REPORT ON SOCIO-ECONOMIC IMPACTS OF PVP CONCEPTS

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REPORT ON SOCIO-ECONOMIC IMPACTS

About PVProsumers4Grid

Europe´s electricity sector is in the midst of major transformation moving from public monopolies into competitive private companies in liberalized markets. The liberalization of the market is expected to deliver more competitive and therefore more efficient and cheaper energy. Due to its cost and growth perspective, photovoltaics (PV) will be a key driver of this development throughout Europe because PV has reached a level of competitiveness that allows moving to self-consumption schemes in many European countries and eventually to peer-to-peer selling of the self-produced energy.

Such a “prosumption” role empowers consumers to participate actively in the electricity market by producing energy themselves. Technical developments such as battery systems or smart meters, and advanced business models promoting self-consumption change the technical design of the electricity systems. The success of these developments depends, however, on the regulatory and administrative framework in terms of energy policy and regulation, grid financing, taxation and legal relationships amongst the involved entities and it requires innovative solutions coupled with suitable business and management models to achieve sustainable system integration.

PV-Prosumers4Grid (PVP4Grid) is an EU-funded project coordinated by BSW-Solar, involving 11 partners from various European countries[1] and running from October 2017 until March 2020. The main objectives of PVP4Grid are to increase the market share and market value of PV by enabling consumers to become PV prosumers in a system-friendly manner, as well as a better power system integration of PV with a focus on market integration. New management and business models to combine PV, storage, flexible demand and other technologies into a commercially viable product, will be assessed, improved, implemented and evaluated.

To achieve this, detailed guidelines for Prosumers and Distributed System Operators (DSO´s), as well as policy recommendations for national and European policy makers on how to achieve the suitable regulatory framework for prosumption, will be developed. Additionally, an online tool to help prosumers to get an economic assessment of PV prosumer projects will be created, among other relevant outcomes.

Please visit www.pvp4grid.eu to learn more about the PVP4Grid project, incl. the outcomes, tools & events.

[1] See project partners and project outcomes on the website: www.pvp4grid.eu.

1 Executive Summary

Renewable energies are the key component of Europe's energy future. The Energiewende is addressed in each of the PVP4Grid countries and has led to new legislation, framework programs and projects. In all eight countries of the PVP4Grid project, photovoltaics plays a key role. However, since the efforts undertaken so far have often not been sufficient to achieve various climate targets, this report focuses on collecting arguments for photovoltaics beyond the ecological perspective. By describing and analyzing socio-economic effects, the resulting macroeconomic benefit of PV prosumers can be quantified. Using the Excel based "Socio-Economic Impact Model" (SEIM) developed by eclareon GmbH, scientifically established methods are applied to analyze employment figures and the annual creation of value encompassing net salaries, company profits, tax revenues and social security contributions of the PV-industries in the individual PVP4Grid countries. The study examines the period between 2019 and 2030, as the objectives of the "National energy and climate plans" (NECPs, published on European level) are to be achieved in this timeframe. The basis of the calculations is a market outlook in each country, which was developed in cooperation with the PVP4Grid consortium. The results show the potential share of PV systems that will be used for prosumption in comparison to the overall PV market.

Under the current and planned political and technical framework conditions, an increased expansion of photovoltaics can be expected in all eight countries. It is predicted that between the beginning of 2019 and the end of 2030 more than 230 GW of PV systems will go operational across all eight countries, of which more than 125 GW are attributable to prosumers. These installations result in a cumulative capacity of around 324 GW in the eight countries (end of 2030) - 165 GW of which are based on self-consumption. During the study period, the number of annual installations is forecasted to grow steadily. How many people are employed in each country on the basis of these installations depends on the individual PV value chain structure of each country. The direct and indirect jobs (counted in full time equivalents, FTE) that are created based on adding one MW of PV can vary from 7 FTE/MW (e.g. in the Netherlands) to over 15 FTE/MW (e.g. in Austria) per country. Based on the input data provided, the SEIM tool estimates that the total number of employees in the entire PV industry will increase from approx. 75.500 FTE (2019) to 346.000 FTE (2030) due to the increasing number of annual installations. In 2030, more than 210.000 of these FTE are based on the demand for self-consumption. The largest number of employees will be in Germany with up to 110.000 FTE in 2030 (with predicted 8,4 GW installations in 2030), of which up to

60.800 FTE (2030) will be based on self-consumption business models. In the eight countries, a total value creation of more than 175 billion EUR is generated in the observed period. EUR 107 billion of this total is generated by demand from prosumers (61 %). The monetary value creation ranges from EUR 501.000 /MW (Spain) to EUR 880.000 /MW (Belgium). The largest share of monetary value creation is based on net salaries paid, which account for around 50 % to 60 % of the total value creation, depending on the country. Again, Germany has the largest share in value creation with over EUR 70 billion in total over the twelve years of the study period. If the annual installations are calculated in relation to the size of the population, the picture changes: Portugal has installed the largest relative amount of PV systems in the 12 years between 2019 and 2030, namely about 1,37 MW/10.000 people and per year. Germany is fourth with 0,74 MW/10.000 people and per year- after the Netherlands with 1,09 MW/10.000 people and per year and Austria with 1,01 MW/10.000 people and per year. When looking at prosumer PV plants only, the Netherlands install the largest amount of PV with 0,89 MW/10.000 people and per year.

The SEIM analysis shows that PV self-consumption leads to more FTE/MW and EUR/MW than the status quo does - in each PVP4Grid country. This is due to the strength of self-consumption concepts in the residential and commercial segments. In these segments, mainly rooftop systems are installed, which are more labor-intensive per MW than ground-mounted systems. In addition, smaller PV systems are more labor-intensive per MW in production and in the downstream part of the value chain, compared to large industrial/utility-scale systems (Waele et al. 2017). Supporting the PVP4Grid concepts at the political level is therefore considered to be beneficial from a socio-economic perspective.

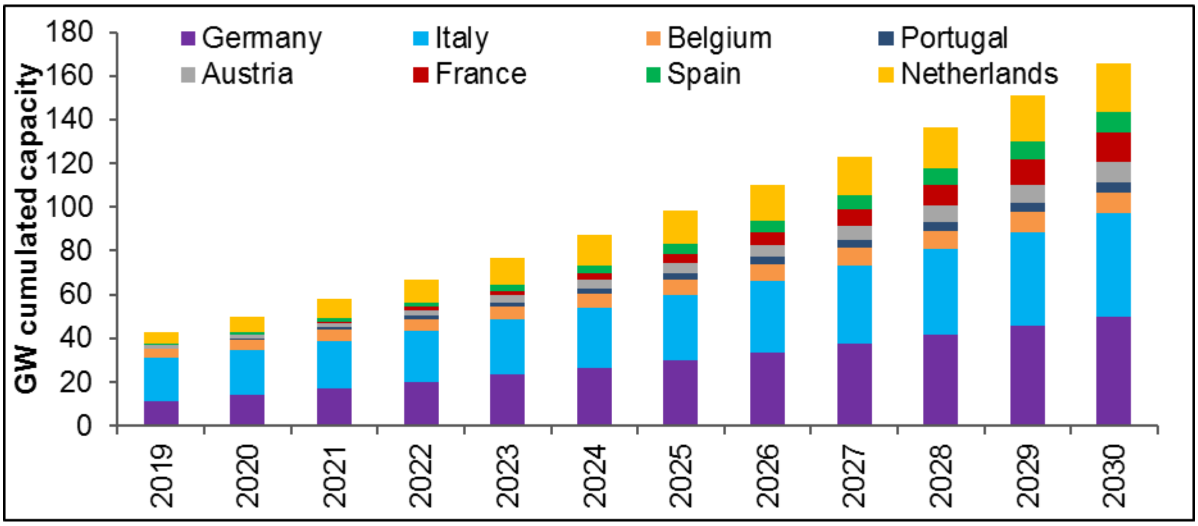

Figure 1.1: Cumulated capacity of self-consumption PV in the PVP4Grid countries

2 Introduction

2.1 Global Market

In November 2018, the investment bank Lazard published a study on electricity production costs including the Levelized Cost of Electricity (LCOE) of various forms of electricity generation. In this report, which is also used in the current Global Market Outlook by SolarPower Europe, the comparatively rapid development of electricity generation using PV over the past ten years is discussed (Lazard 2018, p. 7; Schmela et al. 2019, p. 8): After the global PV LCOE averaged 350 USD/MWh in 2009, the average LCOE in 2018 had decreased to 43 USD/MWh which has been only 1 USD/MWh more than the LCOE of wind power. In the period from 2009 to 2018, the share of PV in total global electricity generating capacity has increased from 0.1% to 2.2% (Schmela et al. 2019, S. 8). This development is likely to continue: in 2018, 102,4 GW of PV were newly installed, which is more than any other generation technology: coal, wind and gas followed with 46 - 50 GW each. Accordingly, 36% of the total newly installed electricity generating capacity can be attributed to PV. Following this trend, in 2025 more cumulative PV capacity will be installed than wind power, in 2030 more than hydropower and in 2040 PV capacity may even surpass coal power (International Energy Agency 2018, p. 25). Both institutions, the IEA and SolarPower Europe, predict a massive growth in annual PV installations not only on a global scale but for the eight PVP4Grid countries as well. However, the development of these national markets may vary because of differences with regards to market segmentation, active business models, national policies or other main drivers for the market. Therefore, this report has developed its own market outlook for both, the development of PV across all segments (also called general PV market) and for the share of self-consumption PV.

Table **1** shows the segmentation of the national PV markets used in this report.

Table 1: Segmentation of PV- markets

Residential-Segment	mainly rooftop
Commercial-Segment	mainly rooftop
Industrial-Segment	mainly ground-mounted

2.2 PV Prosumer

This PVP4Grid report is focused on comparing socio-economic impacts of the prosumer-market to those observed in the general PV-market. The report follows the definition of a prosumer in the “Renewable Energy Directive” (European Commission; Lettner et al. 2018). According to this directive, the market must be differentiated based on different business models used: Prosumers (or self-consumption (SC) PV) use the generated electricity to meet their own demand. This is opposed to systems that feed the generated electricity into the grid (Lettner et al. 2018). The PVP4Grid project has defined which business-models can be associated with self-consumption. The current political and technological situation of the different concepts in each of the PVP4Grid countries has been assessed in earlier PVP4Grid reports under the headline “Report on PVP4Grid concepts and barriers”.[2] The three different concepts are:

- Concept 1: Direct single use
- Concept 2: Local collective use
- Concept 3: District level energy models

In these reports, it becomes evident that the amount of SC-PV in each country varies a lot both on the macro level of general business models and on the micro level of the different SC-concepts. Especially on the macro level each country needs to be evaluated individually with a focus on current policies and the question, how future policies might affect the segmentation. On the micro level the PVP4Grid project states a loose segmentation based on different system sizes. Self-consuming PV systems with a capacity below 10 kWp are allocated to concept one, systems between 10 kWp and 100 kWp to concept two and systems over 500 kWp to concept three. PV systems with a capacity between 100 kWp and 500 kWp are a combination of local collective use and district level energy models. Based on discussions with national experts it became clear, that this segmentation is a simplification to describe a European average. The national segmentations usually deviate from this basic concept. In the end, national legislation like the EEG in Germany or the plans that are stated in the national NECPs will determine which business model or concept becomes the main driver for self-consumption PV.

[2] Published on the PVP4Grid homepage: https://www.pvp4grid.eu/pv-prosumer-concepts/

3 Methodology of Socio-Economic Impact Modelling (SEIM)

There are no “one size fits all” -rules for the calculation and evaluation of socio- economic impacts, but there is a framework of different methodologies that can be used for this type of study. Fundamentally, the consideration of socio-economic effects is based on the integration of the two processes "social assessment" and "economic assessment". Even if the observed effects and the applied methods differ in detail between the two processes, both resort to the same fundamental approach based on the following steps:(Social Sciences Program Australia 2005, pp. 5-6; Taylor et al. 1995, pp. 84-92):

1) Scoping
2) Profiling
3) Elaboration of alternatives
4) Projection and assessment of effects
5) Monitoring, limiting and management
6) Evaluation

For the assessment of the socio-economic impacts in the context of the PVP4Grid- project the steps “Elaboration of alternatives” and “Monitoring, limiting and management” were not undertaken for the following reason: As this study carries out an assessment of the effects of a future timeframe encompassing the whole PV-industry, the value of a “no action- scenario” is zero. The step “Monitoring, limiting and management” could only be realized by a future monitoring of the socio-economic effects, which is not foreseen in the PVP4Grid-project. In the process of “scoping” the boundaries for the assessment have been set taking into account the timeframe and the financial resources of the PVP4Grid project as well as the experience eclareon gathered from earlier projects. Figure 3.1 shows the different segments that compose socio-economic impacts.

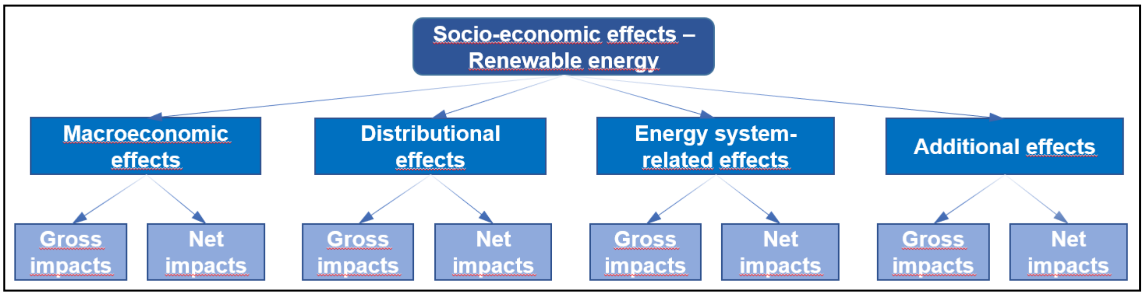

Figure 3.1: Components of the socio-economic analysis, depicted according to IRENA and the BMU (Wallasch et al. 2014, p. 10; van Mark 2010, p. 4)

This report focusses on gross macroeconomic impacts, who are the core of describing socio-economic impacts Every other segment is taking them into account and further examines aspects like the regional distribution of the macroeconomic impacts. Other comparable studies, for instance Wallasch for IRENA, Waele for SolarPower Europe or Hrischl for the IÖW use the same approach. To assess net impacts a very labor-intensive Input-Output-Modell would be needed, which is not compatible with the scope and resources of the present study. Therefore, the socio-economic impact model used for this report is aiming to describe gross macroeconomic impacts. Macroeconomic impacts include effects on labor and on the monetarily evaluated value creation (Wallasch et al. 2014; Mühlenhoff 2010). The effects on the labor market are calculated in "Full Time Equivalents" (FTE) over one year along the PV-value chain.

For the evaluation of the effects on the labor market, the method of the employment-factor approach was used. Defined by several studies (Meyer and Sommer 2014, Wallasch et al. 2014, Wainman et al. 2010) as the most appropriate method for reports like the one at hand, this approach can describe direct and indirect job creation of a segmented industry. Direct job creation describes the changes on the labor market directly inside the analyzed value chain, indirect effects describe changes in industries that are not part of the value chain but act as suppliers and service providers to this value chain. Indirect labor encompasses services such as transport, extraction of aluminum, cable manufacturing etcetera. Induced job creation, evolving from the growing or shrinking purchasing power in the analyzed society due to direct or indirect employment effects is not evaluated in this report.

The SEIM method of this report analyzes the value chain and allocates employment-factors to each branch of the PV-industry. Prior to the modelling itself these factors are calculated for each country on the data basis of the "Solar PV Jobs & Value Added in Europe" report by Waele that was published by SolarPower Europe and Ernst & Young (Waele et al. 2017). In addition, this report specifies in which parts the value chain is to be divided. The segments can be seen in Figure 3.2.

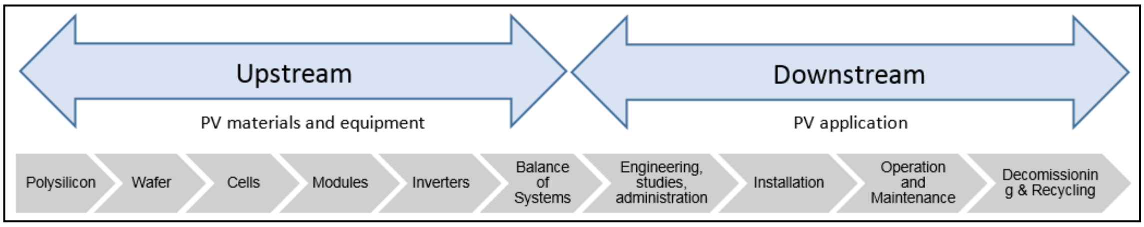

Figure 3.2: PV-value-chain (Waele et al. 2017)

The monetary value creation is calculated with the “income approach” (Wallasch et al. 2014; Wainman et al. 2010). Based on this approach the different components shown in Figure 3.3 of the value creation are calculated separately and, in the end, summed up to form a primary key-indicator.

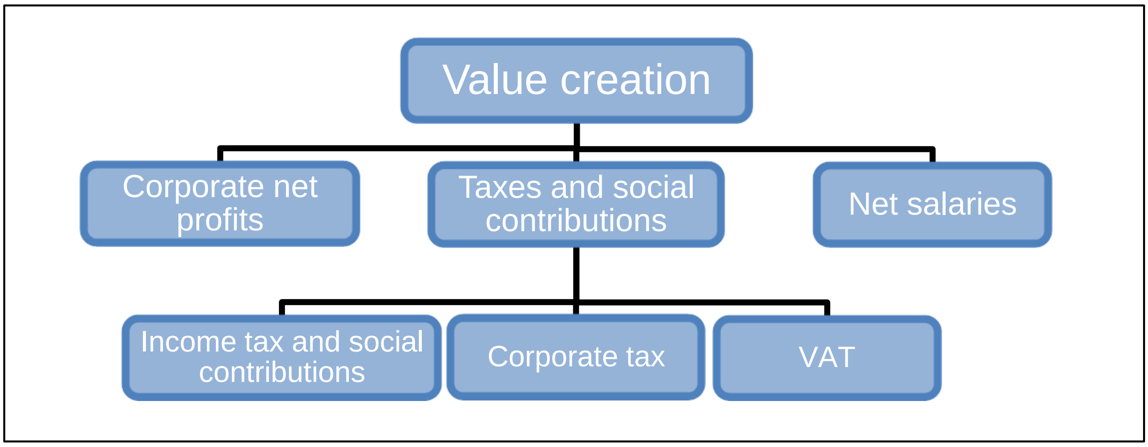

Figure 3.3: Components of the monetary value creation (Wallasch et al. 2014, Hirschl et al. 2010)

Based on the income-approach, which was used by the IÖW to evaluate socio- economic impacts as well, the target of the SEIM used in this report is to calculate different taxes, social contributions, corporate profits and net salaries related to yearly installations and cumulated PV capacities. On this macroeconomic level the potential savings resulting from the operation of a PV-system, gathered by the owner, are not considered, solely the perspective of the PV-industry is described. As forecasts are subject to uncertainties and divergences, even more so the further they are in the future, a scenario analysis was included in the report. It shows a best-case and a worst-case scenario, which are based on the different forecasts of the market development. The models aimed at providing a maximum of transparency, plausibility and reperformance to allow the project partners to understand, evaluate and use the results of this study. How these methods have been transformed into a calculation tool is described in chapters 3.1 and 3.2

3.1 Employment-factor analysis

Ernst & Young have calculated how direct and indirect job creation is distributed along the PV-value chain (Waele et al. 2017). By relating the specific employment figures to the cumulative and the annually installed capacities, the employment factors, which are essential to the applied method, can be calculated. In addition, a few assumptions have to be made.

1) The allocation of the annually active PV jobs, to the annually installed systems and the PV cumulated active capacity at that time, describes the average job creation under these specific market conditions Therefore, each MW of PV capacity is only counted for the respective year of commissioning, even if a plant was commissioned in January, while the upstream workload was realized in the previous calendar year.
2) The O&M part of the value chain creates labor during the entire lifetime a PV system. Therefore, the amount of jobs in this segment are based on cumulated capacities.
3) Labor in other parts of the value chain depends on the annual installations of PV. Hence, if there were no PV installations in a specific year, only the segment O&M would be active.
4) The part “Decommissioning and Recycling” (D&R) only creates labor at the end of the lifespan of a PV system (approx. 25-30 years). 25 years ago, there have been only 37 MW of PV capacity distributed between the entire European Union. Therefore, the D&R segment was not taken into account for the calculation of the socio-economic effects in this report.

After calculating the employment factors, the annual number of PV jobs can be calculated with O&M related jobs based on cumulative capacity in the respective year. Using this method not only the total PV value chain can be analyzed, but also a job creation in the single value chain elements can be described as well. Two more methodological aspects are still to be mentioned.

1) The segments of installations, O&M and D&R are more labor-intensive for rooftop PV than they are for ground-mounted PV. Accordingly, a correction factor for installations and O&M is being applied, +15 % for rooftop PV and -15 % for ground-mounted PV.
2) The assessment aims to describe macroeconomic effects until 2030. When describing complex systems over an extensive time period several uncertainties emerge. If possible, the future evolution of the industry must be included in the assessment. Ernst & Young and SolarPower Europe have evaluated the structures of the 2021 national PV-industries, which they think are the most likely. Building on their assessment the used factors are interpolated. In addition, a general increase of effectiveness is assumed with a factor of 2 % each year. This value is a conservative evaluation, this value can be up to 3,3 % high indicated by the consultancy Strategy&.

3.2 Value creation

In addition to employment, the second evaluated macroeconomic dimension is the monetary value creation, based on new PV installations in general and the subset of self-consumption PV systems. The SEIM- tool calculates the value creation as the sum of the following components:

- Net profits of involved companies (private net profits)
- Net wages of involved employees (private net salaries)
- Paid taxes to state or municipalities (public value creation)

For a general assessment and to allow for a comparative view between countries also the sum of the values is shown. This allows a view on the global socio-economic impact of the prosumer’s activities.

3.2.1 Public value creation

The financial profit for the public entities is composed by three components (Mühlenhoff 2010):

- VAT
- Social security contribution and income tax, paid by the employees
- Business taxes, paid by companies

The German Ministry for Finances publishes every year a report to show the German tax rates in an international context (German Federal Ministry of Finance 2018). To form a comparable data base, this report is used in the calculation of the public value creation for all eight participating countries. VAT on sales and installations of PV- systems must be paid by the end costumer. It is added to the net price and is calculated based on the turnover in the residential sector:

VAT total = VAT rate x turnover residential

Turnovers in the tool are calculated based on the market outlooks. To calculate turnovers based on these outlooks, each PV-segment is divided into five different, representative PV-system sizes and their specific prices in €/kW (including installation). Since the paid VAT in the commercial and industrial sectors is later deducted from the text burden by the companies, there is no value created by VAT in these market segments. For this reason, the contribution of VAT in the commercial and industrial sector is not included in the calculation of the public value creation. In the publication of the German Ministry of Finances the social security contributions are listed together with the income tax. They are separated in the following three segments:

- Single household, no children, medium salary
- Couple, two children, one income, medium salary
- Couple, two children, one income + 33% of a second income, medium salary

With this input data, the SEIM model calculates a medium contribution for income taxes and social contributions. The third part of the public value creation emerges from corporate taxes and is calculated on base of the earnings before interest and taxes (EBIT). As already described for the calculation of income taxes, the tax rates are taken from the publication of the German Ministry of Finances. The results are calculated with the following formula:

Corporate tax total = corporate tax rate x EBIT

The EBIT is calculated based on turnovers of the PV-industry and return on sales, RoS, the respective formula is shown below. The research of RoS rates, that are common in the PV-Industry, shows significant differences between different information sources and over time. For example, the economic report of the “HSE Solarpark Thüringen” (Balance sheet, income statement and key figures of HSE Solarpark Thüringen GmbH & Co. KG) shows a turnover profitability of 11% for 2013, 8,6% for 2014 and 22% for 2015. For the calculation in the SEIM a simplified RoS of 8 % was used.

Return on Sales = EBIT / turnover

As there are different types of business taxes in each country as well as differences between the EU- member states, the report of the Ministry merges those taxes into a combined tax rate (BMF 2018). The global public value creation is calculated as:

Public value creation = VAT total + Income tax/Social Contribution + Business Tax

3.2.2 Corporate net profits

The net profit of the involved economic players is called private net profits and is added to the value creation of the society. Using the RoS and the calculated turnovers, the gross profit EBIT can be calculated. To get the result for the net profit this value must be reduced by corporate taxes. EBIT also includes the interest on the debt capital, but as these interests must be the gross profit of a third party, they are included as part of the net profit and are not deducted from the EBIT (Wöhe et al. 2016). As a result, the calculation of the net profit is described in the formula below:

Net profit = EBIT – (tax rate x EBIT)

3.2.3 Net salaries

The third part of the assessment of value creation by PV self-consumption is the income of employees. This part of the value creation emerges from net salaries payed to the employees of the PV-industry (direct labor) or to employees in companies that supply the PV industry (indirect labor). The number of employees is identical to the calculated number of employees from chapter 3.1. In order to assess net salaries from many employees with different salary, the national PV-industries was modeled in a first step. The involved companies were classified by the number of employees based on the assumption that companies of different size exist and that employees are paid differently depending on the type of company they work for. All jobs were then allocated to executives, salaried employees, unskilled labor and apprentices. To each employment relationship and company size an average salary is assigned. The calculated FTEs are distributed to the different brackets and multiplied by the specific average salary. The result is the amount of gross salaries payed by the PV-industry and based on PV-installations and cumulated capacities (O&M). To calculate the net income, the gross value is reduced by income taxes. In order to be able to better compare results between countries, minor special taxes like church tax and solidarity contribution (in Germany) are not included in this calculation. To sum up the value creation, all three parts are summed up, to form a general indicator for value creation. By dividing the overall PV market into the general PV and the self-consumption PV market the employment and the monetary value that is created by self-consumption can be compared to the status quo.

3.3 Integration of national partners

To gather the necessary data several different data sources have been used. Openly available data in reports such as the “Global Market Outlook 2019-2023” were taken into consideration as well as the databases eurostats and EurObserv’ER and the national energy and climate plans. Macroeconomic key parameters have been researched in sources that offer a comparable data base for each assessed country (e.g. “Die wichtigsten Steuern im internationalen Vergleich 2018” by the German Federal Ministry of Finance). Yet the core of the data research has been the collection of primary information from the different national partners involved in the project. The primary data was collected with the help of a detailed questionnaire (159 questions) and by conducting several interviews based on the answers preliminary given in the questionnaires. Table 2 shows to whom the questionnaires were sent. The questions are available in Annex 1

Table 2: National partners and for which country they received a questionnaire

Belgium	Becquerel Institute – Intelligence & Research on Solar Photovoltaics & Energy Transition
Germany	BSW - German Solar Association
France	Becquerel Institute – Intelligence & Research on Solar Photovoltaics & Energy Transition
Italy	Ambienteitalia – Research, expert advice and planning for sustainability
Netherlands	Copernicus Institute of Sustainable Development – University Utrecht
Austria	TU Vienna, Institute of Energy Systems and Electrical Drives, Energy Economics Group
Portugal	APESF - Associação Portuguêsa de Empresas do Sector Fotovoltaico.
Spain	UNEF - Unión Española Fotovoltaica

Finally, to confirm plausibility of the collected data, it is compared to publications of Fraunhofer Institute for Solar Energy Systems ISE, SolarPower Europe, EuObserver`ER, Eurostats and the National Energy and Climate Plans (Wirth 2019; Schmela et al. 2018).

3.4 SEIM-editor

The prevision of a market development is always difficult and can only be as realistic as the prevision of the political, administrative and economic environment. Besides the experience of the participating experts and the proven capacity in elaboration of market scenarios, it is mainly the NEPCs that give a reliable base for the assessment of the next ten years. As the NECPs are official targets of the EU and progresses will be checked in regular frequency, the quantitative targets of these plans are expected to be executed during this period. To be able to consider other developments, the SEIM tool allows for an easy adaption of the input values. On the worksheet “Results” the user can find the “Manual Scenario Editor” where he can change the settings for the following values:

1) Annual market size
2) Return of sales
3) VAT
4) Salary increases per year
5) Income tax
6) Corporate tax

With this tool the assessment cannot only be changed to verify the development when conditions in the PV- market change, but it can also be adapted to the real development in the near future.

4 Austria

4.1 PV overview

The recent development of the energy sector in Austria is evaluated to be negative in terms of the implementation of Renewable Energies – at least until now. Despite having the highest share of renewables in energy (electricity, heat, fuel) total energy consumption, compared to the other evaluated countries, the value of 33 % stagnated since 2013. In electricity consumption Austria has traditionally an even higher share of renewables (72,2 % in 2017) (Eurostat database[3]). Austria is able to reach these high values by using the geographically favourable conditions for hydro power in the Alpes with having 61 % of this technology included in their electricity production (E-Control BDEW 2018).[4] Therefore, the current application of renewable energies in Austria can be seen as positive, but due to the low pressure to act, the political situation for photovoltaics must be viewed critically.

The recently inaugurated government with the participation of the green party (operational since January 2020) faces huge expectations. Recently, Austria had to increase energy imports significantly as the total energy consumption has increased. The value of imported energy (mainly fossil sources) from January to July 2019 with 6,2 Billion Euros is 8 % higher than in the same period in 2018 (all numbers ee-news/ Austria Statistik). However, not only fossil fuels are imported but also electricity, which led to the payment of 540 Mio. EUR to the neighbouring economies (2018, IG Windkraft). The current electricity supply is dominated by hydro power, which contributes about 76,5 % to the national renewable electricity supply, followed by wind with 11,7 %. PV only produces 2,7 % of the renewable electricity in Austria (2018, Statistik Austria).

Due to the political crisis in 2019 which led to general elections, many plans and developments were blocked and certainly will be revised once the new government will be in office, even the NECP is expected to be updated. The new government, which includes the green party, is expected to revise the legal framework of the energy sector. Additionally, the Clean Energy for all Europeans Package is about to be implemented on a national level. The financial and technical environment can be considered as stable and positive, and under these

[3] Eurostat, Share of energy from renewable sources: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_ind_ren&lang=en

[4] https://oesterreichsenergie.at/stromerzeugung-231.html

circumstances a more ambitious renewable energy policy might have a huge impact. Also, the mentioned high dependency on energy imports could be a motivation to increase national electricity production – which necessarily will have to be predominantly renewable to achieve the targets defined by the European Community. The latest news from 06.01.2020 (ee-news) already show the significant changes in the new government`s energy strategy: An ambitious climate protection program was announced with the target to turn Austria CO_2 neutral by 2040. To achieve this goal, a new ministry for climate will be created. Latest surveys show that this strategy is backed by a large majority of the Austrian population. More than 2/3 of the people are in favor of more ambitious climate politics (EEÖ).

While it is not clear what the impact of the political support will be on renewables, other framework conditions work in favour of renewables – and especially of PV – in Austria. In general, the grid infrastructure is sufficient to enable the integration of several GW of new PV at reasonable costs for grid reinforcement. Also, the bureaucratic procedure to install PV is not considered to be a major problem, even though the situation cannot be evaluated to be simple in general. Legally, electricity supply in Austria falls under the regional competence of the regions ("Bundesländer") and thus the administrative procedures for renewable generators differ from one region to the next. This fact also can be seen in the commercial structure of the electricity business. Each of the nine regions historically had their own monopoly electricity company who still dominate as energy suppliers and distribution system operators the market.

The PV support scheme is based on a feed-in-tariffs (FiT), and investment support. The access to the FiT is rather complicated and depends on the individual self-consumption rate. Self-consumption is not very attractive due to low electricity prices, particularly in the commercial sector. A positive aspect is the implementation of the second PVP4Grid concept, meaning a collective self-consumption, which was legally enabled by the 2017 amendment of the ElWOG (Electricity Industry and Organization Act). However, the model faces significant barriers such as the necessity that 100 % of the owners of a building on which PV shall be installed need to approve the installation.

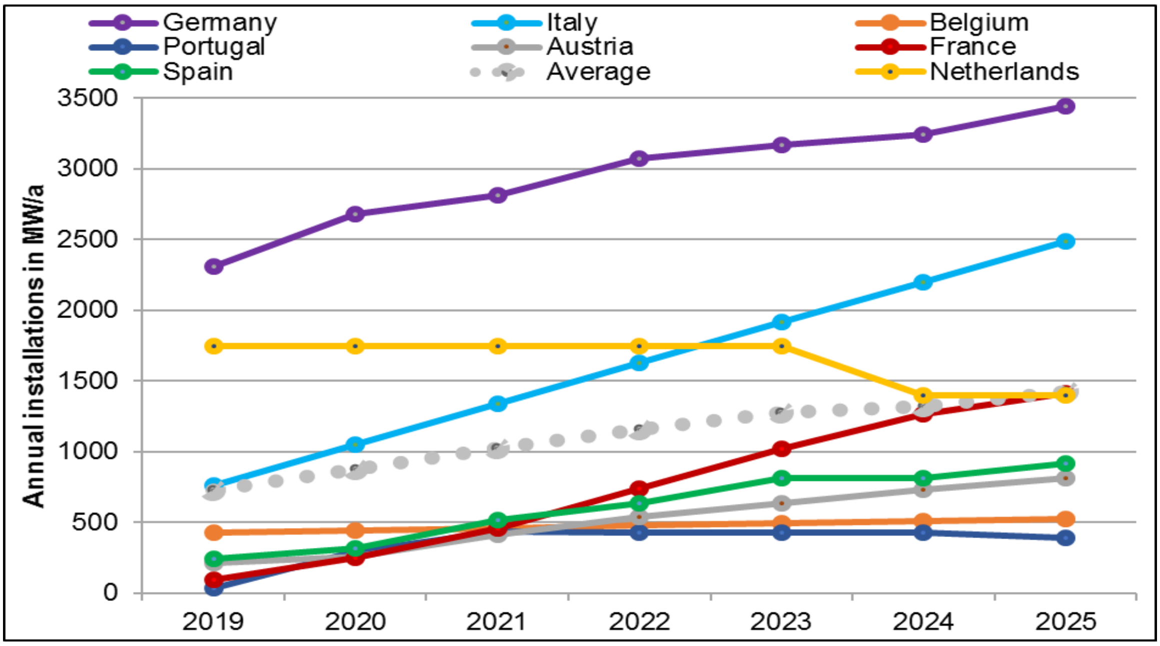

Figure 4.1: The Austrian (grey) development is expected to reach a medium position in our ranking

4.2 Input Financial Values

To calculate the development of the Austrian prosumer market, the following input data was used. The system costs are in a range between around 700 EUR/kWp for large utility-scale ground mounted systems and 1.567 EUR/kWp for residential rooftop PV installations. The tax rates are in line with other participating countries that show the same economic environment. The corporate tax rate is at 25 % and the average income tax at 23,8 %, the VAT rate is at 20 %.

4.3 PV market

At first, the general outlook for the PV market in Austria will be presented. Afterwards the prosumer market is calculated by evaluating the share that self-consumption has in each segment of the overall PV market. The three concepts of prosumption, that were identified and described by the PVP4Grid project (see chapter 2.2), are examined together and differentiated at the end of the SEIM-simulation. The market outlook has been developed with the help of the Austrian national partner, the Energy Economics Group of the TU Vienna, of the PVP4Grid project.

4.3.1 General PV-outlook

The evaluation of the forecasted market development must consider the special political situation described above. The new government with an environmental party, is expected to push the Austrian energy strategy towards renewables. Therefore, a growth in the national PV industry, especially starting 2021 when potential new political frameworks for PV are becoming active, can be expected. The annual installations of PV in general are going to start at 250 MW in 2019 and are predicted to reach 1,1 GW in 2025. The PV market is expected to grow annually until 1,25 GW are reached and is then expected to remain stable on this level. This outlook leads to a cumulated PV capacity of 6,1 GW by the end of 2025 and to 12,4 GW by 2030 (PV Austria 2019[5]). The segmentation of the annual installations is depicted in Figure 4.2. In comparison to the other evaluated countries, Austria has a small industrial segment in 2019 – which is in line with the assessment of the SolarPower Europe's General Market Outlook (GMO) – and is mainly driven by residential and commercial systems. However, the expected development of new policies as well as political and technical guidelines will create new business models in the Austrian market, not only for utility-scale PV systems but for self-consumption installations as well. These new business models are also important reasons, why the significance of the industrial PV segment in Austria is predicted to grow. With this prediction, Austria might reach a well-balanced PV market by 2025, that does not depend on one single segment or business model.

[5] 2,5 GW below the 2018 outlook of the Federal Association Photovoltaic Austria

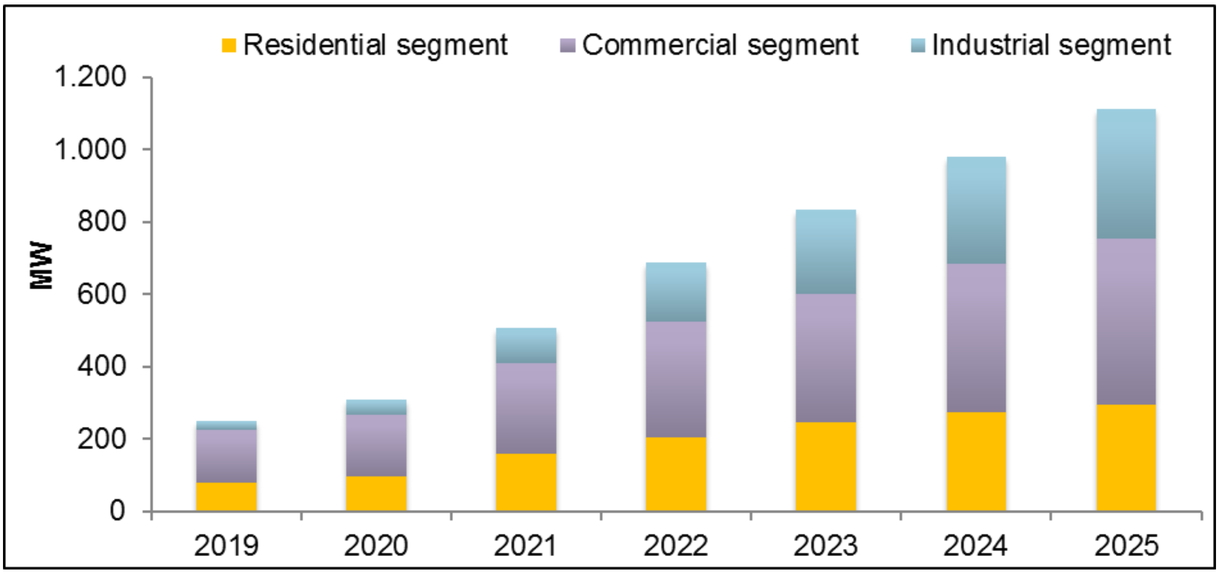

Figure 4.2: Segmentation of the annual installation, Austria

In the residential and commercial segment, self-consumption is the main driver for future installations. 99 % of residential PV-systems are going to be installed with the opportunity to self-consume the generated electricity, in commercial systems this percentage is estimated to be 90 % (Figure 4.3). Figure 4.4 shows the industrial segment, which will, as soon as the new business models of this segment will be functional, are expected to have a 30 % share of PV-self-consumption systems.

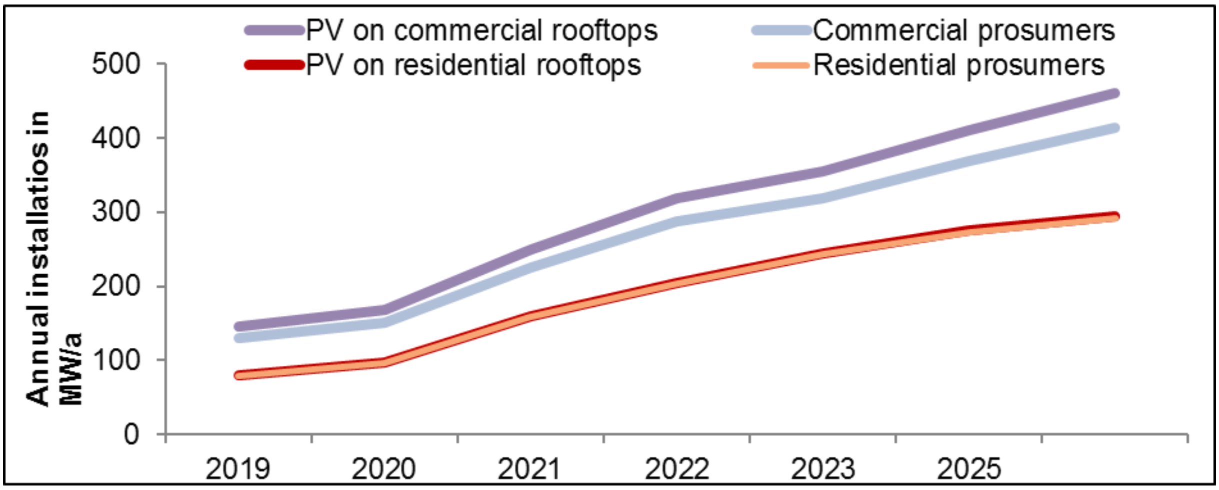

Figure 4.3: Share of self-consumption in the residential and commercial segment, Austria

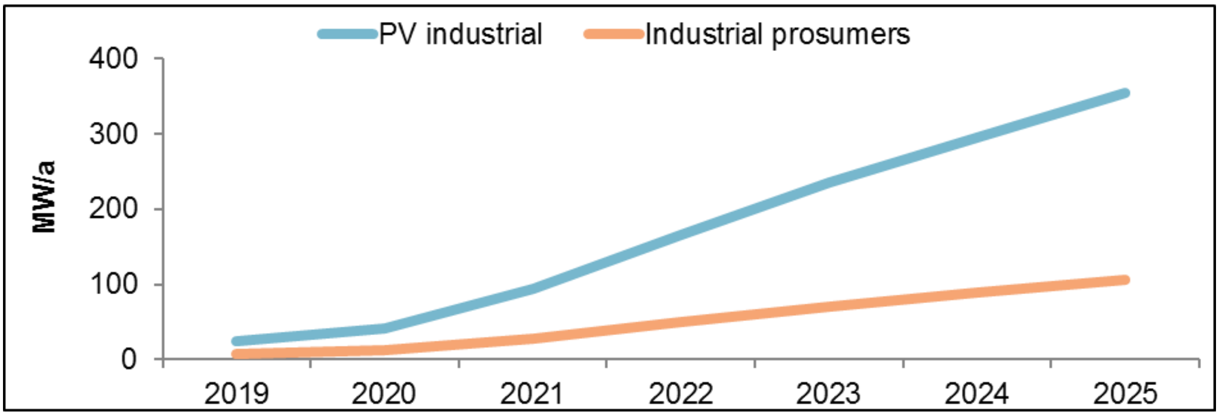

Figure 4.4: The industrial self-consumption is expected to be at 30 % of future installations, Austria

The share of all self-consuming concepts and the entire PV market in Austria is shown in Figure 4.5. It shows three concepts: Self-consumption (concept 1), local collective use (concept 2) and district level energy models (concept 3). By 2025, 4,7 GW of the cumulated 6,1 GW PV-systems are forecasted to be operated as self-consumption, which corresponds to a relative share of 76 %. The allocation of these systems between the three PVP4Grid concepts is depicted in Figure 4.6. Due to the lack of regulatory frameworks for concept three (district power model, status in 2019) and policies to enable concept two (local collective use) that have just recently been released (in 2017[6]), the main share of self-consumption PV will be operated as concept one (single direct use) installations. Given the new legislation, the new government and the development of PV-LCOE in general, it is expected, that the share of concept 2 will start to become more important already in 2020. The first district power mode PV-systems that are not test sites are expected to go operational in 2020. Since the future development of these concepts is depending on many factors, the shares of the 3 concepts used in the SEIM-tool are the most likely options according to the research done by the consultancy eclareon and the EEG of the TU Vienna. By 2025, it can be expected that 50% of the Prosumers will be using concept one, 30 % concept two and 20 % the third concept.

[6] (2017 amendment of the ElWOG - Elektrizitätswirtschafts-und organisationsgesetz)

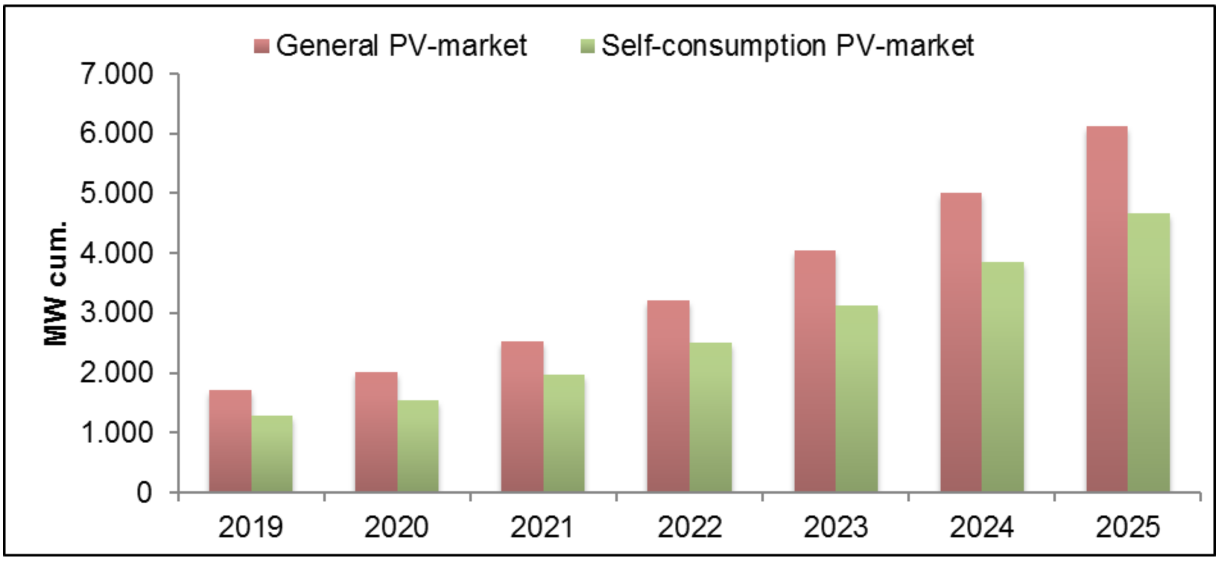

Figure 4.5: The ratio between prosumer and general PV market, Austria, SEIM calculation

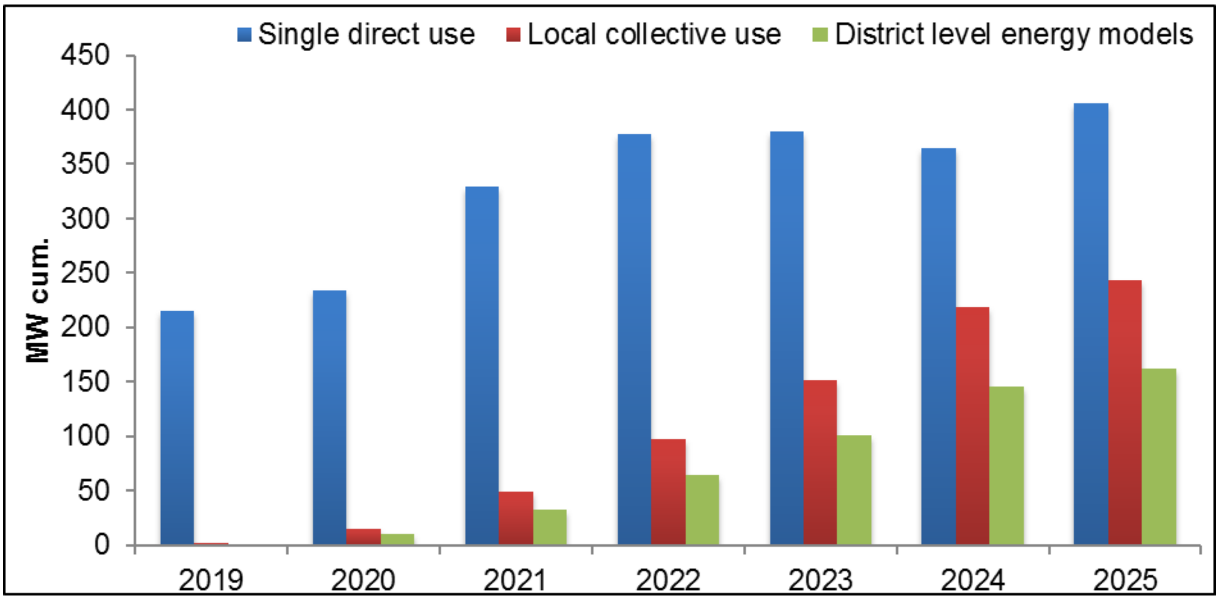

Figure 4.6: The expected segmentation of the new installed prosumer PV, Austria, SEIM calculation

4.4 PV-employment

The employment factors used to assess the job creation by PV installations in Austria are calculated based on the input provided by the Austrian national Partner of the PVP4Grid project, in addition, historical data on installations, cumulated capacities and employment were taken into account.[7] In line with the development of the PV market, the employment based on self-consumption PV installations is presented separately from the development of the overall, general PV market and the results until 2025 are presented in Figure 4.7 that shows the development of FTE of the overall market (general PV) and of the subsegment of self-consumption PV.

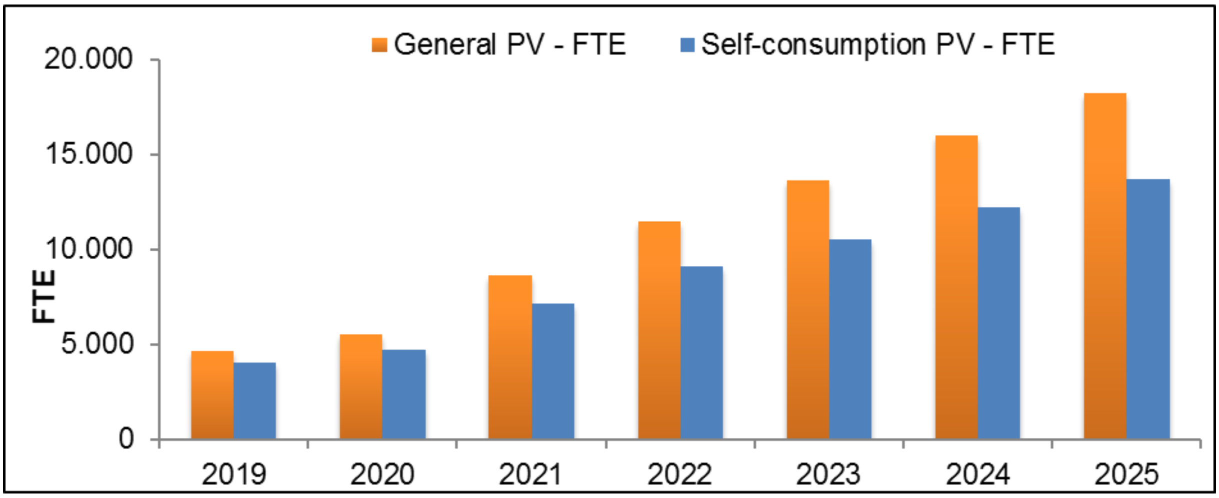

Figure 4.7: Employment based on general PV and on the self-consumption segment, Austria, SEIM calculation

The number of jobs counted as FTE in Austria in 2019, based on 250 MW of PV installations, is at 4.643 FTE. The gradient with which the labor market is growing is largely determined by the growth of the annual installations (Figure 4.2). Reaching 18.244 FTE by 2025, of which 75 % (13.700 FTE) are based on the demand for self-consumption PV. The allocation of the FTE to the active value-chain in Austria is presented in Figure 4.8. The importance of inverter production sticks out and distinguishes Austria from the other evaluated countries. The large number FTEs working in inverter production is mainly due to the Austrian production sites of Fronius, one of the most important inverter manufacturers in Europe. Only activities linked to the installation are deemed to create more direct and indirect workplaces.

[7] Eurostats, IEA-PVPS national survey reports, EurObserv'ER

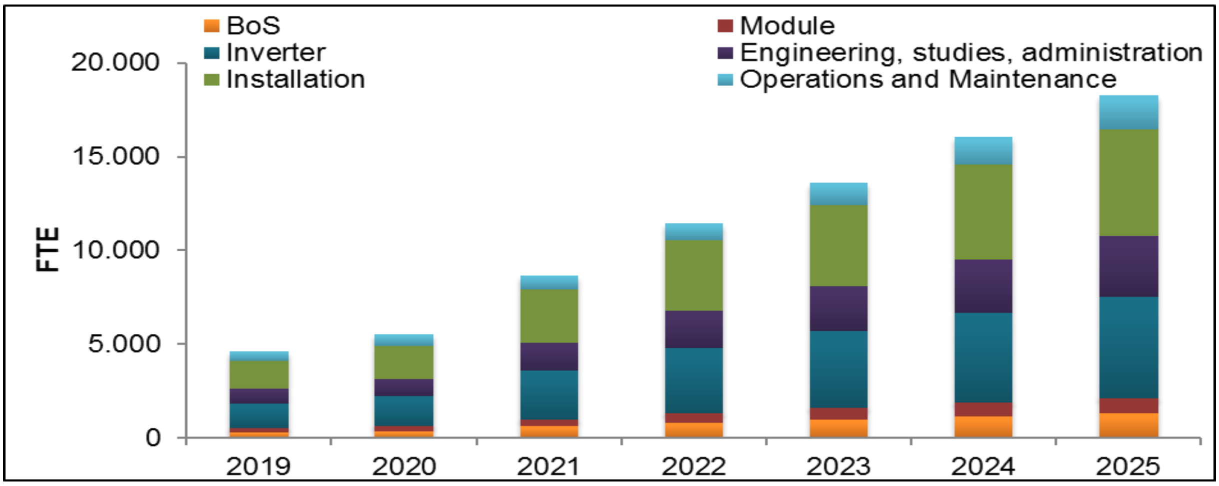

Figure 4.8: Distribution of FTE along the PV-value chain, Austria, SEIM calculation

60 % of the FTE are working in the downstream domains, which offer more job security than upstream domains due to having a lower risk of being outsourced in the future. By comparing the 40 % upstream jobs to the European average of 25 %, it becomes evident, that Austria is doing a good job with keeping parts of the value chain local and therefore localizing the value that is created, on the both levels (employment and monetary value creation) (Waele et.al. 2017).

Again, the FTE that are based on the demand for self-consumption PV can be allocated to the three PVP4Grid concepts. The structure is shown in Figure 4.9 and follows loosely the structure depicted in Figure 4.6.

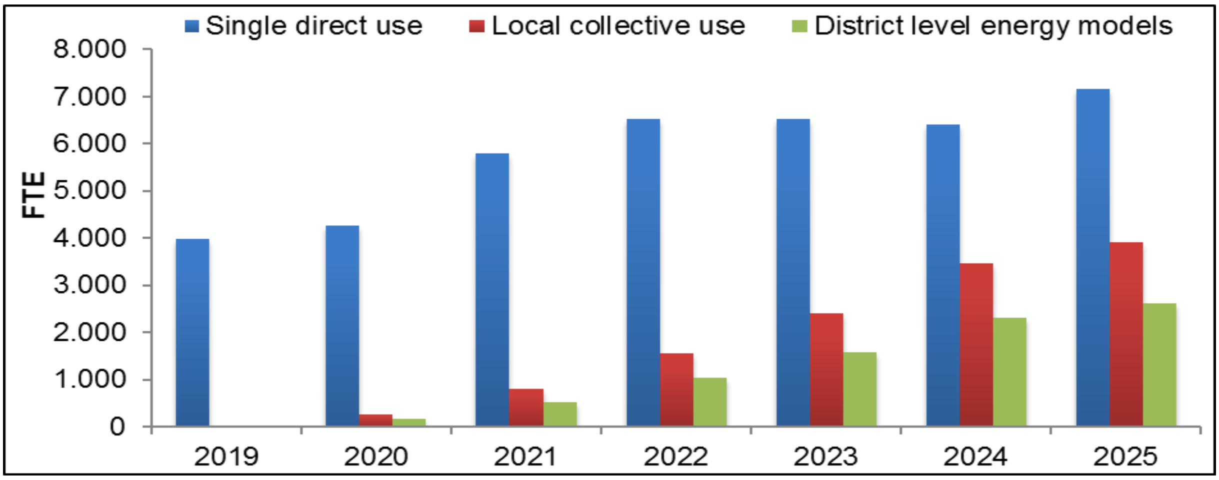

Figure 4.9: Employment based on the three evaluated self-consumption concepts, Austria, SEIM calculation

The key figures to describe the socio-economic impacts on the employment level start in 2019 at 16,4 FTE/MW in the year of construction and annual 0,3 FTE/MW over the lifetime of a system for cumulated capacities. These numbers decline with a growing share of less labor-intensive industrial PV and reach 14,8 FTE/MW by 2025. Self-consumption PV is responsible for 15,1 FTE/MW by 2025 (0,3 FTE/MW over the lifetime).

4.5 Value creation

In general, the annual value creation is determined by the annual installation. The sum of value creation based on the 2019 installations is around 222 million EUR/a (see Figure 4.10). In the following years it rises and reaches 882 million EUR/a by 2025. Looking only at the subset of self-consumption systems, the value creation starts at 195 million EUR/a and rises to 682 million EUR/a by 2025. This value creation can be divided into the three components “public value creation”, “net salaries” and “private net profits” (Figure 4.11). With around 62 %, the net salaries are responsible for the main share of value creation, followed by around 30 % based on taxes and social security contributions and around 8 % of corporate net profits.

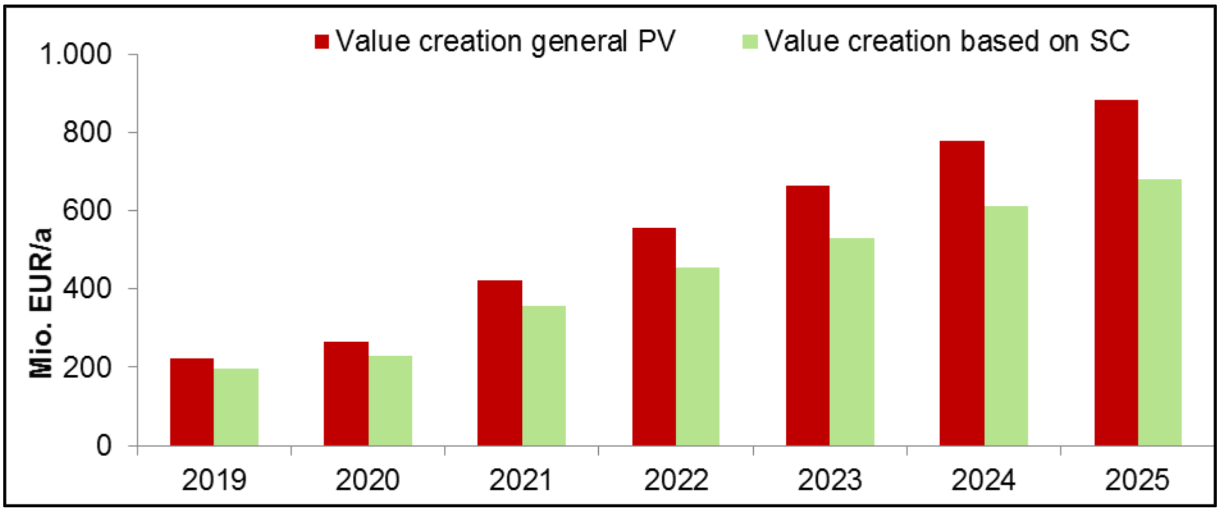

Figure 4.10: Annual value creation via PV in Austria, general PV vs. based on SC, SEIM calculation

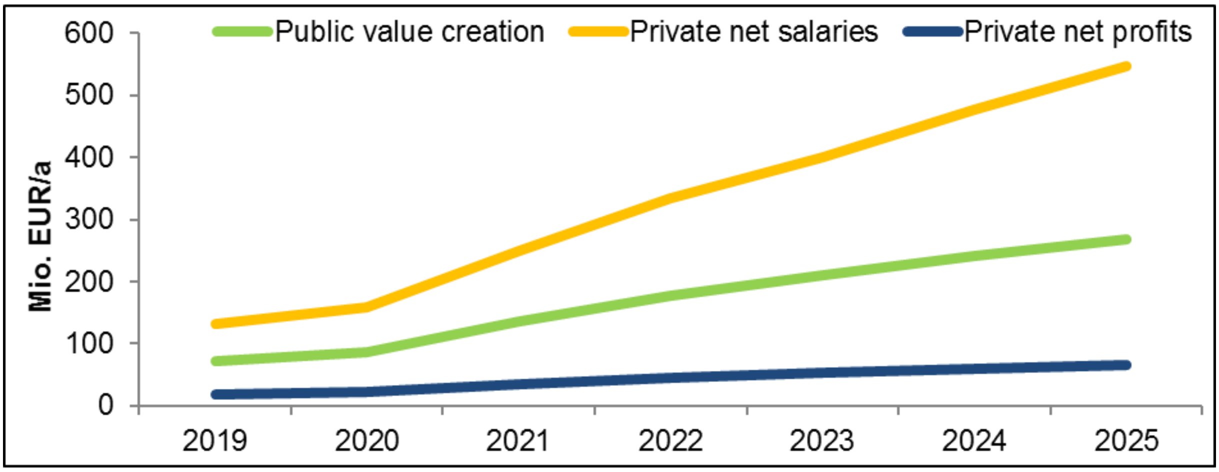

Figure 4.11: Structure of value creation in Austria, public vs. salaries vs. private profits, SEIM calculation

Based on the share of self-consumption PV in the overall PV market, the value that is created by the three different self-consumption-concepts can be seen in Figure 4.12. Analogous to Figure 4.9 the single direct use is the most important concept in Austria today and in the future, but the local collective use as well as district power models are expected to become more important in the future. The single direct use business model dominates because it was the first PVP4Grid concept that gained significance in the PV-industry in Austria. In terms of key figures to describe the value creation in Austria, around 740.000 EUR/MW are generated in the first year, 11.500 EUR/MW for cumulated capacities via O&M. Prosumer PV in Austria is responsible for around 780.000 EUR/MW (12.100 EUR/MW via O&M).

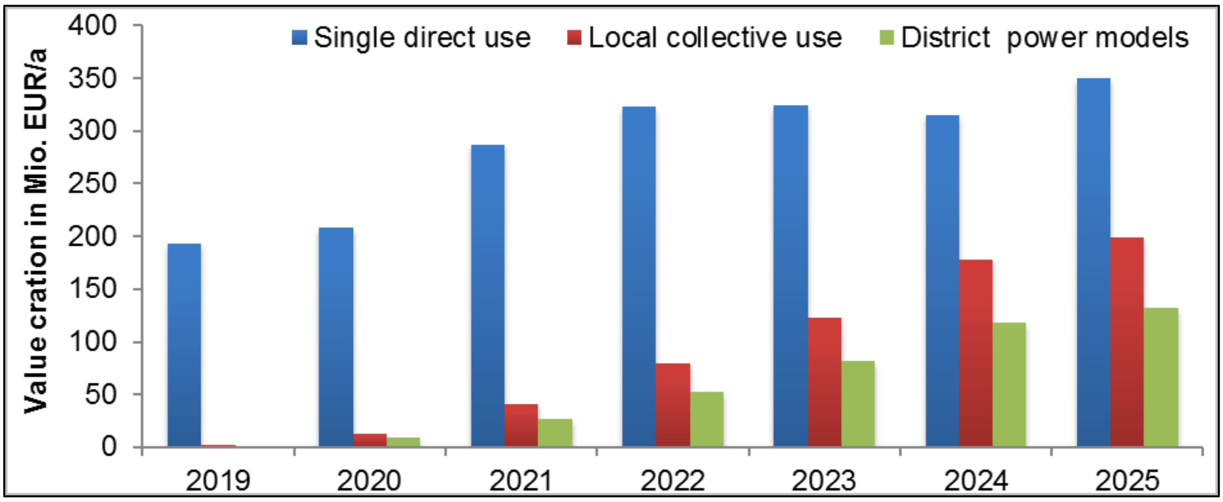

Figure 4.12: Value creation allocated to the three evaluated self-consumption concepts, Austria

4.6 Scenarios

As there are opportunities for PV in Austria to grow even faster, the gap between the base case scenario and the best-case scenario was estimated to reach 30 % of the annual installations. An argument supporting the best-case scenario is the new legal framework and a new government that is expected to push the development of renewables. These influences could lead to the establishment of new business models in the Austrian market. Their potential is difficult to predict, due to the lack of historical data on the PVP4Grid concepts two and three. The good infrastructural and technical conditions in Austria make an even stronger growth of annual installations possible. However, as said before, future technological developments and political support for PV may vary, which may have a strong influence on the development of the overall PV market as well. However, there are also risks that could hamper market growth: for example, the new government still needs to implement their plans, as mountainous country Austria is blessed with hydropower that decreases the urgency to grow other renewables, especially if they are deemed to be expensive for the society. For these reasons, the worse-case scenario foresees a growth of 30 % less than in the base case scenario. Figure 4.13 shows the development under all 3 scenarios until 2030. According to the best-case scenario Austria could reach a cumulated capacity > 15 GW by 2030.

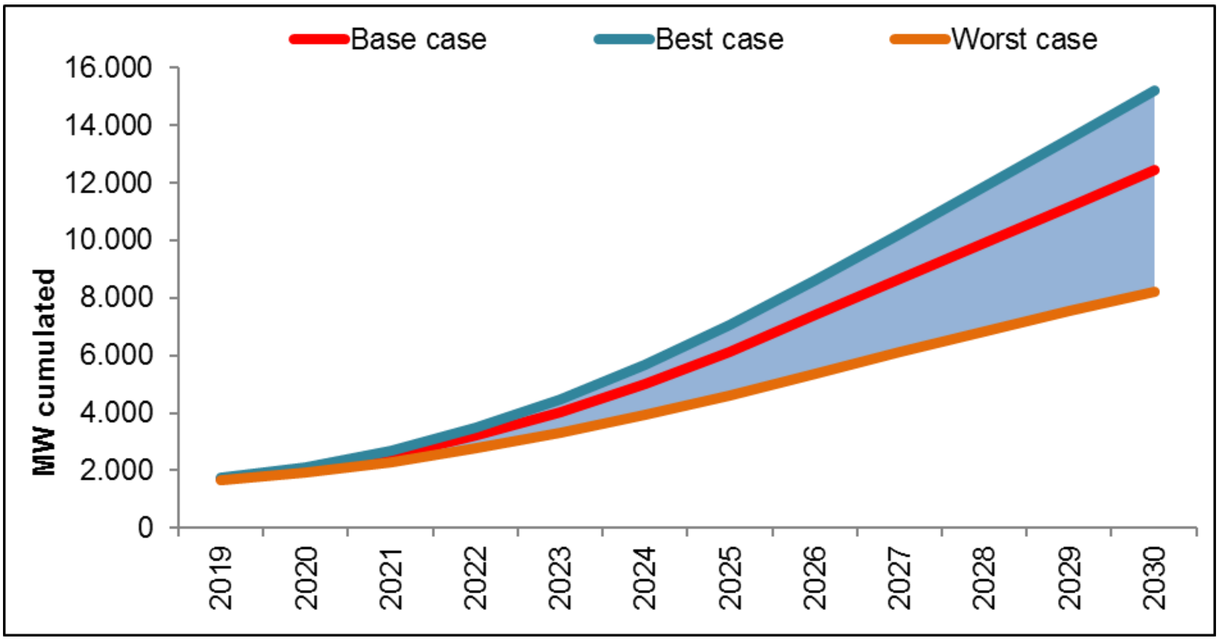

Figure 4.13: Austrian scenario, cumulated capacity until 2030

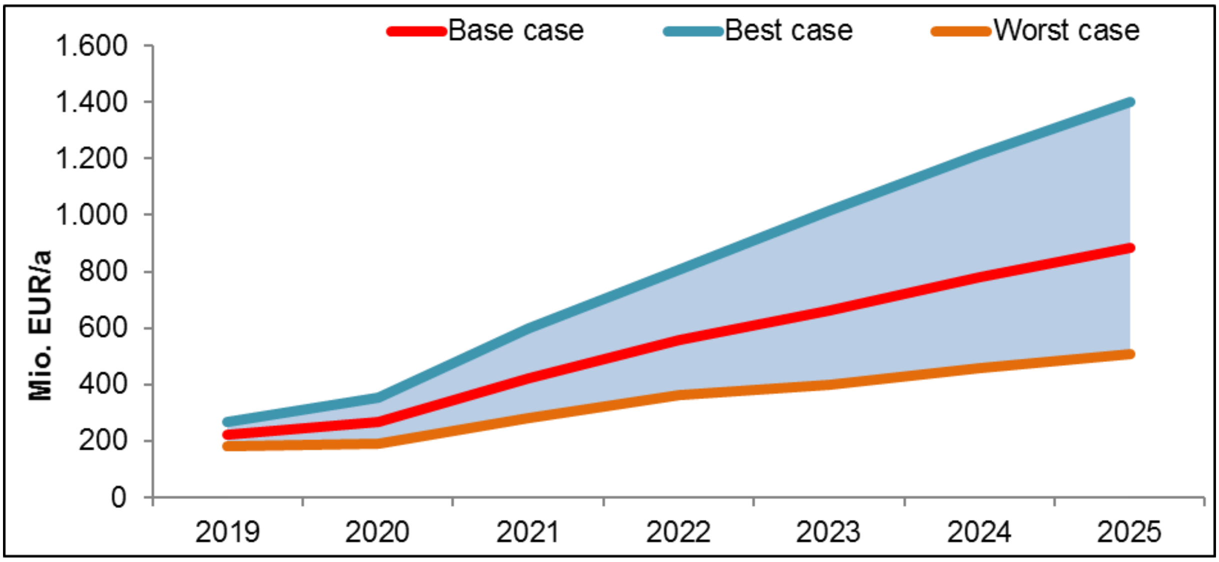

Figure 4.14: Austrian scenario, annual value creation until 2025

5 Belgium

5.1 PV overview

The Belgian prosumer market shows steady growth in the forecast developed for this report. Although it stays below the average of the eight participating countries, it must be taken into account that it is one of the smaller countries that in addition has the geographical disadvantage of being the second most northern country in the evaluation, which means that the solar irradiation is lower than in the Southern countries.

The political and technological framework as well as the forecast was discussed with the Becquerel Institute. There are some country specific aspects in the Belgium PV market which might also be of interest for the strategic direction of electricity market in other countries. The Belgian PV market is driven mainly by private self-consumption, due to the lack of any small-scale feed-in business model. Until now there are very few commercial or industrial installations. In addition, electricity prices for consumers are relatively high which has a positive impact on the profitability of self-consumption PV especially taking into account that annual net-metering is still allowed in Wallonia and Flanders. Another aspect is that the VAT is as low as 6 % for renewable energy systems in buildings older than 10 years, which also constitutes a favourable condition for PV growth in the residential sector.

The energy market shows a very high share of nuclear capacity (approx. 50%) and gas (20%). There is no coal fired power plant in Belgium since 2016 (International Energy Agency 2019). In the renewable sector there is little hydro power installed (approx. 100 MW) and the natural conditions of the country might not allow a higher share of this technology in the future. 3,8 GW of wind is already installed and Belgium is planning on the installation of up to 4 GW offshore wind until 2024 (energiefirmen.de; STATBEL; APERe[8]; BOP[9]).

The electricity market in Belgium is split between the 3 main regions who define their own strategies and market conditions. Flanders in the north, Wallonia in the south and in between there is Brussels. The regional governments define the political environment for renewable energies and also must agree on any national energy policy like the NECP. This coordination

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[8] http://apere.org/fr/observatoire-eolien

[9] http://www.belgianoffshoreplatform.be/en/news/offshore-wind-energy-in-the-belgian-part-of-the-north-sea-up-to-4000-mw-by-2024/

effort may have been a reason why the first draft of the Belgian NECP had rather low targets and faces many recommendations by the European Commission.[10] The Belgian electricity supply is well diversified and is distributed over more than 10 companies. The grid infrastructure is well developed and there are no barriers foreseen for the future implementation of renewable energies. Also, the administrative procedures are reasonable and do not hinder the further development. Even when the political situation with the 3 regions seems to be complicated at times, the Belgian PV market has shown a stable growth over the last years. Figure 5.1 presents the annual self-consumption PV installations in comparison to the other evaluated countries.

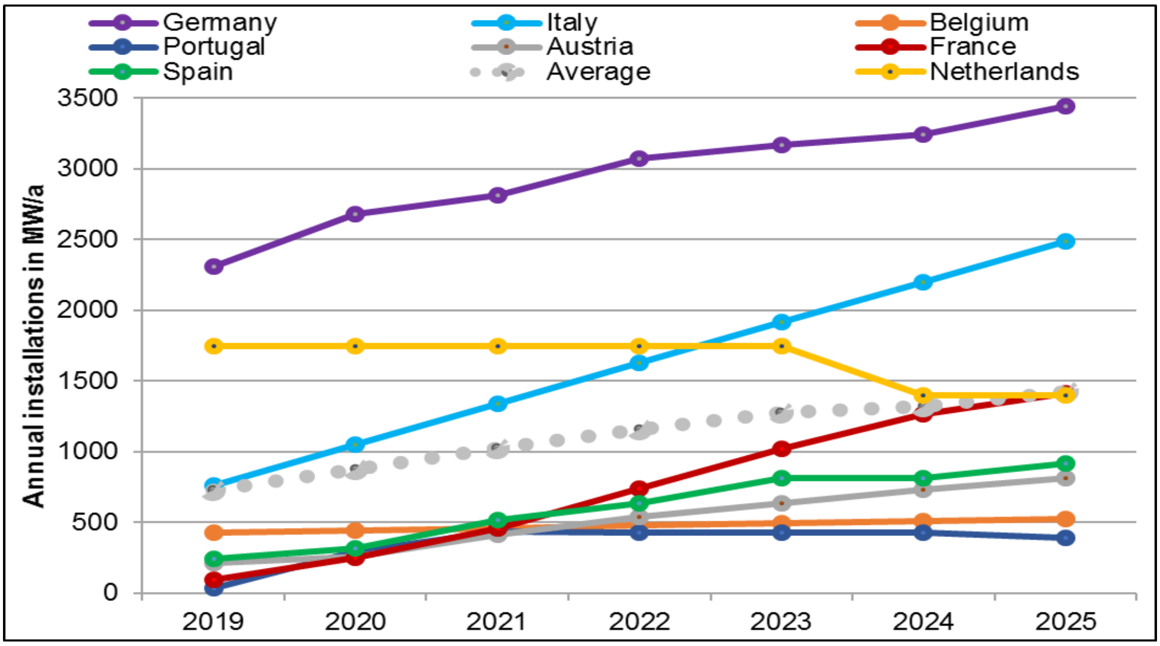

Figure 5.1: Annual Installations in Belgium (orange line) in the ranking of European neighbours, self-consumption PV

5.2 Input Financial Values

System costs in Belgium were found to have a range between 750 EUR/kWp for large scale ground mounted PV and 1500 EUR/kWp for residential systems. These values are much more balanced than in some other markets in Europe and are even on a low level. Nevertheless,

[10] 2019/C 297/01: Commission Recommendation of 18 June 2019 on the draft integrated National Energy and Climate Plan of Belgium covering the period 2021-2030

the Belgian salaries with an average of around 4.650 EUR/month in the PV industry are relatively high. The increase of salaries in the PV sector is considered as 1% per year over the study's timeframe.

The rates of income taxes and social contributions are in a medium range among the eight European countries with an averaged value of 27,6 %. With 29,58 % the corporate tax rates are the second highest in the ranking of the eight countries, only second to France, but will decrease to 25 % starting in 2021. VAT for renewable energy systems is defined on a low rate of 6 % for buildings older than 10 years, and 21 % for newer ones.

5.3 PV market

At first the general market outlook for Belgium will be presented. Afterwards the prosumer market is calculated by evaluating the share self-consumption has in each segment of the PV market. The three concepts of prosumption, that where identified and described by the PVP4Grid project, are examined together and differentiated at the end of the SEIM-simulation.

5.3.1 General PV-outlook

On one hand it seems to be particularly difficult to evaluate the opportunities and the future development of the Belgian PV market given the powerful role of the 3 main regions. As said before, the first draft of the Belgian NECP received an extensive list of recommendations by the European Commission: in fact, there are three regional NECPs listed, Wallonia, Flanders and Brussels, which have not yet agreed on a common future strategy. Hence, the national NECP is still being discussed.

On the other hand, the Belgian PV market has shown a very stable development during the last years and there are reasons for optimism: the industrial and commercial segments did not have the framework conditions needed to grow and there potential therefore remains untapped. Also, the administrative procedures for installing PV are reasonable and should not hinder growth. In addition, new business models like collective self-consumption are under development and could give new impulses to the prosumer segment. Even when the currently still existing annual net-metering scheme will be phased out (Brussel already stopped this business model, Flanders will follow soon, only Wallonia did not make a decision about their net-metering scheme), the conditions for private prosumers will most likely continue to be favourable. The low VAT rate for some renewable energy systems is one of the positive stimulators of this market, the high electricity prices in Belgium contribute to the profitability of self- consumption and the planned introduction of collective self-consumption business models even opens more opportunities. Under these aspects the prosumer segment should have a stable and growing business perspective.

Another factor favouring PV is the plan to phase out nuclear power capacity until 2025 – a rather short period to decommission a technology which still contributes approx. 50% to the Belgian electricity supply. As alternative there is a significant capacity in gas fired plants – but this technology is relatively expensive in terms of electricity production which is an advantage for the development of the renewable energy sector.

The SEIM model starts with a cumulated PV capacity of 3,9 GW at the end of 2018. PV-market is expected to install 459 MW in 2019. To meet 10 GW by 2030 the Belgian PV market needs to grow further. Figure 5.2 shows the expected PV installations for the general market with the identified segmentation of residential, commercial and industrial systems. It becomes evident, that the residential market is the main driver for PV in Belgium with around 75 % of the annual installations.

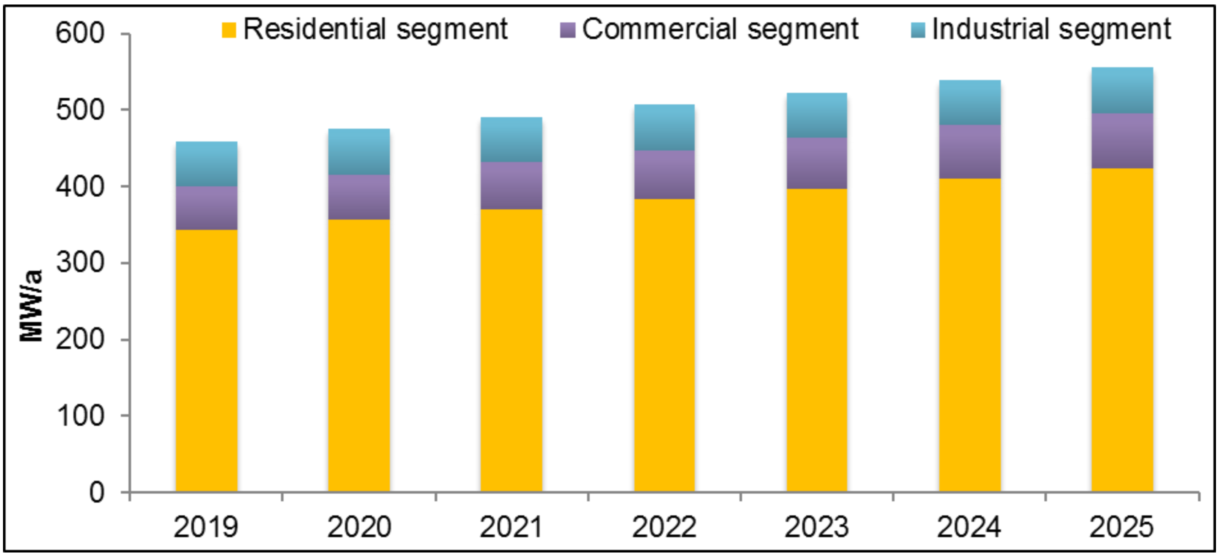

Figure 5.2: General PV outlook including the segmentation, Belgium

5.3.2 Outlook for self-consumption

The conditions for self-consumption in Belgium are good. All of the future installations in the residential or the commercial segment are considered to be self-consumption, which can be seen in Figure 5.3. With self-consumption being the only viable business model for PV, the graphs are congruent. For industrial PV the situation is different: Based on discussions with the Becquerel Institute a share of 50 % for self-consumption PV in the industrial segment was deemed to be fair and is shown in Figure 5.4.

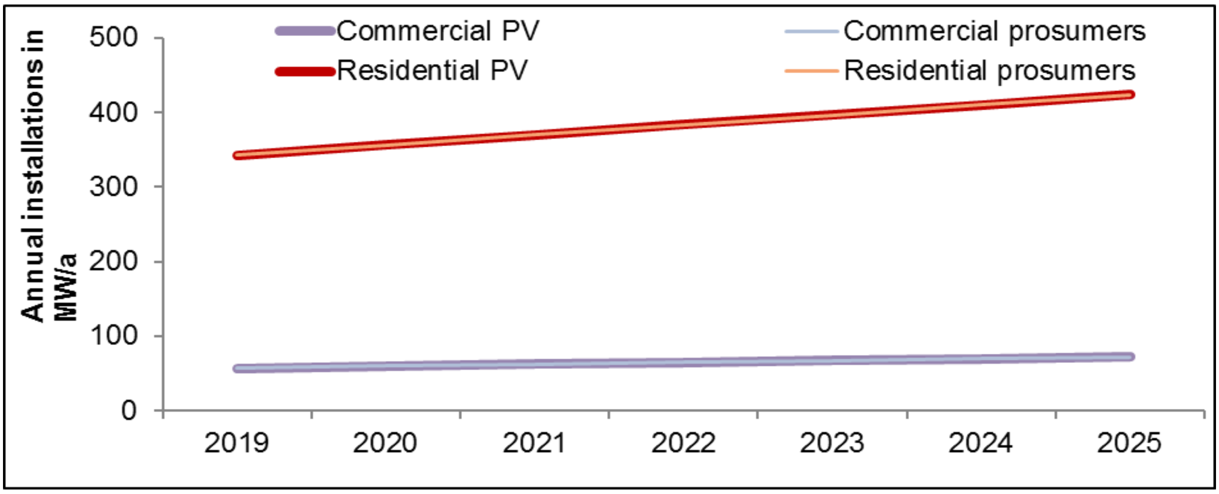

Figure 5.3: Annual installations in the residential and commercial segment with the share of Prosumer PV, Belgium

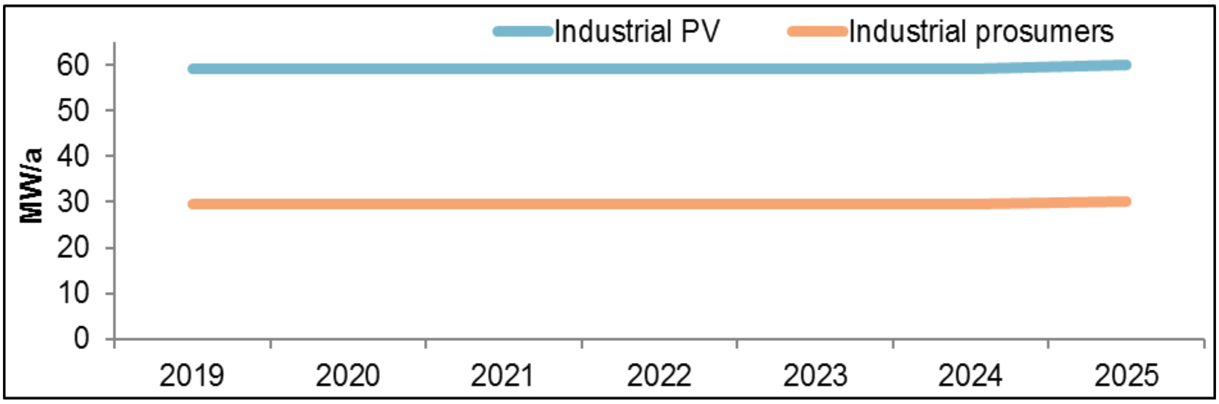

Figure 5.4: Annual installations in the industrial segment and the share of Prosumers in this segment, Belgium

As the residential segment is the largest PV market in Belgium and as self-consumption is the only valid business model in this segment, the share of prosumers in the general PV market is at 90 %. The slowly growing annual installations lead to a nearly linear growth of cumulated capacity, as can be seen in Figure 5.5.

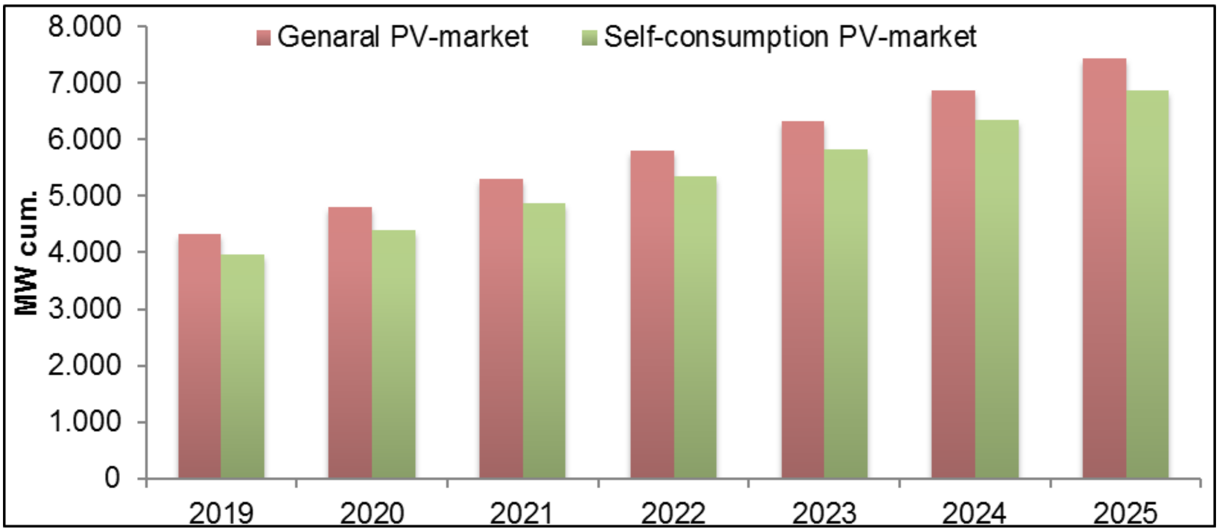

Figure 5.5: This graphic shows the high share of self- consumption in the Belgian market, SEIM calculation

Over the course of the PVP4Grid project three different business models or concepts to self-consume have been evaluated. Therefore, the installations in the self-consumption segment have been split between the three different concepts.

- Concept 1: Direct single use
- Concept 2: Local collective use
- Concept 3: District level energy models

Between these three concepts, the Belgian "Report on PVP4Grid Concepts and Barriers"[11] uses a differentiation based on system sizes. The report indicates, that systems < 10 kWp belong to the first concept. According to the Becquerel Institute the third concept is not relevant for today's PV-market since this concept is only used at test sites for the time being. Therefore, the residential prosumers are allocated to concept one and the commercial and industrial prosumers to concept two (99 %). Any future deviation to this is not visible and cannot reliably be modelled, therefore the SEIM tool leaves this allocation unchanged over time. The development from 2019 to 2025 is shown in Figure 5.6.

[11] Published on the PVP4Grid Homepage: https://www.pvp4grid.eu/pv-prosumer-concepts/

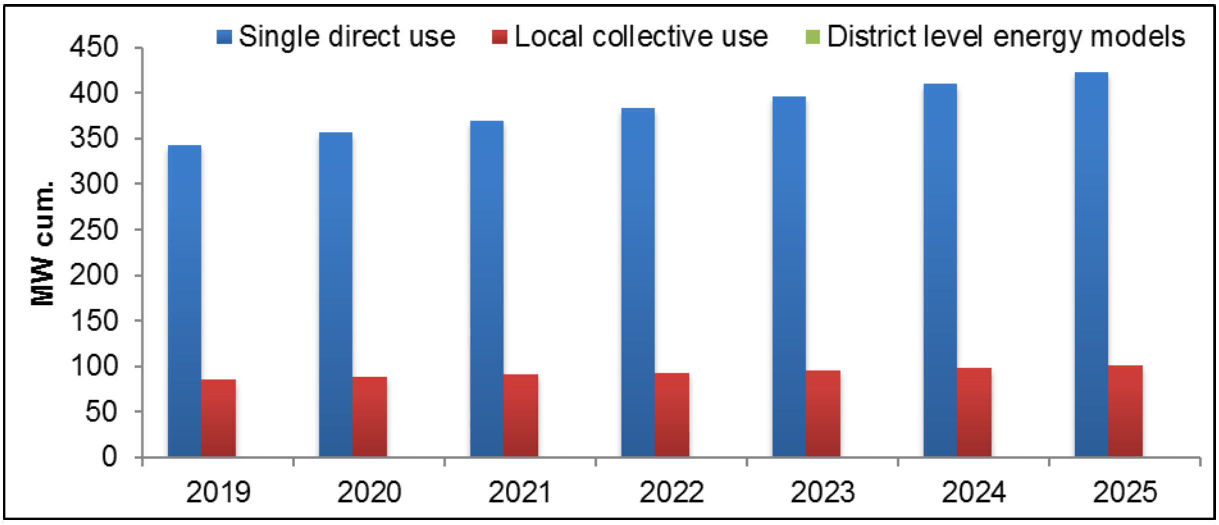

Figure 5.6: The expected segmentation of the annually installed prosumer PV, Belgium, SEIM calculation

5.4 PV-employment

The employment factors used to assess the job creation by Belgium PV are calculated based on the differentiation of the value chain given by SolarPower Europe and E&Y in the "Solar PV Jobs & Value Added in Europe" report (Waele et al., 2017). Again, the employment based on self-consumption is calculated in contrast to general PV and the results are graphically presented until 2025. In Figure 5.7 the development of FTE based on general PV and based on the share of self-consumption PV is presented.

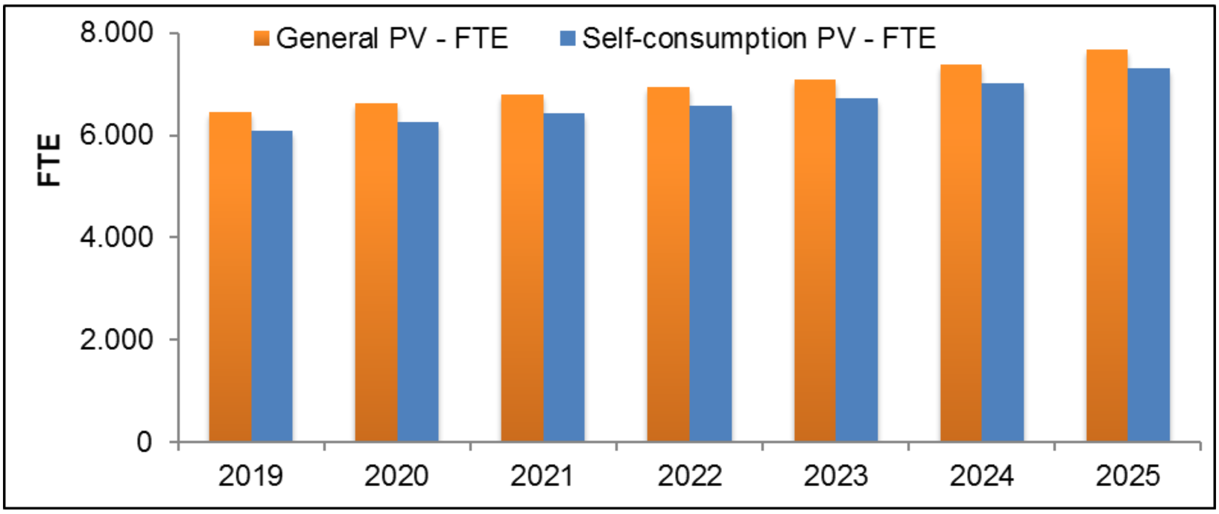

Figure 5.7: Employment based on general PV and on the self-consumption segment, Belgium, SEIM calculation

The number of jobs in the PV industry in Belgium largely follows the annual installations of PV systems. In 2019 nearly 6.500 full-time workplaces were active in Belgium, based on the demand that was met in this year. With the future market growing, the number of jobs is forecasted to grow as well. Effects like economies of scale or the rise of general production efficiency based on learning curves add less jobs/MW in the future. However, this effect is compensated by the increase of permanent jobs in the O&M segment. By 2030 the number of full-time jobs, estimated by the SEIM-tool, will be at 9.200 FTE. Around 94 % of these FTE are based on the demand of self-consumption PV, which accounts for 6.090 FTE in 2019 and around 8.800 FTE in 2030. Figure 5.8 indicates how the FTEs are distributed along the PV value chain.

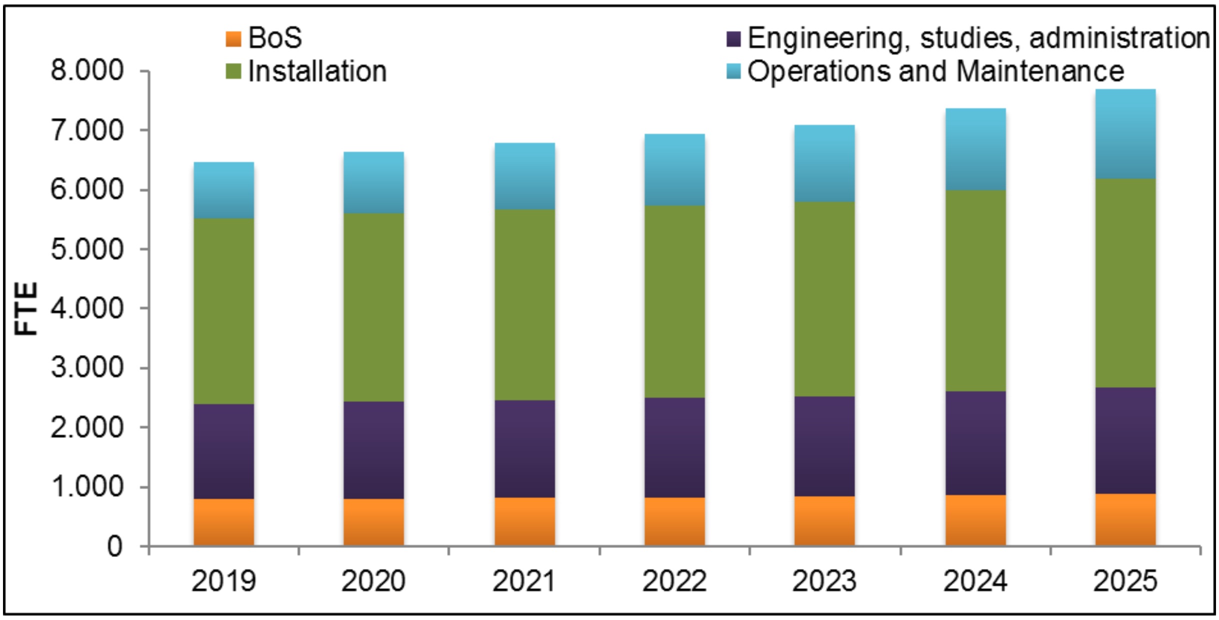

Figure 5.8: Distribution of FTE along the PV-value chain, Belgium, SEIM calculation

The installation sector accounts for most of the FTEs along the value chain. Due to a growing cumulated PV capacity in Belgium, the segment O&M is slowly gaining significance over time. There is no decisive difference between the distribution of FTE based on the general PV market and based on self-consumption. In the evaluated timeframe the upstream jobs of the PV value chain account for around 12 % of all FTE. Therefore, up to 88 % of the workplaces are created downstream which offers a better job security since these jobs tend to be local (Waele et al., 2017, S. 35). Per MW of cumulated capacity 0,2 FTE are created in the O&M

part of the value chain and remain unchanged over the lifetime of the PV system[12]. 12,0 FTE/MW (2019) to 11,1 FTE/MW (2030) are created for each newly installed PV system, but these jobs are only created in the year when the system goes into operation.

5.4.1 Employment based on the three prosumer concepts

The job creation based on self-consumption PV can be divided into the three different concepts evaluated in the PVP4Grid project. The segmentation of Prosumer concepts given by the Belgian "PV prosumer concept" report, published on the PVP4Grid homepage, was modified based on a discussion with the Becquerel Institute and stated in chapter 5.3.2. Figure 5.9 indicates the distribution of FTE between the three concepts. The single direct use of self-consumed PV is the most important concept for the Belgian PV labor market with around 75 % of the self-consumption-based FTE. The impact of the third concept on the labor market can be neglected.

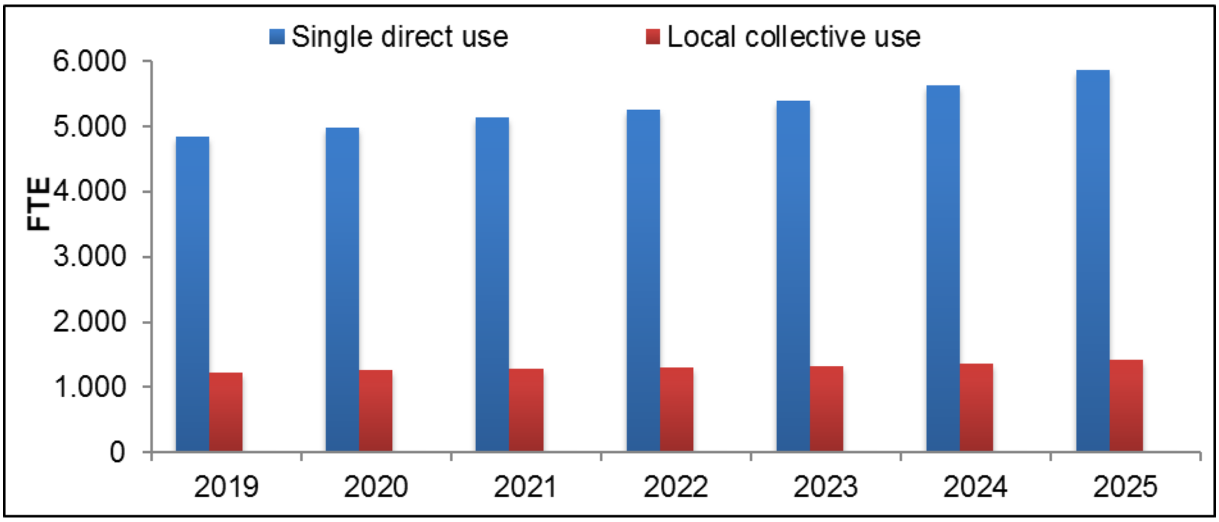

Figure 5.9: Employment based on the three evaluated self-consumption concepts, Belgium, SEIM calculation

For each cumulated MW of self-consumption PV 0,2 FTE are created in O&M over the entire lifetime of the system. In the year of their installation new systems create 12,1 FTE/MW to 11,2 FTE/MW in the remaining value chain components. Since self-consumption in the residential market is the main driver for the overall PV market, these key figures show only a small

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[12] Reduced only by general efficiency gains.

deviation from the general indicators stated in chapter 5.4. As a consequence, policies that influence self-consumption positively have a great impact on the job creation of the Belgian PV market.

5.5 Value creation

In general, the annual value creation is determined by annual installations. The sum of value creation based on the 2019 installations is around 469 million EUR/a. From 2019 onwards the value-added that is created by the PV industry is constantly on the rise (see Figure 5.10). It is estimated to reach 567 million EUR/a in 2025. The value creation based on self-consumption starts at 446 million EUR/a in 2019 and rises with a higher gradient to 543 million EUR/a by 2025. In 2030, the value chain of self-consumption-PV will create value of around 658 million EUR. As mentioned before, value creation can be divided into three components. With 56 % to 59 %, the net salaries are responsible for the main share of value creation, taxes and social security contributions account for 36 % and corporate net profits for 7 %. This context is depicted in Figure 5.11.

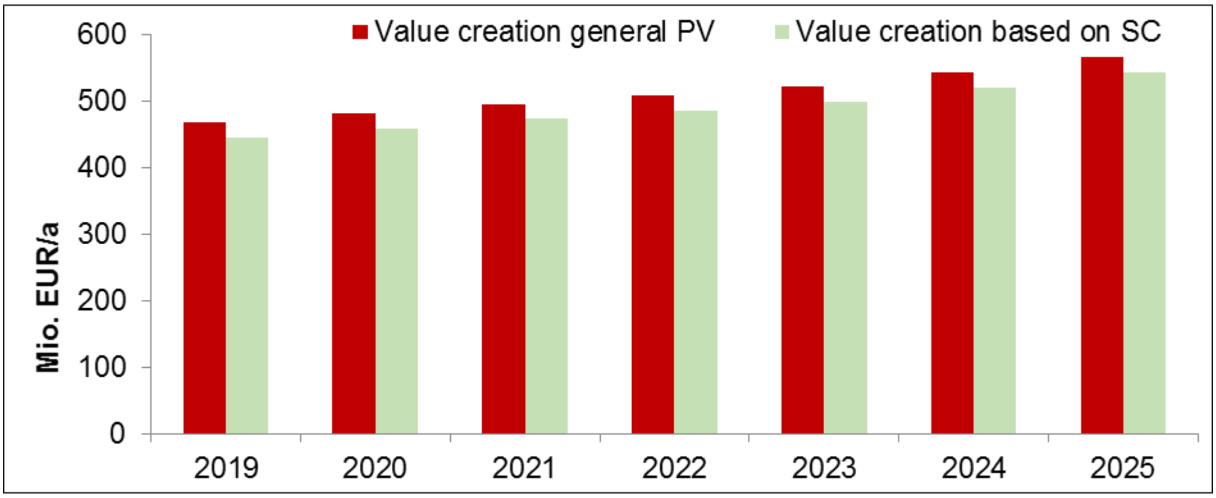

Figure 5.10: Annual value creation via PV in Belgium, general PV vs. based on SC, SEIM calculation

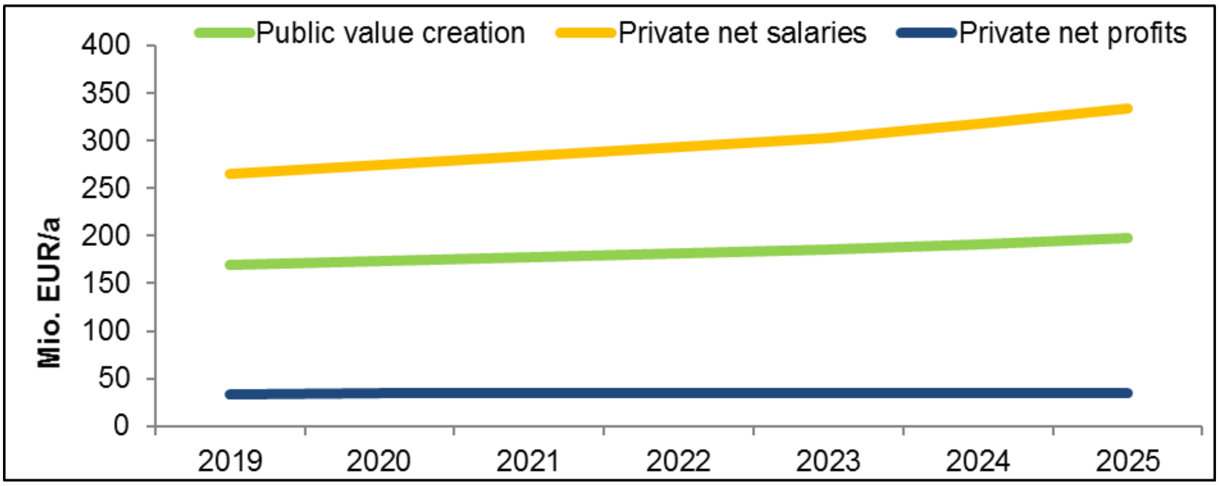

Figure 5.11: Structure of value creation in Belgium, public vs. salaries vs. private profits, SEIM calculation

Based on the share of self-consumption-PV in the estimated market outlook, the value creation that can be allocated to the three different SC-concepts can be seen in Figure 5.12. Analogous to Figure 5.9, the single direct use is the most important concept in Belgium, followed by the local collective use. As said above, the district power model can be neglected in the base-case of this specific SEIM analysis.

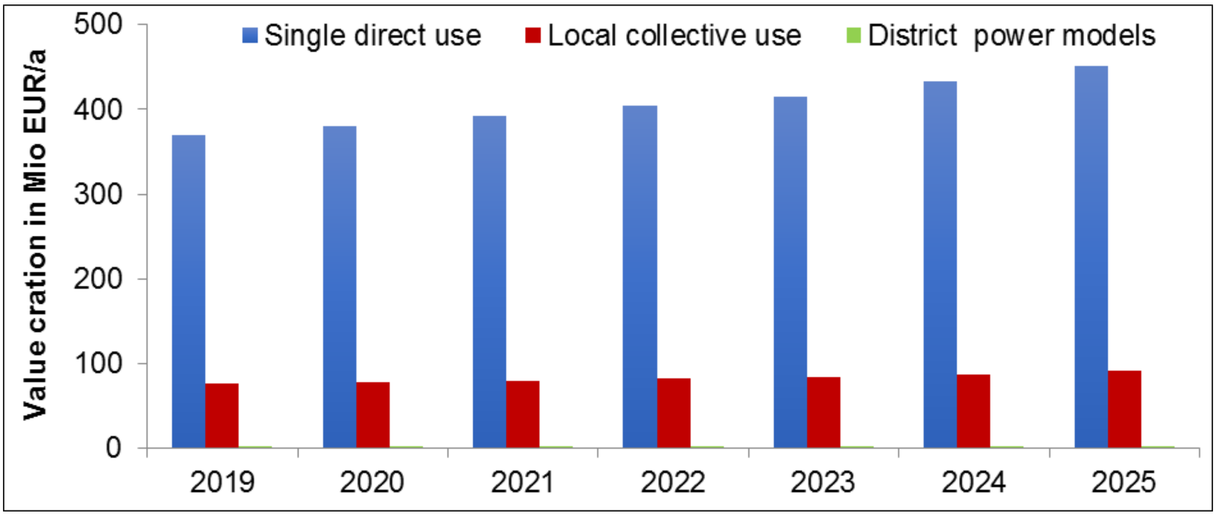

Figure 5.12: Value creation allocated to the three evaluated self-consumption concepts, Belgium, SEIM calculation

Per MW installed, O&M for self-consumption-PV creates around 12.500 EUR of value-added every year during the total lifetime of the system. In the year of the installation around 900.000 EUR/MW are created in the other parts of the value chain. Compared to the general PV market, these values again indicate the deployment of self-consumption-PV to be beneficial in terms of macroeconomic effects in Belgium. For general PV, the corresponding key figures are around 12.000 EUR/MW (O&M) as well and 870.000 EUR/MW in the first year.

5.6 Scenarios

As there are some opportunities for PV in Belgium to grow even faster, the gap between the base case scenario and the best-case scenario is large. Especially the development of the third self-consumption concept might have the potential to boost the national market. The simplified access to self- consumption and the development of different prosumer concepts is considered to be a very effective driver for the PV-market. These aspects have been taken into account for the generated scenarios. Figure 5.13 is extended until 2030 to show, that, under optimal conditions and by establishing new business models, Belgium could reach a cumulated PV capacity of around 18 GW, which would have huge socio-economic effects both on the labor market and in terms of value creation (Figure 5.14). It becomes clear, that the opportunities outmatch the risks linked to the current political situation in Belgium.

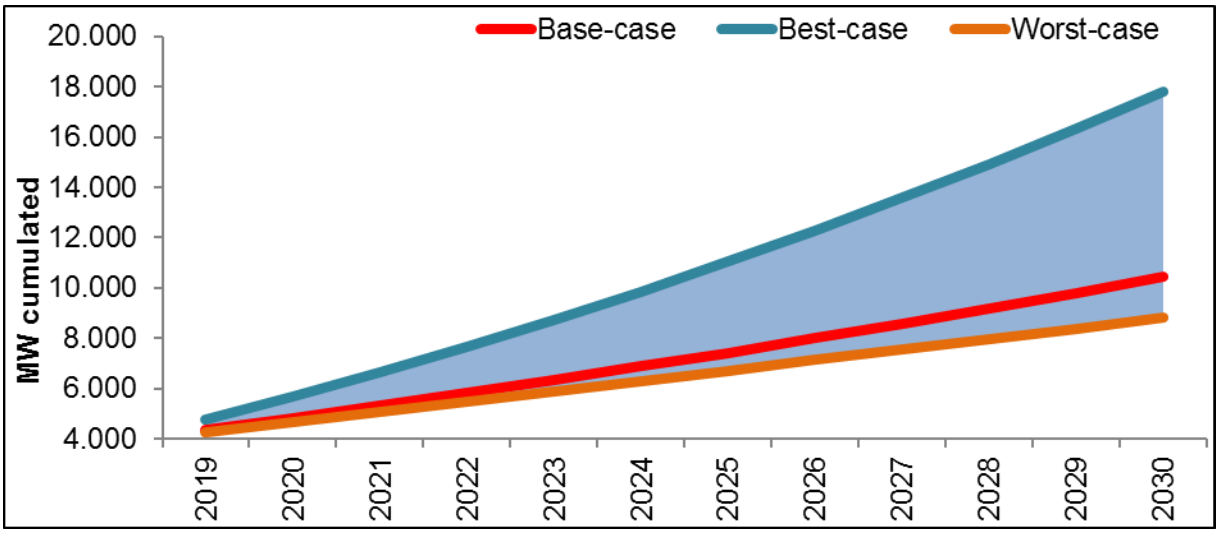

Figure 5.13: Cumulated PV capacity in Belgium until 2030, 18 GW PV-capacity is possible

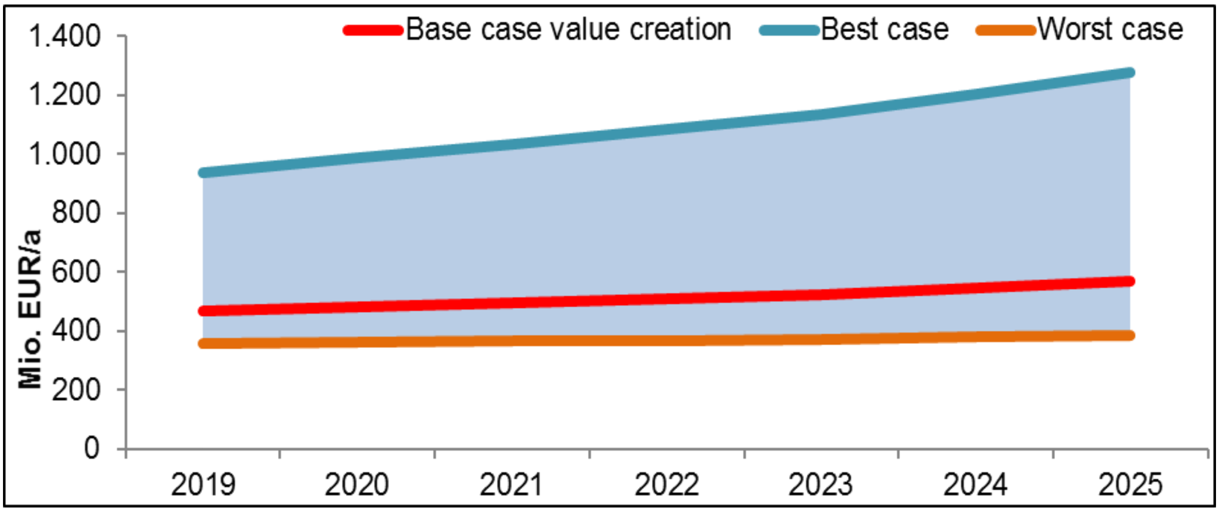

Figure 5.14: Scenarios for the annual value creation in Belgium

6 France

6.1 PV overview

France is one of the participating countries with a formerly monopolistic market structure. Today, it is still a very controlled market. This has two reasons. First is related to the little flexibility the currently operational electricity generating technologies, nuclear power, allows. Nuclear power makes up the main contribution to France's electricity production with a share of over 70% (IEA Database).[13] Nuclear is regarded as a low emission technology and will continue to dominate the French market, even though the "Energy Transition for Green Growth Act" (LTECV) from 2014 stipulates a reduction of nuclear energy to a share of 50% until 2035. Additionally, 4 coal fired plants with a capacity of 3 GW are likely closing until 2022. As these base load power plants show little flexibility, it is complicated to adapt the system to renewable energies with their fluctuating production capacities.

Due to these changes, the renewable energy sector might develop rapidly, despite the technical issues likely to emerge, when the different technologies are conflated. The second reason for France's controlled market is that its largely nationalized. The state-owned EDF holds a 78 % share of the electricity market (Reuters 2019[14]), which gives the company a powerful position negotiating technological phase out. Under these conditions the production of renewables recently reached 21% of France's energy mix. Half of this production is based on hydro. PV has only gained traction in the last decade (Figure 6.1).

[13] https://www.iea.org/countries/france

[14] https://uk.reuters.com/article/uk-france-electricity-edf/french-utility-edf-launches-new-retail-offer-to-fend-off-rivals-idUKKCN1TJ2QF

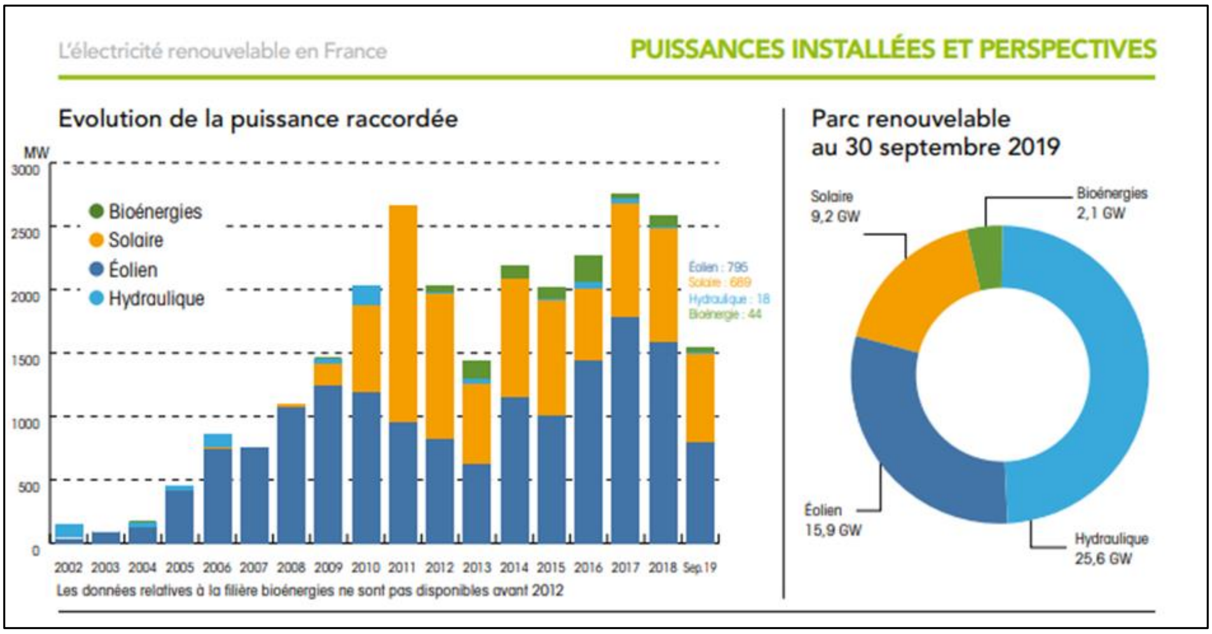

Figure 6.1: Renewable Energies in France, Figure by L'Association des distributeurs d'électricité en France (ADEeF 09/2019)

Figure 6.1 shows that since 2010 PV holds a significant share in new installations of renewable energies, only second to wind. Since then, 9,2 GW of capacity have been installed with around 900 MW annual installations (Eurostat). However, almost all the capacity distributed through tenders went to utility-scale systems and not self-consumption.

While there is well-developed grid infrastructure to integrate PV in France, the administrative procedure is often referred to as complicated and tedious. Moreover, low electricity prices currently hinder the profitability of business-models based on prosumption. The NECP in France defines the following targets:

Table 3: NECP goals in France, scenarios "Ampère" and "Volt"

2030 goals for:	"Ampère"	"Volt"
Wind	39 GW	40 GW
Hydro	26 GW	26 GW
PV	36 GW	48 GW
RES	40 %	40 %

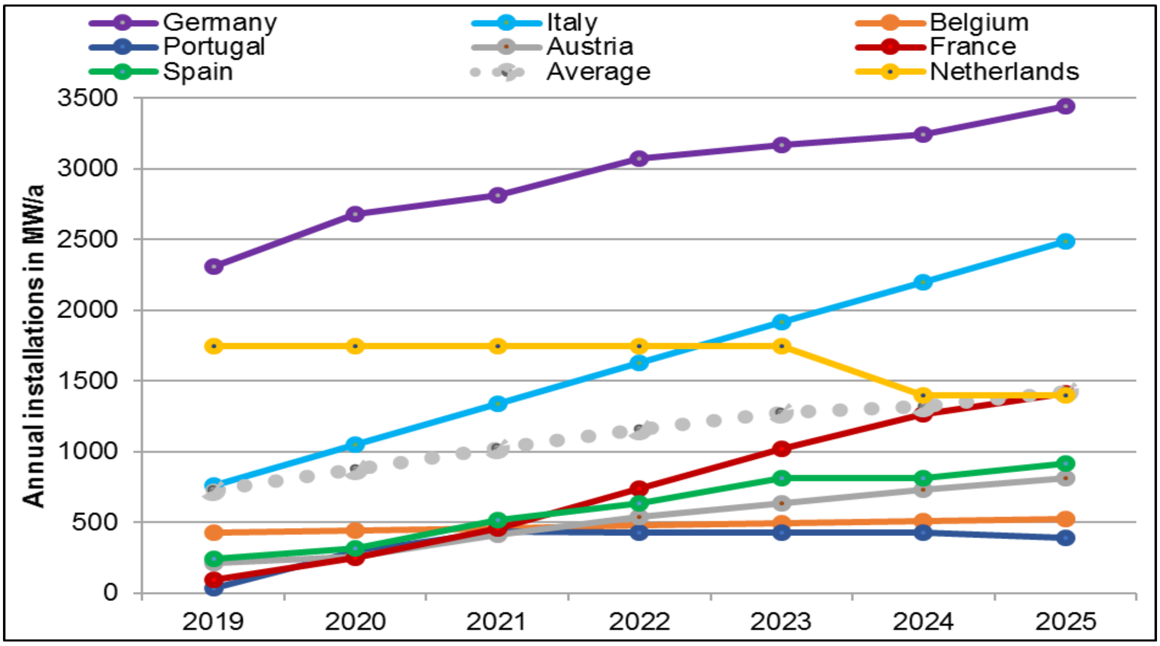

Figure 6.2: France (red) under the current legal framework, annual installations of self-consumption PV

Figure 6.2 presents the outlook for self-consumption PV in France compared to the other evaluated countries. The current situation, reflected in 2019, shows a low share of self-consumption PV within the already low number of PV installations (considering the size of the French market).

6.2 Input Financial Values

With a range of 800 EUR/kWp for large centralized utility-scale systems, to over 2400 EUR/kWp, for BAPV systems below 3 kWp, the system costs in France are in the expected range (IEA-PVPS France report 2018). The gross salary in the PV-industry in France is on average 3600 EUR/month. The increase of the salaries in the PV sector is considered as 1% per year over the study's time frame. The VAT for PV is at 20 %, except for systems below 3 kWp that are installed on buildings older than two years. These have a VAT rate of 10 %. Income tax and social contributions average at 21,6 % and the corporate tax rate is at 34,43 %, which is the highest value in the assessed countries.

6.3 PV market

First, the general market outlook for France is presented. Subsequently, the prosumer market is calculated by evaluating the share of self-consumption in each segment of the PV market.

The three concepts of prosumption, identified and described by the PVP4Grid project, are analysed together and contrasted at the end of the SEIM-simulation. The market outlook has been developed in collaboration with the Becquerel Institute, national partner to the PVP4Grid project for France.

6.3.1 General PV-outlook

The market outlook is presented in Figure 6.3. It aims to surpass the PV-friendly NECP scenario “Ampère” by a narrow margin with a cumulated PV-capacity of 50 GW in 2030. To reach the goal of 50 GW, the PV-industry needs to install 40 GW between 2019 and 2030. Based on the 900 MW that have been installed in 2018, the PV-industry in France needs to grow rapidly. Modelled in a simplified way by the SEIM-tool, France needs to add additional 400 MW of annual installations each year to the number of installations added in the previous one. However, an extreme jump in added PV installations is considered to be unhealthy due to unsustainable job creation and the need to commission foreign companies – since the national industry might not be able to grow fast enough.

This growth in PV is a substantial challenge for the political commitment and technical adjustments that need to be made in France. Due to the ambitious NECP, good infrastructural conditions and the reduction of coal and nuclear power in France, this study’s assessment is a positive outlook on the future PV-market in France.

Figure 6.3 depicts the segmentation of the French PV-market. It becomes evident that under the current legal and technical framework, industrial installations are the main driver for the general PV-market. Over 60 % of PV installations are predicted to be industrial. Moreover, the commercial market has a share of around 30 %. The residential market accounts for the remaining 10 % of installations. The reason for this low amount of residential installations is the low amount of self-consumption PV. These are, most likely, a consequence of France’s low energy prices.

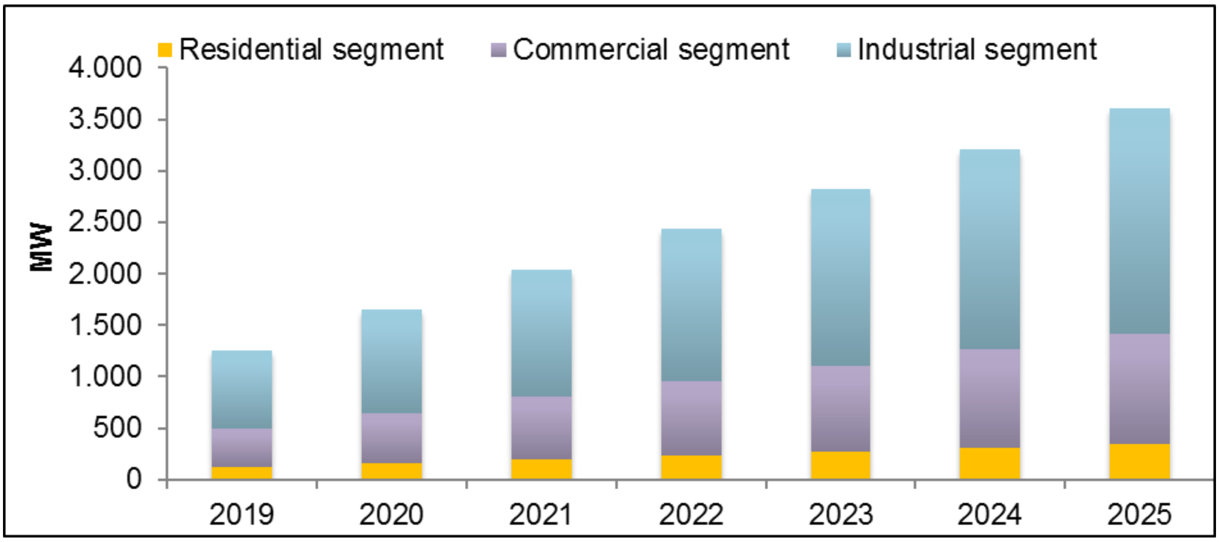

Figure 6.3: Annual installation in France, general PV-market with segmentation (based on the NECP and the Global Market Outlook by SolarPower Europe)

6.3.2 Outlook for self-consumption

Figure 6.4 shows the share of self-consumption within general PV. Starting 2019, self-consumption PV is mainly installed in the residential segment with a share of 50 %. In the commercial segment only 5 % of the installations are considered to be prosumer-systems. Due to the rapid growth which is necessary to reach the 50 GW goal, an amendment of national self-consumption guidelines, on the political and the technical level, is necessary and predicted in the SEIM simulation. With profitable prosumer business models as new drivers of the general PV-market, the share of prosumers in the residential segment is modelled to reach 100 % in 2022. In the commercial segment it is expected that the share of prosumers will growing as well, reaching 100 % in 2027. In contrast, the industrial market will hold on to its main share of installations which are not operated under any kind of prosumer business models. Due to the low share of residential and commercial PV and the low shares of self-consumption in these segments in 2019 (and before) the self-consumption market is developing slowly. It will only reach a cumulated capacity of 4 GW in 2025, but will accelerate from there, predicted to reach 13,6 GW (cumulated) in 2030. Therefore, the share of self-consumption is growing over time. It is displayed in Figure 6.5, starting at 2 % in 2019 and closing with 27 % of cumulated PV capacity in 2030.

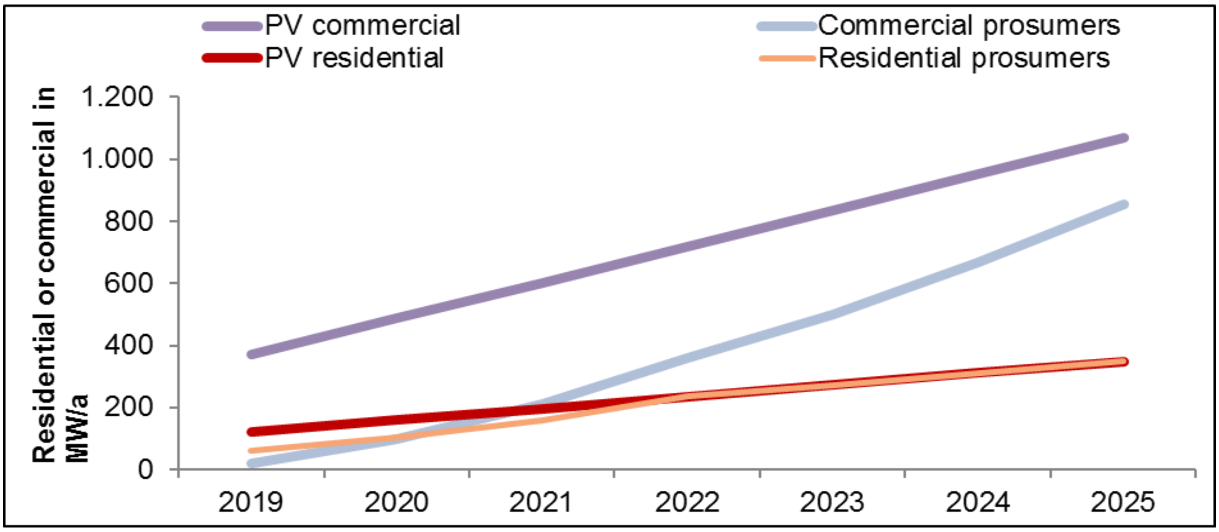

Figure 6.4: The share of self-consumption in residential and commercial PV-systems is expected to grow, France, SEIM calculations

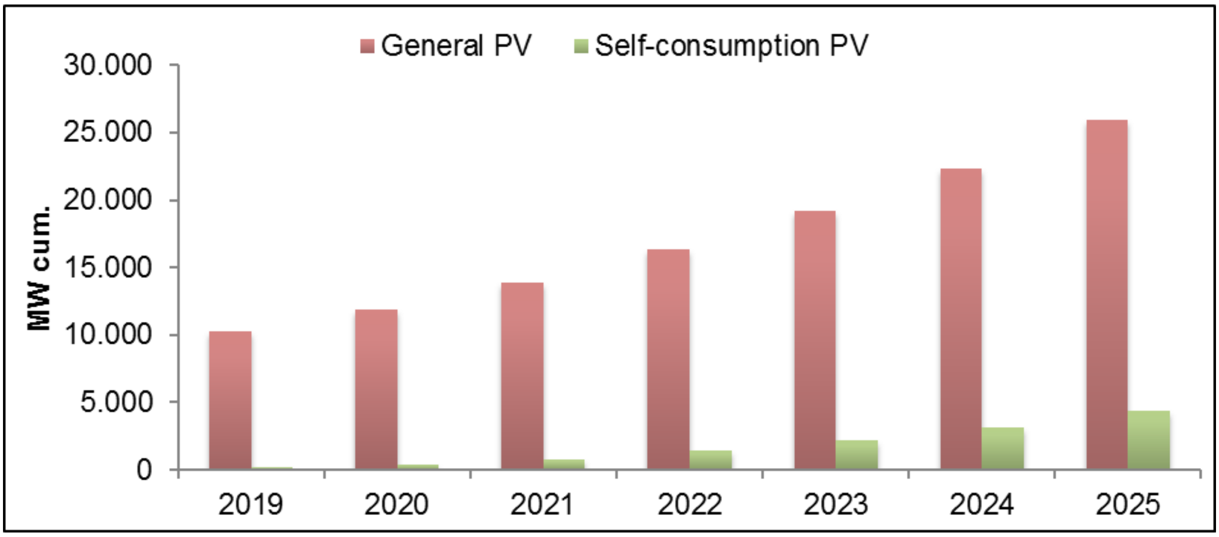

Figure 6.5: The ratio between prosumer and general PV market, France, SEIM calculations

Over the course of the PVP4Grid project three different business models of self-consumption have been evaluated. Therefore, the installations in the self-consumption segment are allocated to the three different concepts.

- Concept 1: Direct single use
- Concept 2: Local collective use
- Concept 3: District level energy models

In the three concepts, the French “Report on PVP4Grid Concepts and Barriers”[15] uses a differentiation based on system sizes. The report indicates, that systems < 10 kWp belong to the first concept. According to the Becquerel Institute the third concept is barely relevant for today’s PV-market since it is only used at test sites. Despite being allowed under the “Ordinance n°2016-1019 of July 27”, it is limited to small PV sizes up to 20 kWp. With 16 projects active at the end of July 2019 and around 100 more planned, only around 2 MW are installed each year in this segment. Due to the small amount, district level energy models are neglected in Figure 6.6. Therefore, the residential prosumers are allocated to concept one and the commercial prosumers to concept two. Any future deviation to this is not visible and cannot reliably be modelled. Therefore, the SEIM tool leaves this allocation unchanged over time. The development from 2019 to 2025 is shown in Figure 6.6.

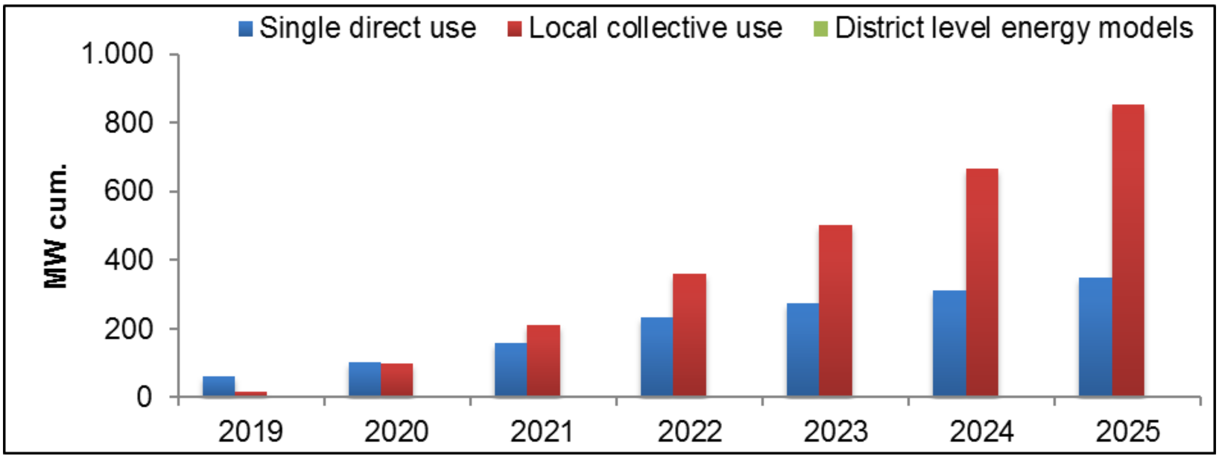

Figure 6.6: The expected segmentation of the new installed prosumer PV, France, SEIM calculations

6.4 PV-employment, general and self-consumption

The employment factors used to assess PV job creation are calculated based on the differentiation of the value chain given by SolarPower Europe and E&Y in the “Solar PV Jobs & Value Added in Europe” report (Waele et al., 2017). Again, the employment based on self-consumption is calculated in contrast to general PV and the results are graphically presented

[15] Published on the PVP4Grid Homepage: https://www.pvp4grid.eu/pv-prosumer-concepts/

until 2025. In Figure 6.7 the development of FTE based on general PV and based on the share of self-consumption PV is presented.

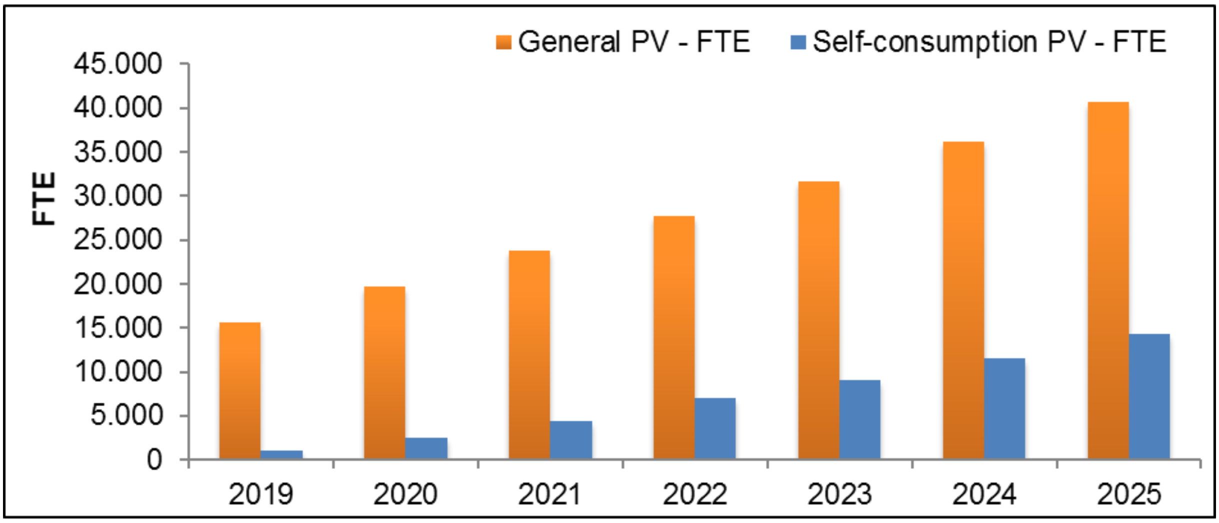

Figure 6.7: Employment based on general PV and on the self-consumption segment, France, SEIM calculations

The number of jobs in the PV industry in France largely follows the increase in annual PV systems installations. In 2019 nearly 15.600 full-time workplaces existed, based on the demand that was met in this year. With future market growth, the number of jobs is predicted to grow as well. Effects such as ‘economies of scale’ or the rise of general production efficiency based on learning curves add less jobs/MW in the future. However, this effect is compensated by the increase of permanent jobs in the O&M segment. By 2030 the number of full-time jobs, estimated by the SEIM-tool, will total 64.500 FTE (with 5.5 GW annual installations in 2030). Around 42 % of these FTE will be based on PV self-consumption demand in 2030, while in 2019 self-consumption accounts for only 6 % (1.000 FTE). Figure 6.8 indicates how the FTEs are distributed along the PV value chain.

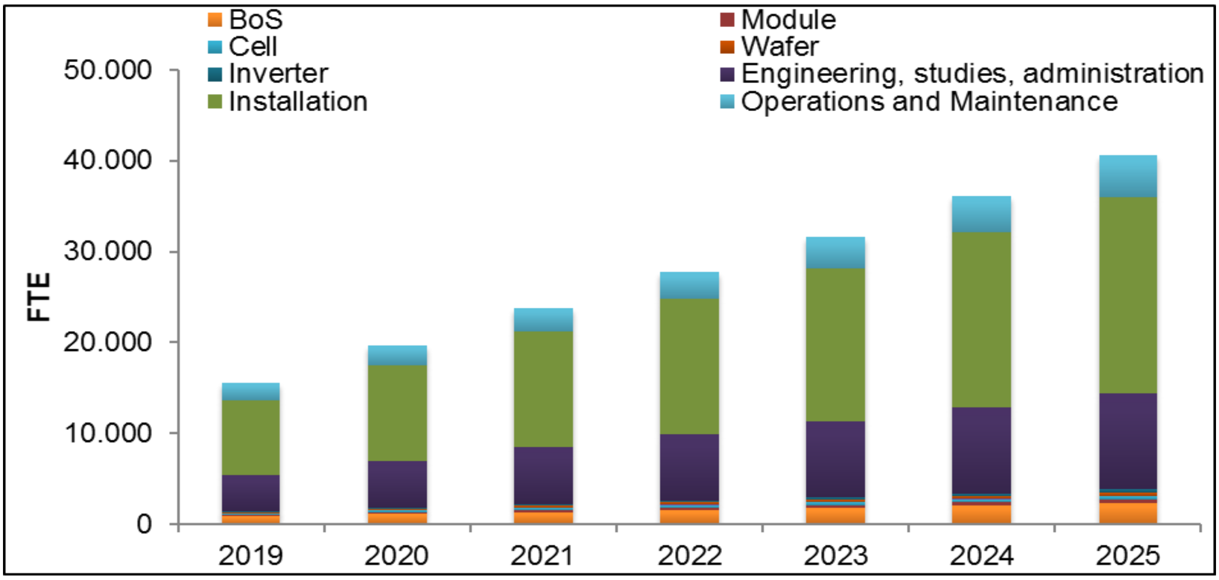

Figure 6.8: Distribution of FTE along the PV-value chain in France, SEIM calculations based on the differentiation of SolarPower Europe (Waele et al. 2017)

The installation sector accounts for most of the FTEs along the value chain. Due to growing cumulated PV capacity in France, the segment O&M is becoming more significant over time. By 2025 O&M will account for the third largest FTE, with "Engineering, studies, administration" as the second largest section. There is no decisive difference between the distribution of FTE based on the general PV market and based on self-consumption. In the evaluated time frame the upstream jobs of the PV value chain account for around 9 % of all FTE. Therefore, up to 91% of the workplaces are created downstream, which offer better job security since these jobs tend to be local (Waele et al., 2017, S. 35). Per MW of cumulated capacity 0,2 FTE are created in the O&M part of the value chain and remain unchanged over the lifetime of the PV system[16]. 10,8 FTE/MW (2019) to 10,0 FTE/MW (2030) are created for each newly installed PV system. However, these jobs are only created in the year the system goes into operation.

The job creation based on self-consumption PV can be apportioned to the three different concepts evaluated in the PVP4Grid project. The segmentation of prosumer concepts given by the French "PV prosumer concept" report, published on the PVP4Grid homepage, was modified based on a discussion with the Becquerel Institute (as stated in chapter 5.3.2). Figure 6.9 indicates the distribution of FTE between the three concepts. The single direct use of self-consumed PV starts in 2019 as the most important concept for the French PV labor market

[16] Reduced only by general efficiency gains.

with around 77 % of the self-consumption-based FTE. With growing installations in the commercial segment and the growing share self-consumption concepts have in newly implemented commercial systems, however, the local collective use is rapidly gaining importance. It surpasses the single direct use in terms of active FTE by 2021 and accounts for 70 % of the self-consumption-based jobs in 2025 (75 % in 2030). The impact of the third concept on the labor market can be neglected, due to low numbers of annual installations.

For each cumulated MW of self-consumption PV 0,2 FTE are created in O&M over the entire lifespan of the system. In the year of their installation new systems create 12,0 FTE/MW (2019) to 11,1 FTE/MW (2030) in the remaining value chain components. As a consequence, policies that influence self-consumption positively have a great impact on the job creation of the French PV market.

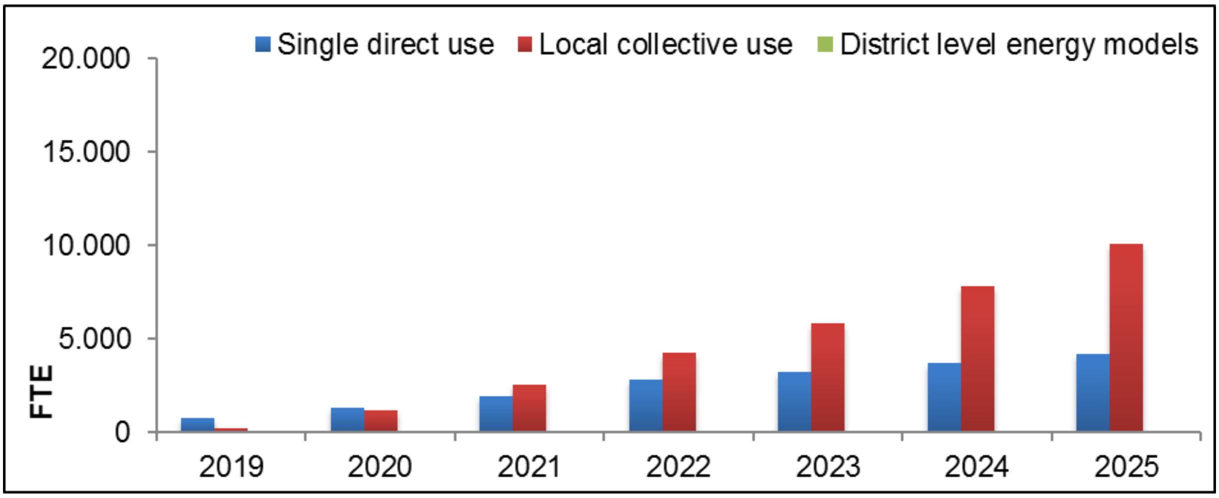

Figure 6.9: Employment based on the three evaluated self-consumption concepts in France, SEIM calculations

6.5 Value creation

In general, the annual value creation is determined by the annual installations. The total value creation based on the 2019 installations is around 828 million EUR/a. From 2019 onwards the value added by the PV industry is constantly rising (see Figure 6.10). It is estimated to reach 2,2 billion EUR/a in 2025. The value creation based on self-consumption starts at 77 million EUR/a in 2019 and rises with a steeper gradient to 729 million EUR/a by 2025. In 2030, the value chain of self-consumption-PV will create value of around 1,4 billion EUR/a. As mentioned before, value creation can be divided into three components. With around 64%, the net salaries are responsible for the main share of value creation. Taxes and social security contributions account for 27 % and corporate net profits for around 9 %. This context is depicted in Figure 6.11.

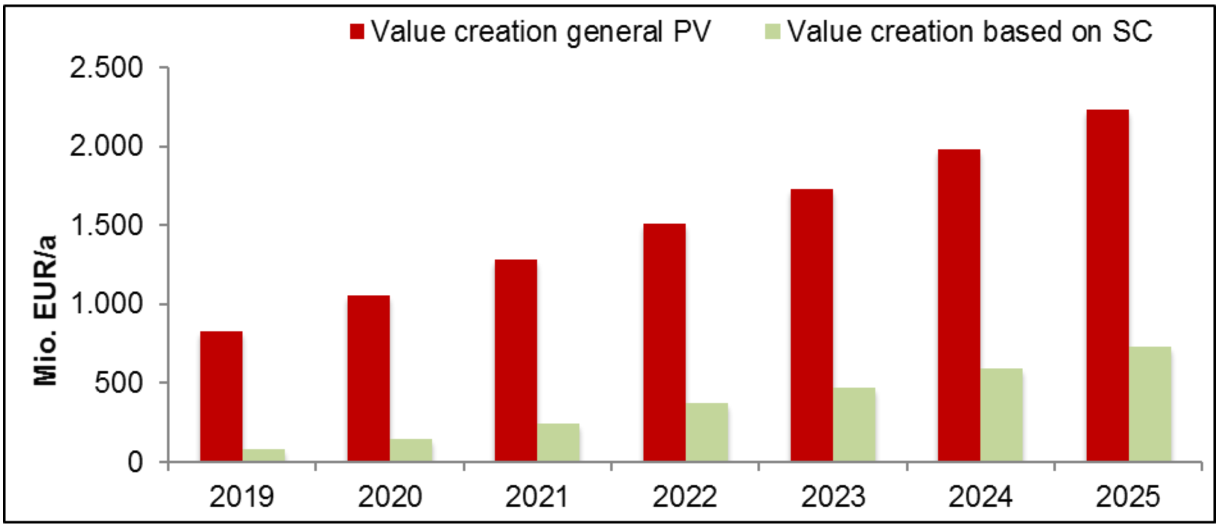

Figure 6.10: Annual value creation via PV in France, general PV vs. based on SC, SEIM calculations

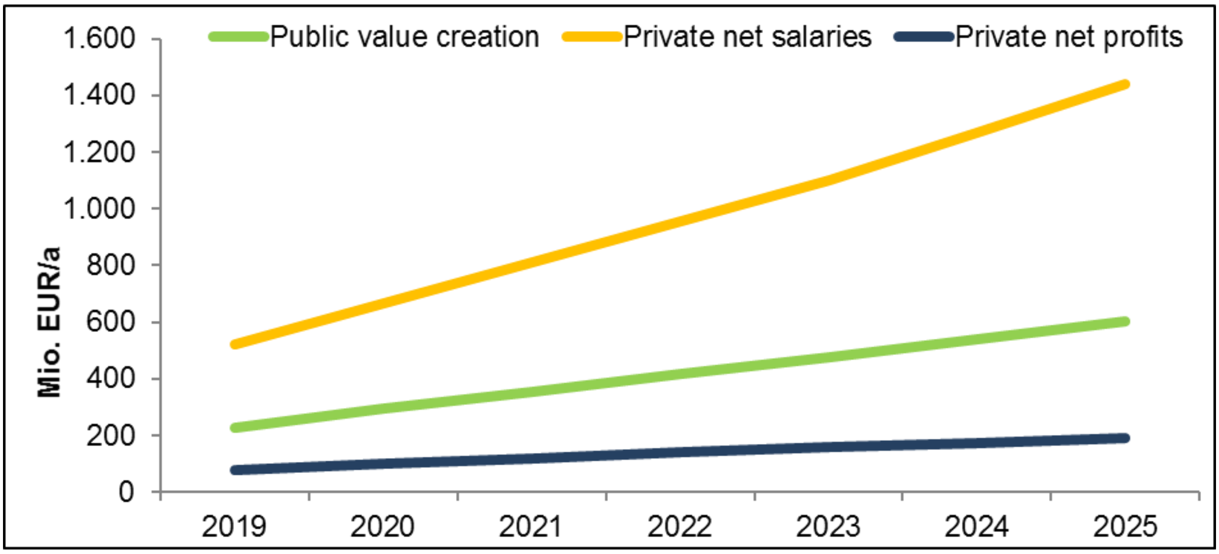

Figure 6.11: Structure of value creation in France, public vs. salaries vs. private profits, SEIM calculations

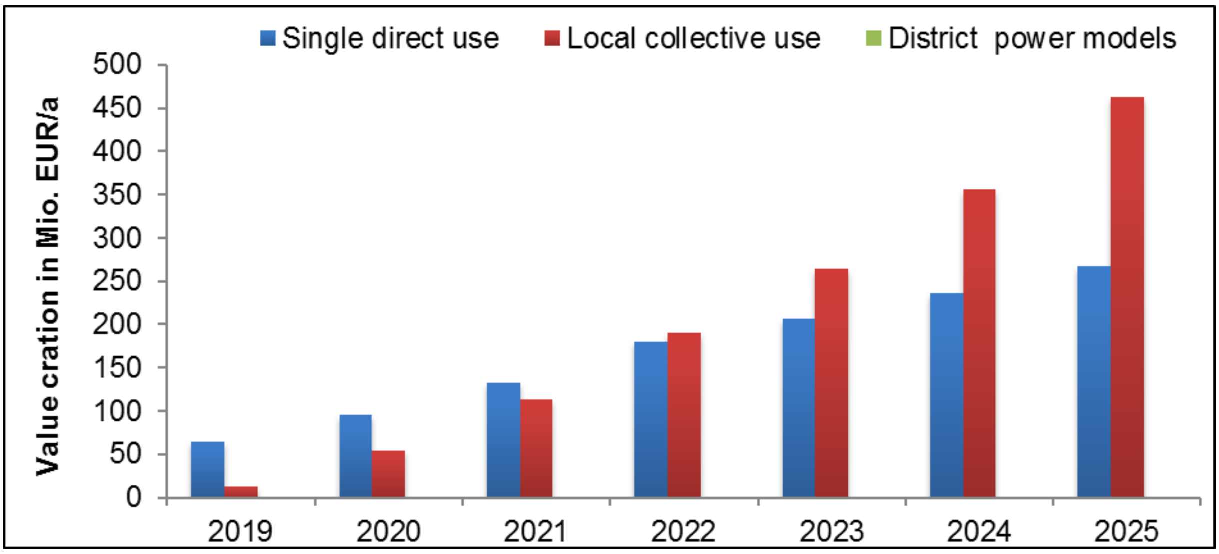

Figure 6.12: Value creation allocated to the three evaluated self-consumption concepts, France, SEIM calculations

Based on the share of self-consumption PV in the estimated market outlook, the value creation that can be allocated to the three different SC-concepts can be seen in Figure 6.12. Corresponding to Figure 6.9, local collective use is the most important concept in France, followed by single direct use. As mentioned above, the district power model can be neglected in Figure 6.12. Per MW installed, O&M for self-consumption-PV creates around 9.700 EUR of value-added every year during the total lifespan of the system. In the year of installation around 630.000 EUR/MW are created in the other parts of the value chain. Compared to the general PV market, these values again indicate the expansion of self-consumption-PV to be beneficial in terms of macroeconomic effects in France. For general PV, the corresponding key figures are around 8.200 EUR/MW (O&M) as well and 560.000 EUR/MW in the first year.

6.6 Scenarios

As there are different opportunities for PV in France to accelerate, the gap between the base case scenario and the best-case scenario is vast. In particular, the third self-consumption concept might have the potential to boost the national market. The simplified access to self-consumption and the development of different prosumer concepts are considered to be very effective drivers for the PV-market. These aspects have been taken into account for the generated scenarios. Figure 6.13 is extended until 2030 to show that, under optimal conditions and by establishing new business models, France could reach a cumulated PV capacity of around 63 GW, which would have huge socio-economic effects both on the labor market and in terms of value creation (Figure 6.14). The immense growth that is necessary to meet the NECP goals in France is possible but it is affected by many unknown variables. If the political situation in the country stays stable and the necessary adjustments are made, PV systems in general, self-consumption in particular, as well as the corresponding industry has a bright future in France.

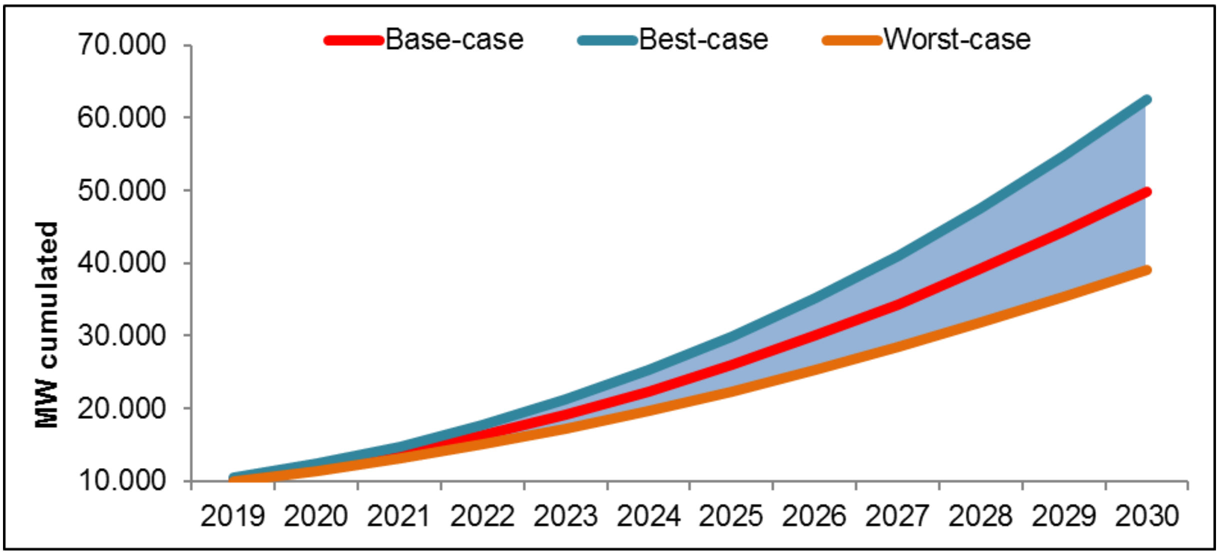

Figure 6.13: French scenario, cumulated capacity until 2030

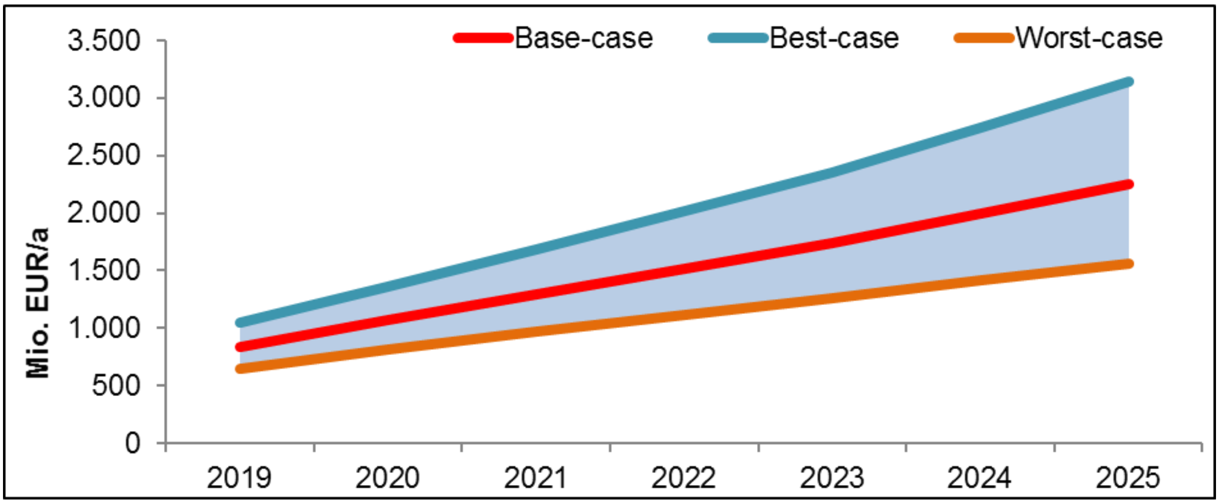

Figure 6.14: French scenario, annual value creation until 2025

7 Germany

7.1 PV overview

PV plays a large and increasingly important role in Germany. In 2018, Germany was the largest PV market of the eight countries analyzed in the report and the sixth largest worldwide, based on annual installations (Schmela et al. 2019 – GMO 2019). In 2019, Germany had a gross electricity generation of 611,5 TWh, 40% of which was attributable to renewable energies. 46,7 TWh of this was generated by photovoltaics, which corresponds to around 7,6 % of gross electricity generation (AGEB). This means that the share of PV has steadily increased since 2010 and ranks second amongst all renewable energies after wind-onshore. At the same time, a study by EuPD, published in November 2019, foresees that the net electricity demand in Germany will increase by 20 % by 2030 due to electromobility and the conversion of electricity to synthetic fuels ("Power-to-X"), and by 66 % by 2040. This would lead to a supply gap of 70 TWh until 2030 (Ammon et al. 2019). At the moment, the research institute EuPD sees PV as the only renewable technology capable to close this gap in Germany given that wind power growth is currently hampered by extensive approval procedures and some rather restrictive legislation (regarding for instance new distance regulations heavily limiting areas available for new installations). However, the corresponding demands of the EuPD regarding new PV installations, as shown in Figure 7.1, are not yet reflected in the current government's legislative texts or framework plans.

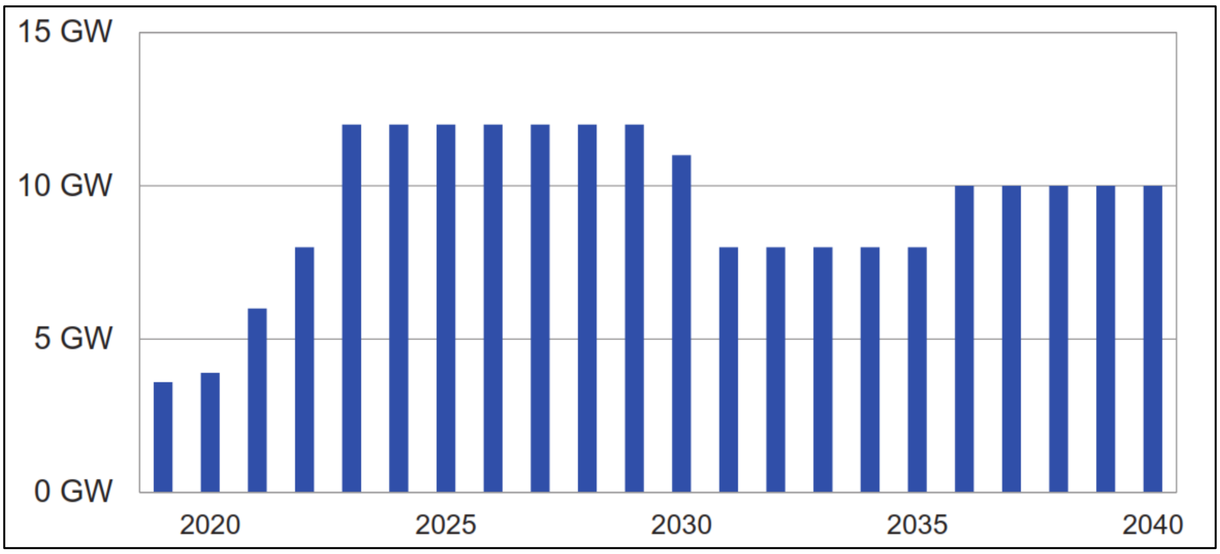

Figure 7.1: EuPD scenario regarding necessary PV installations to cover the supply gap

The German PV market - after a peak between 2009 and 2012 and the following decrease – has grown again by almost 4 GW new installations in 2019. It is plausible that the public discussion on the needed shift to renewable energy ("Energiewende"), the resulting pressure on the government and new scientific findings (for example the supply gap mentioned above, Ammon et al. 2019) will lead to a further increase in annual installations. However, the current version of the Renewable Energy Sources Act (German "Erneuerbare Energien Gesetz", EEG) only stipulates 2.5 GW of new PV installations per year, while the coalition agreement of the current government (including the political parties CDU, CSU and SPD) states the intention to install a further sum of 4 GW PV systems in the period of 2018 to 2020. Nevertheless, these additional installations would still fall short of the EuPD targets. This is also true for Germany's NECP which plans for a maximum cumulated PV capacity of 105 GW to be reached (in three different scenarios) by 2030. According to the EuPD, 162 GW should be installed by that time. Taking all of the aforementioned numbers, demands and requirements into consideration, in this report a base case was chosen that will lead to about 120 GW of cumulated installed PV capacity in 2030.

A key factor for the future development of PV in Germany is whether the current cap on subsidies under the EEG is lifted or remains in place. The EEG states that, as soon as a cumulative capacity of 52 GW, is reached, which will most likely be the case already in 2020, the subsidy for new PV (<750 kWp) systems will be discontinued. A yet non-binding statement of intent to remove the cap was made by the government. Initially, this intention was to be formalized in the Coal-Exit Act, which will be discussed by the cabinet at the end of January 2020. But since one of the government parties, the SPD, wants to prevent the new strict distance regulations for the installation of wind power, the Federal Ministry for Economic Affairs and Energy (BMWi), who is charge of energy matters and is led by one of the conservative parties of the coalition, the CDU, may leave the PV subsidy cap in place until an agreement is reached for new installations of wind power (pv-magazine 2020[17]).

From the perspective of PV plant operators, the conditions for PV in Germany are positive. A survey carried out by the IÖW in Germany showed that the economic motivations are the

[17] https://www.pv-magazine.de/2020/01/21/neuer-referentenentwurf-zum-kohleausstiegsgesetz-weiter- ohne-eeg-aenderungen/

decisive factor for private individuals for installing a PV system (IÖW 2017[18]). Studies by Agora-Energiewende or erneuerbareenergien.de have already proven the economic viability of PV systems in the residential segment in 2016 (Agora-Energiewende 2016; erneuerbareenergien.de, 2016). Yet despite this, the residential segment in Germany is comparatively weak, with only around 15% of the total installations (Schmela et al. 2019). Germany's energy infrastructure offers a very good basis for PV expansion. According to the IÖW, the upgrade of the grid can even be reduced by increased self-consumption of PV electricity, and general grid stability may benefit from smart regulatory systems (IÖW 2017).

Accordingly, if certain political measures are undertaken, the future of PV in Germany is very positive and the year 2020 plays an important role. If the cap remains in place, the annual installations described by the EuPD will rather not be achieved. This is also reflected in the GMO of SolarPower Europe, which predicts that in the worst-case scenario annual installations could fall to 1,5 GW by 2022. In the light of the federal government's draft climate protection program, which was adopted at the end of 2019 and determines a goal of 98 GW new PV installations by 2030, this scenario seems no longer feasible and, as discussed, the general outlook for PV in Germany is quite positive.

In future installations, self-consumption will play an increasingly important role. All three PVP4Grid business models (single direct use, local collective use, district power models) are possible according to the legal and technical frameworks. Single direct use is used in conjunction with feed-in tariffs and local collective use based on PPAs or on the "Mieterstrommodell" (German for "electricity (generation) model for tenants") which makes PV electricity and its benefits also accessible for tenants. Although the third concept (district power models) is permitted, it is hardly ever used (PVP4Grid-GER-Report on PVP4Grid Concepts and Barriers 2018). According to data provided by a German research institute, around 57 % of residential PV systems are prosumer installations by the end of 2018, but in future installations this number could increase to almost 100 %. The same applies to the commercial segment. The annual installations forecasted for Germany are shown in Figure 7.2, which provides a comparison between all eight PVP4Grid countries.

[18] https://www.ioew.de/fileadmin/user_upload/DOKUMENTE/Vortraege/2017/gaehrs_swantje_prosumer_in_der_energiewirtschaft.pdf

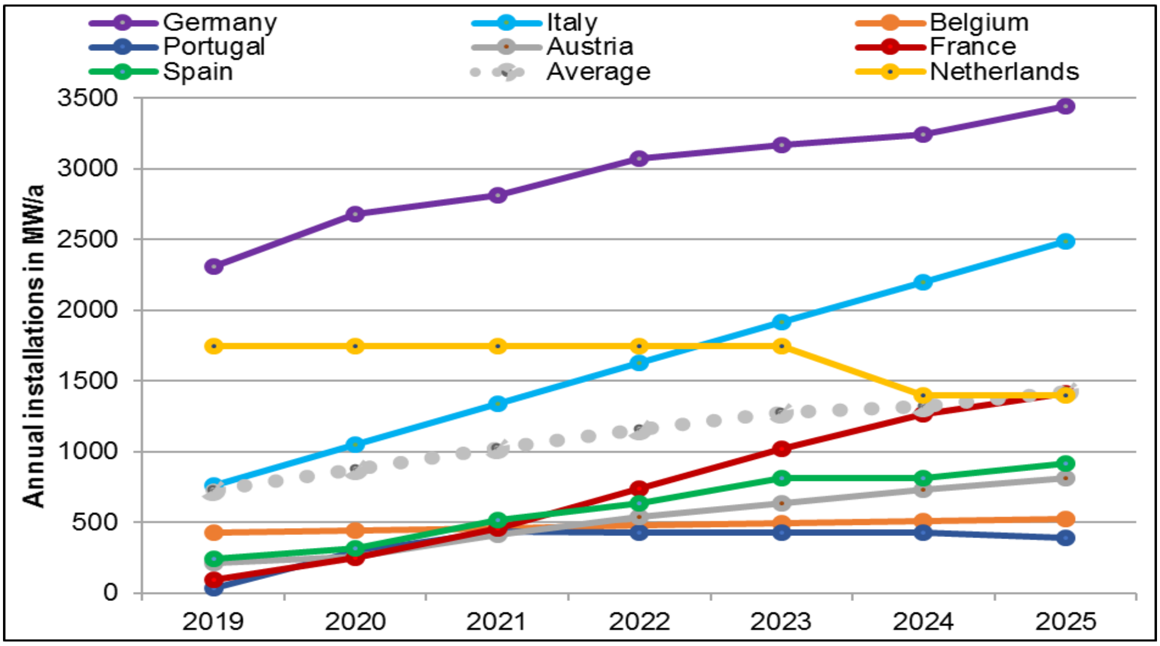

Figure 7.2: Germany's (purple) self-consumption outlook shows a considerable growth and high performance, data gathered from the PVP4Grid consortium

7.2 Input Financial Values

This chapter describes the input data used for the SEIM calculation. The system costs are considered to range between a minimum of 750 EUR/kWp for utility-scale ground mounted systems and 1.550 EUR/kWp for residential rooftop installations. The income tax and social security contributions average 29,5 %, the corporate tax level in Germany is at 29,9 %. The VAT rate for renewables is at the most common VAT rate of 19 %.

7.3 PV market

At first, the general outlook for the PV market in Germany will be presented. Afterwards, the prosumer market is calculated by evaluating the share that self-consumption has in each segment of the overall PV market. The three concepts of prosumption, that where identified and described by the PVP4Grid project, are examined together and differentiated at the end of the SEIM-simulation. The market outlook has been developed with the help of the German PVP4Grid project partner, Bundesverband Solarwirtschaft e.V. (BSW) and is based on estimates provided by EuPD research.

7.3.1 General PV-outlook

The German PV-market outlook is based on the base-case scenario that was discussed in chapter 7.1. This scenario targets 120 GW of cumulated capacity by 2030 which is achieved by a continuous growth of annual installations each year (Figure 7.3). The segmentation is based on the EEG- based capacity additions for 2019 as published by the Bundesnetzagentur[19], EuPD Research, the BSW and the GMO. Besides a continuous overall growth of annual PV installations, also the distribution of capacity additions between the residential, commercial and industrial segments changes over time: the industrial sector gradually gains in importance and will become the largest segment by 2024. In 2019, nearly 4 GW of PV-systems were installed, with a high share of systems in the range between 500 kWp and 750 kWp which is the limit for direct PV support. In this scenario, annual installations will increase to 6.250 MW installations by 2025 and to more than 8.300 MW by 2030. Considerable growth is also predicted in this scenario for the residential market – from 555 MW in 2019 to 900 MW in 2025 and 1.300 MW in 2030 – but it will stay far behind the other two segments. The growth predicted in this outlook can be described as feasible for the German PV-industry, as there are no extreme peak years foreseeable at the moment that might be hard to be realized by the existing PV companies. These predictions reflect optimism on the current PV-specific political situation in Germany, as the nuclear-exit as well as the coal-exit were decided.

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19 https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/ZahlenDatenInformationen/EEG_Registerdaten/EEG_Registerdaten_node.html

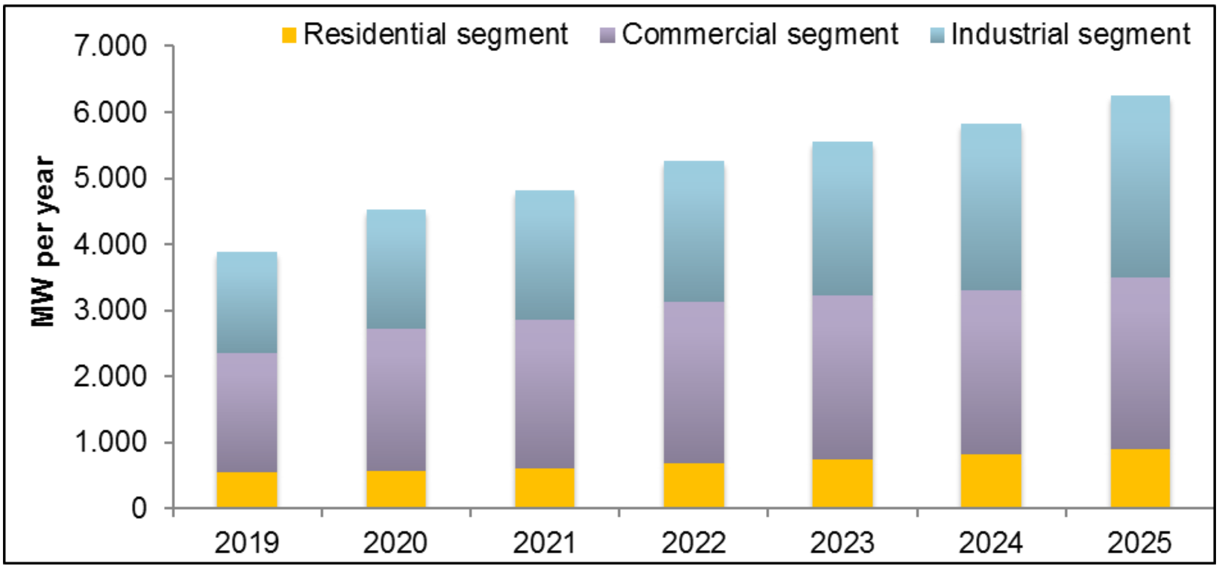

Figure 7.3: Annual PV installation in Germany, general PV-market with segmentation (own estimation based on EuPD Research, the BSW and the Global Market Outlook by SolarPower Europe)

7.3.2 Self-consumption

The bureaucratic effort to operate self-consumption concepts is still significant and leaves an opportunity to further boost the installation of prosumer systems. Thus, for example, the grid operator must be notified of any consumption from systems >7 kWp (PVP4Grid-GER-Report on PVP4Grid Concepts and Barriers 2018). In the developed market outlook, the future installations of PV in the residential and commercial segments are operated with business-models, that are based on the PVP4Grid concepts. Figure 7.4 depicts the number of installations in the two segments and the share of self-consumption PV. The industrial market is driven by utility-scale, industrial-systems that are not operated based on a self-consumption concept. The growing annual installations add up to cumulated capacities that are shown in Figure 7.5. The share of self-consumption PV in relation to all installed systems up to 2018 is lower than this will be the case in the future (see chapter 7.1). Therefore, in the industrial market the share prosumption has in cumulated capacities is constantly on the rise. It starts at 20 % in 2018, will grow to 36 % in 2025 and will end up at 42 % in 2030. This would mean, that in this scenario by 2030 over 50 GW of PV would be based on PVP4Grid-concepts.

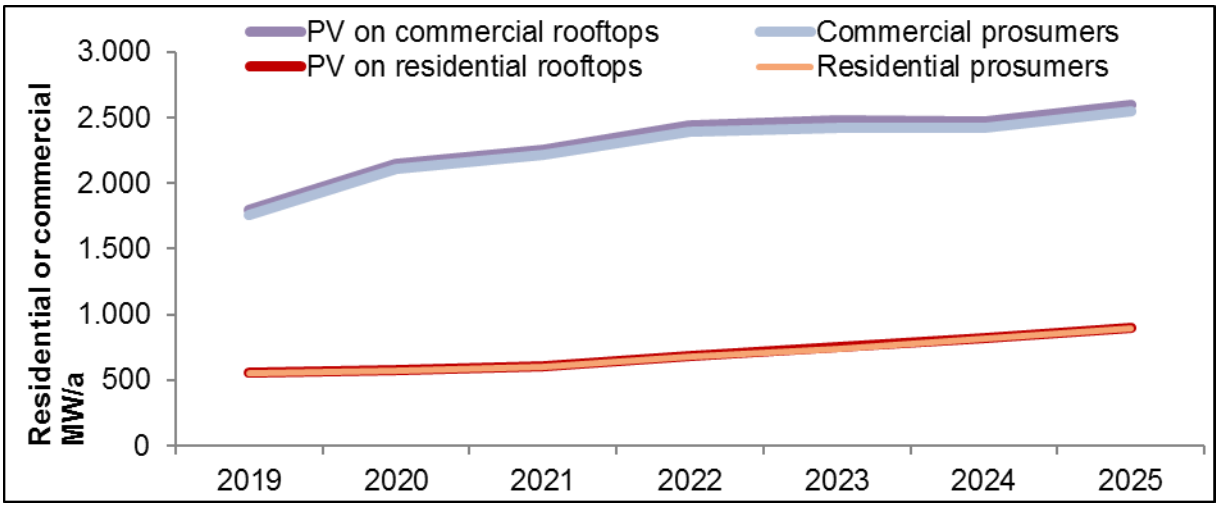

Figure 7.4: Annual installations in the German residential and industrial segment (own estimation based on EuPD Research, the BSW and the Global Market Outlook by SolarPower Europe)

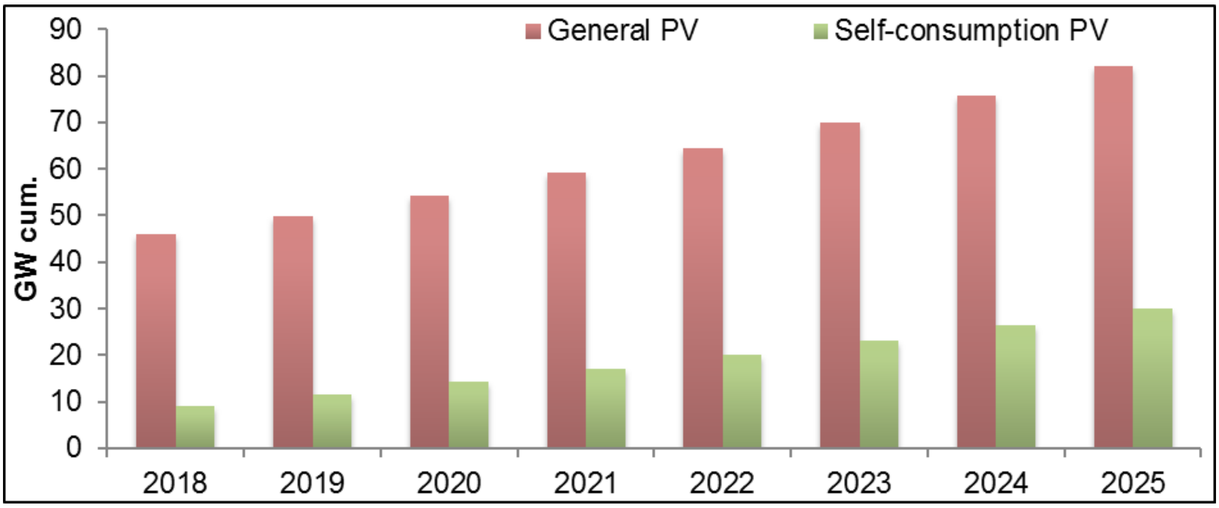

Figure 7.5: The ratio between prosumer and general PV, cumulated capacity, Germany, SEIM calculation

In the context of the PVP4Grid project, three different prosumer business models (or concepts) have been evaluated. Therefore, the installations in the self-consumption segment have been split between the three different concepts:

- Concept 1: Direct single use
- Concept 2: Local collective use
- Concept 3: District level energy models

Between these three concepts, the German "Report on PVP4Grid Concepts and Barriers"[20] uses a differentiation by system size. The report stipulates that systems < 10 kWp belong to the first concept, systems between 10 kWp and 100 kWp to the second, systems larger than 500 kWp are allocated to the third concept and systems between 100 kWp and 500 kWp can follow both collective use concepts 2 and 3. This segmentation is a simplification of the current situation in which many systems have a size between 100 kWp and 500 kWp. There are residential installations larger than 10 kWp that are operated under concept 1 or systems larger than 500 kWp that are operated under a local collective use. Using the simplified PVP4Grid categorization, residential systems are allocated to single direct use, and commercial prosumers are allocated to the concepts two and three based on their system size. As the future shares and boundaries of the concepts cannot be forecasted reliably enough, the SEIM tool does not change this allocation over time. The development from 2019 to 2025 is shown in Figure 7.6. Due to a high amount of annual installations in the commercial segment, especially in the range between 10 kWp and 500 kWp, the concept 2 will be subject to significant growth (Bundesnetzagentur 11/2019). This concept is predicted to be the main driver of self-consumption PV in Germany, keeping in mind the simplification that was adopted from the PVP4Grid project.

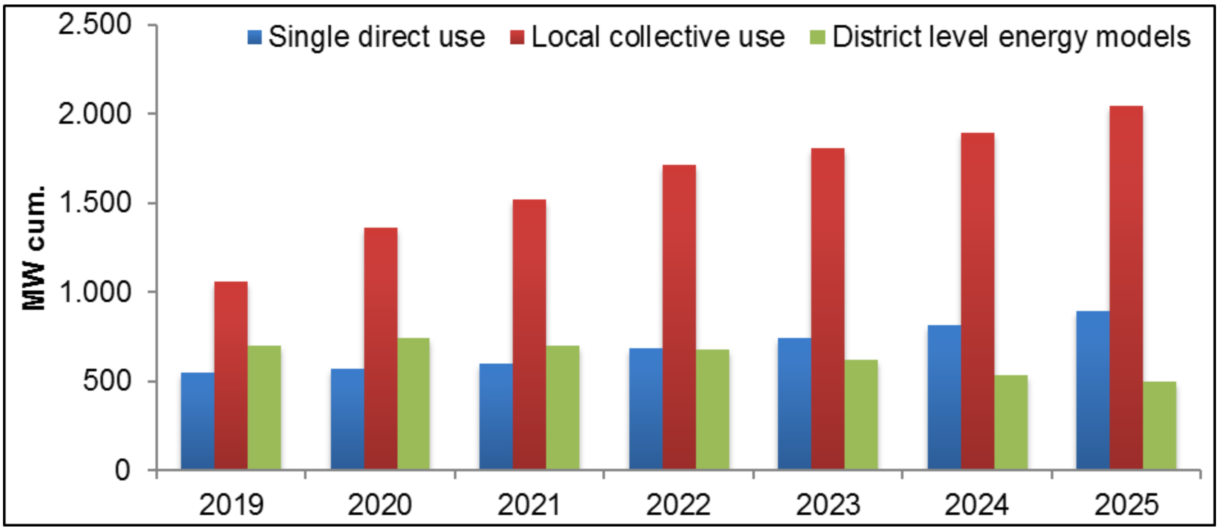

Figure 7.6: A possible segmentation of the new installed prosumer PV, Germany, based on SEIM calculation and PVP4Grid project categories

[20] Published on the PVP4Grid homepage: https://www.pvp4grid.eu/pv-prosumer-concepts/

7.4 PV-employment, general and self-consumption

The employment factors used to assess the job creation by PV installations in Germany are calculated based on the value chain used by SolarPower Europe and E&Y in their “Solar PV Jobs & Value Added in Europe” report (Waele et al., 2017). As said before, the employment based on self-consumption PV installations is distinguished from the overall, general PV market and the results are graphically presented until 2025. Figure 7.7 shows the development of FTE jobs based on general PV and based on the share of self-consumption PV.

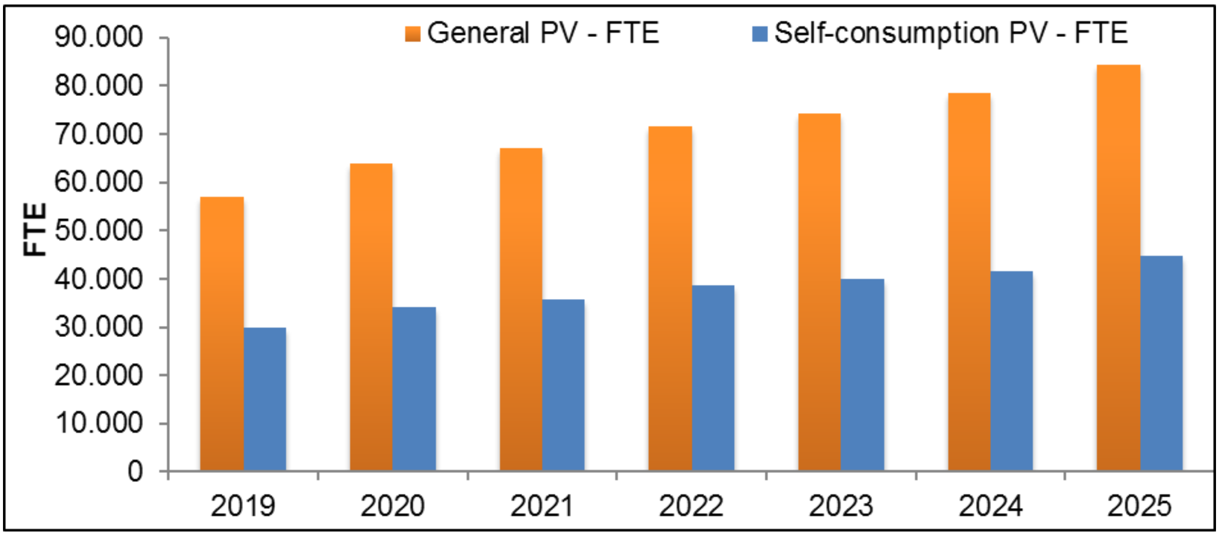

Figure 7.7: Employment in FTE, based on general PV and on the self-consumption segment, Germany, SEIM calculation

The number of jobs (FTE) in Germany is growing constantly, in line with the growing PV-installations. In the basic scenario, the PV industry will grow from 56.900 FTE in 2019 to 84.400 FTE in 2025. The developed market outlook will lead to 114.900 FTE in 2030 under the assumption that 8,4 GW will be installed in that year. 53 % of those FTE are based on the demand for self-consumption PV. Figure 7.8 indicates how the FTEs in Germany are distributed along the PV value chain.

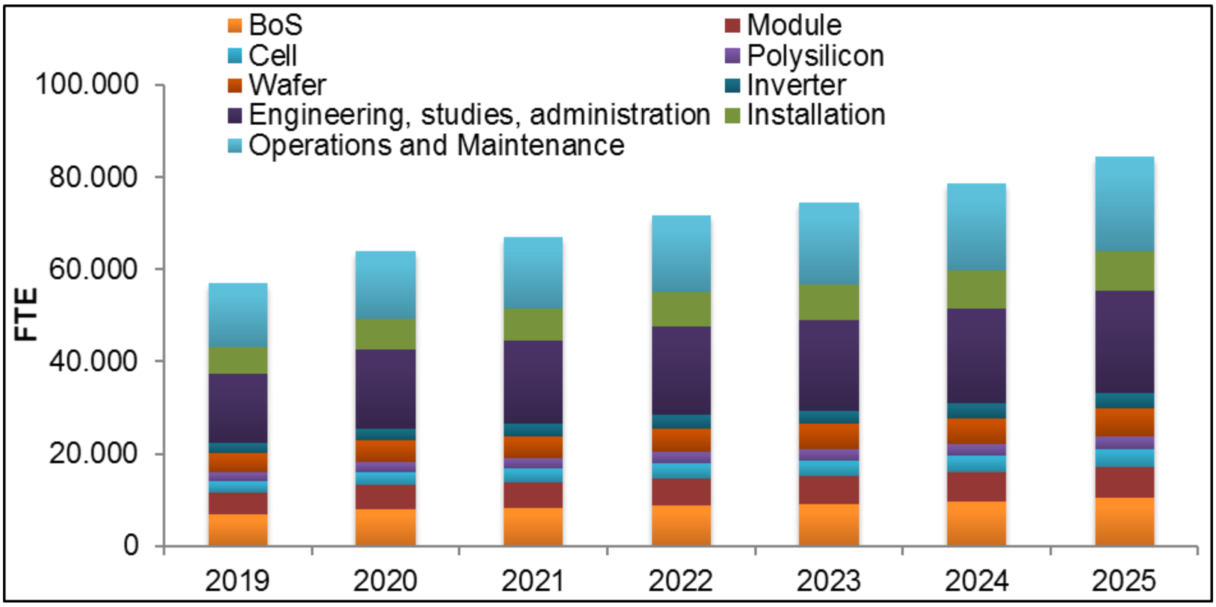

Figure 7.8: Distribution of FTE along the PV-value chain, segmentation based on SolarPower Europe, Germany (Waele et al. 2017), SEIM calculation

Most of the jobs are created by the value chain activities linked to `Engineering, studies, administration´ and `O&M´. The O&M segment is the only part of the value chain whose size is determined by the number of cumulated capacities, rather than by annual installations. In steadily growing markets like Germany, O&M is slowly gaining significance – starting with 24 % of all FTE in 2019 and ending up with 26 % of all FTE in 2030 – but due to the high amount of annual installations, O&M is not able to surpass the `Engineering, studies, administration´ part of the value chain (26 % of all FTE). In comparison with the other examined markets, the German PV industry stands out in the following way: It is the only one that creates a relevant number of jobs in each part of the value chain. Even though there are two segments stronger than the others, the industry is much more independent of individual segments than this is in case in other PVP4Grid countries. Regarding the distribution of jobs along the value chain, there is no big difference between the distribution of FTE based on the general PV market and based on self-consumption.

In the timeframe considered by the SEIM-tool the upstream jobs of the PV value chain account for 38 % to 40 % of all FTE. In consequence, 62 % to 60 % of the workplaces are downstream and offer a better job security due to being local (Waele et al., 2017, S. 35).

In order to describe the effect, the PVP4Grid self-consumption concepts have on the German PV-industry, the self-consumption jobs are allocated to the concepts already actively used.

The allocation of FTE is based on the breakdown of annual installations and cumulative capacity as described in chapter 7.3.2 and is presented in Figure 7.9. In this simplified categorization, 24 % of all FTE are based on the demand for local collective use PV, around 15 % are based on district level energy models and around 13 % are based on the single direct use.

For the general PV industry, the following key figures can be calculated: Per MW of cumulated capacity, 0,25 FTE in the segment O&M are created and remain unchanged over the lifetime of the PV system[21]. Around 10,4 FTE/MW are created for each newly installed PV system, but in this model these jobs are only accounted for in the year of installation. For each MW of cumulated self-consumption PV 0,29 FTE in the segment O&M are created (over the entire lifetime of the system). In the year of their installation, new self-consumption systems create 11,4 FTE/MW (2019) to 10,5 FTE/MW (2030) in the remaining value chain components. Therefore, prosuming PV systems create more jobs than utility-scale systems. This effect occurs because smaller PV systems tend to be more labor intensive per kWp installed than larger utility scale systems and because rooftop systems are also more labor intense (per kWp installed and maintained) than ground mounted parks (Waele et al. 2017). As a consequence, the installation of self-consumption PV can be seen as beneficial for job creation.

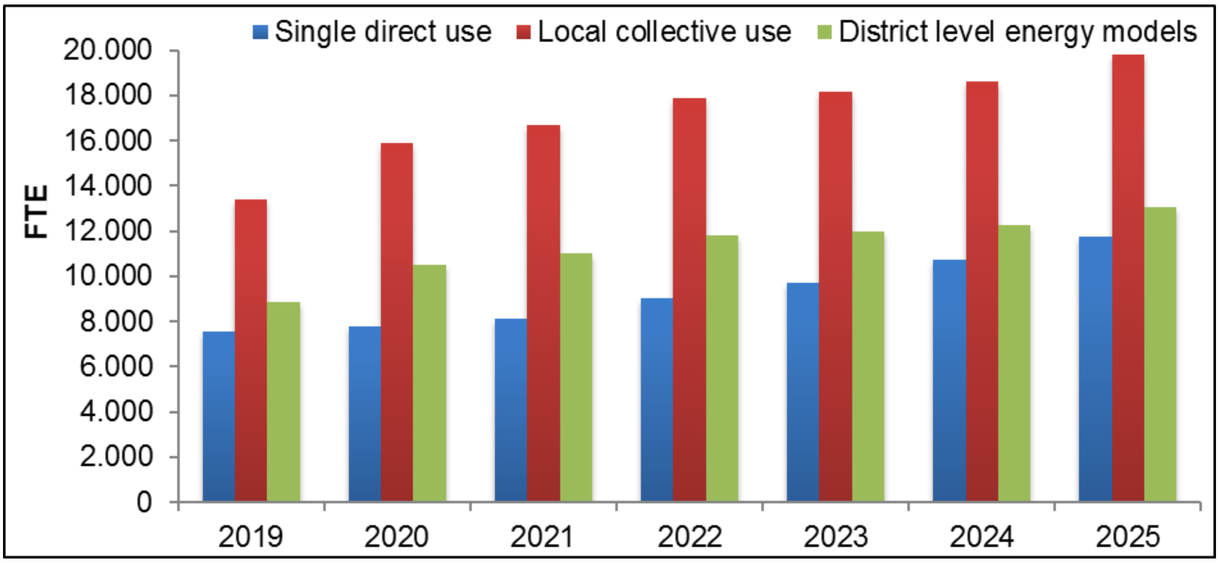

Figure 7.9: Possible scenario of employment based on the three developed self-consumption concepts, Germany, SEIM calculation

[21] Reduced only by general efficiency gains.

7.5 Value creation

In general, the annual value creation is determined by the annual installations. The value creation based on the 2019 installations is around 3,8 billion EUR/a and is growing every year (see Figure 7.10). It rises to approx. 5,9 billion EUR/a by 2025 and the PV installations in 2030 will generate a value added of approx. 8,4 billion EUR/a. Looking only at self-consumption systems, the value creation starts at 2,1 billion EUR/a and rises to 3,3 billion EUR/a by 2025. This value creation can be divided into the three components “public value creation”, “net salaries” and “private net profits”. With 64 % of the value creation, the net salaries account for the main share of the value creation, followed by around 31 % based on taxes and social security contributions and 5 % of corporate net profits. This is depicted in Figure 7.11.

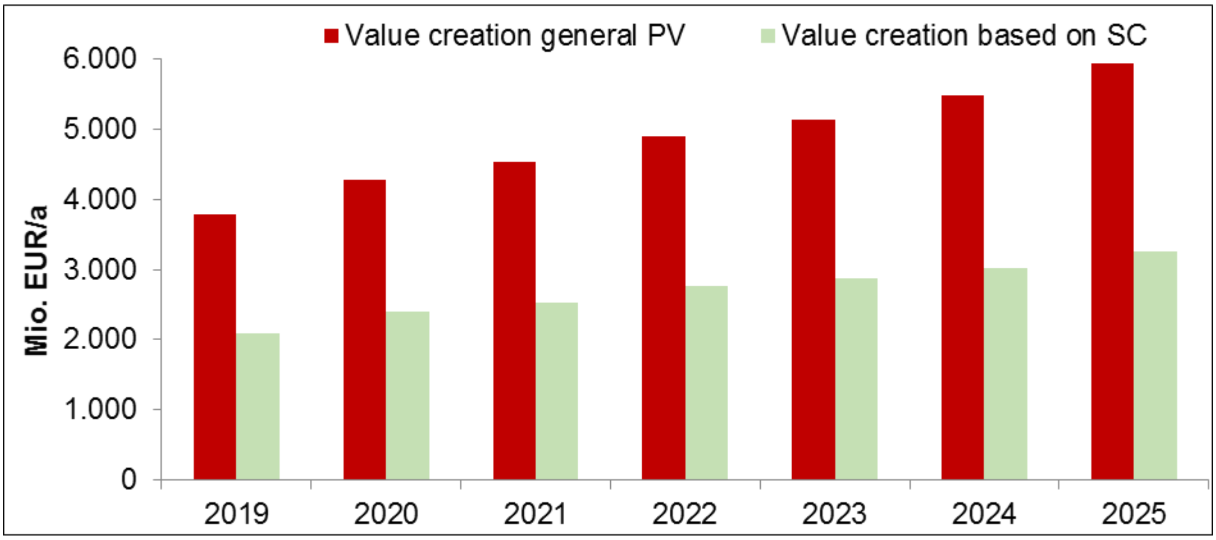

Figure 7.10: Annual value creation via PV in Germany, general PV vs. based on SC, SEIM calculation

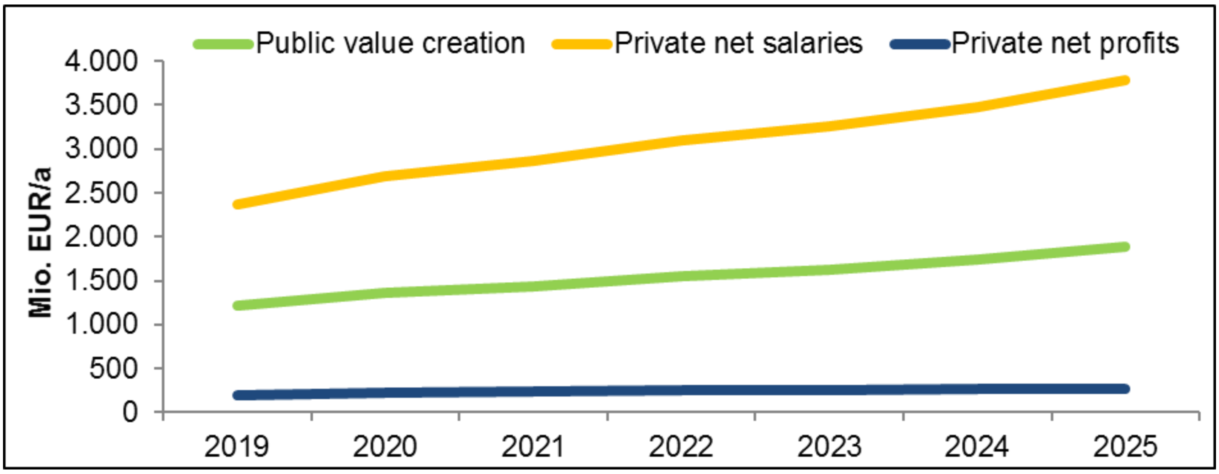

Figure 7.11: Structure of value creation in Germany, public vs. salaries vs. private profits, SEIM calculation

Per installed MW of self-consumption PV, around 18.400 EUR are created each year over the lifetime of the system. In the year of the installation, around 798.000 EUR/MW of value added are created. Compared to the general PV market, these values indicate the deployment of self-consumption PV to be beneficial in terms of macroeconomic effects in Germany compared to the overall PV market, where the corresponding key figures are 16.100 EUR/MW (O&M) and 750.000 EUR/MW in the first year. Again, all value created based on self-consumption PV is allocated to the three simplified PVP4Grid concepts as is explained in chapter 7.3.2. The results are presented in Figure 7.12.

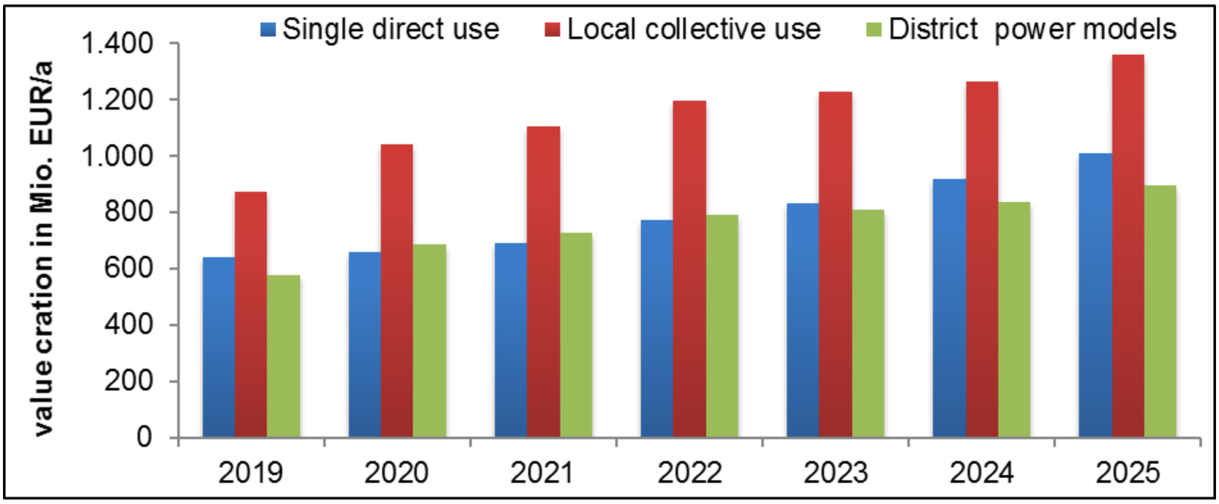

Figure 7.12: Value creation allocated to the three evaluated self-consumption concepts, Germany, SEIM calculation

7.6 Scenarios

The base-case scenario developed for this report is aiming to reach 120 GW by 2030. To achieve this goal, the German PV market needs to grow fast in terms of absolute numbers. The installation of many PV systems in the years 2009 to 2012 as well as a stable 4-digit (MW) annual PV-market between 2013 and 2018 already seem to indicate that the German PV-industry can handle the installations predicted in the base-case. The numbers for PV installations in 2019 (until the end of November) that were published by the Bundesnetzagentur are in line with the base-case scenario. If legal and technical frameworks are released to support the development of the PVP4Grid concepts an even faster growth seems possible. With reference to the EuPD study, the best-case scenario is calculated to reach more than 160 GW of cumulated capacity by 2030, which would have large socio-economic effects on both the labor market and the value creation. However, the current situation in Germany also leaves room for a more pessimistic market scenario. Therefore, the worst-case scenario is guided by the German NECP and leads to a cumulated capacity of less than 98 GW in 2030. Both of these scenarios are presented, together with the base case scenario, in Figure 7.13 and in Figure 7.14.

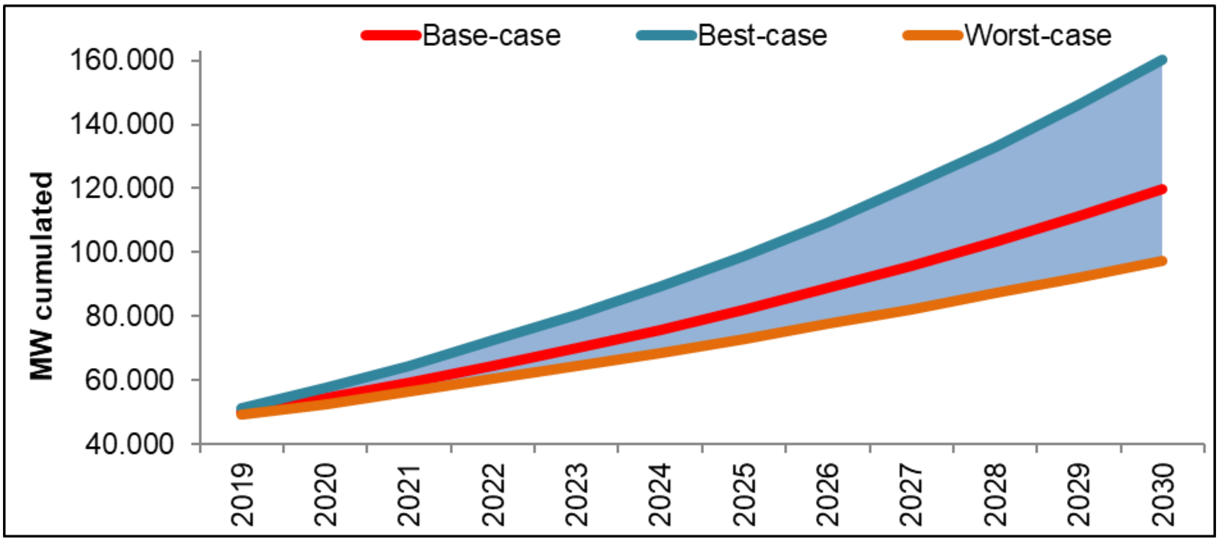

Figure 7.13: German scenarios, cumulated capacity until 2030

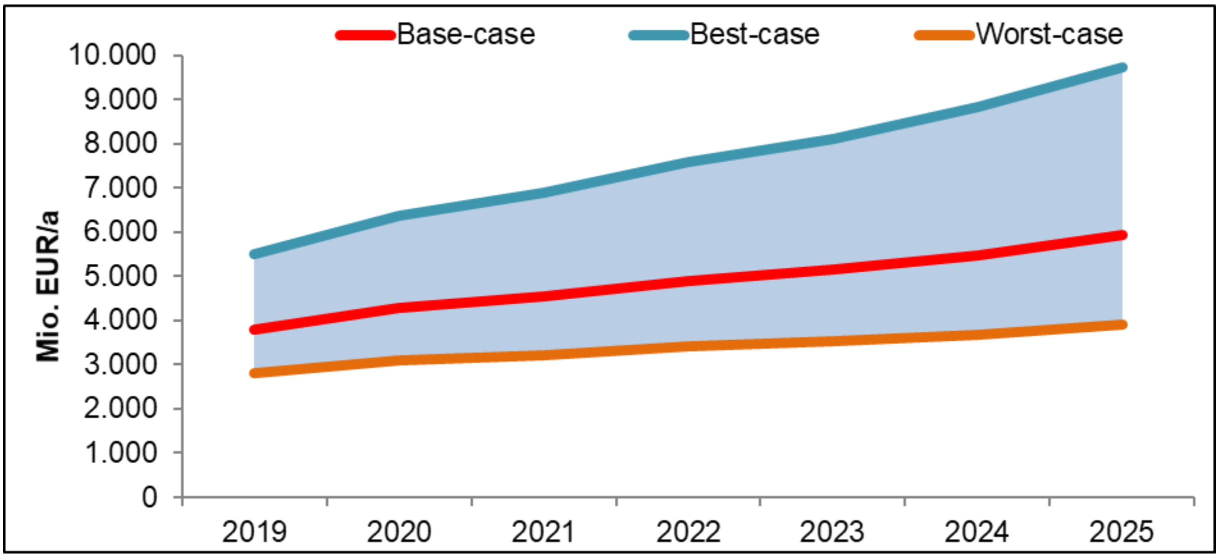

Figure 7.14: German scenarios, annual value creation until 2025

8 Italy

8.1 PV overview

With around 20 GW (2018) Italy already has installed a lot of PV capacity. However, in the last years only around 400 MW were installed annually.[22] The high amount of cumulated PV capacity can mainly be traced back to 2011 when nearly 10 GW were installed. This boom was caused by a policy of the Italian government (the 'Conto Energia'), issued to develop the PV market with Feed-in Tariffs. This scheme was capped at an annual cost of 6,7 billion EUR, which was reached in 2013. Since then, growth on the Italian PV market is mainly based on self-consumption schemes. To reach the 2030 goal of 50 GW PV capacity, stated in the Italian NECP, the PV-industry needs to install on average an annual capacity of 2,5 GW. In Figure 8.1 the growth of the PV-industry until 2025 is presented.

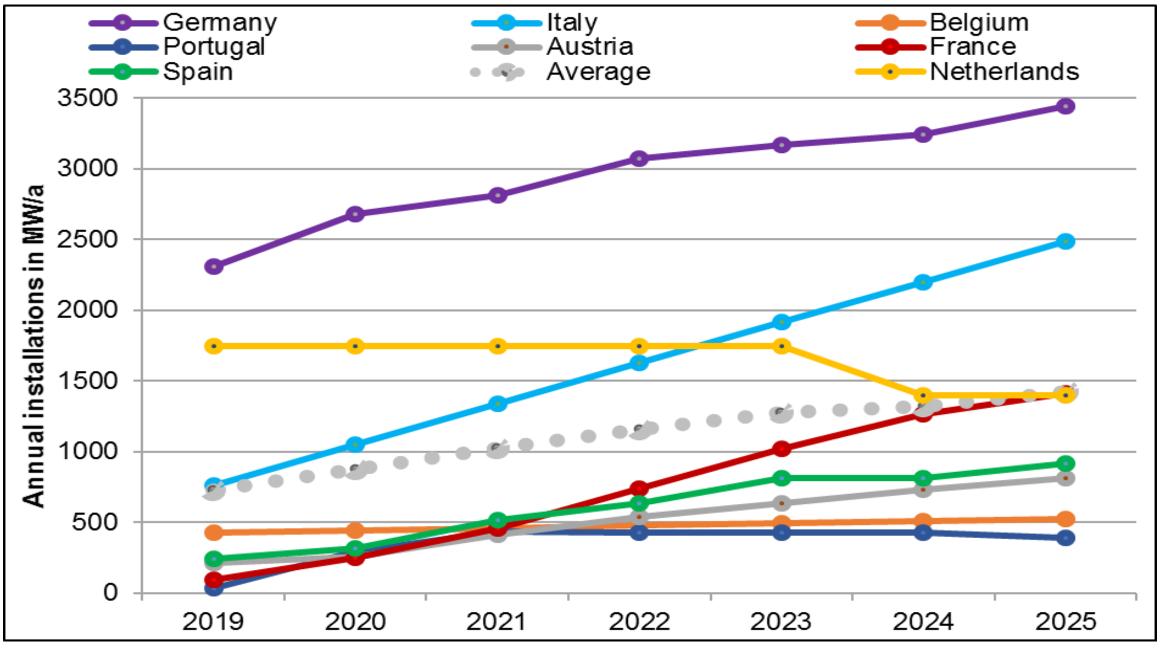

Figure 8.1: Italy's (light-blue) self-consumption outlook shows a substantial growth and a high performance

Looking at the development of the Italian PV market, there are several framework conditions established by the Italian government, that could serve as an example for other European

[22] Based on the database EurObserv'ER; https://www.eurobserv-er.org/online-database/

markets. During 2010 and 2013 the economic benefit of installing PV was very high due to a high FiT. During this period a lot of Italians familiarised themselves with PV as an electricity generation technology. Consequently, the knowledge about PV nowadays is widely spread among Italian citizens. Together with the decreasing prices for PV-components this social acceptance of PV creates the base for PV distribution across all levels of society. After the FiT support scheme was widely phased out in 2013 the only option for interested consumers to use PV was self-consumption. Given that Italians are generally well informed and interested in the technology, the main challenge for the deployment of PV is to make it financially viable – and to create a reasonable bureaucratic environment.

The Italian government's fiscal policy helped to create good economic conditions for renewable energy: First, the VAT for renewable energy systems is only 10%, compared to 22 % of regular VAT. This supports the residential demand for PV, not only by decreasing the investment costs, but also by showing the political will to support renewable energy systems. Second, a private investor in Italy can reduce up to 50% of the investment in PV from his tax liabilities during the first ten years after the system was installed. This support measure has been existing for over 15 years now which has created confidence in the governmental support for investments in RE. Moreover, this fiscal support scheme is also administered by a simplified procedure: it must only be requested in the first year after the installation, in the following years it is automatically considered by the tax authorities. All these measures lead to an optimistic view on the PV growth, at least in the residential self- consumption market. The government recently tried to extend the successful residential support scheme to the commercial self-consumption sector by a new decree (FER1 Decree 2019). However, as this decree is new it still has to prove its efficiency. In addition, the PV sector is waiting for technical guidelines on commercial or industrial self-consumption, whose details will play an important role for the development of these market segments in Italy.

The role of renewable energies and their contribution to energy generation is relatively strong in Italy. While there are no active nuclear power plants since 2018 (after a referendum in 2011), there are some coal fired plants in operation. The ambitious Italian NECP allows the decommission of this technology until 2026. With 18,8 GW (of which 140 MW were installed in 2018) of cumulated power the hydro sector is the strongest of the renewable sectors in terms of energy production. Wind contributes 10,3 GW to the installed capacity (511 MW of installations in 2018).

8.2 Input Financial Values

This chapter describes the input data used for the SEIM calculation. The system costs are considered to range between a minimum of 800 €/kWp for utility-scale ground mounted systems and 1.600 €/kWp for residential rooftop installations. The salary in the PV industry averages 3.500 €/month. The income tax and social security contributions average 23,5 %, the corporate tax level in Italy is at 27,9 %. The VAT rate for renewables is at 10 %.

8.3 PV market

At first, the general outlook for the PV market in Italy will be presented. Afterwards, the prosumer market is calculated by evaluating the share that self-consumption has in each segment of the overall PV market. The three concepts of prosumption, that where identified and described by the PVP4Grid project, are examined together and differentiated at the end of the SEIM-simulation. The market outlook has been developed with the help of the Italian PVP4Grid project partner, Ambiente Italia.

8.3.1 General PV-outlook

Stability is of uttermost importance in order to create positive socio-economic impacts. For Italy this means to keep the already existing support scheme stable while creating in parallel the legal and technical environment to establish new business models. New legislations like the FER1 Decree 2019 and the NECP are allowing for a very optimistic outlook on the future of PV in Italy. As shown in chapter 7.1, the largest share of these activities will take place in the prosumer sector. Like in most of the other participating countries it is foreseen that PV will be the strongest renewable energy technology in terms of installed capacity by 2030. While the wind capacity is planned to reach 18,4 GW in 2030 (15,7 GW in 2025) and hydropower is planned to reach 19,2 GW in 2030 (19,2 GW in 2025), the goal for PV capacity in 2030 is 50 GW. If these targets are met, this would lead to a share of 30 % of renewables in the overall energy production (55,4% in electricity / 33% in thermal / 21,6 % transport) in Italy in 2030.

Despite this positive perspective, there are several topics that still need to be addressed to make the growth of renewables sustainable. One of them is the further simplification of bureaucratic processes which are often still considered to be complicated – despite the existing simplifications in the residential segment. One example often named is a very restrictive legislation for landscape protection. Another topic to be addressed in order to increase the share of renewables is the upgrade of the electricity grid that is not yet ready to support the development foreseen until 2030. However, this problem was considered to be a minor problem by interviewed experts.

Finally, the political environment in Italy has to be taken into consideration. Italy has seen several governments in the last years which might have caused low confidence in political stability. Based on the goal to reach 50 GW by 2030 and annual installations that were beneath 500 MW leading up to 2019, the PV-market in Italy is expected to grow linearly by more than 300 MW per year. This market outlook is based on a mathematical simplification taking the NECP goal and the current situation as input data. The actual development of PV in Italy depends heavily on the timing of future policies or technical guidelines. The segmentation is shown in Figure 8.2, with residential systems having a share of 50 %, commercial systems having a share of 18 % and industrial systems a share of 32 %. These values have been developed in cooperation with Ambiente Italia and are based on the segmentation leading up to 2019.

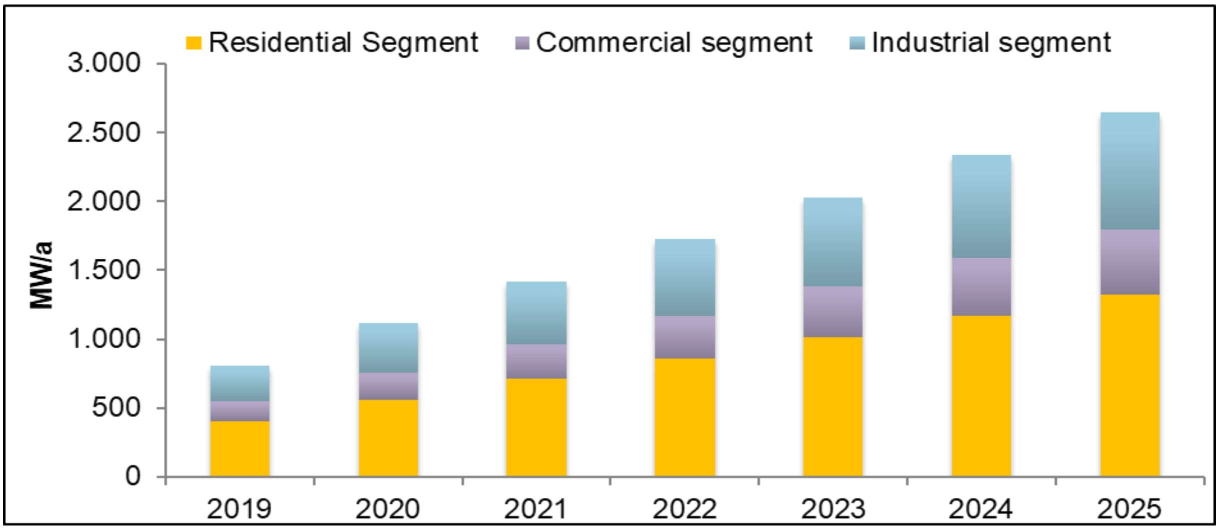

Figure 8.2: Annual PV installation in Italy, general PV-market with segmentation (based on Ambiente Italia and the Global Market Outlook by SolarPower Europe)

The announcement of a legal framework for collective self-consumption or even a district power model has to be mentioned as one of the possibilities to support prosumer activities in Italy. Self-consumption is currently the only business-model for PV in the residential and commercial sectors (Figure 8.3). The industrial sector is predicted to develop 82 % of its PV activities in the self-consumption segment (Figure 8.4).

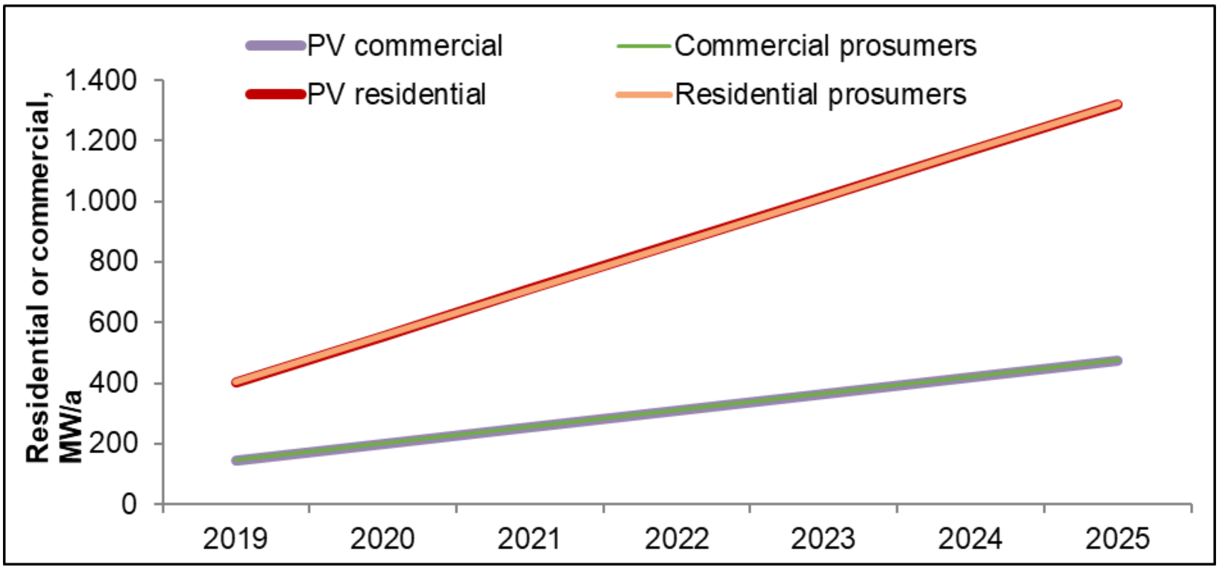

Figure 8.3: Annual installations in the Italian residential and industrial segment

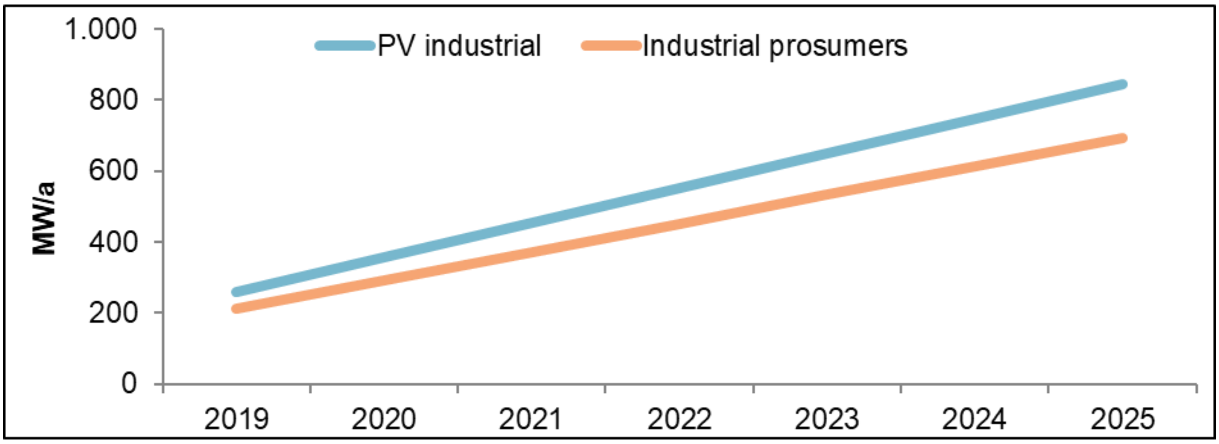

Figure 8.4: Annual installations in the Italian industrial segment

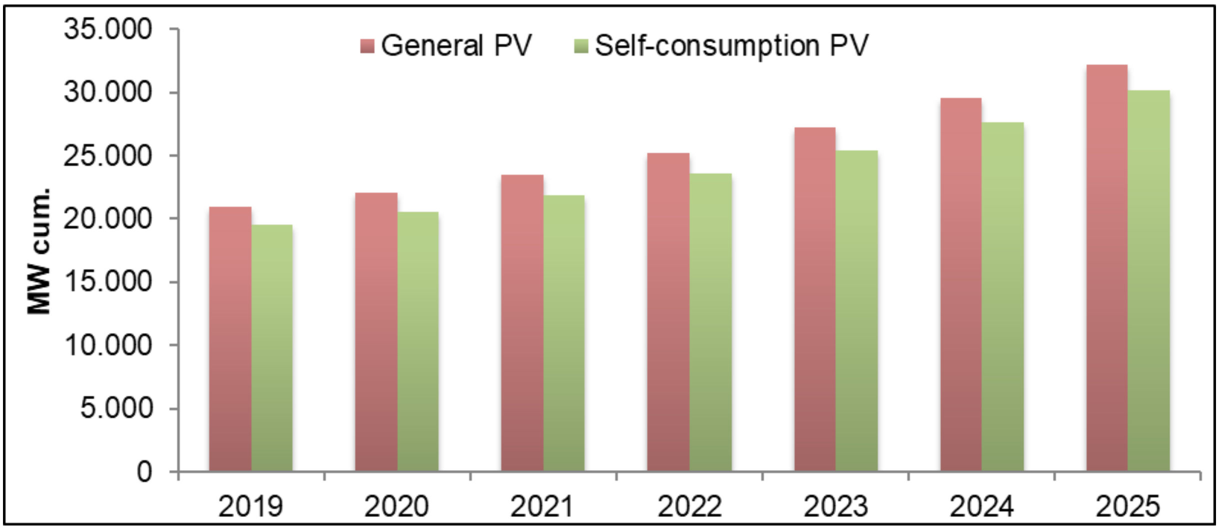

Figure 8.5: The ratio between prosumer and general PV market, Italy, SEIM calculation

The development of the cumulated capacity is shown in Figure 8.5. The share of self-consumption PV under the current legal framework is at 94 %. The only systems that are not considered to operate as Prosumer-systems are installed in the industrial segment. In the context of the PVP4Grid project three different prosumer business models (or concepts) have been evaluated and the installations in the self-consumption segment have been split between these three concepts accordingly.

- Concept 1: Direct single use
- Concept 2: Local collective use
- Concept 3: District level energy models

In Italy the allocation of self-consumption PV to the three concepts is rather easy due to concept one (direct single use) being the only one active (Report on PVP4Grid Concepts and Barriers).[23] All forms of local collective use of PV-systems are not allowed under the resolution 578/2013/R/eel "Sistemi Semplici di Produzione e Consumo" (SSPC). Therefore, all self-consumption systems operate under the framework of concept one. This evaluation is a simplification, due to the expectation that the other concepts will eventually gain significance, but it is uncertain today when this will happen and what the impact would be.

[23] Report published on the PVP4Grid homepage: https://www.pvp4grid.eu/pv-prosumer-concepts/

8.4 PV-employment, general and self-consumption

The employment factors used to assess the job creation by PV installations in Italy are calculated based on the value chain used by SolarPower Europe and E&Y in their “Solar PV Jobs & Value Added in Europe” report (Waele et al., 2017). As said before, the employment based on self-consumption PV installations is distinguished from the overall, general PV market and the results are graphically presented until 2025. Figure 8.6 shows the development of FTE based on general PV and based on the share of self-consumption PV.

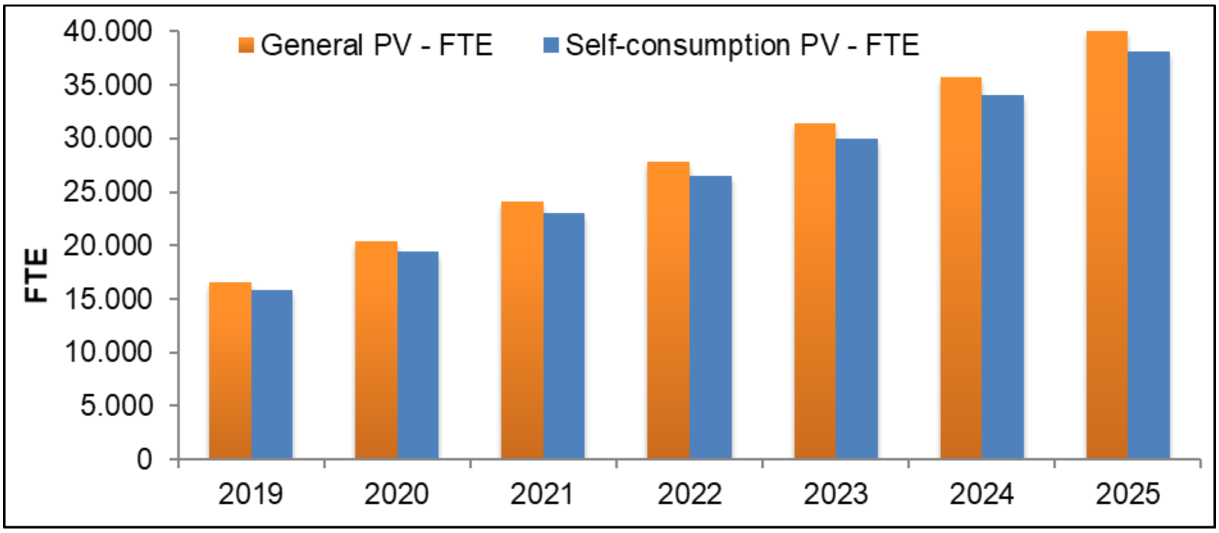

Figure 8.6: Employment in FTE, based on general PV and on the self-consumption segment, Italy, SEIM calculation

The number of jobs (FTE) in Italy is growing constantly, in line with the growing PV-installations. In the basic scenario the PV industry will grow from 16.600 FTE in 2019 to 40.000 FTE in 2025. The developed market outlook will lead to 63.000 FTE in 2030 under the assumption that the NECP target is met exactly. 95 % of those FTE are based on the demand for self-consumption PV. Figure 8.7 indicates how the FTEs in Italy are distributed along the PV value chain.

Most of the jobs are created by the value chain activities linked to `Installation´, `Engineering, studies, administration´ and `O&M´. The O&M segment is the only part of the value chain whose size is determined by the number of cumulated capacities, rather than by annual installations. In steadily growing markets O&M is slowly gaining significance. In Italy, due to a high amount of operational systems and a low amount of annual installations at the beginning of the evaluated timeframe, O&M is the domain that offers the most jobs more than 38 % of the total. This relative share is going to decline to 23 % until 2025 and will further decline as long as the annual installations are growing. Regarding the distribution of jobs along the value chain, there is no big difference between the distribution of FTE based on the general PV market and based on self-consumption. In the timeframe considered by the SEIM-tool the upstream jobs of the PV value chain account for 15 % to 18 % of all FTE. In consequence, up to 85 % of the workplaces are downstream and offer a better job security due to being local (Waele et al., 2017, S. 35).

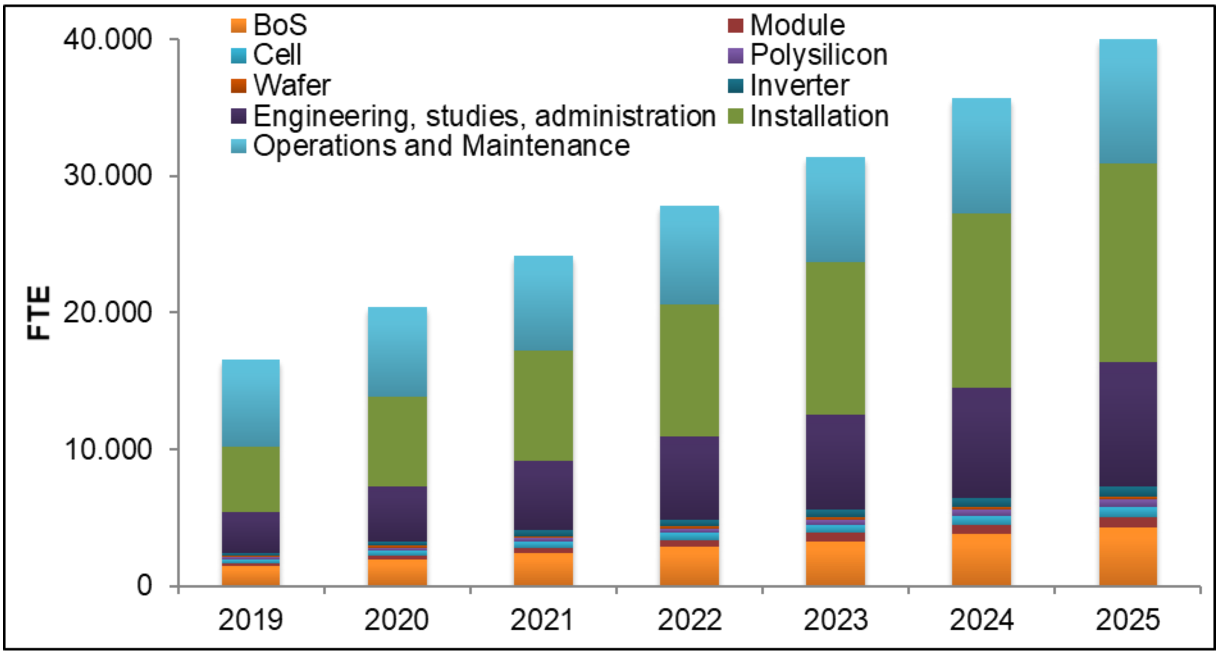

Figure 8.7: Distribution of FTE along the PV-value chain, Italy, SEIM calculation

In order to describe the effect PVP4Grid self-consumption concepts have on the Italian PV-industry, the self-consumption jobs are allocated to the active concepts. All self-consumption FTE are active based on the concept one: single direct use. For the general PV industry, the following key figures can be calculated: Per MW of cumulated capacity, 0,3 FTE in the segment O&M are created and remain unchanged over the lifetime of the PV system[24]. Around 11,9 FTE/MW are created for each newly installed PV system, but in this model these jobs are only accounted for in the year of installation. Due to self-consumption being the main driver of the

[24] Reduced only by general efficiency gains.

Italian market the key figures for self-consumption-employment are not very different to the general key figures.

8.5 Value creation

In general, the annual value creation is determined by the annual installations. The value creation based on the 2019 installations is around 841 million EUR/a and is growing every year (see Figure 8.8). It rises to approx. 2,2 billion EUR/a by 2025 and the PV installations in 2030 will generate 3,4 billion EUR/a. Looking only at self-consumption systems, the value creation starts at 807 million €/a and rises to 2,1 billion EUR/a by 2025. Again, all value that is created based on self-consumption PV is allocated to concept one (single direct use). This value creation can be divided into the three components "public value creation", net salaries" and "private net profits". With around 63 % of the value creation, the net salaries are responsible for the main share of the value creation, followed by 30 % based on taxes and social security contributions and 7 % of corporate net profits. This is depicted in Figure 8.9.

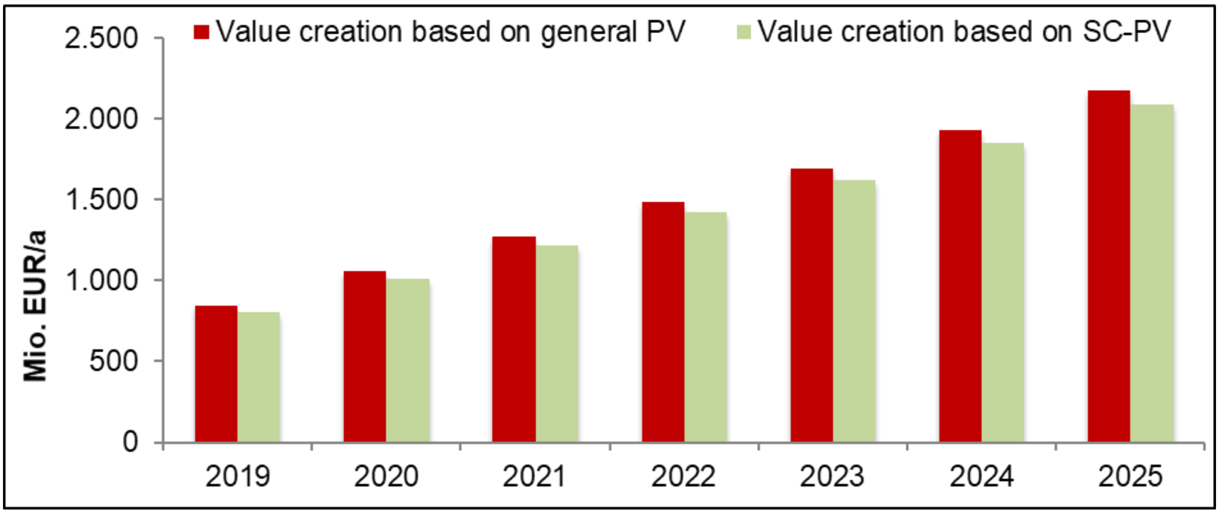

Figure 8.8: Annual value creation via PV in Italy, general PV vs. based on self-consumption, SEIM calculation

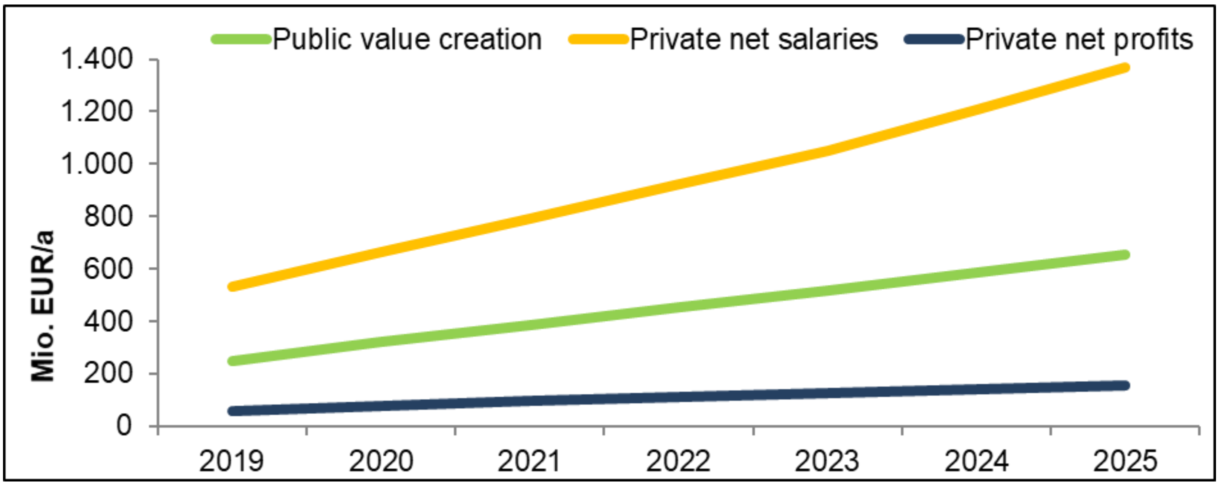

Figure 8.9: Structure of value creation in Italy, public vs. salaries vs. private profits, SEIM calculation

Per installed MW of self-consumption PV, around 13.000 EUR are created each year over the lifetime of the system. In the year of the installation, around 688.000 EUR/MW of value added are created. Compared to the general PV market, these values indicate the deployment of self-consumption PV to be beneficial in terms of macroeconomic effects in Italy compared to the overall PV market, where the corresponding key figures are 12.800 EUR/MW (O&M) and 675.000 EUR/MW in the first year.

8.6 Scenarios

The base-case scenario developed for this report is bound to the fixed goal of the Italian NECP. To reach this goal, the Italian PV market needs to grow faster than the market of any other country of the PVP4Grid study. The installation of many PV systems in the years 2010 to 2013 already seem to indicate that the Italian PV-industry is able to handle the growth predicted in the base-case. If legal and technical frameworks are released to support the development of the PVP4Grid concepts two (local collective use) and three (district power models) an even faster growth seems possible. Under the best possible conditions up to 60 GW cumulated PV capacity might even be reached, which would have large socio-economic effects on both: the labor market and the value creation. On the other hand, the relatively small number of PV-installations in recent years (up to 2019), a limited number of available business-models and a frequently changing political situation also need to be considered. These factors could lead to a worst-case far below the NECP goal. Both of these scenarios are presented, together with the base case scenario, in Figure 8.10 and in Figure 8.11.

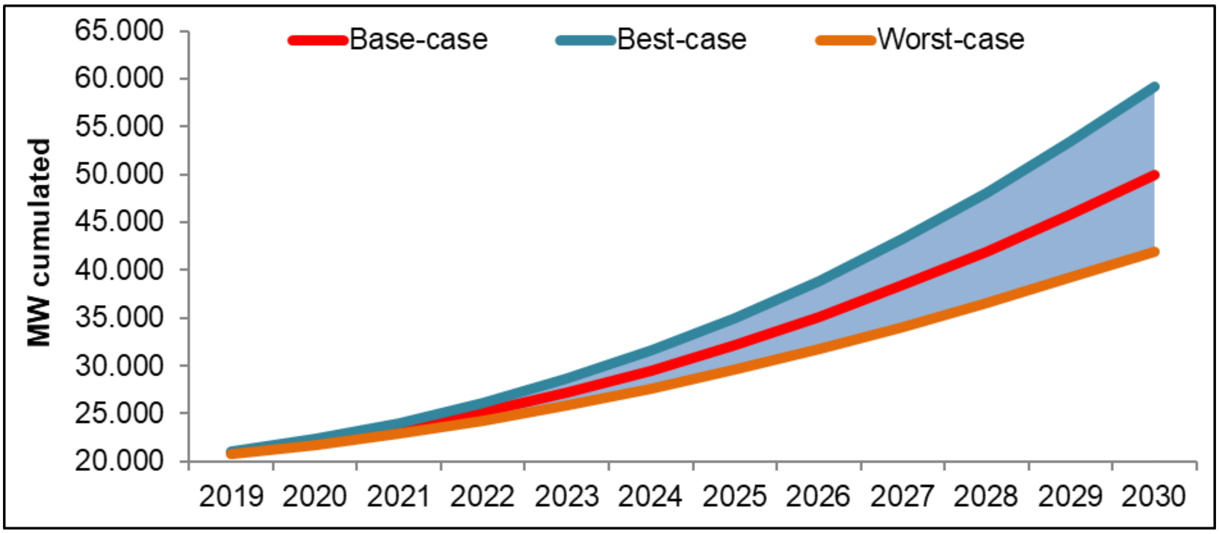

Figure 8.10: Italian scenarios, cumulated capacity until 2030

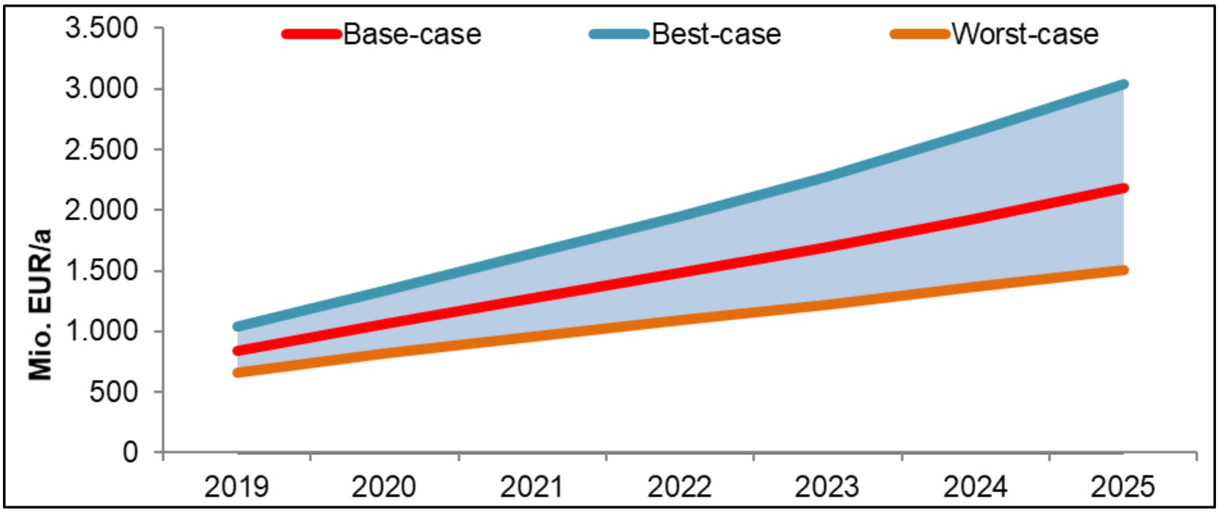

Figure 8.11: Italian scenarios, annual value creation until 2025

9 Netherlands

9.1 PV overview

The Dutch market for self-consumption differs from other European markets regarding the compensation of self-produced energy. Net-metering has been the leading business-model for PV applications in the past decade. However, the Dutch government plans to maintain the net-metering scheme only until 2023, phasing it out slowly until 2031.[25]

The Netherlands will face major challenges in the energy sector over the next decade. Today, 80 % of electricity production is based on fossil fuels. However, the composition of the Dutch energy production is changing. The main energy source has long been natural gas. After Norway, the Netherlands is the second largest producer of natural gas in the EU and exports a considerable amount to neighbouring countries. Therefore, natural gas had a share of 54 % in the Dutch electricity production in 2018 (IEA database[26]). After several earthquakes disrupted the exploitation of the "Slochterenveld" field - one of the ten largest natural gas fields in the world - the government decided to drastically reduce natural gas exploitation and cease production by 2030 – due to "security" reasons and not climate aspects (Climate and Economics Minister Eric Wiebes in 2018, Deutschlandfunk). Coal, which in 2016 contributed one third to Dutch electricity production, has already been reduced to 11 % in 2018 and in 2017 only 1.1 % of Dutch electricity production was based on nuclear power (Duits-Nederlandse Handelskamer DNHK, Eurostat[27]). Therefore, it becomes evident that the Netherlands are under pressure to find solutions on how to substitute gas and coal in the energy mix.

In 2012, the Dutch government declared the renewable energy sector to be one of the nine "top sectors" - economic activities that will be strongly supported by the state (DNHK). The main focus is on wind power - due to the naturally favourable conditions for this technology – and offshore wind production in particular is expected to grow significantly (DNHK). In contrast, unfavourable geographical conditions hinder the installation of hydroelectric power plants in the Netherlands (DNHK).

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[25] https://www.pv-magazine.com/2019/04/26/netherlands-to-maintain-current-net-metering-conditions-until-2023/

[26] https://www.iea.org/data-and-statistics

[27] https://ec.europa.eu/eurostat/cache/infographs/energy/bloc-3b.html

So far, PV has only made a small contribution to national electricity production. Almost 80 % of PV is allocated in small systems of less than 10kWp (2017, PVP4Grid-NL-Report). Since 2016, however, the Netherlands have begun to heavily support the installation of PV, increasing annual installations from around 500 MW in 2016 to 1500 MW in 2018 (CBS[28]). Spurring this development are rather straightforward administrative procedures and a well-developed grid infrastructure. Therefore, no extraordinary obstacles hinder the introduction of renewable energy in the foreseeable future - despite the usual challenges arising when substituting base load technologies with fluctuating renewables. With the continuation of a stable strategy for national renewable energies promotion and the general economic stability of the Netherlands, the market development for PV for self-consumption should reach a high plateau.

A study by the Energy Research Centre of the Netherlands ECN has shown that the majority of potential roof space for PV in the Netherlands is on private homes. The ECN concluded that business model 1 would have by far the largest share of the self-consumption market (Londo, 2017). Table 4 is taken from the PVP4Grid-NL-report.

Table 4: Estimation of the potential solar PV on the roofs of dwellings

Residences: segments	Number of dwellings (2012) million	Potentiaal solar PV (2012) [TWh/year]	Potential [%]
Buy single-family houses	3,6	~11.7 TWh	64
Buy multi-family houses	0,7	~1.5 TWh	8
Rent (housing corporation) single-family houses	1,0	~2.4 TWh	13
Rent (corporation) multi-family houses	1,2	~1.5 TWh	8
Rent (private) single-family houses	0,3	~0.6 TWh	3
Rent (private) multi-family houses	0,4	~0.6 TWh	3
Total	7,1	~18 TWh	100

[28] Central Agency for Statistics database: Renewable electricity; production and capacity

Since ECN has recently suggested the delayed elimination of net-metering between 2023 and 2031, the Dutch government has postponed its plan to phase out net metering in 2020. This serves the purpose of managing the PV market sustainably, avoid uncertainty and secure the competitiveness of new business-models. Therefore, it is possible to say that the Dutch government, while not aiming at high targets, is proceeding cautiously, taking into account current scientific studies and insights (Bellini 2019)[29]. Also, the government grants residential and commercial investors a payback period of seven years when new business models are developed (PVP4Grid-NL-Report). All this is expected to enable a stable self-consumption market, with NECP likely reaching 15 GW by 2023 and 27 GW by 2030 (general PV). The outlook for Dutch self-consumption in comparison to the other eight evaluated countries is represented in Figure 9.1.

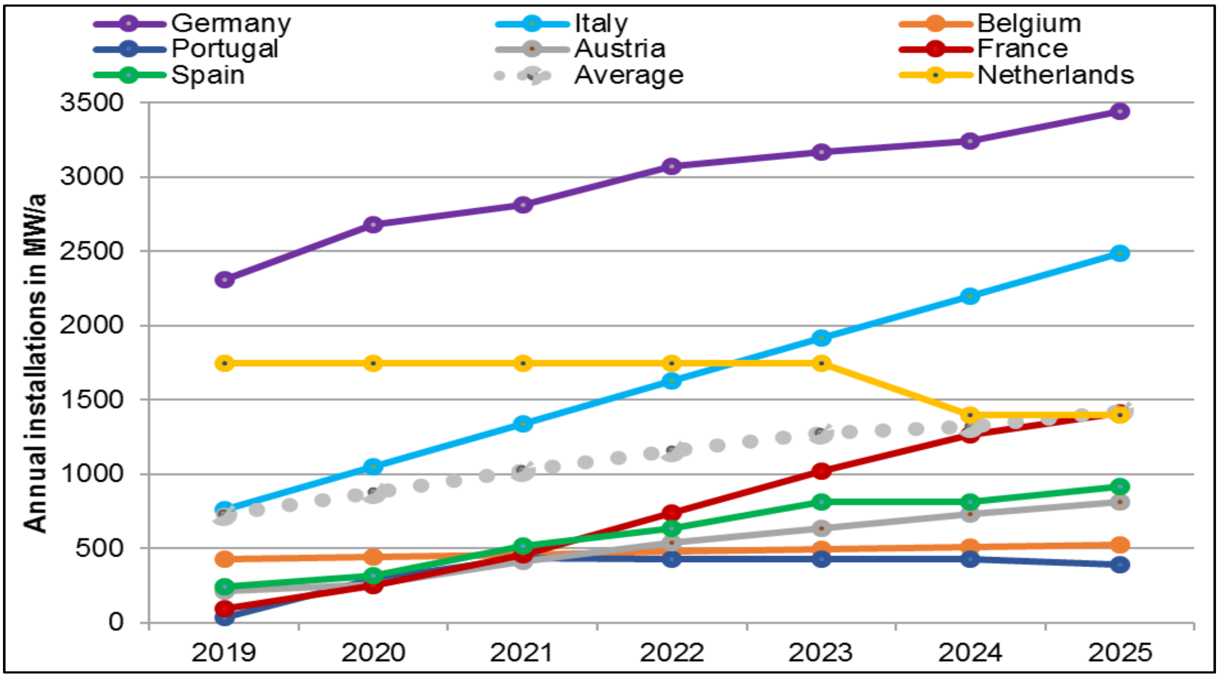

Figure 9.1: The Netherlands market (yellow) under the current legal framework, annual installations of self-consumption PV

[29] https://www.pv-magazine.com/2019/04/26/netherlands-to-maintain-current-net-metering-conditions-until-2023/

9.2 Input Financial Values

The system costs assessed range from 720 EUR/kWp for large scale PV ground-mounted systems to 1900 EUR/kWp for rooftop systems on residential buildings <1 kWp. These values are similar to the neighbouring Belgium. The increase in salaries in the PV industry is considered to be 1 % per year over the period of the report. The average rates used for calculation are 25,03 % for income tax and social contributions. Corporate tax is set at 25 %. The VAT rate in the Netherlands is at 21 %.

9.3 PV market

First, the general market outlook for the Netherlands is presented. Subsequently, the prosumer market is calculated by evaluating the share of self-consumption in each segment of the PV market. The three concepts of prosumption, identified and described by the PVP4Grid project, are analysed together and contrasted at the end of the SEIM-simulation. The market outlook has been developed in collaboration with the Becquerel Institute, national partner to the PVP4Grid project for the Netherlands.

9.3.1 General PV-outlook

Considering the major challenges Dutch electricity supply will face in the coming years (exit from coal and the gas business), the outlook for the near future can be described as positive. The uncertainty about the new framework after 2023, when the net metering concept will be replaced, has implications on the results of this study. For 2024 the annual market is expected to decline. However, the Netherlands have enormous residential rooftop potential for PV. In order to achieve the NECP's objectives and to meet the prospective changes in electricity supply, it is expected that this potential will be realized in the coming years, which could compensate for any negative effects of the grit metering phase out. The Dutch PV market is already at a high, but it has proven since 2016 that it is capable of absorbing further growth. To reach the set target for cumulative capacity of 15 GW in 2023, the Dutch market needs to expand its annual installations by 600 MW to around 2140 MW of general PV installations per year. With the new regulation entering in 2023, the market is calculated in such a way that the target of 27 GW cumulative capacity in 2030 will be reached. However, considering market uncertainty under the new system, the market may potentially decrease by 20 % to 1700 MW annual installations. This market size would secure the target for 2030. While 1700 MW are a substantial market size it seems to be a feasible task, considering the commitment the Dutch government has already shown. Figure 9.2 shows the segmentation of annual installations which is based on the “Dutch Solar Trendreport 2019” commissioned by Solar Solutions International[30]. Residential systems have a share of 38 % within total annual installations, commercial systems a share of 36 % and industrial systems a share of 26 %. This segmentation will remain unchanged until 2030 since the residential market is the driver of the Dutch industry, even when new schemes are implemented (Londo 2017).

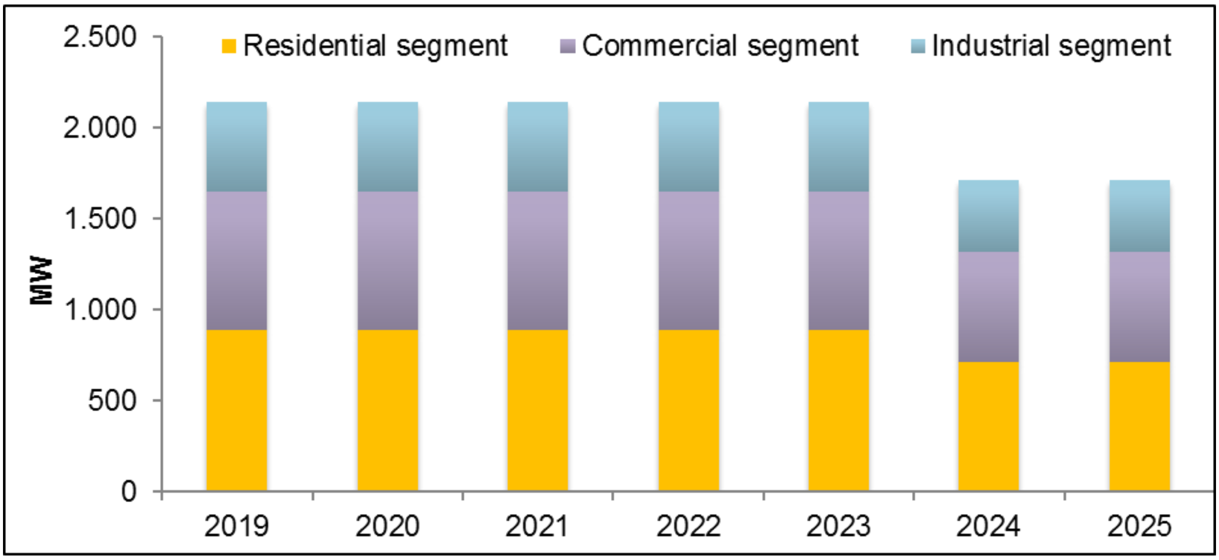

Figure 9.2: Annual installation in the Netherlands, general PV market with segmentation (based on the Climate and Energy Outlook 2019 of the Netherlands Environmental Assessment Agency PBL and the Global Market Outlook by SolarPower Europe)

9.3.2 Outlook for self-consumption

Net-metering is the most important business-model for residential and commercial PV in the Netherlands. Therefore, the future outlook for self-consumption PV is positively assessed. Residential and commercial systems are operated in PVP4Grid frameworks, which are defined for prosumption (PVP4Grid-NL-Report). Due to the district power models allowed under the Postal Code Rose Policy, the residential PV segment is estimated to have a share of 20 % self-consumption PV. The development of this segment is presented in Figure 9.3.

[30] Dutch National Solar Trend Report 2019 ©Dutch New Energy Research

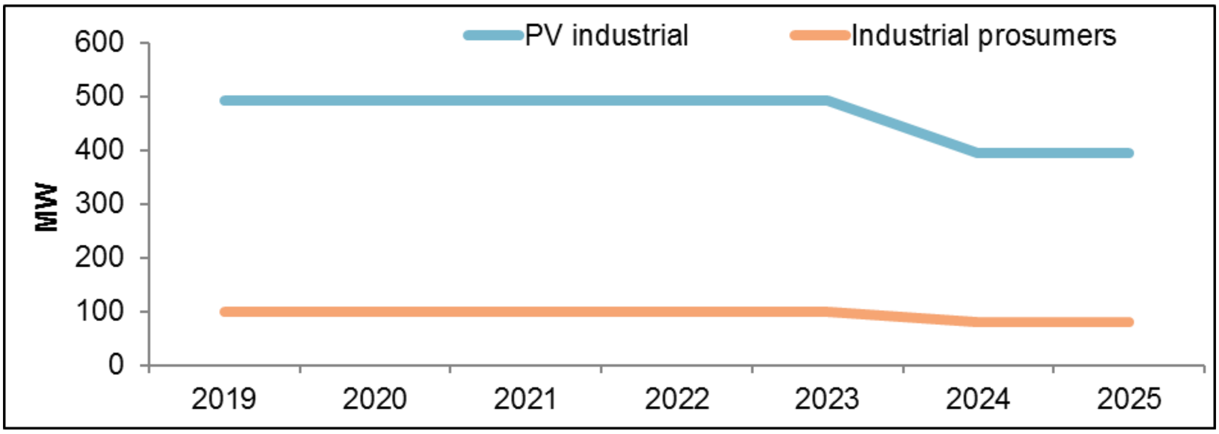

Figure 9.3: The share of self-consumption in industrial PV-systems is expected to grow, Netherlands, SEIM calculations

Due to the strong focus on prosumer concepts in residential and commercial PV, as well as PVP4Grid concepts contributing to the industrial segment, the share of prosumer systems in cumulated capacity is at a constant high of 82 %, as depicted in Figure 9.4.

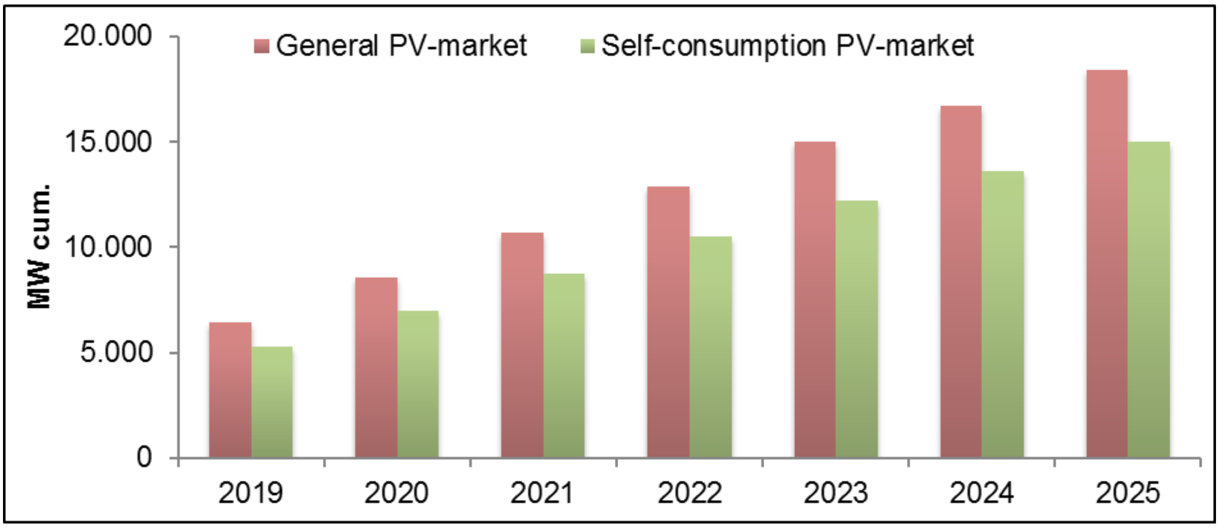

Figure 9.4: The ratio between prosumer and general PV market, Netherlands, SEIM calculations

Over the course of the PVP4Grid project three different self-consumption PV electricity business models or concepts have been evaluated. Therefore, the number of total annual installations in the self-consumption segment have been split up into these three different categories:

- Concept 1: Direct single use
- Concept 2: Local collective use
- Concept 3: District level energy models

For each of the three concepts, the Dutch “Report on PVP4Grid Concepts and Barriers”[31] uses a further differentiation based on system size. The report indicates that systems < 10 kWp belong to the first concept (Direct single use). The Dutch concept of “saldering” (net-metering) is used in the residential and commercial segments and operated under the framework of Concept 1 and 2 (direct single use and local collective use). Therefore, the entire residential segment is assigned to Concept 1, as well as the main part of the commercial segment. Local collective use only applies to apartment buildings owned by individuals. These are affected by the Postal Code Policy as well (PVP4Grid-NL-Report). This Postal Code Policy enables Concept 3 as well, which holds a 20 % share of the industrial segment. Any future deviation is not visible and cannot reliably be modelled. Therefore, the SEIM tool leaves this allocation unchanged over time. The development from 2019 to 2025 is shown in Figure 9.5.

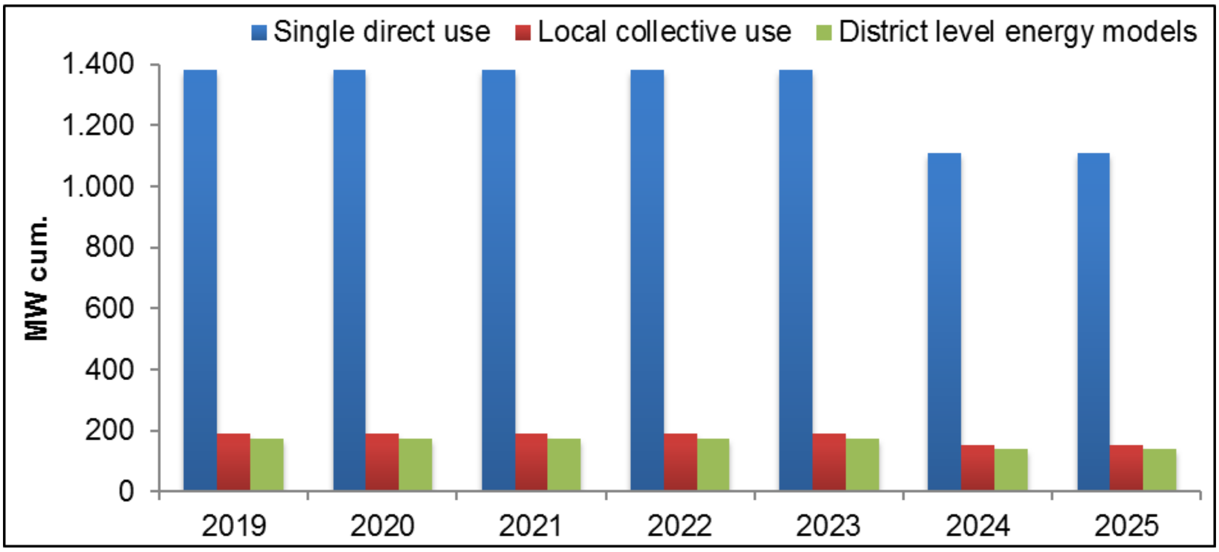

Figure 9.5: The expected segmentation of the new installed prosumer PV, Netherlands, SEIM calculations

[31] Published on the PVP4Grid Homepage: https://www.pvp4grid.eu/pv-prosumer-concepts/

9.4 PV-employment, general and self-consumption

The employment factors used to assess the job creation by Dutch PV are calculated based on the differentiation of the value chain given by SolarPower Europe and E&Y's in "Solar PV Jobs & Value Added in Europe" report (Waele et al., 2017). Again, employment based on self-consumption is calculated against general PV and the results are graphically presented up until 2025. In Figure 9.6 the development of FTE based on general PV and the share of self-consumption PV is presented.

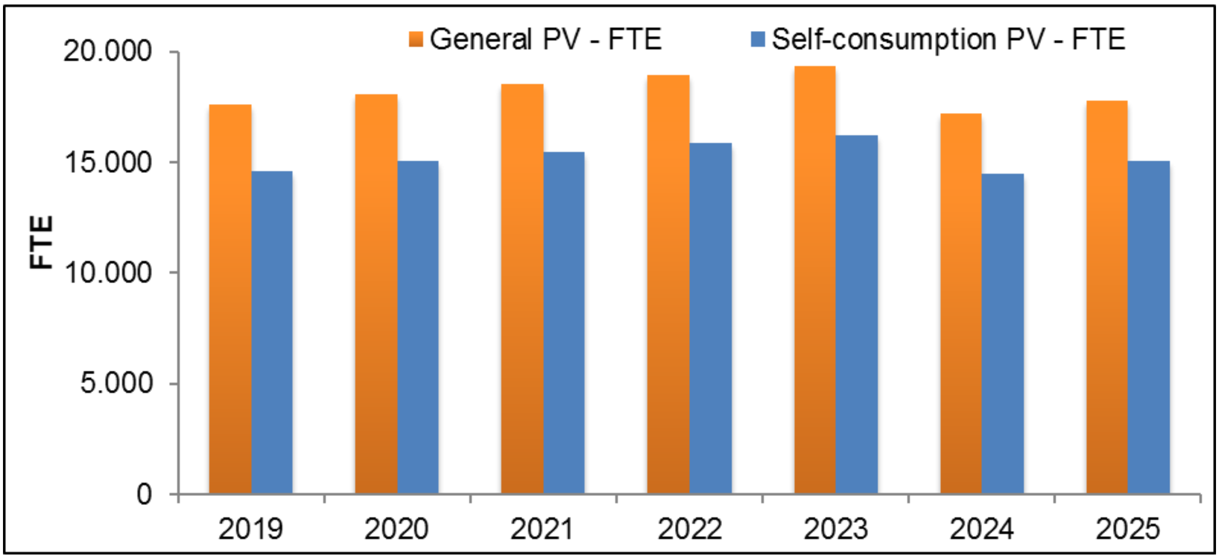

Figure 9.6: Employment based on general PV and on the self-consumption segment, Netherlands, SEIM calculations

The number of jobs in the PV industry in the Netherlands largely coincides with the total annual installations of PV-systems. In 2019 almost 17.600 full-time jobs existed in the Netherlands, based on the demand met that year. As the future market is likely to be stable until 2023, the number of jobs is expected to increase slightly due to the increase in permanent jobs in the O&M segment. When net metering expires in 2023, FTE first adapt to the decline in annual installations, but slightly grow from 2023 onwards. By 2030 the number of full-time jobs, estimated by the SEIM-tool, will be at 20.900 FTE. Around 84 % of these FTE are located within realm of self-consumption PV, which accounts for 14.600 FTE in 2019 and 17.800 FTE in 2030. Figure 9.7 indicates how the FTEs are distributed along the PV value chain.

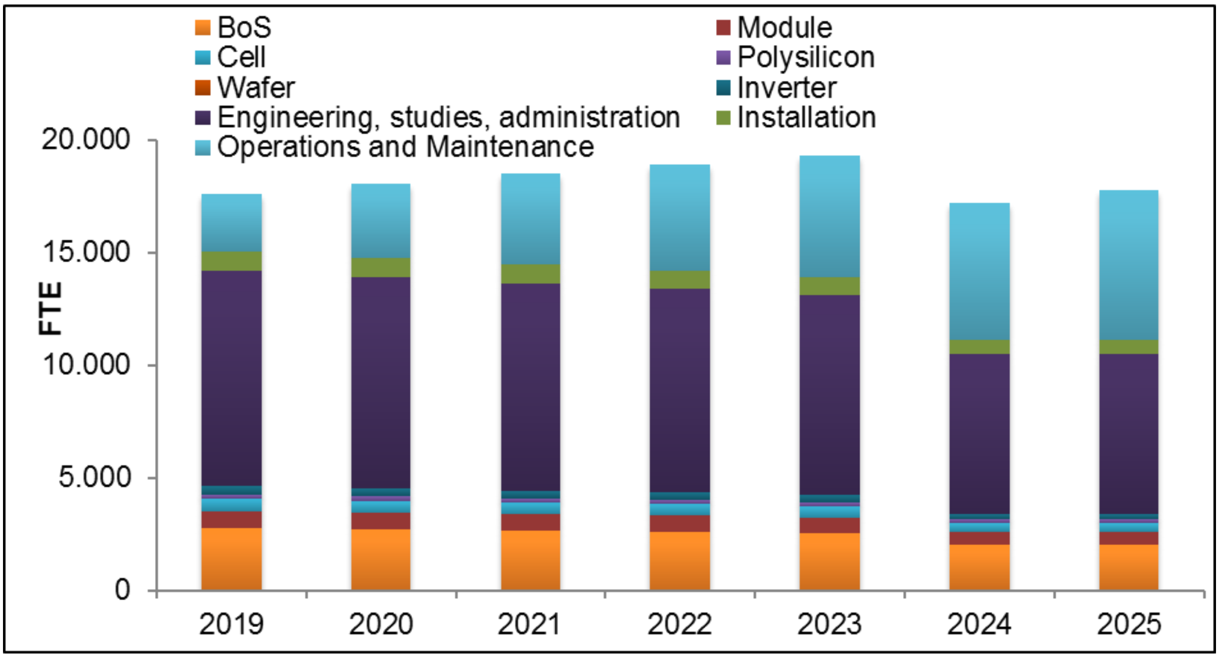

Figure 9.7: Distribution of FTE along the PV-value chain in the Netherlands, SEIM calculations based on the differentiation of SolarPower Europe (Waele et al. 2017)

The "engineering, studies, administration" sector accounts for most of the FTEs along the value chain. Due to growing cumulated PV capacity in the Netherlands, the segment O&M is slowly gaining importance over time and takes second place in terms of FTE.

There is a major difference between the Dutch PV value chain and the other value chains evaluated. The share of the "installation" domain, usually one of (or the) biggest domains in the value chain, is drastically smaller in the Netherlands. Reason for this is most likely above average commissioning of foreign companies with PV installation. Figure 9.7 indicates learning curves in all segments (which – except O&M – become smaller over time), such as the relative decrease of fixed costs due to economies of scale and the increase in overall production efficiency. Only the creation of permanent jobs in O&M allow this segment to continue its growth, thus completely offsetting the negative effects.

There is no decisive difference between the distribution of FTE based on the general PV market and FTE based on self-consumption. In the evaluated timeframe the upstream jobs of the PV value chain account for around 25 % of all FTE. Therefore, up to 75 % of the workplaces are created downstream which offer better job security since these jobs tend to be local (Waele et al., 2017, S. 35). Per MW of cumulated capacity 0,4 FTE are created in the O&M part of the value chain and remain unchanged over the life span of the PV-system[32]. 6,9 FTE/MW (2019) to 6,5 FTE/MW (2030) are created for each newly installed PV-system. However, these jobs are only created in the year the system goes into operation. Compared to the other evaluated countries, the job creation in the Netherlands in the first year is very low. This can be ascribed to the low number of employees in the "installation" sector.

9.4.1 Employment based on the three prosumer concepts

The job creation based on self-consumption PV differs in the three concepts evaluated in the PVP4Grid project. FTE allocation of the different self-consumption concepts (chapter 9.3.2) is indicated in Figure 9.8. The single direct use of self-consumed PV is the most job generating business model, with around 80 % of the self-consumption-based FTE, followed by 15 % local collective use and 5 % district power model. This distribution is estimated to be stable in the assessed time frame.

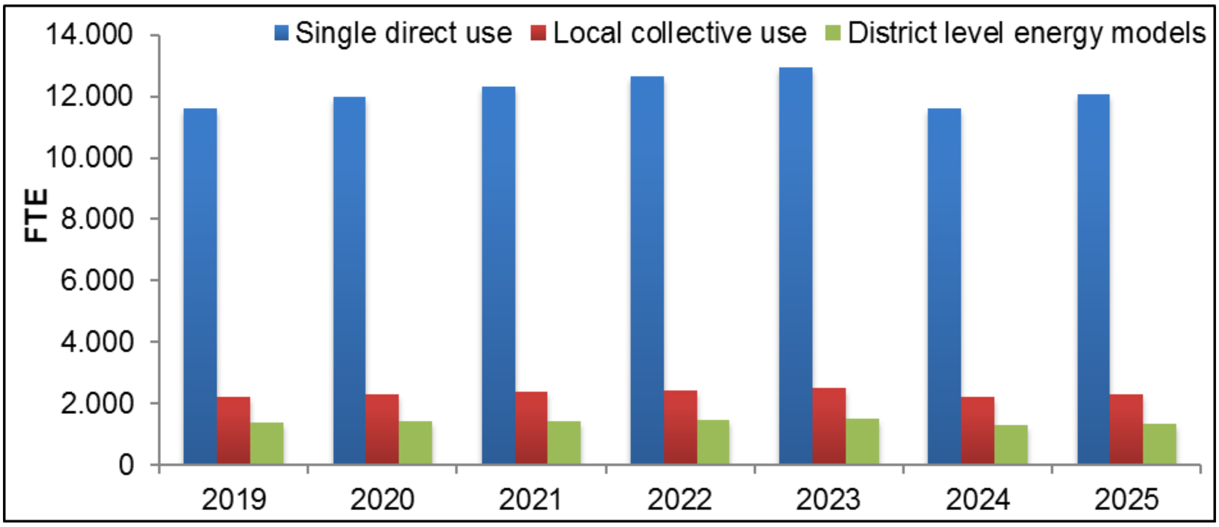

Figure 9.8: Employment based on the three evaluated self-consumption concepts in the Netherlands, SEIM calculations

For each cumulated MW of self-consumption PV 0,4 FTE are created in O&M over the entire life span of the system. In the year of their installation new systems create 7,1 FTE/MW (2019) to 6,5 FTE/MW (2030) in the remaining value chain components. Since self-consumption is the main driver for the overall PV market, these key figures show only a small variation from

[32] Reduced only by general efficiency gains.

the general indicators stated in chapter 9.4. As a consequence, policies positively influencing self-consumption might also have a great impact on job creation in the Dutch PV market.

9.5 Value creation

In general, the annual value creation depends on the total number annual installations. The total value creation based on the 2019 installations is around 1.509 million EUR/a. From 2019 onwards the value-added by the PV industry is slowly rising (see Figure 9.9). It is estimated to reach 1.603 million EUR/a in 2023. Then it is projected to decrease relative to the decrease in annual installations to 1.389 million EUR/a in 2024 (1.626 million EUR/a in 2030). The value creation based on self-consumption starts at 1.309 million EUR/a in 2019 and rises to 1.392 million EUR/a by 2023. In 2030, the value chain of self-consumption PV will create around 1.424 million EUR/a in value. As mentioned before, value creation can be divided into three components. With approximately 59 %, the net salaries are responsible for the main share of value creation, taxes and social security contributions account for 35 % and corporate net profits for 7 %. The value creation is depicted in Figure 9.10.

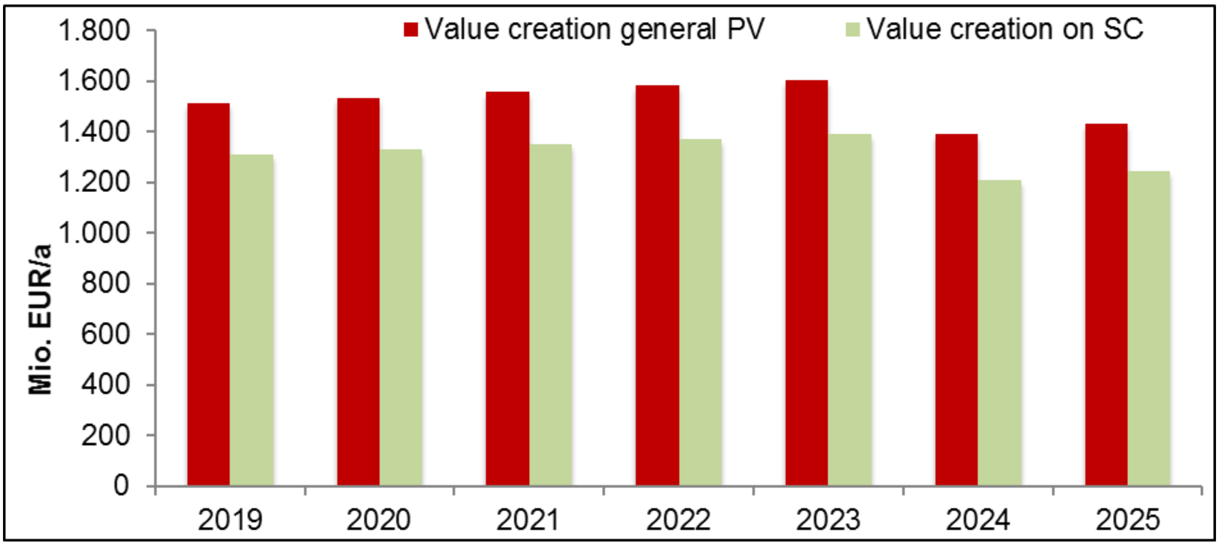

Figure 9.9: Annual value creation via PV in the Netherlands, general PV vs. based on SC, SEIM calculations

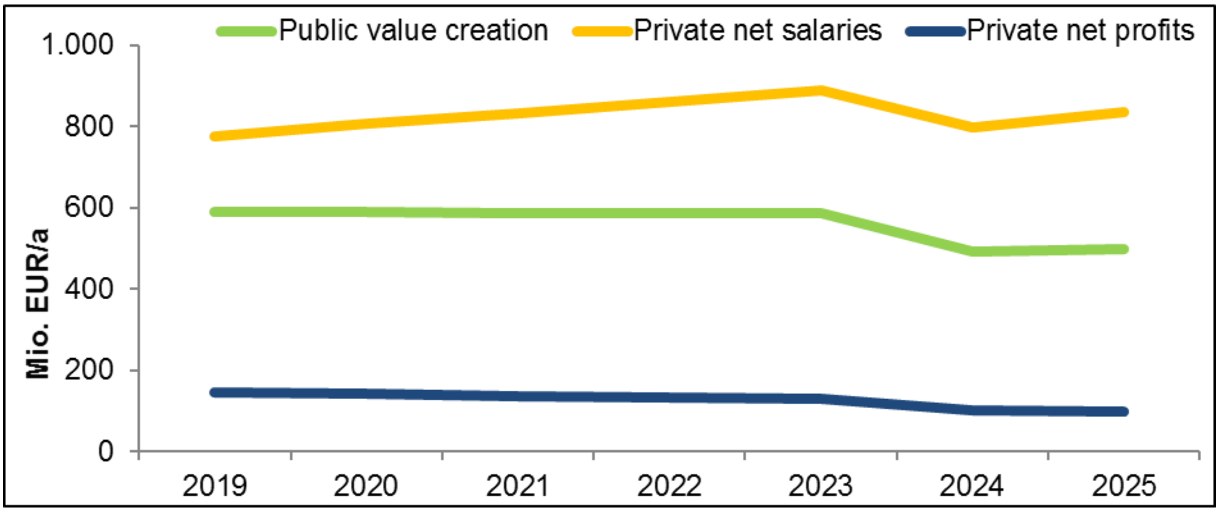

Figure 9.10: Structure of value creation in the Netherlands, public vs. salaries vs. private profits, SEIM calculations

Based on the share of self-consumption PV in the estimated market outlook, the value creation that can be allocated to the three different self-consumption concepts is shown in Figure 9.11. Analogous to Figure 9.8, single direct use is the most important concept in the Netherlands, followed by local collective use.

Per MW installed, O&M for self-consumption PV creates around 25.000 EUR of annual value-added during the total lifespan of the system. This value is higher than in most of the other evaluated countries, due to the high level of salaries in the Netherlands (compared to Spain, Portugal and Italy) and the high total of FTE (see chapter 9.4) created in the O&M segment per MW installed. In the year of installment around 630.000 EUR/MW are created in the other parts of the value chain. Compared to the general PV market, these values indicate that self-consumption PV in the Netherlands has beneficial macroeconomic effects. For general PV, the corresponding key figures are around 23.000 EUR/MW (O&M) as well and 600.000 EUR/MW in the first year.

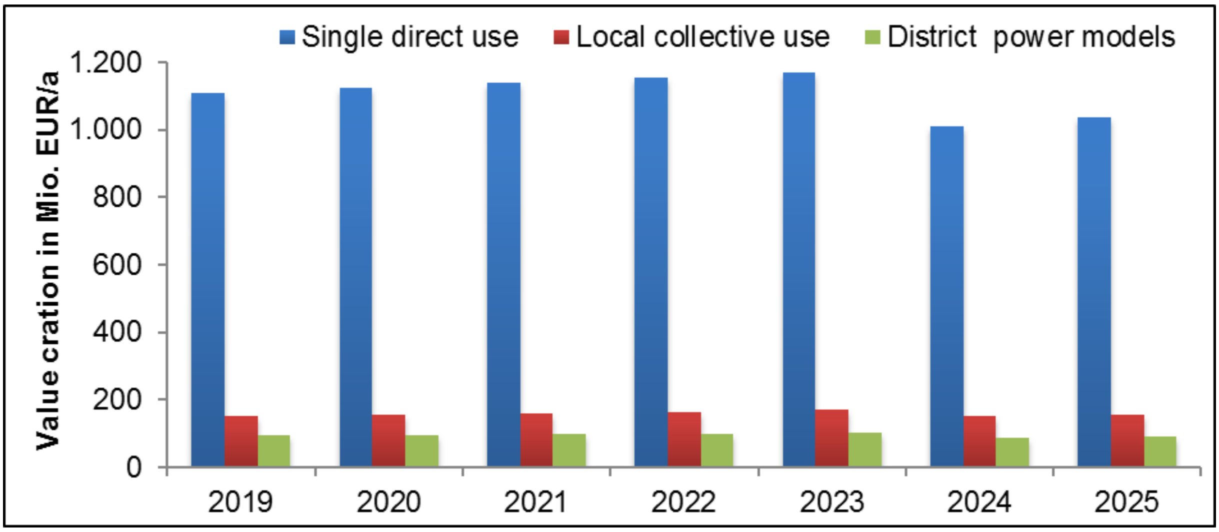

Figure 9.11: Value creation allocated to the three evaluated self-consumption concepts, Netherlands, SEIM calculations

9.6 Scenarios

As there is momentum for accelerated PV growth in the Netherlands, the gap between the base case scenario and the best-case scenario is considerable. Especially the development of the third self-consumption concept (district level energy models) might have the potential to boost the national market. The simplified access to self-consumption and the development of different prosumer concepts is considered to be an effective driver for the PV market. These aspects have been taken into account for the generated scenarios. Figure 9.12 is extended until 2030 to show that under optimal conditions and by establishing new business models, the Netherlands could reach a cumulated PV capacity of around 33 GW by 2030, which would have considerable socio-economic effects both on the labor market and in terms of value creation (Figure 9.13). However, the margins used for calculating the best, base and worst-case scenario are commensurate (15 %). Due to uncertainties about the future Dutch business model and the influence it might have on the market, the worst-case scenario estimates the value creation and the cumulated capacity for annual installations of less than 22 GW in 2030.

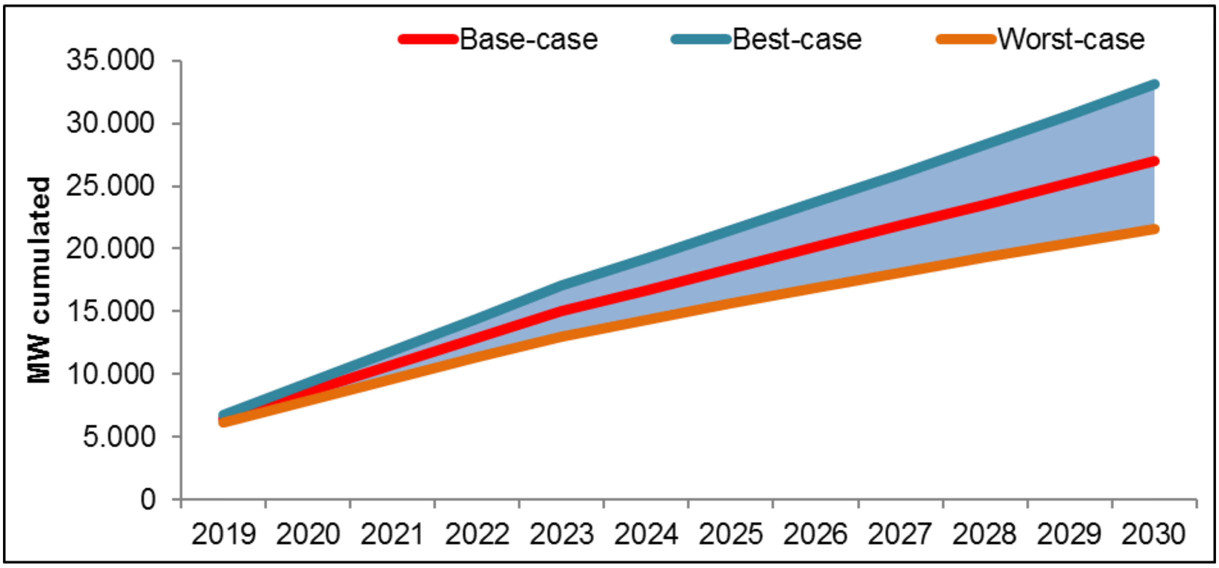

Figure 9.12: Dutch scenario, cumulated capacity until 2030

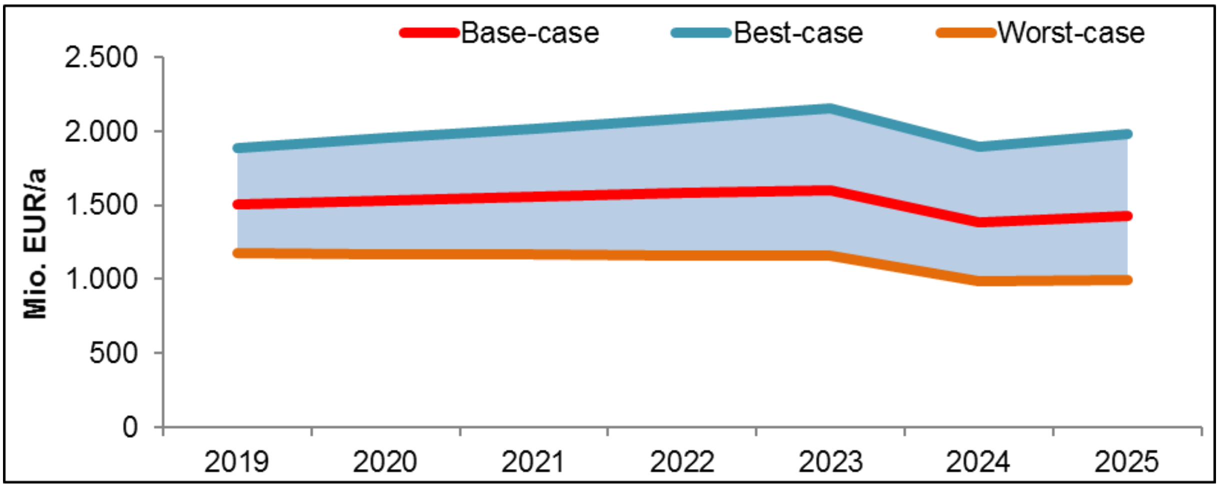

Figure 9.13: Dutch scenario, annual value creation until 2025

10 Portugal

10.1 PV overview

Portugal had for many years ambitious targets for the implementation of renewable energies in the electricity sector. While in the last fifteen years the focus of the national energy strategy was on wind energy and its successful integration in the electricity system, in the last few years the interest in PV increased significantly. One of the reasons was the decrease of investment costs in the PV sector and the subsequent reduction of its LCOE. But not only the decrease of the prices changed the Portuguese government`s attitude towards PV: There are two more main reasons supporting the implementation of more PV in the Portuguese energy system.

The first one is related to the wind and the traditional hydro sector, whose productivities has almost reached its maximum available resource potential, which will not be enough to fulfil the very ambitious targets defined in the NECP. Additionally, both have their strong resource availability in the same time of the year, in winter. The hydro production in summertime has gone down strongly due to a very low rainfall index. The availability of wind power resources also declined on average by 25% in summertime (DGEG). This decline is even more prevalent during the midday hours when the sun radiation is stronger. PV production obviously is quite adapted to fill this gap as its main production peaks when the other two technologies cannot supply their maximum capacity. The second reason supporting the development of PV is that the national grid has not enough capacity to integrate and transport much more energy without significant infrastructure investments. Therefore, decentralized production for which self-consumption PV can be seen as a role model, offers the opportunity to avoid major grid investments as it produces energy right there where it is needed.

But not only technology-specific reasons explain the increasing investment in PV and in self-consumption in Portugal. The recovering economy and the good financial situation allow for more engagement in the renewable sector. Of course, the ambitious targets in the NECP help to find more support for the implementation of self-consumption PV and other decentralized models. Portugal plans to decommission the last two coal-fired power plants until 2023 and, consequently, the national targets for renewable energy must increase steadily to allow for this transition. The electric energy supply in 2030 is planned to rely on more than 80% of renewable energies and these technologies shall cover 47% of the total energy consumption of the country at the time (NECP). To reach these objectives the wind and PV sectors must have clear and well-defined market oriented and timely support schemes. The overall goal of the general PV installations in Portugal until 2030 is at approx. 9-10 GW, and only a small percentage of around 15% of this is foreseen as self-consumption, which is rather low compared to other European countries (NECP).

The first legal framework for self-consumption was set-up in 2014 with the implementation of the Decree-Law 153/2014 which came into force in the beginning of 2015. But even though the PV sector and the government itself were very optimistic about its impact on the market, the realized capacity was in fact quite low. Several reasons for this failure can be identified, but only very few of them could be solved in the meantime. The first big issue was the missing technical regulation. This aspect led to a high uncertainty regarding the technical requirements that must be addressed. Moreover, it led to different interpretations of potential technical solutions foreseen by the authorities. Authorities, DSOs, TSOs and the PV industry ended up in long discussions about how to develop solutions and the market.

In addition, some other problems that were based on the legislation and the definition of several limits implemented in the legal framework hindered market development. The lower limit for the system size within the smallest segment of PV installations can be given as an example: While the Decree Law defined a limit of 200 W for installations that could be installed without any specific legal requirements, the technical development made this provision obsolete because within only 1 year the size of PV-modules increased and there were simply no 200 W-modules available anymore and as a consequence no one was able to install a system under this legal regime. The same happened in the residential segment where systems up to 1500 W were only subject to a simplified permission. These systems allowed under a simplified administrative procedure were also the preferred solution of many household owners but within a very short timeframe the power capacity of a standard PV module increased to more than 300 W which did not align with the legal boundaries for the simplified administrative procedure. Not only the inflexibility of the legal definitions, but also the limits themselves were set much too low to create a higher interest in the residential market.

Shortly after having this legal framework as a minimum base for market development established, another issue arose, which impacted the whole PV market. The internet platform that was created to implement all legal procedures (named SERUP) – which was already working for several years even before self-consumption became a topic – crashed several times in the end of 2018 as well as in 2019 and it didn’t work properly for a long time. The administrative procedures that used to take only a few weeks, suddenly took up to 1 or even 1,5 years. Several attempts to solve the problem failed and the market suffered a lot under these conditions. In addition, the confidence of potential clients decreased rapidly as news about these negative aspects were spread.

10.2 Input Financial Values

The system costs were considered to have a minimum of 700€/kWp for large ground-mounted systems up to a maximum of 1.800€/kWp for small residential rooftop installations. The income of the PV sector`s employees in Portugal is on a very low level, showing not even half of the Italian values and placing Portugal last in the ranking of the 8 participating PVP4Grid countries. Nevertheless, the medium salary of 1.722 EUR/month is an acceptable level in a country with a minimum salary of only 635 €/month (from 2020 on). It also must be considered that in Portugal 14 salaries are paid within one year by law, counting twelve normal salaries for the months, one for a holiday period and another one for Christmas season. Portugal shows the highest values in the ranking regarding the preview of salary increases in the next years. The good economic development as well as the policy of the current government who has put a priority on salary development will contribute to a higher growth of salaries than in most of the other countries.

“Public value creation depends on private value creation” (see Italian chapter) – while this relation is positive in the Italian case it also shows the negative relation in Portugal. The low-income level does not allow for a high tax rate or social security contributions rates that average 17,7% which is much lower than in the other evaluated countries. The corporate tax rate has a value of only 21%. The VAT tax rate is 23 %. It is a barrier in the implementation of residential self- consumption systems as the VAT does exclusively hit the private investments – commercial investments will deduce the paid VAT in the tax declaration. Some years ago, the VAT rate for renewable energies in Portugal was on a much lower level (6%), then it was raised to the medium tax rate of 13% and in the crises after 2008 it reached the general tax rate of 23%. The renewable sector`s attempts to get back to a lower level have not been successful, but the better economic situation of the Portuguese economy might allow future changes in this topic.

10.3 PV market

At first the general overall outlook for the PV market in Portugal will be presented. Afterwards the prosumer market is calculated by evaluating the share that self-consumption has in each segment of the overall PV market. The three concepts of prosumption, that where identified and described by the PVP4Grid project, are examined together and differentiated at the end of the SEIM-simulation. The market outlook has been developed with the help of APESF.

10.3.1 General outlook

The market development in the last two years was hindered by a series of extraordinary problems. Especially the crash of the internet platform, where the administrative procedures take place, led to a very low level of installations in 2019. Nevertheless, it can be expected that the publication of the Decree Law 162/2019 will create much better conditions for prosumers. The market for smaller prosumer systems will grow already in 2020, but probably only in the residential segment where a simplified procedure was implemented. Commercial prosumer activities will take place mainly from 2020 on, when the technical guidelines shall be published and the details of installations in this segment will be known. However, as the installation of these PV systems will take some time, APESF expects the growth of this segment to start only in 2021, when those power plants will go operational.

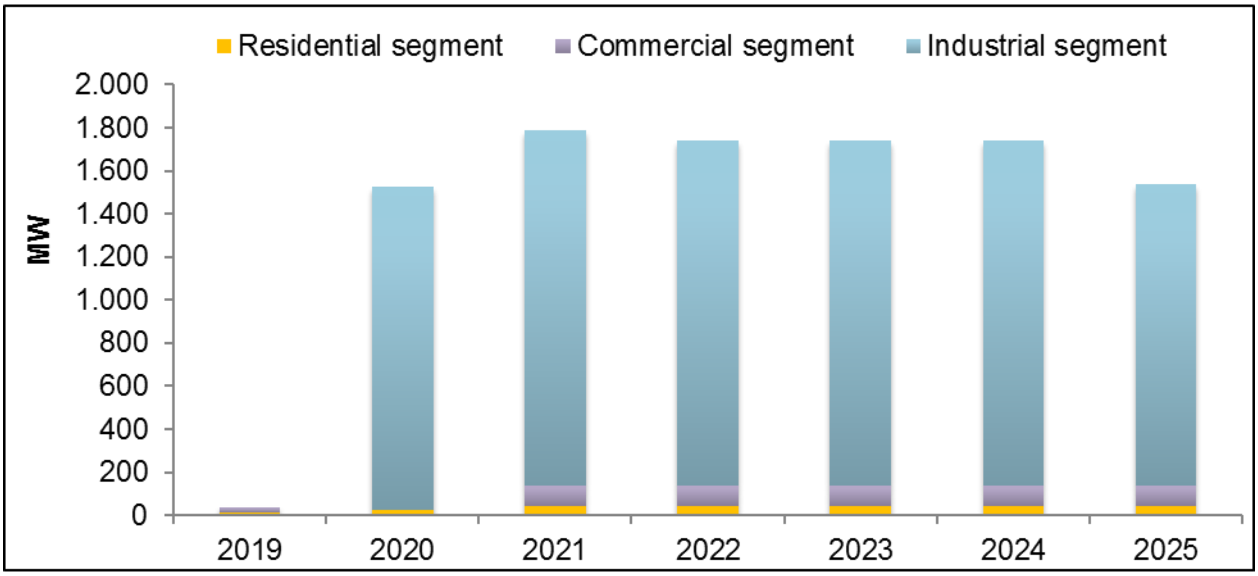

Figure 10.1: Annual PV installation in Portugal, general PV-market with segmentation (based on APESF and the Global Market Outlook by SolarPower Europe)

Figure 10.1 depicts the Portuguese market outlook, that was developed with APESF. Due to a very ambitious NECP, the Portuguese market is expected to grow significantly during the next years. Considering the optimistic evaluation of the impact on market development of the new Decree Law it might come to significant changes in this preview. While the prosumer segment could increase by the factor 3-4, the industrial segment might suffer from the current state of the public grid. For this reason, some experts expect a shift of investments from the industrial sector to the commercial self- consumption.

Figure 10.2 depicts the share of SC in the residential and the commercial segment. As self-consumption is the only reasonable business model for residential rooftop systems, the share of prosumer systems in this segment is 100%. Under the assumptions of the model, cumulated capacity in Portugal will reach over 10 GW by 2025 already, which is shown in Figure 10.3. With the current assumptions the cumulated market for self-consumption is set to 1 GW in 2026 in accordance with the official expectations in the NECP. However, several experts expect the prosumer market to be significantly higher, up to 3-4 GW (Figure 10.4),especially due to the publication of the new Decree Law 162/2019 which comes into force in the beginning of 2020.

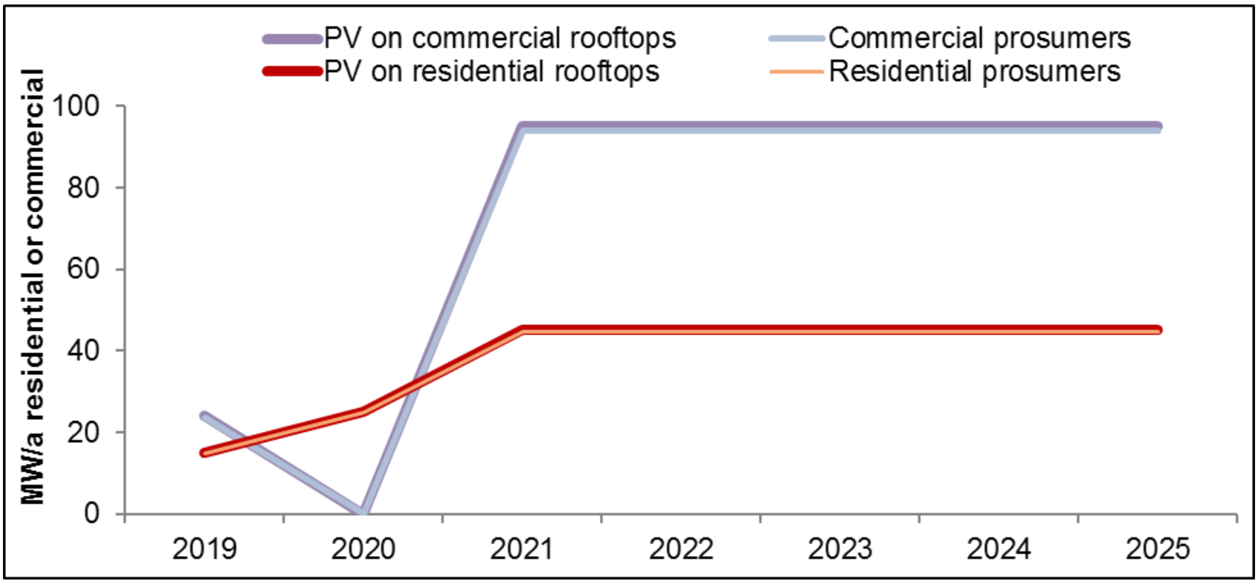

Figure 10.2: The share of self-consumption in the Portuguese residential and commercial segment is expected to be at 99 %

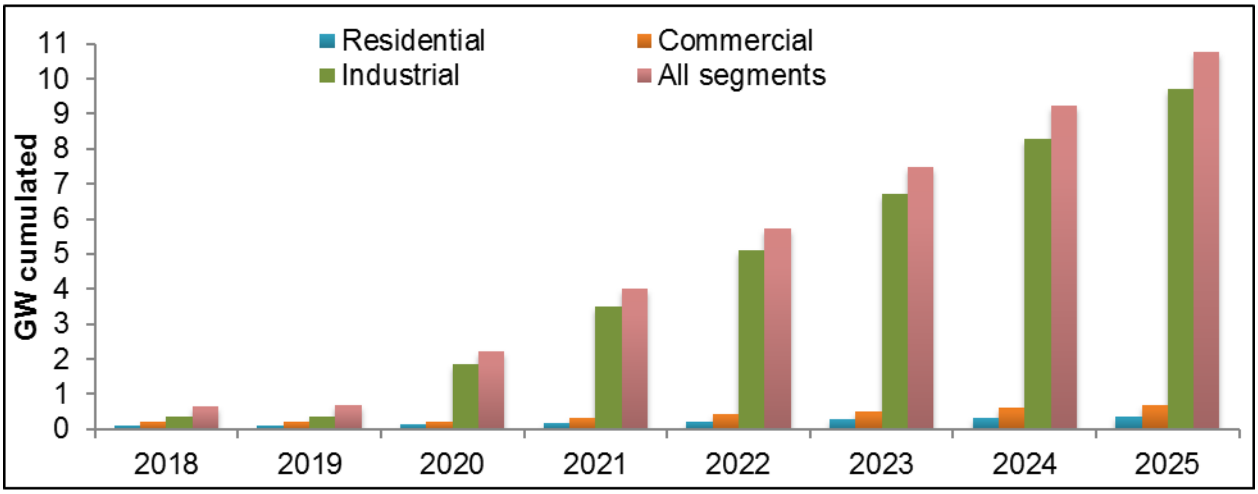

Figure 10.3: Cumulated capacity in GW, Portugal, SEIM calculation

10.3.2 Self-consumption

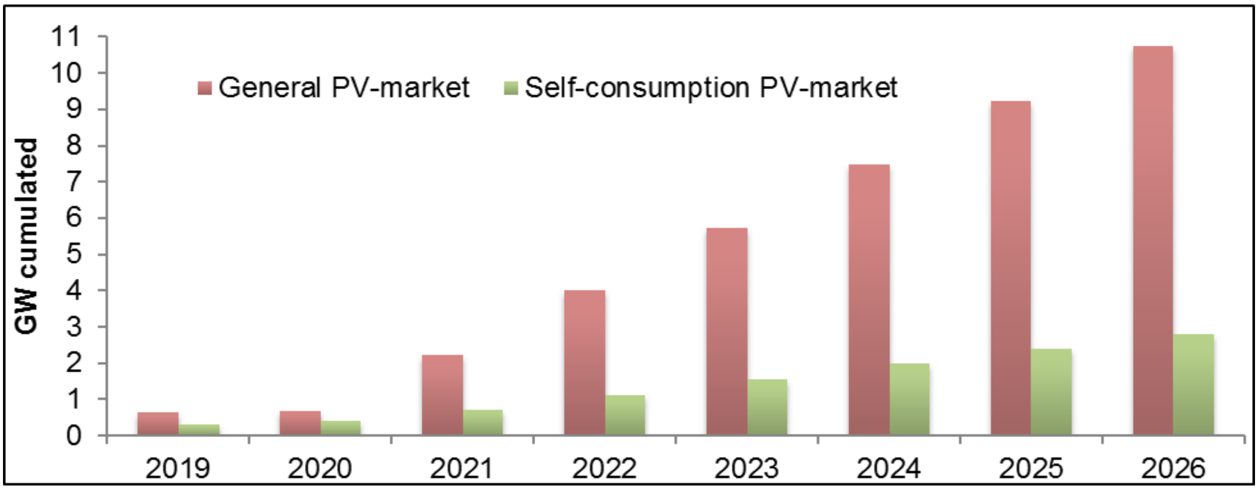

Figure 10.4: The ratio between prosumer and general PV market, Portugal, SEIM calculation

This recently published Decree Law 162/2019 and the expected reformulation of the legal framework are good reasons to be optimistic. The growth of the self-consumption segment can be significantly higher than expected in this study.

With the publication of the NECP the authorities must change the framework conditions, otherwise the targets cannot be reached. In late 2019, the completely new elaborated legal framework for self-consumption was published and is foreseen to come into force on the 1st of January 2020. A large share of the targets of the European Clean Energy Package were implemented in the Decree Law 162/2019 and as one of the main improvements the creation of common self- consumption groups, so called energy communities, is allowed now. From this, the sector expects a significant impact on the market development. Therefore, this more positive market outlook is converted into the best-case scenario. According to some experts, the 1 or 1,5 GW of self- consumption capacity initially forecasted until 2030 can increase to a three times higher value.

Especially the PVP4Grid concepts two and three are reflected in the new legislation, with especially concept three having large potential. The solar radiation in Portugal is on a high level and production costs for PV- electricity are significantly lower than the normal consumer prices. As one of the examples for the implementation of this self-consumption business model, shopping malls offer a high potential as they combine large roof areas with high electricity consumption during the day. While before only electricity companies were allowed to commercialize electricity, from 2020 on this business model is also accessible for others. The new legal framework allows the trade of electric energy under simplified conditions in the case of common self-consumption. Electricity can always be sold to other consumers when the main business purpose of the company is not the sale of energy. Shopping mall owners are enabled to produce energy and sell it to the different shops and services in the mall. Portugal has the highest share of shopping malls per capita in Europe, thus a significant number of group-3-installations can be expected and might open a GW-market for self-consumption in Portugal. During the development of the legislation this has already been visible, when the biggest Portuguese company in this sector showed a lot of interest in the development.

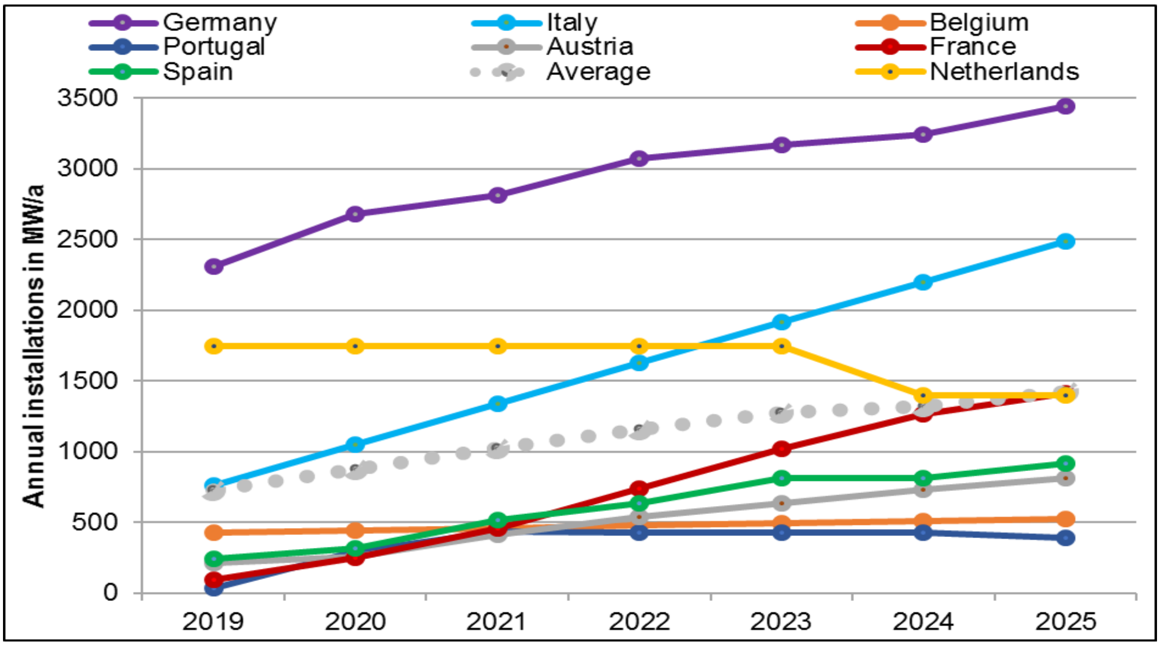

Figure 10.5: Portugal (dark blue) under the current legal framework, annual installations of SC PV

In contact with APESF, the association states that beside the optimism the remaining problems need to be addressed. The new Decree Law has established a deadline for the end of 2020 for the implementation of new technical guidelines and regulations. Until then the uncertainty will hinder a more accurate market development. The details that will be published in this context will have a significant influence on the success of self- consumption PV in Portugal in the next years. Beside the technical part, the function of the administrative procedures – which focus mainly on the function of the mentioned internet platform – is an important issue for the near future. Once again it must be underlined that the increase of the VAT for renewable energy systems from former 6%, then 13% and now 23% is a barrier for the residential market. The Portuguese VAT for renewable energies might be reduced in the future. VAT in Portugal represents approx. a fifth of the total amount of investment and the reduction of this could have a positive impact.

The government also has foreseen a higher investment in the public grid, which could as well help to develop the PV sector and its activities. But the planning and realization of infrastructural investments need a lot of time and the framework to reach the NECP goals must be fixed in the next years. Generally speaking, the administrative procedures, not only those directly related to PV, but also those related to the economic environment as a whole are essential for the near future`s development. It now is an obligation of all market players to cooperate and to achieve good results in all of the above-mentioned topics to make Portugal`s PV and self- consumption market a success.

10.4 PV-employment

Portugal offers a good environment for investments. In the second half of 2019 several international companies like Nokia, Google, Siemens and others announced new investments in the country. This has led to a situation of raising salaries in several sectors like renewable energies and IT, which is reflected in the expectation of a steady growth rate of average salaries in the PV industry. On the other hand, the government tries to protect the large number of jobs in the traditional industries.

The expected strong growth of the PV-market until 2021 is going to create jobs in the sector – and the NECP is a stable fundament for long term jobs in PV. After 2021 the number of jobs in the PV-industry will be constant. Figure 10.6 shows the amount of jobs that are generated in Portugal based on the demand for PV installations. Starting in 2020, between 12.100 FTE and 14.300 FTE will be active in the industry of which between 2.500 FTE to 3.700 FTE being active based on self-consumption.

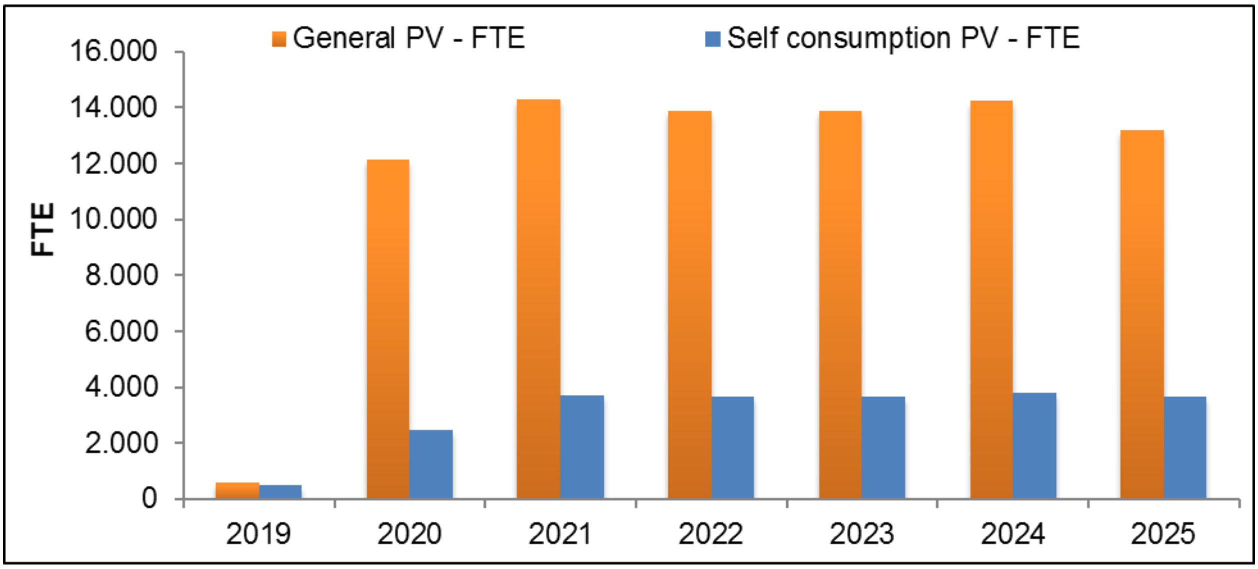

Figure 10.6: Employment based on general PV and on the self-consumption segment, Portugal, SEIM calculation

Figure 10.7 reflects the fact that Portugal is not active in all links of the PV value chain. The missing links like Polysilicon, Cells and Wafers would need extremely high investments and therefore no future activities are expected in these areas. But of course, the total development is expected to reflect the market growth.

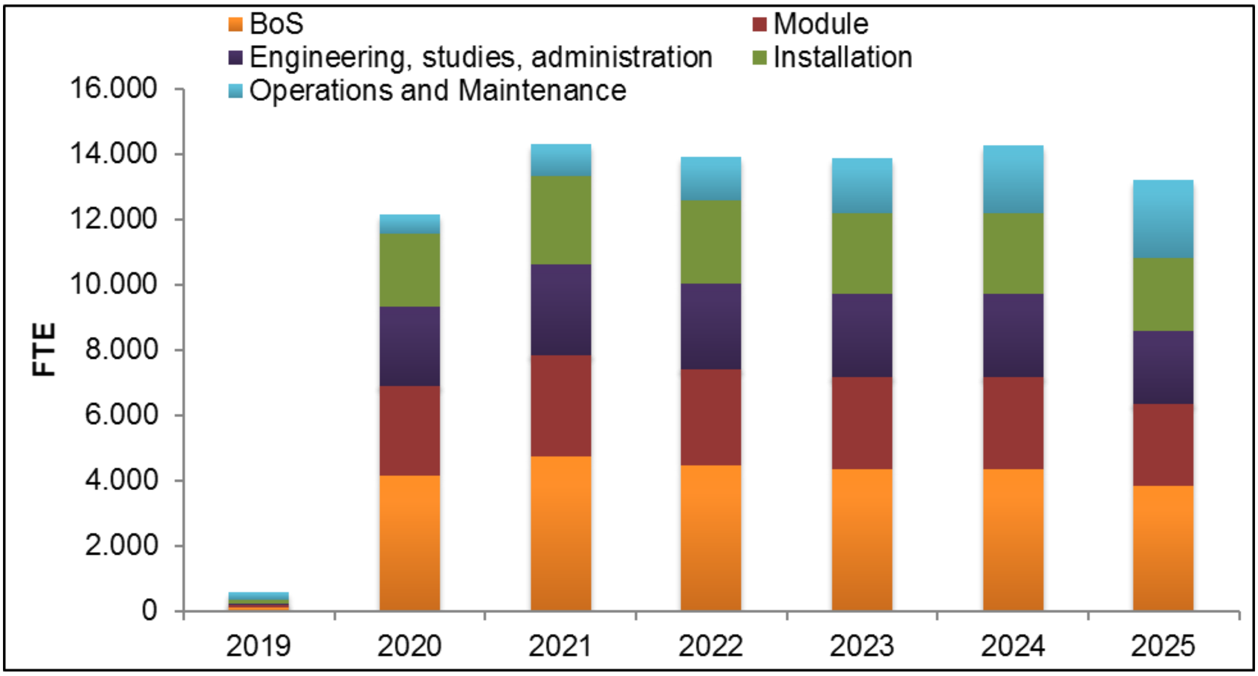

Figure 10.7: Distribution of FTE along the PV-value chain, Portugal, SEIM calculation

With BoS and Module production as the main drivers, the upstream parts of the PV value chain account for 55 % of all FTEs which is the highest relative value of all eight evaluated countries. This might change a soon as the O&M segments gain significance via rising numbers of cumulated capacity. Assessed by the SEIM-tool, the share of upstream jobs will be beneath 50 % in 2025.

Beside the fact that a growing PV market favors employment, the Prosumer segment shows some special characteristics in comparison to ground-mounted PV. As the prosumer systems are relatively smaller than ground-mounted PV, the specific costs and the needed labor is higher. Figure 10.6 shows the prevision of employment in the PV sector. While the installed prosumer capacity is expected to account for around 20 % of the general PV market, the employment is predicted to be higher, at approx. 27 %. Another relevant argument for self-consumption PV becomes evident when ground-mounted utility scale PV installations are compared to prosumer installations. Prosumer systems, generally smaller one, mainly will be installed by local or regional companies. Ground-mounted power plants are often planned and constructed almost completely by foreign labor. However, in the calculations of the SEIM tools the effects of foreign labor were not modeled which would basically mean that less local FTEs would be created by larger systems.

10.5 Value Creation

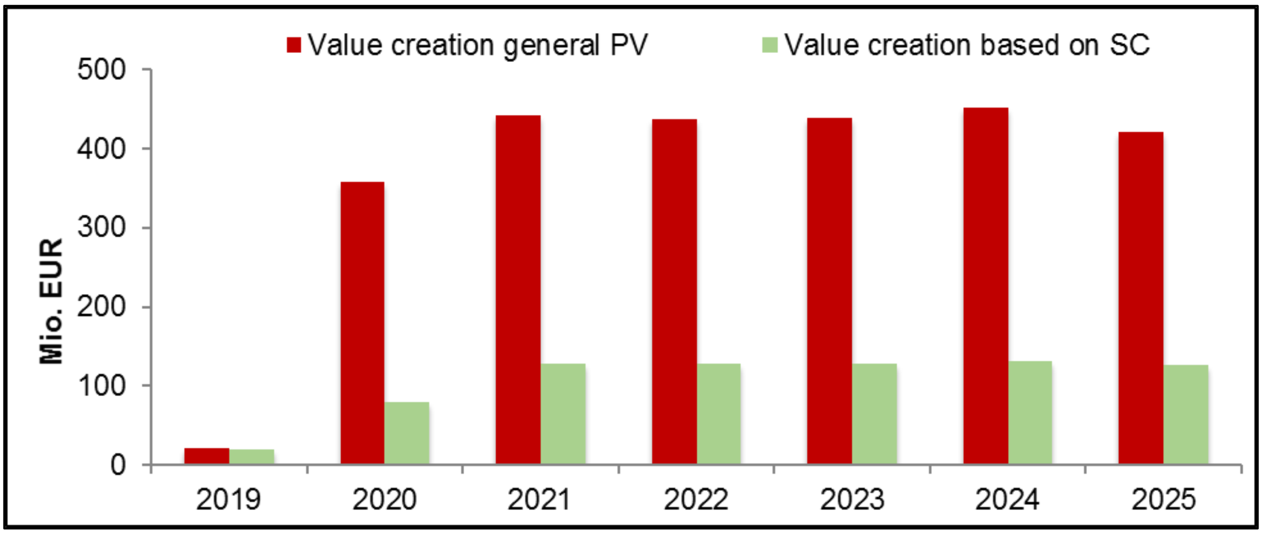

Figure 10.8: Annual value creation via PV in Portugal, general PV vs. based on SC, SEIM calculation

Figure 10.8 depicts how much value is created annually by the Portuguese PV-industry. After a massive growth of value creation between 2019 and 2021 – based on the same relative development of annual installations shown in Figure 10.1 – the value creation will stabilize at around 420 mil. € to 450 mil. €. 30 % of this amount is based on the demand for self-consumption PV. The 30 % indicate again, that self-consumption does create more socioeconomic value than utility-scale PV. Figure 10.9 presents the allocation of the value creation between the three components, public value creation, private net salaries and private net profits. Due to low VAT revenues (based on low residential installations only) and a relatively low income-tax rate the public value creation barely surpasses the private net profits. As can be observed in all countries examined, net salaries are the most important value creating component.

It is expected that commercial and industrial self-consumption will be the main drivers in the prosumer market. As these entities are reducing the VAT from their tax declaration, VAT's contribution to public value creation is rather limited. Due to the positive development of the income structure in the PV sector, the income taxes deliver the main part of public value created by PV.

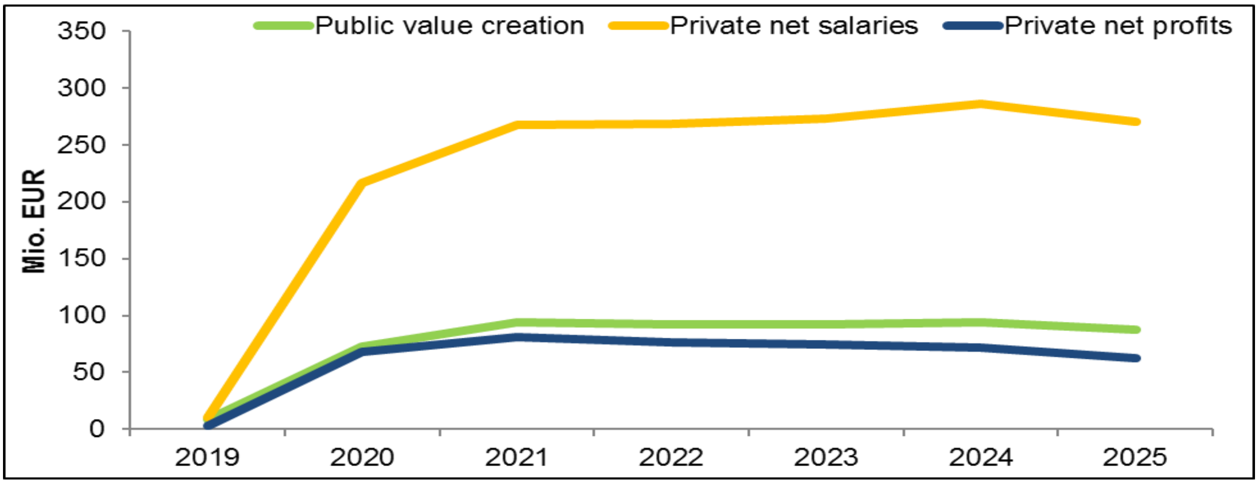

Figure 10.9: Structure of value creation in Portugal, public vs. salaries vs. private profits, SEIM calculation

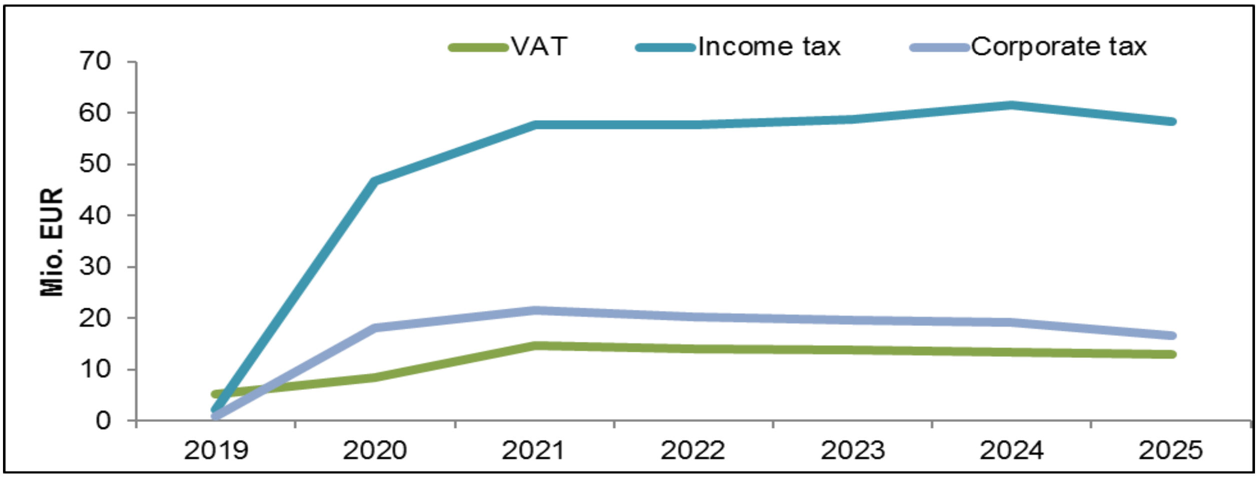

Figure 10.10: Allocation of public value creation, Portugal, SEIM calculation

10.6 Scenarios

The base case scenario follows the official plan to issue calls for tender twice a year. The uncertainty is mainly related to the realization of the authorized capacity. If a high share of the authorized systems will be realized, the total market could surpass the foreseen target. However, the fact that a large proportion of the tenders in 2019 were awarded for only 16 €/MWh (DGEG) calls into question the possibility of implementing these projects. Experts in Europe discussed this issue (e.g. Solar Power Europe's strategy committee) and no explanation was found on how the plants could be realized with these low revenues. In case of unexpected barriers, the development could also be significantly lower than the assessment. As some of Portugal`s capacities (financial, grid and administrative) are limited, the best-case vision is not too far away from the base case. Problems, like the crash of the registration platform or risks in the economic development, can lead to a much lower development than predicted. This is shown in the worst-case scenario.

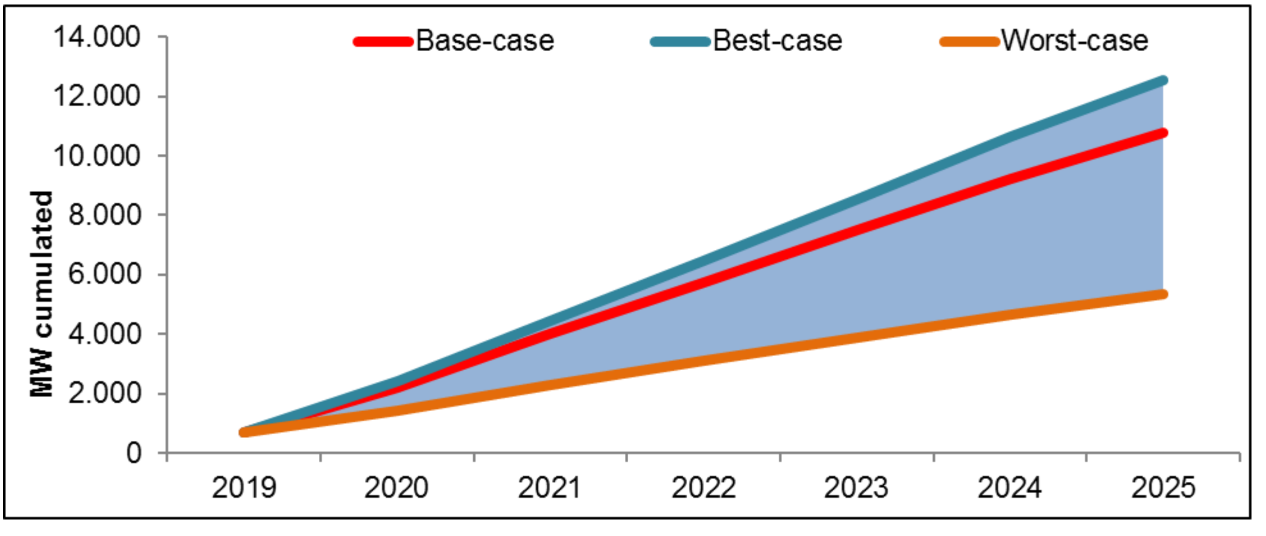

Figure 10.11: Portuguese scenario, cumulated capacity until 2030

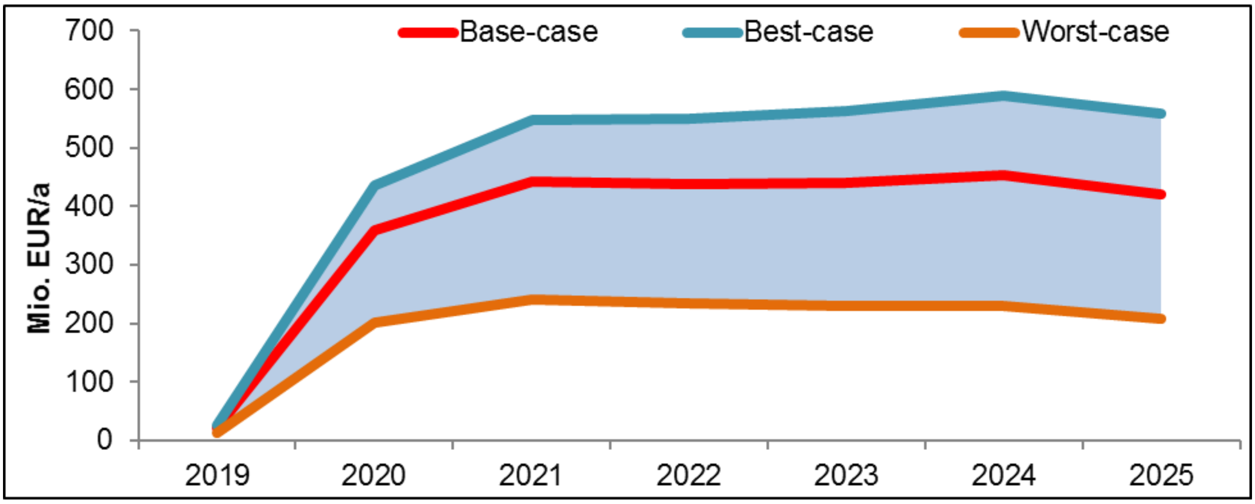

Figure 10.12: Portuguese scenario, annual value creation until 2025

11 Spain

11.1 PV overview

Among the participating countries, Spain has probably the best natural conditions for PV. However, this natural advantage was not reflected in its values and market previsions for several years. Spain is by far the largest country in the south-west of Europe and its solar radiation is higher than in most of the other countries.[33] But the current government changed the framework conditions for PV and especially for self-consumption drastically. One of the first steps was the elimination of the so-called “sun tax” which had not only a negative impact on the profitability of PV-systems, but was also a legal condition of high symbolic attendance and object to many public discussions.

While the earlier simulation for this study was based on the less favourable conditions of the former government, the new legal framework and especially the NECP draw a completely different picture. Especially the very ambitious Spanish NECP expects a significant market growth of PV. Figure 11.1 shows the estimated installations of self-consumption PV in the context of the eight PVP4Grid countries.

[33] Irradiation conditions checked via https://globalsolaratlas.info/map.

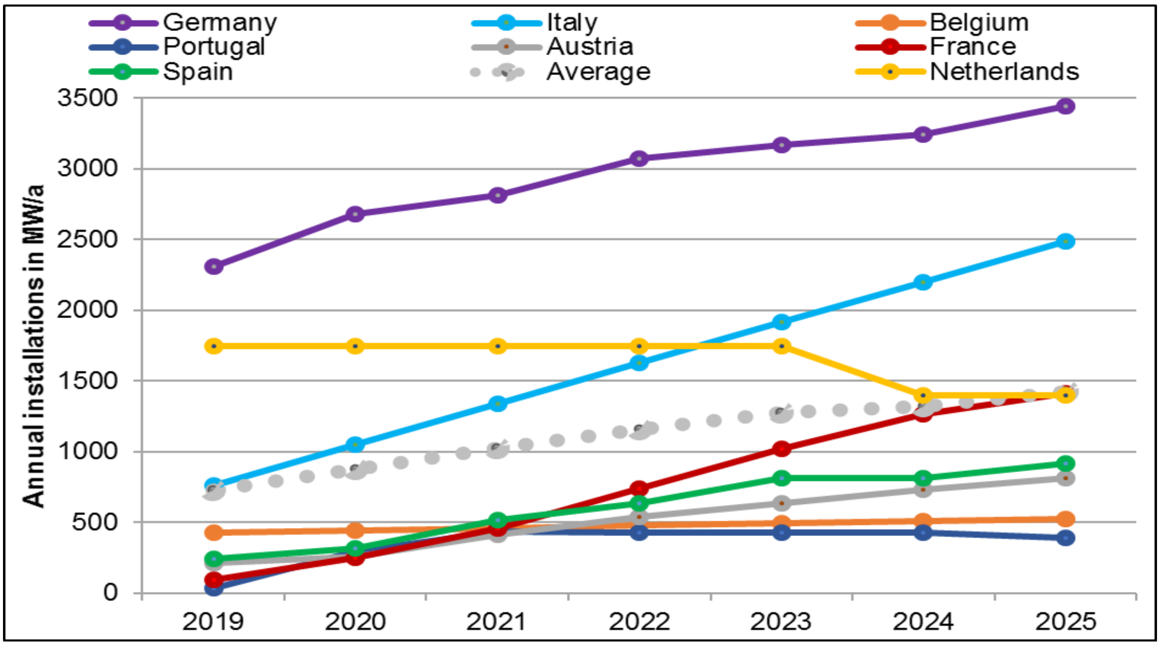

Figure 11.1: Spain (green) under the current legal framework, annual installations of self-consumption PV

One important influential market factor is the legal framework, another important factor is the situation on the national energy market and the resulting potential for the development of PV. Today, about 50% of installed electricity generating capacity in Spain is based on renewable energies which is shown in Figure 11.2.

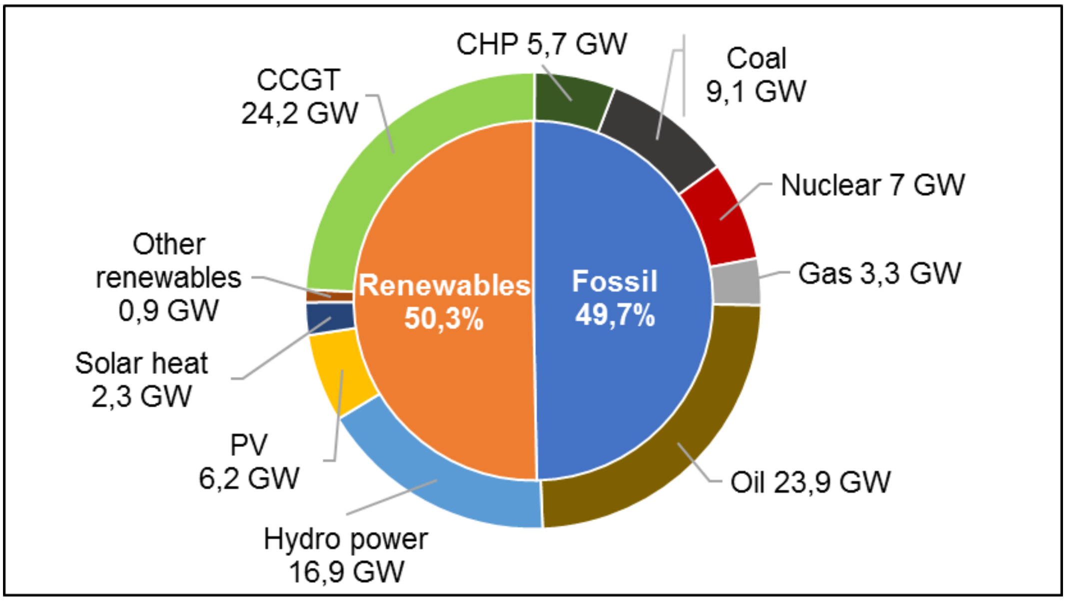

Figure 11.2: Installed energy producing capacity in Spain in October 2019, Graphic based on REE – Red Eléctrica de España

PV has a share of 6,2 GW of the combined 101 GW installed capacity, which leads to the conclusion that there is still a huge gap to fulfil the targets of the NECP, in which the foreseen total PV capacity by 2030 is 37 GW with a total of 74 % of renewables.[34]

But the realistic potential must be evaluated not only by targets and potential capacity, but also from the point of view of the industry and the financial sector. It is the industry that installs the PV capacity and there must be enough confidence in the political and economic environment to secure the required investments. The following table shows the actual situation regarding the requests and the authorization of potentially installed PV capacity in Spain. PV can only be installed on sites approved by the authorities; solely by the currently requested sites, 71 GW have already been granted and locations for 32 GW more are currently under review (UNEF, status in October 2019).

[34] NECPs can be found at: https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/national-energy-climate-plans

Table 5: Requests and authorization for general PV in Spain, status 31. October 2019 (UNEF)

	GW
In service	6,2
Authorized	71
Rejected	51
In process	32
Total request	**103**

Looking at Table 5 and taking into consideration both the improved governmental framework conditions for PV and the natural high irradiation, it becomes evident that the environment favours the development of PV in Spain. The authorized 71 GW would already be enough to vastly surpass the 2030 target, even if the 32 GW which are still to be approved are not even considered.

The conditions for self- consumption have been improved drastically as well. In 2019 the combined installation of 300-400 MW is expected, concrete numbers have not yet been published. In addition, it is estimated that the share of self-consumption on the general market is going to grow over the next decade. The improvement of the legal framework for self-consumption is visualised in detail in Table 6, which compares the old legislation (RD 900/2015) and the new legislation (RDL 15/18). The new modalities of self-consumption are summarized in Figure 11.3.

Table 6: Improvement for PV self- consumption (UNEF)

Legislation	RD 900/2015 (old legislation)	RD-L 15/2018
Taxes elimination	**Temporary charge for self-consumed energy**	**Renewable self-consumption free of charges**
Technical and Administrative Simplification	**Generation counter**	**The second counter disappears**
	Access and connection procedures	**Exempt: NO surpluses or up to 15kW**
	Limit up to 100kW	**Eliminated. The limitation of contracted power as well**
	Registration obligations	**Declarative. Regional Government ex officio for low voltage <100kW**
Limitation of restrictions and barriers	**Release of surplus**	**Compensation Mechanism**
	Internal network only	**Distribution network to the Transformation Center considered**
	Single consumer	**Shared consumption is allowed**

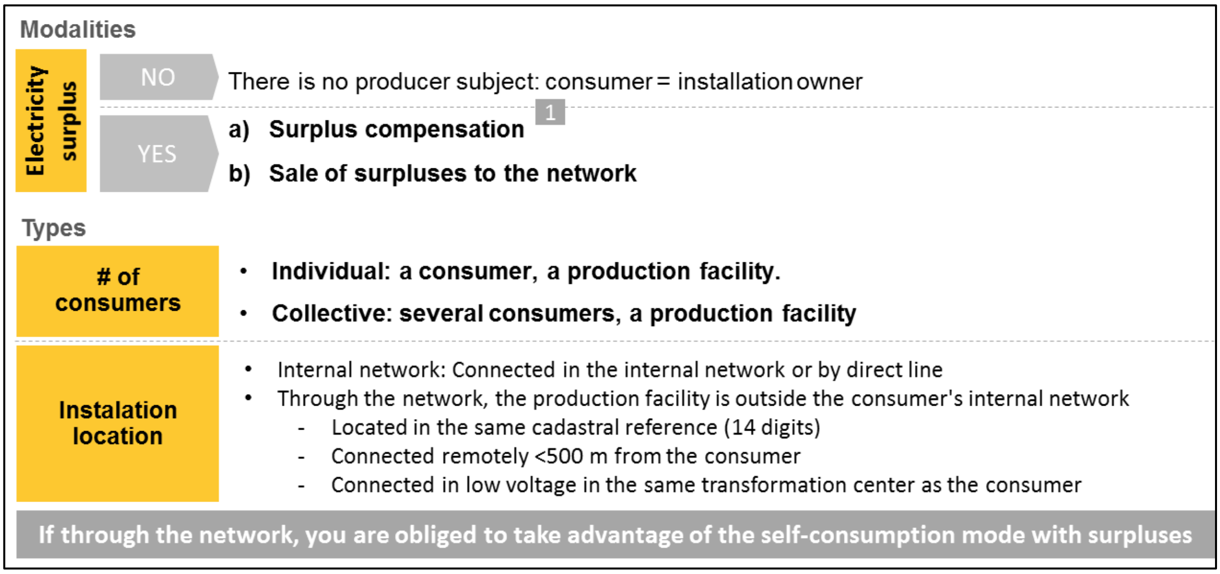

Figure 11.3: Self-consumption under the RD-L 15/2018 legal framework (graphic by UNEF)

11.2 Financial values

To calculate the development of the Spanish prosumer market the following data was used as input in the SEIM-tool. The system costs range from under 750 EUR/kWp for ground mounted systems larger than 1 MWp up to over 2.000 EUR/kWp for residential rooftop PV systems smaller than 5 kWp. These values are comparable to those in Italy, therefore Spain's costs for residential rooftop installations are amongst the highest in the ranking.

The average gross salary is composed of four categories which are described in chapter 2. They add up to an average gross salary of around 26.000 EUR/year with a growth rate of 3 % over the calculated years. The tax rates are in line with those in other participating countries that have a similar economic environment, namely Portugal. The average corporate tax rate is set at 25 % and the income tax is averaged to 17,2 %. The VAT rate is at 21 %. All these values are investigated under a changing environment for PV. Even if the political strategy changed dramatically, it would take some time to see the impact on the market. It can be expected that system prices will decrease faster than foreseen, because of the elimination of some cost intensive factors like the obligation for a second electricity meter (which was a technical requirement to self-consume). Also, the number of employees per MW installations will decrease based on efficiency gains, while the gross salary is growing constantly on a low level.

11.3 PV market

At first the general outlook for the PV market in Spain will be presented. Afterwards the prosumer market is calculated by evaluating the share that self-consumption has in each segment of the overall PV market. The three concepts of prosumption, that where identified and described by the PVP4Grid project, are examined together and differentiated at the end of the SEIM-simulation. The market outlook has been developed with the help of UNEF.

11.3.1 General PV-outlook

As presented in the overview in chapter 11.1, the PV-market outlook for Spain can be evaluated as very optimistic. Under the recently modified framework conditions, due to the NECP especially, the cumulated PV capacity is estimated to reach 37 GW in 2030. However, taking into consideration the requested capacity still to be approved (32 GW) and especially the already authorized PV- systems (71 GW, Table 5), far more capacity may be added. Still, looking at the low level of PV installations of the past few years, the SEIM-tool uses the presumably rather conservative 37 GW goal for the base case scenario. The annual installations are based on the UNEF forecast, see Figure 11.4, and the segmentation between residential, commercial and industrial provided by SolarPower Europe (Global Market Outlook 2019-2023, see Figure 11.5). However, the significantly positive impact of the actual government, the uncertainty after several elections without a clear mandate for one of the political parties must be considered: Although the NECP as a binding document should guarantee the development of the PV- market until 2030, a possible change in the government could lead to new barriers and new rules. Especially the segmentation of the PV- market can be changed easily without losing its conformity to the NECP. Therefore, all the conclusions of this study have to be seen in the context of their strong dependency on political goal-setting that may vary in accordance with the parties/ governments in power.

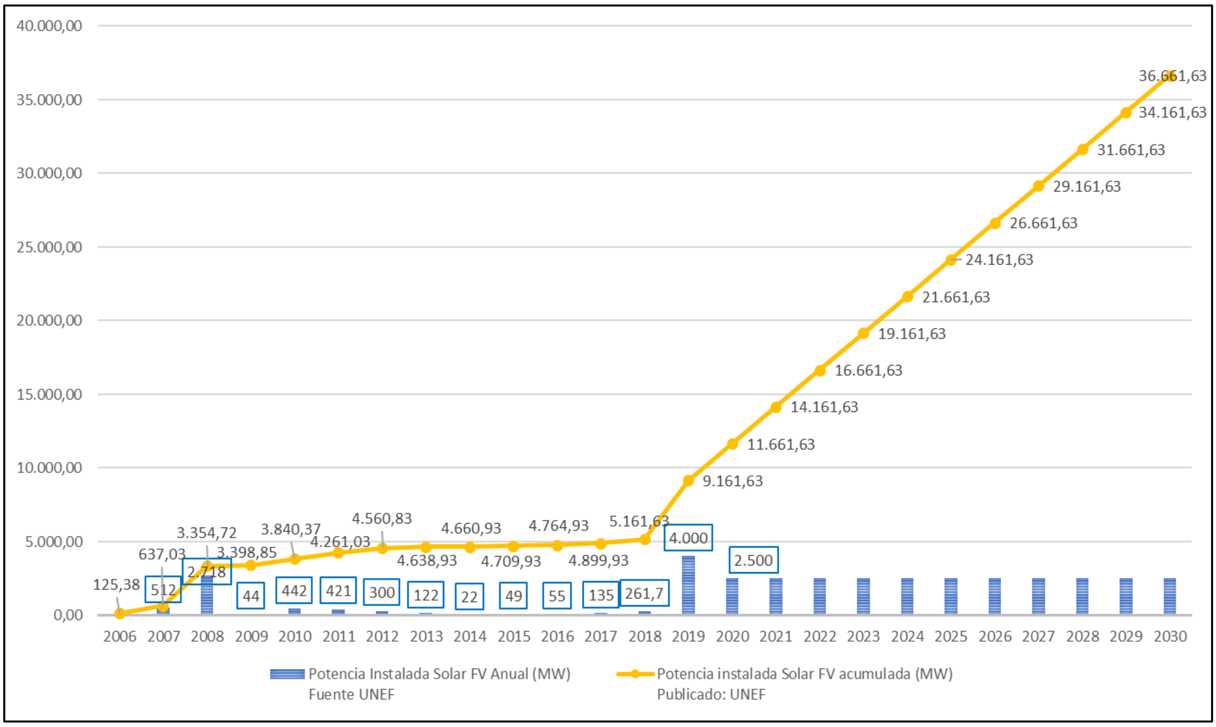

Figure 11.4: Necessary PV capacity to reach the targets of the Spanish NECP, graphic by UNEF – Unión Española Fotovoltaica

Figure 11.5 shows the segmentation of the Spanish PV market. The industrial segment is the main driver which accounts for 3,2 GW of the 4 GW that were planned to be installed in 2019. Only 12 % of the annual installations are predicted to be commercial, around 10 % to be residential.

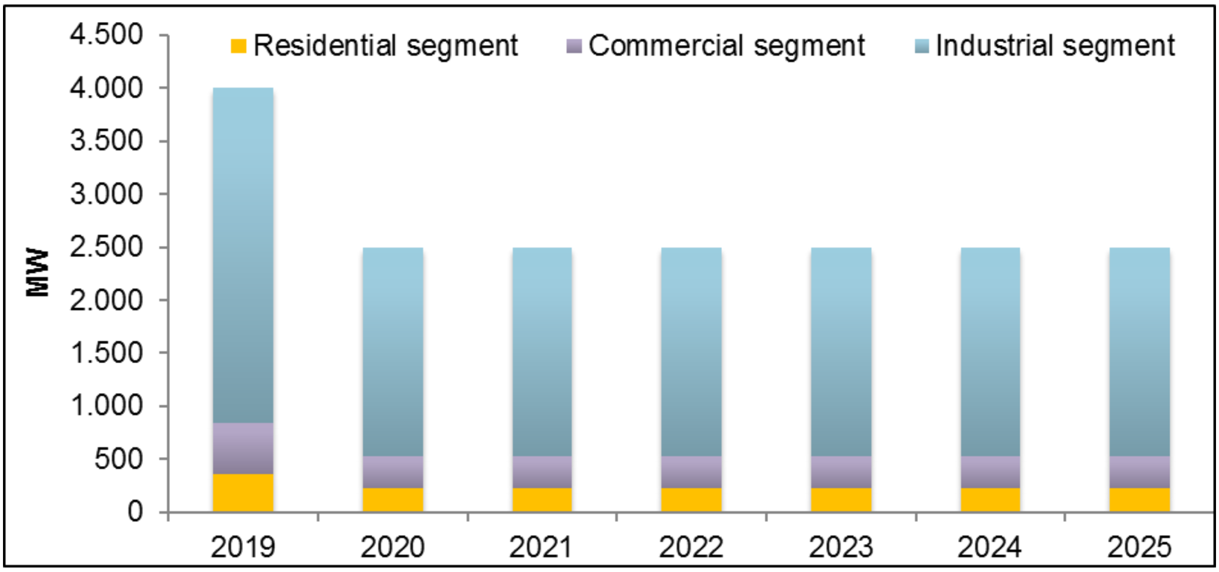

Figure 11.5: Annual PV installation in Spain, general PV-market with segmentation (based on UNEF and the Global Market Outlook by SolarPower Europe)

11.3.2 Self-consumption

The Spanish government created positive conditions not only for the installation of additional PV- capacity, it also improved the conditions for the self-consumption segment significantly (Figure 11.3). Barriers were eliminated that had a negative impact on the profitability of the prosumer activities, especially the cost intensive and publicly discussed “sun-tax”. In addition, the obligation of a second meter contributed to higher system costs and the elimination of this obligation increases the profitability of self-consumption. Moreover, the new government simplified the administrative procedures which will also contribute to a better development of the prosumer segment in Spain. In 2019 only around 350 MW of the 4 GW of installed capacity were self-consumption systems. Self-consumption had a share of 10 % in the residential market in 2019, and of 30 % in the market for commercial installations. The industrial segment is made of utility scale systems which only include a small share of around 2 % of self-consumption systems. In the following years these shares are forecasted to grow until they reach 99 % in the residential market, and around 30% in both the commercial and the industrial markets by 2023. This development is depicted in Figure 11.6 and in Figure 11.7.

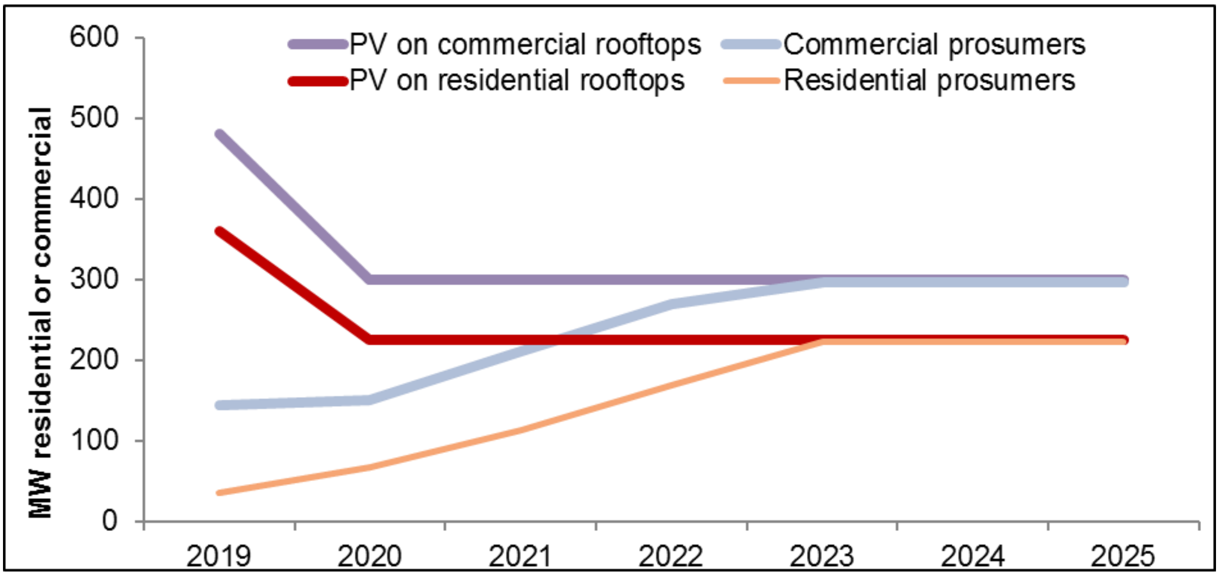

Figure 11.6: The share of self-consumption is expected to reach up to 99 % in 2023 and to continue on this level until 2030, Spain

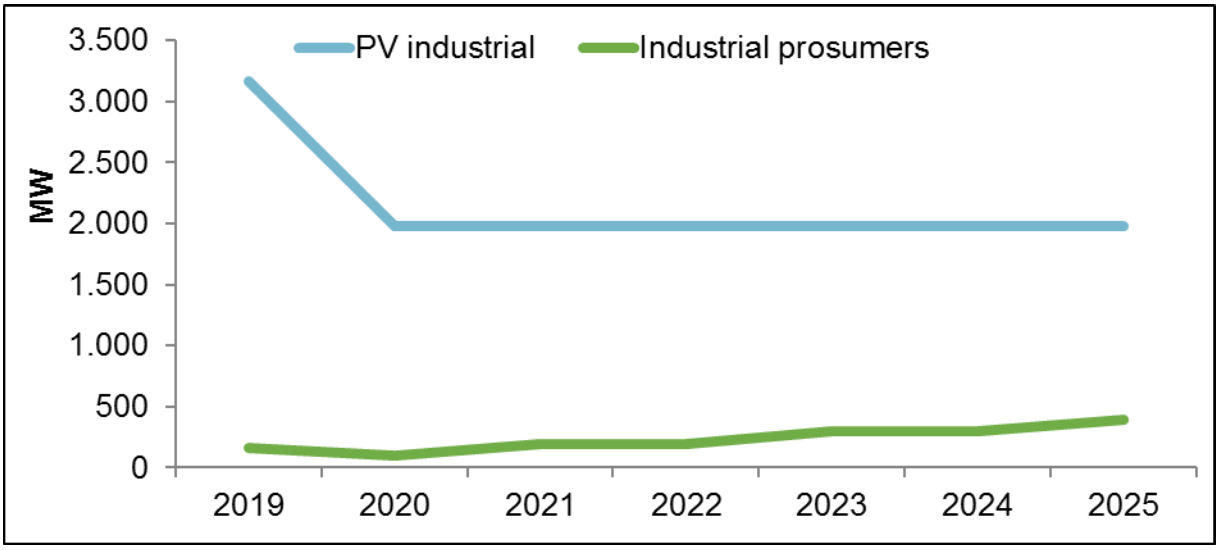

Figure 11.7: The industrial self- consumption is expected to increase during the next years, Spain

The stable annual installations of the overall PV market of 2,5 GW (see Figure 11.5) lead to a linear growth of cumulated capacity. Although the share of self-consumption PV in Spain is growing, it will not account for more than 20 % of the overall PV market by 2025 (25 % by 2030) due to the large share and growth of the utility-scale PV market segment. The ratio of the overall (general) PV market to the self-consumption market is shown in Figure 11.8.

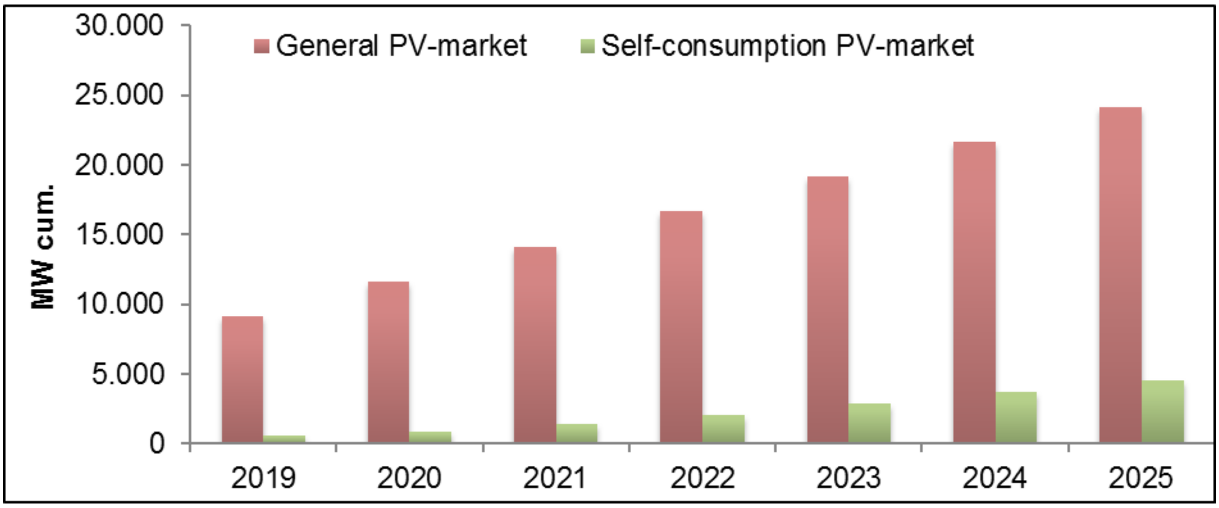

Figure 11.8: The ratio between prosumer and general PV market, Spain, SEIM calculation

In the context of the PVP4Grid project three different business models (or concepts) to be a Prosumer have been evaluated. Therefore, the installations in the self-consumption segment have been split between the three different concepts.

- Concept 1: Direct single use
- Concept 2: Local collective use
- Concept 3: District level energy models

Between these three concepts, the Spanish "Report on PVP4Grid Concepts and Barriers"[35] uses a differentiation by system sizes. The report indicates, that systems < 10 kWp belong to the first concept, systems between 10 kWp and 100 kWp to the second, systems larger than 500 kWp are allocated to the third concept and systems between 100 kWp and 500 kWp can follow both collective use concepts. The future shares and boundaries of the concepts can't be forecasted, therefore the SEIM tool does not change this allocation over time. The development from 2019 to 2025 is shown in Figure 11.9.

[35] Published on the PVP4Grid homepage: https://www.pvp4grid.eu/pv-prosumer-concepts/

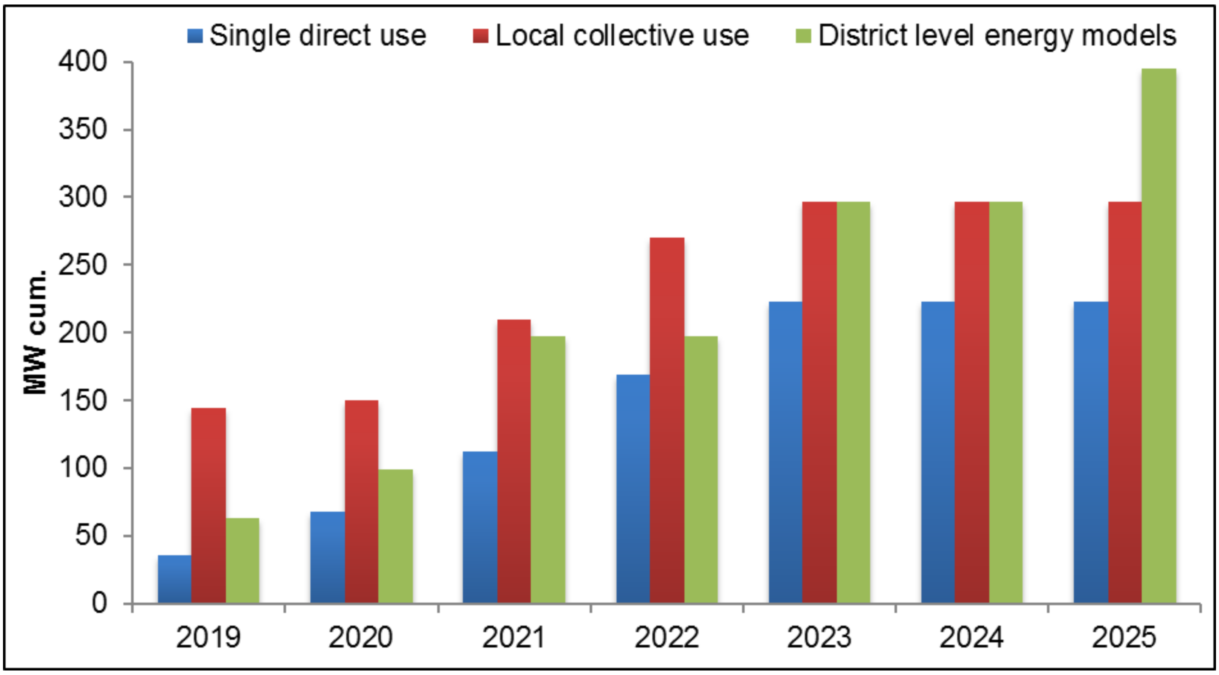

Figure 11.9: The expected segmentation of the new installed prosumer PV, Spain, SEIM calculation

11.4 PV-employment

The employment factors used to assess the job creation by PV installations in Spain are calculated based on the value chain used by SolarPower Europe and E&Y in their "Solar PV Jobs & Value Added in Europe" report (Waele et al., 2017). Again, the employment based on self-consumption PV installations is distinguished from the overall, general PV market and the results are graphically presented until 2025. Figure 11.10 shows the development of FTE based on general PV and based on the share of self-consumption PV.

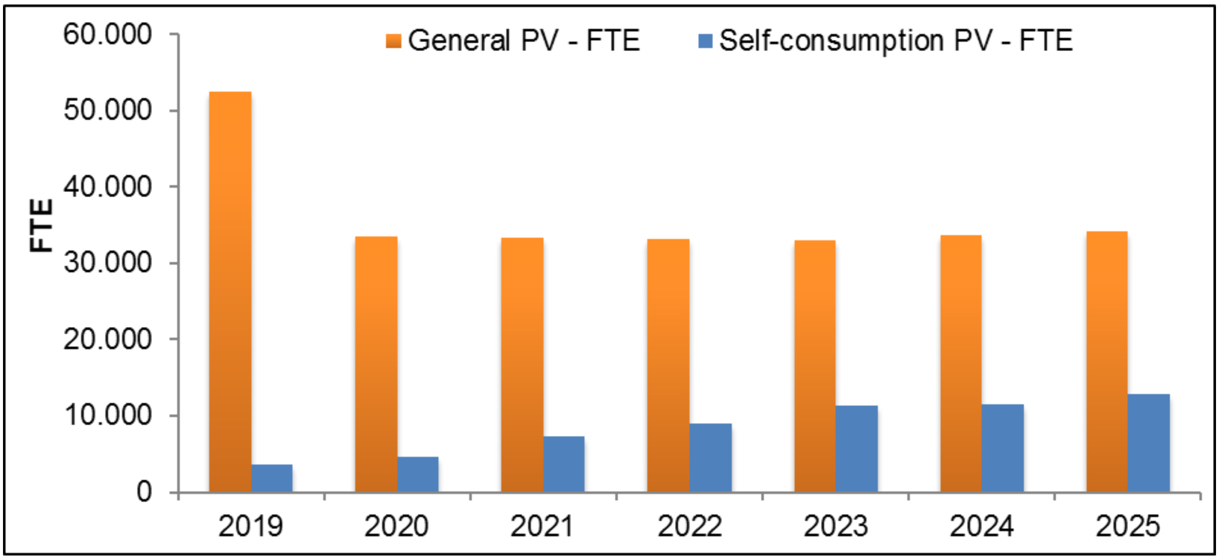

Figure 11.10: Employment based on general PV and on the self-consumption segment, Spain, SEIM calculation

The number of jobs (FTE) peaked in Spain in 2019, based on the 4 GW PV installations. In the basic scenario (bound to the NECP goal) around 52.400 FTE were estimated to be active to meet the demand of this specific year. Due to lower PV installations after 2019 – see Figure 11.6 and Figure 11.7 – the number of FTE drops to 33.400 FTE and slowly rises due to sustainable job creation in the O&M domain of the value chain. The share of FTE based on self-consumption PV increases constantly: While in 2019 only 7 % (3.651 FTE) of PV jobs were active in the self-consumption segment, by 2025, this share increases to 38 % (12.860 FTE) and to 41 % in 2030 (15.200 FTE). Figure 11.11 indicates how the FTEs in Spain are distributed along the PV value chain.

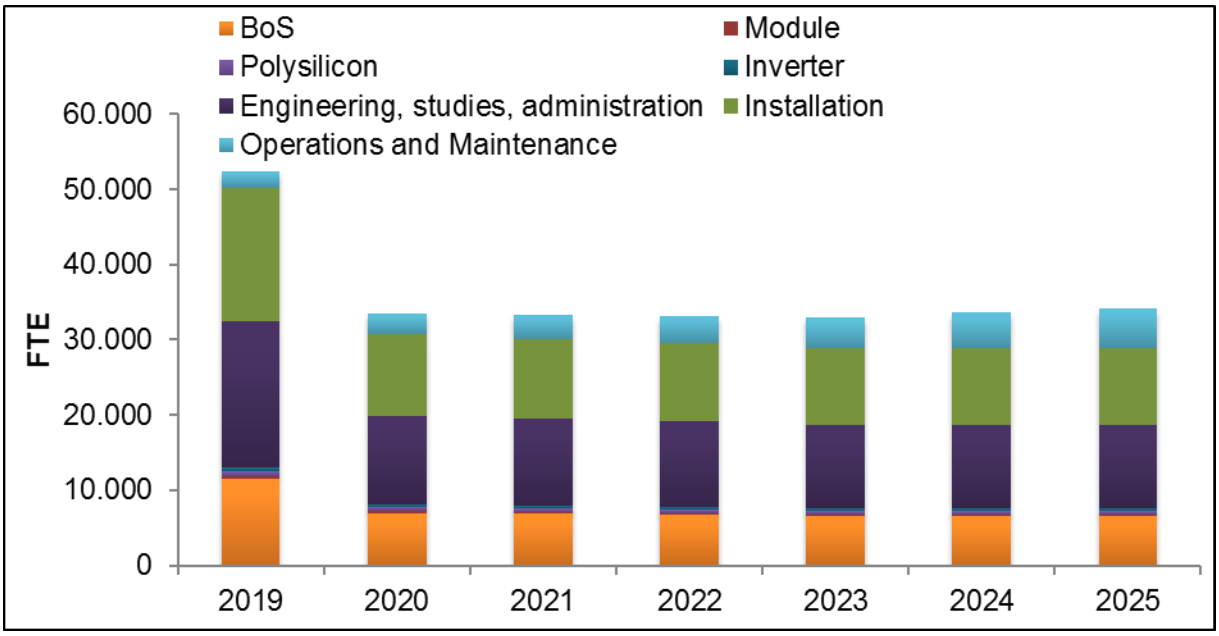

Figure 11.11: Distribution of FTE along the PV-value chain in Spain, SEIM calculation based on the breakdown of the Spanish value-chain by SolarPower Europe (Waele et al. 2017), SEIM calculation

Most of the jobs are created by the value chain activities linked to `Installation´, `Engineering, studies, administration´ and `BoS´. Due to growing numbers of cumulated PV in Spain, the number of FTEs active in the O&M segment is also becoming more important over the years. Regarding the distribution of jobs along the value chain, there is no big difference between the distribution of FTE based on the general PV market and based on self-consumption: In the timeframe considered by the model the upstream jobs of the PV value chain account for 20% to 25 % of all FTE. In consequence, up to 80 % of the workplaces are downstream and offer a better job security due to being local (Waele et al., 2017, S. 35). Per MW of cumulated capacity, 0,2 FTE in the segment O&M are created and remain unchanged over the lifetime of the PV system[36]. 12,6 FTE/MW (2019) to 11,6 FTE/MW (2030) are created for each newly installed PV system, but in the model these jobs are only accounted for in the year of installation.

[36] Reduced only by general efficiency gains.

11.4.1 Employment based on self-consumption PV

In the PVP4Grid project self-consumption PV can be divided into three different concepts, namely “single direct use”, “local collective use” and district level energy models. For the evaluation of FTEs, the segmentation of Prosumer concepts given by the Spanish “PV prosumer concept” report, published on the PVP4Grid homepage, is used. Figure 11.12 indicates the distribution of FTE between the three concepts. The local collective use of self-consumed PV is the most important concept in the Spanish PV labor market until 2025.

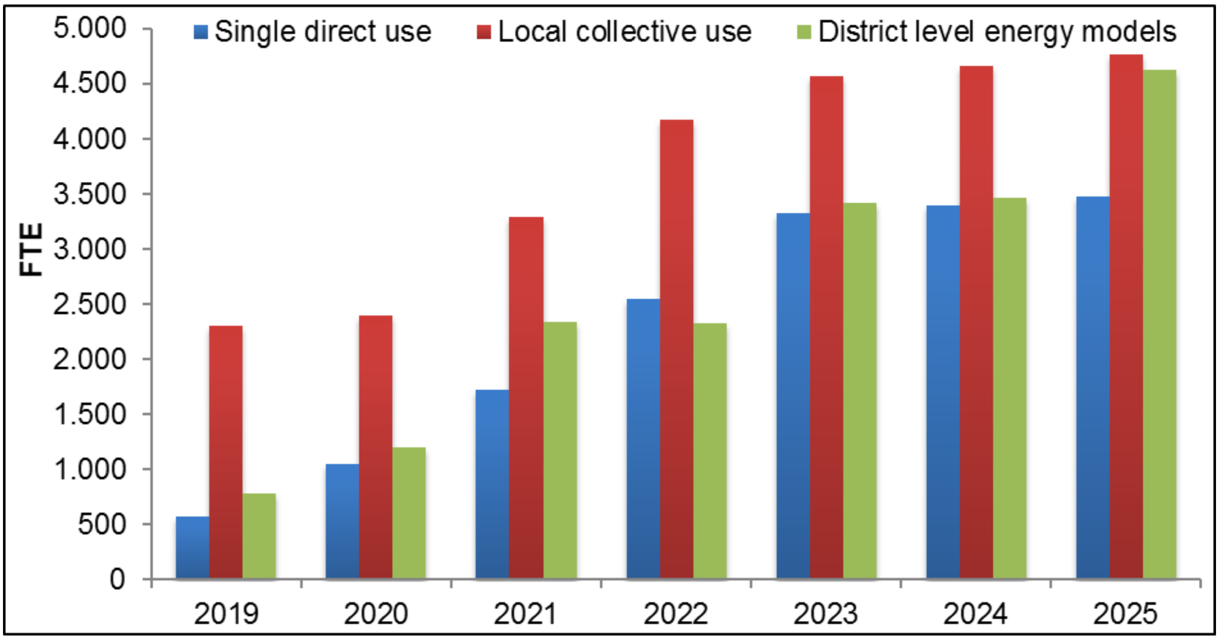

Figure 11.12: Employment based on the three evaluated self-consumption concepts in Spain, SEIM calculation

Eventually the “District level energy models”-concept will surpass the “local collective use” concept regarding the number of jobs created. This will depend on future policies and the dismantling of market barriers for the third concept. For each MW cumulated, 0,3 O&M related FTEs are created in the self-consumption PV (over the entire lifetime of the system). In the year of their installation new systems create 14,3 FTE/MW (2019) to 12,5 FTE/MW (2030) in all other value chain components. Therefore, prosumer PV systems create more jobs than feed-in systems because prosumer systems tend to be smaller PV systems which are more labor intensive than larger utility scale systems.

11.5 Value creation

In general, the annual value creation is determined by the annual installation. The sum of value creation based on the 2019 installations is around 2 billion EUR and simultaneously depicts the peak in annual value creation (see Figure 11.13). In the following years it declines to approx. 1,3 billion EUR per year with small annual increases. Looking only at self-consumption systems, the value creation starts at 150 million EUR/a and rises with to 470 Million EUR/a by 2025. This value creation can be divided into the three components “public value creation”, “net salaries” and “private net profits”. With around 66 % of the value creation, the net salaries are responsible for the main share of value creation, followed by 24 % based on taxes and social contributions and 10 % of corporate net profits. This is depicted in Figure 11.14.

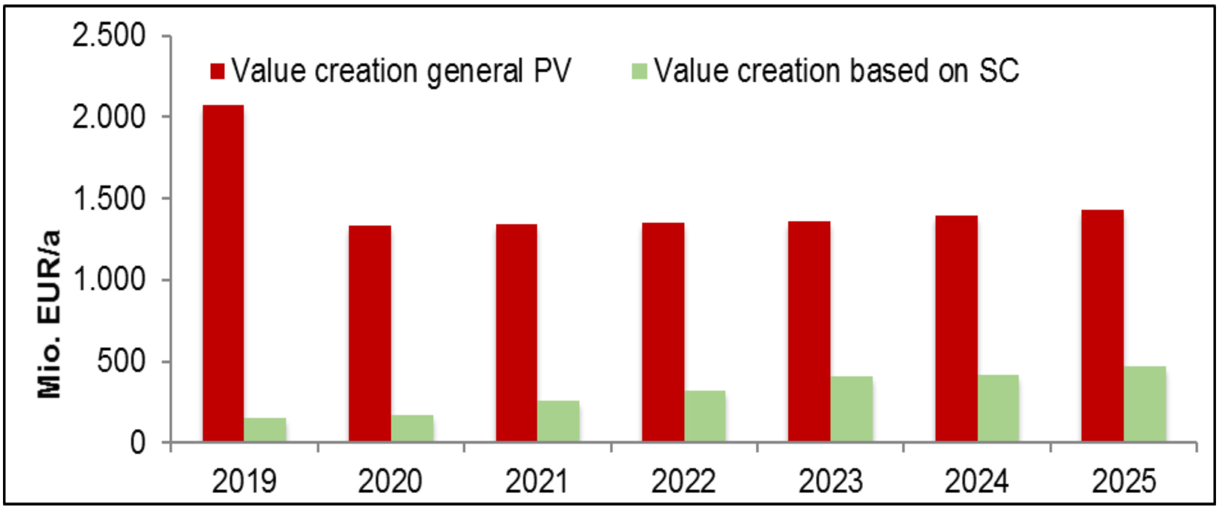

Figure 11.13: Annual value creation via PV in Spain, general PV vs. based on SC, SEIM calculation

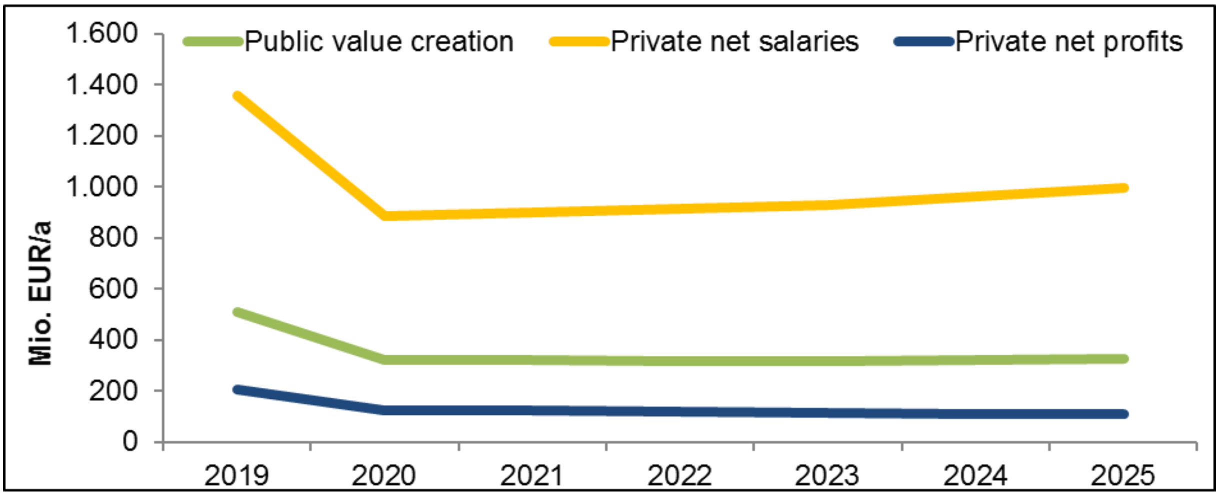

Figure 11.14: Structure of value creation in Spain, public vs. salaries vs. private profits, SEIM calculation

Based on the share of self-consumption PV of the overall PV market, the value that is created by the three different self-consumption-concepts can be seen in Figure 11.15. Analogous to Figure 11.12 the local collective use is the most important concept in Spain, followed by future district power models that in the model will surpass the local collective use in terms of value creation by 2028. This is because of the high amount of industrial PV that will be installed (Figure 11.5), from which the concept three – where large scale PV is necessary – will benefit.

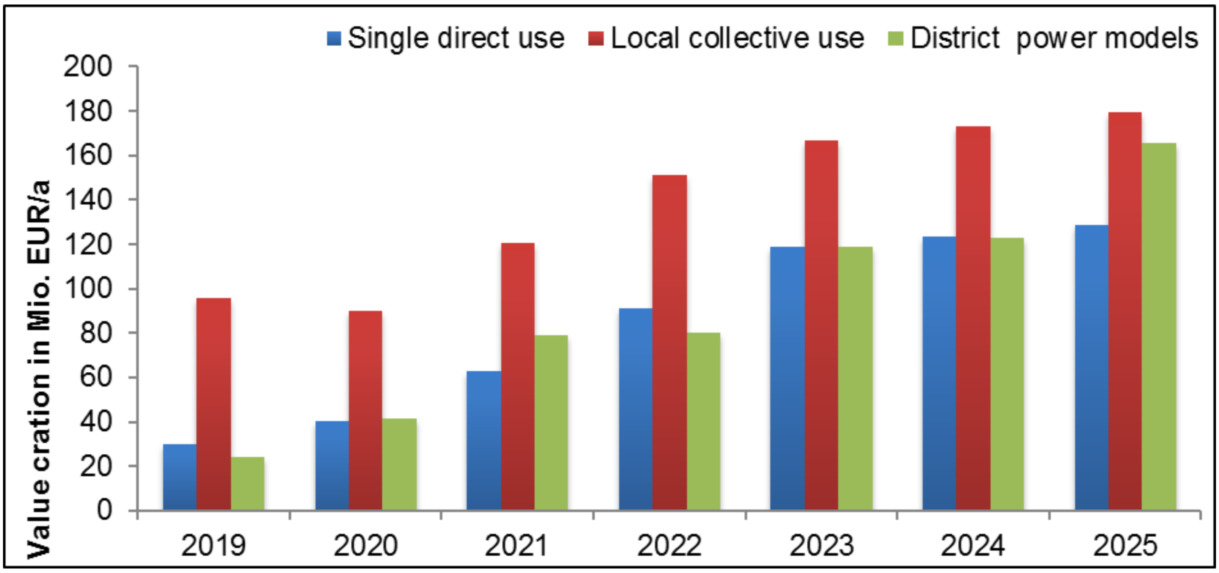

Figure 11.15: Value creation allocated to the three evaluated self-consumption concepts, Spain, SEIM calculation

Per MW installed of self-consumption PV around 10.000 EUR are created each year over the lifetime of the system. In the year of the installation, around 500.000 EUR/MW of an added value is created. Compared to the general PV market, these values indicate the deployment of self-consumption PV to be beneficial in terms of macroeconomic effects in Spain compared to the overall PV market, where the corresponding key figures are 7.600 EUR/MW (O&M) and 490.000 EUR/MW in the first year.

11.6 Scenarios

As there are some opportunities for PV in Spain to grow even faster, the gap between the base case scenario and the best-case scenario is large. An argument supporting the best-case scenario is the large volumes of PV capacity both already authorized and in process of authorization. Moreover, the simplified administrative procedure for self- consumption PV and the creation of the different prosumer concepts are considered very effective drivers for the PV-market. However, as said before, future technological developments and political support for PV may vary and this may have a strong influence on the development of the PV market. Hence, it cannot be excluded that the PV market will actually grow slower than in the base-case scenario. This is displayed in the “worst case” calculations of the model. Figure 11.16 is extended until 2030 to show, that under optimal conditions and by using every authorized location, Spain could reach a cumulated capacity beyond 90 GW, which would have large socio-economic effects on both: the labor market and the monetarily described value creation.

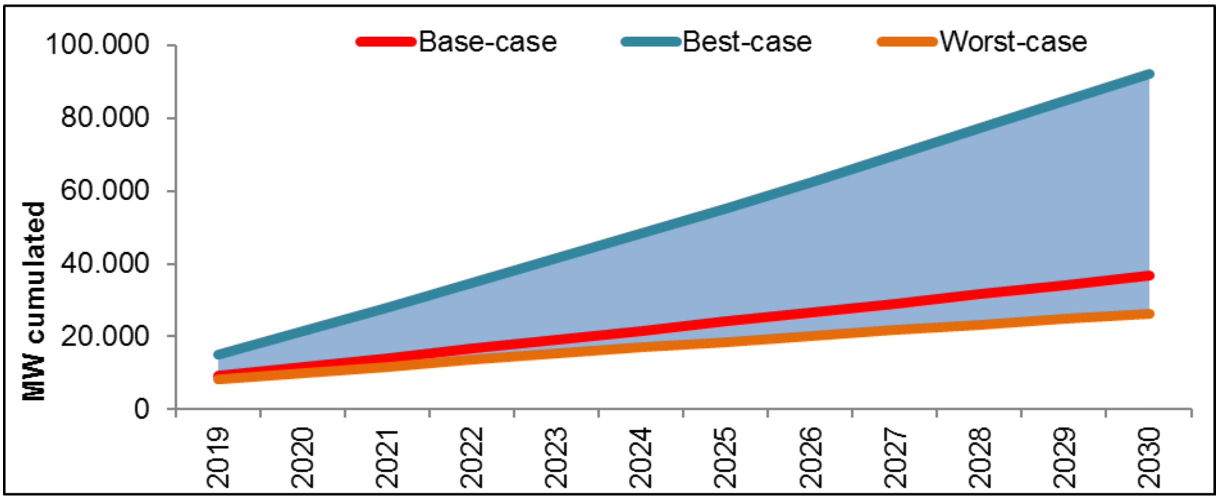

Figure 11.16: Spanish scenario, cumulated capacity until 2030

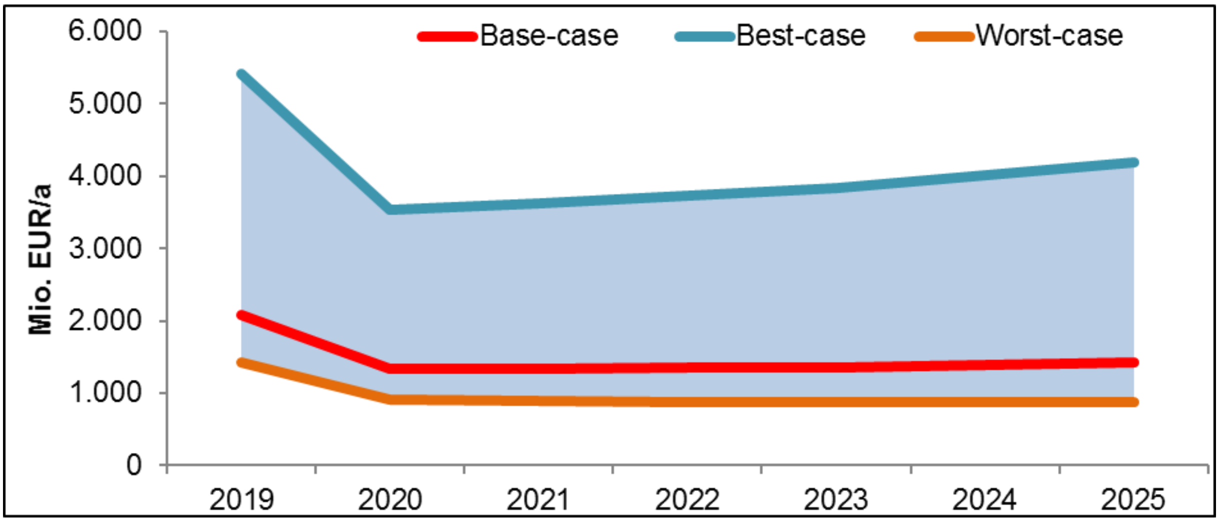

Figure 11.17: Spanish scenario, annual value creation until 2025

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List of abbreviations

APESF	Portuguese association of PV companies
APREN	Portuguese Association for Renewable Energies
BMF	German Federal Ministry of Finance
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BoS	Balance-of-System
BSW	German Solar Industry Association
CGE	Computable General Equilibrium Model
D&R	Decommissioning & Recycling
EBIT	Earnings before interest and taxes
EEG	Renewable Energy Sources Act
EUR	Euro
FTE	Full-time equivalents
GDP	Gross Domestic Product
GoS	Gross Operating Surplus
GVA	Gross Value added
HDI	Human Development Index
I-O	Input-Output
IEA	International Energy Agency

IÖW	Institute for Ecological Economy Research
IRENA	International Renewable Energy Agency
kWh	Kilowatt hour
KWp	Kilowatt peak
LCOE	Levelized cost of electricity
NECP	National energy and climate plan
O&M	Operation & Maintenance
SEIM	Socio-Economic Impact Modeling
UE	Sales revenues
UNEF	Spanish Photovoltaic Association
UR	Return on sales
VAT	value added tax

References

ADEeF (09/2019) Association of the Distributors of Electricity in France; Online available under http://www.adeef.fr/en/news/

AGEB: Auswertungstabellen 1990-2018 and Stromerzeugung nach Energieträgern 1990 – 2019; Arbeitsgemeinschaft Energiebilanzen e.V.; Online available under https://ag-energiebilanzen.de/

Agora-Energiewende (2016): Eigenversorgung aus Solaranlagen: Das Potenzial für Photovoltaik Speicher-Systeme in Ein-und Zweifamilienhäusern, Landwirtschaft sowie im Lebensmittelhandel;

Ammon, Martin; Bruns, Thorben; Semerow, Natalja (2019): Energiewende im Kontext von Atom- und Kohleausstieg. Perspektiven im Strommarkt bis 2040. EuPD Research; Bundesverband Solarwirtschaft e.V. - BSW; The smarter EEurope. Online available under http://bit.ly/thesmartere-studie-PM

APERe (2019): Puissance installée ; Observatoire éolien ; Ed. Association pour la Promotion des Energies Renouvelables ; Online available under http://apere.org/fr/observatoire-eolien

Bacon, Robert; Kojima, Masami (2011): Issues in estimating the employment generated by energy sector activities. Ed. The World Bank. Sustainable Energy Department

Bellini, Emiliano (2019): Several pv-magazine articles:

Winners, projects, prices of Portugal's record PV auction. Ed. pv magazine; Online available under https://www.pv-magazine.com/2019/08/09/winners-projects-prices-of-portugals-record-pv-auction/

Neuer Referentenentwurf zum Kohleausstiegsgesetz weiter ohne EEG-Änderungen; Online available under https://www.pv-magazine.de/2020/01/21/neuer-referentenentwurf-zum-kohleausstiegsgesetz-weiter-ohne-eeg-aenderungen/

Blyth, Will; Gross, Rob; Speirs, Jamie; Sorrell, Steve; Nicholls, Jack; Dorgan, Alex; Hughes, Nick (2014): Low carbon jobs: The evidence for net job creation from policy support for energy efficiency and renewable energy. UK Energy Research Centre UKERC. Online verfügbar unter http://www.ukerc.ac.uk/asset/0A611DB6-DCEA-4628-97FC16042EAD4F20/

BMF (2019): Steuern von A bis Z. Ed. Bundesministerium der Finanzen. Berlin, Germany. Online available under: https://www.bundesfinanzministerium.de/Content/DE/Downloads/Broschueren_Bestellservice/2018-03-26-steuern-von-a-z.html

BOP (2019): Offshore wind energy in the Belgian part of the North Sea: up to 4,000 MW by 2024; Belgian Offshore Platform; Online available under http://www.belgianoffshoreplatform.be/en/news/offshore-wind-energy-in-the-belgian-part-of-the-north-sea-up-to-4000-mw-by-2024/

Breitschopf, Barbara; Nathani, Carsten; Resch, Gustav (2011): Economic and Industrial Development. Review of approaches for employment impact assessment of renewable energy deployment. Ed. Fraunhofer-Institut für Solare Energiesysteme ISE. Renewable Energy Technology Deployment IEA-RETD; rütter + partner; Energy Economics Group EEG. Karlsruhe

Bundesnetzagentur. (2019). EEG-Registerdaten. https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/ZahlenDatenInformationen/EEG_Registerdaten/EEG_Registerdaten_node.html

CBS Central Agency for Statistics database: Database on energy composition in the Netherlands; Online available under https://www.cbs.nl/en-gb

Coenenberg, Adolf Gerhard; Fischer, Thomas M.; Günther, Thomas (2016): Kostenrechnung und Kostenanalyse. 9., überarbeitete Auflage. Stuttgart: Schäffer-Poeschel Verlag.

DNHK Duits-Nederlandse Handelskamer: Data on the energy production in the Netherlands; Online available under: https://www.dnhk.org/

E-Control BDEW (2018): Data on electricity production; Online available under https://www.bdew.de/energie/stromerzeugung/

EEG, of the 13.05.2019: Erneuerbare-Energien-Gesetz vom 21. Juli 2014 (BGBl. I S. 1066), das zuletzt durch Artikel 5 des Gesetzes vom 13. Mai 2019 (BGBl. I S. 706) geändert worden ist. Online available under https://www.gesetze-im-internet.de/eeg_2014/EEG_2017.pdf

EEÖ (2019): Umfrage zeigt: Menschen wollen ambitionierte Klimapolitik; Erneuerbare Energien Österreich; Online available under https://www.erneuerbare-energie.at/presseaussendungen/2019/12/18/umfrage-zeigt-menschen-wollen-ambitionierte-klimapolitik

energiefirmen.de: Data on the European energy-industry; Online available under: https://www.energiefirmen.de/wirtschaft/markt/strom

erneuerbareenergien.de. (2016): Photovoltaik-Speicher-Kombinationen erreichen Netzparität. Online available under https://www.erneuerbareenergien.de/photovoltaik-speicher-kombinationen-erreichen-netzparitaet/150/436/94690/.

EurObserv'ER: Interactive Database. Ed. Europäische Kommission. ADEME French Environmental & Energy Management Agency. Online available under https://www.eurobserv-er.org/online-database/

European Commission (2016): Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast); 2016/0382 (COD); Brussels, 30.11.2016; COM(2016) 767 final

EUROSTAT (2019): Datenbank. Ihr Schlüssel zur europäischen Statistik. Ed. EuropäischeKommission. Luxemburg. Online available under https://ec.europa.eu/eurostat/de/data/database

Hirschl, Bernd; Aretz, Astrid; Prahl, Andreas; Böther, Timo; Heinbach, Katharina (2010): Kommunale Wertschöpfung durch Erneuerbare Energien. Berlin: Institut für ökologische Wirtschaftsforschung (Schriftenreihe des IÖW, 196). Online available under http://www.kommunal-erneuerbar.de/

HSE Solarpark Thüngen GmbH & Co. KG (2015): Bilanz, GuV und Kennzahlen der HSE Solarpark Thüngen GmbH & Co. KG

IG Windkraft (2019): Austrian Wind Energy Association; Online available under https://www.igwindkraft.at/?

International Energy Agency (2018): World energy outlook 2018. Paris, Frankreich. Online available under https://www.iea.org/weo2018/

International Energy Agency (2019): IEA-PVPS national survey reports; Used for all eight countries; Online available under http://www.iea-pvps.org/?id=93

International Energy Agency (2020): Database on national electricity production and consumption; Online available under https://www.iea.org/countries/france

IÖW. (2017): Prosumer in der Energiewirtschaft; Institut für Ökologische Wirtschaftsforschung; Online available under https://www.ioew.de/fileadmin/user_upload/DOKUMENTE/ Vortraege/2017/gaehrs_swantje_prosumer_in_der_energiewirtschaft.pdf

Koch, Volkmar; Kuge, Simon; Geissbauer, Reinhard; Schrauf, Stefan (2014): Industrie 4.0. Chancen und Herausforderungen der vierten industriellen Revolution. PricewaterhouseCoopers International pwc

Lazard (2018): Lazard's Levelized Cost of Energy Analysis. Version 12.0. Lazard. Online available under https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf

Lettner, Georg; Auer, Hans; Fleischhacker, Andreas; Schwabeneder, Daniel; Dallinger, Bettina; Moisl, Fabian (2018): Existing and Future PV Prosumer Concepts. Technical University Vienna, PVP4Grid. Online available under https://www.pvp4grid.eu/pv-prosumer-concepts/

Londo, M.; Matton, R.; Usmani, O.; van Klaveren, M.; Tigchelaar, C. (2017): De salderingsregeling: Effecten van een aantal hervormingsopties. (eng.: The netting scheme: Effects of a number of reform options) ECN, ECN-E-17-023.

LTECV (2015): La loi relative à la transition énergétique pour la croissance verte; publiée au Journal Officiel du 18 août 2015 ; Online available under https://www.ecologique-solidaire.gouv.fr/loi-transition-energetique-croissance-verte

Meyer, Ina; Sommer, Mark Wolfgang (2014): Employment Effects of Renewable Energy Supply. A Meta Analysis. Policy Paper No 12. Hg. v. WWW for Europe - Welfare Wealth Work. Online available under www.foreurope.eu

Mühlenhoff, Jörg (2010): Value Creation for Local Communities through Renewable Energies. Results of the study by the Institute for Ecological Economy Research (IÖW). In: *Renews Special* (Issue 46). Online available under www.renewables-in-germany.com

NECP: The National Energy and Climate Plans of Austria, Belgium, France, Germany, Italy, Netherlands, Portugal and Spain have been used; Online available under https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/national-energy-climate-plans

PBL (2019): Climate and Energy Outlook 2019, Summary; Netherlands Environmental Assessment Agency; Online available under https://www.pbl.nl/sites/default/files/downloads/pbl-2019-climate-and-energy-outlook-2019-summary-3825.pdf

PV Austria (2019): Die Österreichische Photovoltaik & Speicher-Branche in Zahlen; Online available under https://www.pvaustria.at/wp-content/uploads/2019_06_18_Fact_Sheet_PV_Branche.pdf

PVP4Grid Reports; Online available under https://www.pvp4grid.eu/

The following reports have been used:

1) D2.1: Existing and Future PV Prosumer Concepts
2) D2.4: Report on PVP4Grid Concepts and Barriers (each country)
3) D3.1: Improvement of PVP4Grid Concepts
4) PV Prosumer Guidelines for eight EU Member States

Schmela, Michael; Rossi, Raffaele; Beauvais, Aurélie; Chevillard, Naomi; Paredes, Mariano Guillén; Heisz, Máté (2019): Global Market Outlook. For Solar Power 2019 - 2023. Ed. SolarPower Europe. intersolar Europe, Global Solar Council. Brüssel, Belgien. Online available under www.solarpowereurope.org

Social Sciences Program Australia (2005): Socio-economic Impact Assessment Toolkit. A guide to assessing the socio-economic impacts of Marine Protected Areas in Australia. Ed. Bureau of Rural Sciences und Department of Agriculture, Fisheries and Forestry. Bureau of Rural Science - Australian Government

STATBEL: Database on the energy production/consumption in Belgium; Online available under https://statbel.fgov.be/de/themen/energie

Statistik Austria (2019): Data on the Austrian energy production; Online available under https://www.statistik.at/web_de/statistiken/energie_umwelt_innovation_mobilitaet/energie_und_umwelt/index.html

Taylor, C. Nicholas; Bryan, C. Hobson; Colin, G. Goodrich (1995): Social Assessment: Theory, process & techniques. Studies in Resource Management no. 7. New Zealand van Mark, Michael (2010): Cost and benefit effects of renewable energy expansion in the power and heat sectors. Ed. Federal Ministry for the Enviroment, Nature Conservation, Nuclear Safety (BMU)

Waele, Céline de; Baboulet, Olivier; Gazzo, Alexis (2017): Solar PV Jobs & Value Added in Europe. Hg. v. Ernst & Young, Solar Power Europe. Online available under https://www.ey.com/Publication/vwLUAssets/EY-solar-pv-jobs-and-value-added-in-europe/$FILE/EY-solar-pv-jobs-and-value-added-in-europe.pdf

Wainman, Gary; Gouldson, Ian; Szary, Anthony (2010): Measuring the economic impact of an intervention or investment. Paper One: Context & rationale. Office for National Statistics. Newport, Vereinigtes Königreich. Online available under www.statistics.gov.uk

Wallasch, Anna-Kathrin; Lüers, Silke; Vidican, Georgeta; Breitschopf, Barbara; Richter, Anita; Kuntze, Jan-Christoph et al. (2014): The Socio-economic Benefits of Solar and Wind Energy. Clean Energy Ministerial (CEM); International Renewable Energy Agency (IRENA). Abu Dhabi. Online available under www.irena.org/Publications

Wirth, Harry (2019): Aktuelle Fakten zur Photovoltaik in Deutschland. Ed. Fraunhofer-Institut für Solare Energiesysteme ISE. Freiburg, Deutschland. Online available under www.pv-fakten.de

Annex

Annex 1: Questionnaire

Questions
Socio-Economic Impact Modelling

#	Part 1: Basic input data	additional information	Unit
1	Enter the name of the country to be researched		Country
2	Please enter the base year for the data collected		Year
3	Please end the time horizon for the model to run		Years
	Model end		Date
	Part 2: Full-time equivalent (FTE) (jobs) calculation - base factor		
	Driven by annual installation		
4	Please enter the average FTE number per annual MWp installed for the country for the entire PV market	BOS	FTE/MWp
5	Please enter the average FTE number per annual MWp installed for the country for the entire PV market	Module	FTE/MWp
6	Please enter the average FTE number per annual MWp installed for the country for the entire PV market	Cell	FTE/MWp
7	Please enter the average FTE number per annual MWp installed for the country for the entire PV market	Polysilicon	FTE/MWp
8	Please enter the average FTE number per annual MWp installed for the country for the entire PV market	Wafer	FTE/MWp
9	Please enter the average FTE number per annual MWp installed for the country for the entire PV market	Inverter	FTE/MWp
		Upstream- total	FTE/MWp
		Downstream	
10	Please enter the average FTE number per annual MWp installed for the country for the entire PV market	Engineering, studies, administration	FTE/MW
11	Please enter the average FTE number per annual MWp installed for the country for the entire PV market	Installation	FTE/MW
12	Please enter the average FTE number per annual MWp installed for the country for the entire PV market	Decommissioning and recycling	
		Downstream- annual total	FTE/MW
13	Please enter the average FTE number per annual MWp installed for the country for self-consumption PV	Engineering, studies, administration	FTE/MW
14	Please enter the average FTE number per annual MWp installed for the country for self-consumption PV	Installation	FTE/MW
15	Please enter the average FTE number per annual MWp installed for the country for self-consumption PV	Decommissioning and recycling	
		Downstream- annual total	FTE/MW
	Driven by cumulated installation		
16	Please enter the average FTE number per cum. MW installed for the country for the entire PV market	Operations and Maintenance	FTE/MW (cum.)
		O&M total	FTE/MW (cum.)
	FTE correction by type of installation		
17	How much more labor intense is the installation of a self-consumption installation based in compariosn to overall FTE values		%
18	How much less labor intense is the installation of a ground mounted installation based in compariosn to overall FTE values		%
	Share of ground mounted vs. rooftop installations (PVP4Grid)		
19	For the annual PV market: what is the share of self-consumption installations?		%
20	For the annual PV market: what is the share of feed-in installations?		%
21	Regarding the cumulated PV market size: what is the share of self-consumption installations?		%
22	Regarding the cumulated PV market size: what is the share of feed-in installations?		%
	Expected FTE Efficiency gains (optional)		
		Upstream	
23	What are the efficiency gains expected in terms of labor efficiency over the next years?	BOS	FTE/MW
24	What are the efficiency gains expected in terms of labor efficiency over the next years?	Module	FTE/MW
25	What are the efficiency gains expected in terms of labor efficiency over the next years?	Cell	FTE/MW
26	What are the efficiency gains expected in terms of labor efficiency over the next years?	Polysilicon	FTE/MW
27	What are the efficiency gains expected in terms of labor efficiency over the next years?	Wafer	FTE/MW
28	What are the efficiency gains expected in terms of labor efficiency over the next years?	Inverter	FTE/MW
		Downstream	
29	What are the efficiency gains expected in terms of labor efficiency over the next years?	Engineering, studies, administration	FTE/MW
30	What are the efficiency gains expected in terms of labor efficiency over the next years?	Installation	FTE/MW
31	What are the efficiency gains expected in terms of labor efficiency over the next years?	Operations and Maintenance	FTE/MW
32	What are the efficiency gains expected in terms of labor efficiency over the next years?	Decommissioning and recycling	FTE/MW
	Part 3: National PV Industry structure (relevant for PVP4Grid)		
	Company size		
33	Please enter typical company sizes for the PV industry	Size 1	# of employees
34	Please enter typical company sizes for the PV industry	Size 2	# of employees
35	Please enter typical company sizes for the PV industry	Size 3	# of employees
36	Please enter typical company sizes for the PV industry	Size 4	# of employees
37	Please fill in the table for the respective companies	Size 1	% and number
38	Please fill in the table for the respective companies	Size 2	% and number
39	Please fill in the table for the respective companies	Size 3	% and number
40	Please fill in the table for the respective companies	Size 4	% and number

Figure A.1: Questions sent to the institutions, questions 1 to 40

	Function		
41	Please fill in the table for the respective companies	Owner & associates, employer, indepe	%
42	Please fill in the table for the respective companies	Employee	%
43	Please fill in the table for the respective companies	Family hands	%
44	Please fill in the table for the respective companies	Apprentices	%
	Monthly gross salaries		
45	Please fill in the average monthly gross salaries by employee type	Owner & associates, employer, indepe	EUR
46	Please fill in the table for the respective companies	Employee	EUR
47	Please fill in the table for the respective companies	Family hands	EUR
48	Please fill in the table for the respective companies	Apprentices	EUR
		Average gross salary	EUR
	Expected salary development		
49	Please enter the overall expected raise in salaries over the next years	Salary raise	%
	Part 4: Social charges and income tax		
	Average rate of income tax and social charges		
50	Please enter the average % of income tax in the country	Income tax	%
51	Please enter the average % of social charges in the country	social charges	%
52	Please enter the average percentage of combined income tax and social charges in the country	combined	%
	Social charges		
	Social charges - percentage		
53	Please enter the % of social charges to be paid in the table	Health insurance - motherhood	%
54	Please enter the % of social charges to be paid in the table	Retirement	%
55	Please enter the % of social charges to be paid in the table	Family insurance	%
56	Please enter the % of social charges to be paid in the table	Health insurance basic	%
57	Please enter the % of social charges to be paid in the table	Health insurance -solidarity	%
58	Please enter the % of social charges to be paid in the table	Unemployment insurance	%
59	Please enter the % of social charges to be paid in the table	Professional education tax	%
		Total	%
	Social charges - Upper limits		
60	Please enter the upper limit for social contributions	Health insurance - motherhood	EUR
61	Please enter the upper limit for social contributions	Retirement	EUR
62	Please enter the upper limit for social contributions	Family insurance	EUR
63	Please enter the upper limit for social contributions	Health insurance basic	EUR
64	Please enter the upper limit for social contributions	Health insurance -solidarity	EUR
65	Please enter the upper limit for social contributions	Unemployment insurance	EUR
66	Please enter the upper limit for social contributions	Professional education tax	EUR
	Value added - income tax		
	Tax brackets		
67	Please enter the income tax bracket in the country	Bracket #1	EUR
68	Please enter the income tax bracket in the country	Bracket #2	EUR
69	Please enter the income tax bracket in the country	Bracket #3	EUR
70	Please enter the income tax bracket in the country	Bracket #4	EUR
71	Please enter the income tax bracket in the country	Bracket #5	EUR
72	Please enter the income tax bracket in the country	Bracket #6	EUR
	Tax rates		
73	Please enter the income tax rate in the country/ bracket	Bracket #1	%
74	Please enter the income tax rate in the country/ bracket	Bracket #2	%
75	Please enter the income tax rate in the country/ bracket	Bracket #3	%
76	Please enter the income tax rate in the country/ bracket	Bracket #4	%
77	Please enter the income tax rate in the country/ bracket	Bracket #5	%
78	Please enter the income tax rate in the country/ bracket	Bracket #6	%
	Part 5: Sales photovoltaics		
	System Cost		
79	Please define 5 typical photovoltaic system sizes	System Size	kWp
80	Please enter average system prices for the above mentionned system sizes	Specific System Cost	EUR/kWp

Figure 0.2: Questions sent to the institutions, questions 41 to 80

Part 6: Market segments and sizes (most probable scenario)

Residential Segment 1 Self-consumption

81	Please enter the typical percentage of "Prosumers" in this segment in your country	**Prosumers in segment 1**	%
		Size	
82	Please enter the typical system size by market segment	Residential small self-consumpiton	kWp
83	Please enter the typical system size by market segment	Residential medium self-consumption	kWp
84	Please enter the typical system size by market segment	Residential medium self-consumption '	kWp
85	Please enter the typical system size by market segment	Residential large self-consumption	kWp
86	Please enter the typical system size by market segment	Residential large self-consumption witl	kWp
		Cumulated installed base (actual)	
87	Please enter the currently installed, cumulated PV system capacity by market segment	Residential small self-consumpito	MWp
88	Please enter the currently installed, cumulated PV system capacity by market segment	Residential medium self-consumption	MWp
89	Please enter the currently installed, cumulated PV system capacity by market segment	Residential medium self-consumption '	MWp
90	Please enter the currently installed, cumulated PV system capacity by market segment	Residential large self-consumption	MWp
91	Please enter the currently installed, cumulated PV system capacity by market segment	Residential large self-consumption witl	MWp
		Expected annual installations (forecast)	
92	Please enter the annually expected additions of the PV market segment	Residential small self-consumpito	MWp
93	Please enter the annually expected additions of the PV market segment	Residential medium self-consumption	MWp
94	Please enter the annually expected additions of the PV market segment	Residential medium self-consumption '	MWp
95	Please enter the annually expected additions of the PV market segment	Residential large self-consumption	MWp
96	Please enter the annually expected additions of the PV market segment	Residential large self-consumption witl	MWp
		Estimated deviation of the expected PV additions	
97	Please enter the estimated deviation of the expected PV additions - upwards	Upwards	%
98	Please enter the estimated deviation of the expected PV additions - downwards	Downwards	%

Commercial Segment 2 Self-consumption

99	Please enter the typical percentage of "Prosumers" in this segment in your country	**Prosumers in segment 2**	%
		Size	
100	Please enter the typical system size by market segment	Commercial segment 1	kWp
101	Please enter the typical system size by market segment	Commercial segment 2	kWp
102	Please enter the typical system size by market segment	Commercial segment 3	kWp
103	Please enter the typical system size by market segment	Commercial segment 4	kWp
104	Please enter the typical system size by market segment	Commercial segment 5	kWp
		Cumulated installed base (actual)	
105	Please enter the currently installed, cumulated PV system capacity by market segment	Commercial segment 1	MWp
106	Please enter the currently installed, cumulated PV system capacity by market segment	Commercial segment 2	MWp
107	Please enter the currently installed, cumulated PV system capacity by market segment	Commercial segment 3	MWp
108	Please enter the currently installed, cumulated PV system capacity by market segment	Commercial segment 4	MWp
109	Please enter the currently installed, cumulated PV system capacity by market segment	Commercial segment 5	MWp
		Expected annual installations (forecast)	
110	Please enter the annually expected additions of the PV market segment	Commercial segment 1	MWp
111	Please enter the annually expected additions of the PV market segment	Commercial segment 2	MWp
112	Please enter the annually expected additions of the PV market segment	Commercial segment 3	MWp
113	Please enter the annually expected additions of the PV market segment	Commercial segment 4	MWp
114	Please enter the annually expected additions of the PV market segment	Commercial segment 5	MWp
		Estimated deviation of the expected PV additions	
115	Please enter the estimated deviation of the expected PV additions - upwards	Upwards	%
116	Please enter the estimated deviation of the expected PV additions - downwards	Downwards	%

Overall Segment 3 Feed-in systems

117	Please enter the typical percentage of "Prosumers" in this segment in your country	**Prosumers in segment 3**	%
		Size	
118	Please enter the typical system size by market segment	Residential segment	kWp
119	Please enter the typical system size by market segment	Commercial segment 1	kWp
120	Please enter the typical system size by market segment	Commercial segment 2	kWp
121	Please enter the typical system size by market segment	Industrial segment 1 (incl. ground-mou	kWp
122	Please enter the typical system size by market segment	Industrial segment 2 (incl. ground-mou	kWp
		Cumulated installed base (actual)	
123	Please enter the currently installed, cumulated PV system capacity by market segment	Residential segment	MWp
124	Please enter the currently installed, cumulated PV system capacity by market segment	Commercial segment 1	MWp
125	Please enter the currently installed, cumulated PV system capacity by market segment	Commercial segment 2	MWp
126	Please enter the currently installed, cumulated PV system capacity by market segment	Industrial segment 1 (incl. ground-mou	MWp
127	Please enter the currently installed, cumulated PV system capacity by market segment	Industrial segment 2 (incl. ground-mou	MWp
		Expected annual installations (forecast)	
128	Please enter the annually expected additions of the PV market segment	Residential segment	MWp
129	Please enter the annually expected additions of the PV market segment	Commercial segment 1	MWp
130	Please enter the annually expected additions of the PV market segment	Commercial segment 2	MWp
131	Please enter the annually expected additions of the PV market segment	Industrial segment 1 (incl. ground-mou	MWp
132	Please enter the annually expected additions of the PV market segment	Industrial segment 2 (incl. ground-mou	MWp
		Estimated deviation of the expected PV additions	
133	Please enter the estimated deviation of the expected PV additions - upwards	Upwards	%
134	Please enter the estimated deviation of the expected PV additions - downwards	Downwards	%

Figure A.3: Questions sent to the institutions, questions 81 to 134

	Part 7: Corporate taxes and VAT		
	VAT		
135	Please eneter the VAT rate for PV systems	VAT	%
	Corporate taxes		
136	Please eneter the average corporate tax rate in the country	Average corporate tax rate	%
137	Please enter the different components of the corporate tax in your country	Component 1	
138	Please enter the different components of the corporate tax in your country	Component 2	
139	Please enter the different components of the corporate tax in your country	Component 3	
140	Please enter the different components of the corporate tax in your country	Component 4	
141	Please enter the different components of the corporate tax in your country	Component 5	
	Part 8: Informal Sector		
	Size of the informal sector (if relevant in your country)		
142	Does the informal sector play an important role in your country?		Yes/ No
	If yes:	Industry structure	
143	Please fill in the table	Size 1	%
144	Please fill in the table	Size 2	%
145	Please fill in the table	Size 3	%
146	Please fill in the table	Size 4	%
	Part 9: Full-time equivalent (FTE) calculation - national adaptations (optional)		
	Local content evolution by market size	Market maturity (MM)	
147	Please enter the current percentage of local content for valuechain element and its expected progression:	BOS	%
148	Please enter the current percentage of local content for valuechain element and its expected progression:	Module	%
149	Please enter the current percentage of local content for valuechain element and its expected progression:	Cell	%
150	Please enter the current percentage of local content for valuechain element and its expected progression:	Polysilicon	%
151	Please enter the current percentage of local content for valuechain element and its expected progression:	Wafer	%
152	Please enter the current percentage of local content for valuechain element and its expected progression:	Inverter	%
153	Please enter the current percentage of local content for valuechain element and its expected progression:	Engineering & Studies	%
154	Please enter the current percentage of local content for valuechain element and its expected progression:	Installation	%
155	Please enter the current percentage of local content for valuechain element and its expected progression:	Operations and Maintenance	%
159	Please enter the current percentage of local content for valuechain element and its expected progression:	Decommissioning and recycling	%

Figure A.4: Questions sent to the institutions, questions 135 to 159