquierda

28001 Madrid - Spain

Lucía Dólera: asociados@unef.es

www.unef.es



Universidad Pontificia Comillas

Calle Alberto Aguilera 23

28015 Madrid - Spain

Ing. Pablo Frías Marín: pablo.frias@iit.upcomillas.es

www.upcomillas.es



6 GLOSSARY

Booster Transformer is a transformer of which one winding is intended to be connected in series with a circuit in order to alter its voltage and the other winding is an energizing winding.

Closed-Loop Operation (or Closed Ring Operation) is the method of operation where each point of a given part of a network is fed from two sources along two distinct paths.

Electricity retailer is a company that is selling electricity to the final user.

Fast Voltage Deviations are defined as the variations that occur instantaneously in a network in case a generation plant suddenly disconnects.

Feeder is a power line transferring power between distribution substations and consumers.

Grid connection fees are to be paid for the connection of the PV system to the grid.

Grid operator: operator of transmission or distributions grids that transmits or distributes electricity within a designated area and co-ordinates its services with other grids.

Grid usage fees are to be paid for the use of the grid (e.g., for transport or storage of generated electricity).

Ground-mounted system: this term covers all PV systems that are installed on the ground.

Grid hosting capacity is the maximum DER penetration for which the power system operates satisfactorily.

Installed capacity is the sum of the PV modules' rated power of a PV system. The rated power is either calculated as sum of the nameplate capacity of the modules or the sum of the flashed power of the PV modules.

Installer: the person or company that installs the PV system.

Inverter is the device that converts direct current (DC) to alternating current (AC).

Land development plan represents the higher level in land use planning. Used for planning on town level.

Land use planning: Branch of public policy that encompasses various disciplines that seek to order and regulate the use of land in an efficient and ethical way.

Legal-administrative barriers are barriers that are caused by regulations stemming from government bodies or grid operators and which delay the authorisation or the installation of PV systems. This definition comprises bureaucratic barriers but also covers barriers that stem directly from the law and not only from its application by the administration.

Listed building: a building that has been placed on a list of Buildings of Special Architectural or Historic Interest. Usually, a listed building may not be demolished, extended or altered without permission from the local planning authority.

Maximum capacity: the highest possible output of a PV system under normal conditions.

On-Load-Tap-Changer (OLTC) is a device for changing the tapping connections of a winding, suitable for operation while the transformer is energized or on load.

Point of common coupling (PCC) is the point on the public electricity network at which customers are connected.

Project developer: a person or company that is in charge for the planning and development of the PV project.

PV system operator: a person or company that (owns and) operates a PV system.

Rooftop system: this term covers all PV systems that are installed on or in the roof of buildings.

Slow Voltage Deviations are defined as the variations that occur in voltage during normal operation, due to the behaviour of generation and load connected to a given network.

Static VAR Compensator (SVC) is an electrical device that provides fast-acting reactive power in an electrical network under various system conditions.

Supervisory control and data acquisition (SCADA) usually refers to centralized systems which monitor and control entire sites, or complexes of systems spread out over large areas (anything from an industrial plant to a nation).

Urban development plan: The lowest level in land use planning. Used for planning on local level and on parts of a town



Reducing barriers to large-scale integration of pv electricity into the distribution grid

info@pvgrid.eu



Cover image credit : Meyer Burger Group