SOLAR BANKABILITY

PV Business Model Country Snapshots

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Foreword

The photovoltaic (PV) sector has overall experienced a significant growth globally in the last decade, reflecting the recognition of PV as a clean and sustainable source of energy. Project investment has been and still is a primary financial factor in enabling sustainable growth in PV installations. When assessing the investment-worthiness of a PV project, different financial stakeholders such as investors, lenders and insurers will evaluate the impact and probability of investment risks differently depending on their investment goals. Similarly, risk mitigation measures implemented are subject to the investment perspective. In the financing process, the stakeholders are to elect the business model to apply and be faced with the task of taking appropriate assumptions relevant to, among others, the technical aspects of a PV project for the selected business model.

The Solar Bankability project aims to establish a common practice for professional risk assessment which will serve to reduce the risks associated with investments in PV projects.

The risks assessment and mitigation guidelines are developed based on market data from historical due diligences, operation and maintenance records, and damage and claim reports. Different relevant stakeholders in the PV industries such as financial market actors, valuation and standardization entities, building and PV plant owners, component manufacturers, energy prosumers and policy makers are engaged to provide inputs to the project.

The technical risks at the different phases of the project life cycle are compiled and quantified based on data from existing expert reports and empirical data available at the PV project development and operational phases. The Solar Bankability consortium performs empirical and statistical analyses of failures to determine the manageability (detection and control), severity, and the probability of occurrence. The impact of these failures on PV system performance and energy production are evaluated. The project then looks at the practices of PV investment financial models and the corresponding risk assessment at present days. How technical assumptions are accounted in various PV cost elements (CAPEX, OPEX, yield and performance ratio) are inventorized. Business models existing in the market in key countries in the European Union (EU) region are gathered. Several carefully selected business cases are then simulated with technical risks and sensitivity analyses are performed.

The results from the financial approaches benchmarking and technical risk quantification are used to identify the gaps between the present PV investment practices and the available extensive scientific data in order to to establish a link between the two. The outcomes are best practices guidelines on how to translate important technical risks into different PV investment cost elements and business models. This will build a solid fundamental understanding among the different stakeholders and enhance the confidence for a profitable investment.

The Solar Bankability consortium is pleased to present this report which is one of the public deliverables from the project work.

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Project Information

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Abbreviations

ANRE	National Energy Regulatory Authority
BIPV	Building integrated PV
CAPEX	Capital Expenditure
CdTe	Cadmium telluride
CfD	Certificate for Difference
DECC	Department of Energy and Climate Change
DSO	Distribution system operator
ECN	Energy Research Center of the Netherlands
EEG	German Renewable Energy Act
EU	European Union
EUR, EUR ct	Euro, Euro cent
FiT	Feed-in tariff
GBP; GBp	Great Britain pound, Great Britain pence
GC	Green Certificate
GSE	Gestore Servici Energetici
GW, GWp	Giga watt, Giga watt peak
IPEX	Italian power exchange
KfW	Kreditanstalt für Wiederaufbau
kW, kWp, kWh	Kilo watt, Kilo watt peak, Kilo watt hour
LCOE	Levelized cost of electricity
MW, MWp	Mega watt, Mega watt peak
NREAP	National Renewable Energy Action Plan
O&M	Operations and maintenance
Ofgem	Electricity Markets Authority
OPCOM	Romanian gas and electricity market operator
OPEX	Operational Expenditure
PPA	Power purchase agreement
PV	Photovoltaic
R&D	Research and development
ROC	Renewable Obligation Certificate
SDE+	Dutch renewable energy stimulation program
TW, TWp, TWh	Tera watt, Terra watt peak, Terra watt hour

1. Executive Summary

1.1. Business Model Oveview

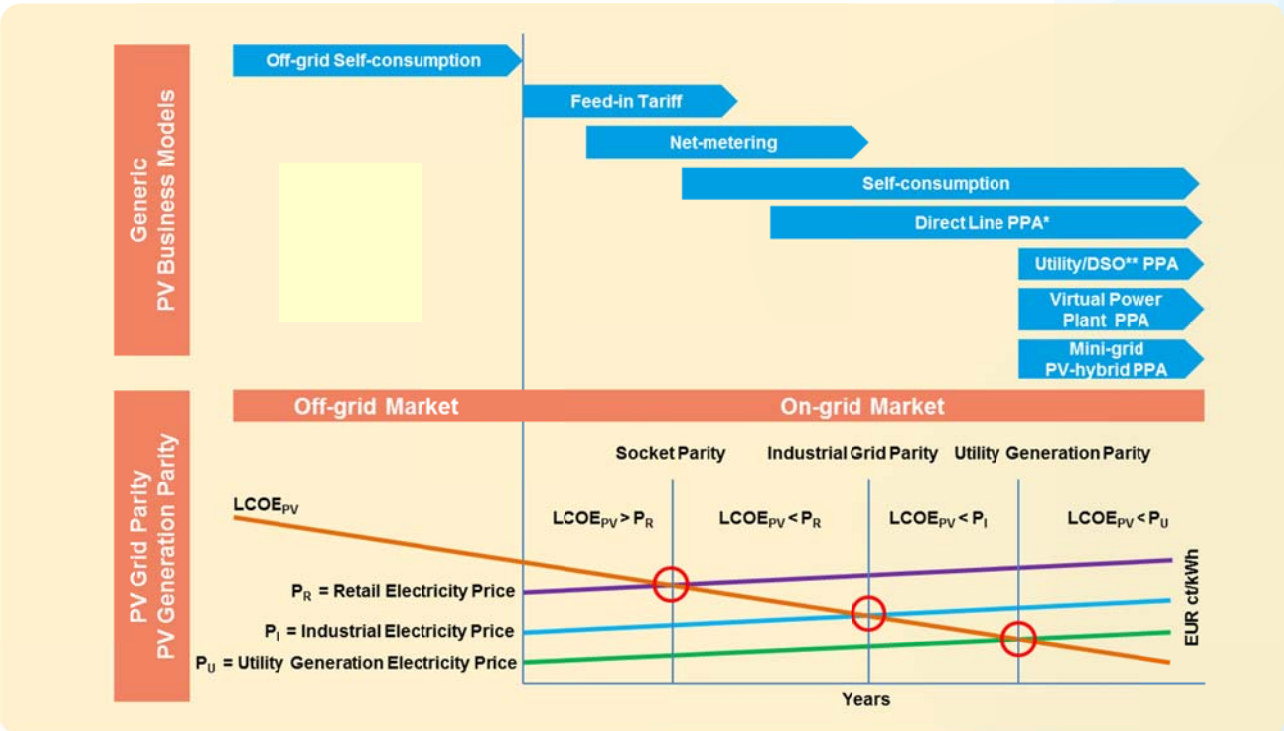
In 2014 cumulative PV installations in Europe reached 89 GWp representing an investment volume of more than 200 bn EUR. The latest Global Market Outlook of SolarPower Europe [1] contains two market scenarios till 2019. The low scenario predicts additional installations of 32 GWp and the high scenario of 69 GWp. With further decreasing PV system prices this could represent estimated investment volumes of less than 50 bn EUR and 100 bn EUR respectively.

Financial stakeholders such as investors, lenders or insurers need to assess the inherent risks of PV projects and their underlying business models. These risks have to be identified, quantified and mitigated, both in the primary PV market for new installations and in the rapidly growing secondary PV market for already existing installations.

With the continuous decline of the levelized cost of electricity (LCOE) the price of PV electricity is getting close to, and in some locations even is dropping below, socket parity. This is the trigger point where the price for PV electricity equals the retail electricity price for residential consumers and where new business models based on self-consumption can be explored. Further decreasing LCOE open the room for additional new business.

In the business model overview eight generic PV business models together with their specific parameters, market framework conditions and underlying value propositions are introduced (figure 1).

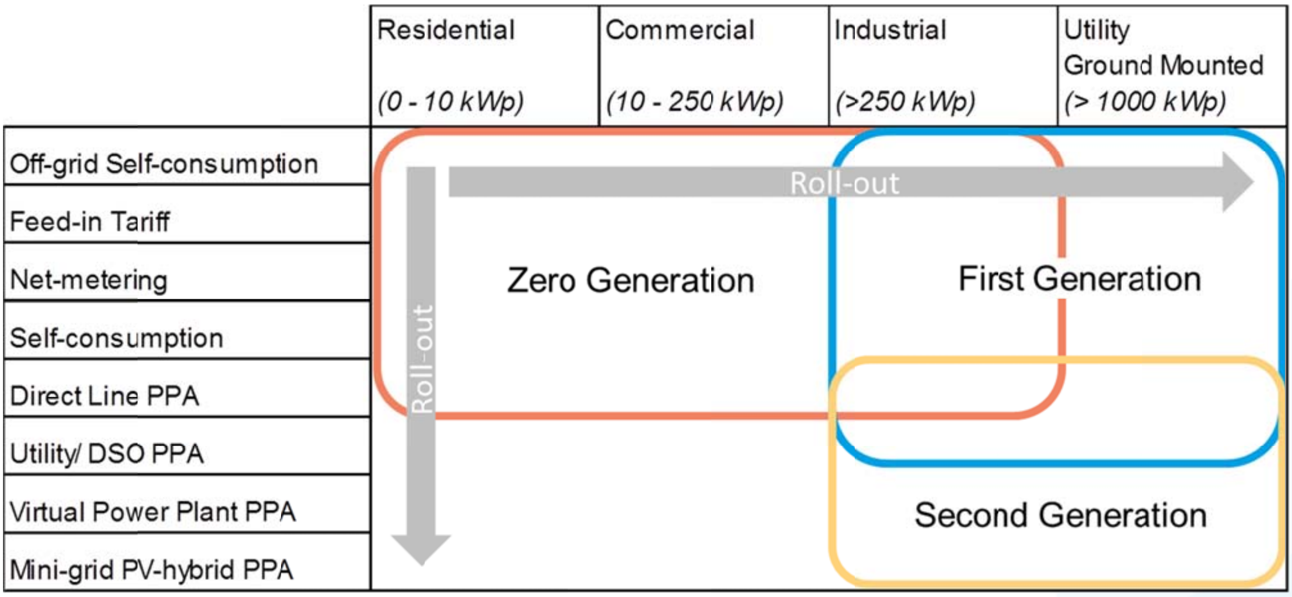
Figure 1: PV LCOE vs. Grid Parity Trigger Points and Generic Business Models [2] [3]



* PPA = Power purchase agreement
** DSO = Distribution system operator

Their roll-out dynamics depend on the national renewable energy policies and associated incentive schemes and an ever increasing complexity of the PV systems and the associated business models. The roll-out can be broken down in three investor generations. In the zero generation building and site owners take over the investor role for the PV system. In the first generation this role is passed on to local-cooperatives and third party financial investors, and in the second generation large utilities, distribution system operators (DSOs) and virtual power plants step in (figure 2).

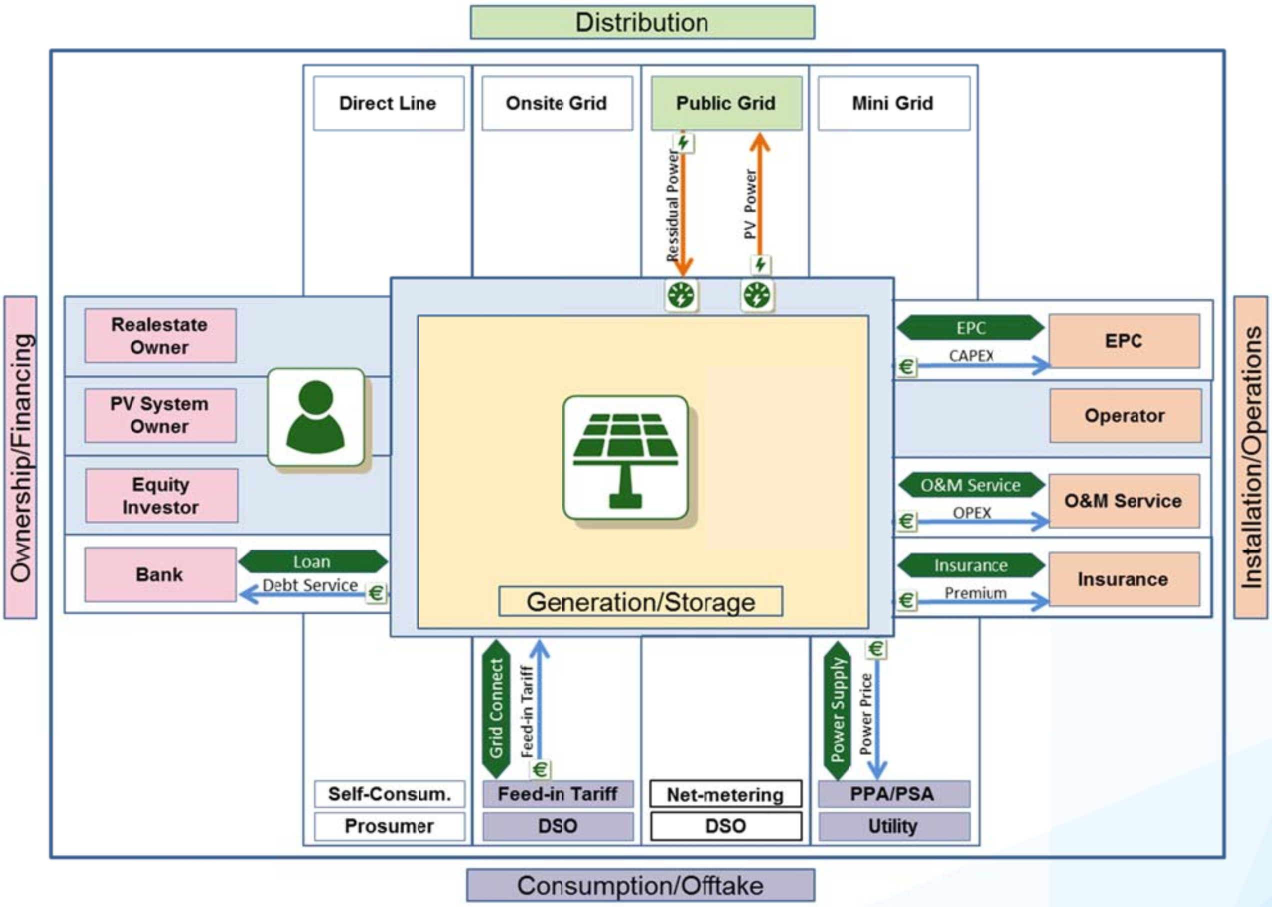
Figure 2: PV Business Model Roll-out [4]



New business models are often formed by a combination of one or more generic business models leading to a higher degree of complexity. PV systems are combined with other components such as batteries or heat pumps. Grid connectivity requirements increased from grid compliant, to grid regulated, to grid balancing capabilities. In many cases mare stakeholders are getting involved and have to be aligned.

Thus, a business model configurator is being introduced to structure and visualize the complexity of different business model constellations in a transparent way.

Figure 3: Business Model Configurator



1.2. Country Snapshots

Seven countries in the EU have been selected for the benchmarking of PV business models. The country snapshots provide an overview over the current situation in seven national PV markets, their framework conditions, the business model roll-out status and examples of new emerging business models.

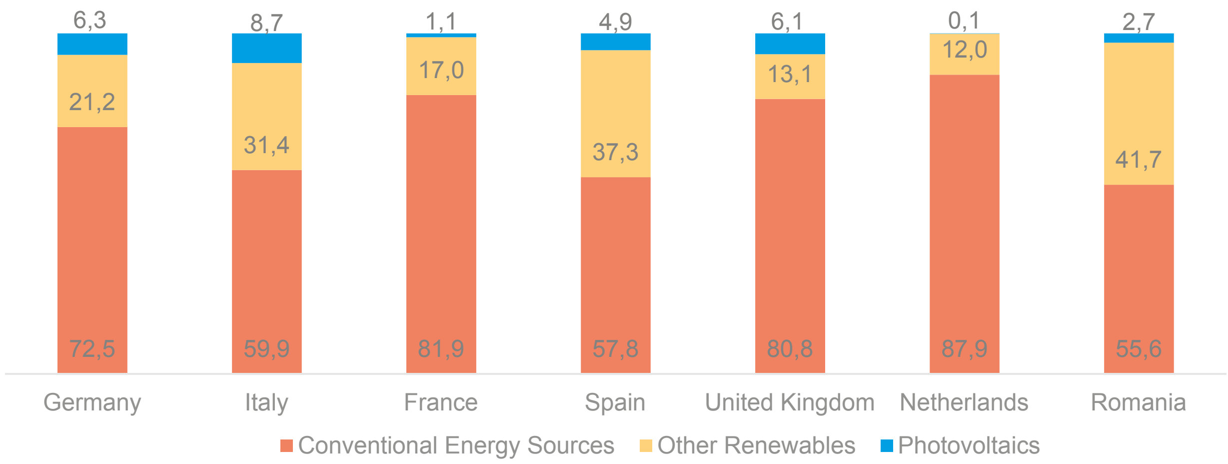
The investment climate in the national PV markets is driven by several factors such as solar irradiation levels, renewable energy policies and incentives, resource mix in the electricity markets, electricity prices and the LCOE of PV (table 1).

Table 1: Investment Climate and Key Parameters

	PV Market Climate Estimate June 2015e	Average Global Horizontal Irradiation (kWh/m² a) [5]	Cumulative Installed PV Capacity (GWp) [1]	NREAP Target 2020 (GWp) [6]	PV share of Net Electricity Production (%) [7]	Residential Electricity Retail Price (EUR ct/kWh) [8]	LCOE Indicator Utility Scale PV (EUR ct/kWh) [9], [10]
Germany	Cloudy	936	38.24	51.75	6.3	29.74	8.16-10.61
Italy	Cloudy	1326	18.31	8.00	8.7	23.39	6.71-8.16
France	Sunny	1100	5.63	4.86	1.1	17.51	6.71-10.61
Spain	Rainy	1600	5.39	8.37	4.9	23.67	6.71-9.00
United Kingdom	Cloudy	970	5.23	2.86	6.1	20.14	10.61-12.00
Romania	Rainy	1200	1.22	0.26	2.7	12.47	8.16-10.61
Netherlands	Sunny	950	1.07	0.77	0.1	17.32	10.20-10.61

Considerable progress has been made in these countries with respect to the realization of the National Renewable Action Plan (NREAP) targets for PV in 2020. In Italy, Germany and the United Kingdom the share of PV electricity production has already exceeded the 5% mark. A further increase will depend on the overall renewable energy targets, the integration with existing electricity markets, and the successful roll-out of new business models (figure 4).

Figure 4: Percentage Share of National Net Electricity Production in 2014 [7]



The investment climate in the seven countries by the end of June 2015 can be summarized as follows:

Germany

The investment climate in the largest global cumulative PV market is cloudy. Annual PV installations have dropped back from a peak of 7.6 GWp to 1.9 GWp in 2014 with a further expected drop in 2015. Feed-in tariffs (FiTs) have been gradually reduced, currently favoring small to medium PV installations. A levy based on the national renewable energy act (EEG) on self-consumption is slowing down the installation rate in the residential and commercial segments. The second auction under a tendering scheme introduced in 2015 has been successfully closed. The roll-out of new business models takes longer than expected. Several examples of new business models can be found, which are still in the research and pilot mode.

Italy

The investment climate in Italy is cloudy. NREAP targets for PV have been exceeded. Annual PV installations have dropped back from a peak of 9.4 GWp to 0.4 GWp in 2014. FiTs have been discontinued and retroactively been cut. A net metering scheme supports the installation of PV systems of up to 500 kWp. The interest in a power purchase and resale scheme for large PV systems is restrained due to rather low power purchase prices and regulatory restrictions. High electricity prices offer some potential for self-consumption; however, examples for these business models are not yet visible.

France

The investment climate for PV in France is changing from cloudy to sunny. Annual PV installations have dropped back from a peak of 1.7 GWp to 0.9 GWp in 2014. The market is incentivized by FiTs favoring residential full Building Integrated PV (BIPV) and commercial simplified BIPV systems. PV systems above 100 kWp are supported by three custom made tender programs with clearly defined volumes. The recently announced decrease in the share of nuclear energy promises future growth opportunities for PV. Self-consumption is being kicked-off in the overseas territories. First self-consumption examples driven by local co-operatives can be found on the mainland.

Spain

The investment climate for PV in Spain is very rainy. The share of other renewables is already quite high and NREAP targets for PV are likely to be missed due to budgetary constraints. Annual installations have dropped back from a peak of 2.8 GWp to 22 MWp in 2014. FiTs have been discontinued and retroactively cut several times. Retail electricity prices would offer good potential for self-consumption; however, the necessary regulatory framework is still missing. In the medium term new utility PPA driven business projects are under development.

United Kingdom

The investment climate for PV in the UK has recently turned from sunny to cloudy. NREAP targets for PV have been exceeded. PV installations have continuously increased in recent years reaching 2.4 GWp in 2014. Market growth has been driven by FiTs for smaller systems up to 5 MWp and a Renewable Obligation Certificates (ROC) based quota system for larger PV systems. The ROC scheme is currently being phased out and a new Contract for Difference (CfD) scheme is being introduced with clearly defined volumes per tender round. New business models based on self-consumption and virtual power plant PPAs are being explored.

Romania

The investment climate for PV in Romania is rainy. NREAP targets for PV have been more than exceeded. Annual PV installations have dropped from a peak of 1.1 GWp to 72 MWp in 2014. Based on a rather generous Green Certificate (GC) scheme the market experienced rapid growth in 2013 before it came to an almost stand still in 2014, when the allocation of new GC was cut in half and their prices dropped due to a significant over supply.
Very low retail electricity prices offer hardly any room for self-consumption and new business model examples are not yet visible.

Netherlands

The investment climate for PV in the Netherlands is sunny. NREAP targets for PV have been exceeded. Among renewables wind and biomass power are favored by national policies. Annual PV installation rates have grown 0.4 GWp in 2014. Small PV systems are incentivized by a net metering scheme. PV systems above 15 kWp are eligible to the renewable energy stimulation program (Stimulering Duurzame Energie, SDE+), which is updated every year and offers support on a best price basis for a clearly restricted volume of PV installations. Despite rather low market volumes new business models are being explored and innovative examples are being implemented.

1.3. Conclusions

Based on the country snapshots ten conclusions have been developed. They can provide some guidance to policy makers, financial market actors, PV plant owners, component manufacturers and energy prosumers on how to jointly develop new business models and their required framework conditions in order to successfully integrate PV into the existing power markets, to facilitate the smooth transition from conventional to renewable energy sources, and to meet enhanced targets on greenhouse gas emissions.

1. National PV installation targets should be corrected upwards reflecting the significantly improved cost competitiveness of PV.
2. Reliable political framework conditions are needed to ensure future investor support for PV installations.
3. Policy makers should closely monitor the development of national PV markets to avoid short term over- or under-compensation.
4. Development of new PV business models takes longer than expected and will require continued political support beyond the era of economic incentives.
5. In many national markets self-consumption is on the brink to economic viability.
6. Rapid decline of storage battery prices will stimulate further growth of self-consumption.
7. Prosumers need a clear and transparent regulatory framework
8. Tenants should be granted the same rights for self-consumption as house owners.
9. Pros and cons of pilot tenders for large scale utility PV power plants should be thoroughly evaluated before further roll-out.
10. The development of virtual power plants should be supported to pioneer so-called smart solutions enhancing market integration and energy efficiency.

2. Introduction

2.1. Context

Cumulative PV installations 2014 in Europe reached 89 GWp representing an investment volume of more than 200 bn EUR. The latest Global Market Outlook [1] of SolarPower Europe forecasts additional installations of 32 GWp till 2019 in the low scenario case representing an estimated investment volume of less than 50 bn EUR. In case of the high scenario additional installations of 69 GWp are forecasted representing an estimated investment volume of less than 100 bn EUR.

Financial stakeholders such as investors, lenders or insurers will have to assess the inherent risks of PV projects and their underlying business models as basis for their decision-making. These risks have to be identified, quantified and mitigated both in the primary PV market for new installations and in the rapidly growing secondary PV market for existing installations.

2.2. Challenge

PV investments are based on underlying business models, their local framework conditions and a viable value proposition. In the past the PV business models were to a large extent driven by national incentive schemes, often depending on net metering, FiT or renewable energy certificates. In light of rapidly growing PV installation rates and limited budgets governments have gradually reduced, phased out or even retroactively cut their incentive schemes. This has led to a significant drop in PV investment activities in Europe.

New business models are hence needed to ensure future investments in PV installations.

With the rapid decline of the LCOE the price of PV electricity power is getting close to - and in some locations even has dropped below - socket parity. This is the trigger point where the price for PV electricity equals the retail electricity price for residential consumers and where new innovative business models can be explored in order to support continued investment in the PV sector over the coming years.

2.3. Objectives

The report provides an overview over the evolution of different business model generations, their classification in eight generic business models and their respective framework conditions.

A business model configurator is being introduced. This tool allows for visualizing and understanding the inherent complexity of recent PV business models which often combine one or more generic business models.

Seven country snapshots analyze the national PV markets, the underlying business models and their integration in the local electricity markets. The roll-out pattern of existing and new PV business models is described and examples of new business models are provided. The snapshots cover Germany, Italy, France, Spain, United Kingdom, Romania and the Netherlands. A comparison of the snapshots contributes to the knowledge sharing across country borders and allows for best practice learning.

The closing remarks provide some guidance to policy makers, financial market actors, PV plant owners, component manufacturers and energy prosumers on how to jointly develop new business models and their required framework conditions in order to successfully integrate PV into the existing power markets, to facilitate the transition from conventional to renewable energy sources, and to meet new targets on greenhouse gas emissions.

In the next phase of the Solar Bankability project the project consortium will develop a technical risk matrix as well as associated risk and cost priority numbers. These will serve as input for a financial modelling exercise. Four different PV system configurations will be subjected to a series of technical risk scenarios in order to develop risk mitigation measures which will be summarized in a best practice guide.

3. PV Business Model Overview

The rapid growth of PV power was facilitated by a parallel development of new and diverse business models which allowed for an initial introduction in remote off-grid niche markets, followed by a kick-start in grid-connected markets. The latter was enabled with the help of net metering FiTs. The drastic decline of the PV system costs has allowed PV power to experience a rapid scale-up and deep penetration of the main power markets in most European countries. Governments have tried to temper the growth of PV by reductions in the incentive schemes, retroactive cuts or the introduction of new taxes and levies. This has first led to stagnation and later to a decline of PV installations in various countries in Europe.

PV power gets closer to socket parity and in some regions with elevated electricity prices and high solar irradiation levels even reach it. The economic support from government incentive schemes is gradually being phased out. New business models are necessary to support future growth of PV installations in Europe.

The emergence of new business models often requires longer lead times from the concept, to an experimental pilot phase. Only after the proof of concept a rapid scale-up can be initiated. Assumptions made at the beginning of a new business model development are often incorrect or incomplete. Regulatory framework conditions are often intransparent and constantly changing.

The degree of complexity tends to increase in new business models. PV systems integrate more and more components like storage batteries, heat pumps, diesel-hybrid generation etc. Grid connectivity requirements increase from grid compliant to grid regulated to grid balancing capabilities. A growing number of stakeholders tend to get involved in new business models. While the value proposition in a residential PV system with FiTs was rather straight forward, the value proposition for all stakeholders of a tenant self-consumption model or a virtual power plant requires much more coordination efforts.

The roll-out dynamics of new business models depend on the national renewable energy policy and associated incentive schemes as well as an increasing complexity of the PV system and the associated business models. The roll-out can be broken down in three investor generations (figure 5) [4]. In the zero generation building and site owners take over the investor role for the PV system. In the first generation this role is passed on to local-cooperatives and third party financial investors, and in the second generation large utilities, DSOs and virtual power plants step in.

Zero Generation

End consumers are the owner of the PV system and DSOs and utilities have a passive role arranging the implementation of the FiT or net metering scheme.

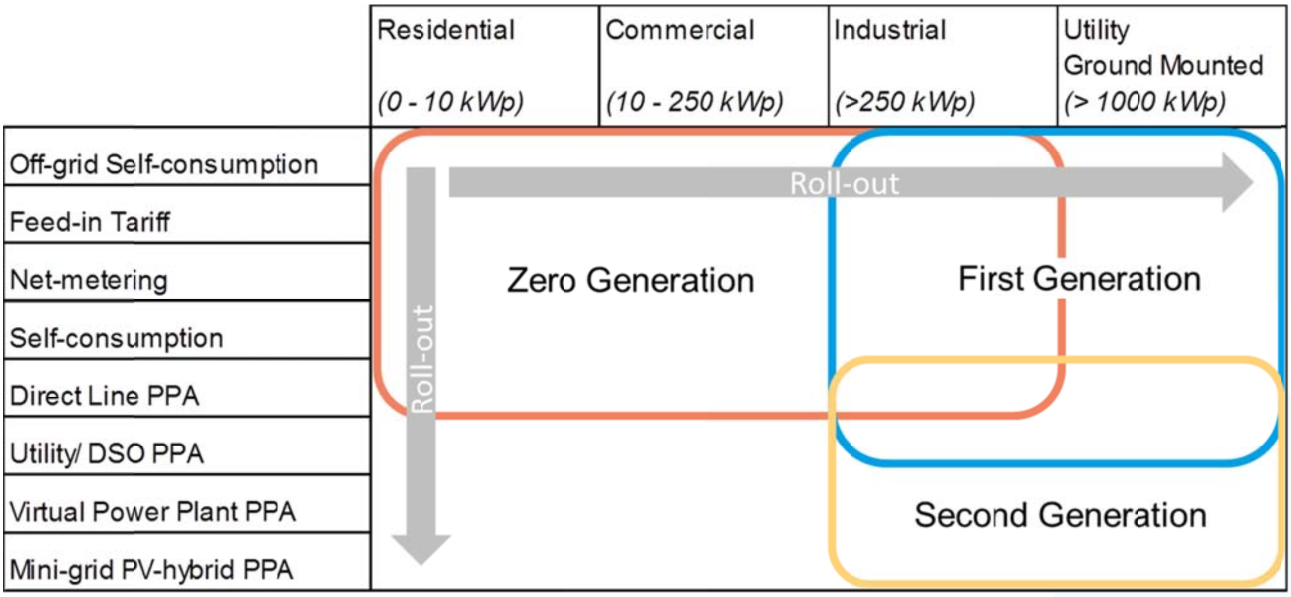
First Generation

Third parties like local co-operatives or financial investors own and operate the PV systems leading to risk reduction for the end consumers and improved financing options.

Second Generation

DSOs, utilities and virtual power plants take over the ownership and operation of large scale PV systems as an integral part of the electricity market on a regional or national level.

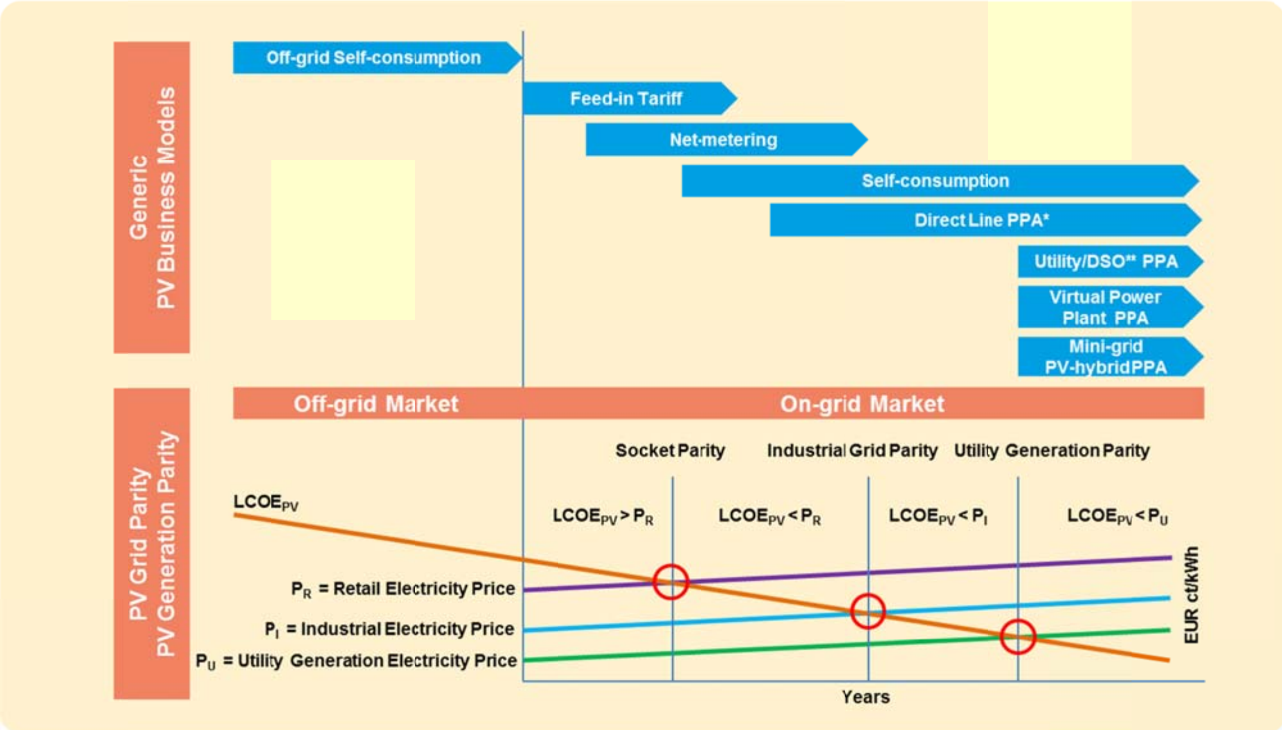
Figure 5: PV Business Model Roll-out



Most new business models are driven through grid parity trigger points where the LCOE for PV meets and subsequently drops below certain electricity prices in the market. The first parity point is the residential grid parity or the so-called socket parity, where it gets more attractive for electricity consumers to become prosumers and consume the electricity from their own PV system rather than buying it from the utility. The upgrade from a pure PV system to a PV+storage system allows them to further increase their self-consumption rate. The next parity points are the commercial and industrial parity points which trigger self-consumption at the commercial and industrial customer level. Generation parity is the rock bottom competitiveness test for PV power and it will take considerably more LCOE reductions for the PV industry to reach that point (figure 6).

These grid parity points are significantly influenced by the composition of the respective electricity reference price which includes different elements such as generation and distribution costs and taxes and levies.

Figure 6: Generic PV Business Models and Grid Parity [2] [3]



* PPA = Power purchase agreement
** DSO = Distribution system operator

A short description of the eight generic business models to be found in the market is provided down below:

Off-grid Self-consumption

In off-grid locations a standalone PV system can generate electricity to power onsite for self-consumption. In combination with a battery system this business model enables a 24/7 electricity supply. Many remote locations with existing diesel generators can be upgraded to PV-hybrid system in order to save fuel costs.

Feed-in Tariff

The owner of the PV system feeds his electricity into the public grid and receives a guaranteed FiT, which exceeds the price of electricity from the grid. FiTs have been used in many countries to kick-start new PV markets.

Net Metering

The PV system owner consumes as much as possible of his own PV electricity on-site. Excess electricity is fed into the grid and balanced by reverse metering or credits from the DSO/utility. The grid acts as a buffer storage allowing the PV system owner to increase his average self-consumption rate. Net metering has been used to kick-start new markets.

Self-consumption

The PV system owner consumes as much as possible of his own PV electricity onsite. Rental or leasing agreements enables shared operations with consumers in the same building. Excess electricity is sold via the public grid to third parties such as utility, DSO or electricity trader.

Direct Line PPA

The PV system owner sells the PV electricity via a direct line under a power purchase agreement (PPA) to a consumer in the same building or in the near vicinity. The consumer takes advantage of a somewhat reduced PV electricity price while he continues to purchase his residual electricity demand via the public grid.

Utility/DSO PPA

The PV system operator sells his PV electricity via the public grid under a long term PPA to a third party, i.e. a utility, DSO or electricity trader. The PPAs are usually awarded under a competitive tendering process.

Virtual Power Plant PPA

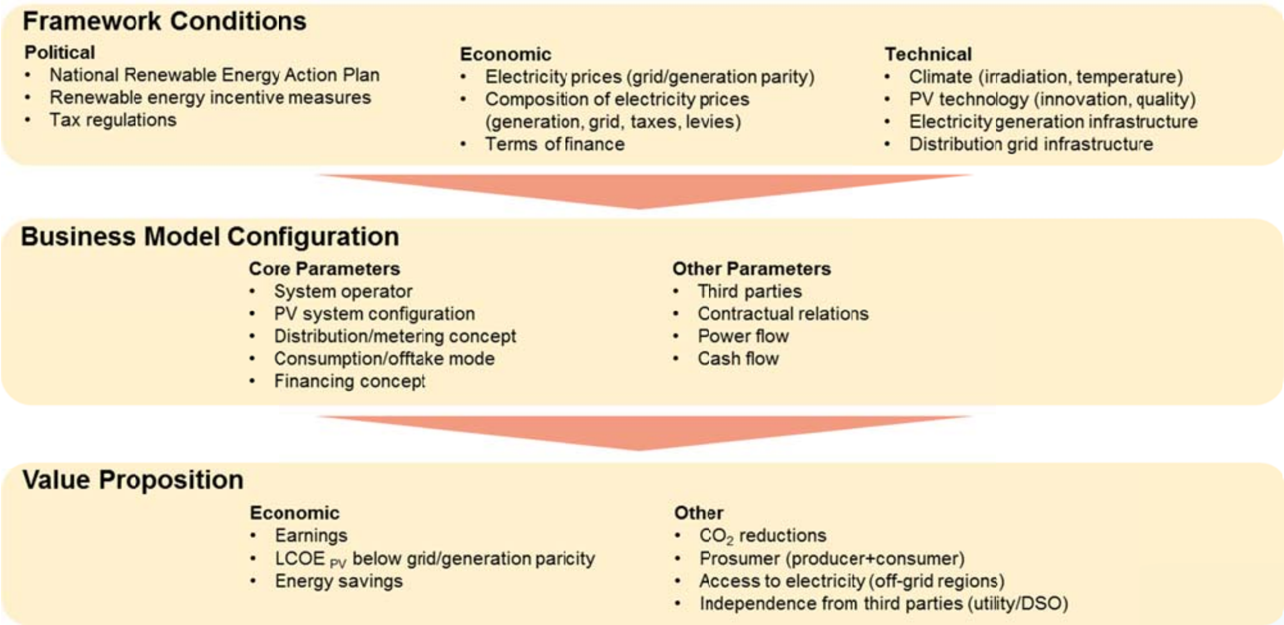
The PV system owner sells the PV electricity via the public grid under a long term power purchse agreement to a virtual power plant, which combines several decentralized generation plants for renewable energies such as PV, wind biogas or hydro.

Mini-grid PV Hybrid PPA

The PV system owner sells his PV electricity via a local mini-grid under a long term PPA to a local hybrid generation plant, which often combines a diesel generator with other renewable energy sources such as PV, wind, biogas or hydro. Mini-grids with PV hybrid generation are often operated in remote regions without public grid.

The formation of new business models depends on a suitable set of political, economic and technical framework conditions (figure 7). It requires a clear definition of core parameters such as the role of the system operator, the location and technical configuration of the PV system, the distribution and metering concept, the consumption and offtake mode and the financing concept. And last but not least there must be a real and tangible value proposition to align all involved stakeholders in order to manage all potential hurdles during its implementation process.

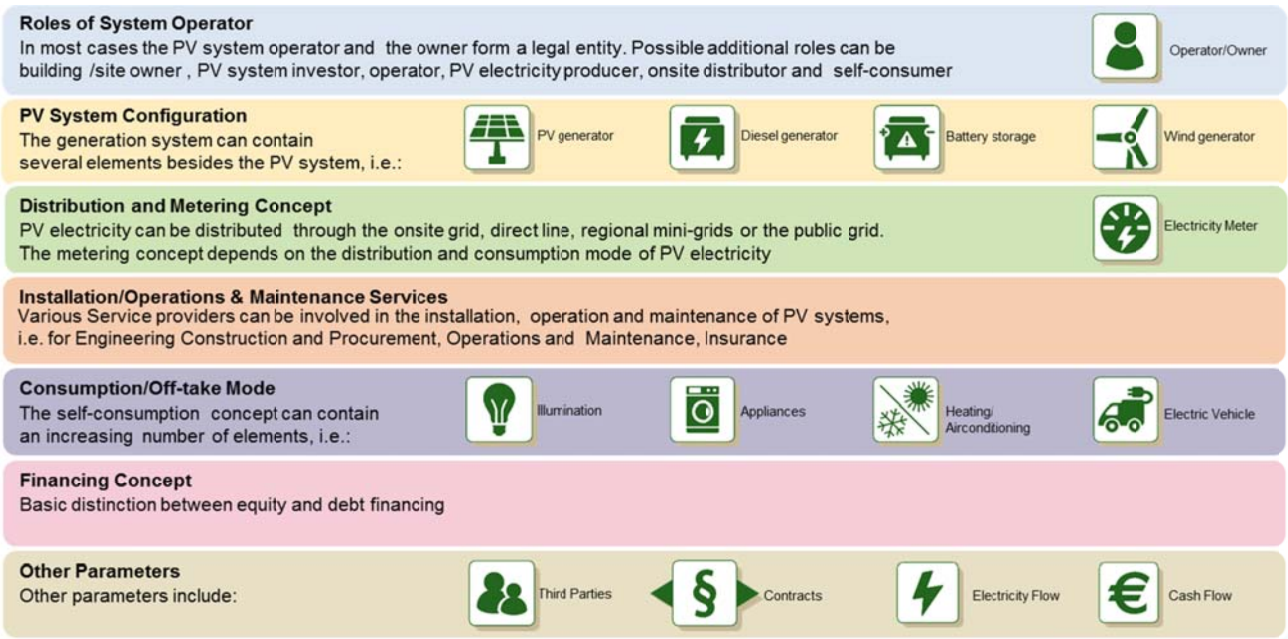
Figure 7: Influencing Factors of a Business Model



In the course of the business model analysis the business model configurator has been developed. This configurator allows structured visualization of different business model constellations.

The configuratior uses a clearly defined set of icons to describe the ownership of the PV system (light blue), the financing concept (red), the technical configuration of the PV system (yellow), the distribution and metering concept (green) the installation and O&M services (brown), the consumption and offtake mode (purple), the flow of electricity and cash as well as the different stakeholders and their contractual relations (figure 8).

Figure 8: Business Model Configurator Elements



The following example of the business model configurator illustrates a residential PV system with self-consumption and FiT compensation for the surplus power (figure 9).

PV system Configurations

The PV system consists of a PV generator plus battery storage to enhance in house self-consumption.

PV System Operator

The system operator is the owner of the system and the building and provides the equity capital for the installation.

Financing Concept

The required debt capital is provided under a loan agreement from a bank.

Distribution and Metering Mode

The system owner uses his onsite household grid for self-consumption. The public grid takes up the surplus PV electricity and provides the residual power from the utility. The flow of electricity to and from the public grid is measured by two separate metering units.

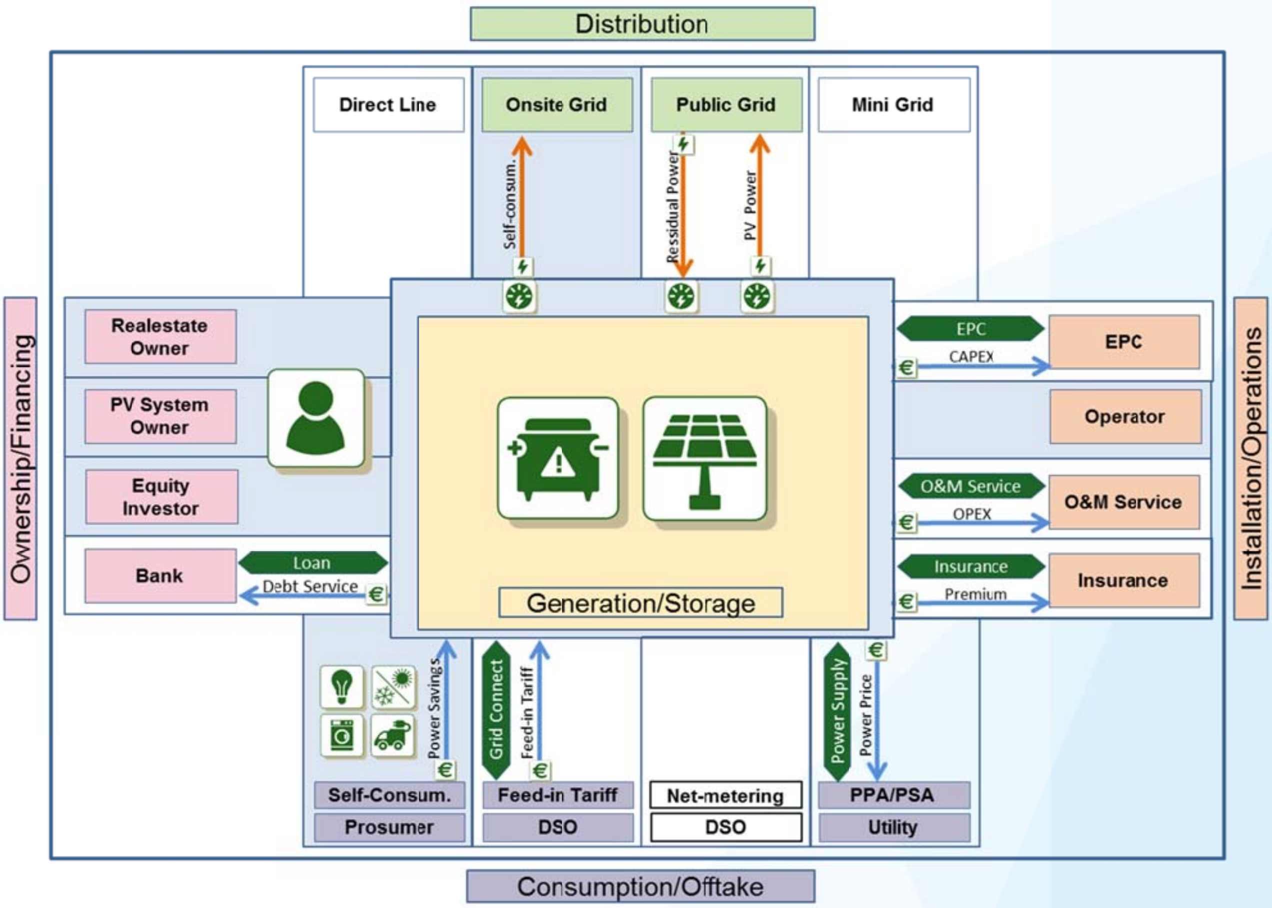
Consumption and Offtake Mode

Most of the PV electricity is used for in house self-consumption as a prosumer for lighting, appliances heating and potentially for recharging an electric vehicle. For the surplus of PV power the owner receives a FiT compensation from his DSO, while he has to pay the utility for the required residual power purchased under a power supply contract.

Installation/Operation

The PV system has been installed by a system installer in the framework of an engineering, procurement and construction contract. The ongoing operations and maintenance services are provided under an O&M contract. Material damage and respective performance losses are covered by an insurance policy.

Figure 9: Business Model Configurator Example: Residential PV+Battery System with Self-consumption



4. Country Snapshots

The country snapshots intend to provide an overview of the diversity of PV markets and the business model roll-out situation in selected countries of the EU.

In the selection process several factors like market importance, climatic conditions, renewable energy policies and incentives, electricity market integration and economic viability have been reflected.

The following seven countries are covered by a snapshot report: Germany, Italy, France, Spain, United Kingdom, Romania and the Netherlands.

Table 2: Investment Climate and Key Parameter [1], [5], [7], [8], [9], [10]

	PV Market Climate Estimate June 2015e	Average Global Horizontal Irradiation (kWh/m² a) [5]	Cumulative Installed PV Capacity (GWp) [1]	NREAP Target 2020 (GWp) [6]	PV Share of Net Electricity Production (%) [7]	Residential Electricity Retail Price (EUR ct/kWh) [8]	LCOE Indicator Utility Scale PV (EUR ct/kWh) [9], [10]
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Netherlands	Sunny	950	1.07	0.77	0.1	17.32	10.20-10.61

The objective of the snapshot is to provide a quick understanding of each national PV market and its business models. The EU funded Horizon 2020 project PV Financing [11] will allow for a more in depth insight into new PV business models and their financing methods.

New PV business models under real market conditions often combine of one or more of the eight generic business models. The feasibility of these new business models depends on a series of influencing factors:

PV market climate

The economic viability of PV depends to a large extent on the geographic and the political climate conditions in a country. The former is significantly influenced by the national solar irradiation levels, showing a wide spread between northern, central and southern European regions. The latter is influenced by renewable energy policies on the national and the European level and associated targets. The NREAP [6] for instance determines for the respective member states technology specific installation targets for the year 2020, as a result of the legally binding target of renewable energy share in their total energy consumption.

PV Incentives

Initially financial support schemes such as FiTs or net metering and flanking tax incentives were needed to kick-start national PV markets. With rapidly decreasing PV system prices and gradually increasing electricity prices incentives have been reduced or even completely abolished. In countries without financial support schemes continued regulatory support is indispensible for the development of new business models. The term grid partity can be misleading if used outside of a cleary defined PV system context, since grid parity can vary with the geographic location and type of PV system, the segment specific electricity price and the taxes and levies which prosumers often have to pay for their self-consumption of PV power.

PV Market

In many countries very lucrative incentive schemes have led to an unsustainable growth followed by drastic incentive cuts and in some cases also retroactive adjustments in order to avoid mainly electricity budget deficits. In most countries cumulative PV installations have already reached their NREAP target way ahead of time. However, such political adjustments have often led to a collapse of the number of PV installations, revenues and employment rates.

PV Market Segmentation

PV markets can be segmented by systems size with a further differentiation by installation type into rooftop or ground mounted systems. The segmentation is frequenlty used by SolarPower Europe [1] in its annual market reporting:

- Residential: 0-10 kWp
- Commercial: >10-250 kWp
- Industrial: > 250 kWp
- Utility: > 1000 kWp (ground mounted)

On a national level these segments show completely different growth dynamics depending on the local policy and incentive scheme as well as the technical, legal and taxation requirements.

Electricity Market

In a drive for a more climate friendly and sustainable power production national electricity markets are currently in a transition from conventional resources to a gradually increasing share of renewable resources. The transition dynamics and the future targets for each technology depend very much on the national availability of the different renewable resources and national policy priorities. Often wind and hydro power are in the lead position. As an indicator for a potential PV saturation SolarPower Europe's comparison of the maximum PV generation versus the minimum national electricity production load can be used [12]. However, due to the seasonality of PV this value can only be of arbitrary nature.

Electricity Prices

Electricity prices vary widely across Europe. Their composition by generation, distribution, tax and incentives is heavily influenced by national energy policy schemes. Once the LCOE for PV systems drops below the socket parity for residential electricity retail prices market opportunities for new business models can be exploited. Due to the rapid decline of the LCOE the so called "socket parity" has been reached in most of the analyzed countries. The LCOE values used in this report represent ACCELIOS Solar's estimates for utility scale PV systems based on figures provided in the PV Status Report 2014 from JRC [9], [10]. The range of national LCOE values reflects the spread of solar irradiation in accordance with geography.

PV Business Models

The development of the national PV market is backed by different business models which follow the declining LCOE. In an early phase residential and commercial PV systems are often installed to provide electricity to remote off-grid locations. In the next phase PV markets above grid parity can be kick-started with FiTs or net metering schemes. Business models based on self-consumption take over market growth below socket parity, initially for residential and later for commercial consumers. With further declining LCOE different variations of PPAs emerge with direct line customers, utilities or DSOs and virtual power plant operators.

New Business Models

Based on desktop research and interviews with national market experts a list of new business models has been composed for each national market. Most innovative business models are in an early R&D or pilot stage. The composition of stakeholders and the project structure often show a higher complexity than net metering or FiT business models. Viability and scale-up of such new business models depend to a large extend on the national technical, financial, tax and legal framework conditions.

4.1. Germany

4.1.1. PV Market Climate

The annual solar irradiation in Germany shows a moderate average value of 936 kWh/m², typical for central European locations (figure 10).

Figure 10: Global Horizontal Irradiation in Germany [13]

The German Government is strongly supporting measures against climate change. With the support of its EEG Germany has become the global market leader in PV installations with a cumulative capacity of more than 38 GW.

Since its peak in 2012 the PV market has drastically declined and has dropped below the annual installation target corridor of 2,4-2,6 GWp. This is mainly due to massive reductions in FiTs and additional levys on self-consumption.

New business models lead to further integration of PV with the existing energy markets. However the adoption rate of new business models remains slow because of their growing complexity and limited profitability.

Given the current PV installation rates Germany is likely to miss its NREAP target in 2020.

4.1.2. PV Incentives

The German PV incentive scheme is based on FiTs, which are defined in the EEG. In the past FiTs were lowered stepwise in parallel to the decrease in PV system prices. The last revision of the EEG took place in August 2014 with the aim to significantly lower the future EEG-allocation to electricity prices (table 3). The current FiT scheme favours small to medium sized PV rooftop systems and ground mounted systems of up to 500 kWp. FiTs are reduced on a monthly basis in order to keep PV installations within the politically desired target. A new levy on self-consumption of PV electricity has been introduced, gradually increasing from 30% in 2014 to 40% in 2016 of the EEG-levy. The FiT for large ground mounted systems has been discontinued and has been replaced in 2015 by a tender program with a total annual volume of 400 MW. A first pilot auction over 150 MW has been successfully completed in April 2015.

Table 3: German FiTs according to EEG 2014 [14]

	Starting April 2015 (EUR ct /kWh)	Starting May 2015 (EUR ct /kWh)	Starting June 2015 (EUR ct /kWh)
Rooftop up to 10 kWp	12.47	12.43	12.40
Rooftop 10 kWp till 40 kWp	12.12	12.09	12.06
Rooftop 40 kWp till 500 kWp	10.84	10.82	10.79
Non-residential Buildings and Ground Mounted till 500 kWp	8.63	8.61	8.59
Ground Mounted Utility Scale	Pilot tender 150 MW		

4.1.3. PV Market

Since 2012 the German PV market has faced a drastic decline. PV installations have decreased by 75% from 7.6 GWp in 2012 to 1.9 GWp in 2014 (figure 11). In the same period of time new investments in PV systems have dropped by 95% from 11.2 bn EUR to 2.3 bn EUR due to the additional drop in PV system prices (figure 12).

Figure 11: PV Installations in Germany [1], [12], [15]

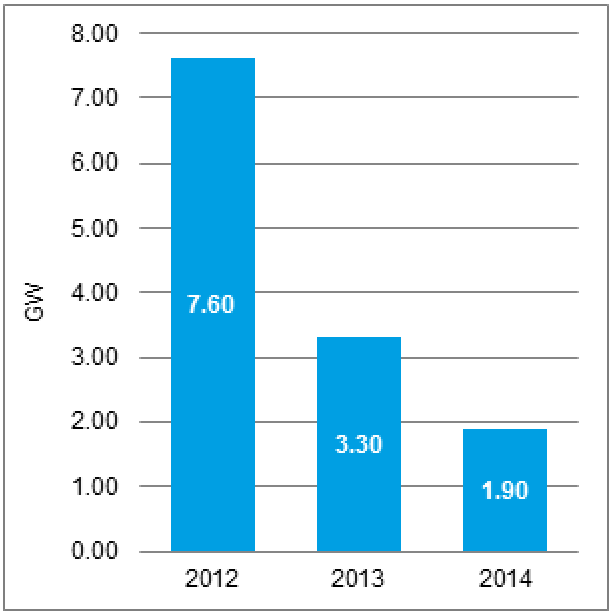
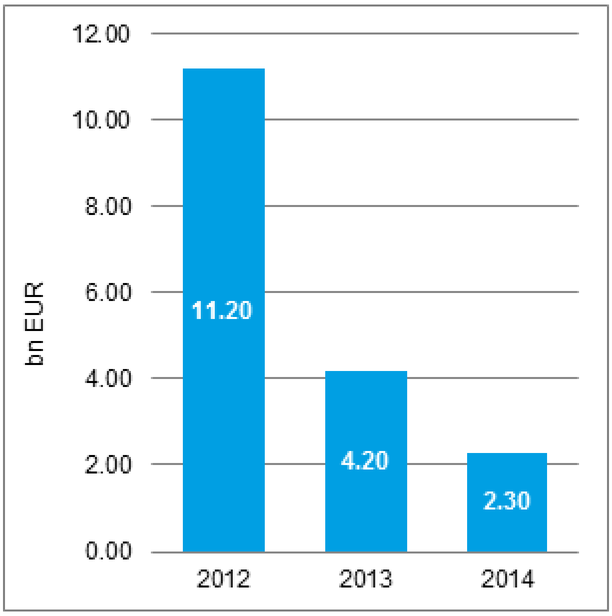
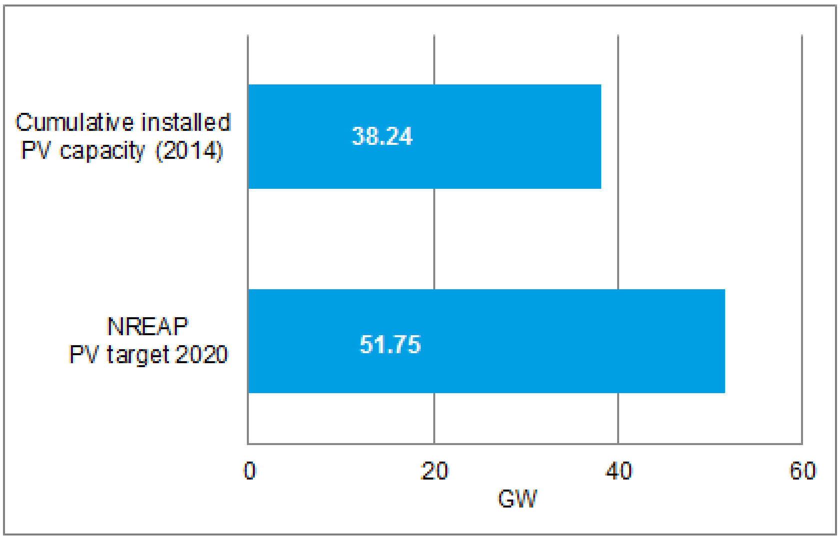


Figure 12: PV Installation in Germany [16]



In 2014 cumulative PV installations reached 74% of the NREAP target of 51.75 GWp for 2020 (figure 14). At current annual installation rates below the target corridor of 2.4-2.6 GWp the realisation of the NREAP target is at risk.

Figure 13: Cumulative Installed PV Capacity vs. NREAP PV Target 2020 in Germany [1], [6]



The decrease in the PV market was accompanied by a sharp cut in PV jobs (figure 14). Official statistics list 133,000 employees in 2011 versus 47,500 in 2014. The majority of jobs were lost in installation of PV systems followed by a smaller part in production of PV components and manufacturing equipment.

Figure 14: PV Employment in Germany [17]

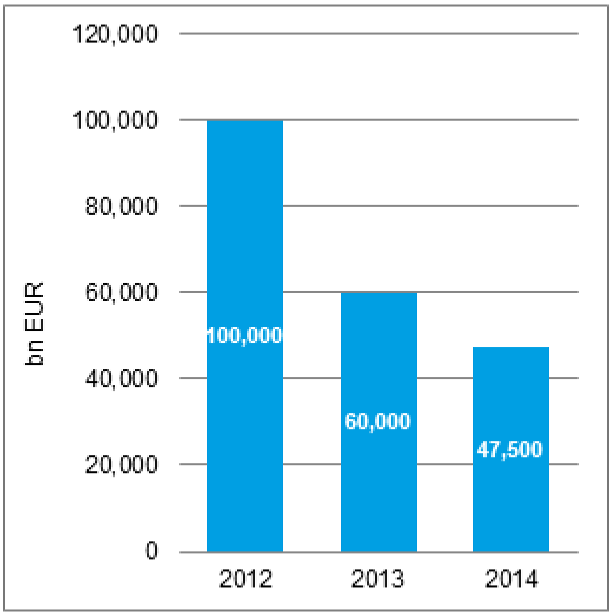
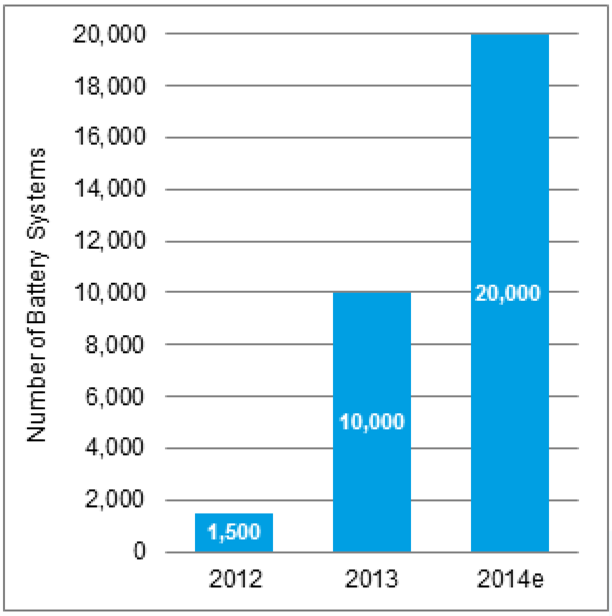


Figure 15: Installation of PV Systems with Battery Storage [18]



However, an emerging market is represented by the use of battery storage systems which can significantly increase the degree of self-consumption . For the time being market growth is driven by a KfW funding program (figure 15). Battery prices in 2014 have dropped by 25% in 2014. Further price declines are expected to kick-start the PV+battery market in the coming years.

4.1.4. PV Market Segmentation

The cumulative PV capacity in Germany has reached more than 38 GW, consisting mainly of commercial rooftop systems followed by ground mounted utility scale power plants (figure 16). The 1.9 GW of PV installations in 2014 show a more equal distributed segmentation, driven by 32% utility, 24% commercial and 24% industrial systems prices (figure 17).

Figure 16: PV Cumulative Capacity Segmentation 2014 [1]

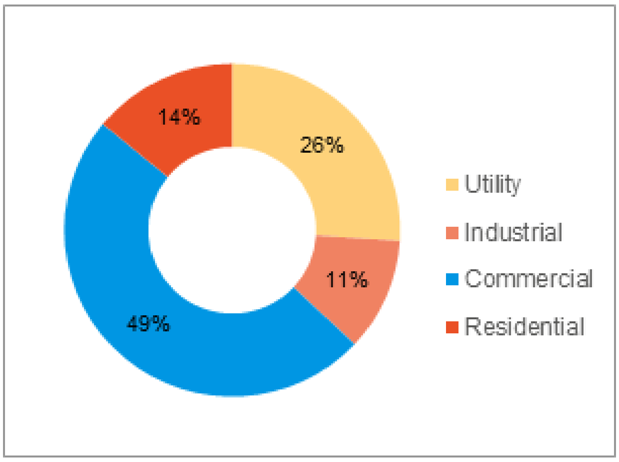
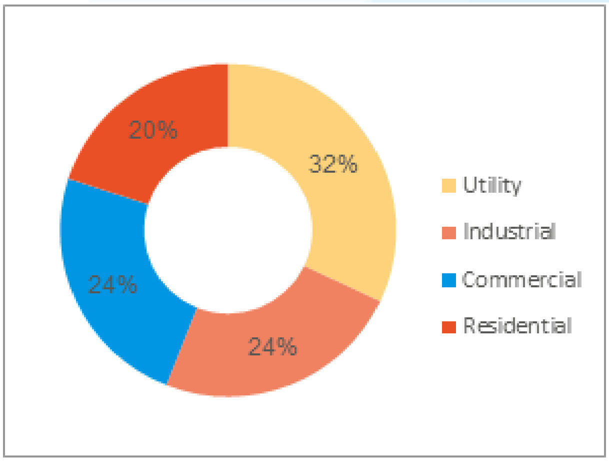


Figure 17: PV Annual Capacity Segmentation 2014 [1]



4.1.5. Electricity Market

The net electricity production in Germany reached 561.9 TWh in 2014. Total renewables contributed 26% on an annual basis and PV increased its share to 6.3% (figure 18).

The maximum instantaneous PV production reached 23.5 GWp in 2014. This represents represents 68% of the minimum national electricity production load profile during summer months (figure 19).

The flexibility of the German grid has been successfully tested by a PV load fluctuation of 10,2 GWp during the solar eclipse on March 20th 2015 [19].

Figure 18: Net Electricity Production 2014 of 561.9 TWh [7], [20]

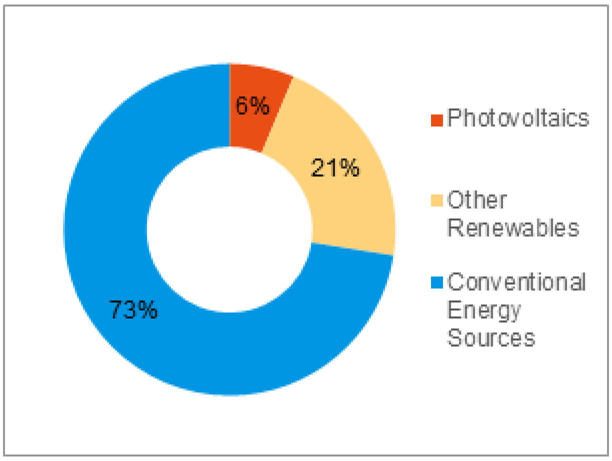
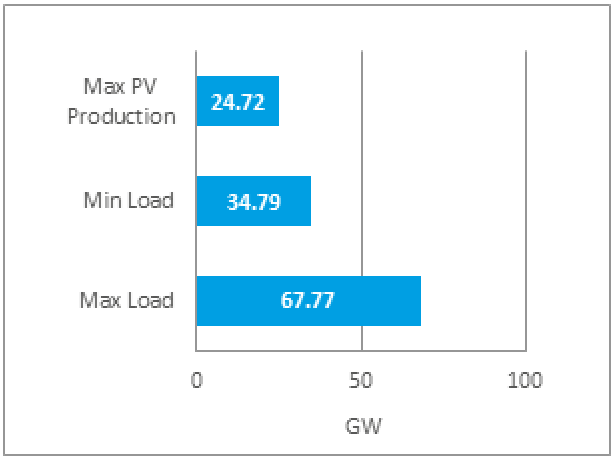


Figure 19: Max. PV Production vs. Min. Load Profile 2014 [12]



German residential electricity retail prices are amongst the highest in Europe reaching 29.81 EUR ct/kWh in 2014. More than 50% depend on taxes and levies while production represents 25% and distribution 23% (figure 19).

The LCOE for utility PV systems ranges from 8.16 to 10.61 EUR ct/kWh. In the first tender round for utility scale PV systems in April 2014 the LCOE reached an average of 9.17 EUR ct/kWh. This is well below retail electricity prices for household consumers and opens opportunities for new PV business models (figure 20).

Figure 20: Composition of Electricity Retail Prices 2014 [21]

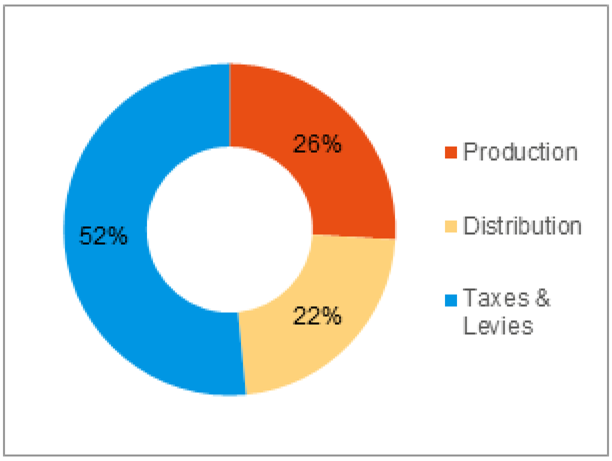
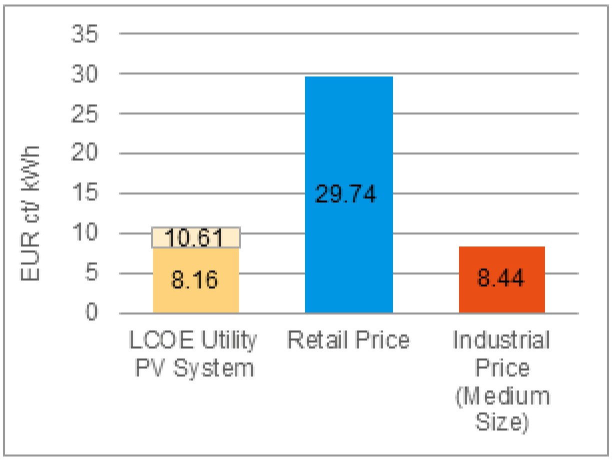


Figure 21: PV LCOE vs Electricity Prices 2014 [9], [10], [22]



4.1.6. PV Business Models

The German PV market is in an advanced stage with a well diversified portfolio of business models. Currently six of the generic business models have been established (table 4).

In an early stage of the market mostly off-grid self-consumption systems were installed. Rapid growth was kick-started with the introduction of an renumerative national FiT scheme across all PV market segments.

Self-consumption business models beyond socket parity are currently being introduced to the market, starting in the residential and followed by the commercial segment. However, this development has been significantly slowed down by the introduction of a EEG-levy on self-consumption in August 2014. In contraxt, new business models are emerging under PPAs with direct line customers, utilities or distribution system operators and virtual power plant operators.

Table 4: Business Model Roll-out in Germany

	Residential (0 - 10 kWp)	**Commercial** (10 - 250 kWp)	**Industrial** (>250 kWp)	**Utility Ground Mounted** (> 1000 kWp)
Off-grid Self-consumption				
Feed-in Tariff				
Net Metering				
Self-consumption [23]				
Direct Line PPA				
Utility/ DSO PPA				
Virtual Power Plant PPA				
Mini-grid PV hybrid PPA				

Market Penetration	Low	High	Emerging

4.1.7. New PV Business Models

The list of new PV business models include two new business model clusters: self-consumption and virtual power plant PPAs. Direct line PPAs tend to have less visibility (table 5).

The new business models are either promoted by start-up companies or niche players and by cooperations between established industrial players and specialized PV companies.

Most of the models are still in a research or pilot phase. Their market penetration will take time, because the technical, legal and economic feasibility needs to be demonstrated before intensive business development activities will allow for a rapid scale up.

Table 5: Selected Examples of New Business Models

Business Model	Description
Self-consumption	**EON/Sungevity [24]** - Both companies have formed a market specific partnership for PV systems, where EON sells high quality systems with a 10 year performance guarantee and Sungevity installs the systems and provides service and maintenance
Sel- consumption	**ENBW/DZ4 [25]** - ENBW has acquired 15% shares in DZ4 in order to form a market specific partnership. DZ-4 will rent out PV systems with battery storage to residential house owners and will be in charge of operations and maintenance, while ENBW takes care of sales and financing. Approximately 700 systems can be financed with the financing budget of 10 Mio. EUR.
Self-consumption	**BMW/Solarwatt [26]** - Under the "i" concept BMW tries to market its 360° e-mobility approach. In a sales cooperation BMW provides the electric vehicles while Solarwatt contributes photovoltaic systems for rooftops and carports including their new storage battery system.
Self-consumption	**Toshiba/ENBW/Gagfah [27]** - The three parties have announced a project to provide 4500 tenants of large apartment buildings in 8 cities with a total of 3 MW of PV electricity
Self-consumption	**Stadtwerke Stuttgart/Beegy [28]** - formed a cooperation to offer modular energy efficiency services including monitoring and optimization of self-consumption. Citizens with a PV system will be offered modular solutions for an intelligent energy management like battery storage, heat pumps and e-vehicles.
Virtual Power Plant	**Grünstromwerk [29]** offers regional green electricity tariffs based on a portfolio of 25% decentralized power plants and 75% eco-certified electricity mostly from Scandinavian hydro plants
Virtual Power Plant	**Lichtblick [30]** offers green electricity tariffs based 100% on renewable energies. In a new approach they want to integrate storage batteries from PV systems in a cluster storage concept which will be remotely managed by Lichtblick. For the time being 1000 storage systems have already been integrated
Virtual Power Plant	**MVV [31]** offers PV system owners in the Mannheim region the option to store their excessive electricity temporarily in a large central storage and to withdraw it again upon demand. The research project includes 14 customers and a 100 kWh storage system
Virtual Power Plant	**Buzzn [32]** is a Munich based start-up company which tries to build a decentralized shared economy platform where neighbours from the same region can sell their excess PV electricity to each other

4.2. Italy

4.2.1. PV Market Climate

Annual solar irradiation in Italy shows a rather elevated average value of 1326 kWh/m², typical for southern European locations (figure 22).

Figure 22: Global Horizontal Irradiation in Italy [33]

The NREAP target of 8 GWp for 2020 has already been reached nine years ahead of plan. Since then the Italian Government has been trying to control the cost of PV incentives first by tempering down the support scheme and later by introducing retroactive cuts.

On July 6th, 2013 the budget cap of the "Nuovo Conto Energia V" had been reached. Since then the FiT program is no longer available. On August 7th, 2014 retroactive FiT cuts for existing PV systems with capacities over 200 kWp were implemented [34], [35], [36].

On top of these adverse economic conditions the Italian PV market suffers from lengthy and bureaucratic regulations and in some cases of intransparent business practices. Therefore the annual PV installation rate has fallen back to just 385 MWp in 2014.

4.2.2. PV Incentives

Since the phase-out of FiTs for new PV installations under the “Nuovo Conto Energia V” in July 2013 the Italian market is mainly driven by net billing, guaranteed power purchase by the Gestore Servici Energetici (GSE) and tax deductions [34].

The so called “scambio sul posto” is a net billing scheme valid for PV systems with a maximum capacity of 500 kWp. Private and commercial system owners can feed their solar electricity into the grid and take out electricity from the grid whenever needed. Twice a year the balance is determined and the system owners have to pay their electricity supplier for their excess consumption or will receive a credit for their in excess production from GSE. However the price paid by GSE for the excess production is considerably lower than the electricity retail price for their excess comsumption.

GSE provides private and commercial PV system owners with a simplified access to the Italian electricity market. The company guarantees the owners of PV systems with a capacity of ≤ 1 MWp a minimum purchase price of 3.89 EUR ct/kWh or the hourly area price (prezzo zonale orario) if that is higher. This guarantee is valid for the first 1.5 Mio kWh of annual electricity production. PV systems above 1 MWp are generally compensated with the hourly area price.

Private investors can depreciate 50% of their PV investment cost up to a maximum amount of 96,000 EUR via tax deductions for rooftop installations in presence of building retrofitting. This tax scheme has been prolonged till December 31st, 2015.

PV systems above 20 kWp can also participtate in a White Certificate scheme where energy efficiency certificates are traded among electricity and gas distributors under national quantitative energy-saving targets.

In January 2015 the Italian Vice Minister for Economic Development announced that PV has been classified as a mature technology and will be excluded from a decree outlining incentives on offer to renewables for the next three years.

4.2.3. PV Market

Italy has the second largest installed PV base in Europe. Cumulative PV installations reached 18.3 GWp in 2014 (figure 23) and the NREAP 2020 target of 8 GWp has already been reached in 2011 (figure 24). Annual PV installations continuously dropped back from a peak of 9.4 GWp in 2011 to 384 MWp in 2014. With a lack of normative stability and government support installation rates are not likely to recover.

Figure 23: PV Installations in Italy [1], [12], [15]

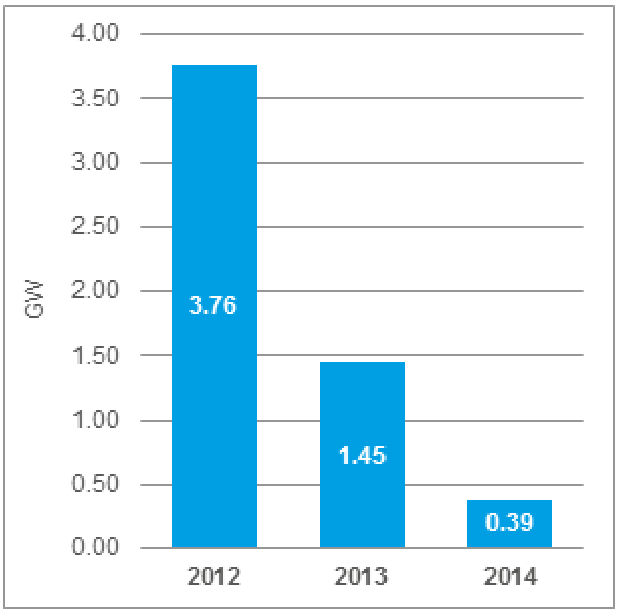
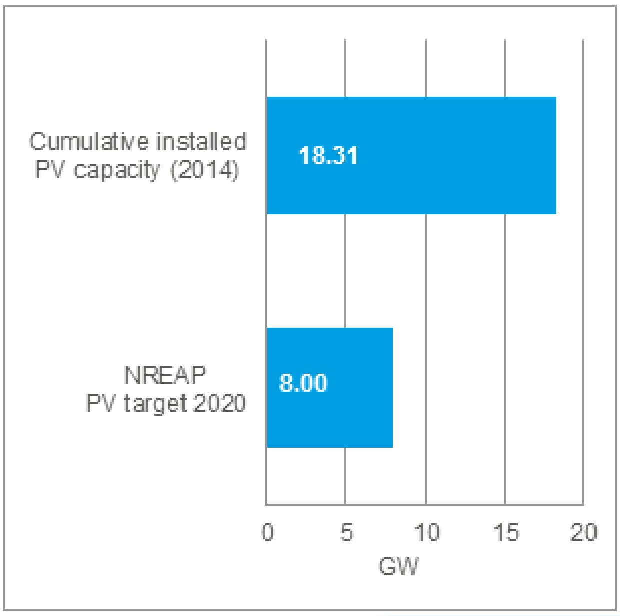


Figure 24: Cumulative Installed PV Capacity vs. NREAP PV Target 2020 in Italy [1], [6]



4.2.4. PV Market Segmentation

More than 60% of cumulative installations are based on large PV systems, 41% on industrial and 20% utility scale systems. Smaller PV systems capture less than 40% market share, with 21% in commercial and 17% in residential systems (figure 25).

In 2014 the change in the Italian PV incentive scheme has led to a complete reversal in market segmentation. 84% of the annual installations were smaller systems with 45% residential and 39% commercial systems. Large scale installations dropped back to 16%, with 12% industrial and 4% in utility scale systems (figure 26).

Figure 25: PV Cumulative Capacity 2014 by Segment [1]

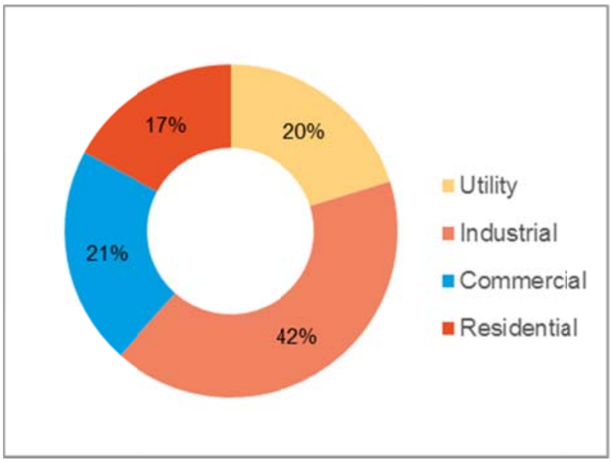
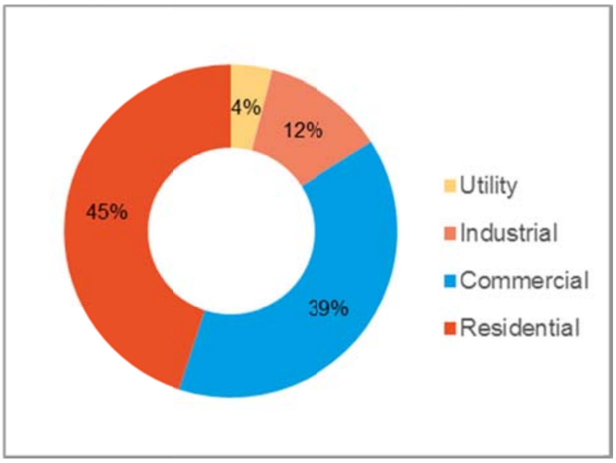


Figure 26: PV Capacity 2014 by Segment [1]



4.2.5. Electricity Market

Net electricity production in Italy reached 266.9 TWh in 2014. Conventional energy sources still represent the majority of 60%. Renewable energies account for 40%, hydro power with 21.7% and solar 8.7% respectively (figure 27).

Maximum instantaneous PV production increased to 13.5 GWp equaling 53% of the minimum national load profile (figure 28).

Figure 27: Net Electricity Production 2014 in Italy: 266.9 TWh [7], [20]

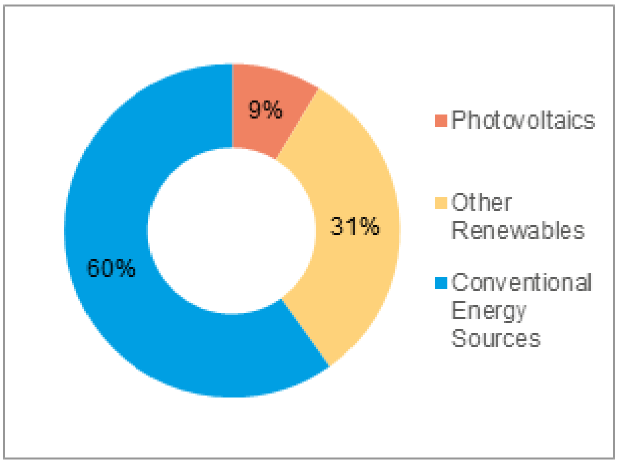
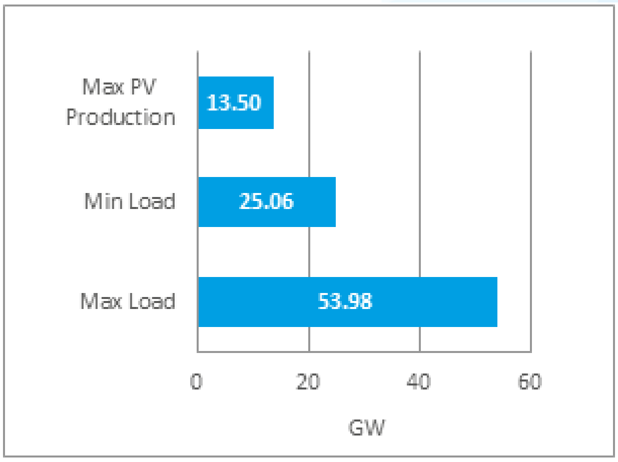


Figure 28: PV Maximum Production vs. Load Profile in Italy 2014 [1]



Retail electricity prices in Italy reached 23.38 EUR ct/kWh in 2014. They can be broken down in 43% generation, 20% distribution and 8.7% taxes and levies (figure 29).

The LCOE for utility scale PV systems ranges from 6.71 EUR ct/kWh in the South to 8.16 EUR ct/kWh in the North. Socket parity has been reached (figure 30). This is well below retail electricity prices for household consumers and opens opportunities for new PV business models.

Figure 29: Composition of Electricity Retail Prices in Italy [21]

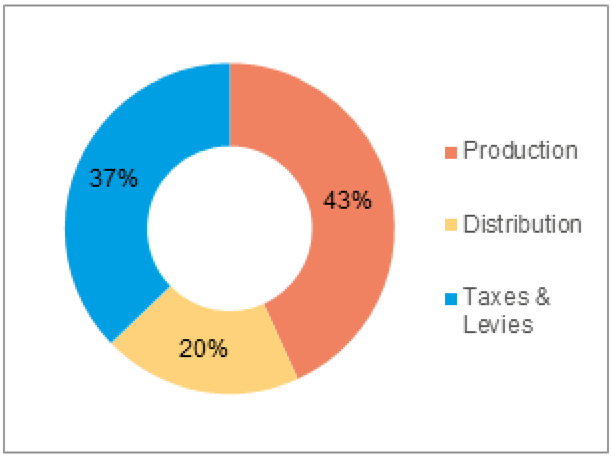
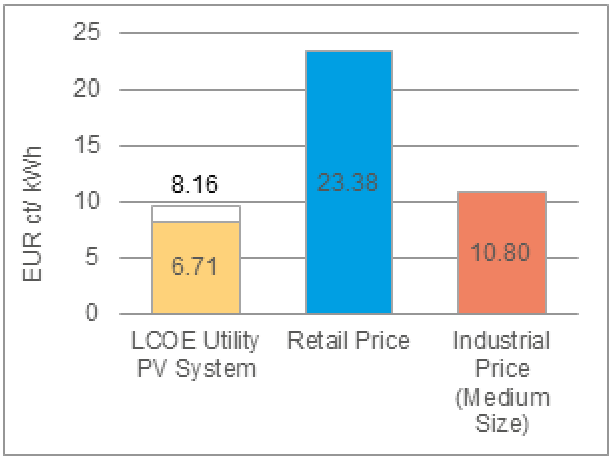


Figure 30: Indication of PV LCOE vs. Electricity Prices in Italy 2014 [9], [10], [22]



4.2.6. PV Business Models

The majority of the installed PV capacity in Italy is economically driven by business models based on FiTs. Their profitability has been significantly reduced by retroactive tariff cuts of 10%-20%.

Since 2013 the net metering scheme supports the installation of residential and commercial PV systems. The upper limit for the net metering scheme has been extended from 200 to 500 kWp.

Under the power purchase and resale scheme large PV system operators can sell their electricity to GSE rather than selling it directly via the Italian power exchange IPEX to third party customers. The market adoption rate of this business model remains limited, because the guaranteed purchase price from GSE remains still below the LCOE.

In light of rather bureaucratic registration procedures for PV systems, retroactive tariff cuts and recently introduces fees to cover the costs of GSE for running the Conto Energia and net metering incentive scheme the challenges for a sustainable Italian PV market have increased.

With the announcement of the Ministry of Economic Development to exclude PV from future incentive schemes new business models will have to center around self-consumption of local prosumers and PPAs with direct line customers, utility or DSOs and virtual power plant operators (table 6).

Table 6: Business Model Roll-out in Italy

	Residential *(0 - 10 kWp)*	**Commercial** *(10 - 250 kWp)*	**Industrial** *(>250 kWp)*	**Utility Ground Mounted** *(> 1000 kWp)*
Off-grid Self-consumption				
Feed-in Tariff				
Net Metering				
Self-consumption				
Direct Line PPA				
Utility/ DSO PPA and PPR				
Virtual Power Plant PPA				
Mini-grid PV hybrid PPA				

Market Penetration	Low	High	Emerging

4.2.7. New PV Business Models

Some examples for new PV business models have become visible in the market (table 7).

Table 7: Selected Examples of New Business Models

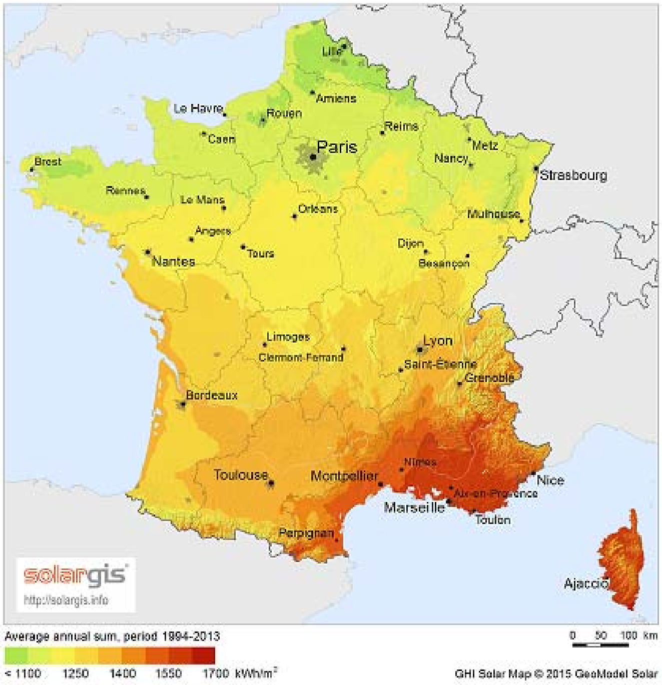
Business Model	Description
Direct Line PPA	**RESFARM [37]** - The EU funded project intends to develop an investment vehicle for a portfolio of standardized commercial PV systems to be installed in cooperation with the Confederazione Italiana Agricoltori where the electricity can be sold i.e. via direct line PPA to nearby consumers.
Virtual Power Plant	**E-Werk Prad [38]** - is an energy co-operative in Bozen with a long track record, which provides its members with electricity from renewable resources. The portfolio of power plants includes hydro, biogas, wind and PV. Currently 80 PV installations with a total capacity of 80 MW belong to the portfolio

4.3. France

4.3.1. PV Market Climate

The annual solar irradiation in France shows an average value of 1100 kWh/m² with significant variance from North to South (figure 31).

Figure 31: Global Horizontal Irradiation in France [39]



The electricity generation in France is dominated by nuclear power [40]. Nevertheless, policy support for renewable energies has grown over the last decade. In 2009 the French government issued a directive setting a target for renewable energy consumption of 23% by 2020. In 2014 another directive has been added with the objective to decrease the share of nuclear energy to 50% and increase the share of electricity from renewable energy to 40% by the year 2030. France offers a reliable investment climate for renewables.

As of today electricity from renewables is mainly producted by wind parks along the 5500 km coast line and by hydroelectric power plants in the Alpes [41]. Despite its large PV potential France has set itself a rather unambitious NREAP target in 2020 for PV, which has already been reached in 2014. Planned reductions in nuclear energy and LCOEs below socket parity offer good opportunities for PV in the future.

4.3.2. PV Incentives

The development of PV installations in France is based on two main incentive schemes FiTs and tendering.

FiTs are valid for 20 years. They vary by type of building, type of system design and PV system capacity. The tariff scheme is divided into three categories: fully BIPV, simplified BIPV and other rooftop or ground mounted systems. The requirements for BIPV rooftop systems increase the complexity and cost of the systems and enjoy a unique place in the European regulatory environment. The FiT scheme is constantly adjusted on a quarterly basis (table 8) [42].

Table 8: French FiTs 2015 (43)

Type of Installation	Power	01.01.2015-31.03.2015	01.04.2015-30.06.2015
Full BIPV	0-9 kWp	26.57 EUR ct /kWh	26.17 EUR ct/kWh
Simplified BIPV	0-36 kWp	13.46 EUR ct/kWh	13.95 EUR ct/kWh
	36-100 kWp	12.79 EUR ct/kWh	13.25 EUR ct/kWh
All Other Installation Types	0-12 MW	6.62 EUR ct/kWh	6.45 EUR ct/kWh

PV systems investements above 100 kWp are incentivized by three different tender programs. These programs allow for segment specific capacity expansions with clearly defined volumes.

In March 2015 a tender program over 120 MWp has been launched for medium sized rooftop systems with a capacity of 100-250 kWp. The program is divided in three rounds of 40 MWp with a duration of 4 months.

In November 2014 a tender program over 400 MWp has been launched for large PV systems above 250 kWp addressing large rooftop (150 MWp), ground mounted (200 MWp) and car parking (50 MWp) applications.

In May 2015 a third tender program over 50 MWp has been added to support PV systems with battery storage on rooftops (25 MWp) and car parkings (25 MWp). This innovative program applies to the overseas departments and Corsica and is intended to stimulate self-consumption in these island regions.

4.3.3. PV Market

PV installations in France reached a cumulative capacity of 5.6 GWp in 2014. The government is controlling annual capacity additions by adjustments of the FiT scheme and individual tender programs. PV installations peaked at 1.7 GWp in 2011 and since then have dropped back to a significantly lower corridor between 1.1 and 0.7 GWp (figure 32). Despite rather moderate capacity additions the NREAP target in 2020 for PV of 4.86 GWp has already been exceeded in 2014 (figure 33).

Figure 32: Volume of PV Installations in France [1], [12], [16]

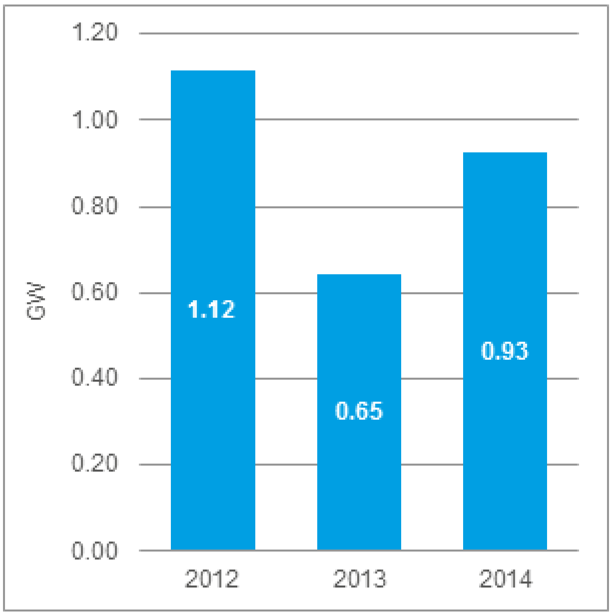
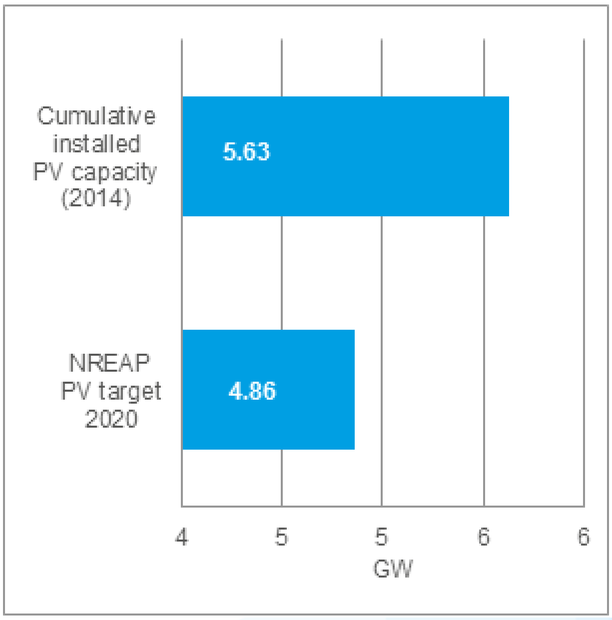


Figure 33: Cumulative Installed PV Capacity vs. NREAP PV Target 2020 in France [1], [6]



4.3.4. PV Market Segmentation

Cumulative PV installations in France have been driven by the commercial segment followed by the ground mounted and residential segment respectively (figure 34). In 2014 tender programs shifted the ground mounted segment into the lead position. The FiT backed commercial and residential segments that together reached a market share of just above 50%. The French market potential for industrial rooftop applications is hardly exploited yet (figure 35).

Figure 34: French PV Cumulative Capacity 2014 by Segment [1]

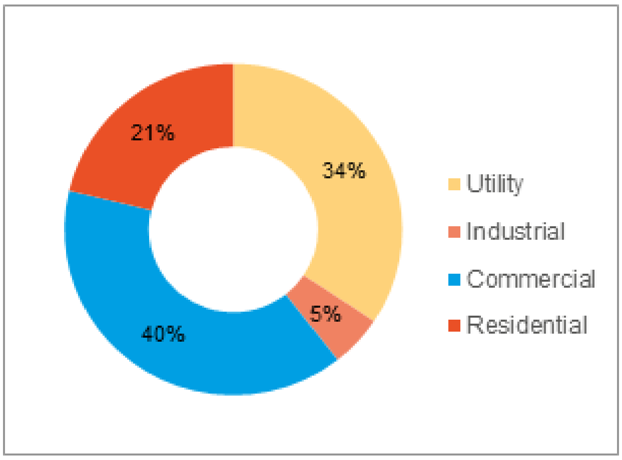
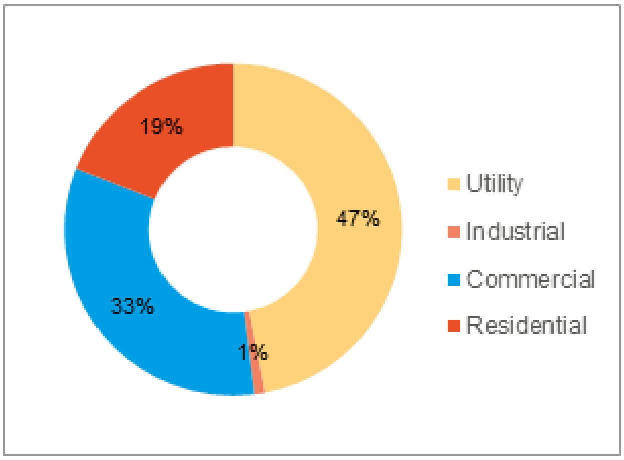


Figure 35: French PV Capacity 2014 by Segment [1]



4.3.5. Electricity Market

Net electricity production in France reached 541.2 TWh in 2014. Nuclear power plants represent the backbone of production with almost 77%. Total Renewables reached a share of 17% while PV contributed just 1% of net electricity production (figure 36).

Maximum instantaneous PV production reached 3.3 GWp in 2014 which represents just 13% of the minimum national load profile (figure 37).

Figure 36: Net Electricity Generation 2014 in France: 541.2 TWh [7], [20]

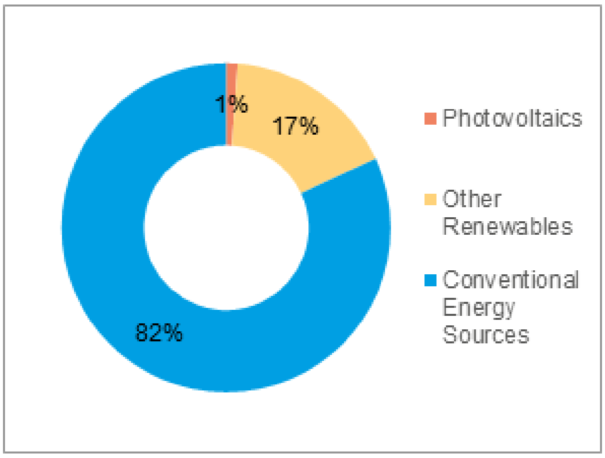
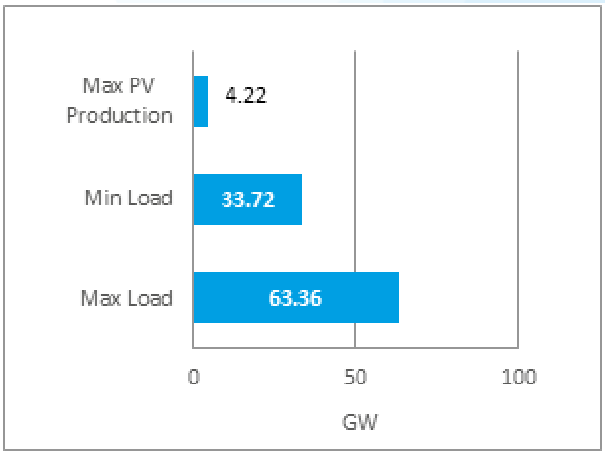


Figure 37: Max. PV Generation vs. Min. French Load Profile 2014 [9], [10], [22]



Retail electricity prices in France are on a relatively low level. In 2014 they reached 17.51 EUR ct/kWh. They are almost evenly composed of production, distribution and taxes and levies (figure 38).

The LCOE of utility scale PV systems has fallen to a range between 6.71 and 10.61 EUR ct/kWh. This is below retail electricity prices for household consumers (figure 39).

Figure 38: Composition of Electricity Retail Prices 2014 [21]

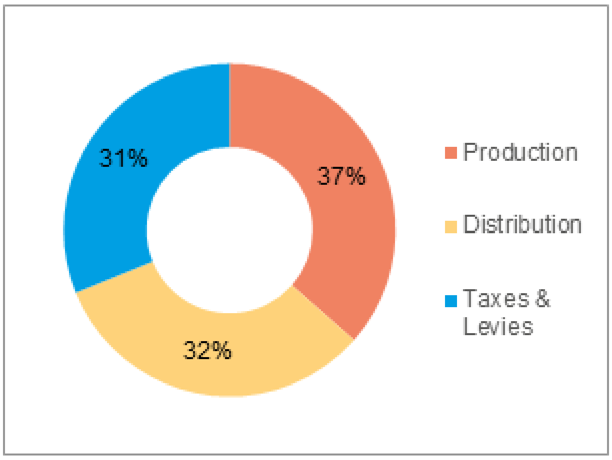
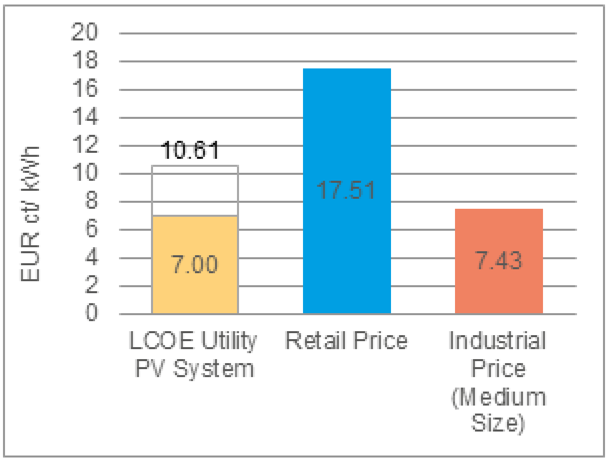


Figure 39: PV LCOE vs. Electricity Prices in France [9], [10], [22]



4.3.6. PV Business Models

The roll-out of PV has been mainly driven by FiTs and tender based business models. Rather low residential electricity prices and high costs for residential and commercial BIPV systems have restrained self-consumption.

The new government tender program for PV systems with battery storage will support the introduction of self-consumption especially in the overseas departments and Corsica.

Socket parity allows the introduction of new business models based on self-consumption and virtual power plant PPAs in the future. However, complexity and administrative hurdles slow down their development in mainland France (table 9).

Table 9: Business Model Roll-out in France

	Residential *(0 - 10 kWp)*	**Commercial** *(10 - 250 kWp)*	**Industrial** *(>250 kWp)*	**Utility Ground Mounted** *(> 1000 kWp)*
Off-grid Self-consumption				
Feed-in Tariff				
Net Metering				
Self-consumption [23]				
Direct Line PPA				
Utility/ DSO PPA				
Virtual Power Plant PPA				
Mini-grid PV Hybrid PPA				

Market Penetration	Low	High	Emerging

4.3.7. New PV Business Models

Some examples for new business models can be found. They are often driven by local renewable energy agencies or cooperatives (table 10).

Table 10: Examples of New Business Models

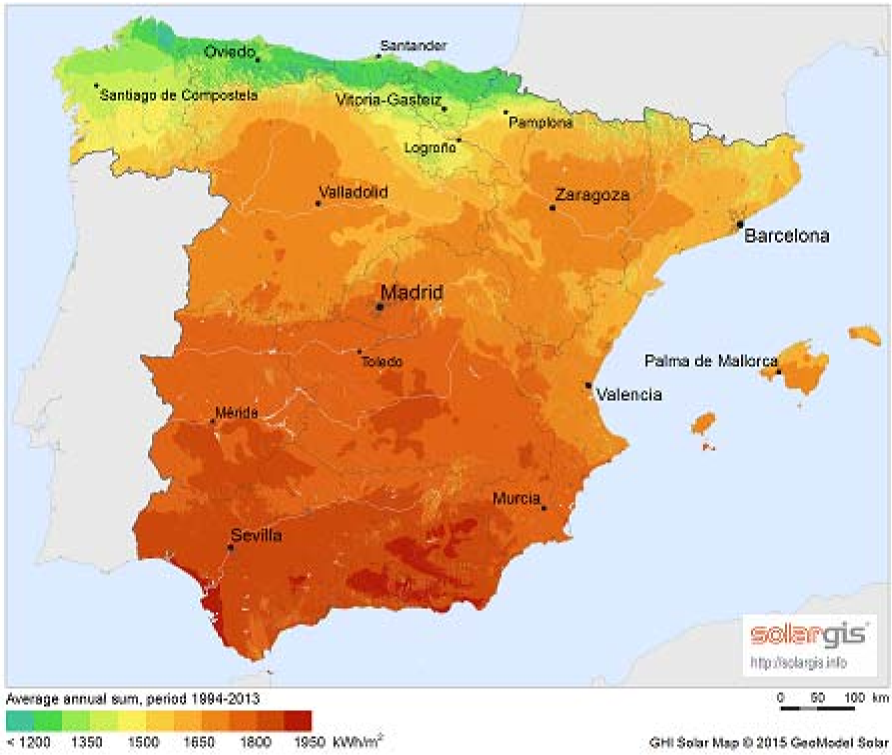
Business Model	Description
Self-consumption	**Service Energie Climat [44]-** Tender 2015 in the Aquitaine region for PV systems between 10-500kWp with 80% self-consumption with or without battery storage
Self-consumption	**Syndicat intercommunal d'assainissement de Rennes Nord [45]**- PV plant of 146 kWp was put in operation in March 2014. 100% of the PV electricity is consumed on site.
Self-consumption	**Enercoop Provence-Alpes Cote d'Azur [46]** - PV plant with 23 kWp commissioned in February 2015 on the roof of the Oceanographic Institute Paul Ricard on Ile de Embiez with 100% self-consumption financed by local investors
Virtual Power Plant	**Enercoop [47]** - Organized in 9 regional cooperatives owning and operating a nationwide network of renewable energy plants offering green electricity tariffs to its customers
Utility PPA	**Ester/Seolis/solairedirect [48]** - The PV parc Tiper 3 with a capacity of 8.4 MWp has been installed in 2014. The electricity is sold under a 30 year PPA at a price of 105,1 EUR/MWh.

4.4. Spain

4.4.1. PV Market Climate

With annual solar radiation of 1600 kWh/m² Spain is among the best suited countries for the installation of PV power in Europe due to its geographical position (figure 40).

Figure 40: Global Horizontal Irradiation in Spain [49]



Thanks to a very generous FiT scheme PV installations soared to 2.7 GWp in 2008. The financial crisis accompanied by significant budget deficits and rising unemployment rates forced the Spanish Government in the following years to drastically reduce PV incentives and to retroactively cut FiTs for existing PV plants [50]. This has put the financial profitability of many PV projects at risk and has caused legal actions of the owners against the Spanish Government. Meanwhile the unstable political framework conditions have led to an almost complete standstill in the PV market. Annual PV installations dropped back to 22 MWp in 2014. At the current installation rates Spain is likely to miss its NREAP target in 2020 for PV.

4.4.2. PV Incentives

The Spanish Industry Ministry was forced to revise all subsidy schemes for renewable energies in order to avoid a latent bankruptcy of the power sector.

During the past years all renewable support schemes for the generation of electricity from renewable sources were at first drastically reduced and then finally blocked.

On June 6th, 2014 the Ministry has introduced a new law that caps the earnings of all existing renewable power plants. Under the decree (Decreto Royal 413/2014) power generators will earn a rate of return of about 7.5% over the system lifetime [51]. This rate, which can be revised every three years, is based on the average interest of a 10-year sovereign bond plus 3 percentage points. These measures have been implemented retroactively to apply from July 2013.

Regulations for self-consumption are rather restrictive with a cap of 100 kWp. Net metering or shared self-consumption for tenants are not allowed. In June the Spanish Government announced the introduction of a “sun tax” for the use of batteries for residential self-consumption.

4.4.3. PV Market

Cumulative PV installations in Spain have reached 5.4 GWp in 2014. More than 75% had been installed before 2009. In the last three years annual PV installations dropped back from 345 MWp to 22 MWp (figure 41). The sharp decline in PV system prices caused an even more accelerated reduction in PV revenues and employment rates.

In 2014 almost 65% of the NREAP target in 2020 for PV of 8.4 GWp had been reached. However the final target is likely to be missed (figure 42).

Figure 41: PV Installations in Spain [1], [12], [15]

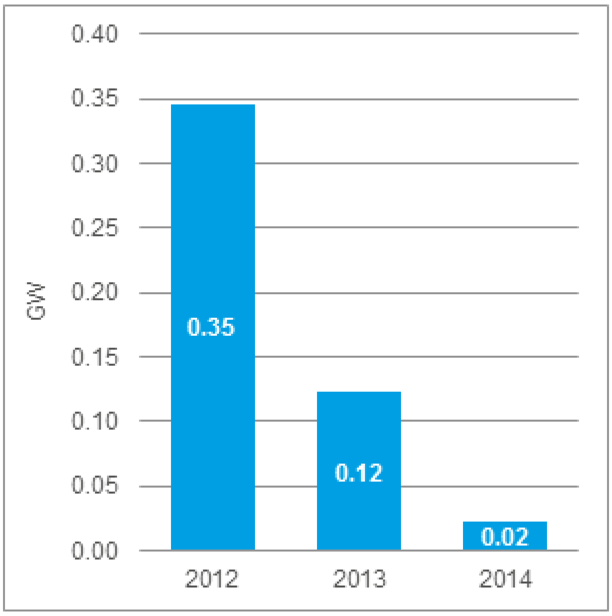
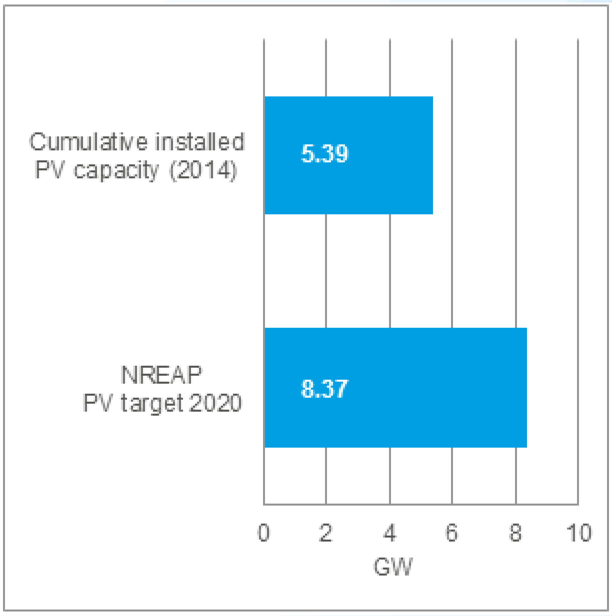


Figure 42: Cumulative Installed PV Capacity vs. NREAP PV Target 2020 in Spain [1], [6]



4.4.4. PV Market Segmentation

The majority of cumulative PV installations consists of large projects, with 85% from the utility and 6% from the industrial segment (figure 43). In the absence of government subsidies the focus of PV installations in 2014 shifted to smaller installations with 20% industrial, 31% commercial and 4% residential systems (figure 44).

Figure 43: PV Cumulative Capacity 2014 by Segment [1]

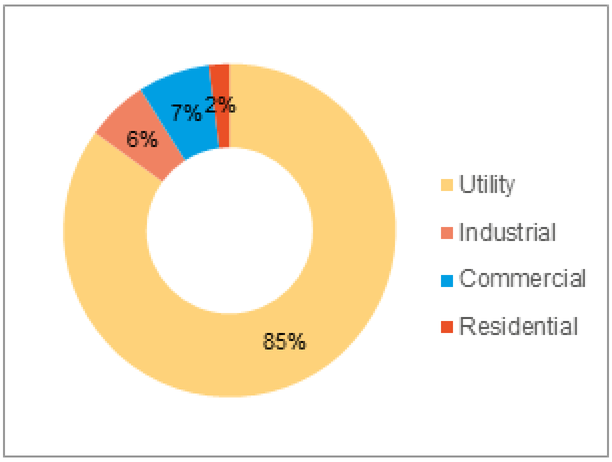
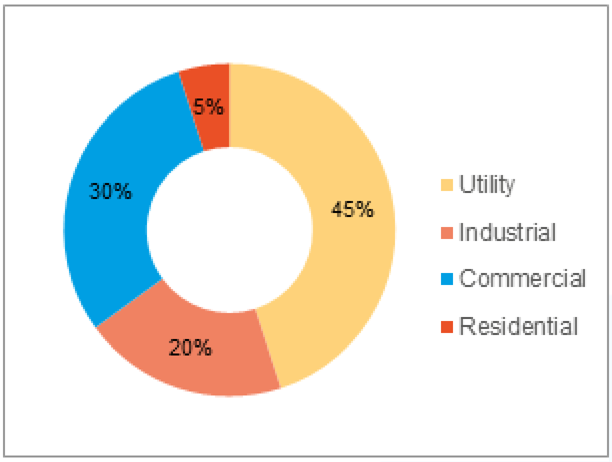


Figure 44: PV Capacity 2014 by Segment [1]



4.4.5. Electricity Market

In 2014 the net electricity production in Spain reached 266.6 TWh. With its share of more than 40% from renewable sources Spain holds a lead position in Europe. Wind and hydro power contribute the major part, followed by PV with just 6% (figure 45).

Maximum instantaneous electricity production from PV reached 18% of the minimum national load profile in 2014 (figure 46).

Figure 45: Net Electricity Production 2014 in Spain: 266.6 TWh [7], [20]

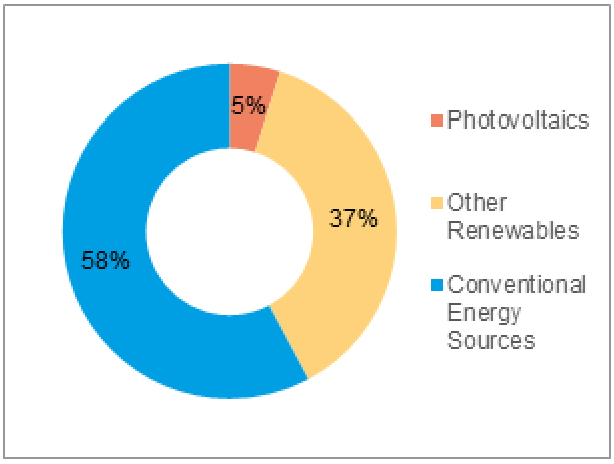
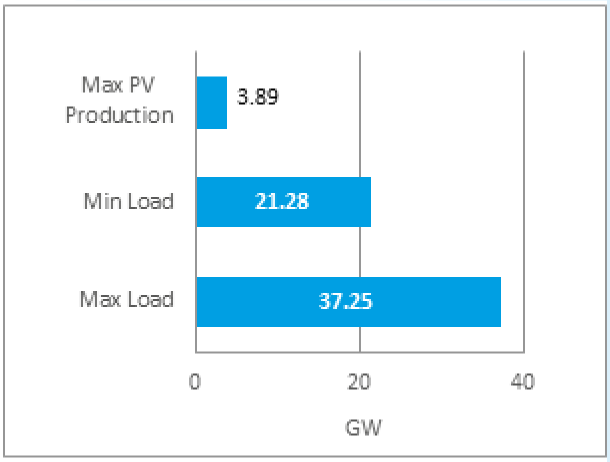


Figure 46: PV Maximum Production vs. Load Profile in Spain 2014 [12]



At the end of 2014 retail electricity prices were at 23.47 EUR ct/kWh, with a breakdown of 58% generation, 21% distribution and 21% taxes and levies (figure 47). Generation cost are significantly higher than the European average.

The LCOE for utility scale PV installations has reached a range of 6.71 to 9.00 EUR ct/kWh (figure 48). This is well below retail electricity prices for household consumers and theoretically opens opportunities for new PV business models.

Figure 47: Composition of Electricity Retail Prices in Spain 2014 [21]

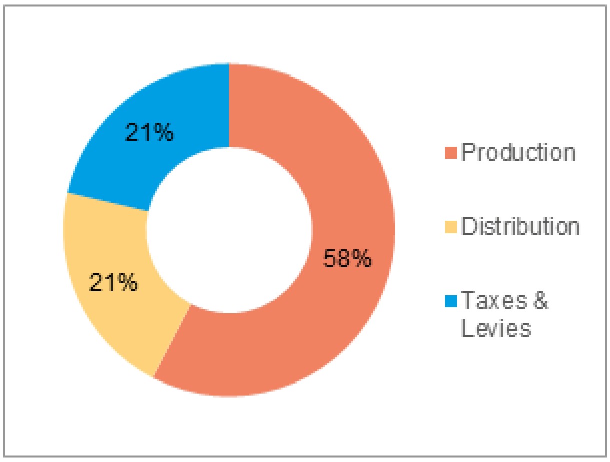
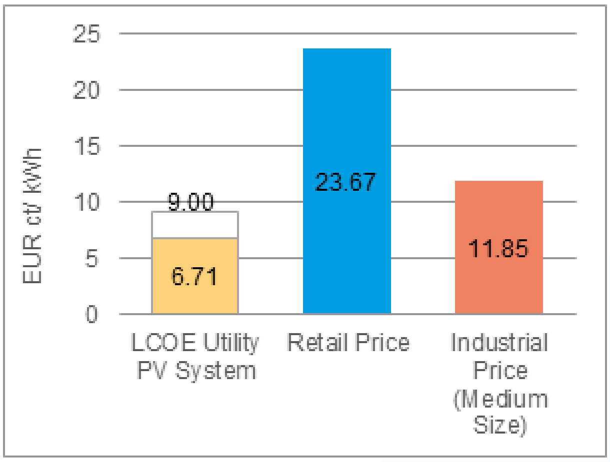


Figure 48: PV LCOE vs: Electricity Prices in Spain [9], [10], [22]



4.4.6. PV Business Models

The Spanish PV market has been driven by a FiT based business model. Continued increase of electricity prices could lead to further expansion of PV self-consumption and the emergence of utility/DSO PPAs (table 11).

Table 11: Business Model Roll-out in Spain

	Residential *(0 - 10 kWp)*	**Commercial** *(10 - 250 kWp)*	**Industrial** *(>250 kWp)*	**Utility Ground Mounted** *(> 1000 kWp)*
Off-grid Self-consumption				
Feed-in Tariff				
Net Metering				
Self-consumption				
Direct Line PPA				
Utility/ DSO PPA				
Virtual Power Plant PPA				
Mini-grid PV Hybrid PPA				

Market Penetration	Low	High	Emerging

4.4.7. New PV Business Models

Since the Spanish market has almost come to a complete stand-still due to political barriers, the commitment to invest time and money into the development of new business models has been held back. Hence, good examples are difficult to find (table 12).

Table 12: Selected Examples of New Business Models

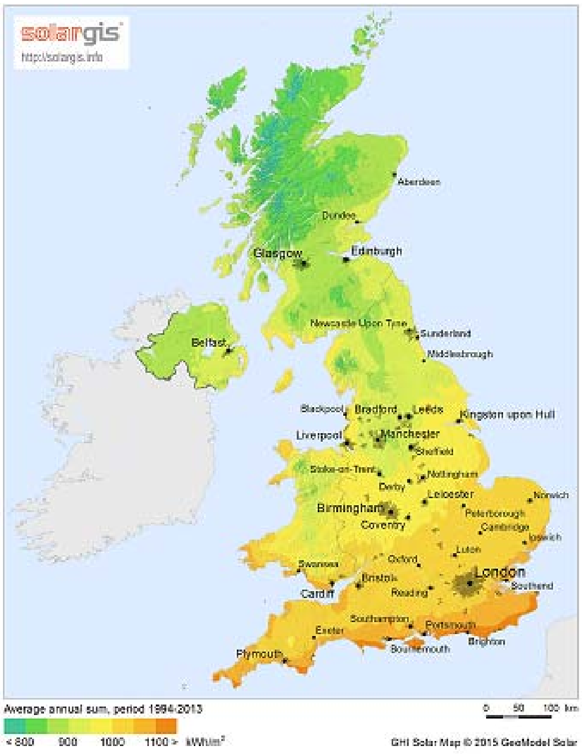
Business Model	Description
Self-consumption	**Som Energia [52]** is a co-operative, where members can invest and buy green electricity. Som Energia builds virtual power plants through the acquisition of projects based on wind, biomass, PV etc. Several commercial PV system have been already been added to the portfolio
Utility PPA	**Enerpro/Solbisco Energy [53]** - Both companies intend to build a 300 MW portfolio of PV plants and to sell the solar power output directly to the electricity market. A first 2,5 MW pilot PV has been commissioned at Marcha in the province of Sevilla
Utility PPA	**JUWI [54]** - It is understood the 450 MW Murcia project will be built without any FiT support, instead competing in the open market with other generation technologies. This confirms largest scale investments are feasible within PV - combined with solar irradiation in Spain also without FiT.

4.5. United Kingdom

4.5.1. PV Market Climate

The annual solar irradiation in the UK reaches an average of 970 kWh/m^2. In the southern parts of the country solar irradiation can even reach up to 1200 kWh/m^2 (figure 49).

Figure 49: Global Horizontal Irradiation in the UK [55]



Since 2011 the PV market has shown a very positive development which has been spurred by government incentives and falling PV system prices. Small systems are subject to a FiT scheme with frequent tariff adjustments. Larger systems benefitted from a ROC scheme, a market based quota system linked to the trade of certificates. A new "Certificate for Difference" (CfD) model has been introduced in 2015 for large PV systems, which focuses on current electricity market prices. However, the adoption rate of this new model remains behind expectations.

The UK Government pursues ambitious climate protection goals including a rapid expansion of renewable energies with a 15% target of the national energy demand in 2020. The NREAP target for PV in the same year of 2.5 GWp has already been reached.

The Department of Energy and Climate Change (DECC) decided in July 2015 to discontinue the ROC scheme for PV systems below 5 MW as of April 2016 and to no longer guarantee FiTs for PV installations with more than 50 kWp ahead of commissioning in order to cool down the market. Therefore the market outlook for the coming years is expected to be less favorable.

4.5.2. PV Incentives

The PV market in the UK is driven by two incentive schemes [56], [57]. FiTs for smaller systems up to 5 MWp and ROCs for larger projets. The latter is currently phased out and replaced by the CfD model.

The FiT scheme is based on electricity generation. If the PV electricity is fed into the grid an export tariff of 4.85 p/kWh is payed in addition. The FiT is paid for a period of 20 years. The Electricity Markets Authority (Ofgem) currently adjusts the FiT scheme every three months.

There exist six different FiT tariffs based on the PV system size, which are further subdivided into three classes "high", "medium" and "low" according to their energy efficiency classification (table 13).

Table 13: FiTs in the UK 2015 [58]

Solar PV System Size	Generation Tariff				Export Tariff
	Eligibility date 1 Apr 2015 to 30 Jun 2015		Eligibility date 1 Jul 2015 to 30 Sep 2015		Eligibility Date 1 Apr 2015 to 30 Sep 2015
	Higher rate (EPC band D or above)	Lower rate (EPC not band D or above)	Higher rate (EPC band D or above)	Lower rate (EPC not band D or above)	
≤ 4kW	13.39 GBp/kWh 18.97 ct EUR/kWh*	6.16 GBp/kWh 8.73 ct EUR/kWh*	12.92 GBp/kWh 18.30 ct EUR/kWh*	5.94 GBp/kWh 8.41 ct EUR/kWh*	4.85 GBp/kWh 6.87 ct EUR/kWh*
> 4kW – 10kW	12.13 GBp/kWh 17.18 ct EUR/kWh*	6.16 GBp/kWh 8.73 ct EUR/kWh*	11.71 GBp/kWh 16.59 ct EUR/kWh*	5.94 GBp/kWh 8.41 ct EUR/kWh*	4.85 GBp/kWh 6.87 ct EUR/kWh*
> 10kW – 50kW	11.71 GBp/kWh 16.59 ct EUR/kWh*	6.16 GBp/kWh 8.73 ct EUR/kWh*	11.71 GBp/kWh 16.59 ct EUR/kWh*	5.94 GBp/kWh 8.41 ct EUR/kWh*	4.85 GBp/kWh 6.87 ct EUR/kWh*
Stand-alone	6.16 GBp/kWh 8.73 ct EUR/kWh		4.44 GBp/kWh 6.29 ct EUR/kWh*		4.85 GBp/kWh 6.87 ct EUR/kWh*

**Exchange rate as of June 30th, 2015*

Large PV systems may benefit from the ROC scheme. This is a quota system, where operators of PV systems are able to earn a certain amount of ROCs per generated MWh depending on the capacity of the plant. Utilities have to purchase these certificates in order to comply with a steadily increasing renewable electricity quota. The ROC model is currently being phased out in two steps. In April 2015 the ROC was discontinued for PV projects > 5 MWp and in April 2016 it will be discontinued for PV projects ≤ 5 MWp.

In the first quarter of 2015 the British Department of Energy and Climate Change introduced a CfD model with the intention to increase competition amongst renewable energies and to lower their cost. Under the CfD model renewable energy projects are tendered out at a fixed electricity strike price valid for 15 years. If the market price drops below the strike price the project owner receives the difference from a Government body. If the market price rises above the strike price the project owner has to reimburse the difference. In the first tender round held in February 2015 a total of 71.6 MWp of PV projects were auctioned off at a strike price between 79.23 GBP/MWh and 50.00 GBP/MWh. Representatives from the PV industry are critizising the CfD model becauce of its limited capacity and the very low strike price as it endangeres the actual implementation of the PV projects.

4.5.3. PV Market

Since 2012 the annual PV installations have almost tripled. In 2014 the UK became market leader in Europe with 2.4 GWp of annual installations (figure 50). Most likely it will hold the position for 2015 too. Cumulative installations reached 5.2 GWp. The NREAP target for PV of 2.5 GWp in 2020 has already been exceeded in 2014 (figure 51). Therfeore the government has increased the target to 10 GWp.

Figure 50: PV Installations in the UK [1], [12], [18]

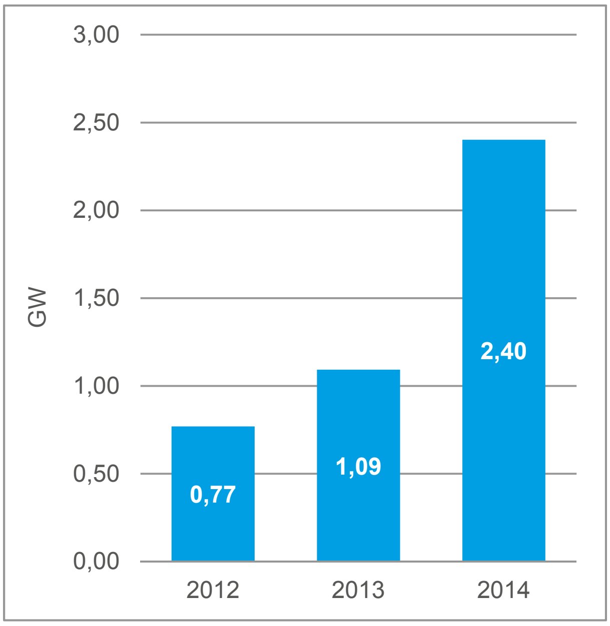
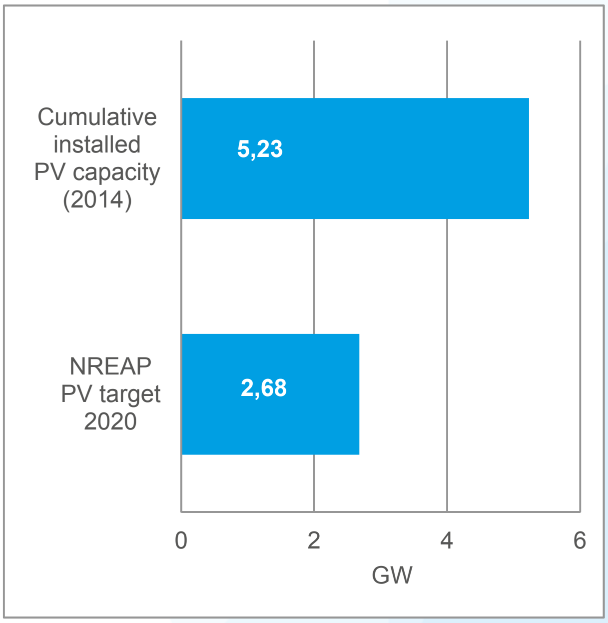


Figure 51: Cumulative Installed PV Capacity vs. NREAP PV Target 2020 in the UK [1], [6]



4.5.4. PV Market Segmentation

Cumulative PV installations in 2014 are dominated by utility scale systems with 54%, followed by residential with 23% and commercial system with 21% respectively. There are hardly any industrial applications (figure 52).

In 2014 utility scale systems dropped back to 39%. Residential and commercial systems caught up and reached a share of 26% and 34% respectively (figure 53).

In 2015 utility scale systems are expected to lose further market share due to the termination of the ROC scheme and the rather sluggish introduction of the CfD model.

Figure 52: PV Cumulative Capacity 2014 by Segment [1]

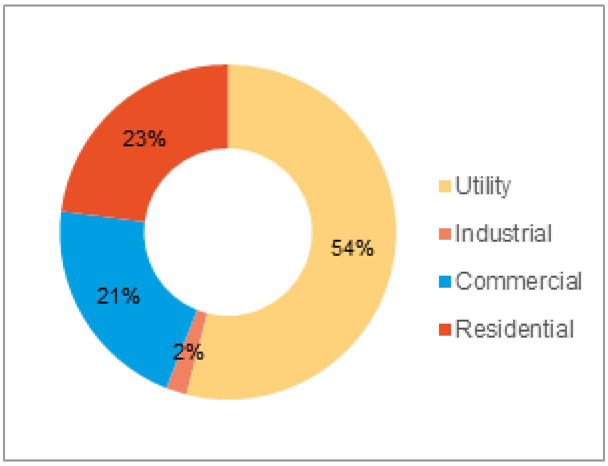
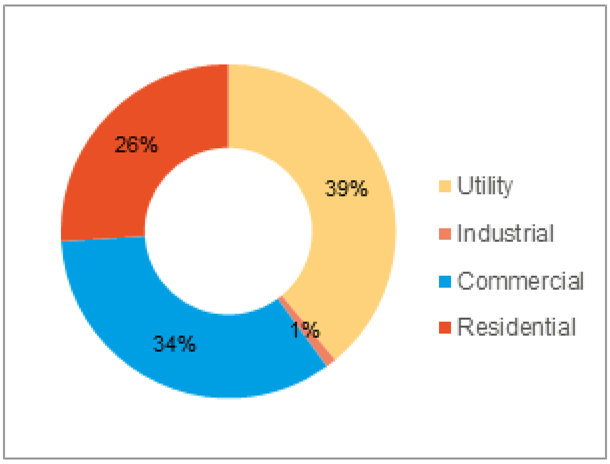


Figure 53: PV Capacity 2014 by Segment [1]



4.5.5. Electricity Market

Net electricity production reached 363.6 TWh in 2014. Renewables contributed 19.2%. PV jumped from 3.8% in 2013 to 6.1% in 2014 (figure 54).

The maximum instantaneous PV production in 2014 reached an estimated 3.5 GW. This represents 17.5% of the minimum national load (figure 55).

Figure 54: Net Electricity Production 2014 in the UK: 363.6 TWh [7], [20]

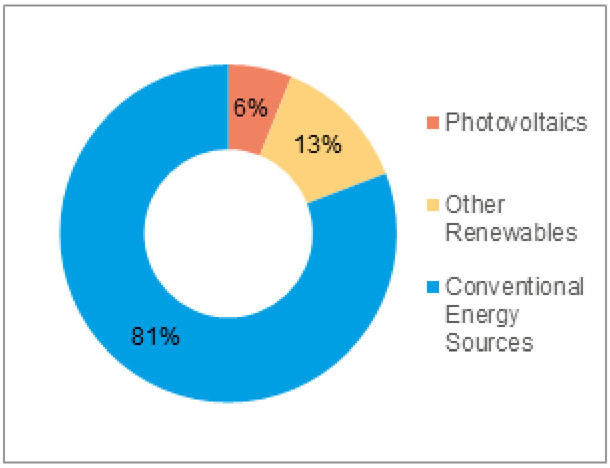
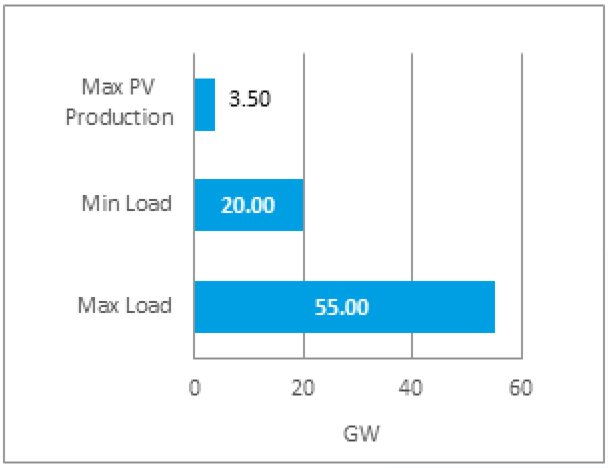


Figure 55: PV Maximum Production vs. Load Profile in the UK 2014 [12]



UK residential electricity prices of 20.13 EUR ct/kWh are positioned in the European middle field. Generation represents 74%, distribution 21% and taxes and levies just 5% (figure 56).

In the South of the UK the LCOE for utility scale PV plants range between 10.61 EUR ct/kWh and 12.00 EUR ct/kWh (figure 57). This is well below retail electricity prices for household consumers and theoretically opens opportunities for new PV business models.

Figure 56: Composition of Electricity Retail Prices in the UK 2014 [21]

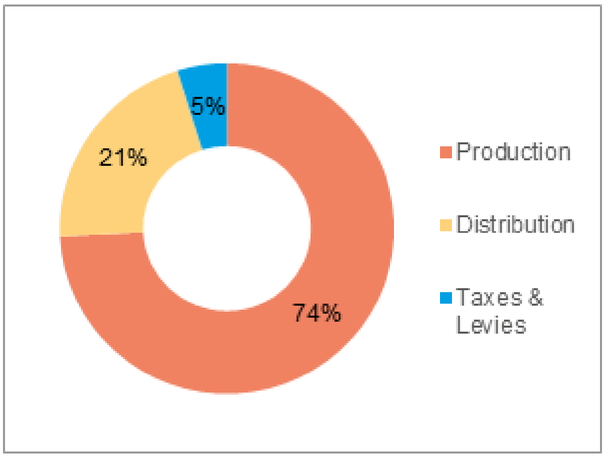
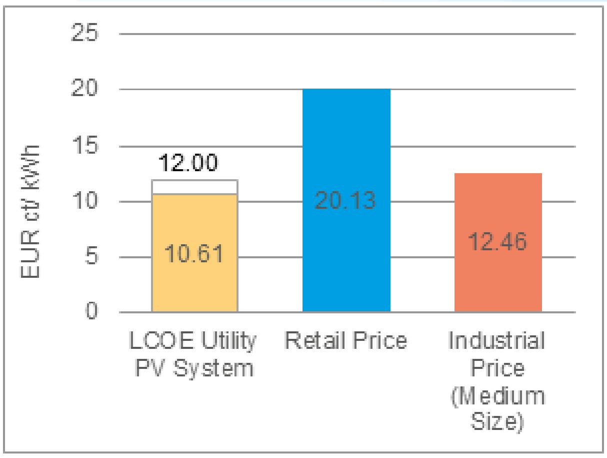


Figure 57: PV LCOE vs. Electricity Prices in the UK [6], [10], [22]



4.5.6. PV Business Models

The roll-out of PV business models in the UK is quite dynamic (table 14). It first started with off-grid self-consumption systems. In 2000 a net metering pilot was introducted by Eastern Electricity in London.

In April 2010 the introduction of the FiT scheme for PV systems of up to 5 MWp initiated a rapid growth phase.

A first step of integration with the existing utility market has been achieved with the adoption of the ROC scheme for large PV systems in April 2013. Currently the ROC scheme is being replaced by the innovative CfD tender model.

Decreasing governmental support slows down the development of new business models.

Table 14: Business Model Roll-out in the UK

	Residential *(0 - 10 kWp)*	**Commercial** *(10 - 250 kWp)*	**Industrial** *(>250 kWp)*	**Utility Ground Mounted** *(> 1000 kWp)*
Off-grid Self-consumption				
Feed-in Tariff				
Net Metering				
Self-consumption				
Direct Line PPA				
Utility/ DSO PPA				
Virtual Power Plant PPA				
Mini-grid PV Hybrid PPA				

Market Penetration	Low	High	Emerging

4.5.7. New PV Business Models

Examples for new business models based on self-consumption and virtual power plants have become visible in the UK market (table 15).

Table 15: Selected Examples of New Business Models

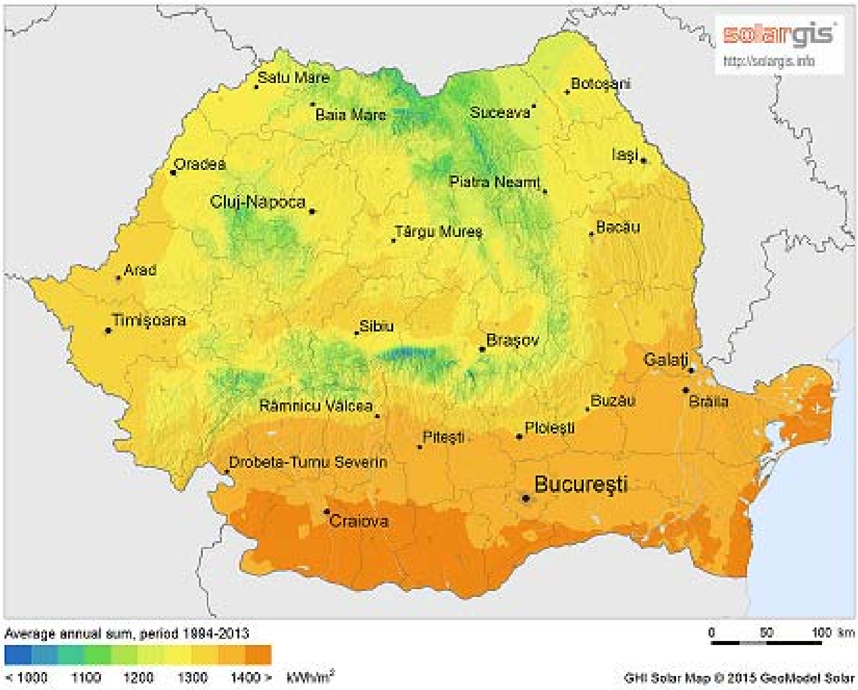
Business Model	Description
Net Metering	**Good Energy [59]** is providing a total power generation model, called Homegen, and buys all the energy produced from the owner. The award winning scheme has been established for small residential systems with below 4KW in total output power.
Virtual Power Plant	**Flexitricity [60]** is a virtual power plant which is paid by the National Grid. All assets including PV and Wind generators are remotely monitored. Target is to acquire new revenues from existing generators.
Virtual Power Plant	**Good Energy [61]** offers PPA agreements to any FiT or ROC site over 100KW in size. Typically these sites are producing more electricity than used onsite. Good Energy is managing the FiT payments and also the purchase of ROC and offer short and long term contract periods with variable tracker rates.

4.6. Romania

4.6.1. PV Market Climate

Annual solar radiation in Romania reaches an average of 1200 kWh/m² which rank at the bottom of southern European countries (figure 58).

Figure 58: Global Horizontal Irradiation in Romania [62]



With the introduction of a GC scheme the Romanian Government has tried to improve the national carbon footprint. Renewable energy producers receive a certain number of GCs for every MWh delivered to the network over a period of 15 years. Electricity suppliers and energy-intense industrial consumers, who do not match the requirement in terms of carbon footprint, are obliged to buy a certain quota of GCs, which is fixed by the Government on an annual basis [63].

Spurred by the GC incentive scheme the PV market has shown a rapid growth since 2011 and has already exceeded the NREAP target for PV in 2020 in 2013. Regulatory changes have reduced the number of GCs per MWh of photovoltaic electricity by 50%. Since then investments in large utility scale PV plants have become economically unattractive.

4.6.2. PV Incentives

The National Energy Regulatory Authority (ANRE) adjusts the GC scheme on an annual basis. The number of certificates assigned to each MWh of delivered electricity depends on the maturity of the particular renewable energy technology. PV systems up to a maximum capacity of 10 MWp are entitled to participate in the GC scheme. In January 2014 the number of GCs for PV was reduced from 6 to 3.

PV electricity and the GCs are traded by OPCOM, the Romanian gas and electricity market operator [64]. Electricity suppliers and energy-intense industrial consumers are obliged by the decree 220/2008 to cover an increasing quota of their demand by renewable energy sources:

- 2012: 12%
- 2013: 14%
- 2014-2018: +1% per annum
- 2019: 19.5%
- 2020: 20%

In 2015 the annual share of electricity from renewable sources has been corrected downwards from 16% to 11,9%. At the end of July 2015 the GCs were traded at a value below 30 EUR. By the end of 2015 a 9 million oversupply of GCs is expected.

4.6.3. PV Market

The cumulative PV installations in Romania reached 1.2 GWp in 2014. With the cut back of GC allocations PV installations dropped back from a massive peak of 1.1 GWp in 2013 to 72 MWp in 2014 (figure 60)

The NREAP target for PV of 260 MWp in 2020 was exceeded more than four times in 2013, which shows a clear underestimation of the market potential (figure 61).

Figure 59: Volume of PV Installations in Romania [1], [12], [15]

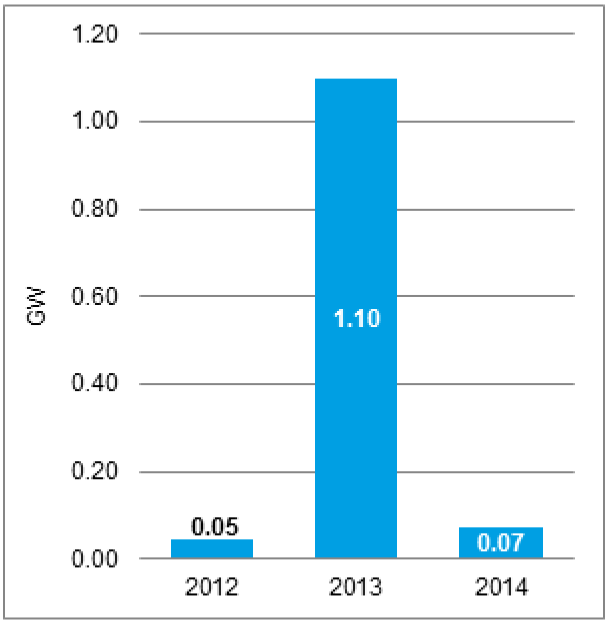
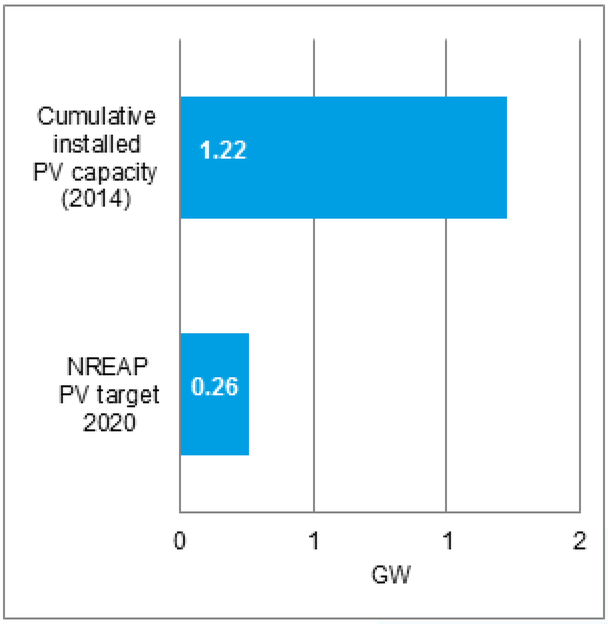


Figure 60: Cumulative Installed PV Capacity vs. NREAP PV Target 2020 in Romania [1], [6]



4.6.4. PV Market Segmentation

The Romanian market is almost exclusively driven by utility scale PV power plants which contributed 99% to the cumulative installations in 2014 (figure 61). The share of residential systems increased slightly in 2014 (figure 62).

Figure 61: Romanian PV Cumulative Capacity 2014 by Segment [1]

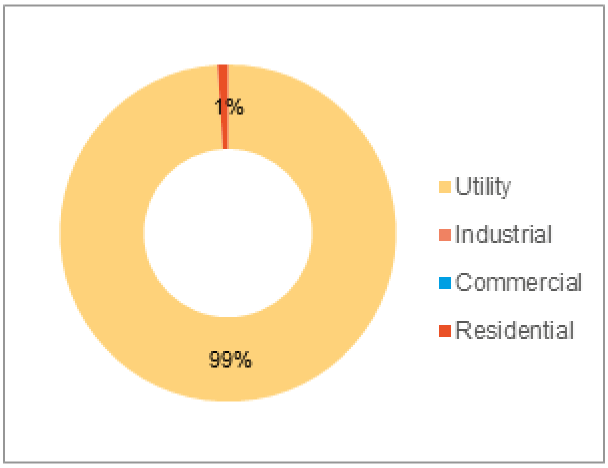
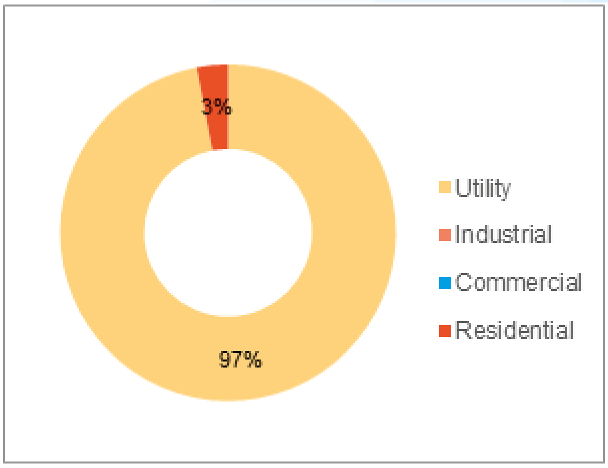


Figure 62: Romanian PV Capacity 2014 by Segment [1]



4.6.5. Electricity Market

Net electricity production in Romania reached 60.6 TWh in 2014. The majority of 56% is based on rather old fossil fuel power plants and two nuclear reactors. With the support of the GC scheme the power production from renewable sources took a major leap forward and reached 44%. PV holds the third position behind hydro and wind and contributes 2.7% (figure 63).

The maximum instantaneous PV production in 2014 reached 0.85 GWp, which represents 21% of the minimum national load profile (figure 64).

Figure 63: Net Electricity Production 2014 in Load Romania: 60.6 TWh [7], [20]

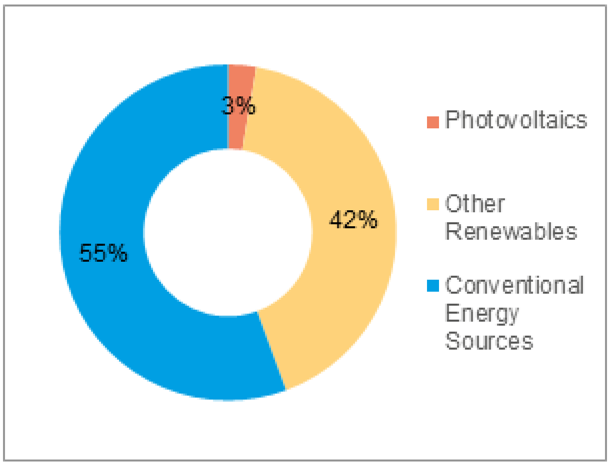
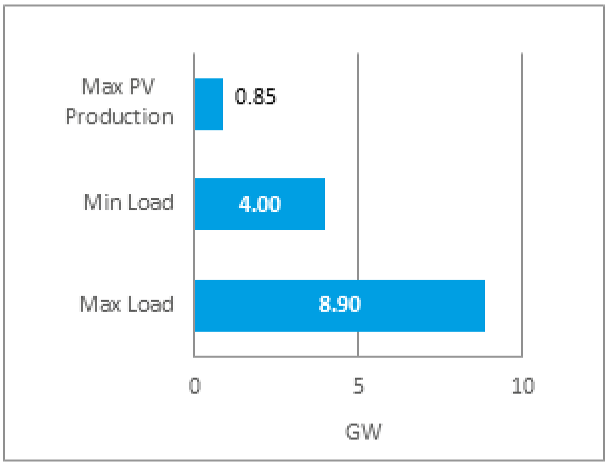


Figure 64: PV Maximum Produciton vs. Romanian Profile 2014 [12]



Residential electricity retail prices of 12.48 EUR ct/kWh are on a very low level. They are split in 30% production, 43% transmission and 27% taxes and levies (figure 65).

The LCOE for utility scale PV installations ranges from 8.16 EUR ct/kWh to 10.61 EUR ct/kWh (figure 66). With very low electricity retail prices there is little room for new business models without incentive schemes.

Figure 65: Composition of Electricity Retail Prices in Romania 2014 [21]

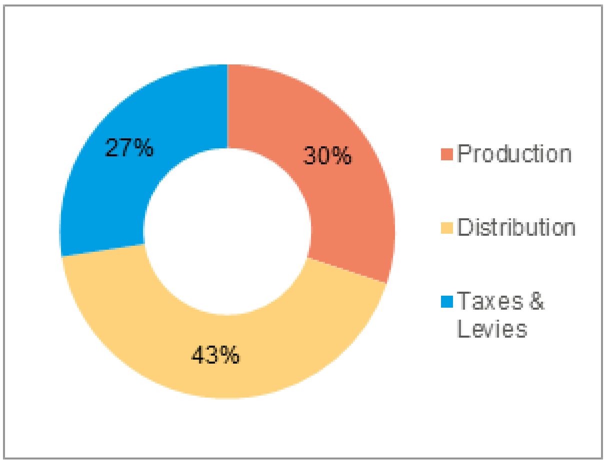
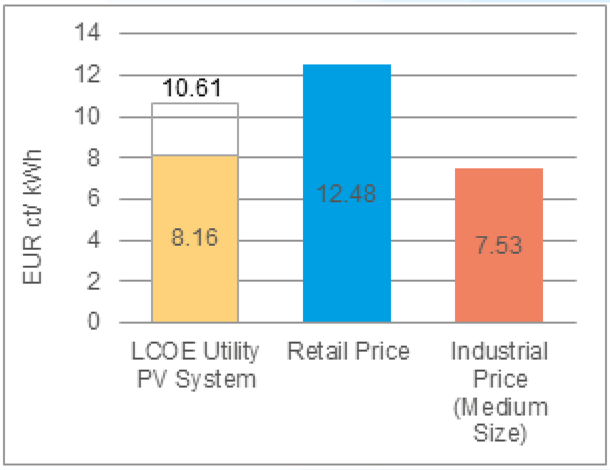


Figure 66: PV LCOE vs: Electricity Prices in Romania [9], [10], [22]



4.6.6. PV Business Models

The Romanian PV market is dominated by a business model based on the GCs for large scale PV power plants (table 16). With the 50% cut in the GC allocation at the beginning of 2014 the market has collapsed. A FiT for PV systems up to 500 kWp is currently under review, which could potentially revitalize the market to a certain extent.

Table 16: Business Model Roll-out in Romania

	Residential *(0 - 10 kWp)*	**Commercial** *(10 - 250 kWp)*	**Industrial** *(>250 kWp)*	**Utility Ground Mounted** *(> 1000 kWp)*
Off-grid Self-consumption				
Feed-in Tariff (CGs)				
Net Metering				
Self-consumption				
Direct Line PPA				
Utility/ DSO PPA				
Virtual Power Plant PPA				
Mini-grid PV Hybrid PPA				

Market Penetration	Low	High	Emerging

4.6.7. New PV Business Models

Very low electricity prices prevent the development of new business models. No example has become visible.

4.7. Netherlands

4.7.1. PV Market Climate

The annual solar irradiation levels in the Netherlands reach an average of 950 kWh/m² (figure 67).

Figure 67: Global Horizontal Irradiation in the Netherlands [65]

The Dutch Government favors the implementation of cost efficient renewable energy technologies. Therefore they focus on onshore wind and biomass [66]. Initially PV has been considered as a rather costly niche technology.

In the year 2008 the SDE+ program introduced a first incentive scheme for PV systems. In the following years the scheme underwent frequent changes and suffered from rather limited subsidy budgets. More recently the rapid decline of PV system cost has led to a rapid market growth in the course of the Dutch net metering scheme. The NREAP target for PV of 0.77 GW in 2020 has already been exceeded in 2014.

4.7.2. PV Incentives

The two dominant PV incentive schemes in the Netherlands are net metering and the SDE+ stimulation program.

Owners of small PV systems with a connection of less than 3 x 80 A who are prosumers producing and consuming their own electricity can benefit of the Dutch net metering scheme (“salderen”). Surplus electricity can be fed into the grid and can be withdrawn later once it is needed. The prosumer can save the energy taxes for the electricity they feed into and withdraw again from the grid. If the feed-in amount exceeds the withdrawn amount he will compensated with a reduced electricity price excluding distribution costs and energy taxes. Net metering has been first introduced in 2004. It only became economically viable after the sharp decline in PV system costs. An initial cap on the feed-in quantity of PV electricity has been eliminated in 2014.

The renewable energy stimulation program SDE was first introduced in 2008. It has undergone frequent changes. In 2011 the program was amended and renamed as the SDE+ program. It offers a structured support in order to achieve the NREAP targets 2020 for each renewable technology. SDE+ incentives are conceived as feed-in premiums and are financed through a levy on the energy bill of end consumers.

Only PV systems larger than 15 kWp are eligible for the SDE+ incentives. In 2015 the SDE+ program is split into nine phases (table 17). In each phase the base price for PV energy is slightly increased. This mechanism ensures that the most cost efficient PV systems will be subsidized first.

Table 17: FiTs In the Netherlands
Dutch Stimulation Program SDE+ 2015 for PV Systems ≥ 15 k [67]

Base Price for PV Energy per Phase	EUR/kWh
Phase 1 from March 31st 9:00h	0.070
Phase 2 from April 20th 17:00h	0.080
Phase 3 from May 11th 17:00h	0.090
Phase 4 from June 1st 17:00h	0.100
Phase 5 from June 22nd 17:00h	0.110
Phase 6 from August 31st 17:00h	0.120
Phase 7 from September 21st 17:00h	0.130
Phase 8 from October 12th 17:00h	0.140
Phase 9 from November 9th 17:00h	0.141

Base Price for PV Energy per Phase	EUR/kWh
Base Energy Price	0.035
Preliminary Correction Price 2015	0.034
Max Full Load Hours per Year	1000
Max Duration (Years)	15
Time till Commissioning (Years)	3

The base electricity price is calculated as follows:

Base price for PV energy = base price energy + correction amount 2015 + SDE^{+} 2015 incentive

The final correction amount for 2015 will be determined by the Energy Research Centre of the Netherlands (ECN) based on the actual development of energy prices.

4.7.3. PV Market

The PV market reached a cumulative installed capacity of 1 GWp in 2014. Since 2012 the annual installations have more than doubled to 0.4 GWp in 2014. This growth has been mostly driven by the net metering scheme for small PV systems (figure 68). The NREAP target has already been exceeded (figure 69).

Figure 68: PV Installations in the Netherlands [1], [12], [15]

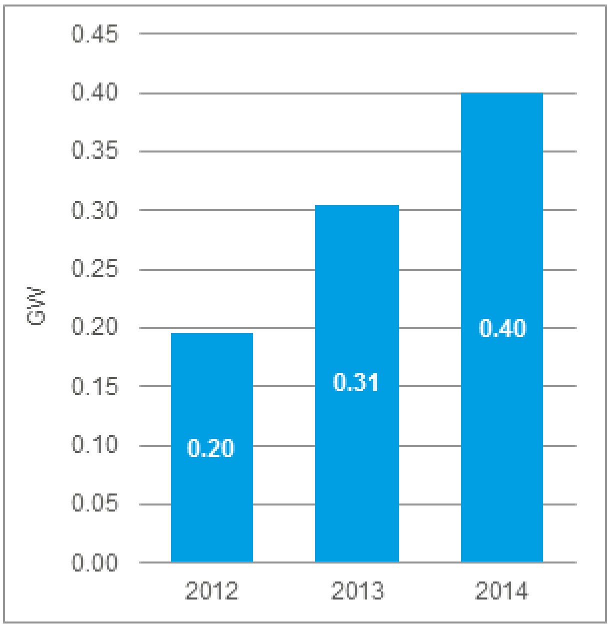
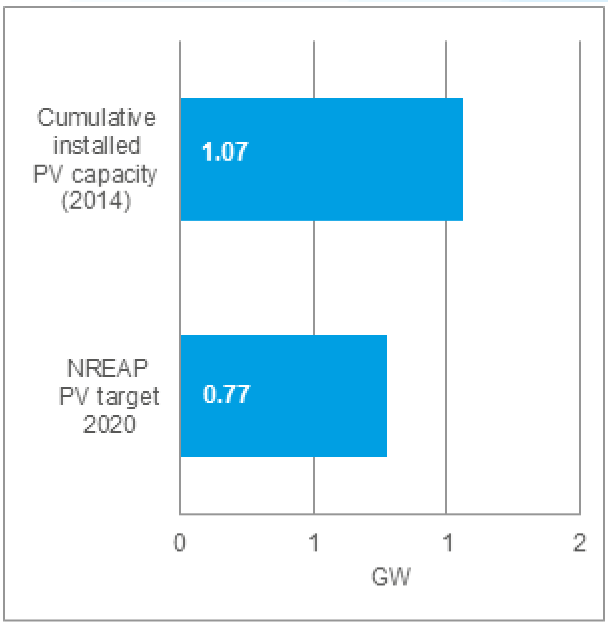


Figure 69: Cumulative Installed PV Capacity vs: NREAP PV Target 2020 in the Netherlands [1], [6]



4.7.4. PV Market Segmentation

The Dutch PV market is mainly driven by small systems. The cumulative market consists of 80% residential and 14% commercial systems (figure 70). In 2014 the residential share dropped slightly to 74% while the commercial share rose to 21%. Large industrial and utility scale PV systems only play a minor role (figure 71). Due to space limitations the capacity of ground mounted systems remains in most cases below 1 MWp.

Figure 70: PV Cumulative Capacity 2014 by Segment [1]

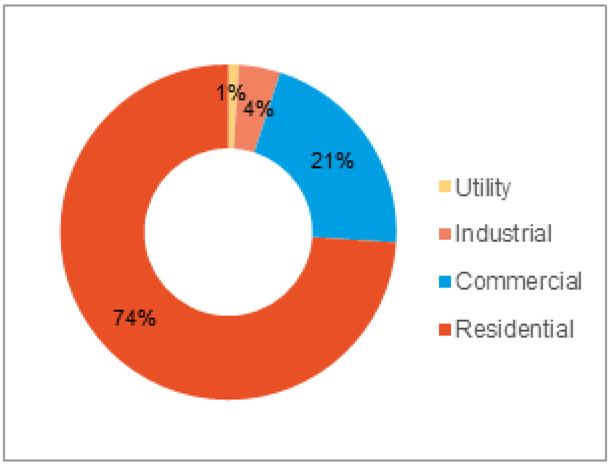
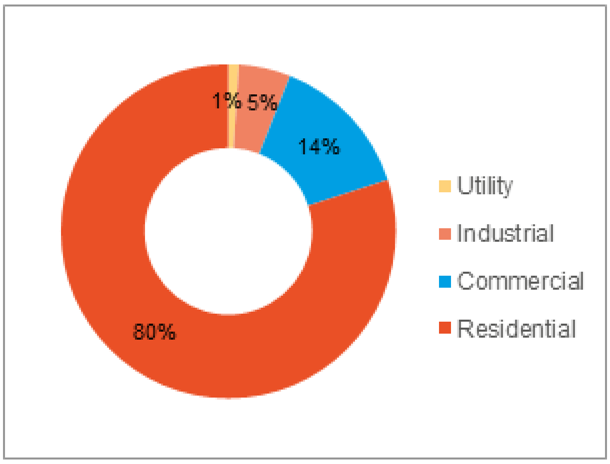


Figure 71: PV Capacity 2014 by Segment [1]



4.7.5. Electricity Market

Net electricity production in the Netherlands reached 96.2 TWh in 2014. The bulk of the 87.9% was produced by conventional energy sources. Total renewables reached a share of 12.1% with a marginal contribution of 0.1% from PV (figure 72). The NREAP target for PV of 0.77 GW in 2020 has already been exceeded in 2014.

The maximum instantaneous PV production in 2014 reached 0.65 GWp, which represents 7% of the minimum national load profile (figure 73).

Figure 72: Net Electricity Production 2014 in the Netherlands: 96.2 TWh [7], [20]

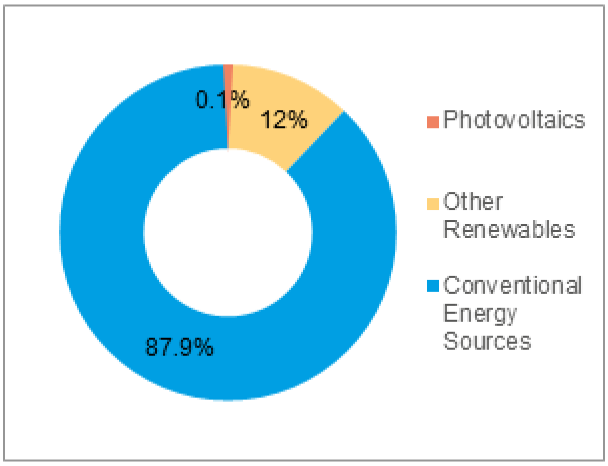
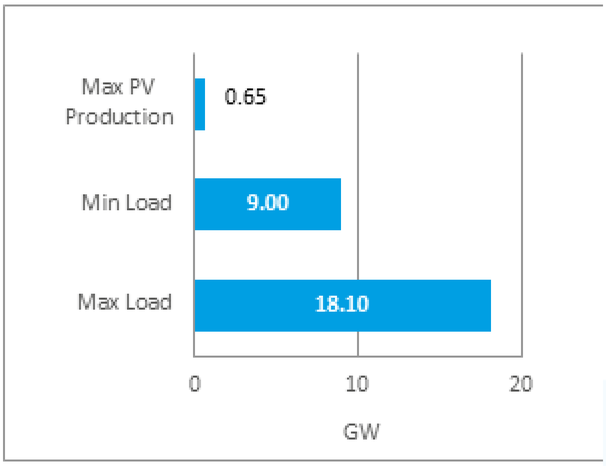


Figure 73: PV Maximum Production vs. Load Profile in the Netherlands 2014 [12]



Retail electricity prices are on a relatively low level. They reached 18.21 EUR ct/KWh and can be broken down in 43% production 30% distribution and 27% taxes and levies (figure 74).

The LCOE for utility scale PV systems ranges from 10.20 EUR ct/KWh to 10.61 EUR ct/kWh (figure 75). This is below retail electricity prices for household consumers and theoretically opens opportunities for new PV business models.

Figure 74: Composition of Electricity Retail Prices in the Netherlands 2014 [21]

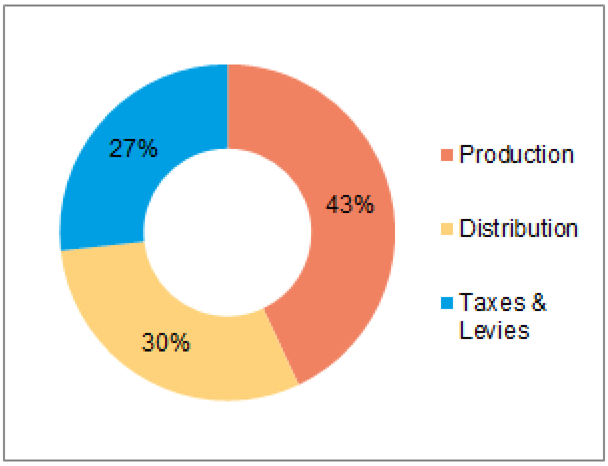
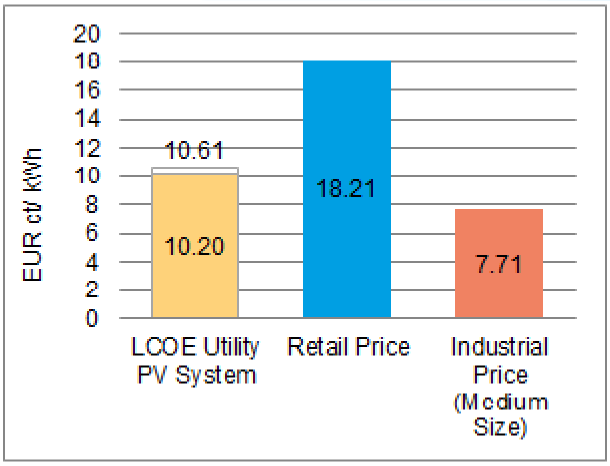


Figure 75: PV LCOE vs: Electricity Prices in the Netherlands [9], [10], [22]



4.7.6. PV Business Models

The main business model which has driven the market growth in the residential and commercial sector is net metering. The SDE+ scheme with its feed-in premiums is limited by volume and has only reached a low market penetration. Prosumers in the residential and commercial segments are exploring new business models trying to increase their self-consumption rate by the use of battery storage and electric vehicles or by tenant PV rental models. Some direct line and utility PPA projects are being piloted. Green electricity can be purchased from virtual power plants operators. However, the green electricity contains mostly power from wind and biomass (table 18).

Table 18: Business Model Roll-out in the Netherlands [68], [69]

	Residential *(0 - 10 kWp)*	**Commercial** *(10 - 250 kWp)*	**Industrial** *(>250 kWp)*	**Utility Ground Mounted** *(> 1000 kWp)*
Off-grid Self-consumption				
Feed-in Tariff				
Net Metering				
Self-consumption				
Direct Line PPA				
Utility/ DSO PPA				
Virtual Power Plant PPA				
Mini-grid PV Hybrid PPA				

Market Penetration	Low	High	Emerging

4.7.7. New PV Business Models

Several examples for new PV business models have become visible in the Dutch market (table 19).

Table 19: Selected Examples of New Business Models

Business Model	Description
Self-consumption	**4NewEnergy/Nijmegen [70])** - Residents of Nijmegen have the possibility to buy a minimum of three solar panels from a large PV system on the roof of a public building and can consume their share of PV electricity under a virtual net metering scheme
Self-consumption	**Nuon/Feenstra [71]** - Nuon and Feenstra have formed a marketing partnership. Nuon offers its customers to invest in PV systems with a 10 year guarantee. The systems can be operated under a net metering scheme with Nuon. Feenstra carries out the installation and maintenance of the PV systems
Self-consumption	**IKEA [72]** - offers in its store in Haarlem pre-configured PV kits of 1.5 and 2,5 kWp with thin-film modules from Hanergy. Prosumer can install their systems on their own roof and use the generated electricity for self-consumption
Self-consumption	**Smart Energy Collective [73]** is a cooperation of 14 companies for smart energy services. In a pilot project located in Hood Dalem 50 households will be equipped with PV and battery storage systems allowing the residents an enhanced degree of self-consumption
Utility PPA	**Delta Wind/Enerco/De Klepperstee [74]** - In 2012 an 840 kWp ground mounted PV park was commissioned in in Ouddorp an Zee. Delta Wind is the park owner and sells its energy under a PPA with SDE subsidies to Enerco. The nearby recreation park De Klepperste will buy approximately 75% of the PV energy in order to run its operations CO2-neutral
Virtual Power Plant	**Greenchoice [75]** offers a green electricity tariff, which contains mostly power from wind and biomass and a 1.1% fraction of PV power

5. Closing Remark

5.1. Conclusion

As a synthesis of the roll-out situation of new PV business models in the seven country snapshots we have developed a set of ten conclusions. These can serve as basis for the discussion between policy makers, financial market actors, PV plant owners, component manufacturers and energy prosumers on how to jointly develop these new business models and their required framework conditions in order to successfully integrate PV into the existing power markets. The overaging objective is to facilitate the transition from conventional to renewable energy sources, and to meet new targets on greenhouse gas emissions.

1. ***National PV installation targets should be corrected upwards reflecting the significantly enhanced cost competitiveness of PV.***
   At the G7 summit in Elmau in June 2015 the participating countries have committed to a reduction of greenhouse gas emissions between 40-70% till 2050. In light of this commitment the NREAP targets for 2020, which were submitted in June 2010, appear retrospectively rather conservative. All seven countries except Spain have already exceeded their NREAP targets for PV in 2020.

2. ***Reliable political framework conditions are needed to ensure future investor support for PV installations.***
   Abrupt and frequent changes of existing support schemes or retroactive cuts have significantly reduced investor's confidence in some of the national PV markets.

3. ***Policy makers should closely monitor the development of national PV markets to avoid short term over- or under-compensation.***
   "Bubble and bust" cycles as seen in the past should be avoided. The PV industry needs more reliable business and employment framework conditions in order to take a leading role in the transition to energy efficient and smart buildings.

4. ***Development of new business models for PV investment takes longer than expected and will require continued political support beyond the period of financial support.***
   Compared to FiT- or net metering-schemes new business models tend to be more complex. Usually a wider range of stakeholders is involved with updated roles and responsibilities. The technical configuration of the PV system has to be expanded and aligned with existing infrastructure. The existing order of electricity market needs to be transformed to accommodate the side by side generation of conventional and renewable power, which will eventually be backed by a smart grid solution. Furthermore, business models that support the decentralized nature of PV and empower the consumer to take a more active role as prosumer should be further explored and valorized. Open issues regarding the tax and legal framework resulting from new business models have to be clarified. A considerable amount of time and effort is required to develop new business models from conception over pilot implementation towards successful scale-up.

5. ***In many national markets self-consumption is on the brink to economic viability [70].*** In most European countries "partial socket parity" for residential prosumers based on a self-consumption rate of 100% has been reached. Reaching full socket parity with a more realistic self-consumption rate of 30-60% will require continuous support in the sense of net metering or FiT for the surplus of electricity which has to be exported to the grid or changes in the grid tariff structure. This becomes important for the commercial sector where direct self-consumption rates above 70% can be achieved. On-site generation will enable the new service offerings by the retailers and will steer the development of more flexible solutions e.g. storage, smart-metering etc. adding value.

6. ***Rapid decline of storage battery prices will stimulate growth of self-consumption.*** Hybrid systems of PV with battery storage in combination with demand side management and parallel adjustment of consumer behavior allow for self-consumption rates above 60%. Market experts predict a rapid price decline for battery systems based on an experience curve driven by the demand from the automotive and PV industry.

7. ***Prosumers need a clear and transparent regulatory framework.*** New business models for prosumers need clear and transparent regulations for grid connectivity, the feed-in of excess electricity, price of feed-in electricity, use of battery storage. For small PV systems under the threshold of 30 kWp administrative requirements should be minimized.

8. ***Tenants should be granted the same rights for self-consumption as PV system owners.*** In many countries the right for self-consumption is legally restricted to PV system owners only. This prevents building owners to invest in energy efficient building concepts with PV systems sharing the benefits with their tenants.

9. ***Pros and cons of pilot tenders for large scale utility PV power plants should be thoroughly evaluated before further roll-out.*** From 2017 tenders are required by the Energy and Environment State Aid Guidelines of the European Commission to grant support to all new PV installations above 1 MW. The success of new business models on the basis of utility and DSO PPAs will depend on the lessons learnt from national pilot tenders. Potential pitfalls like under-fulfillment of political targets, exclusion of renewable energy co-operatives from the bidder group, high administrative tender cost and sunk cost for unsuccessful bidders etc. should be avoided.

10. ***The development of virtual power plants should be supported to pioneer the so-called smart solutions enhancing market integration and energy efficiency.*** Virtual power plants offer the opportunity to cluster surplus power even from smaller PV systems and to balance the power across other renewable energy generation plants and storage systems. In many cases they offer dedicated green electricity tariffs, which take advantage of the decentralized nature of PV power and its public acceptance in the region.

5.2. Next Steps

In the further course of the Solar Bankability project technical risks will be summarized in a risk matrix and associated risk priority numbers will be developed. The risk priority numbers will subsequently be converted in cost priority numbers. These parameters will be used as input for a financial modelling analysis.

The selection of business models should allow for the best analysis and simulation of technical risks. Rather than choosing a portfolio of new emerging business models we decided to focus on existing business models with different technical system configurations which allow to highlight individual system specific technical risk scenarios.

Thus, an unnecessary overlap with the project "PV Financing" can be avoided, which will look more in detail at new business models and their financing conditions, and which is also co-funded by the European Commission.

For the financial modelling within the Solar Bankability project we have selected four business models

1) Model 1: Residential rooftop PV system with crystalline modules located in central Europe (base case),
2) Model 2: Residential rooftop PV system with crystalline modules and battery storage located in central Europe,
3) Model 3: Utility scale ground mounted PV system with crystalline modules located in central Europe,
4) Model 4: Utility scale ground mounted PV system with CdTe modules located in southern Europe.

In order to access the financial sensivity of each model specific stress scenarios will be defined and subsequently simulated in a financial modelling. The outcomes will be used to develop risk mitigation measures and to summarize them in a best practice guide in support of the overall objective:

The Solar Bankability project aims at establishing a common practice for professional risk assessment which will serve to reduce the risks associated with investments in PV projects.

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