Framework and Requirements' Analysis

Development of innovative educational material for Building-integrated PV (Dem4BiPV)

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Executive Summary

The purpose of this report is to provide a review and outlook on the global and European Building Integrated Photovoltaics (BIPV) market. The study attempts in fact to provide a comprehensive review of the market situation and the future trends in the European market but especially for Austria, Cyprus, France, Germany, Italy and Netherlands up to the year 2020. The report presents and analyses the results of different market studies in particular from the Global Industry Analysts, the IEA SHC Task 41 Solar Energy and Architecture and Swiss BIPV Competence Centre of SUPSI & Solar Energy Application Centre (SEAC). In addition, it presents the price levels for the various product categories.

The primary investigation is a survey which has been developed by the Dem4BIPV Consortium and that has been conducted among a multidisciplinary group of BIPV stakeholders. The aim of the survey was to identify major knowledge gaps, the target audiences for education and to define the courses for each target audience, but also more information about the BIPV future from stakeholder perspectives. With a total number of 100 participants from 15 countries the survey was analysed in different ways. Stakeholders from different sectors (i.e. R&D, architects, BIPV producers and PV installers, façade producers, investors, etc.) participated in the online survey. The information collected ranges from an overview about the familiarity with BIPV to engagement to BIPV, needed knowledge base and skills of the different groups, as well as the main group for educational need of students and professionals.

The major part deals with analysing the BIPV barriers and educational needs. The report presents the main barriers for BIPV and the educational topics that have to be addressed in BIPV courses with scores in the different levels. Besides that the important players for further deployment are identified. Also the vision of integration of BIPV in the building envelope, as well as the main requirements that must be addressed to bring BIPV from a niche market to a mass-market are presented. The report ends with a conclusion and discussion.

Key findings

The BIPV market was rapidly growing in the last years, from 1.5 GW in 2014 to 2.3 GW in 2015 and the global BIPV market grew about 40%. An outlook on the BIPV market estimates 4.8 GW for 2020 in Europe and 11.1 GW worldwide. The new players on BIPV have to enhance their knowledge base and skills in relation to BIPV systems, primarily the architects, civil and electrical engineers along with mechanical and environmental engineers. The main group for educational need is identified as the professionals (i.e. Architects, Engineers, Planners etc.), followed by building contractors and post-graduate students (MSc) in relevant fields (i.e. architectural, engineering, etc.). One of the main barriers is the design integration of the BIPV, constructional & economical and the regulatory barriers. The price of the BIPV system is mentioned as the major barrier of BIPV, followed by appropriate BIPV software-tools for early integration in the design, the lack of different BIPV products, materials and technologies. Also "customization vs. standardization" issues are important as well as the lack of information and demonstration examples.

Looking at the educational needs, three main groups are high-prioritised (i) design integration, (ii) regulatory and (iii) constructional topics. In detail these are mounting systems and building envelope material properties, different BIPV products/materials/technologies, BIPV software, laws and directives.

For further deployment of BIPV the architects, building contractors, building planers, façade and mounting systems producers, as well as investors play an important role in the future. To envision the integration of BIPV in the building envelope environment is seen in the roofs and the façade system. The main requirements that must be addressed concerning BIPV systems is the cost of the BIPV system, the durability and maintenance, as well as image, size and colour.

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1. Introduction

The market for Building-Integrated Photovoltaics (BIPV) is still to be considered as a niche market, but with high potential to increase in the next years. To bring BIPV from a niche market to a mass market some specific activities at technical, legal and cultural level, but also in the educational sector will be necessary. BIPV brings the worlds of construction and photovoltaics (PV) together with all the challenges and chances inherent to such a change of paradigm.

Most existing photovoltaic modules are developed as purely technical elements, starting only from the "energy production" point of view, by sizing the modules and systems to optimize energy collection, manufacturability, handling, and installation, but only giving a marginal attention to architectural integration issues. PV modules must be developed to respond to their own technical constraints but should furthermore become architectural elements, easy to integrate into the building envelope. They should possibly fulfil more than one function, consequently supporting designers' integration efforts and reducing the overall cost (IEA-SHC-Task41 2013).

BIPV has a multifunctional role as building envelope material and power generator, thus providing substantial savings in terms of electricity and material costs. This means also that there is now room for a new palette of module types with a clear "building function", each addressed to a specific building application, such as metallic cladding, glazed façade element, balcony fence, tilted roof shingle, etc. (Global industry Analysts 2015)

Education and training are crucial for both economic and social progress. Therefore, the project "Dem4BiPV" has been conceived, which is based on the principle of European cooperation through which innovative educational material utilizing ICT will emerge on the topic of BIPV. This is regarded as being of crucial importance for the future development and penetration of the BIPV market in Europe with a potential significant contribution in meeting Europe's energy challenges. This project has been designed and structured to meet the real needs of the BIPV market and contributes positively to EU benchmarks for 2020 in relation to education. It also indirectly tackles fast-rising youth unemployment, as it places emphasis on delivering the right skills for employment in the BIPV industry and increasing the efficiency of higher education in the field of sustainable energy and on working collaboratively with all relevant stakeholders.

1.1 Definitions of Building–Integrated Photovoltaics

While the field of application of BIPV has been defined in various ways, as general rule these specific products always serve a dual and full function as construction and electricity-producing components. "Building Integrated Photovoltaic modules are considered to be building-Integrated, if the PV modules form a construction product providing a function as defined in the European Product Regulation CPR 305/2011. Thus the BIPV module is a prerequisite for the integrity of the building's functionality. If the integrated PV module is dismounted (in the case of structurally bonded modules, dismounting includes the adjacent construction product), the PV module would have to be replaced by an appropriate construction product" (ÖVE/ÖNORM 2015). BIPV modules could be considered as an "integral" element of the building contributing both, as a technical unit, to produce electricity but also, as functional and constructive unit since is an essential part of the building skin, to replace conventional building materials.

1.2 Functional and constructive development aspects

Several researchers have theorized the need for a functional/constructive integration of active solar elements in the building envelope. The main stressed advantages are the reduction of the overall cost and the smaller architectural integration effort they bring.

Integrating solar modules in the building envelope means to integrate the energy collection function (active production of solar energy) while preserving/ensuring the other envelope functions. A good knowledge of the latest is therefore fundamental to understand which parts PV modules could replace. However, PV modules are not only used in envelopes (separation of inside/outside) but can also be used in external separation elements, like balconies, or in external equipment, like canopies.

Building envelopes have the following main protection and regulation functions:

- Protection from intrusion, rain, wind and noise;
- Insulation from winter cold and excessive summer heat (weather protection);
- Regulation of the visual relations inside/outside and outside/inside, as well as the supply of fresh air, daylight, and passive solar gains;
- Regulation of users' comfort, while reducing the use of non-renewable energies

In Table 1 a review of BIPV solutions is presented with advantages and disadvantages of the different BIPV applications and the target segment. Table 2 displays the different BIPV segments. The BIPV is divided in three parts: Façade, Pitched roofs and flat or curved roofs with their subgroups.

A Comparative Review of BIPV Solutions

Product/ Attribute	Standard In-Roof System	Cladding System	Solar Tiles & Shingles	Flexible Laminates
Applications	Pitched roofs	External building walls Curtain walls	Pitched roofs	Flat & curved roofs
Target Segments	Residential & Commercial buildings	Public & Commercial buildings	Residential buildings, old buildings	Commercial & industrial buildings
Advantages	Suited for old & new roofs Easy handling High efficiency/performance	High efficiency systems Availability of colors & visual effects	Aesthetic appeal implies use in residential roofs High efficiency levels Light weight	Very light weight Ease in handling & deployment Possibility of curved installations
Disadvantages	Application limited to few roof types Aesthetic appeal is low	High installation cost Low system performance owing to design limitations Shadows could lead to lower portions of facades remaining unused	Small size results in longer installation time Risk of breakage Unfavorable cost-performance ratio	Cannot be used to replace building component functions Low efficiency leading to larger system areas

Table 1: A Comparative Review of BIPV Solutions (Strategic Business Report, 2015).

Table 2: The BIPV segmentation (Francesco Frontini 2015)

In the future field of building materials, BIPV can be used as a building envelope material offering also the electricity generation advantage. Different ways are shown in Table 3.

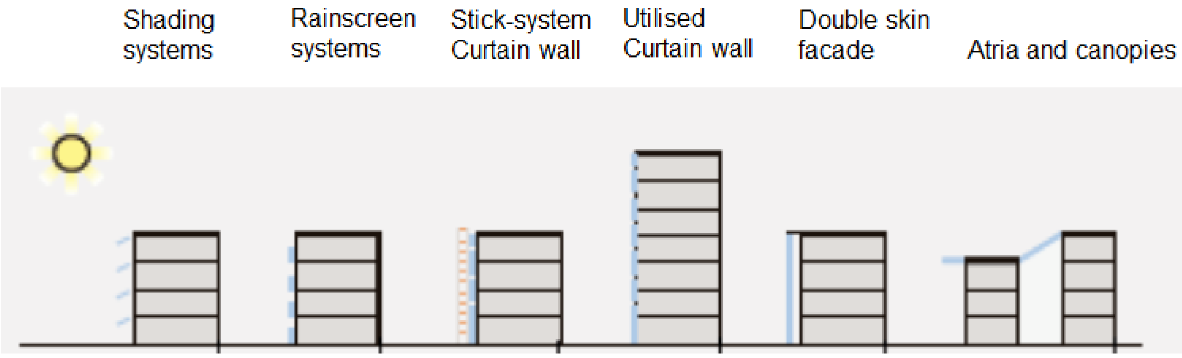


Table 3: Ways of BIPV building envelope installation(Global industry Analysts 2015).

Multifunctionality of BIPV

Stakeholders like architects, designers and builders are beginning to take notice of the multitude of benefits offered by BIPV in terms of minimizing electricity losses, enhancing energy efficiency, producing energy in place, electromagnetic shielding, weather and noise protection, improving aesthetics and thermal insulation. In addition to the dual benefits of electricity generation and serving as the building envelope material, BIPV can - for example - regulate daylight by powering an automatic sun-blind. Besides, BIPV systems can offer sun protection and the integrated photovoltaic can eliminate the need for additional space for installation of PV systems, rails of brackets compared to standard PV modules in non–integrated PV systems. Like all PV users, end-users of BIPV can also earn additional revenues by selling surplus electricity produced through BIPV installations, to various utility companies, even though the achievable revenues might be limited.

All in all, BIPV demonstrates an ecological image of a building owner among the public and enables builders to attain their green goals. BIPV modules not only compensate the planning and financing costs of the project, but ultimately lower the overall project cost. (Global industry Analysts 2015). Different BIPV products have also different merits and demerits. In Table 4 the five main sectors of BIPV are compared.

A Comparative Review Different BIPV Products

BIPV Product	Merits	Demerits
Standard In-Roof Systems	• Ideal for new and old roofs • Delivers high performance/efficiency • Highly competitive • Easy to handle	• Application limited to selected roof types • Limited aesthetic value due to low level of visibility
Semitransparent Systems	• Ideal for prestigious buildings with visible skylights and facades • Highly aesthetic and unobtrusive BIPV solution • Eliminates marginal daylight • Holds ability to diversify light intake • Suitable for flush mounting due to uniform appearance because of thin film cells	• Semi-transparent systems can be very heavy • Difficulty in concealing the cables • Limited shapes and sizes of cells • Relatively costlier products, as they are usually customized • Silver tabbing crosses the transparent spaces between cells • Due to seamless integration, PV modules are difficulty to notice
Cladding Systems	• High efficiency product • Visual effects and different colors can be included	• High installation cost • Eliminates the use of lower parts of facades due to possible shadows • Lower performance due to design limitations
Solar Tiles &Shingles	• Suitable for residential pitched roofs • Light-weight product • High efficiency product • Easy to install	• Greater chances of breakage • Unfavorable cost-performance ratio • Small unit size and thus the longer installation time
Flexible Laminates	• Suitable for weak roofs • Light-weight product • Easy to install and handle • No roof penetration • Curved installations possible • Low BOS cost	• Low efficiency level and the ensuing need for larger system areas • Impotent to replace other building components functions

Table 4: A comparative review different BIPV products (Global Industry Analysts, 2015).

A Glance at selected BIPV products offered in Europe is included in Annex 1.

Furthermore, because BIPV replaces building materials, in contrast to conventional building added PV (BAPV) systems, a new list of requirements must be considered when designing a building-integrated PV (BIPV) system:

- Colour, image, size
- Cost
- Design life
- Building movements
- Weather tightness
- Thermal performance
- Acoustic performance
- Safety (during installation and operation lifetime)

The typical design life of building envelopes and their components depends on the building use. Three types of elements must be considered when discussing the design life of building envelopes:

- Replaceable elements: elements which are intended to last less than the design life of the building and for which replacement has to be considered at design stage. For example, double-glazed units (20–25 years) and sealants (20–25 years). BIPV is integrated in this type.
- Maintainable elements: elements that are intended to last the whole design life of the building with periodic treatment and maintenance. For example weathering gaskets.
- Lifelong elements: elements that are intended to last the whole design life of the building without maintenance. For example, structural bracketry and cladding framing members.

The above leads to several reasons why BIPV is installed:

- Aesthetics
- Energy efficiency in buildings
- Replacing building materials
- Theft-protection
- Limited space
- Shading

1.3 Common applications of BIPV in Europe

Within the project "CONSTRUCT-PV" 162 BIPV projects have been studied in order to determine some useful insights and obtain the most common applications of BIPV in Europe. The results of the intervention of BIPV are shown in Figure 1. More than 50% of the new installations are in new constructions. (Marchi 2015)

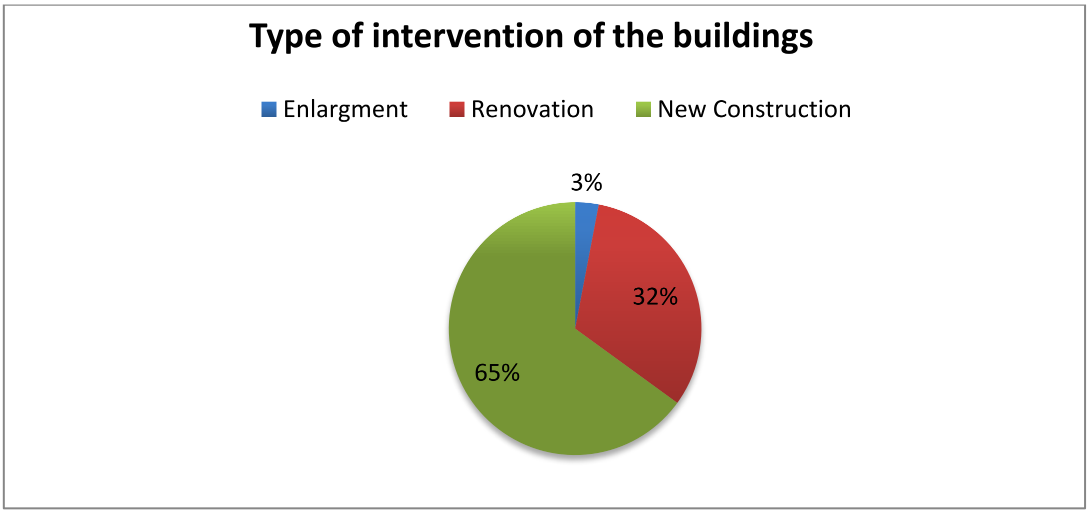


Figure 1: Type of intervention of the buildings (modified by (Marchi 2015))

An interesting result is shown in Figure 2. More than 50% of integrated BIPV is in the form of façades in the analysed projects. The other part of installation is in roof applications.

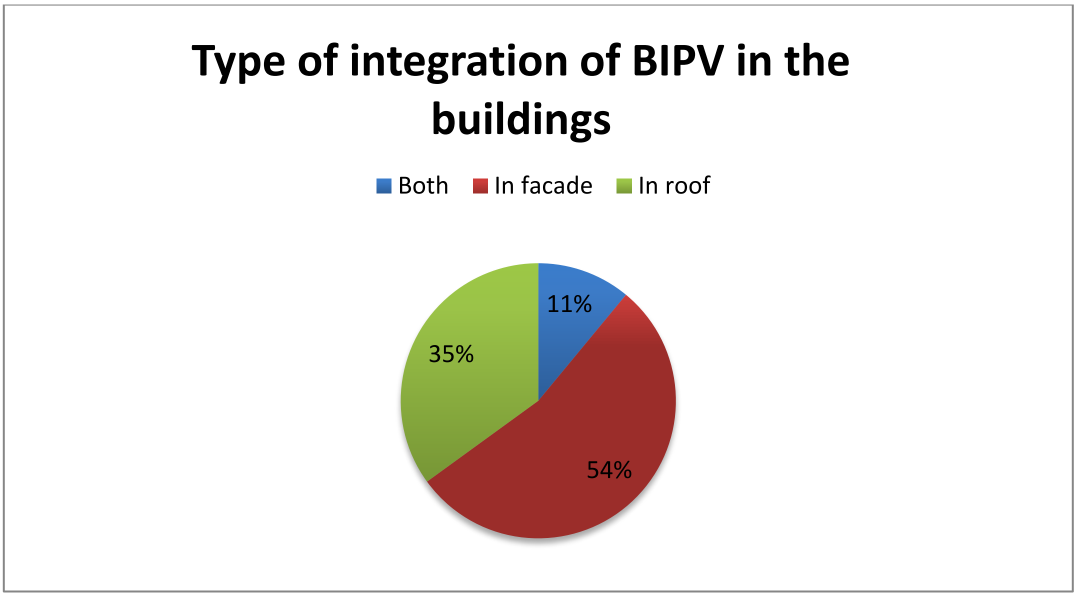


Figure 2: Type of integration of BIPV in the buildings (modified by (Marchi 2015))

The building typology is presented in Figure 3. Most of the installations were in agricultural, buildings, hotel, functional urban structures and residential buildings. The lowest amount of applications is in sport venues.

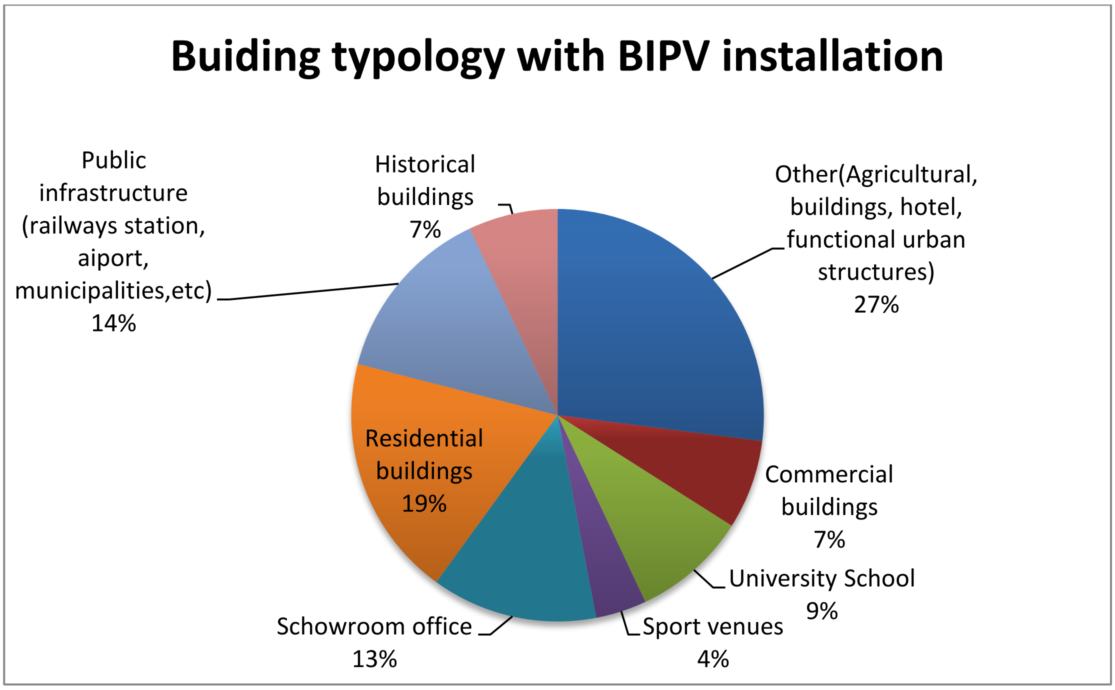


Figure 3: Building typology with BIPV installation (modified by (Marchi 2015))

2. BIPV Markets and Outlook

The BIPV market is rapidly growing in the last years. The global market was estimated at 2.3 GW in 2015 compared to 1.5 GW in 2014. Developed countries, especially Europe and the United States, are dominating the global BIPV market. This can be explained by the fact of the new environmental regulations, coupled with rising pressures to minimize energy consumption from buildings to reduce the CO_2 emissions. With 41.7 %, Europe is leading the BIPV market of installation capacity in 2015. The IEA global trend analysis forecasts 27 % of the electricity production from solar in 2050, out of that 16% out of PV, 11 % out of solar thermal electricity. Table 5 shows the world recent past, current and future analysis for BIPV by region- US, Canada, Japan, Europe, Asia-Pacific (Excluding Japan) and rest of world markets with annual installation capacity in kilowatts for years 2014 through 2020.

Region/Country	2014	2015	2016	2017	2018	2019	2020	% CAGR
US	319,152.7	476,080.1	675,319.6	917,421.7	1,200,446.3	1,491,194.4	1,765,723.3	33.0
Canada	41,910.5	61,164.2	86,082.5	119,430.9	156,788.9	190,467.2	228,274.9	32.6
Japan	142,686.5	200,702.8	268,419.9	348,543.2	434,215.1	520,406.8	611,894.3	27.5
Europe	649,867.3	966,963.4	1,440,547.8	2,103,398.0	2,928,861.3	3,806,625.5	4,838,100.4	39.7
Asia-Pacific	300,401.2	491,912.6	772,263.9	1,158,507.2	1,671,772.5	2,328,704.6	3,133,860.1	47.8
Rest of World	81,337.9	124,666.6	184,319.6	262,544.8	354,698.0	451,246.8	560,538.8	37.9
Total	**1,535,356.1**	**2,321,489.7**	**3,426,953.3**	**4,909,845.8**	**6,746,782.1**	**8,788,645.3**	**11,138,391.8**	**39.1**

Table 5: Global BIPV Market perspective and the recent past of annual installation capacity (in kW) from 2014 to 2020 (Global industry Analysts 2015)

Market growth at country level mainly depends upon regional as well as national polices. Several countries such as Spain, France, Italy, Germany, Austria and Greece introduced their own feed-in tariff system to boost the BIPV installation in their country. An impact on the market is also favoured by government mandates that necessitate all new buildings constructed in the EU to be nearly zero energy after 2020. (Commission 2011)

Growing at a Compounded Annual Growth Rate (CAGR) of 39% over the analysis period 2014-2020, annual installation capacity of BIPV market is projected to further surpass 11GW by the year 2020. The growth is justified through the rapidly plunging installed cost per watt; enhanced aesthetics of BIPV; improving efficiency of c-Si modules as well as flexible thin-film panels; and unabated desire among residential and commercial owners to "go green" and to reach the national energy efficiency targets.

In the upcoming years, BIPV market is expected to grow strongly driven mainly by the revival of construction industry. New constructions, retrofits and refurbishment works in both commercial and residential sectors are also expected to drive up strong demand for BIPV products in the coming years. Future growth prospects in the global BIPV market are significantly dependent on the extent of efforts by key members of the BIPV supply chain to enhance design and integration of PV into building structure; development of BIPV specific building codes and standards; and availability of attractive incentives at local and federal level to ensure cost-effectiveness of BIPV products. Segment-wise, BIPV Roofing represents the largest segment in the global BIPV market, with an estimated 38,4% share of annual installation capacity in 2015. From an estimated 890 MW in 2015, the BIPV roofing market is projected to reach about 3 GW by 2020, growing at a compounded annual growth rate of 29% over the review period.

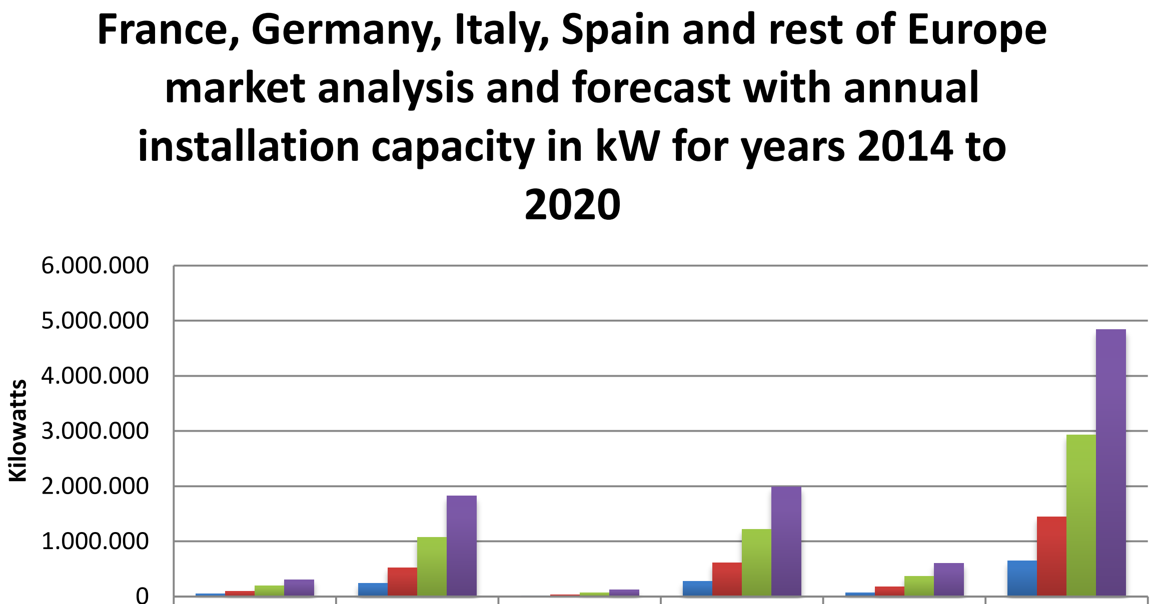
2.1 BIPV Market overview in EU28

For the year 2015 the BIPV market in Europe is estimated at 967 MW installed capacity and has the lead in BIPV installations worldwide. Due to attractive incentives, France, Italy and Germany have led to the increase in acceptability of these products in the residential sector. With support of special tariffs available for BIPV, markets such as the UK and Alpine countries are displaying healthy growth. Growing awareness about the merits of BIPV technology coupled with distinctive tariffs played a significant role in driving BIPV installations across Europe. The BIPV market in Europe is also being positively impacted by the regulatory framework in place for enhancing energy efficiency of residential and non-residential buildings. Stringent regulations are also being adopted due to rising energy costs, growing environmental concerns and political resolutions to reduce CO2 emissions. Also, several European governments have agreed for imposing passive house standards for new contracts by 2020, which has the goal to build nearly zero energy houses. On the European level the Directive on Energy Performance in Buildings (EPBD) (Directive 2010/31/EU) and the Renewable Energy Directive (1/77/EC) was set up by the European Commission (EU). The member states are making attempts to adopt renewable energy, particularly solar energy in buildings as a step forward to meet the energy targets. The Directive 2010/31/EU aims to improve energy performance of buildings within the EU and increase the share of renewable energy. In addition the directive also requires all new buildings in the EU to meet the requirements of "nearly- zero energy buildings" by 2020. BIPV could support this target through the power production to meet own energy requirements and of course the efficient structures of construction. Furthermore the fact that BIPV seamlessly integrates into the building's structure or envelope, whereby there is no need for extra space for BIPV installations compared to large-scale PV plants. At the moment about 200 BIPV products are offered, addressing the major applications pitched roofs, facades and flat and curved roofs. In the appendix 12 a selection of BIPV products offered in Europe are presented (Francesco Frontini 2015).

A list of feed-in tariff rates in selected countries for rooftop solar PV and BIPV systems, targets for electricity production from renewable energy sources in selected countries and *percent of renewable sources in electricity production for select countries is included in Annex 2.*

2.2 Market analytics in EU28

As already mentioned the BIPV market is strongly growing in the last years. Figure 4 shows the European recent past, current and future of BIPV by countries - France, Germany, Italy, Spain and rest of Europe market with annual installation capacity in kW for years 2014 to 2020. The data is reported at the manufacture level. Countries analysed under „Rest of Europe" include Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, Greece, Hungary, Ireland, The Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Sweden, Switzerland, Turkey and the UK. Error tolerance for the data is 10%(+/-) (Global industry Analysts 2015).



	Germany in kW	France in kW	Spain in kW	Italy in kW	Rest of Europe in kW	Total
2014	45.404	241.370	13.829	278.271	70.993	649.867
2016	96.279	523.565	33.580	611.627	175.498	1.440.548
2018	193.925	1.075.083	69.523	1.222.177	368.154	2.928.861
2020	307.277	1.822.297	121.661	1.988.281	598.584	4.838.100

Figure 4: European recent past, current and future analysis of BIPV by countries (Global industry Analysts 2015)

2.3 Market analysis Germany

The BIPV market in Germany is estimated at 65,9 MW for the year 2015 and projected to reach 307 MW by 2020 in terms of installation capacity, over the analysis period 2014-2020 (Global industry Analysts 2015).

Rooftop solar market is projected to experience a strong growth in the coming years, with several governments worldwide undertaking initiatives to develop cost-efficient solar powered buildings in the residential and commercial sector. The rooftop led market is one of the key trends gaining momentum in the German market and several European markets as well, stimulated by the feed-in tariffs. The trend is a result of the German renewable energy sources act (EEG) that came into effect in the year 2000, which introduces the feed-in tariffs. Also the decision of phasing out nuclear power by the year 2022, the country holds the potential to emerge as the leading nation for renewable energy program in the coming years. The development is expected to continue, factors such as the constant increase in electricity prices led to a scenario, wherein the grid electricity is proved to be more costly for businesses and private households compared to self-generated solar power.

Financial support

The Feed-in tariffs for small PV plants are shown in Figure 5 from the years 2012 to 2014.

Start of Operations	up to 10 KWp	up to 40 kWp	up to 500 kWp	up to 500 kWp
EEG 2012 (from 01.07.2014)	12.88	12.22	10.9	8.92
EEG 2014 (from 01.08.2014)	12.75	12.4	11.09	8.83
EEG 2014 (from 01.09.2014 (0.5% degression))	12.69	12.34	11.03	8.79
EEG 2014 (from 01.10.2014 (0.25% degression))	12.65	12.31	11.01	8.76
EEG 2014 (from 01.11.2014 (0.25% degression))	12.62	12.28	10.98	8.74
EEG 2014 (from 01.12.2014 (0.25% degression))	12.59	12.25	10.95	8.72

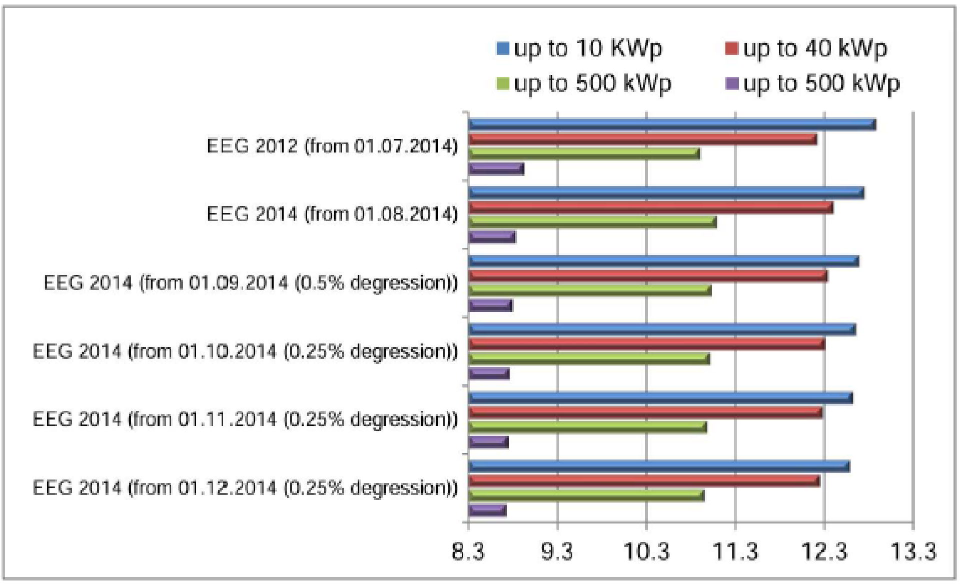


Figure 5: Feed-in tariffs for small solar PV installations (up to 500 kWp) in (€ct/kWh) (Global industry Analysts 2015)

Market Outlook

Due to several initiatives and actions from the government, but also in the business and private household sector an increase of the installed annual capacity is expected as shown in Figure 6. A CAGR of 37,5% over the analysis period 2014-2020 is expected.

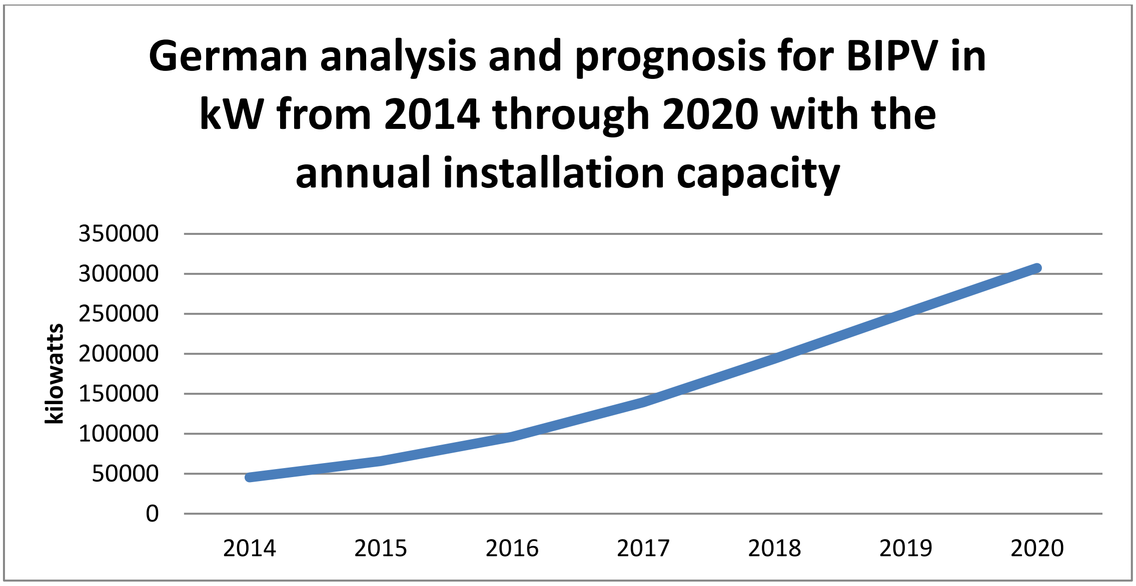


Figure 6: German market analyses for BIPV in kW from 2014 through 2020 with the annual installation capacity(Global industry Analysts 2015)

2.4 Market analysis Austria

In terms of installation capacity, BIPV market in Austria is estimated at 24 MW for the year 2015. The major installation of PV was on roofs with about 87,5%, but only 1,3% roof integrated and 0,6 % façade installation (Peter Biermayr 2016) The roof and façade integration systems installed in comparison with total installed PV is in the range of only a few percent, as shown in Figure 7. The installed BIPV in 2015 is in the same range as 2010. Between 2011-2014 a slight increase of PV installation is shown and then a decrease, which can be lead back to the trend of the world-wide market. The diagram shows that the PV market is stalling in the last five years. Figure 8 shows that about 85% of all PV-systems in Austria are installed on buildings. But only 1.9% are BIPV, with 0.6% facade integration has a very small share. The "Green field" installations have also a small part with only 12.4%.

The suitable area on roofs and facades, which could be used to install Photovoltaics is about 230 km^2 according to the Austrian PV-Roadmap while the needed area to achieve a share of 27% on the energy demand is about 170 km^2. This means, that the biggest part of suitable and well solarized roofs and facades may be used for solar electricity production in the future. To achieve the targeted climate goals and 100% renewable energy supply, the share of PV has to increase from 1 TWh to at least 29,9 TWh yearly production. To reach this goal, the installed PV capacity has to rise to 9.7 GW till 2030 and 26.7 GW by 2050. The 100% renewable electricity supply by 2030 needs an annual installation of 600MW PV per year before 2030 and 820 MW after 2030. Recommendations for achieving the roadmap goals are described in the Austria PV-Roadmap 2016 (H. Fechner 2016).

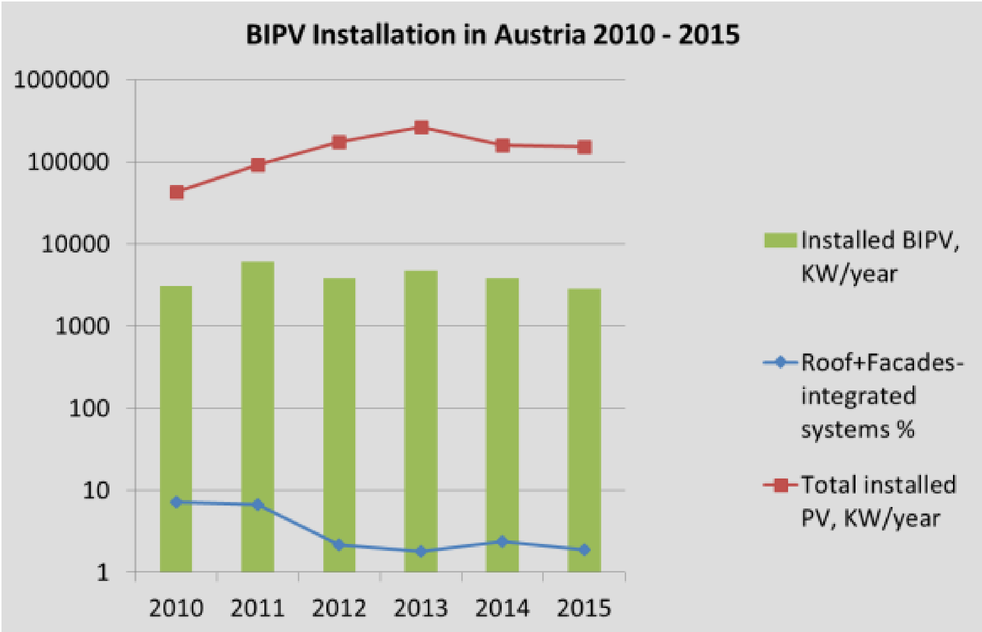


Figure 7: BIPV Installation in Austria 2010 – 2015 (Shokufeh Zamini 2016)

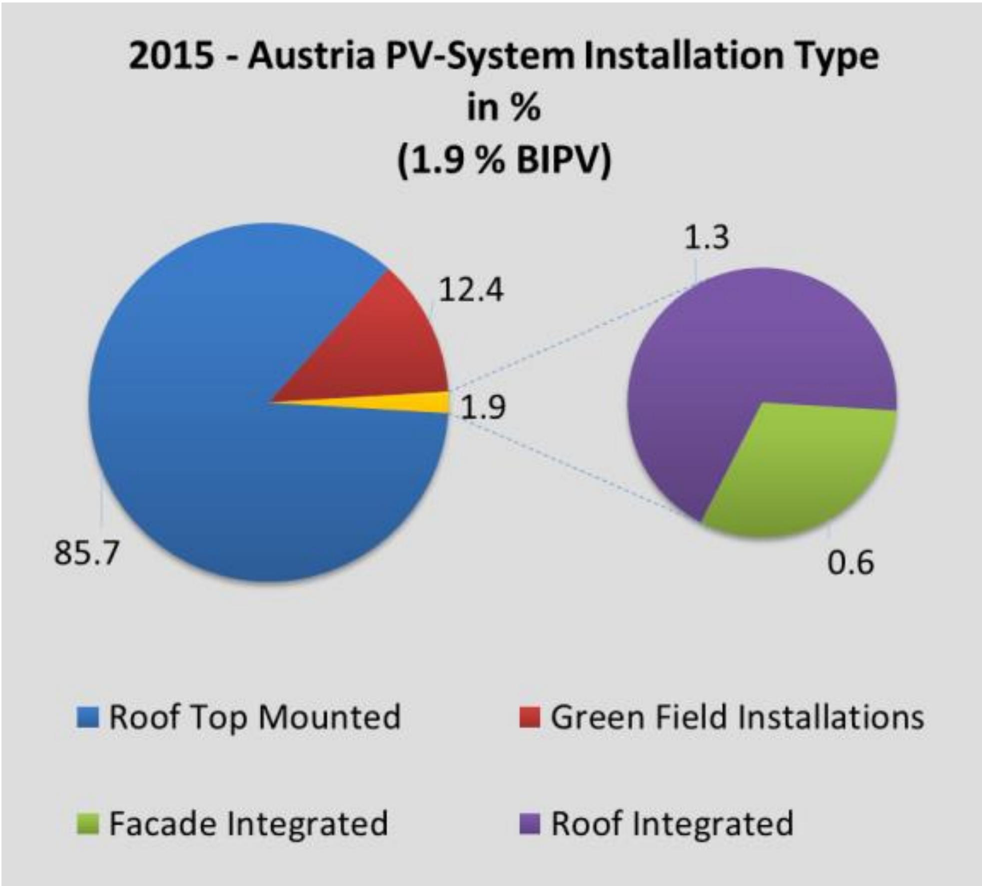


Figure 8: Share of BIPV in the PV-Systems installed in year 2015 (in % of installed PV capacity) (Shokufeh Zamini 2016)

Financial support

Investment support up to maximum of 5kW is 375 €/kW for building-integrated PV up to 5kWp in 2016; for systems larger 5kWp a feed-in tariff is available, which is exclusively dedicated to PV installations on buildings (no support for PV-installations elsewhere).

2.5 Market analysis Netherlands

The global market for PV has been turbulent in the past years, with sharp price reductions in 2012 and increasing interest in the technology and its gains. This is also reflected in the increase in installed capacity in the Netherlands, which has grown to 1.5 GWp at the end of 2015. Now that prices have more or less stabilized, market volumes show a healthy growth and national support schemes (i.e, SDE+) are being reduced. At the same time BIPV is emerging as an interesting market segment, also in the Netherlands.

A first roadmap for BIPV in the Netherlands has been presented recently, and has identified market potential as well as barriers and challenges, both societal and technological (Van den Hurk and Teunissen, 2015). Figure 9 shows the expected growth. The Dutch BIPV market will have a ~300 MWp size in 2020, which may constitute 5-10% of the full PV market. Note that the 2015 market size was only 25 MWp, which is less than 2% of the PV market in 2015. Hence, a strong growth is expected.

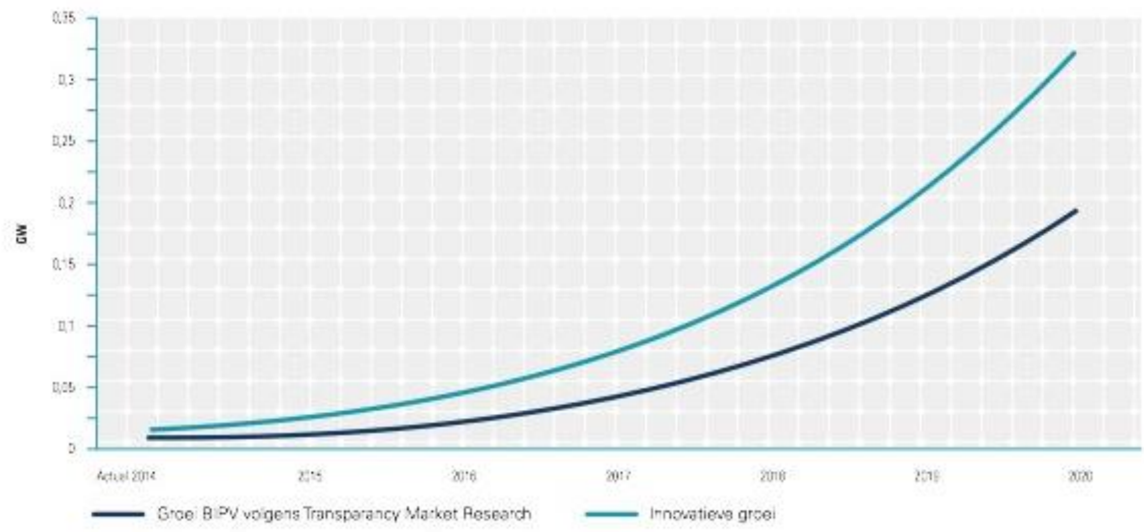


Figure 9: Expected BIPV market growth in the Netherlands (Van den Hurk and Teunissen, 2015)

In addition, Van Horrik et al. (2016) have identified factors for success or failure of the Dutch BIPV sector, see Table 6. It has been found that the most important factor for success is intensive collaboration between PV suppliers and developers with the building sector parties (advisors, project developers, suppliers). Such collaboration ensures that the BIPV product is fitting well in the building project, both in a technical and in a process manner. Also, building parties thus develop knowledge on new, BIPV, products leading to increased awareness and support of these products in the building sector. In contract, the main factor for failure has been found to be the provision of knowledge on BIPV products and legal issues. Thus the need for information is the largest related to the aesthetical aspects, building integration and design possibilities.

Factors of success	Factors of failures
Realisation of market products	Too high ambitions for product development
Sustainable collaboration with PV and building sector parties	Insufficient collaboration with building sector parties
Strong focus on optimization of technical aspects	Limited information on products and limited marketing
Optimization of implementation process such that it connects well with regular building process	Perception of PV in general affects perception of BIPV in particular
Strong focus on providing service to customers and other stakeholders	Products are not linked to market demand
	Legal and quality assurance are unclear
	Power of entrepreneurs is limited, due to economic circumstances

Table 6: Overview of factors of success and failure of the Dutch BIPV market (Source: van Horrik et al., 2016)

Osseweijer et al. (2016) have presented an analysis of the existing BIPV stakeholders, the BIPV ecosystem and policy and legislation for BIPV in the Netherlands. An overview is shown in Figure 10: Stakeholder map for the BIPV ecosystem (Osseweijer et al., 2016).

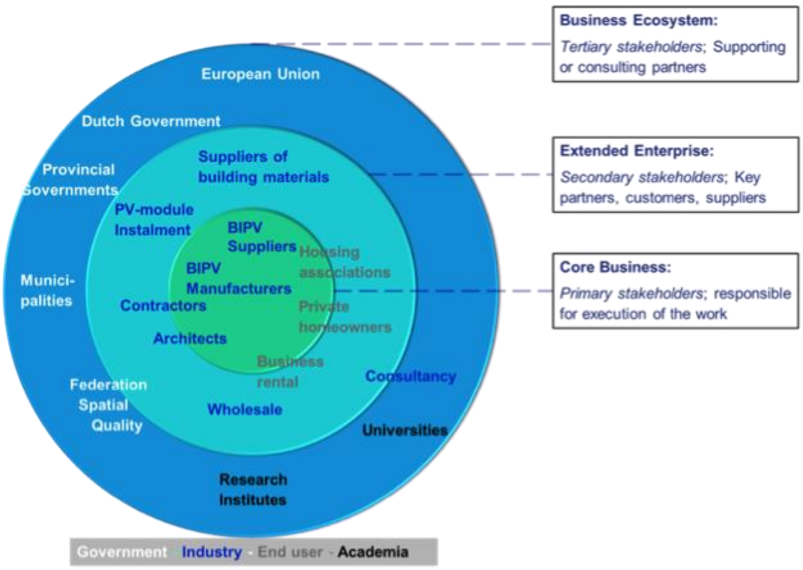


Figure 10: Stakeholder map for the BIPV ecosystem (Osseweijer et al., 2016)

Based on the activities sketched above, a large project has been granted within the framework of the European Fund for Regional Development. In this project, led by the branch organization

Holland Solar, BIPV stakeholders will collaborate intensively to develop BIPV further in the Netherlands (Holland Solar, 2016).

2.6 Market analysis Cyprus

The concerns over climate change as well as the increasing fossil-fuel prices have encouraged over the last few years, many European countries including Cyprus to gradually move away from conventional electricity generation and experience a rapid growth of renewable technologies. In the case of Cyprus, which is an insular energy system, the natural environment and the climatic conditions are favourable to solar energy technologies and hence PV is considered to have the greatest potential.

At present, BIPV installations in Cyprus are limited to only a few small capacity systems, mainly PV systems installed as shading systems, with an overall insignificant power capacity share compared to roof- and fixed-mounted systems.

In particular, based on information obtained by the Ministry of Energy, Commerce, Industry and Tourism (MECIT) of Cyprus, up until the beginning of 2014 the installed total PV capacity investigated was 40.161 MW. From this PV installed share 48% (19.174 MW) are fixed mounting systems, 36% (14.364 MW) are roof mounted and 16% (6.622 MW) tracking systems (tracking in two axis), as shown in Figure 11.

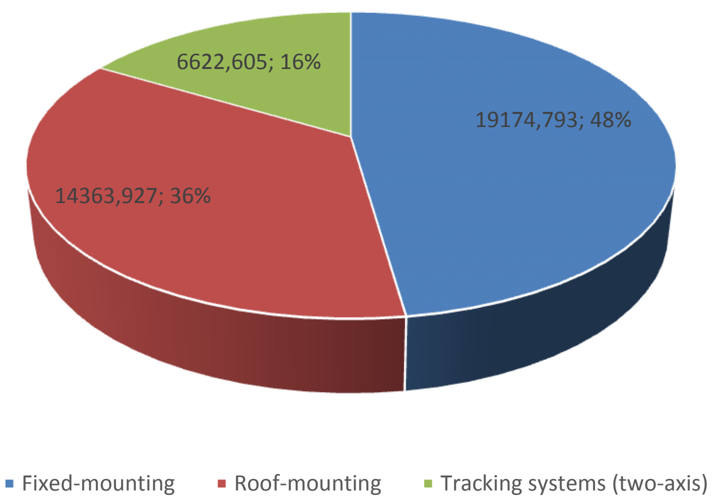


Figure 11: Mounting installation description of PV systems in Cyprus up until the beginning of 2014

By the end of 2015 approximately 80 MWp of grid-connected PV systems were installed in Cyprus with a large share comprising of roof-mounted building applied systems. Solar PV is also the predominant renewable energy technology with an increasing integration potential exhibited in all future renewable technology roadmap scenarios for the country, see Figure 12. It is also expected that PV will supply between 15% and 27% of the electricity consumed in Cyprus in the year 2030 (IRENA, 2015).

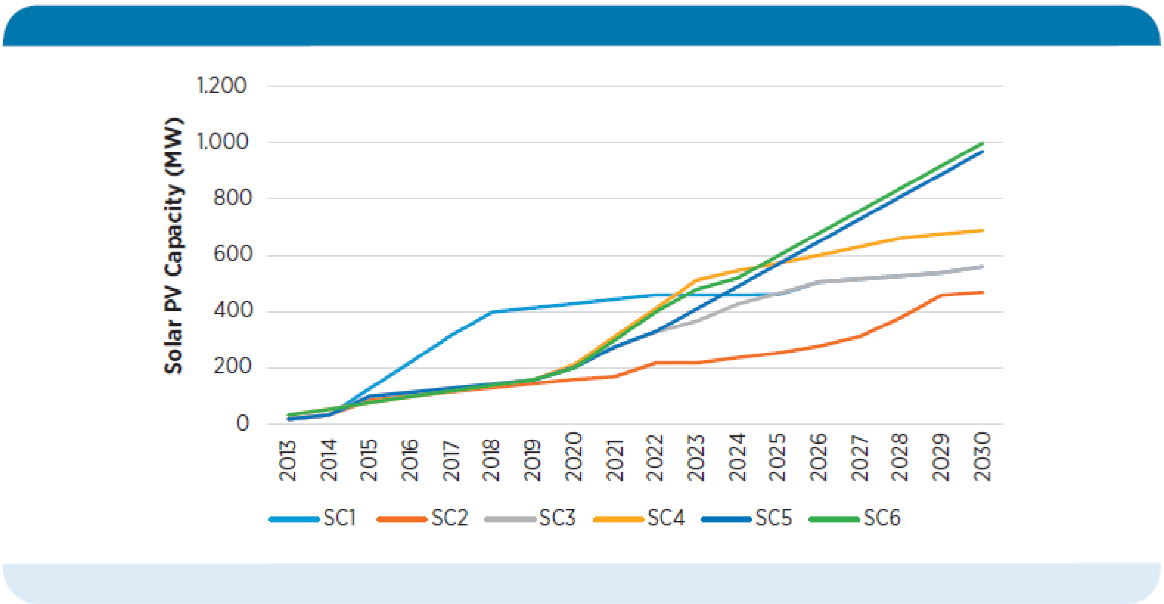


Figure 12: Development of solar PV capacity in Cyprus under different scenarios (IRENA, 2015)

Over the past years, a range of subsidy schemes and incentives have been announced in order to encourage PV system deployment in Cyprus and all subsidy schemes focused on building applied installations of roof-top systems and fixed-mounted PV.

More specifically, the Cyprus government has launched the support schemes in 2004 which were based on feed-in tariffs (FiTs) for the promotion of renewables and to achieve national targets on RES production and RES technology penetration. The support schemes were prepared and administered by the Ministry of Energy Cyprus under the "Special Fund for the promotion of Renewable Energy Sources (RES) and Energy Conservation", which was established in 2003 under Law No.33(I)/2003. In addition, the tariff is determined by the Cyprus Energy Regulatory Authority (CERA). Up until 2012, the announced FiTs schemes covered small wind systems up to 30 kW, and large wind farms residential PVs up to 7 kW, commercial PVs up to 150 kW, CSPs and biogas from landfill, biomass.

In 2012, a FiT scheme was also announced for 50 MW of large commercial PV systems with power capacity up to 10 MW based on a bidding process.

Furthermore, more FiT schemes were announced in 2013 covering small photovoltaic systems in the nominal power capacity range of 20-150 kW. In the same year, CERA launched the Net Metering scheme for domestic photovoltaics for a power capacity of 3 kW (for a total of 15.2 MW) and the Self Consumption scheme for industrial and commercial unit PV systems with a power capacity of up to 1 MW (for a total of 10 MW).

Finally, in 2014 the only support schemes announced in Cyprus were the Net Metering scheme for domestic photovoltaics for a power capacity of 3 kW (for a total of 15 MW) and the Self Consumption scheme for industrial and commercial unit PV systems with a power capacity of 10-500 kW (for a total of 5 MW). The same scheme was announced this year, 2016, promoting the installation of Net-metering PV systems with capacity up to 5 kW connected to the grid for all consumers (residential and non-residential) and the self-generation systems with capacity up to 2000 kW for commercial and industrial consumers.

It is also worth mentioning that PV system installation guidelines in Cyprus are only published for building applied PV systems and there is no framework for BIPV at present. Specifically, for the installation of building applied PV systems is governed by the provisions of the Cypriot Circular Directive 3/2008 which specifically states that for final approval and connection to the grid permit the installed PV system should be:

- Harmoniously applied to the shell of the building (as per schematics 1-3 of Figure 13).
- In the case of sloping roofs all the PV modules must be adjoined, except when the building has two or more sloping roofs that face the south. The slope of the roof must be between 15°- 45° which is the common roof inclination in Cyprus (as per schematics 3-4 of Figure 13). The orientation range of the roof must be within -35° – 35° due South.
- In the case the PV system is installed on a horizontal roof, the height of the module must not exceed the 1.20m from the maximum height of the house and should be placed in parallel lines, at least 1.20 m from the edge of the roof (as per schematics 5-6 of Figure 13).
- Small systems (<100 kW) that are installed on the ground to cover supplement the electricity demand of a current building, should be installed at a height up to 1.20m from the natural ground (as per schematic 7 of Figure 13).

Currently, there is no legislation concerning BIPV. However, Regulation 366/2014 was issued by the Ministry of Energy, Commerce, Industry and Tourism of Cyprus in order to update the minimum energy performance requirements of buildings so that NZEB aspects (relevant to BIPV) are taken into account. Incentives to promote NZEB practices were given in 2015 in the form of support schemes for building refurbishment whereby, depending on the type of retrofitting investment conducted, up to 75% reimbursement is provided.

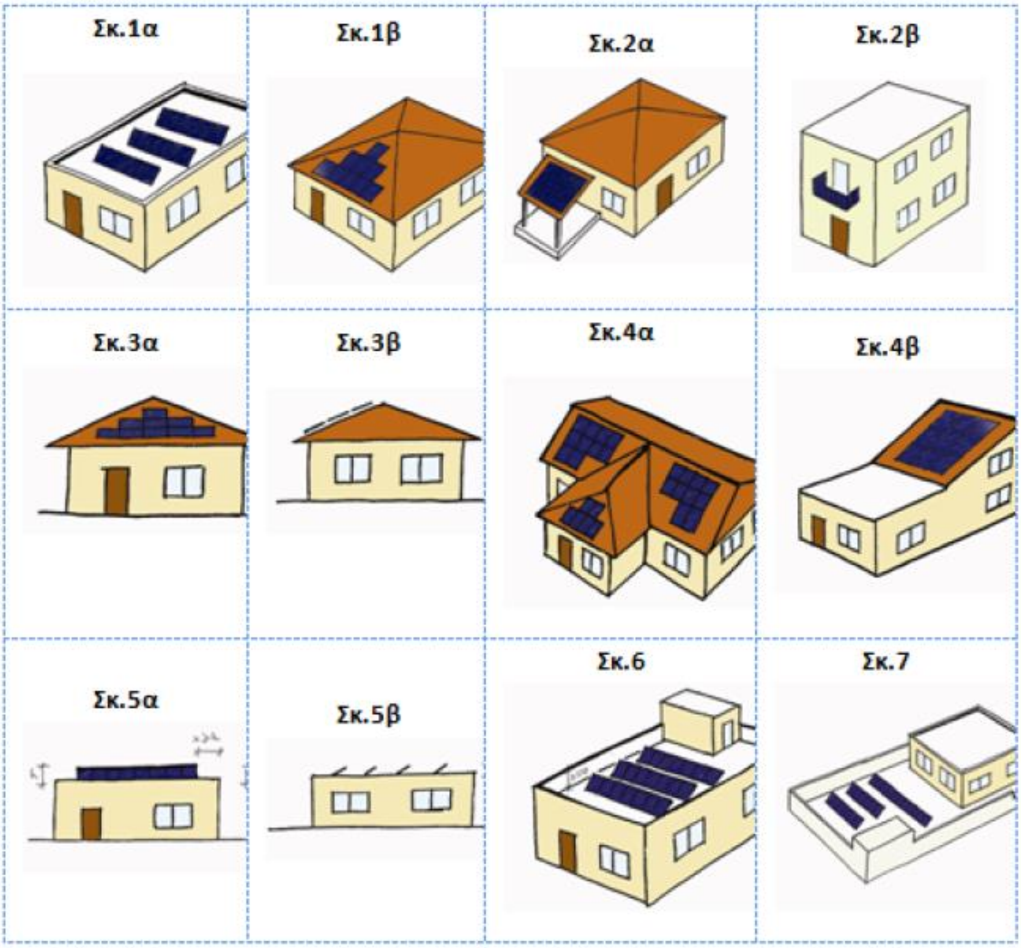


Figure 13: PV system installation guidelines of the Cypriot Circular 3/2008

2.7 Market analysis France

In terms of installation capacity, BIPV market in France is estimated at 355,1 MW for the year 2015 and projected to reach 1,8 GW by 2020.

Between 2008 and 2010, due to the government support offered in form of feed-in tariffs the solar power generation in France increased rapidly. The French government passed a legislation that mandates all new buildings in commercial areas to have green roofs, referring to roofs at least partially covered with either living plants of solar modules.

Financial support

The feed-in tariffs have changed during the last years. In 2010 the French government took the decision to reduce feed-in tariffs, in order to deal with rising inflation in the PV sector. In 2010, feed-in tariffs were abandoned. In March 2011, a new set of feed-in tariffs was established. With an aim to reduce applications of solar PV, the government revised feed-in tariffs based on the number of applications filed during the prior quarter.

The latest feed-in tariffs for solar PV installations during second quarter of 2016 are shown in Table 7.

Installation type	Power	01.04.2016 -30.6.2016
BIPV	0-9 kW	24,63 €ct/kWh
BIPV	0-36kW	13,27 €ct/kWh
Simplified BIPV	36-100kW	12,61 €ct/kWh
Ground mounted without integration	0-12MW	5,80 €ct/kWh

Table 7: Feed-in tariffs in France from 01.04.2016 -30.6.2016 (Ministre de l'Environnement 2016)

Market Outlook

Due to several initiatives and actions from the government, but also by the businesses and private households an increase of the installed annual capacity is expected as shown in Figure 614. A CAGR of 40,1% over the analysis period 2014-2020 is expected.

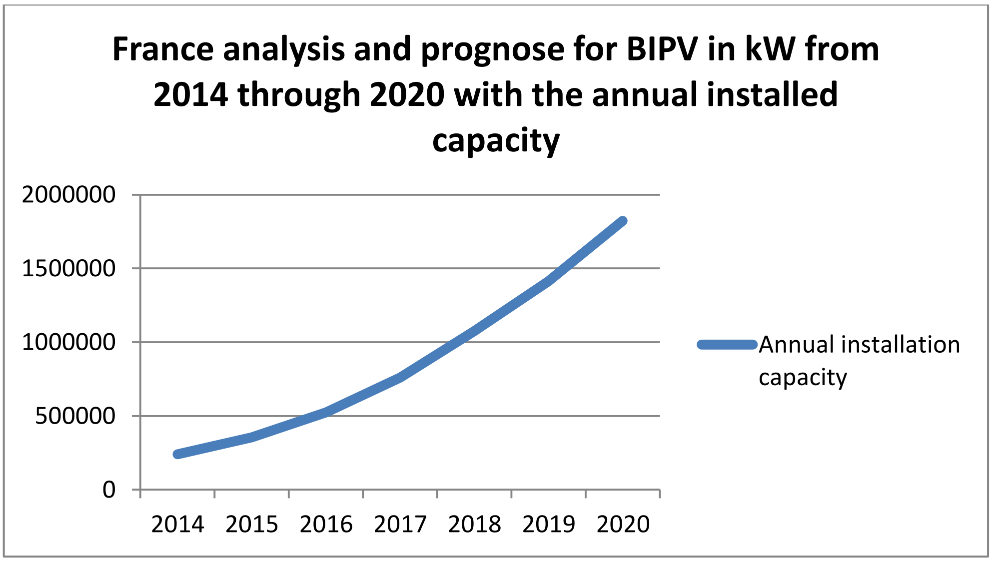


Figure 14 France market analysis for BIPV in kWs from 2014 through 2020 with the annual installed capacity (Global industry Analysts 2015)

3. BIPV system costs

BIPV is often marked as expensive product. But how expensive is it really? For answering this question a survey from Swiss BIPV Competence Centre (SUPSI) & Solar Energy Application Centre (SEAC) is used.

SUPSI and SEAC BIPV price survey

The reviewed prices of the survey from SUPSI and SEAC covered both BIPV and BAPV systems. To have a reference of the BIPV, the BAPV and the conventional buildings materials were included. The end-user prices are converted to €/m2. The end-user PV system cost is calculated over the area that the PV systems cover on the roof or facade. The advantage of using the unit €/m2 is the possibility to directly compare various PV technologies to conventional buildings materials. Regarding the BIPV roofing systems, 44 parties participated in the survey. Regarding the BIPV façade systems, 4 parties participated in the survey, 8 installers of BAPV roofing systems and the rest is divided in In-roof mounting system, full roof solution and BIPV tiles.

Figure 15 shows the results of the price survey including the conventional roofing materials. The costs (€/m2) in the figure can be separated in conventional roofing materials and PV systems (both BAPV as well as three types of BIPV product groups). The price range of the box-and-whisker plot is from 25%, 75% quartiles, and median within each product group were displayed.
The figure shows a significant price range for the different conventional roofing materials. The price of concrete and ceramic tiles varied between 30 €/m^2 for cheap concrete tiles to almost 75 €/m2 for expensive ceramic tiles. This can be explained by the type and brand of roof tile used. Furthermore the size of the roof and the installer experience has an impact on the price per square meter. Investigating the roof slates we see an even wider price range that varies between almost 75 €/m^2 to 125 €/m^2. The prices of different slate materials play an important role here. For metal roofing the price range can be explained mainly by the thickness of metal and how they are finished. Degreased and painted metal sheets are more expensive. The final conventional roofing material considered is thatch roofing which costs between 85€ and 105€ per square meter. The PV products were all priced roughly 200 €/m^2 higher than the conventional roofing materials. The BAPV system price varied between 225 and 300 €/m^2 (Note: This price range includes the roof tile underneath the PV panels, as these are required to make the roof water-tight in BAPV systems). For the in-roof mounting system the price varies between 350 €/m2 and almost 500 €/m^2. For the BIPV tiles the price varied between 225 and 500 €/m^2. For the 'full roof solution' category, the price ranged from 200 €/m2 to almost 650 €/m^2" (Francesco Frontini 2015).

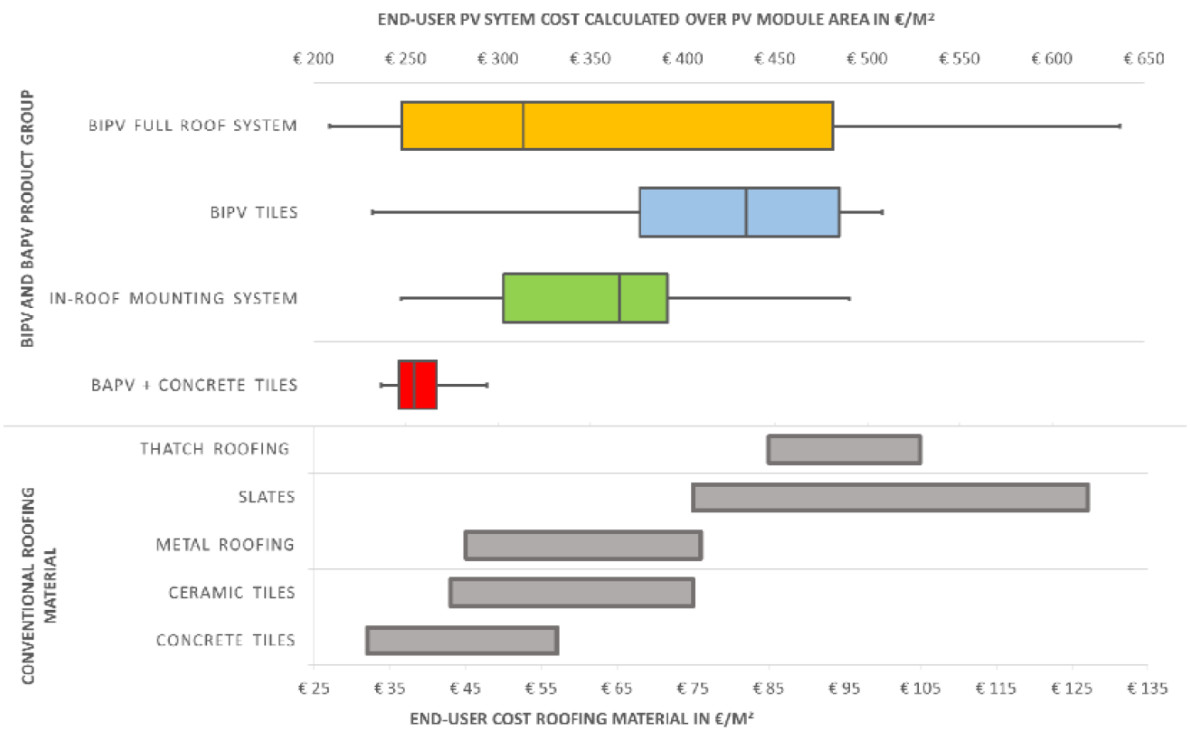


Figure 15: End-users system calculated over PV product area in €/m² *(Francesco Frontini 2015)*

Figure 16 shows a benchmark of the conducted price survey, comparing conventional facade materials with BIPV facade solutions. It displays the results of the price survey (€/m2), which compares conventional facade systems with some BIPV solutions. Conventional facade technologies include fibrocement, brick-ceramic, metal, stone, wood, window and curtain walls. Prices range all the way from 30-50 €/m2 for a low cost fibre-cement facade (similar to a traditional plaster) to 1.100 €/m2 for a special curtain wall (e.g. self-lighted, interactive facade, etc.). The price of the BIPV systems varied from 100-150 €/m2 for a thin film PV cold facade (with a really simple sub-structures and a low efficiency solar technology) to 750 €/m2 for a high end PV solar shading system. This indicates the following important conclusion: for facades a very interesting price point has been obtained, as BIPV systems are very comparable in price with conventional facade materials. Low cost BIPV facade strengthen the promise of BIPV because these applications are cost-wise suitable as a substitute for the conventional facade solutions. (Frontini et al.,2015).

It is a challenge to get the BIPV prices from the producers and installers. A frequently used argument is the demanded discretion by the customer regarding the project costs. This may be explained considering that very often BIPV facades have been experimented in pilot-demonstrative projects so that the cost was specifically linked to the context and influenced by building size, technology adopted, owners policy, etc. Thus, the absence of a well-established market influenced this phase of research. Only some smaller producers or installers provided some cost data: the main reason was to promote and advertise BIPV demonstrative buildings showing their cost-effectiveness also at a small-medium scale (residential multi-storey building e.g.).

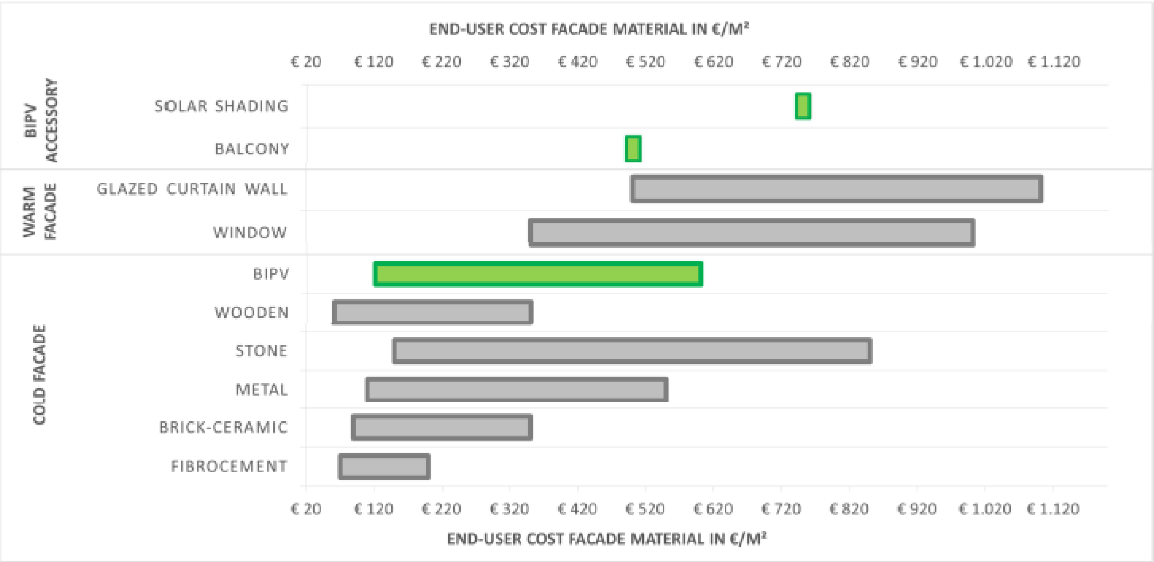


Figure 16: End-user cost facade material in €/m^2 *(Francesco Frontini 2015))*.

In conclusion, BIPV in-roof systems, BIPV tiles and BIPV full roof solutions are already widespread available. The BIPV market has specialized and customized niche products for which it is difficult to find participants in a price survey. BIPV roof products are still priced about 200 €/m2 above conventional roof products. These added costs should be paid back by the electricity sales or through the multifunctional benefit. BIPV full roof solutions are a highly promising emerging field of technology, as several products were already found to be lower priced than the alternative of roof tiles topped with conventional BAPV systems. BIPV facades are a highly promising emerging field, as the products were priced very similar to conventional facade materials. This holds the promise of 'PV for free', e.g. a building with BIPV built without any added costs compared to a conventional building.

The PV technology today is mostly economic driven and therefore a crucial factor for its success. While the first goal is surely to minimize the initial investment, also other factors are more and more showing an economic relevance during the life-cycle such as an adequate maintenance, the energy management/optimization and the quality of modules and its installation (e.g. degradation, damages, etc. affecting energy production and durability). In BIPV applications PV becomes an integrated part of the building skin that cannot be singularly considered in terms of architecture, technology, performance, energy behaviour or costs. Accordingly a more accurate evaluation of the cost-effectiveness could also consider all the costs and benefits in the life-cycle.

4. Introduction of the requirements' analysis of BIPV – The Dem4BIPV survey

In order to collect opinions related to various topics of building integrated photovoltaics a questionnaire was designed. Firstly, an internal questionnaire among the Dem4BIPV project partners revealed the main stakeholder groups. The Dem4BiPV consortium developed and agreed on using the groups shown in Table 8 and topics for the questionnaire to identify the main barriers and educational needs for building integrated photovoltaics.

Participants in the questionnaire were invited to state their opinion on a 4-point scale (no need, not so strong need, fairly strong need, very strong need), besides 'don't know' for the educational need and on a 5-point scale („Not important at all"; „Fairly Unimportant"; „Neither important nor unimportant"; „Fairly important"; „Very important"; „Don't know/ No answer"=0) for the barriers of BIPV. The questionnaire was available on the Internet (Google forms) from February to April 2016. The questionnaire was done by telephone interviews, independent online or by telephone instruction. The link of the survey was also shared with the European Technology and Innovation Platform Photovoltaics and IEA PVPS-Task 15 members.

In total 100 completed questionnaires were analysed. The survey consisted of a few short questions, to identify the needs for education on the field of BIPV in their countries. In addition different other information was collected, to have a clear picture also about the interest, experience, familiarity and favour of BIPV, as well as groups of students and/or professionals, knowledge base and skills is needed and vision of the integration of BIPV in the building skin.

The Questionnaire is included as Annex 14.

Group	Topic
Constructional integration	Combination with conventional building materials
	Building envelope material properties
	Moisture protection
	Orientation/inclination
Energetic integration	Electrical interconnection
	Electrical protection
	Effects of integration type on energy performance
Design integration	Glass (optical, colours,..)
	Sun protection
	Different BIPV /products / materials / technologies
	Aesthetics (variety of colours, sizes and types)
	BIPV software /tools for early integration in the design process
Regulatory barriers	Building law (EPBD - Energy)
	Heritage law
	Noise regulation
	Heat regulations
	Renewable Energy Directives
Economical barriers	Price of the BIPV systems
	Payback time
	Maintenance of the modules
	Feed-in tariffs
Standards	EC (low voltage directive)
	CENELEC
	prEN 50583
Maintenance and recycling	Recycling
	Exchange of the Modules
Manufacturing barriers	Customization vs. Standardization
Market driven barriers	Market maturity
Cultural barriers	Cultural barriers
Lack of information	Best practice examples/demonstration examples

Table 8: Groups and topics used in questionnaire

4.1 Profile of participating Stakeholders and Countries

A total number of 100 participants from the building sector (architects, building contractors, building planners, manufacturers of building envelop products, electrical engineers), BIPV manufacturers (BIPV producers, mounting systems producers, façade manufacturers), installers (PV installers, electricians, façade installers), investors and research organisations took part in the survey. The target countries were Austria (AT), Cyprus (CY), Germany (DE) and The Netherlands (NL). The survey was also opened to experts from other countries in Europe and worldwide. The number of responses in total per country is shown in Figure 17.

About 30 percent of the stakeholders have no experience in the BIPV sector. Over 40 percent has up to 5 years of experience. Only a number of 10 stakeholders have an experience of more than 10 years as shown in Figure 19.

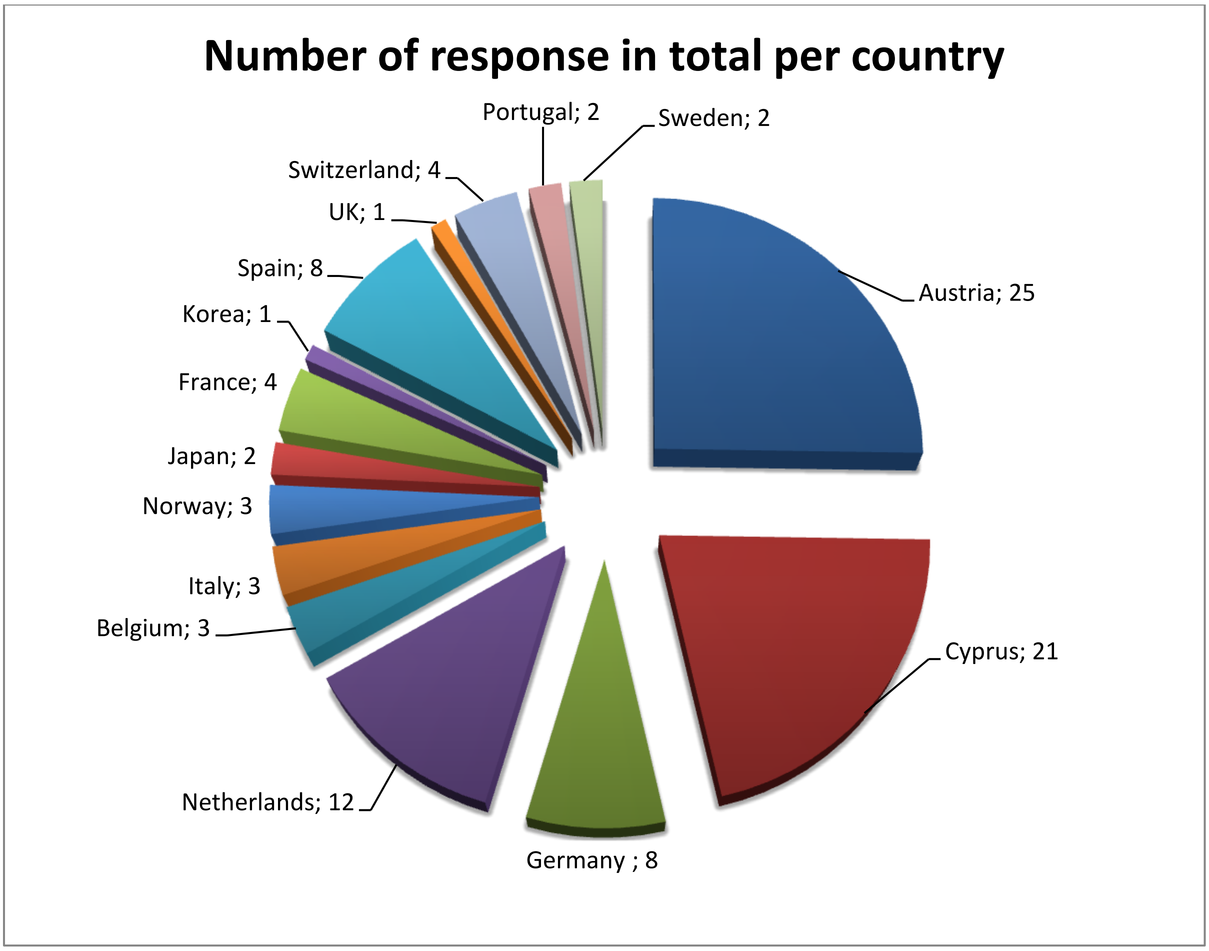


Figure 17: Number of response in total per country

Figure 18 shows the participation of the different stakeholder groups. The majority of the participants are from the R&D&I sector, followed by architects. A significant fraction of about 10% of the total response comes from PV installers, BIPV producers and consultants. Facade manufacturers and experts from the educational sector share about 5%. Different stakeholders shared the rest. There was a lack of participation from facade installers, electricians and buildings planners.

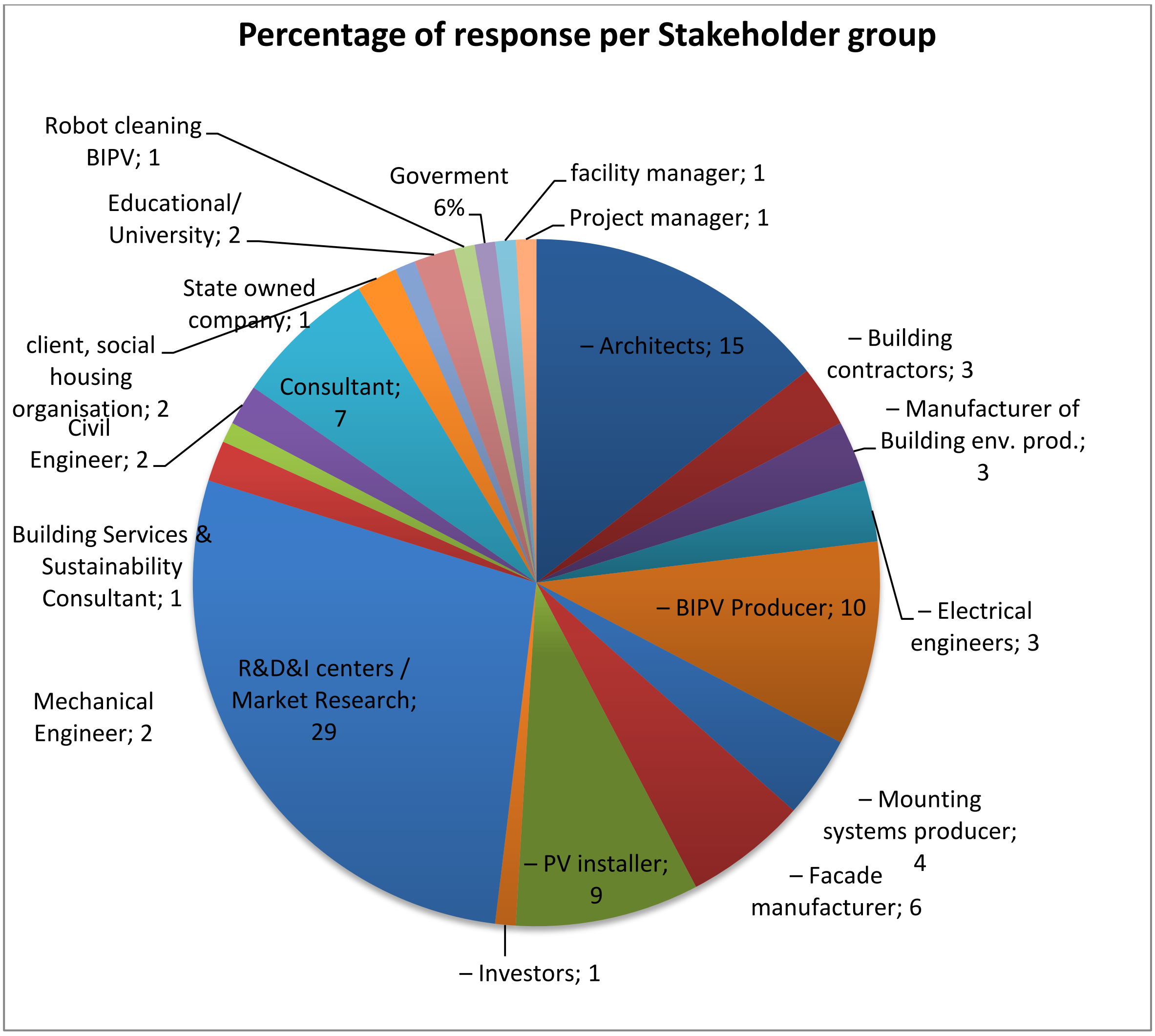


Figure 18: Percentage of response per stakeholder group

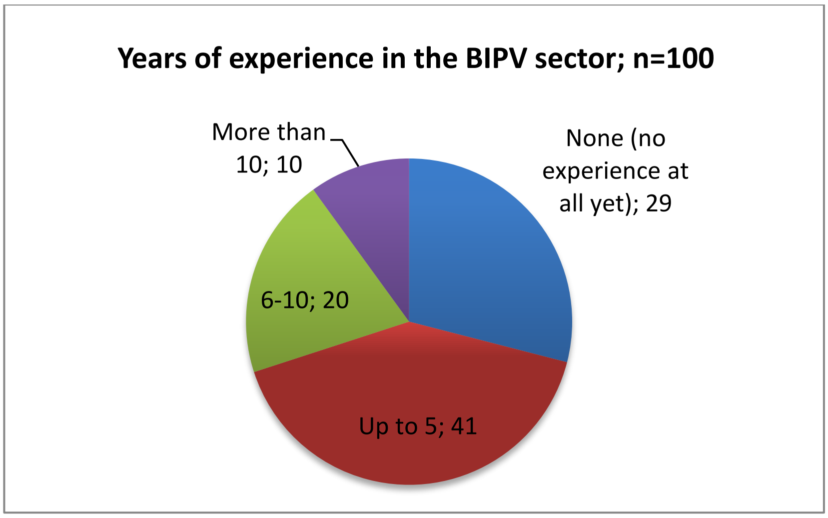


Figure 19: Years of experience in the BIPV sector; n=100

Number of involvements in installation of any BIPV systems

More than 50 percent of the stakeholders are not involved in installation of any BIPV systems. Only 29 percent of interviewed were involved in up to 10 installations.

The number of involvements in Austria, Cyprus, Germany and Netherlands is included as Annex 3.

4.2 Analysis of tendencies according to stakeholder groups, years of experience and number of employees

To identify tendencies due to stakeholder groups various comparison and analysis are done. No significant trend or tendencies is apparent from the graphs.

Comparing the familiarity of BIPV systems to attitude towards BIPV no coherence is significant. The correlation factor of about 0,2 confirmed this.

List of the analyses:

- Familiarity with BIPV systems vs. attitude towards BIPV
- Familiarity with BIPV systems vs. Years of experience in the BIPV sector
- Attitude towards BIPV vs. Years of experience in the BIPV sector
- Familiarity with BIPV systems vs. number of involvements in BIPV installations
- Attitude towards BIPV vs. number of involvements in BIPV installations

The Number of employees in the institutions is included in Annex 4.
All the other figures are included in Annex 5.

5. Questionnaire analysis – Familiarity, Attitudes towards BIPV systems, knowledge base and skills, Education need on BIPV by groups of students and/or professionals

5.1 Familiarity with BIPV systems

A high percentage of the participants taking part in the survey declared to be "very familiar" with BIPV (see Figure 20). About 50% of the respondents' worldwide declare that they are fairly familiar with BIPV.

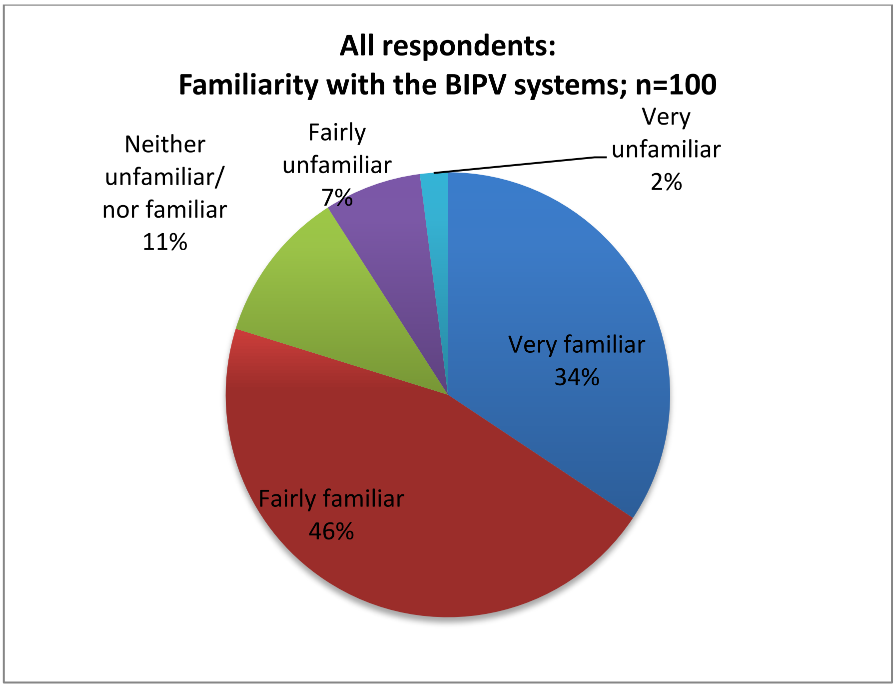


Figure 20: Familiarity with BIPV from the stakeholders taking part in the survey

Individual analyses of the familiarity with BIPV systems in Austria, Cyprus, Germany and Netherlands, the number of involvements in Austria, Cyprus, Germany and Netherlands and the sum of the countries is included as Annex 6.

5.2 Attitudes towards BIPV systems

BIPV is dealing with different stakeholders from different sectors, so the attitudes to BIPV show variation in the answers. The analysis comprised the respondents from the partner countries in Austria, Cyprus, Germany and Netherlands. The answers of the other stakeholders are in the same range. The category "very favourable" is compared to the response of the different stakeholders. Figure 21 presents the stakeholder response in the category "very favourable" with a majority of BIPV producers, followed by architects, PV installers and R&D experts.

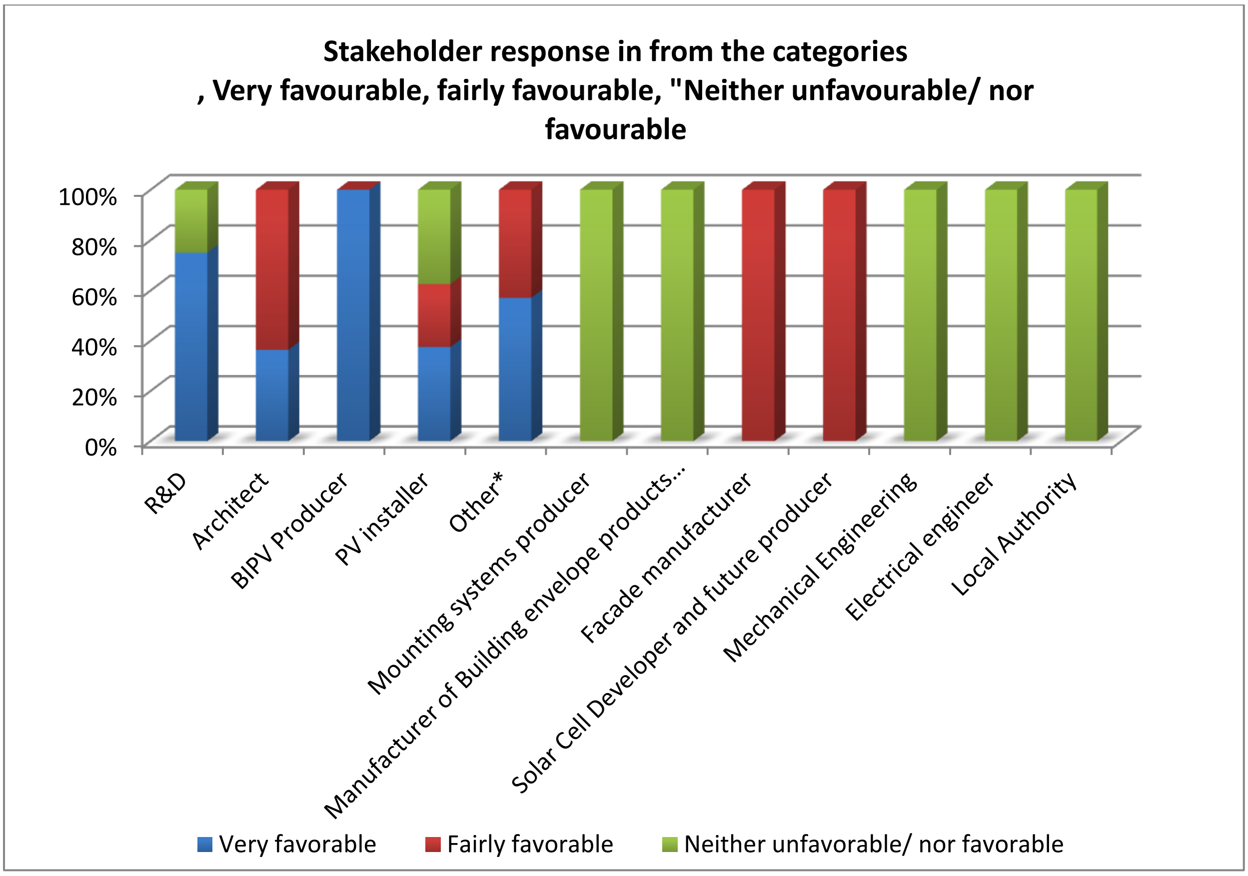


Figure 21: Stakeholder's attitude towards BIPV

**F&E institution, Electrical engineer, Mounting systems producer, Building contractor, Building Services & Sustainability, Consultant, Consultancy in BIPV policy, Pilot project development, Legal reseach, Project manager, University, Education, Research. Civil & Environmental Engineer, Electrical engineer, Investor, BIPV Producer, PV module producer, Mounting systems, producer, government, Robot cleaning BIPV, Civil Engineer*

Two stakeholder groups only selected the category "Very unfavourable": Building contractors and Research & Education.

Analysis per country are included in Annex 7.

5.3 Needs for enhancing the knowledge base and skills in relation to BIPV systems

Knowledge base and skills are one of the major issues in relation to BIPV. According to the stakeholders' architects are the major group with a need for knowledge base and skills. Figure 22 shows clearly that the opinion from the stakeholders identified the architects being the major group who needs knowledge base and skills in relation to BIPV systems. Followed by the civil and electrical engineers with a score of 30. The mechanical and environmental engineering reached about 20 points. Figure 22 shows all the results from the stakeholders.

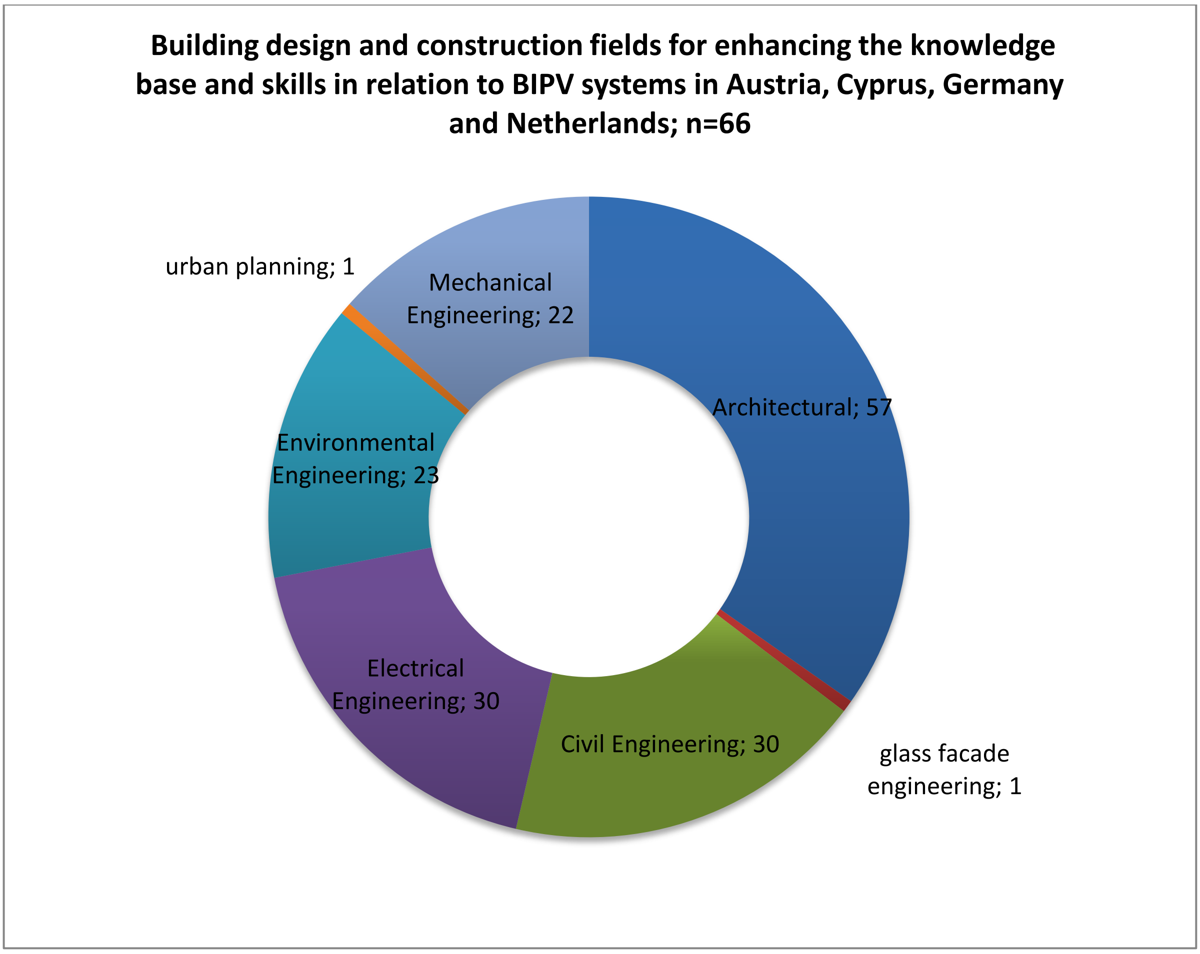


Figure 22: Building design and construction fields in need for enhancing the knowledge base and skills in relation to BIPV systems in Austria, Cyprus, Germany and Netherlands

Individual analyses of the different category are included in Annex 8.

The analyses per country are included in Annex 9.

5.4 Education need on BIPV by groups of students and/or professionals

The aim of the Dem4BIPV project is to develop an innovative and multidisciplinary, high quality course for BIPV in order to provide the necessary skills to the future BIPV professionals. This will be implemented at the postgraduate level and will be part of a Master's in Sustainable Energy. Nevertheless, the course should be extended to other students and professionals. As shown in Figure 23 the major demand is indicated for professionals such as Architects, Engineers, Planners, etc. in Austria, Cyprus, Germany, and The Netherlands. There is also fairly high demand by buildings contractors and post- graduate students (MSc) in relevant fields.

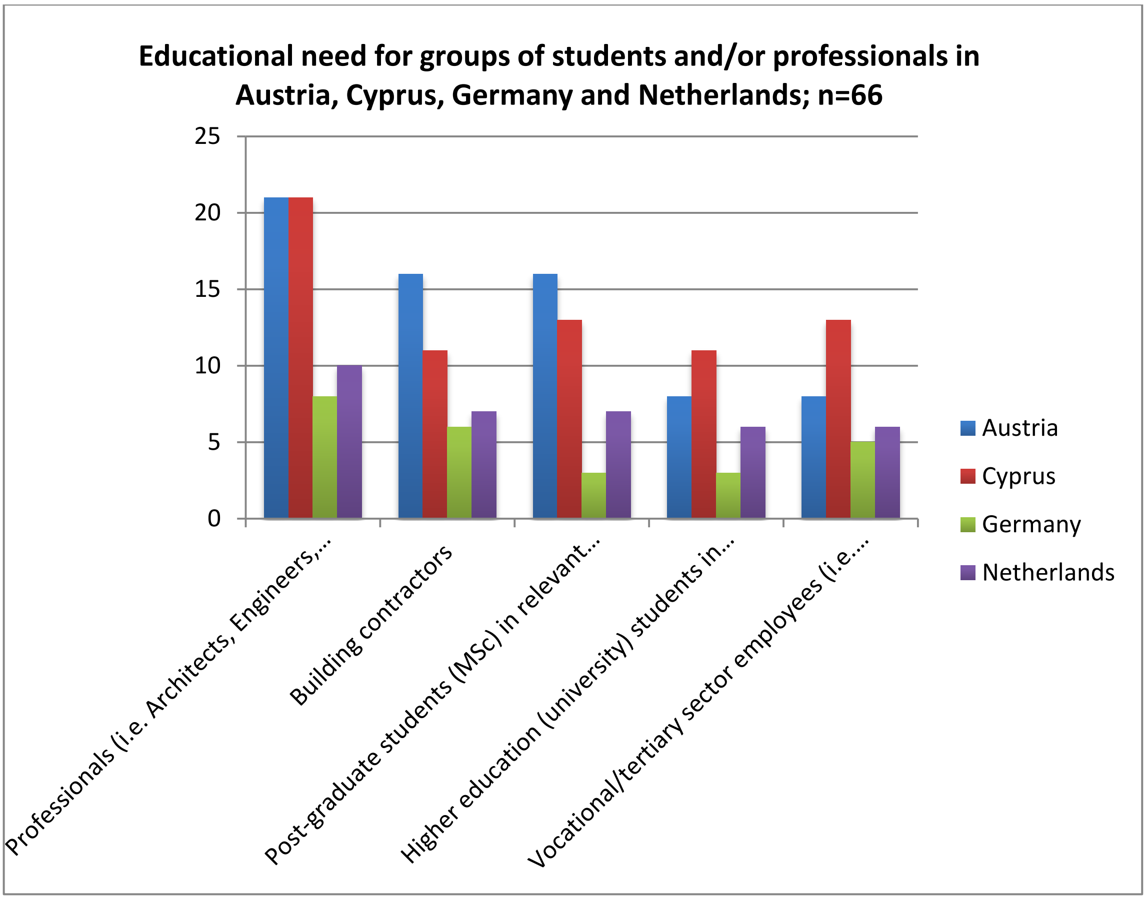


Figure 23: Educational need for groups of students and/or professionals in Austria, Cyprus, Germany and Netherlands; n=66

The sum of the consortium countries shows that the professionals are declared as the main group for educational need on BIPV (shown in Figure 24).

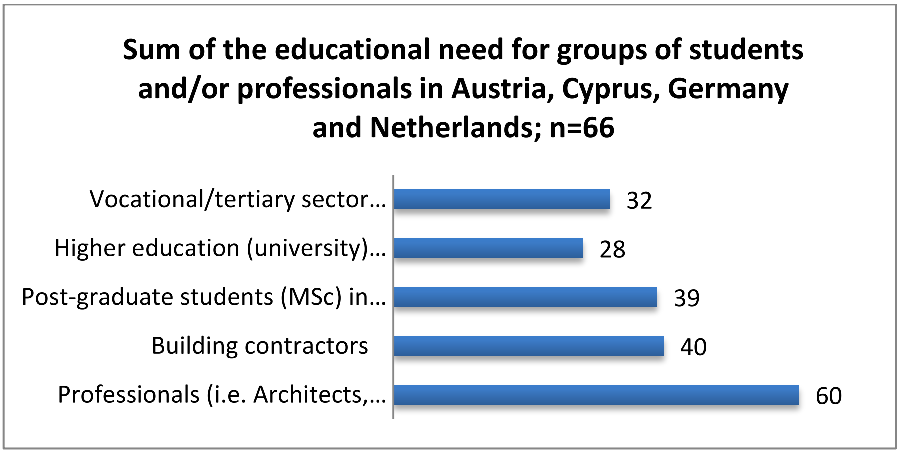


Figure 24: Sum of the educational need for groups of students and/or professionals in Austria, Cyprus, Germany and Netherlands; n=66

Education need on BIPV by groups of students and/or professionals for Austria, Cyprus, Germany and Netherlands is included in Annex 10.

6. Questionnaire analysis - Analysis of the barriers towards BIPV integration

One of the main barriers that was highlighted is the lack of European and international standards for BIPV elements, which merge the IEC (low voltage directive) and CENELEC (electro technical standardization body) needs with the CPD (construction product directive) directives. Nowadays each country has its own national legislations (Germany: Normentwurf E DIN VDE 0126-21, Photovoltaik im Bauwesen; the Netherlands: NEN NVN 7250:2007 Solar Energy Systems - Integration In Roofs And Facades - Building Aspects), which regulate the use of the photovoltaic module as a building component.

A lack of information of standards at the international level can also be found when we speak about feed-in-tariffs and subsidies for PV modules, both for building integration and ground mounted installations. This problem leads to very different national markets with different implementations of BIPV products. This is the case in Italy, France (and partially in Switzerland), where the feed-in-tariffs are very convenient for BIPV installations (as the requirements are related to the use of special PV products for building integration) as opposed to the ground mounted or added PV systems. But each country has different criteria, meaning that what is considered as BIPV in Italy can be differently interpreted in France or in Switzerland with an important influence on the market potential of the product in the different countries, depending on the brand potential of the product in the different countries. This problem will be solved only when the BIPV system becomes more economically feasible and the grid parity is reached. In this case national PV incentives will not be needed anymore. On the other hand, the international survey conducted within the framework of IEA SHC Task 41 showed that architects found the availability of suitable products for building integration being one of the main strategies to enhance the use of PV modules in the everyday architectural practice. Building integrated photovoltaic modules should not only be developed as added technical elements but as building components that have to fulfil the functional, constructional and formal requirements of the building components they replace. This document focused on these requirements in order to highlight the architects' needs of a widespread use of photovoltaics in the built environment (IEA-SHC-Task41 2013).

The question about the barriers towards BIPV adoption was one of the main parts of the questionnaire within the DEM4BIPV project. The main barrier towards BIPV including all response all over the world was indicated as the design integration of BIPV with 2037 points followed by constructional integration of BIPV with 1854 points. Figure 25 illustrates the distribution of the barriers on the further development on BIPV.

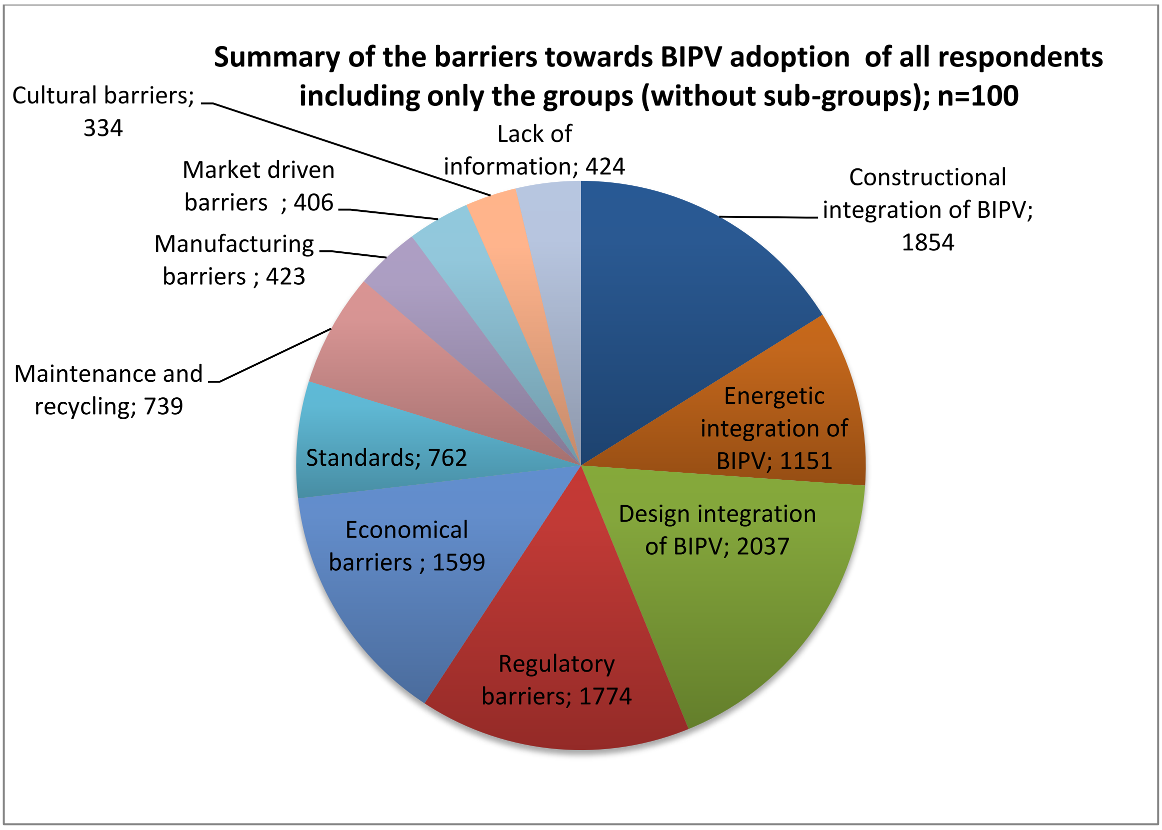


Figure 25: Summary of the barriers towards BIPV adoption of all respondents including only the groups (without sub-groups); n=100

Please note the indexes are: „Not important at all"=1; „Fairly Unimportant"=2; „Neither important nor unimportant"=3; „Fairly important"=4; „Very important"=5; „Don't know/ No answer"=0; Then the answers are summarized.

In detail the major barrier is the price of the BIPV systems according to the questionnaire analysis. Close behind the minor choice of different BIPV products/materials/technologies on the market for a reasonable price. Also BIPV software for early integration in the design process is still missing. Another important barrier is also the lack of information to the different stakeholders groups who are not familiar with BIPV at the moment. To bring the BIPV from the niche to the big market best practice and demonstration examples are needed. Another hurdle is the compromise between the customization of the BIPV systems and the standardization. More details about the result are illustrated in Figure 26.

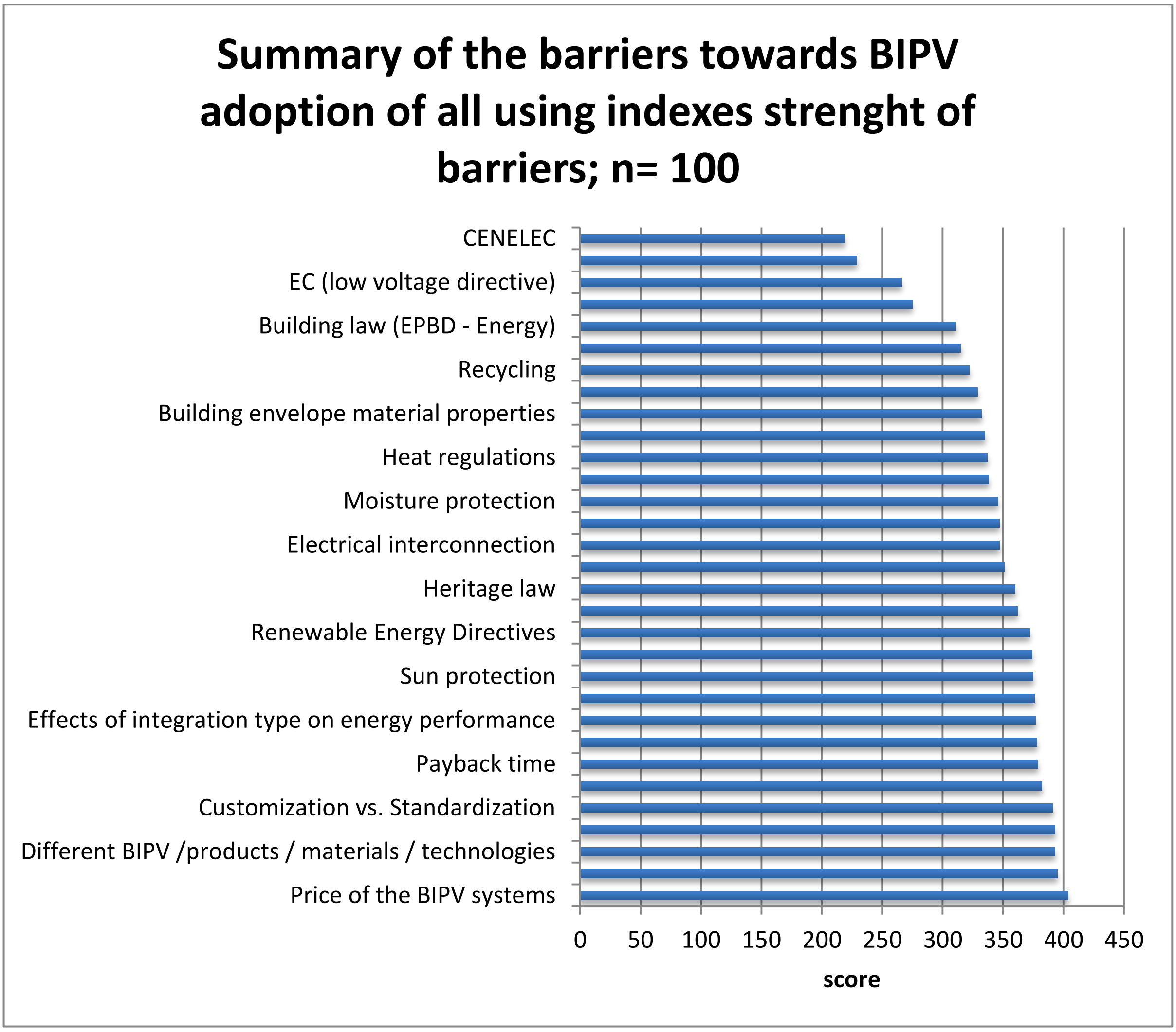


Figure 26: Summary of the barriers towards BIPV adoption; n= 100

Analysis of the consortium partners Austria, Cyprus, Germany, the Netherlands display a similar profile as mentioned above.

The graphs of the consortium analysis, as well as the analysis per country are included in Annex 11.

7. Questionnaire analysis – Educational needs

The main focus of the survey is to identify the needs of education on BIPV. Three groups are more prominent with more than 1300 points: The design integration of BIPV with the most points, the constructional integration of BIPV and the regulatory barriers. Also the economical need is pointed out with 1123. The energetic integration of BIPV and standards is not seen as a strong need for education in this field. The educational requirements for education of all respondents are presented in Figure 27.

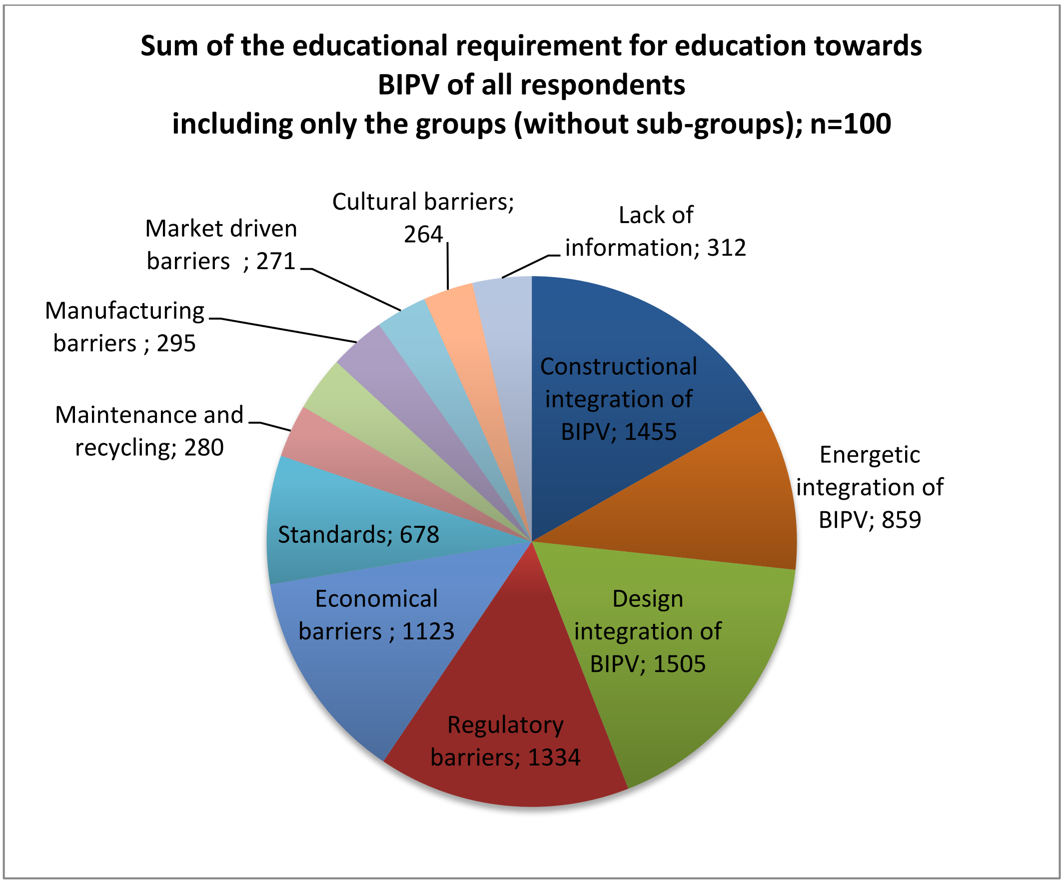


Figure 27: Summary of the educational requirement for education towards BIPV for all respondents including only the groups (without sub-groups); n=100

Please note the indexes are: „ There is no strong need at all "=1; „ There is a need but not so strong "=2; „ There is a fairly strong need "=3; „ There is a very strong need "=4; „Don't know/ No answer"=0; Then the answers are summarized.

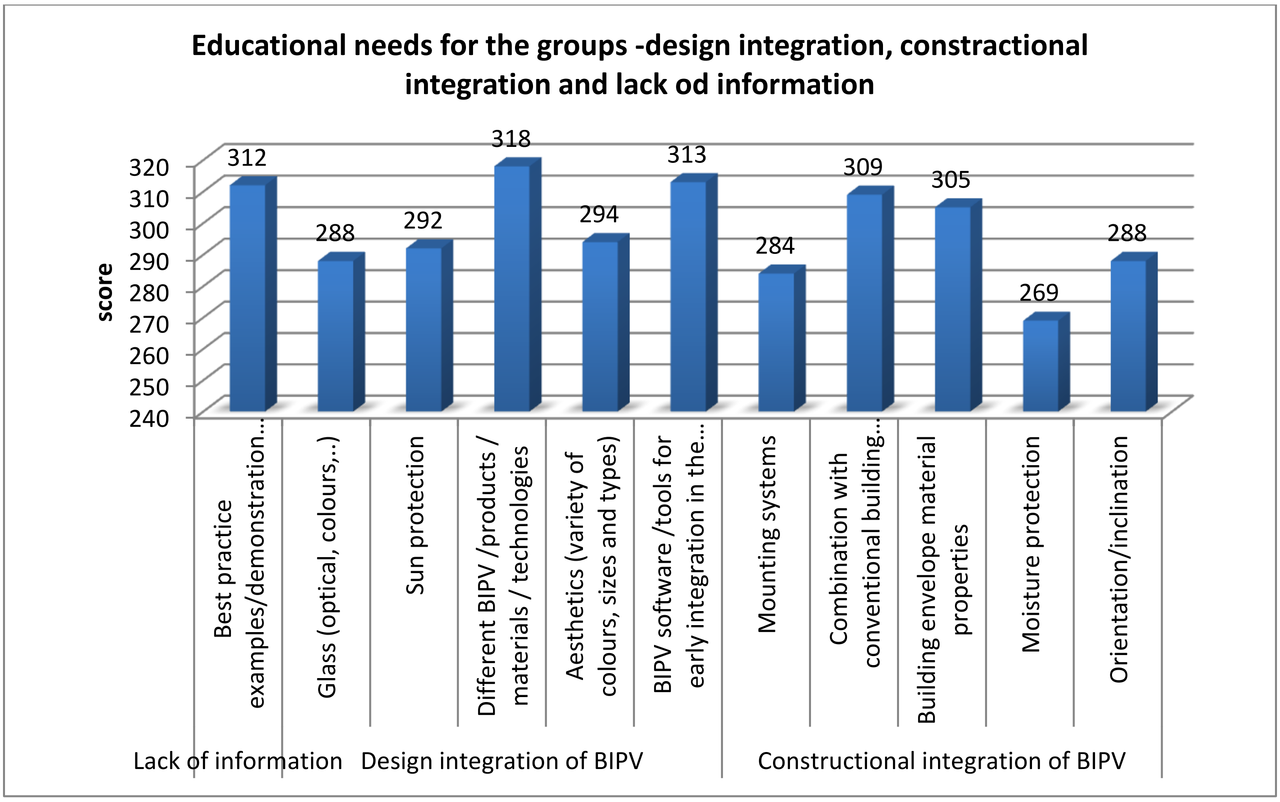


Figure 28: Educational needs for the groups -design integration, constructional integration and lack of information

In Figure 28 the educational needs for specific groups are presented. The topics products, materials and technologies for BIPV requires the major education needs according to respondents. Followed by software tools for early integration of BIPV in the building process. The lack of information, which is also a lack of communication, could be lead back to the missing knowledge about BIPV characteristics, technologies, yield, etc. and needs also education in different sectors.

Figure 29 shows the different national and European laws, regulation and directives. Some of them are still a barrier for the further development and installation of the wider deployment of BIPV. Therefore course and teaching materials in this sector have to be prepared.

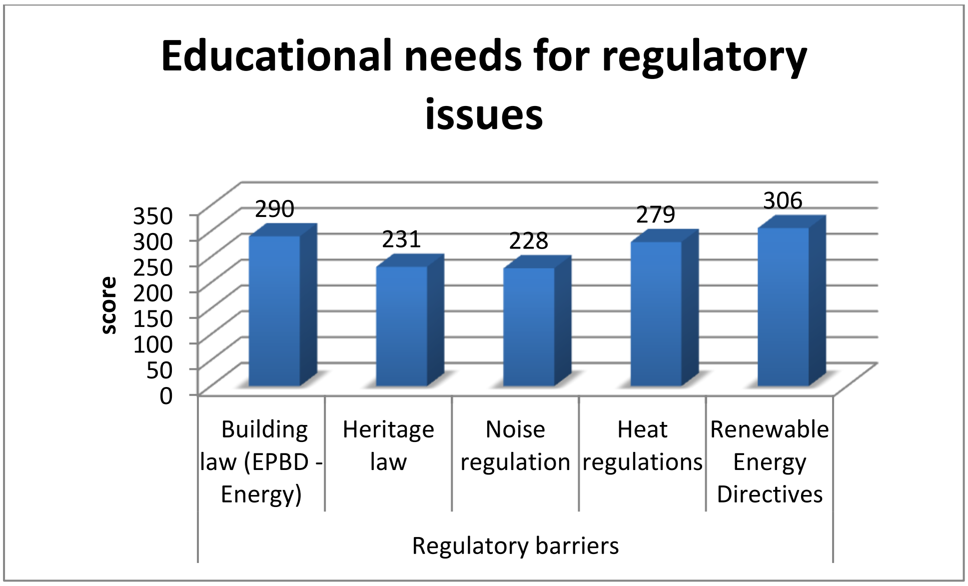


Figure 29: Educational needs for regulatory issues

The analysis of the results by country (Austria, Cyprus, Germany and Netherlands) is very similar to the analysis of the total answers recorded.

The graphs of the educational needs per country are included in Annex 12.

7.1 Other Barriers and educational needs mentioned from the Stakeholders

Some of the barriers were repeated and reinforced by the stakeholders. New barriers as the high bureaucracy in some of the countries, but also technical issues like storage of the produced where mentioned. The economic aspects take a major role as barriers for the further deployment of BIPV. Apart from the price of the BIPV module the comparison with standard PV modules is mentioned as an issue. The economics of BIPV has to be calculated in a different way including the savings for building envelopment. On the cultural and social side the lack of trust and understanding of the importance of this technology constitute a barrier for further investments but also the willingness of integration of BIPV in the building process. Awareness and education from the early beginning in the primary school and best practice may be needed to increase stakeholders trust in BIPV products. A new generation of architects with a knowledge base about the BIPV products, needs, characteristics, concepts, etc. is needed. In addition, the lack of communication between the different stakeholder groups, but also the lack of communication about these technologies is inhibiting the BIPV deployment.

The entire list of the barriers mentioned from the stakeholder is included in Annex 13.

8. Further important issues in wider deployment of BIPV

8.1 Stakeholder groups with an important role in wider deployment of BIPV

Figure 30 illustrates the importance of different stakeholders for wider deployment of BIPV. The main stakeholder groups are the architects, BIPV producers and the investors. Followed by building contractors, building planers façade and mounting systems producers.

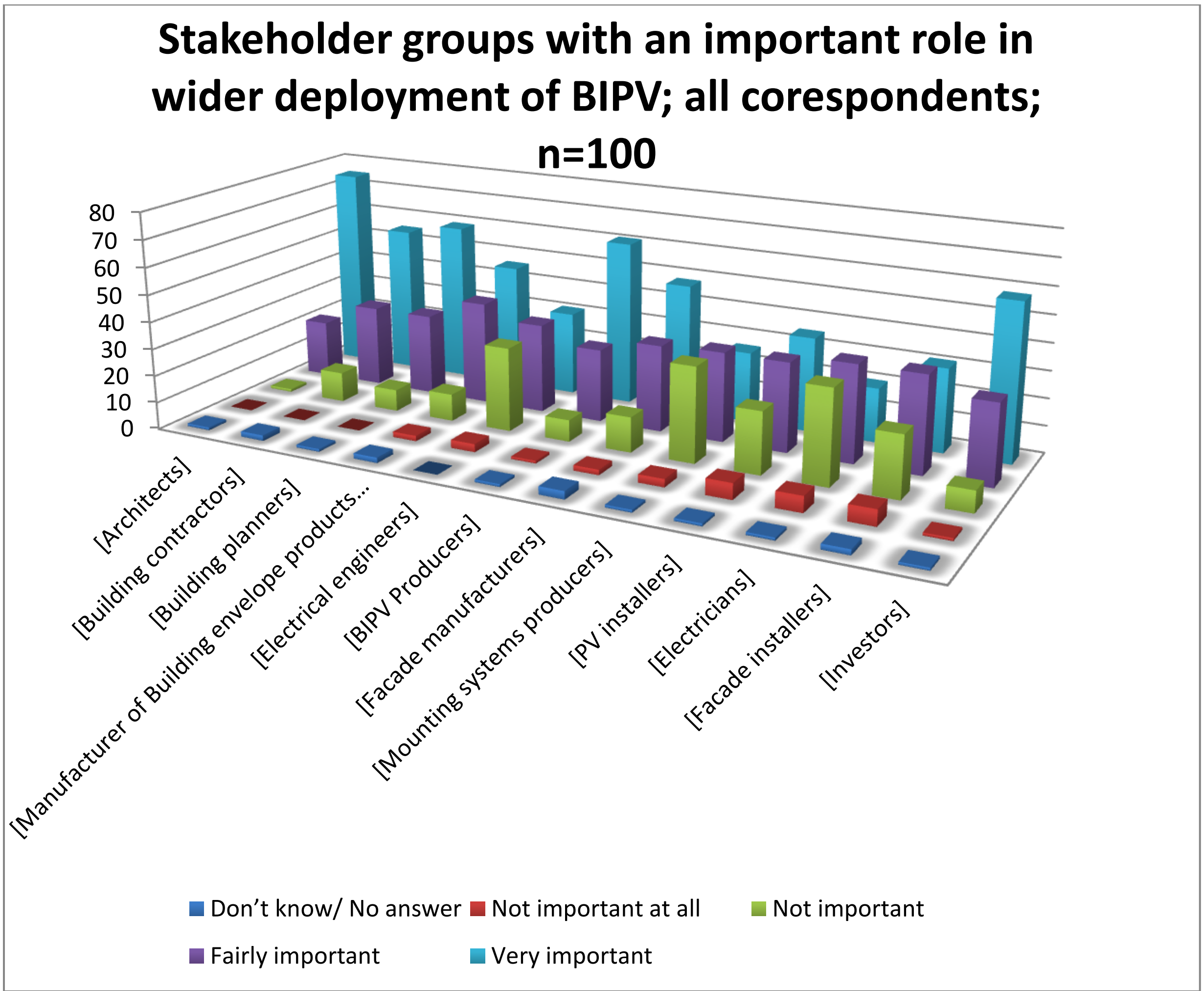


Figure 30: Stakeholder groups with an important role in wider deployment of BIPV; n=100

8.2 Envision and requirements on BIPV systems for the market breakthrough

As mentioned in chapter 1.1 the PV system can be integrated in different ways. The result of this analysis is shown in Figure 31. The facade and roof integration was mentioned as major application for BIPV with 80 points. Other integration opportunities like atria, canopies, curtain walls and rainscreens have just a minor effect.

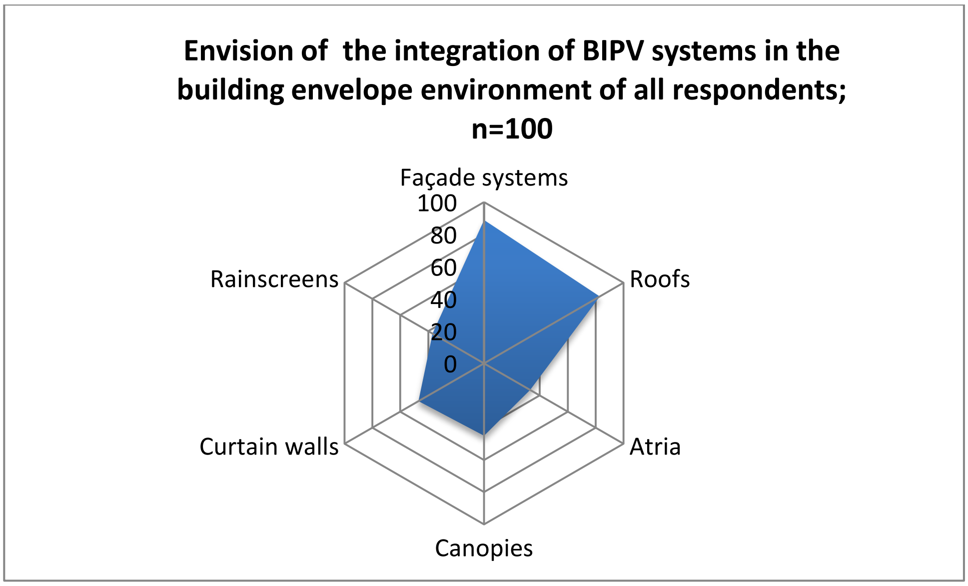


Figure 31: Envision of the integration of BIPV systems in the building envelope environment of all respondents; n=100

8.3 Main requirements that must be addressed by a BIPV system in the building envelope environment

Another aspect, which was prompted in the questionnaire, were the requirements that a BIPV system must meet. The cost, colour and durability & maintainability are indicated as the most important requirements that must be solved. Figure 32 shows the separation per requirement.

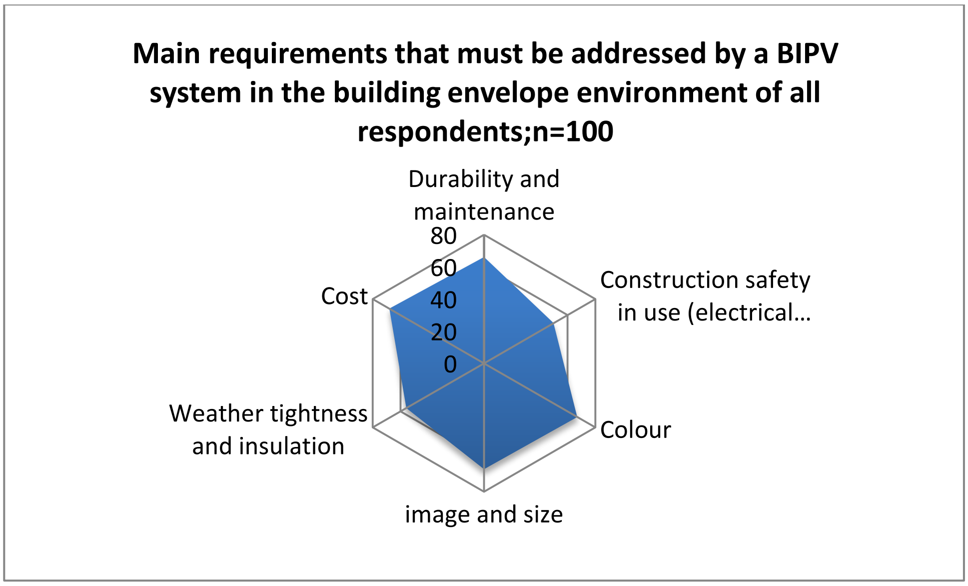


Figure 32: Main requirements that must be addressed by a BIPV system in the building envelope environment of all respondents; n=100

9. Discussion and Conclusion

The aim of the Dem4BIPV project is to develop an innovative and multidisciplinary, high quality course for BIPV in order to provide the necessary skills to the future BIPV professionals. In order to meet this goal, an outlook on the BIPV global market and the European market was given.

The BIPV market is rapidly growing in the last years, **from 1.5 GW in 2014 to 2.3 GW in 2015** and the **global BIPV market grew by** about 40%. With 41.7 %, Europe is leading the BIPV market of installation capacity in 2015. The IEA global trend analysis forecast 27% of the electricity production from solar in 2050, out of that 16% from PV and 11 % from solar thermal electricity. For the year 2015 the BIPV market in Europe is estimated at 967 MW installed capacity and has the lead in BIPV installations worldwide. An outlook on the BIPV market estimates 4,8 GW for 2020 in Europe. The BIPV market in Europe is **positively influenced** by the **regulatory framework** for enhancing energy efficiency of residential and non-residential buildings. At the European level the Directive on Energy Performance in Buildings (EPBD) (Directive 2010/31/EU) and the **Renewable Energy Directive (1/77/EC) was set up by the European Union** (EU). The member states are making attempts to adopt renewable energy, particularly solar energy in buildings as a step forward to meet the energy targets. The Directive 2010/31/EU aims at improving energy performance of buildings within the EU and increasing the share of renewable energy.

Nevertheless, to meet these figures, education for the future BIPV professionals is needed. To get more information about the need for education but also the barriers and other useful information about attitude to BIPV systems, a **survey** was developed. A total number of **100 participants from 15 countries** took part in the survey, whereby the bigger part was from the consortium partner countries: Austria, Cyprus, Germany and Netherlands. The **main participants** were the following stakeholder groups: **R&D sector, architects, BIPV producers and PV installers**. More than 50% of the participants have not been involved in BIPV system installation yet. About 30 % had already installed about 10 BIPV systems. The survey analysis shows that the majority of the stakeholders are "fairly familiar" to "very familiar" with BIPV systems. The **architects, BIPV producers and the PV installers are very favourable** to BIPV. Also, the façade installers and façade manufactures are "fairly favourable" to BIPV. Only individuals from the stakeholder groups Building contractors and Research & Education indicated to be "very unfavourable" to BIPV. That shows that the intention of the stakeholder to wider deployment on BIPV is given.

BIPV brings different sectors of professionals together, which did not work together in the past. The new players on BIPV have to enhance their **knowledge base and skills** in relation to BIPV systems. **Primarily the architects, civil and electrical engineers followed by the mechanical and environmental engineer**s according to the survey result. The **main group for educational need** is identified as the **professionals** (i.e. Architects, Engineers, Planners etc.), followed by **building contractors and post- graduate students (MSc)** in relevant fields (i.e. architectural, engineering, etc.).

BIPV is still a niche product and struggles with different barriers. From the survey different barriers are prompted on a 5-point scale („Not important at all"; „Fairly Unimportant"; „Neither important nor unimportant"; „Fairly important"; „Very important"; „Don't know/ No answer"=0). One of the **main barriers** summarized by all the correspondents is the "**design integration of the BIPV", followed by the "regulatory and constructional and economical barriers**". Looking at the topics in detail, the price of the BIPV system is mentioned as the main barrier of BIPV, followed by appropriate **BIPV software-tools for early integration in the design, the different BIPV products and materials/technologies**. Also **"customization vs. standardization"** issues are important as well as the lack of information and demonstration examples. Apart from the barriers mentioned already the stakeholders referred to the following barriers: bureaucracy, Building Information Modelling (BIM), economic pay-back time calculated with the aesthetically/ functionally equivalent non-PV element, automatized electrical design, etc. The barriers mentioned above are often caused by insufficient knowledge of the different stakeholders and persons behind the institutions.

The main goal of the survey and this report is to identify these **educational needs** of stakeholders from different sectors. The survey shows that the three main groups are **design integration, regulatory and constructional topics**, which have to be addressed with high priority. In detail these are **mounting systems and building envelope material properties, different BIPV products/materials/technologies, BIPV software as well as laws and directives**.
For the **further deployment of BIPV the architects, building contractors, building planers, façade and mounting systems producers, as well as investors play an important role in the future**. According to the survey roofs and façade systems will be the main application of BIPV. The main requirements that must be addressed by a BIPV system in the building is the cost of the BIPV system, the durability and maintenance, as well as image, size and colour. Table 9 gives an overview on the survey results.

Outlook	Profile of participating Stakeholders	Familiarity with BIPV	Positive to BIPV	Knowledge base and skills in relation to BIPV	Main group for educational need
From 967MW in 2015 to 4,8GW in 2020 in Europe	A total number of 100 participants took part 15 countries involved in the survey	Majority of the stakeholders are "fairly familiar" to very familiar; more than 80%	The architects, BIPV producers and the PV installer are very favourable towards BIPV.	Primarily the architects, civil and electrical engineering, then the mechanical and environmental engineering need skills in relation to BIPV	Professionals building contractors post- graduate students (MSc) in relevant fields
	Main participants from R&D, architects, BIPV producers and PV installer.		Façade installer and façade manufacture are "fairly favourable" with BIPV.		
	More than 50% of the participant was not involved in BIPV system installation yet				

Barriers towards BIPV adoption	Educational needs for BIPV	Plays an important role for further deployment of BIPV	To envision the integration of BIPV		Main requirements that must be addressed by a BIPV system
Design integration of BIPV, followed by the "regulatory and constructional and economical barriers".	Design integration, regulatory and constructional topics	Architects, building contractors, building planers, façade and mounting systems producers, as well as investors plays	Roofs and the façade system		Cost of the BIPV system, the durability and maintenance, as well as image, size and colour.
	Mounting systems and building envelope materials properties, different BIPV products/materials/technologies, BIPV software, laws and directives				

Table 9: Overview of the questionnaire results

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11. Annexes

Annex 1: Select BIPV products offered in Europe

A Glance at Select BIPV Products Offered in Europe

Company	BIPV Product	PV Technology	Application
Asola Technologies	VITRUM Balcony	Mono-crystalline	Accessories
Asola Technologies	VITRUM Super	Multi-crystalline	Cold Façade
Asola Technologies	VITRUM Carport	Mono-crystalline	Solar glazing/Skylight
Galaxy Energy GmbH	Galaxy Energy Indachsystem	Mono-crystalline	Solar Glazing/Skylight
Roto Sunroof GmbH	Sunroof SRP	Mono-crystalline	In-roof mounting systems
Schletter GmbH	-	-	In-roof mounting systems
Schletter GmbH	Plandach 5	-	Full roof BIPV
Si Module GmbH	SI-Power Indach	Mono-crystalline	Full roof BIPV
Solarwatt	Glass-Glass Modules	Mono-crystalline	Solar glazing
Soltech	Techo Solar	-	Full roof BIPV
SUNOVATION GmbH	eFORM Color	Mono-/ Multi-crystalline	Cold Façade
SUNOVATION GmbH	eFORM Crystal	Mono-/ Multi-crystalline	Solar glazing
Aerspire	AER (Aesthetic Energy Roof)	Monocrystalline	Full roof solution
ClickCon GmbH & Co. KG	ClickPlain Rooftop Array Mounting System	-	Full roof BIPV
Colt International Ltd.	Shadovoltaic	Mono-/ Multi-crystalline	Accessories
Creteq	Zigzag Solar	Mono-crystalline	Accessories
The Ernst Schweizer AG	Solrif	-	Full roof BiPV
Ertex Solar	VSG insulating Glass module	Mono-/ Multi-crystalline	Solar glazing

Annex Figure 1 *Select BIPV products offered in Europe (1/2)*

Company	BIPV Product	PV Technology	Application
Fornace Fonti srl	Tegole DF2-DF3 photovoltaic tile	Mono- / Multicrystalline	Small sized Solar tiles - Shingles
Helvetic Energy	Aldo Voltaik	Mono- / Multicrystalline	In-roof mounting systems
Jansen/Schüco	Shüco Prosol	Mono-/ Multi-crystalline/ Thin film	Accessories/Solar glazing/Cold Façade
Kaneka	See-Trough PV module	Thin film (triple junction)	Solar glazing/sky light
Megasol Energie	Megasol NICER	Mono-/ Multi-crystalline	Full roof BIPV
Mijn Energiefabriek	In-dak Easy-in	-	In-roof mounting systems
Monier	Monier VI90	Monocrystalline	Large sized Solar tiles - Shingles
Naps Systems	Naps Solar Sunshade system	-	Accessories
Naps Systems	Naps Solar Glazing System	-	Warm Façade
Rheinzink	-	Thin film	Roof
Sapa Building System	Sapa Solar	Mono- /Multi-crystalline / Thin film	Cold Façade/ Warm Façade/ Skylight / Solar glazing
Scheuten Glas	Optisol Shade	-	Accessories
Scheuten Glas	Optisol Screen	Multicrystalline	Solar glazing
Scheuten Glas	Optisol Skin	Mono-crystalline	Cold façade
Scheuten Glas	Optisol Sky	Multicrystalline	Skylight / Solar glazing
SCX Solar B.V.	SCX Soloroof™	Thin film/ Mono /Multicrystalline	Full roof Solution
Smartroof NV	SmartRoof	Monocrystalline	Small sized Solar tiles - Shingles
Société d'Energie Solaire SES	-	Monocrystalline	Full roof BiPV / Solar tiles – Shingles

Annex Figure 2 *Select BIPV products offered in Europe (2/2)*

New technologies are coming. Companies and laboratories are exploring new generation thin film technologies using materials such as Copper Indium Selenide (CIS) and Cadmium Telluride (CdTe). CIS thins film cells, which presently account for a minor share of the global market, are expected to witness rapid growth in the coming years. Another major development in the field of PV materials was the use of organic materials for solar cells. Through further research it is likely that a few years time would be needed for commercially producing the cells.

Annex 2: Feed-in Tariff Rates in Select Countries for Roof-Top Solar PV and BIPV Systems

Feed-in Tariff Rates in Select Countries for Roof-Top Solar PV and BIPV Systems

Country/Tariff	Description	Roof-Top	BIPV	Term	As of
Algeria	Large scale tariff, launched April 2014	$0.6836/kWh	$0.6836/kWh	20 years	May, 2014
Argentina		up to 30MW = $0.2162	up to 30MW = $0.2161	15 years	Apr, 2013
Armenia		$0.0527/kWh	$0.0527/kWh	until 2016	Feb, 2013
Australia	New South Wales	<10kW = $0.6103		7 years	Feb, 2014
	Queensland	<5kW = $0.0868		20 years	
		<5kW = A$0.08			
	South Australia	<30kW = $0.5967		20 years	
		<30kW = A$0.076			
	Victoria	<5kW = $0.6103		15 years	
		<100kW = A$0.08			
	Australian Capital Territory	<200kW = $ 30.94		20 years	
Austria		5 kW-20 kW = $0.5134 <20kW = $0.4458			Nov, 2014
	Effective Jan, 2015	5kWh - 200kWh = $0.143	5kWh - 200kWh = $0.143		
Belgium	Flanders	$0.33 - $0.42			Apr, 2013
		> 1MW (> 50% consumption) = $0.15			
		> 1MW (< 50% local consumption) $1.6103			
	Wallonia	< 5kW =	Varies		
		5kW - 10kW = $0.4408			
		10kW - 250kW = $0.54			
		> 250kW = $0.0882			

Annex Figure 3 *Feed-in Tariff Rates in Select Countries for Roof-Top Solar PV and BIPV Systems(1/7)*

Country/Tariff	Description	Roof-Top	BIPV	Term	As of
Bulgaria		Up to 5kW = $0.2634	Up to 30kW = $0.073	20 years	Dec, 2013
		Up to 30kW = $0.2013	30-200kW = $0.1297		
		30-200kW = $0.1567	200kW-10MW = $0.1189		
		200kW-1MW = $0.1432	>10MW = $0.1175		
Canada	Ontario	<10kW =$0.8241		20 years	March, 2015
		>10 - 250kW =$0.7295			
		>250kW-500kW =$0.6485			
		>500kW =$0.5539			
	Ontario	<10kW= $0.3			
		>10 - 100kW= $0.27			
		> 100 kW- 500 kW= $0.25			
China	26 Aug, 2013	mainly distributed = CNY0.42/kWh		20 years in proposal	March, 2014
	December, 2013, under Golden Sun Program			the program stopped receiving new applications in March 2013	
	December, 2013		listed in the first batch and connected before 31 May, 2013 = 5.5CNY/W	Not Specified, for demonstration projects only	
			listed in the second batch and connected before 30 June, 2013 = 5.5CNY/W		
			Overdue but connected before 31 Dec, 2013 = 5CNY/W		
			overdue but connected before 30 June, 2014 = 4CNY/W		
	April, 2012			Not Specified	
	January, 2012, under Golden Sun Program		connected before 30th June, 2013 = 7 CNY/W	Program stopped receiving new applications in March 2013	
			BAPV, connected before 30th June, 2013 = 5.5CNY/W		
Croatia			<10kW = $0.6214		Feb, 2013
			<30kW = $0.5539		
			>30kW = $0.3513		
Cyprus		Up to 20kWp = $0.4863	Up to 20kWp = $0.2769	15 years	Feb, 2013
		21-150kW = $0.4593	21-150kW = $0.4593		
Czech Republic		<30kWp = $0.6485		20 years	Feb, 2013
		>30kWp = $0.3242			
		>100 = $0.3107			
Denmark		$0.1094/kWh	$0.1094/kWh	1-10 years	Jan, 2014
		$0.073/kWh	$0.073/kWh	11-20 years	
Ecuador		$0.4269/kWh	$0.4269/kWh	15 years	Feb, 2013

Annex Figure 4 *Feed-in Tariff Rates in Select Countries for Roof-Top Solar PV and BIPV Systems(2/7)*

Country/Tariff	Description	Roof-Top	BIPV	Term	As of
France	Residential facilities - 1 January - 31 March 2013	0-9kW =$0.4268			March, 2014
	Educational or health facilities - 1 January - 31 March 2013				
	Other buildings - 1 January - 31 March 2013		0-9kW =$0.4268		
			0-12MW =$1.1051		
	1 January 2014 - 31 March 2014		0-9kW=$0.39		
			Simplified BIPV 0-36kW=$0.2		
			Simplified BIPV 36-100kW=$0.19		
	1 January 2014 - 31 March 2014	0-12MW = 7.30 c €/kWh			
Germany	Jan-14	0-10kWp = $0.19	0-10kWp = $0.19	20 years w/gradual degression rate based on capacity targets	Feb, 2014
		10-40kWp = $0.18	10-40kWp = $0.18		
		40kWp-1MWp = $0.16	40kWp-1MWp = $0.16		
		1-10MWp = $0.13	1-10MWp = $0.13		
Greece	February 2013 - price per MW	$162	$130		May, 2013
	August 2013 - price per MW	$162	$130		
	February 2014 - price per MW	$156	$123		
	August 2014 - price per MW	$156	$123		
	February 2015 - price per MW	$149			
	August 2015 - price per MW	$149			
	February 2016 - price per MW	$143			
	August 2016 - price per MW	$143			
	February 2017 - price per MW	$136			
	August 2017 - price per MW	$130			
	February 2018 - price per MW	$123			
	August 2018 - price per MW	$117			
	Feb, 2019	$110			
	Aug, 2019	$104			
India		$0.3918/kWh	$0.3918/kWh	20 years	Nov, 2014
		$0.12/kWh	$0.12/kWh		
Israel		<50kW = $1.0132		20 years	Feb, 2013
		51kW-12MW = $0.4458			
		12MW-60MW = $0.3242			
		>60MW = $0.2972			

Annex Figure 5 *Feed-in Tariff Rates in Select Countries for Roof-Top Solar PV and BIPV Systems(3/7)*

Country/Tariff	Description	Roof-Top	BIPV	Term	As of
Italy	Plants coming on line in the first 6 months of new decree: inclusive tariff	1-3kW = $0.2715	1-3kW = $281		Nov, 2014
		3-20kW = $0.2553	3-20kW = $264		
		20-200kW = $0.227	20-200kW = $236		
		200-1MW = $0.1824	200-1MW = $191		
		1MW-5MW = $0.1621	1MW-5MW = $170		
		>5MW = $0.1527	>5MW = $160		
	Plants coming on line in the first 6 months of new decree: energy consumption tariff	1-3kW = $160	1-3kW = $170		
		3-20kW = $144	3-20kW = $229		
		20-200kW = $116	20-200kW = $125		
		200-1MW = $71	200-1MW = $81		
		1MW-5MW = $51	1MW-5MW = $59		
		>5MW = $1	>5MW = $50		
Japan		<10kW/h for surplus generation = $0.5485/kWh	<10kW/h for surplus generation = $0.5485/kWh	20 years - excluding tax	Nov, 2014
		$0.31kW/h	$0.31kW/h		
		>10 kW = $0.5485/kWh	>10 kW = $0.5485/kWh	10 years - including tax with a separate FIT for any surplus power generated	
		US$0.36kW/h	US$0.36kW/h		
Jordan		US$0.17per kWh			Apr, 2013
		US$0.19per kWh			
Kenya		$0.2026 per kWh	$0.2026 per kWh	15 to 20 years	Feb, 2013
Lithuania		<30kW = $0.5634	<30kW = $0.7025	12 years	Apr, 2013
		>30 = Auction	>30 = Auction		
Luxembourg		<30kW = $0.5674		15 years	Feb, 2013
		31kW-1000kW = $0.4999			
Malaysia	2012	<4kW = $0.4231		20 years	Nov, 2014
		4-24kW = $0.4109			
		24-72kW = $0.4042			
		72kW-1MW = $0.3906			
		1-10MW = $0.3255			
		10-30MW = $0.2916			
	2013	<4kW = $0.3933			
		4-24kW = $0.3784			
		24-72kW = $0.3662			
		72kW-1MW = $0.3594			
		1-10MW = $0.2984			
		10-30MW = $0.2672			
	2014	<4kW = $0.3567			
		4-24kW = $0.3472			
		24-72kW = $0.3391			
		72kW-1MW = $0.3255			
		1-10MW = $0.2753			
		10-30MW = $0.2468			

Annex Figure 6 *Feed-in Tariff Rates in Select Countries for Roof-Top Solar PV and BIPV Systems(4/7)*

Country/Tariff	Description	Roof-Top	BIPV	Term	As of
Malaysia	Effective January 2015	≤ 4kW = $0.27		21 years	Nov, 2014
		above 4kW - ≤ 24kW = $0.27			
		above 24kW - ≤ 72kW = $0.23			
		above 72kW - ≤ 1MW = $0.22			
		above 1MW - ≤ 10MW = $0.18			
		above 10MW - ≤ 30MW = $0.16			
Mongolia	Grid connected 2007-2017	$0.15 - $0.18	$0.15 - $0.18	Until 2017	Oct, 2013
	Off Grid 2007-2017	$0.2 - $0.3	$0.2 - $0.3	Until 2017	
Netherlands		0.6kW-15kW = $0.5174		15 years	Feb, 2013
		15kW-100kW = $0.4769			
Nigeria	2012				May, 2013
	2013				
	2014				
	2015				
	2016				
Pakistan	Northern region 1MW - 100MW			25 year upfront payment.	Feb, 2014
	Southern region 1MW - 100MW			25 year upfront payment	
Portugal		>5kW = $0.4323		20 years	Feb, 2013
		<5kW = $0.5674			
		<11kW = $0.4404			
		12 to 250kW = $0.2905			
		250kW = $0.3513			
		<250kW = $0.3513			
Romania		Between $0.27 and $0.48/kWh	Between $0.27 and $0.48/kWh		Apr, 2013
Slovakia	July 2011 and after	up to 100kW and placed on a building =$0.3499/MWh		15 years	Apr, 2013
Slovenia	Guaranteed Purchase	<50kW = $0.5674	<50kW = $0.6485	15 years	Feb, 2013
		50kW-1000kW = $0.5134	50kW-1000kW = $0.5944		
		1MW-10MW = $0.4323	1MW-10MW = $0.4863		
		10MW-125MW = n/a	10MW-125MW = n/a		
	Operating Support	<50kW = $0.4999	<50kW = $0.5809	15 years	
		50kW-1000kW = $0.4458	50kW-1000kW = $0.5269		
		1MW-10MW = $0.3648	1MW-10MW = $0.4188		
		10MW-125MW = $0.3107	10MW-125MW = $0.3648		
South Africa		$0.17	$0.166/kWp	20 years	Feb, 2013

Annex Figure 7 *Feed-in Tariff Rates in Select Countries for Roof-Top Solar PV and BIPV Systems(5/7)*

Country/Tariff	Description	Roof-Top	BIPV	Term	As of
South Korea		<30kW = $0.5134		20 years	Feb, 2013
		30-200kW = $0.4863			
		200kW-1MW = $0.4863			
		>1MW = $0.4593			
Spain		<20kW = $0.3608	<20kW - $0.3838	25 years	Nov, 2013
		>20kW = $0.2618	>20kW = $0.2618		
Switzerland		<10kW - $0.37	<10kW = $0.4809	25 years	Nov, 2014
		<30kW = $0.304	<30kW = $0.48		
		<100kW - $0.28	<100kW - $0.37		
		<1000kW = $0.25	<1000kW = $0.37		
		<1000kW = $0.24	>1000kW = $0.32		
	Reductions will begin 1 April 2015 and conclude 1April 2016.	<10kW = $0.28	<10kW = $0.37	25 years	
		<30kW = $0.23	<30kW - $0.369		
		<100kW = $0.229	<100kW = $0.30		
		<1000kW - $0.20	<1000kW - $0.30		
		>1000kW - 0.21	>1000kW - $0.28		
Taiwan	January - June 2012	1-10kWp = $0.34		20	Feb, 2013
		10-100kWp - $0.31			
		100-500kWp = $0.29			
		>500kWp = $0.26			
	July - December 2012	1<10 = $0.32		20	
		1-10kWp - $0.29			
		10-100kWp = $0.28			
		100-500kWp - $0.28			
		>500kWp = $0.25			
Thailand	2007	$0.28	$0.28	10	Sep, 2013
	2009	$0.28	$0.28	10	
	2010	$0.23	$0.23	10	
	2013	6.96THB - 6.16THB		25	
The Philippines		$0.2526 per kWh	$0.2526 per kWh		Feb, 2013
Turkey		$1.22	$0.01	10 years	Feb, 2013
Uganda		$0.37	$0.3729/kWh	20 years	Feb, 2013
Ukraine	Until 31 March 2013	<100kW - $0.5032	<100kW - $0.5032		Feb, 2013
		>100kW - $0.5561	>100kW - $0.5561		
	April 1, 2013	<100kW = $0.4611	<100kW = $0.4611		
		>100kW = $0.4747	>100kW = $0.4747		
		>10kW = $0.4747	>10kW = $0.4747		
	January 1, 2015	<100kW - $0.4069	<100kW - $0.4069		
		>100kW = $0.4204	>100kW = $0.4204		
		>10kW - $0.4204	>10kW - $0.4204		
	January 1, 2020	<100kW = $0.3662	<100kW = $0.3662		
		>100kW = $0.3797	>100kW = $0.3797		
		>10kW = $0.3797	>10kW = $0.3797		
	January 1, 2025	<100kW - $0.3255	<100kW - $0.3255		
		>100kW = $0.3255	>100kW = $0.3255		
		>10kW - $0.3255	>10kW = $0.3255		

Annex Figure 8 *Feed-in Tariff Rates in Select Countries for Roof-Top Solar PV and BIPV Systems(6/7)*

Country/Tariff	Description	Roof-Top	BIPV	Term	As of
UK	Rates available to 1 May 2013 until 1 July 2013	0-4kW = US$0.232	≤4 kW (retro fit) = US$0.3526	20 years	Mar, 2015
		>4-10kW = US$0.2102	≤4 kW (new build) = US$0.3526		
		>10-50kW = US$0.1958	4-10kW = US$0.2848		
		50-100kW = US$0.1668	10-50kW = US$0.2577		
		100-150kW = US$0.1668	50-100kW = US$0.217		
		150-250kW = US$0.1596	150-250kW = US$0.1899		
		>250kW-5MW = US$1.0293	250-5MW = US$0.1221		
		Stand-alone = US$1.0293	250kW+ = US$0.0963		
		Export tariff = US$0.6972	stand-alone = US$0.1221		
	Rates available 1 April 2015 until 1 July 2015	0-4kW= US$0.2			
		>4-10kW= US$0.18			
		>10-50kW= US$0.18			
		>50-100kW= US$1.5			
		>100-150kW= US$1.5			
		>150-250kW= US$1.43			
		>250kW= US$0.93			
		Stand-alone= US$0.93			
		Export tariff= US$0.73			
US	Hawaii	500kW-5MW = $1.01/kWh		20 years	Dec, 2013
		>20kW-500kW = $0.13/kWh			
	Florida: Gainesville	<10kW = $0.45	<10kW = $0.43	20 years	
		10-300kW = $0.39	10-300kW = $0.39		
		300kW-1MW =$ 0.32	300kW-1MW = $0.32		
	Rhode Island	<30kW = $0.45	<30kW = $0.49	20 years	
	Washington	<30kW = $0.45	<30kW = $0.49	20 years	
		30-100kW = $0.44	30-100kW = $0.48		
		100kW+ = $0.43	100kW+ = $0.47		
	California	<1MW = $0.12 (10 years)		10-20 years	
		<1MW = $0.12 (15 years)			
		<1MW = $0.13 (20 years)			

Annex Figure 9 *Feed-in Tariff Rates in Select Countries for Roof-Top Solar PV and BIPV Systems(7/7)*

Annex 2.1: Targets for Electricity Production from Renewable Energy Sources in Selected Countries

TABLE 8: Targets for Electricity Production from Renewable Energy Sources in Select Countries

Country	Renewable Electricity Generation Target
Algeria	5% by 2017 40% by 2030
Argentina	8% by 2016
	3 GW by 2016
Australia	20% by 2020
Austria	70.6% by 2020
Bangladesh	5% by 2015 10% by 2020
Belgium	20.9% by 2020
Bulgaria	20.6% by 2020
Brazil	19.3 GW by 2021 (Bio-power) 7.8 GW by 2021 (Hydropower (small-scale)) 15.6 GW by 2021 (Wind)
Chile	20% by 2025
China	13 GW by 2015 (Bio-power) 290 GW by 2015 (Hydropower) 35 GW by 2015 (Solar PV) 100 GW grid-connected by 2015; 200 GW by 2020 (Wind)
Colombia	3.5% by 2015; 6.5% by 2020 (Electricity (grid-connected)) 20% by 2015; 30% by 2020 (Electricity (off-grid))
Croatia	39% by 2020
Cyprus	16% by 2020
Czech Republic	14.3% by 2020
Denmark	50% by 2020 100% by 2050
Egypt	20% by 2020
Estonia	18% by 2015
Finland	33% by 2020 13.2 GW by 2020 (Bio-power) 14.6 GW by 2020 (Hydropower)
France	27% by 2020

Annex Figure 10 *Targets for Electricity Production from Renewable Energy Sources in Selected Countries(1/3)*

Country	Renewable Electricity Generation Target
Germany	40–45% by 2025 55–60% by 2035 65% by 2040 80% by 2050
Greece	40% by 2020
Hungary	11% by 2020
India	30 GW added 2012–2017 2.7 GW added 2012–2017 (Bio-power) 2.1 GW added 2012–2017 (Hydropower (small-scale))
Indonesia	26% by 2025
Iraq	2% by 2030
Ireland	42.5% by 2020
Israel	10% by 2020
Italy	26% by 2020
Japan	3.3 GW by 2020; 6 GW by 2030 (Bio-power) 49 GW by 2020 (Hydropower) 0.53 GW by 2020; 3.88 GW by 2030 (Geothermal power)
Kuwait	15% by 2030
Latvia	60% by 2020
Lithuania	21% by 2020
Luxembourg	11.8% by 2020
Malaysia	5% by 2015 9% by 2020 11% by 2030 15% by 2050
Mexico	35% by 2026
Netherlands	37% by 2020
New Zealand	90% by 2025
Nigeria	10% by 2020 100% by 2020
Philippines	40% by 2020
Poland	19.3% by 2020
Portugal	45% by 2020
Qatar	2% by 2020 20% by 2030
Romania	43% by 2020

Annex Figure 11 *Targets for Electricity Production from Renewable Energy Sources in Selected Countries(2/3)*

Country	Renewable Electricity Generation Target
Russia	2.5% by 2015 4.5% by 2020
Slovakia	24% by 2020
Slovenia	39.3% by 2020
South Africa	9% by 2030
Spain	38.1% by 2020
Sri Lanka	10% by 2016 20% by 2020
Sweden	62.9% by 2020
Thailand	10% by 2021
Turkey	30% by 2023
United Kingdom	50% by 2015
Ukraine	20% by 2030
Uruguay	90% by 2015
Vietnam	5% by 2020

Annex Figure 12 *Targets for Electricity Production from Renewable Energy Sources in Selected Countries(3/3)*

Annex 2.3 Percent of renewable sources in electricity production for select countries

% of Renewable Sources in Electricity Production for Select Countries

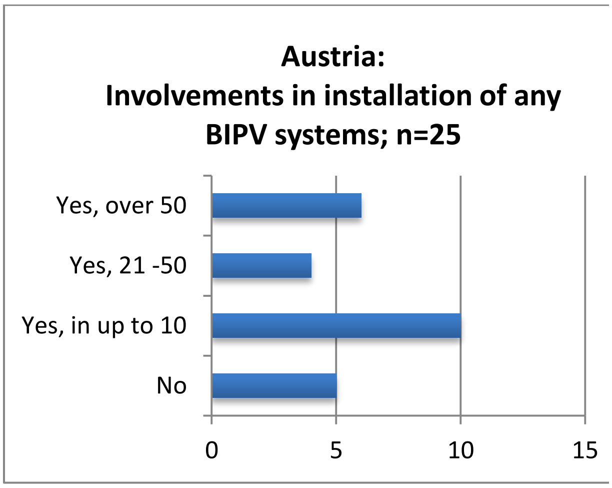
Country	Share of Electricity Generation from Renewables
Algeria	1.0
Australia	10.0
Austria	74.5
Bangladesh	4.0
Belgium	14.5
Brazil	84.3
Bulgaria	12.5
Canada	52.8
Chile	37.5
China	21.6
Colombia	80.6
Croatia	48.4
Czech Republic	10.5
Denmark	48.5
Finland	40.6
France	16.7
Germany	27.0
Greece	16.6
Hungary	7.8
Iceland	100.0

Annex Figure 13 *Percent of renewable sources in electricity production for select countries (1/2)*

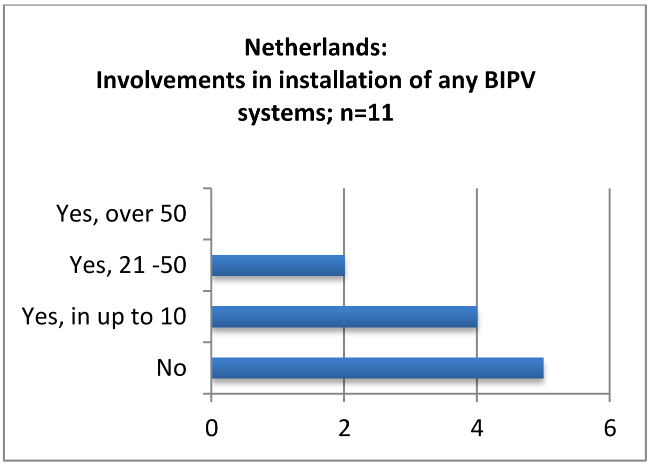
Country	Share of Electricity Generation from Renewables
India	14.5
Indonesia	12.5
Ireland	20.4
Italy	31.5
Japan	13.5
Luxembourg	36.5
Malaysia	5.3
Mexico	15.4
Netherlands	12.6
New Zealand	72.6
Nigeria	16.4
Peru	54.8
Philippines	29.8
Poland	11.6
Portugal	48.5
Romania	25.8
Russia	16.3
Slovakia	20.8
Slovenia	29.4
South Africa	3.0
South Korea	4.0
Sri Lanka	28.7
Sweden	58.4
Switzerland	60.6
Taiwan	5.8
Thailand	8.2
Ukraine	7.8
United Kingdom	12.0
United States	13.5
Uruguay	60.6
Venezuela	65.0

Annex Figure 14 *Percent of renewable sources in electricity production for select countries (2/2)*

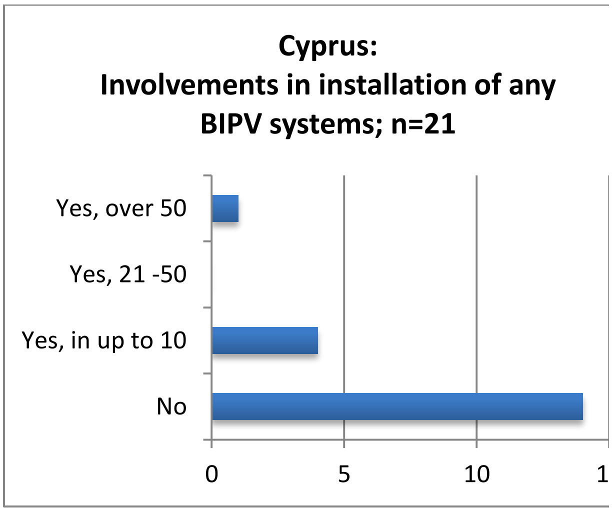
Annex 3: Number of involvements in installation of any BIPV systems



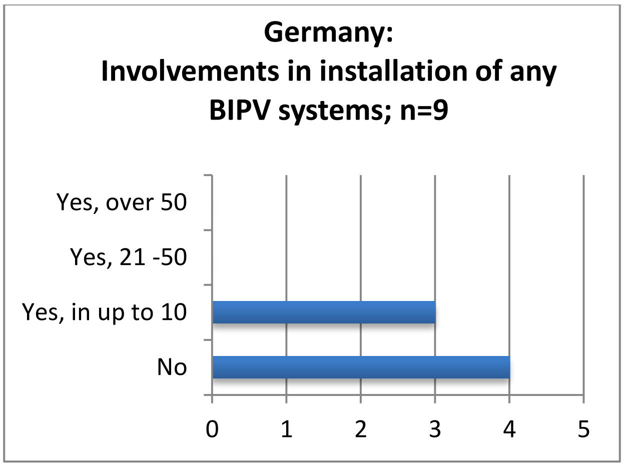
Annex Figure 15 *Austria: Involvements in installation of any BIPV systems; n=25*



Annex Figure 17 *Netherlands: Involvements in installation of any BIPV systems; n=11*

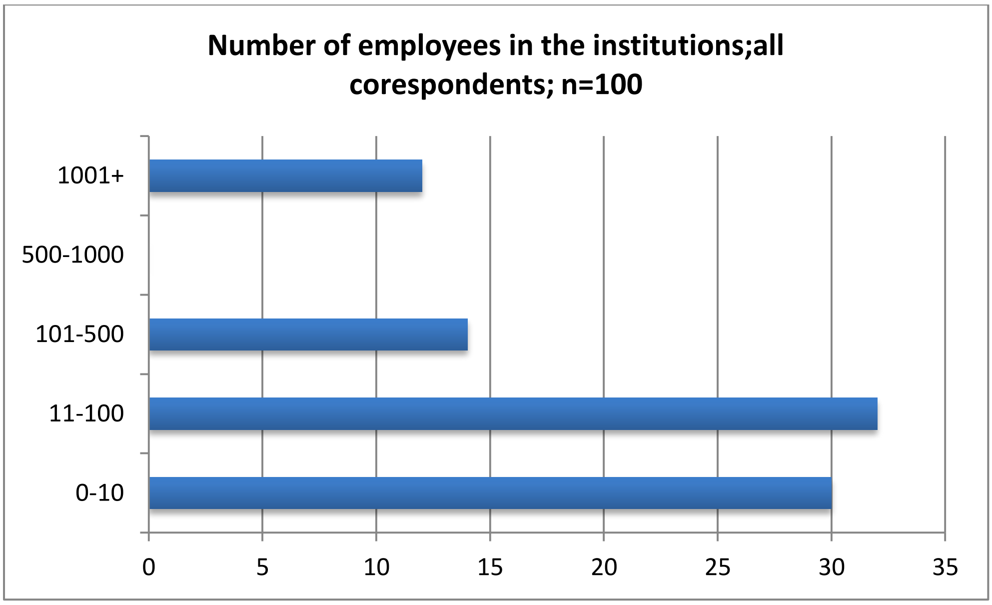


Annex Figure 16 *Cyprus: Involvements in installation of any BIPV systems; n=21*



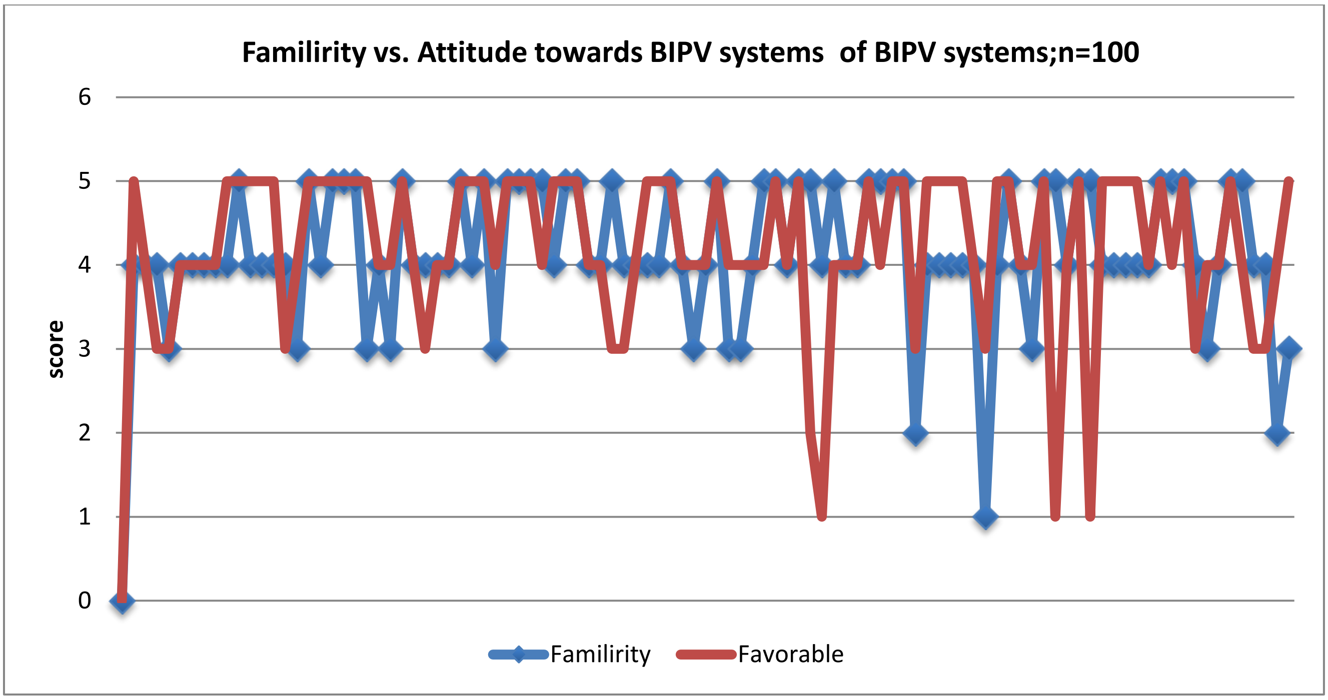
Annex Figure 18 *Germany: Involvements in installation of any BIPV systems; n=9*

Annex 4: Number of employees in the institutions of each stakeholder

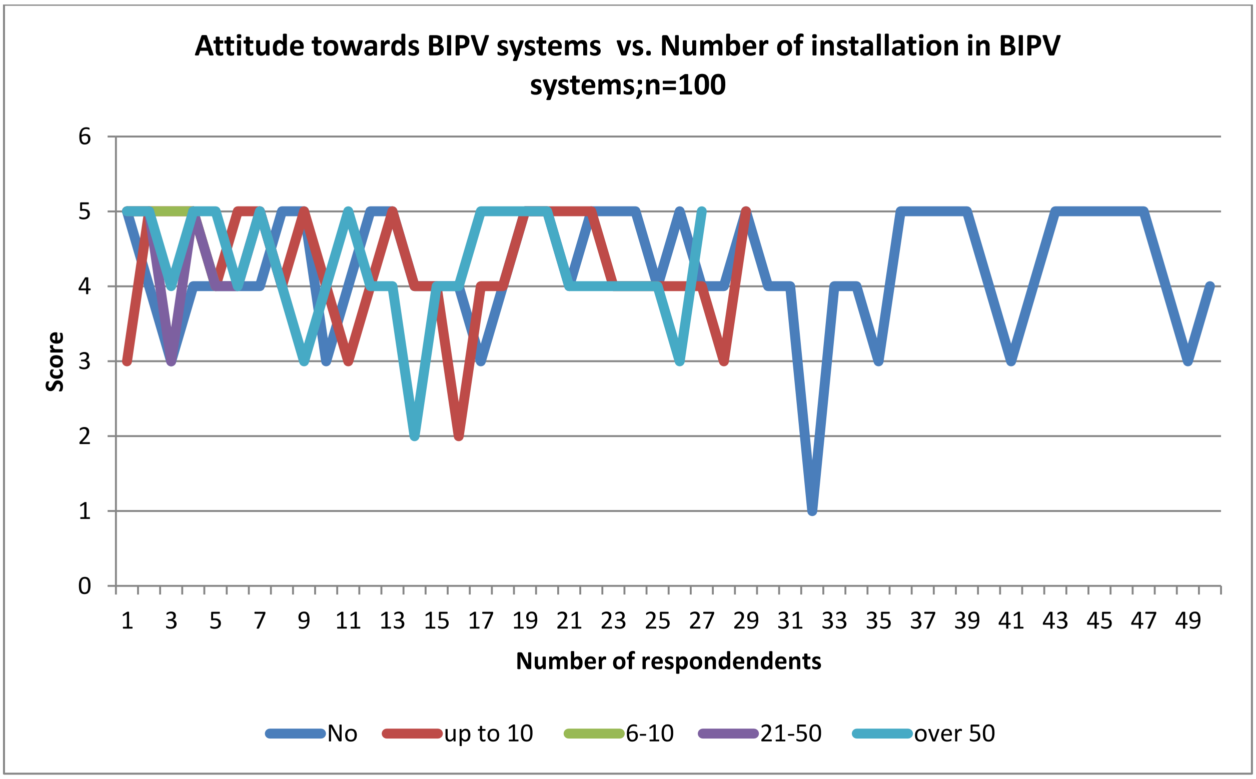


Annex Figure 19 *Number of employees in the institutions;all corespondents; n=100*

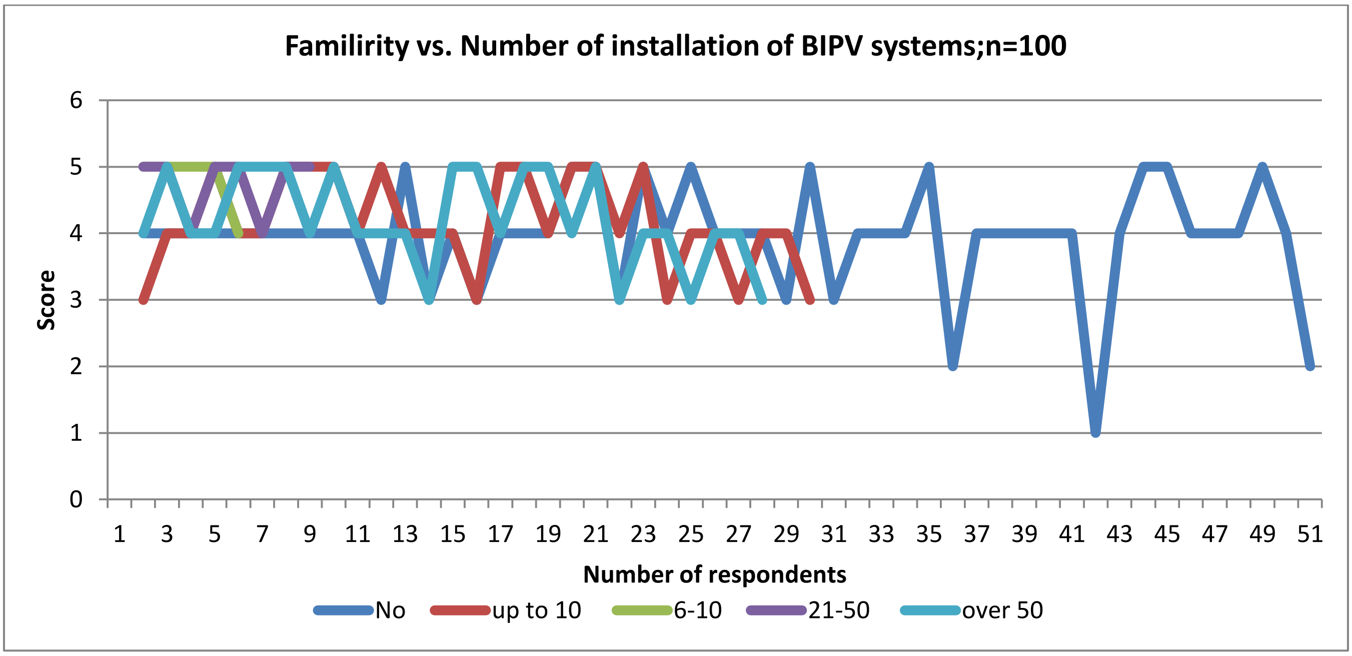
Annex 5: Analysis of tendencies according to stakeholder groups, number of experience, number of employees



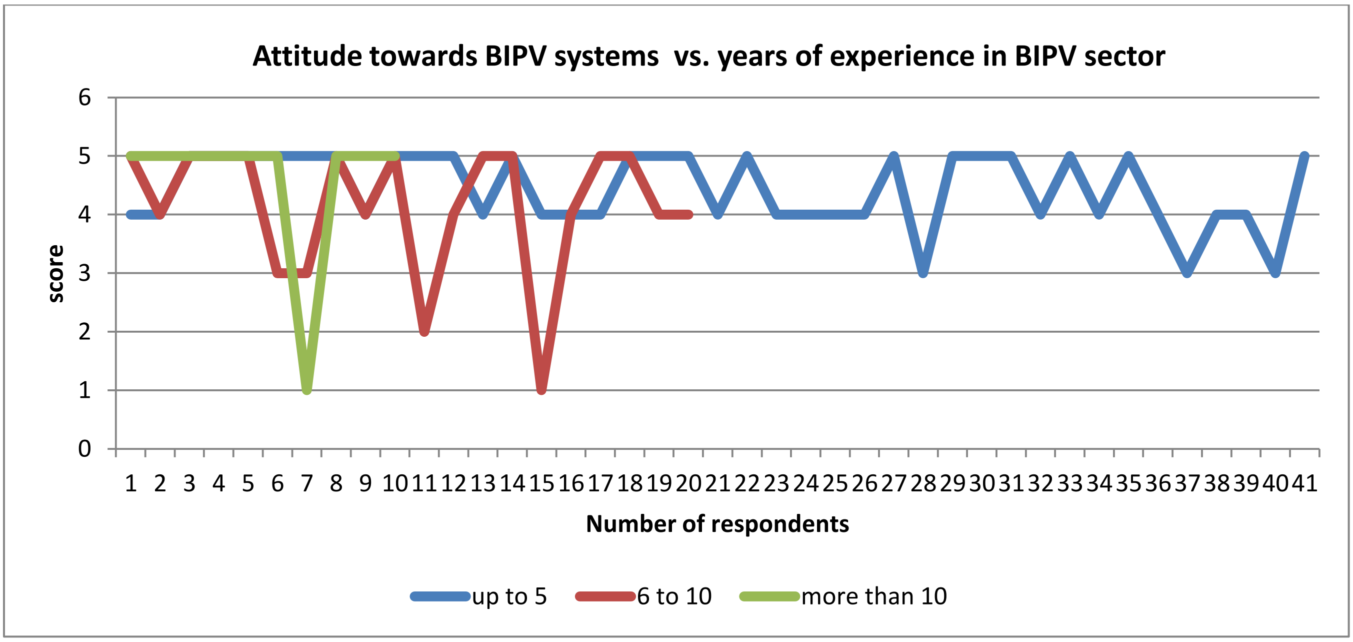
Annex Figure 20 *Familirity vs. Attitude towards BIPV systems of BIPV systems;n=100*



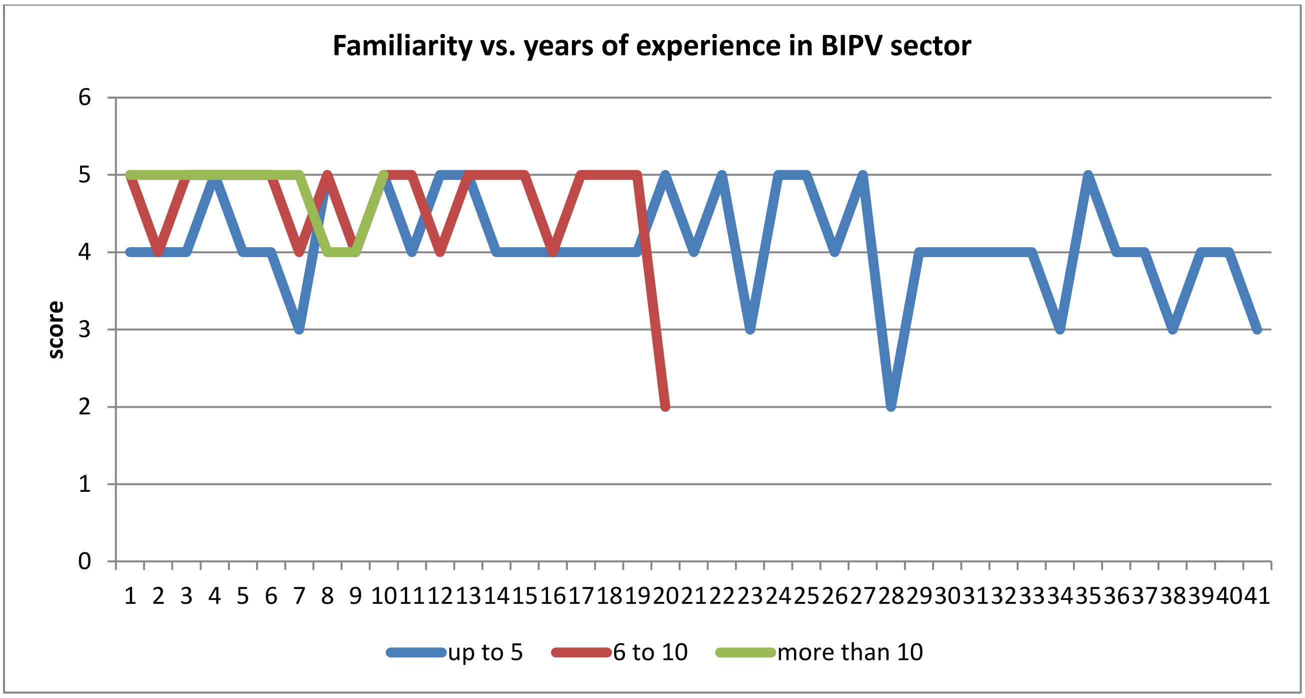
Annex Figure 21 *Attitude towards BIPV systems vs. Number of installation in BIPV systems;n=100*



Annex Figure 22 *Familirity vs. Number of installation of BIPV systems;n=100*

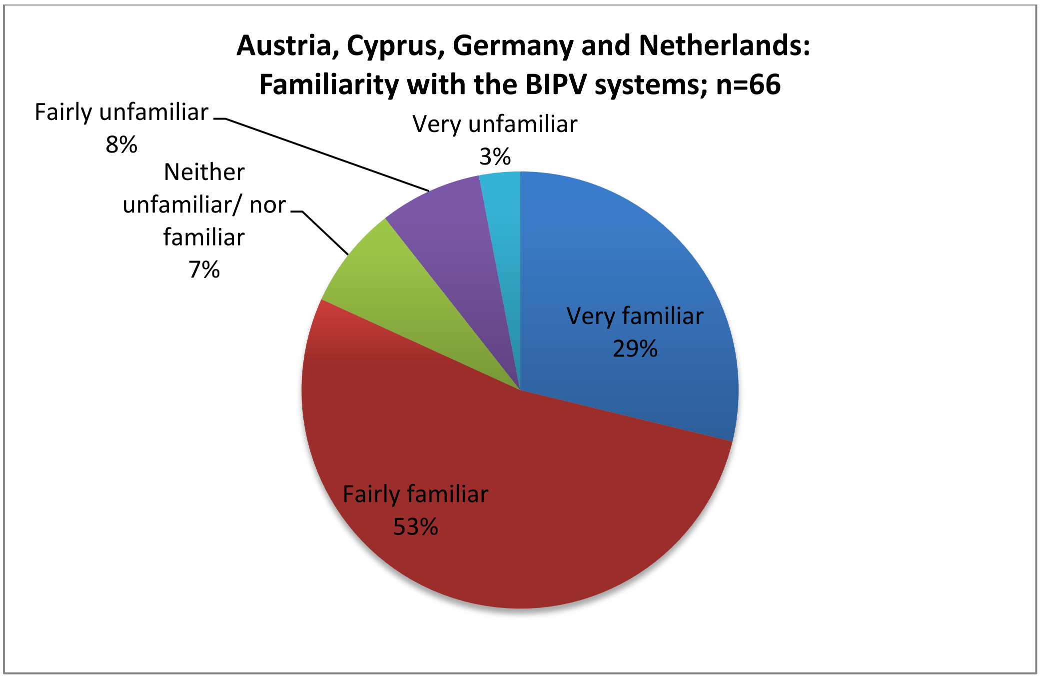


Annex Figure 23 *Attitude towards BIPV systems vs. years of experience in BIPV sector*

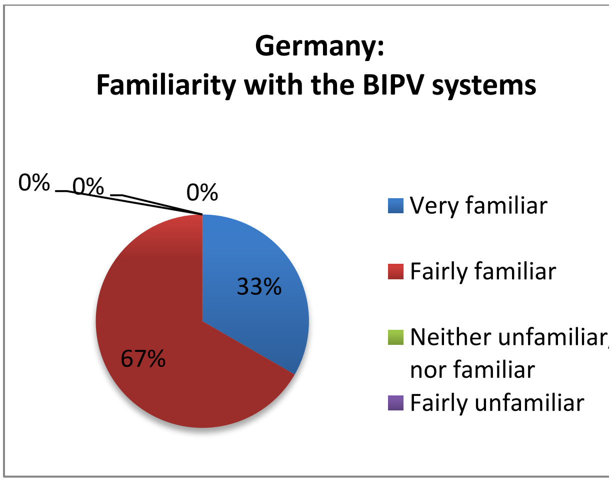


Annex Figure 24 *Familiarity vs. years of experience in BIPV sector*

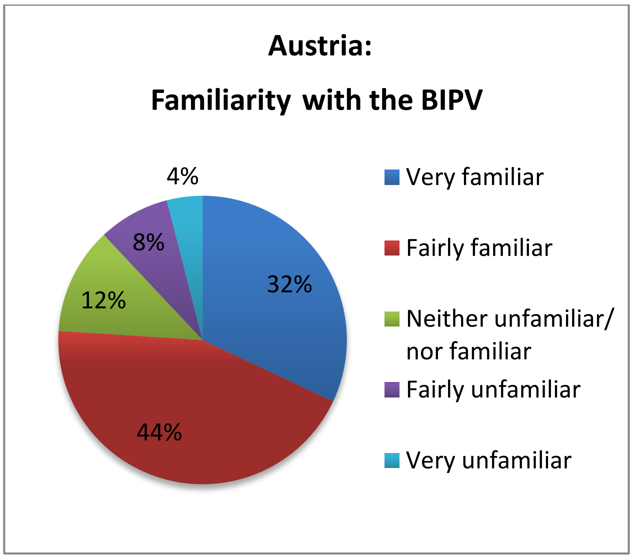
Annex 6: Familiarity with the BIPV systems



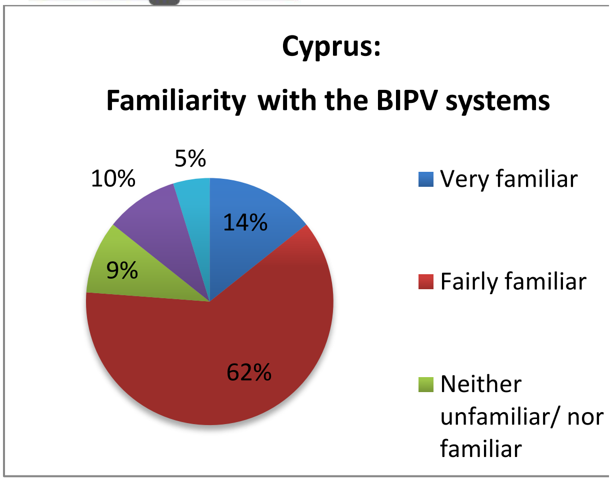
Annex Figure 25 *Austria, Cyprus, Germany and Netherlands: Familiarity with the BIPV systems; n=66*



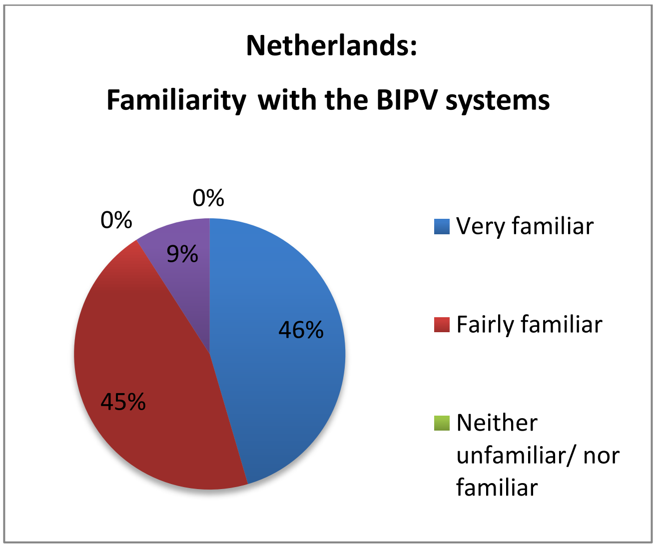
Annex Figure 26 *Germany: Familiarity with the BIPV systems*



Annex Figure 27 *Austria: Familiarity with the BIPV*

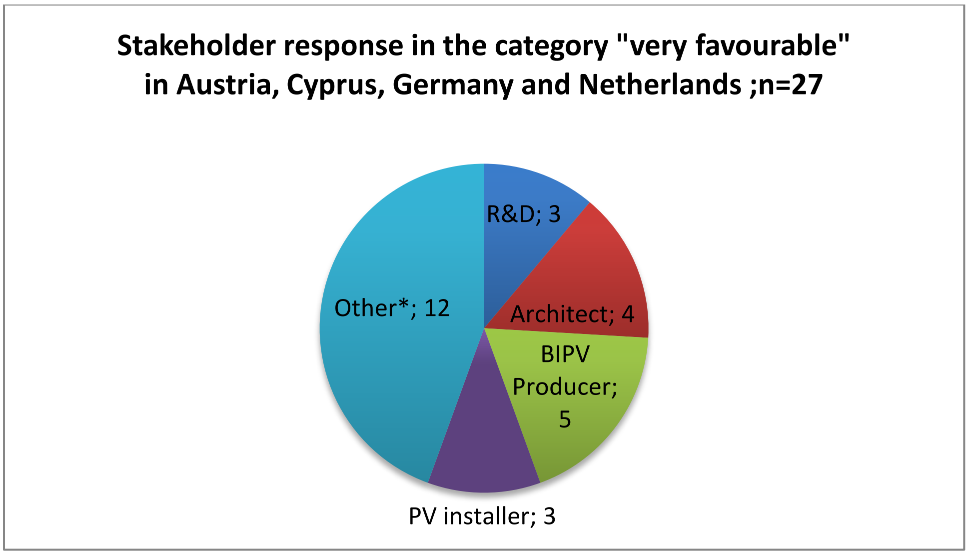


Annex Figure 28 *Cyprus: Familiarity with the BIPV systems*



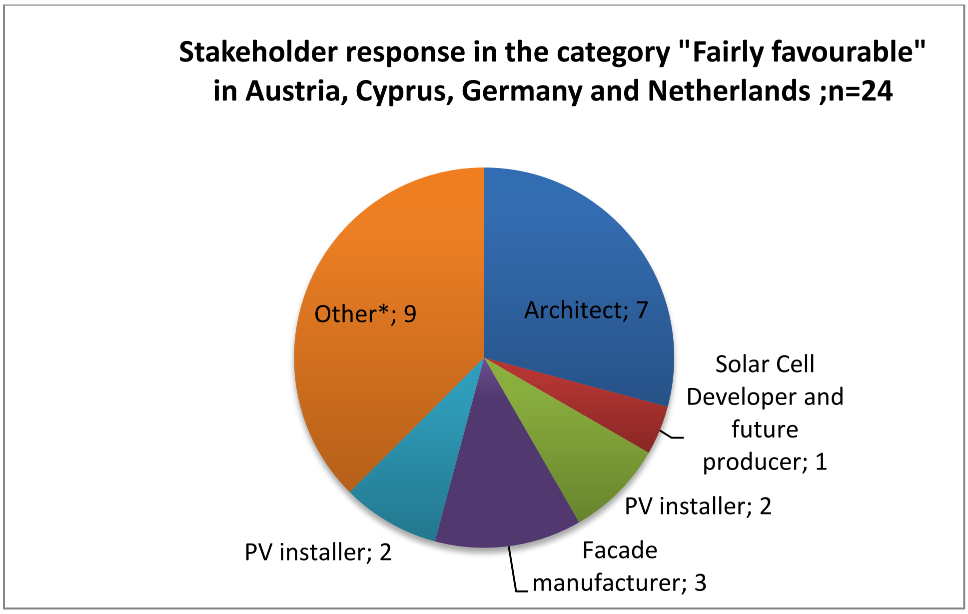
Annex Figure 29 *Netherlands: Familiarity with the BIPV systems*

Annex 7: Attitude towards BIPV systems



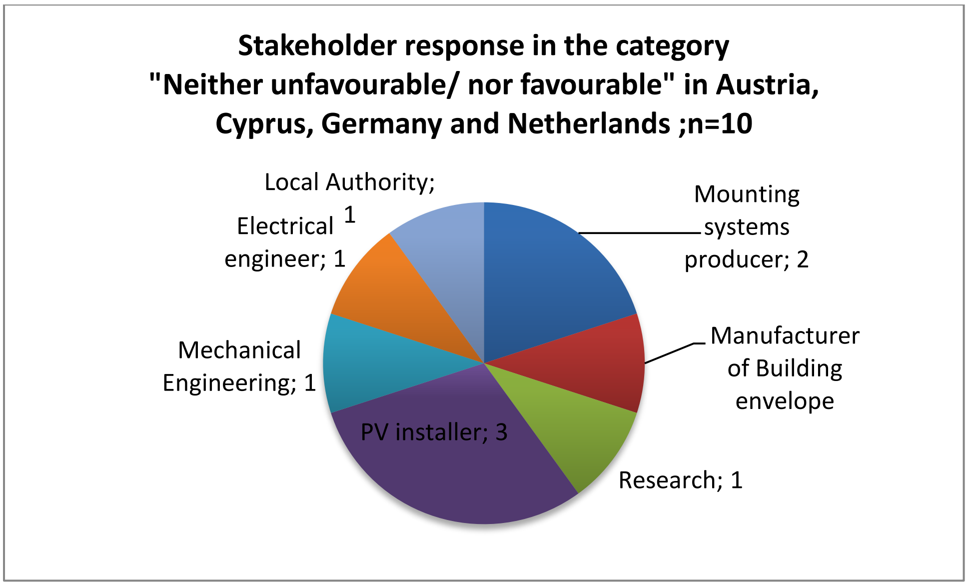
Annex Figure 30 ***Stakeholder response in the category "very favourable" in Austria, Cyprus, Germany and Netherlands ;n=27***

**F&E institution, Electrical engineer, Mounting systems producer, Building contractor, Building Services & Sustainability, Consultant, Consultancy in BIPV policy, Pilot project development, Legal reseach, Project manager, University, Education, Research*



Annex Figure 31 *Stakeholder response in the category "Fairly favourable" in Austria, Cyprus, Germany and Netherlands ;n=24*

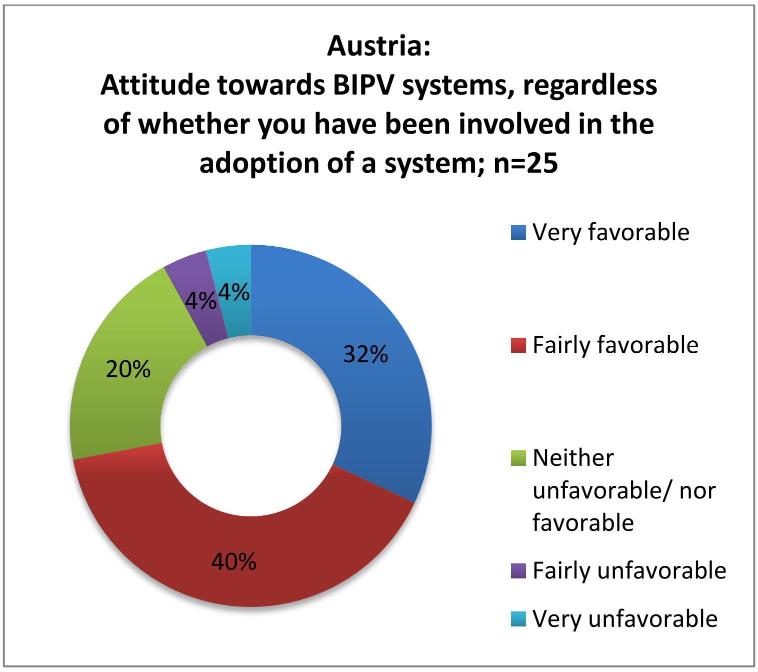
**Civil & Environmental Engineer, Electrical engineer, Investor, BIPV Producer, PV module producer, Mounting systems, producer, government, Robot cleaning BIPV, Civil Engineer*



Annex Figure 32 *Stakeholder response in the category "Fairly favourable" in Austria, Cyprus, Germany and Netherlands ;n=24*

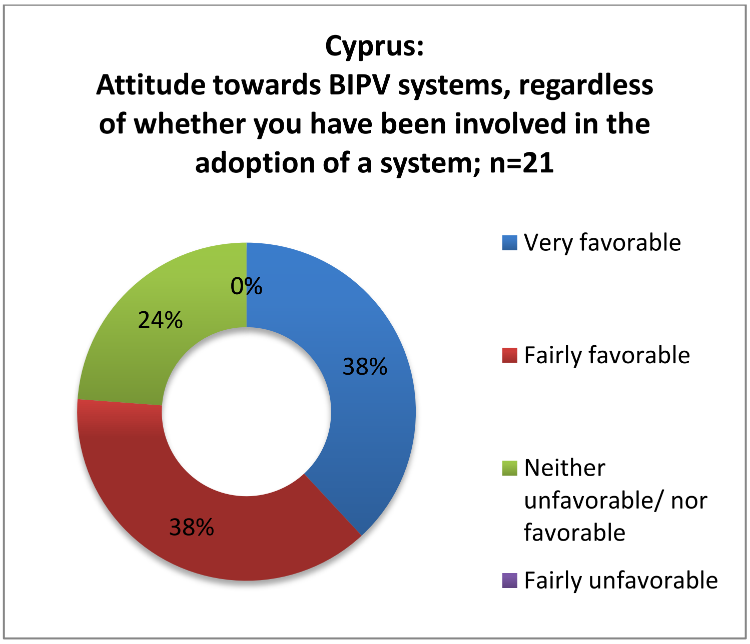
Annex 8: Attitude towards BIPV systems, regardless of whether you have been involved in the adoption of a system

Austria



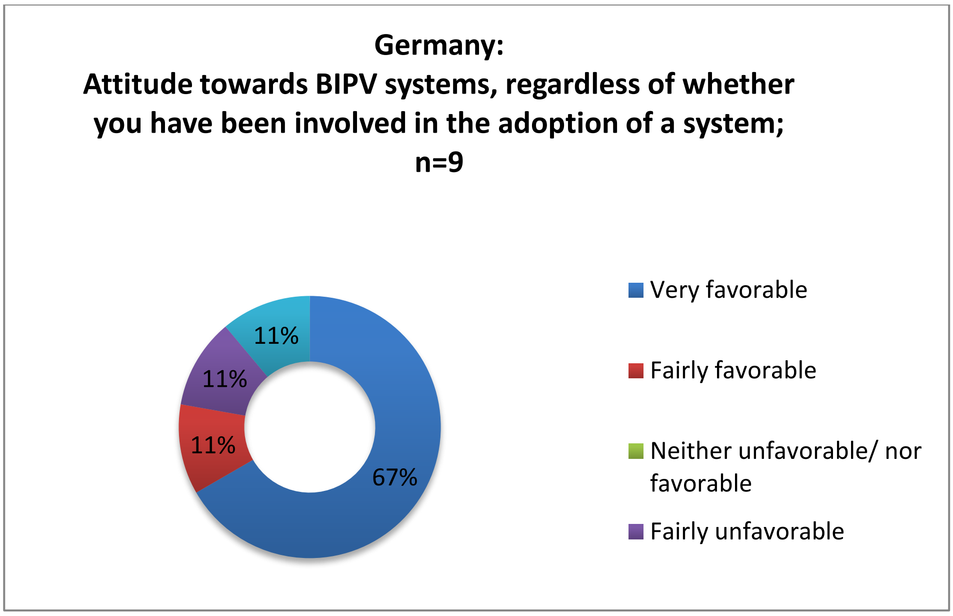
Annex Figure 33 *Austria: Attitude towards BIPV systems, regardless of whether you have been involved in the adoption of a system; n=25*

Cyprus



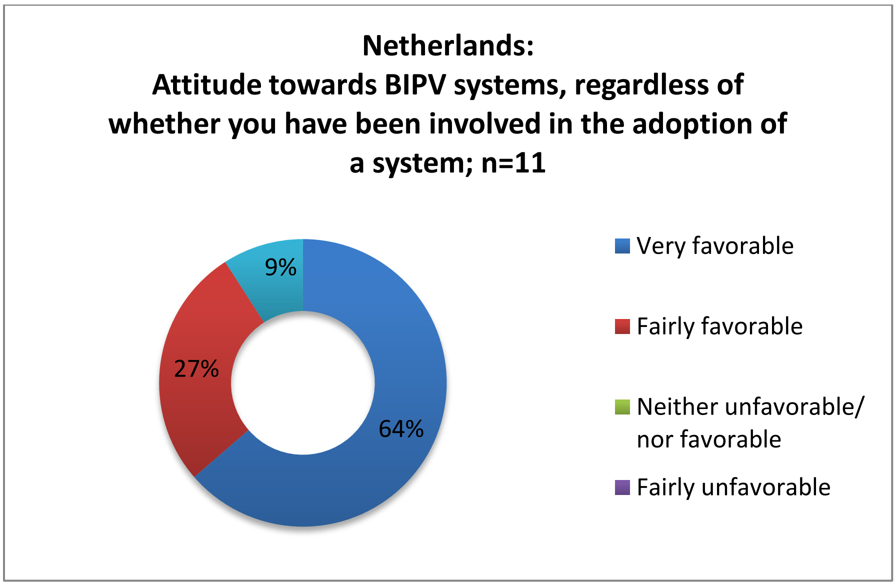
Annex Figure 34 *Cyprus: Attitude towards BIPV systems, regardless of whether you have been involved in the adoption of a system; n=21*

Germany



Annex Figure 35 *Germany: Attitude towards BIPV systems, regardless of whether you have been involved in the adoption of a system; n=9*

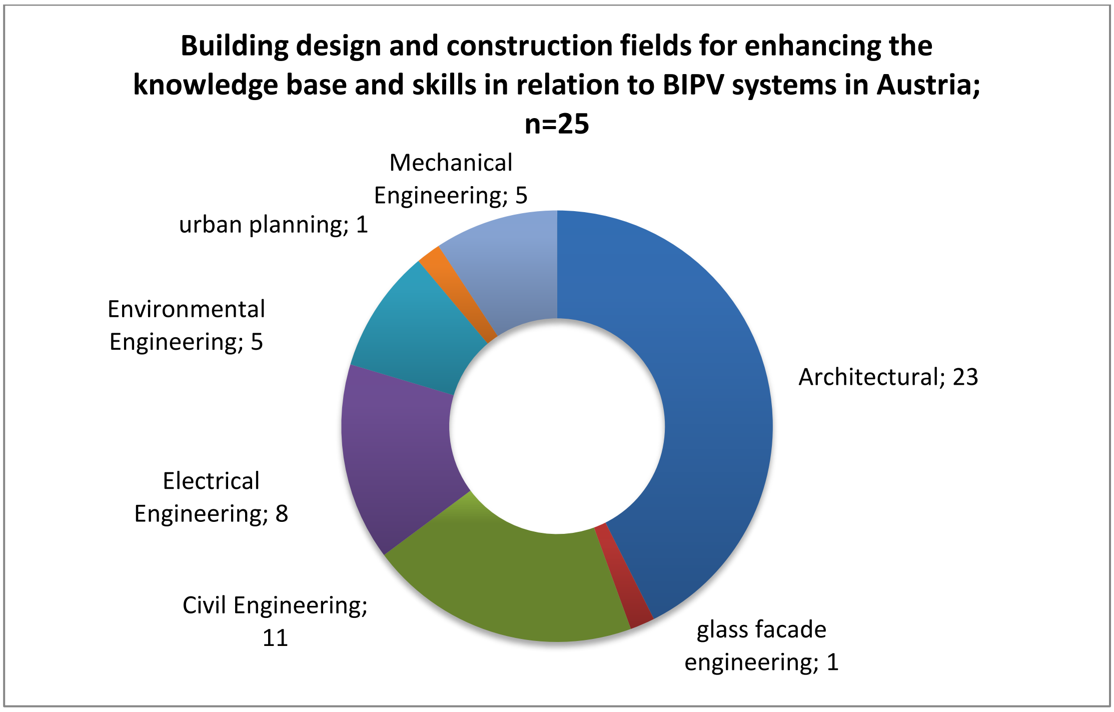
Netherlands



Annex Figure 36 *Netherlands: Attitude towards BIPV systems, regardless of whether you have been involved in the adoption of a system; n=11*

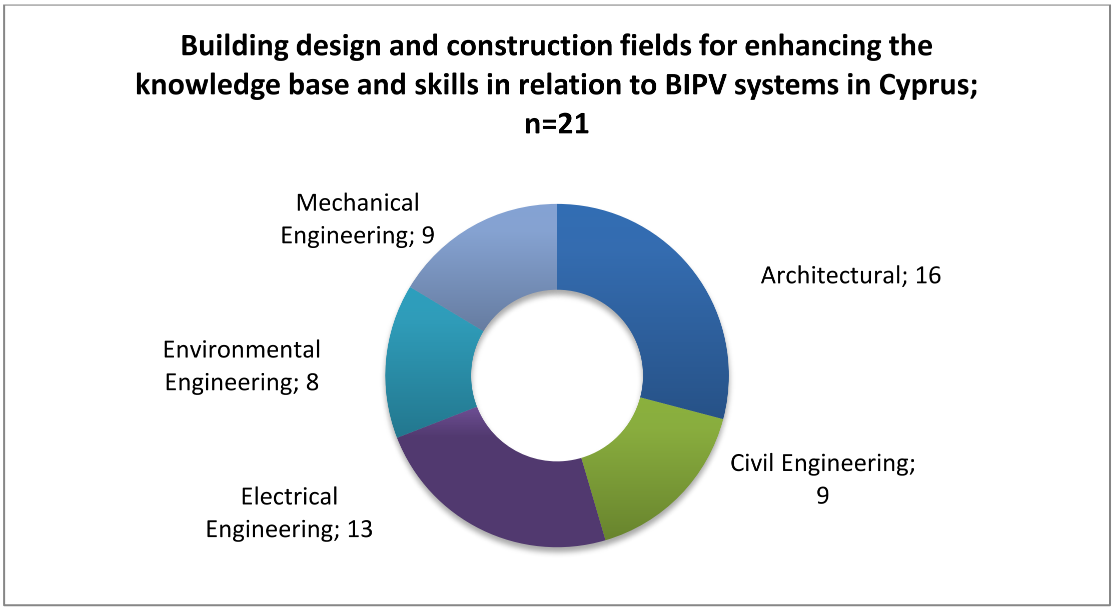
Annex 9: Fields need for enhancing the knowledge base and skills in relation to BIPV systems

Austria



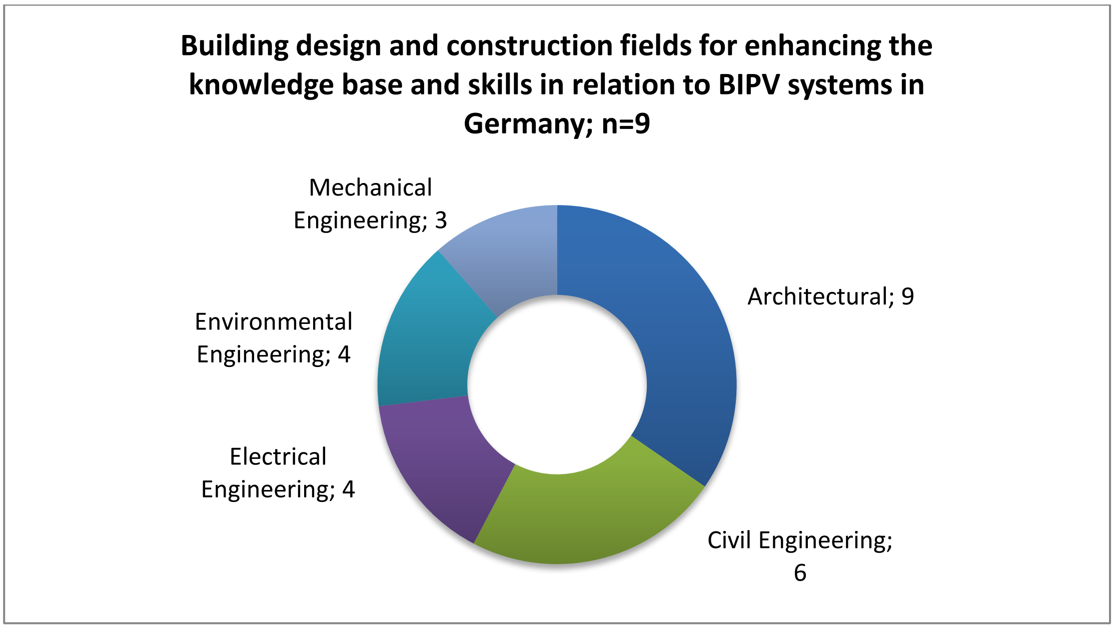
Annex Figure 37 *Building design and construction fields for enhancing the knowledge base and skills in relation to BIPV systems in Austria; n=25*

Cyprus



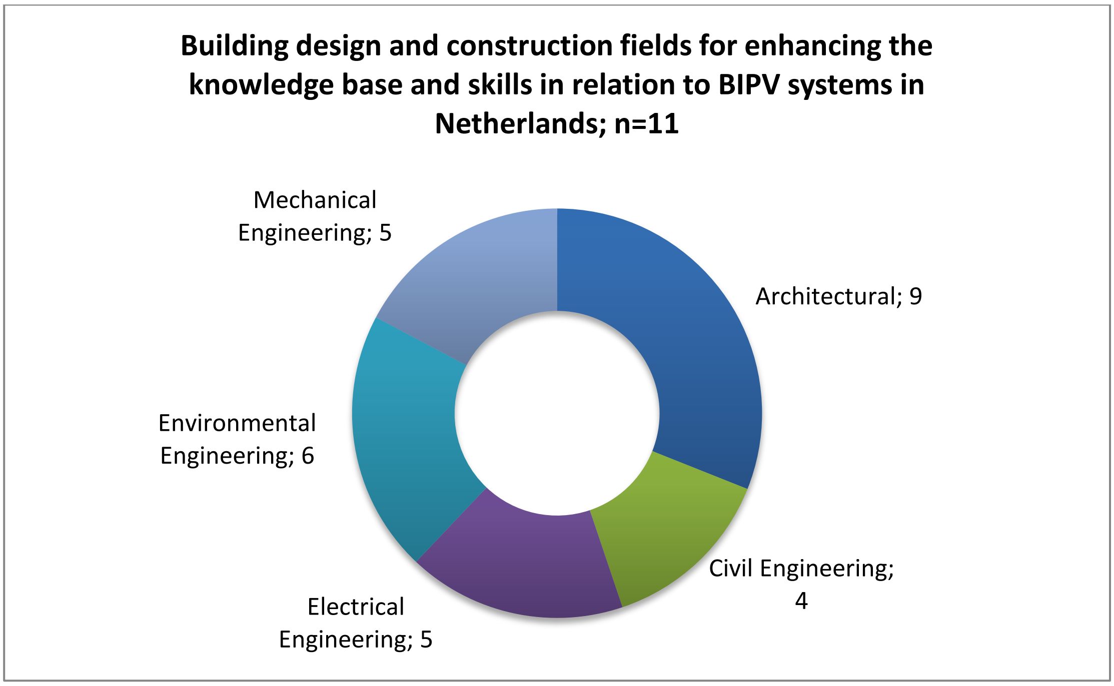
Annex Figure 38 *Building design and construction fields for enhancing the knowledge base and skills in relation to BIPV systems in Cyprus; n=21*

Germany



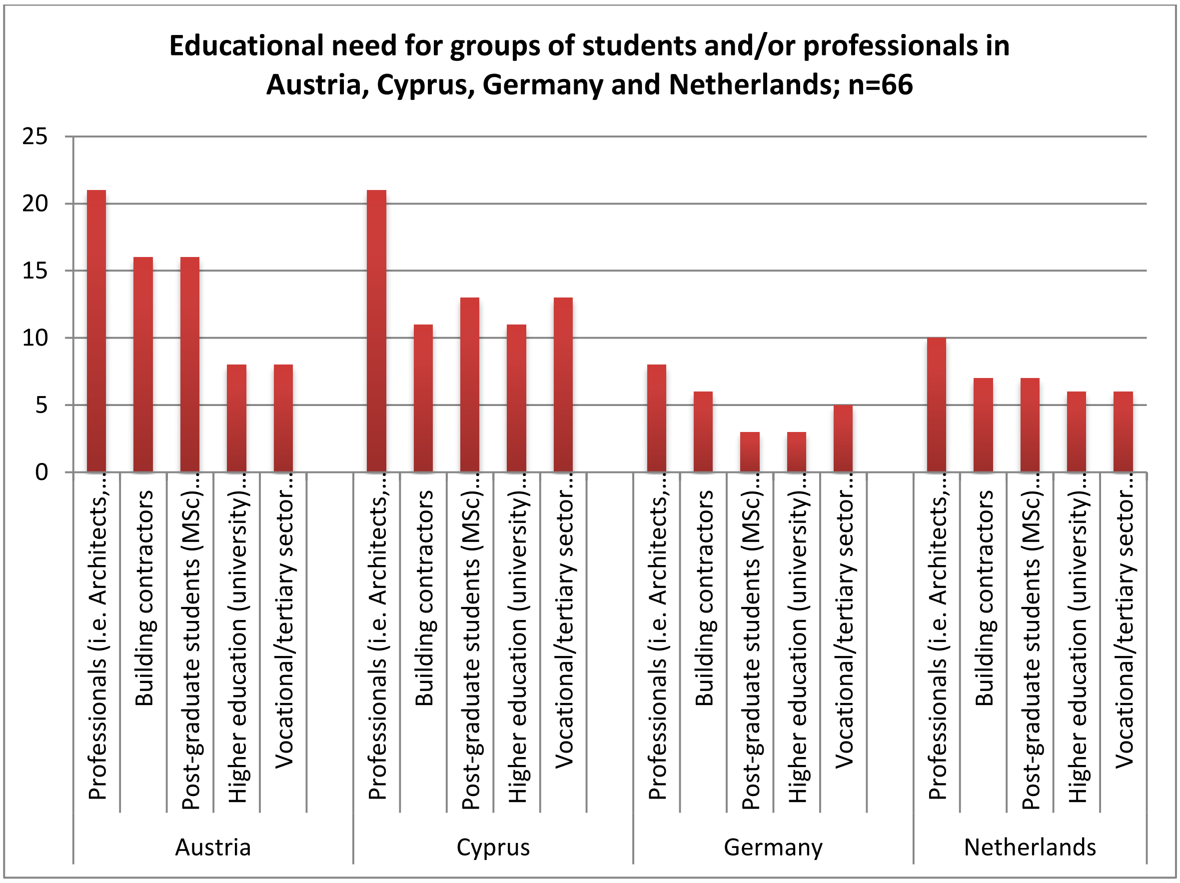
Annex Figure 39 *Building design and construction fields for enhancing the knowledge base and skills in relation to BIPV systems in Germany; n=9*

Netherlands



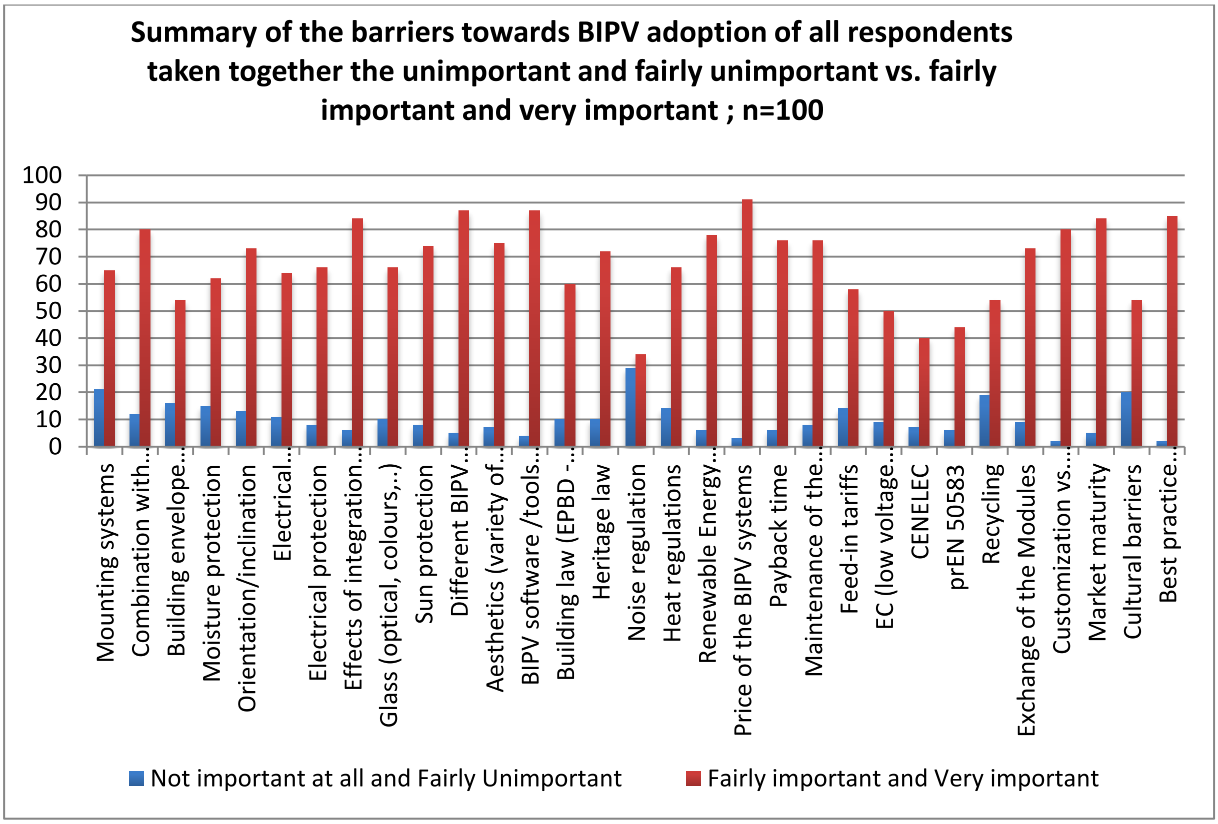
Annex Figure 40 *Building design and construction fields for enhancing the knowledge base and skills in relation to BIPV systems in Germany; n=9*

Annex 10: Education need on BIPV by groups of students and/or professionals

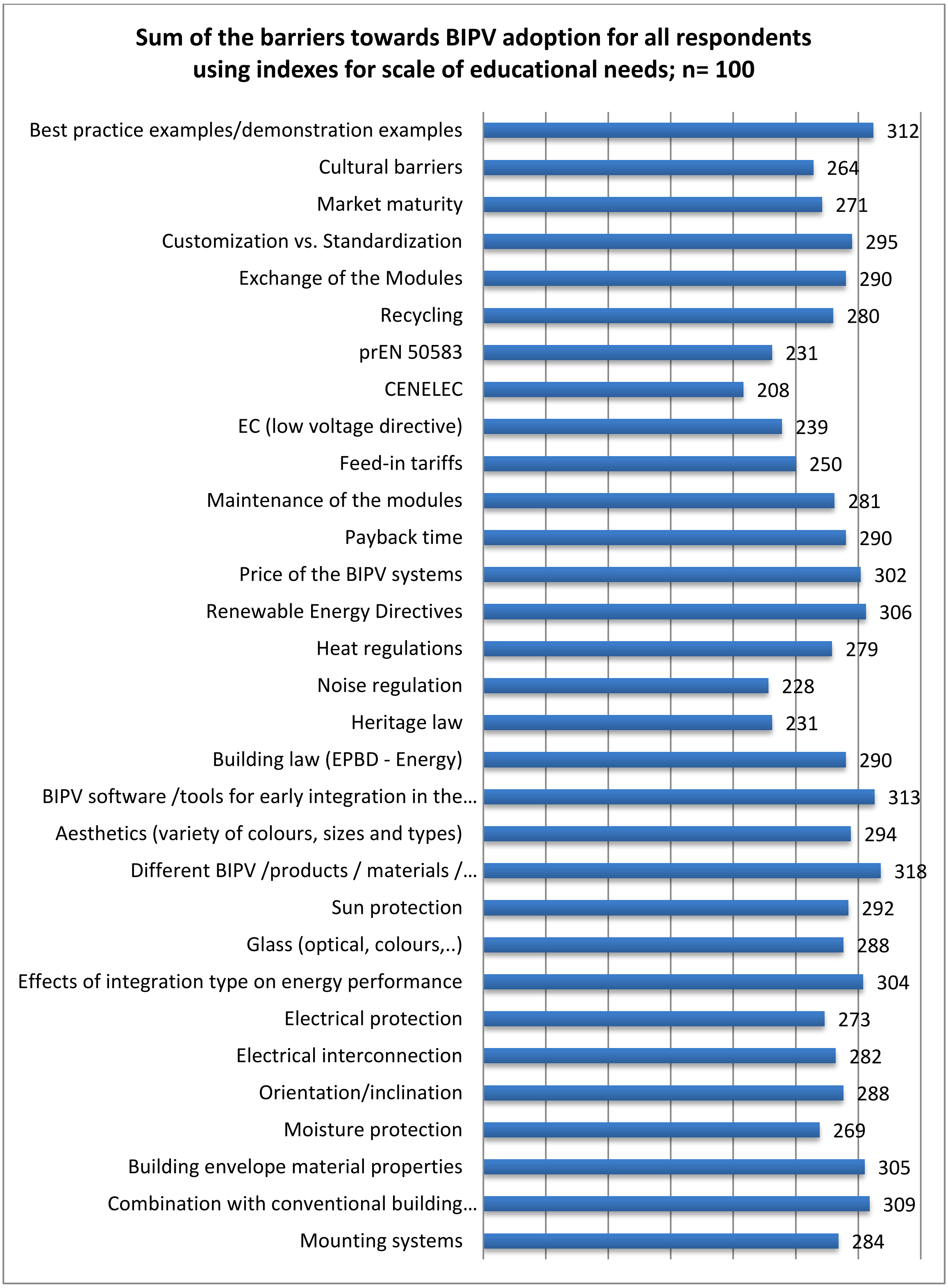


Annex Figure 41 *Educational need for groups of students and/or professionals in Austria, Cyprus, Germany and Netherlands; n=66*

Annex 11: Summary of the barriers towards BIPV adoption

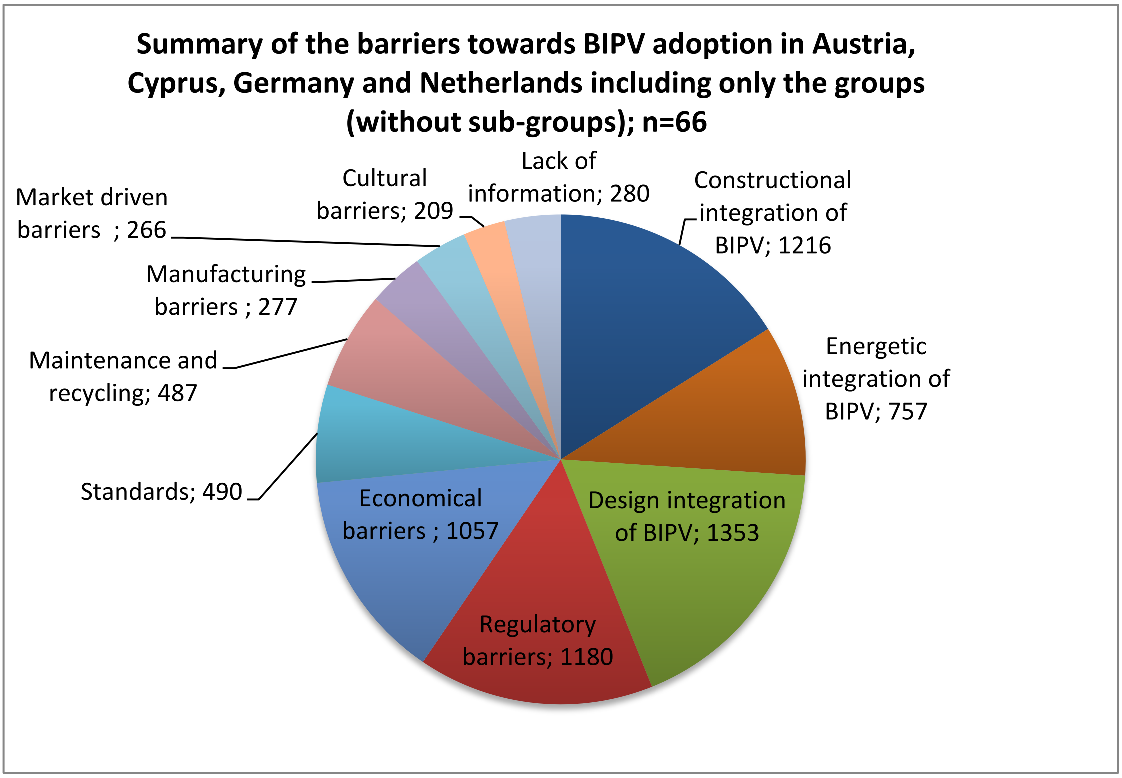


Annex Figure 42 *Summary of the barriers towards BIPV adoption of all respondents taken together the unimportant and fairly unimportant vs. fairly important and very important ; n=100*

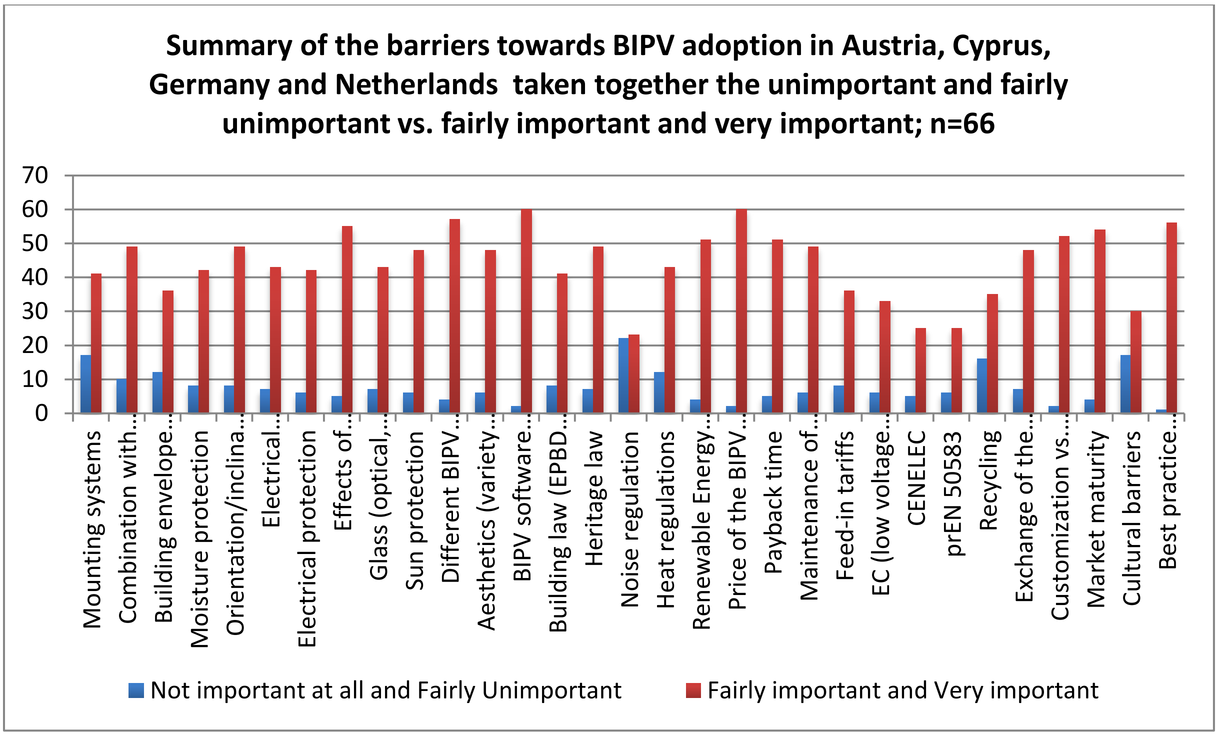


Annex Figure 43 *Sum of the barriers towards BIPV adoption for all respondents using indexes for scale of educational needs; n= 100*

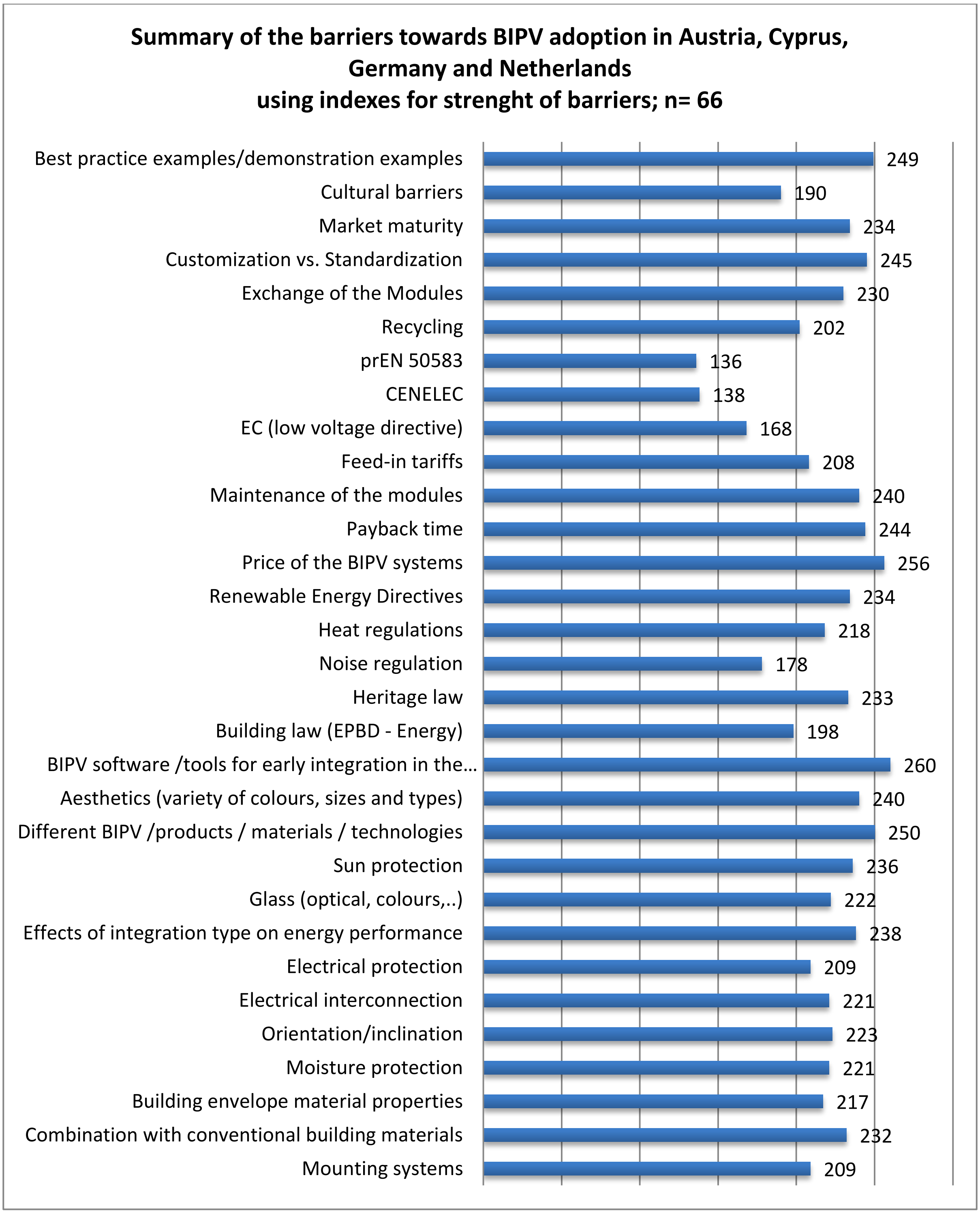
Annex 11.1: Austria, Cyprus, Germany and Netherlands



Annex Figure 44 *Summary of the barriers towards BIPV adoption in Austria, Cyprus, Germany and Netherlands including only the groups (without sub-groups); n=66*

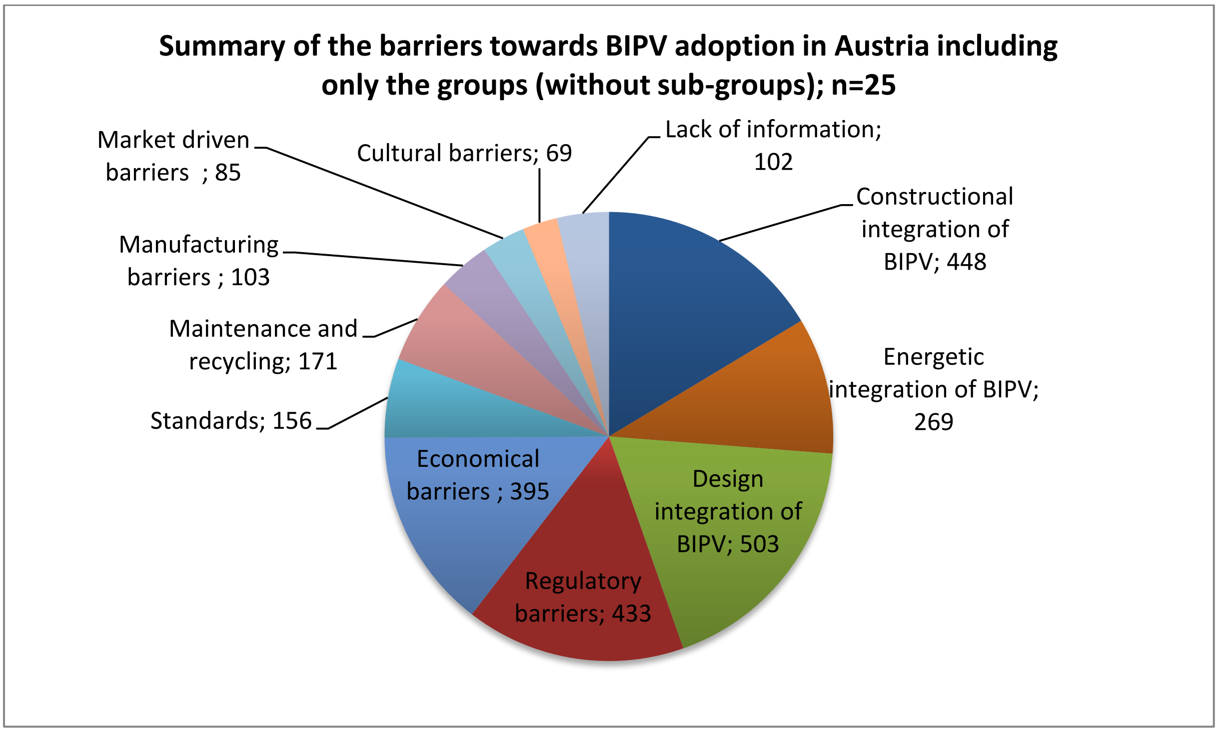


Annex Figure 45 *Summary of the barriers towards BIPV adoption in Austria, Cyprus, Germany and Netherlands taken together the unimportant and fairly unimportant vs. fairly important and very important; n=66*

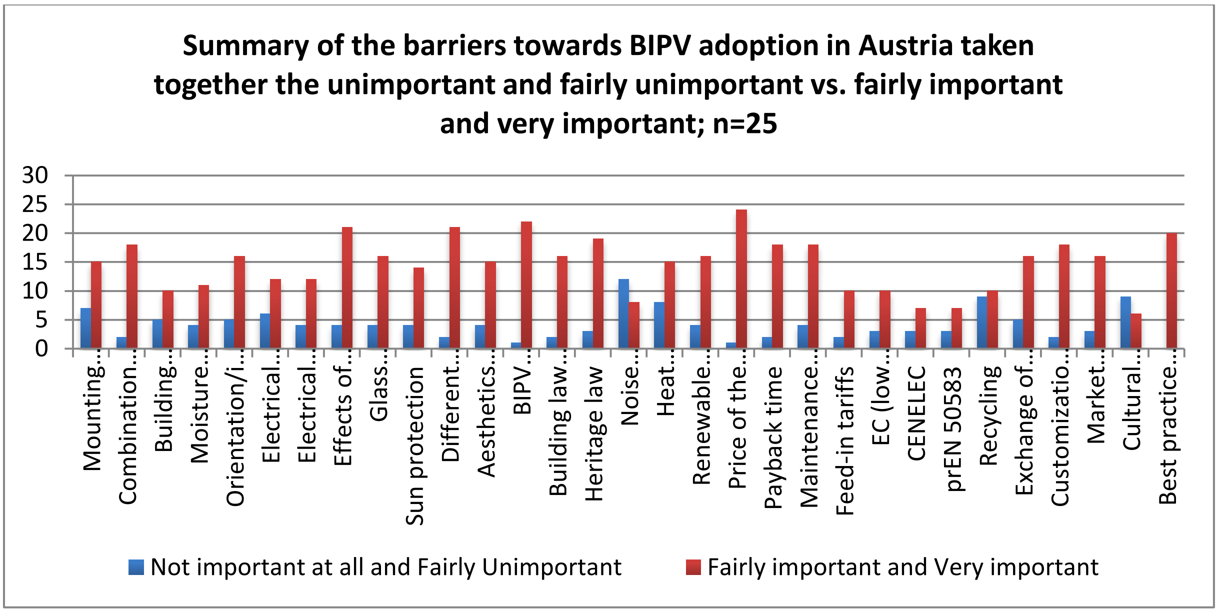


Annex Figure 46 *Summary of the barriers towards BIPV adoption in Austria, Cyprus, Germany and Netherlands using indexes for strenght of barriers; n= 66*

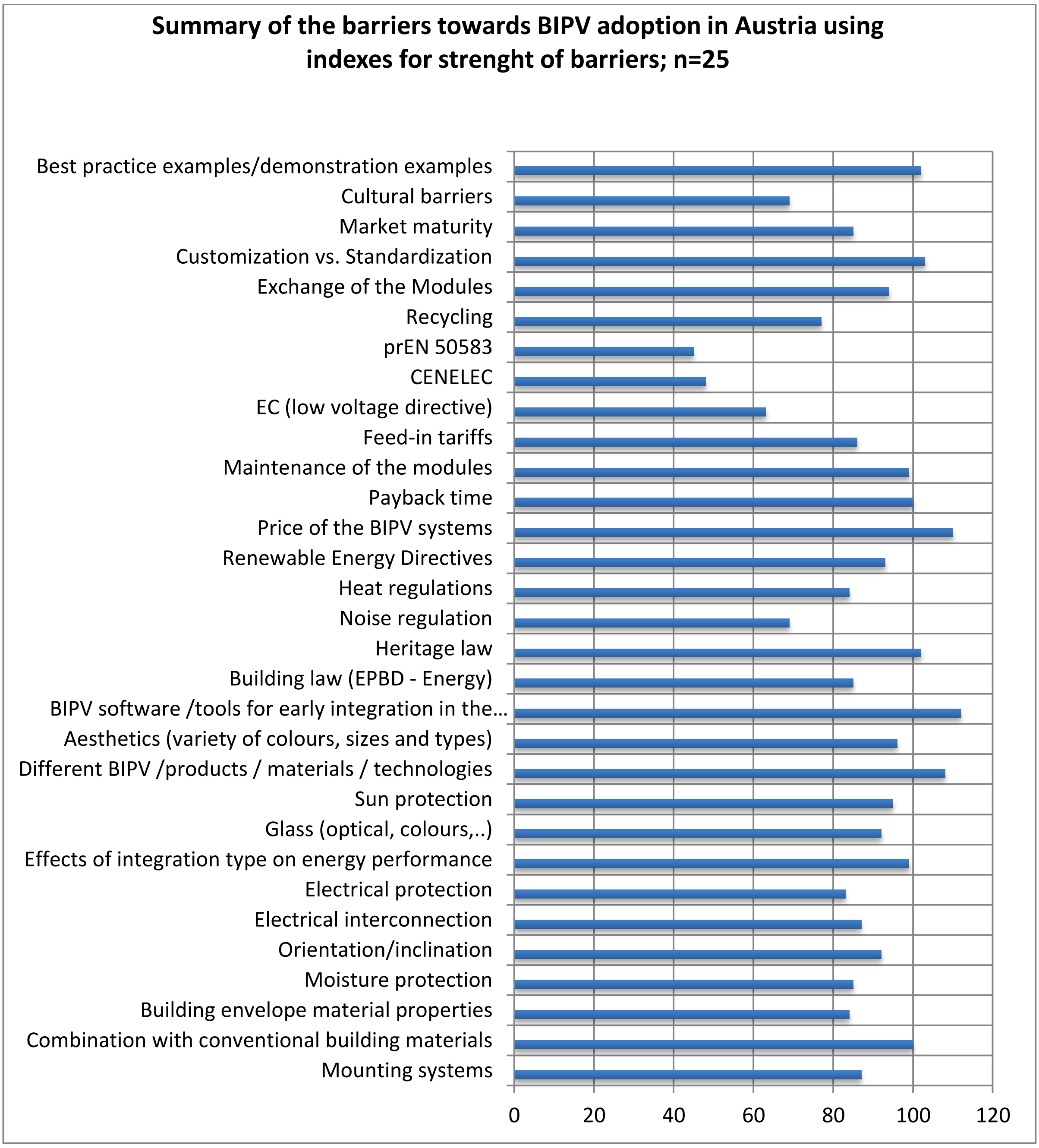
Annex 11.2: Austria



Annex Figure 47 *Summary of the barriers towards BIPV adoption in Austria including only the groups (without sub-groups); n=25*

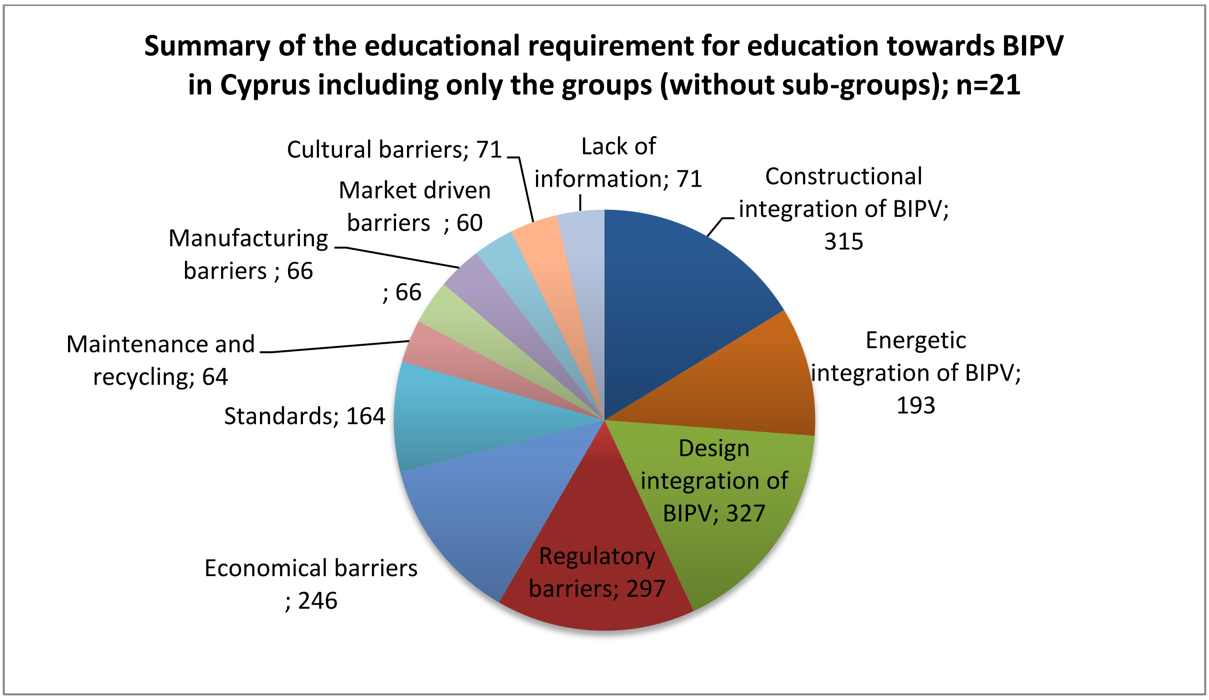


Annex Figure 48 *Summary of the barriers towards BIPV adoption in Austria including only the groups (without sub-groups); n=25*

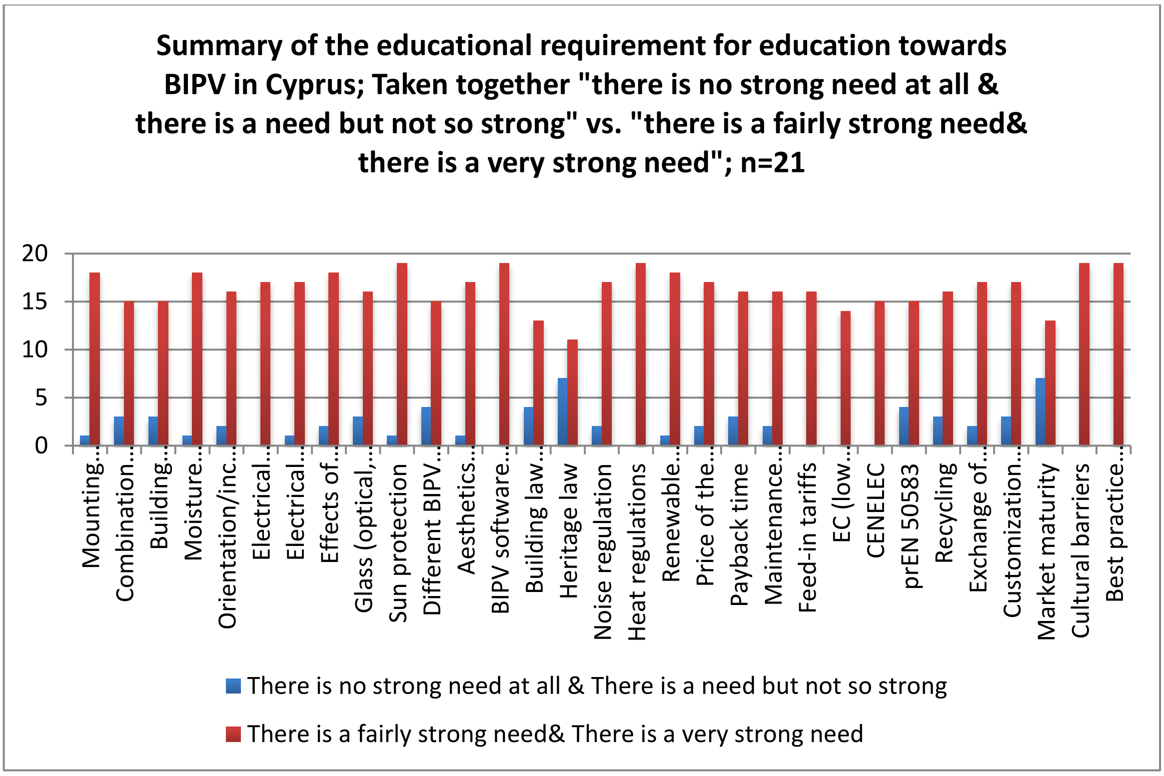


Annex Figure 49 *Summary of the barriers towards BIPV adoption in Austria using indexes for strenght of barriers; n=25*

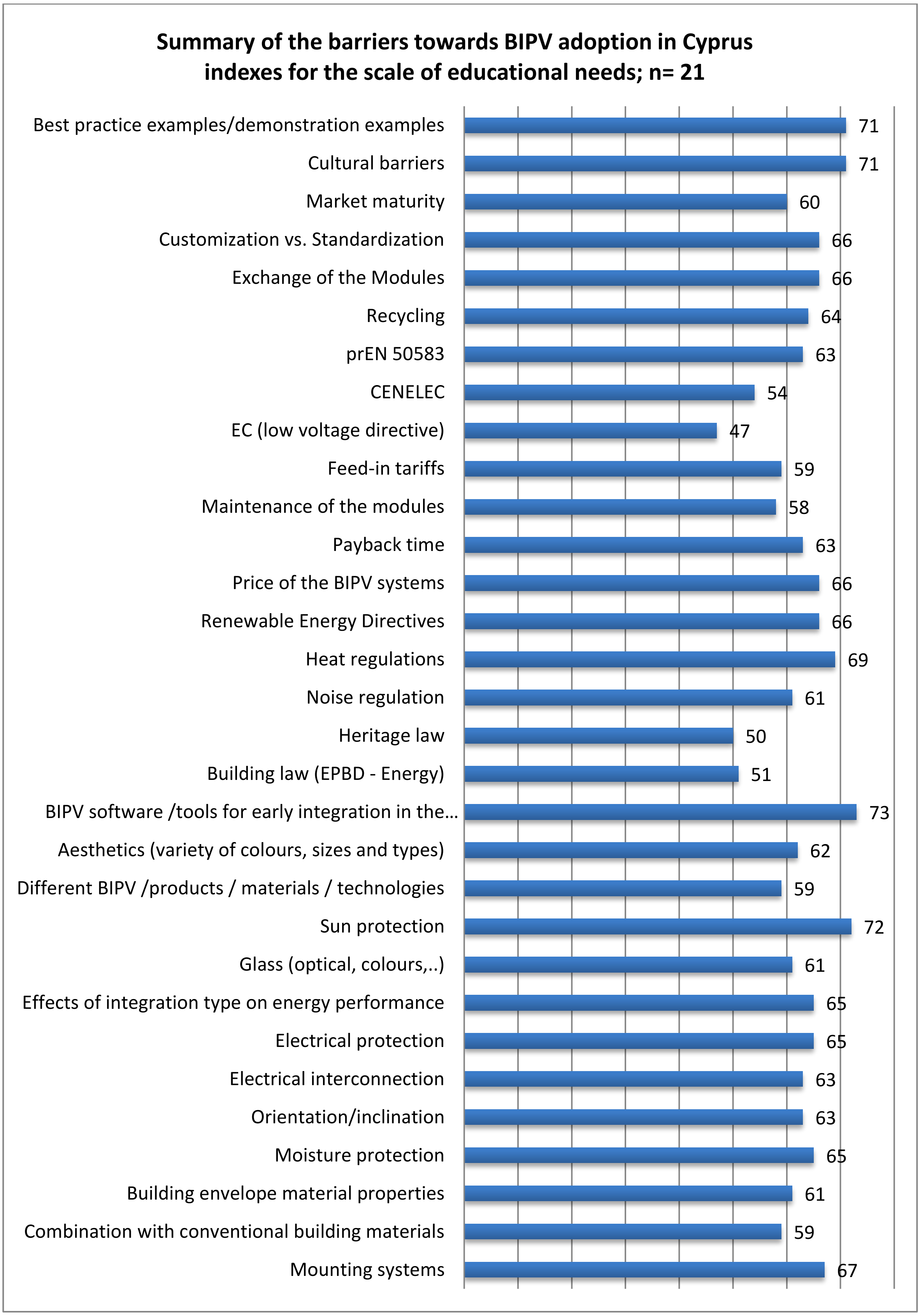
Annex 11.3: Cyprus



Annex Figure 50 *Summary of the educational requirement for education towards BIPV in Cyprus including only the groups (without sub-groups); n=21*

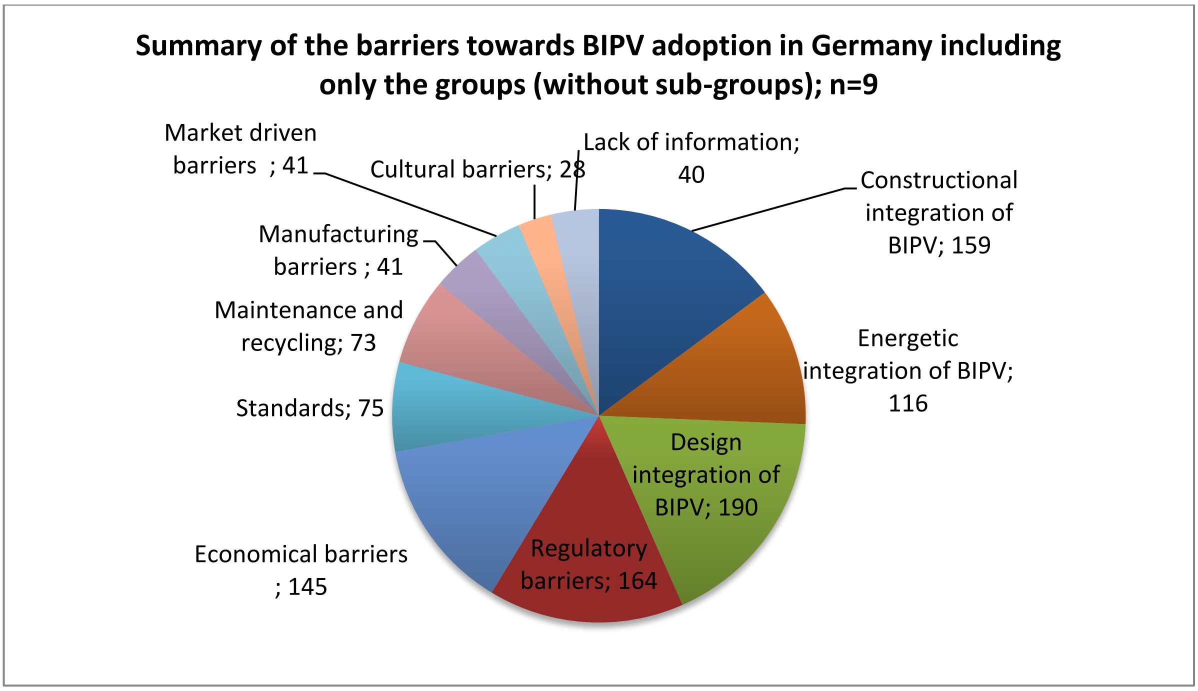


Annex Figure 51 *Summary of the educational requirement for education towards BIPV in Cyprus; Taken together "there is no strong need at all & there is a need but not so strong" vs. "there is a fairly strong need& there is a very strong need"; n=21*

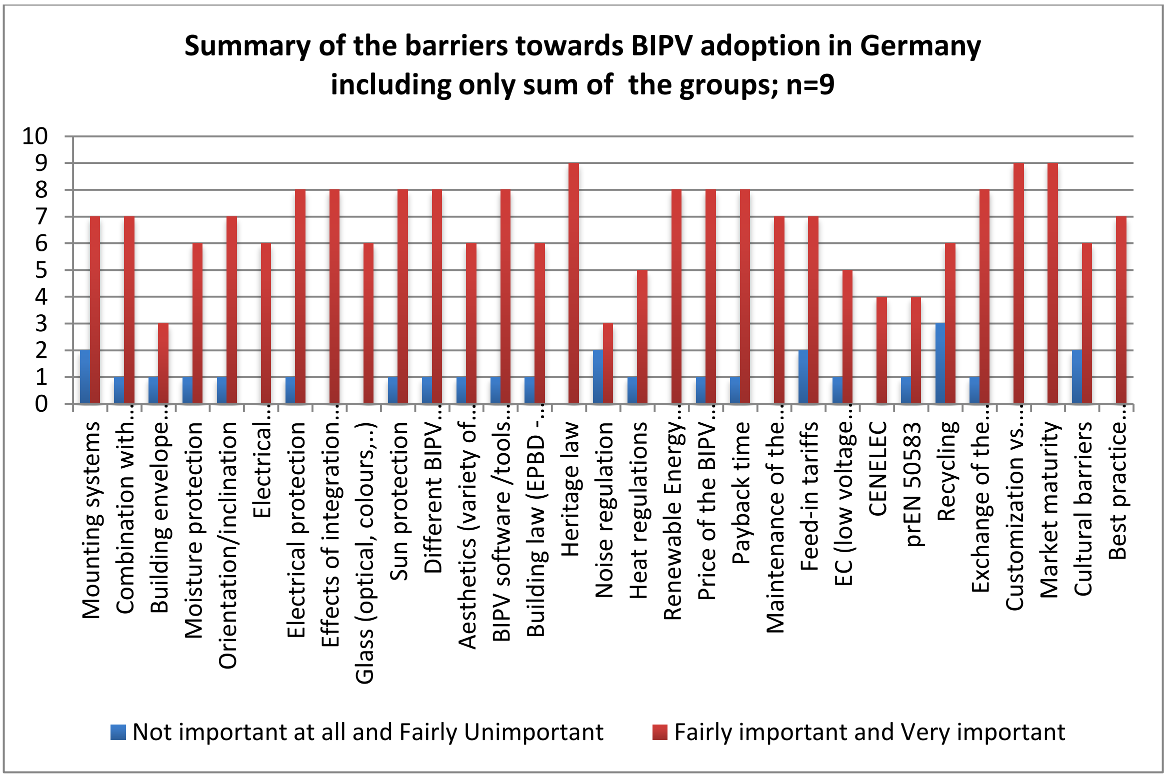


Annex Figure 52 *Summary of the barriers towards BIPV adoption in Cyprus indexes for the scale of educational needs; n= 21*

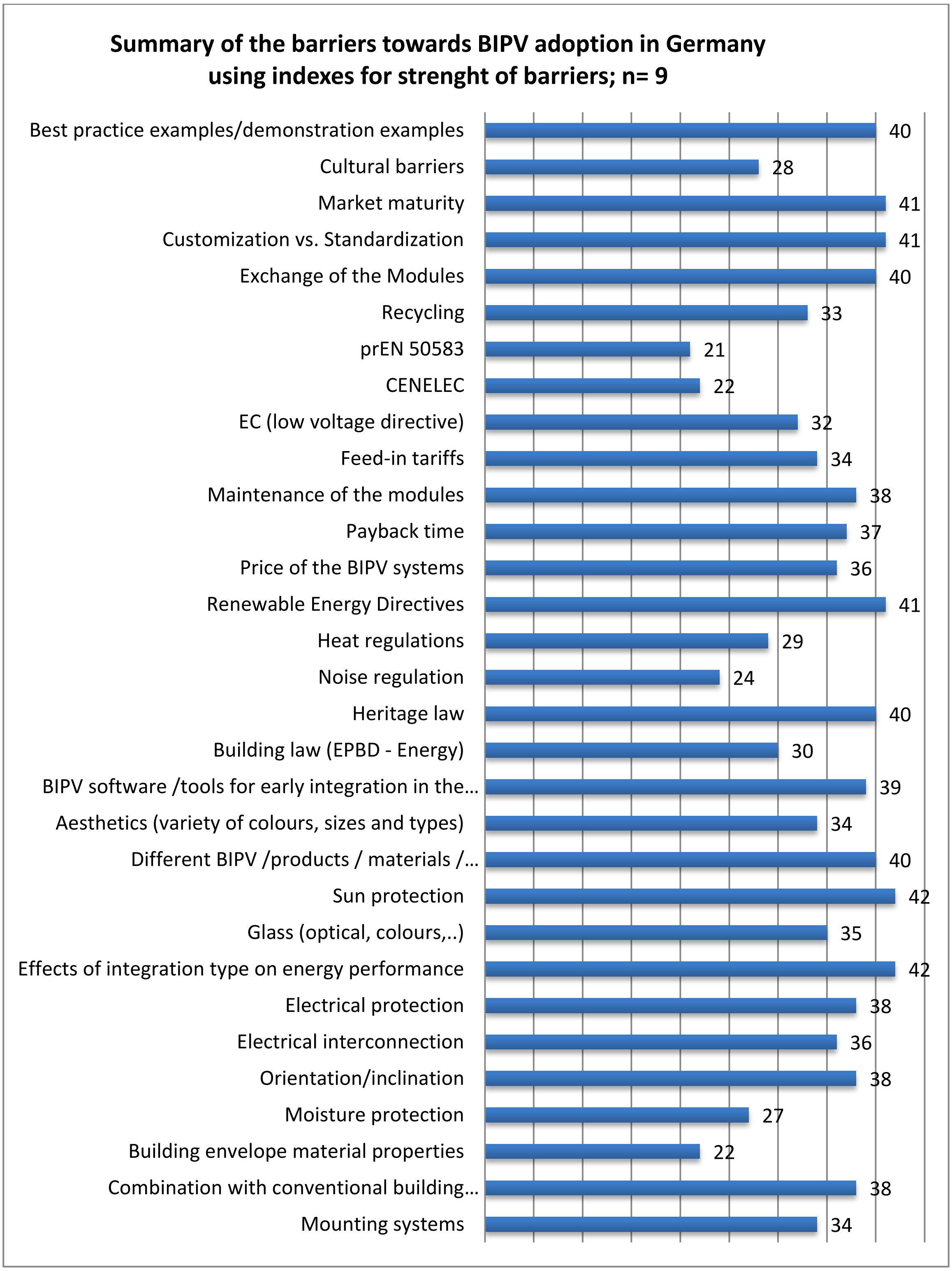
Annex 11.4: Germany



Annex Figure 53 *Summary of the barriers towards BIPV adoption in Germany including only the groups (without sub-groups); n=9*

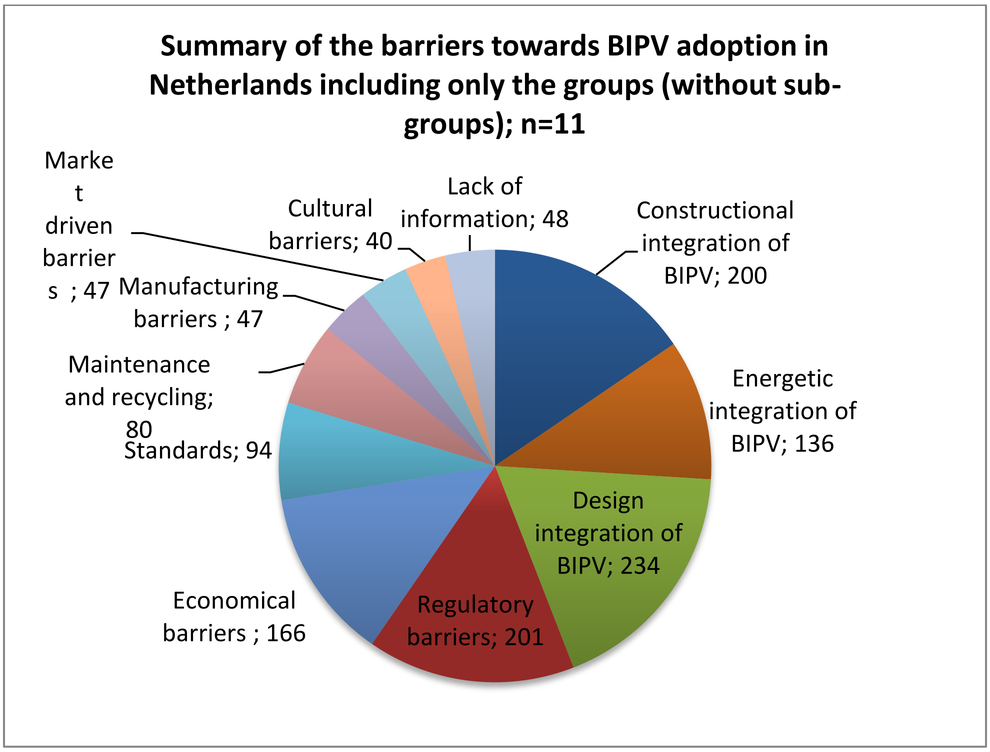


Annex Figure 54 *Summary of the barriers towards BIPV adoption in Germany including only sum of the groups; n=9*

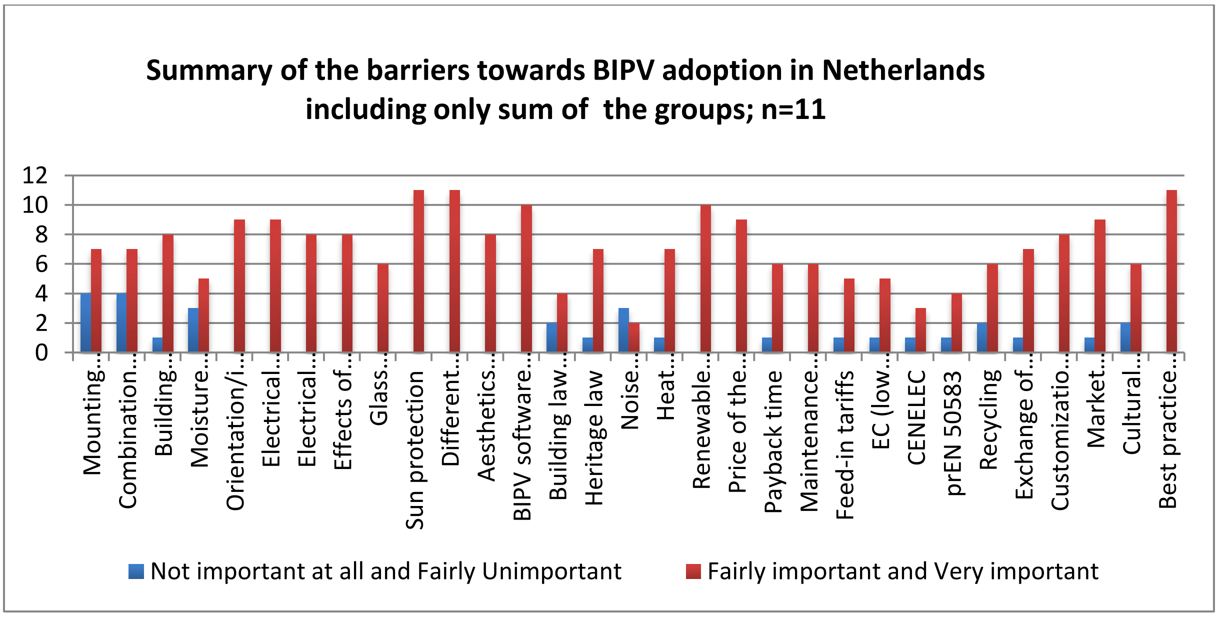


Annex Figure 55 *Summary of the barriers towards BIPV adoption in Germany using indexes for strenght of barriers; n= 9*

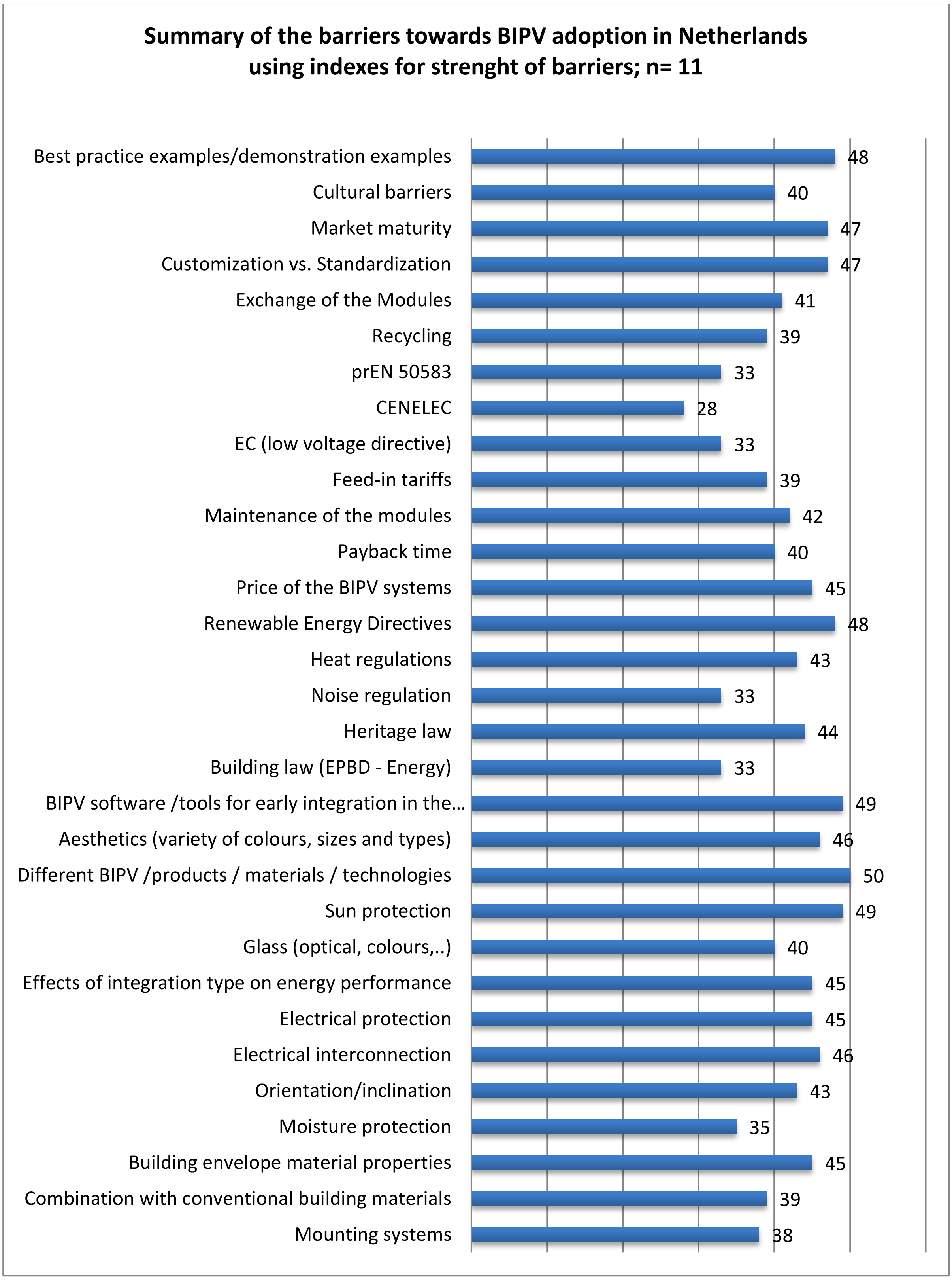
Annex 11.5: Netherlands



Annex Figure 56 *Summary of the barriers towards BIPV adoption in Netherlands including only the groups (without sub-groups); n=11*

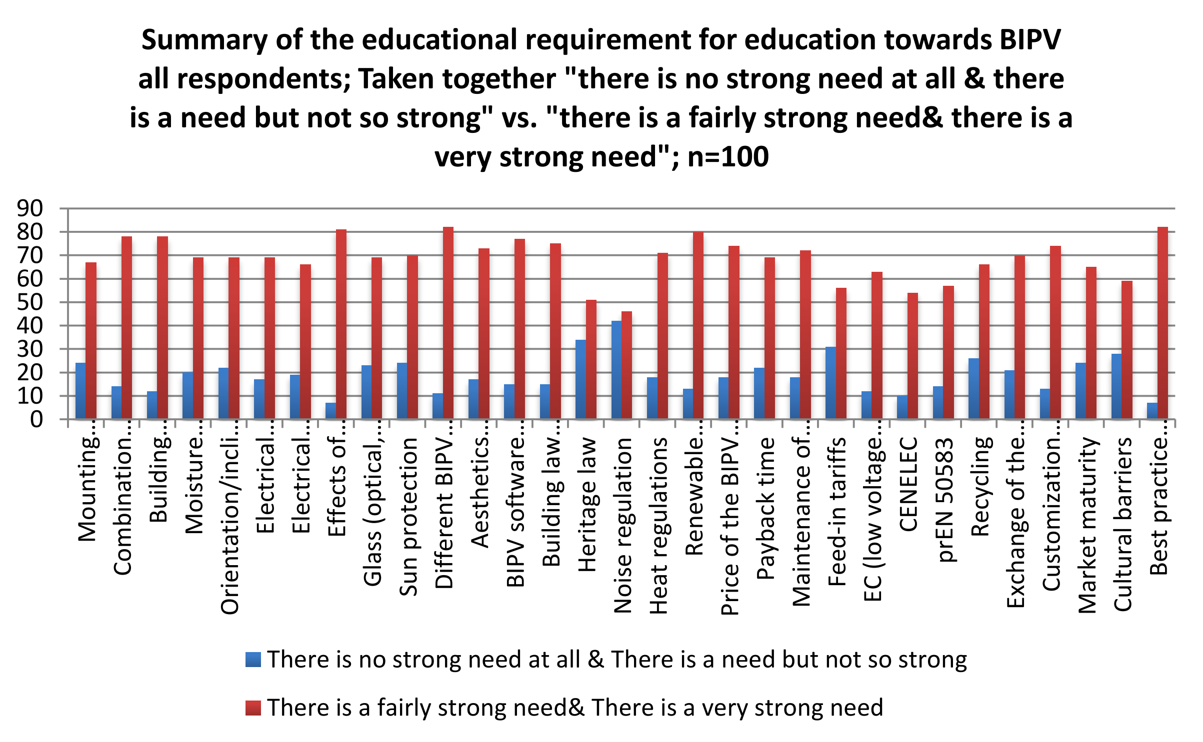


Annex Figure 57 *Summary of the barriers towards BIPV adoption in Netherlands including only sum of the groups; n=11*

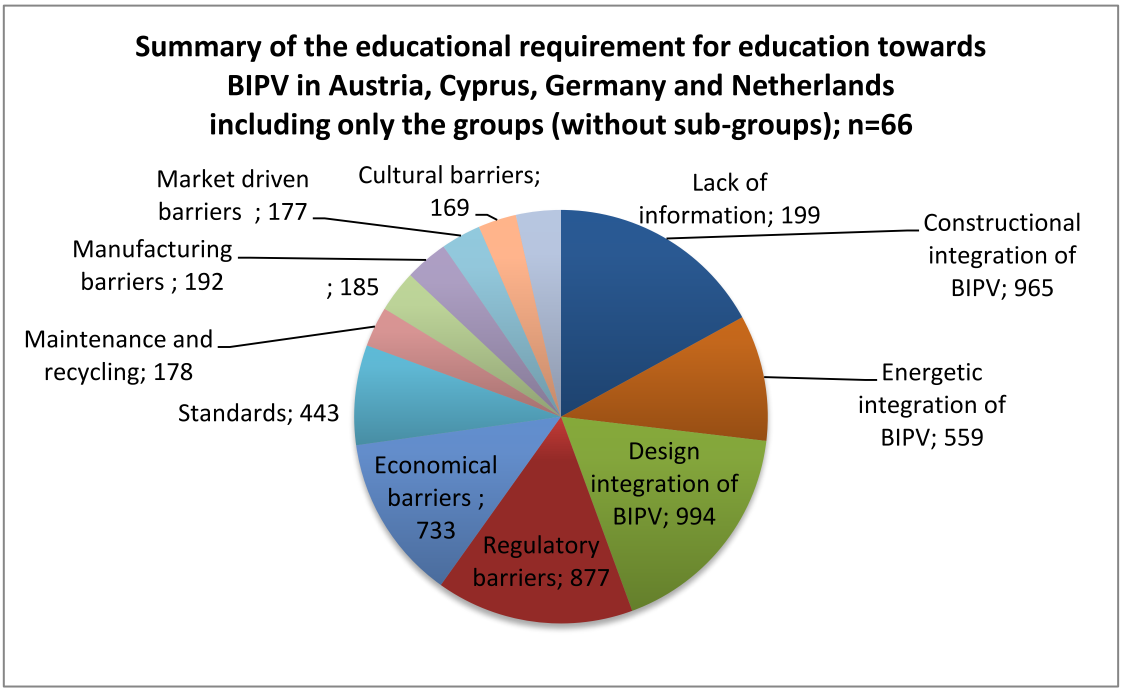


Annex Figure 58 *Summary of the barriers towards BIPV adoption in Netherlandsusing indexes for strenght of barriers; n= 11*

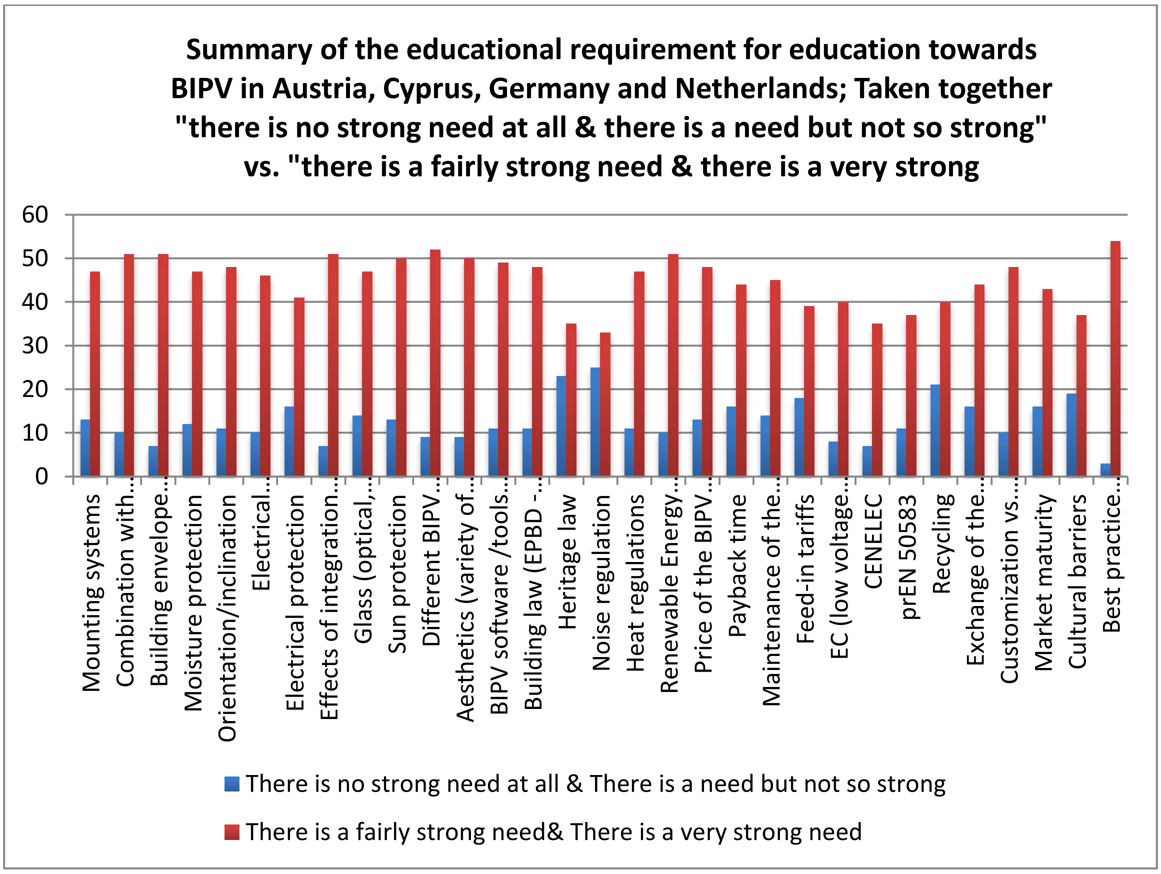
Annex 12: Questionnaire analysis – Educational needs



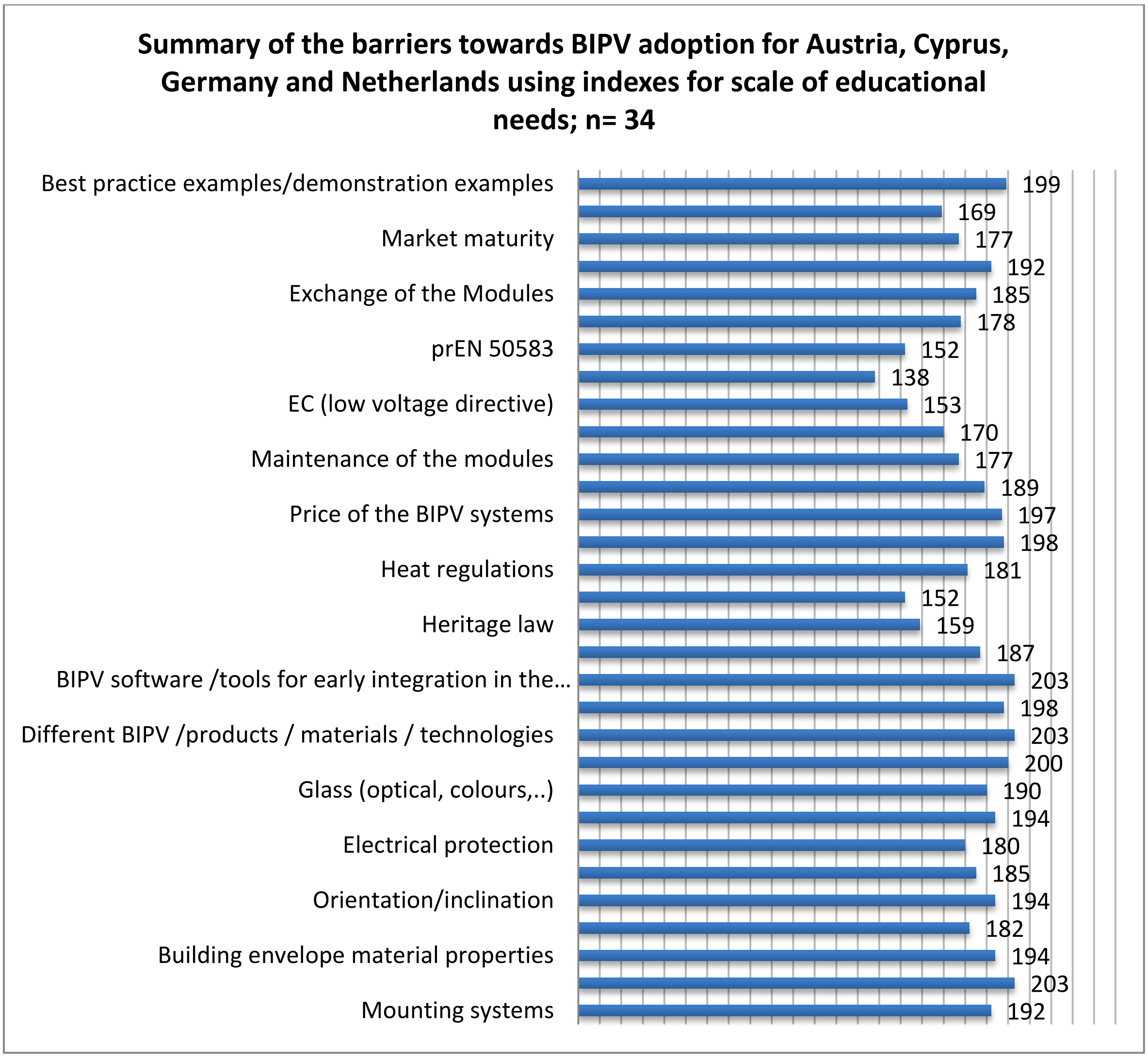
Annex Figure 59 *Summary of the educational requirement for education towards BIPV all respondents; Taken together "there is no strong need at all & there is a need but not so strong" vs. "there is a fairly strong need& there is a very strong need"; n=100*



Annex Figure 60 ***Summary of the educational requirement for education towards BIPV in Austria, Cyprus, Germany and Netherlands including only the groups (without sub-groups); n=66***

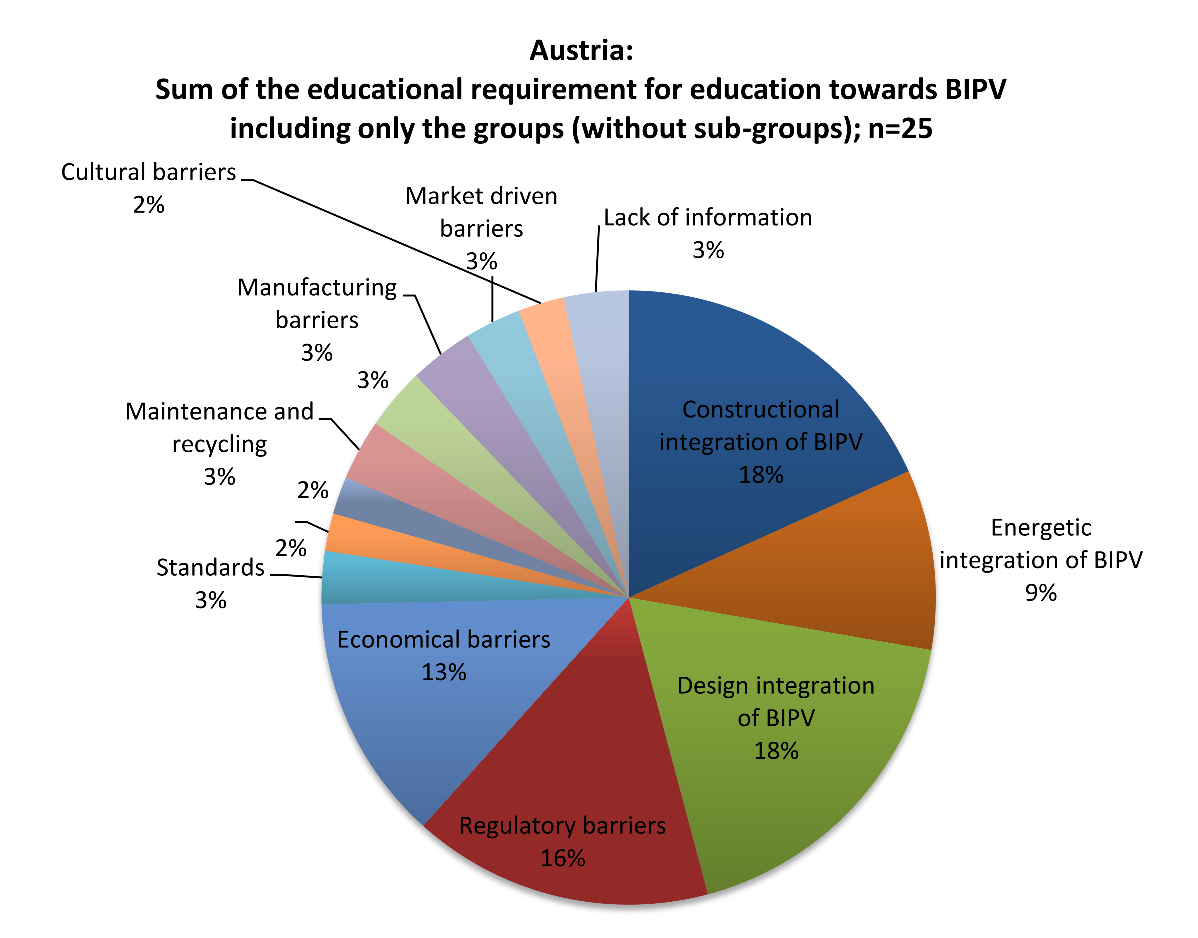


Annex Figure 61 *Summary of the educational requirement for education towards BIPV in Austria, Cyprus, Germany and Netherlands; Taken together "there is no strong need at all & there is a need but not so strong" vs. "there is a fairly strong need & there is a very strong need*

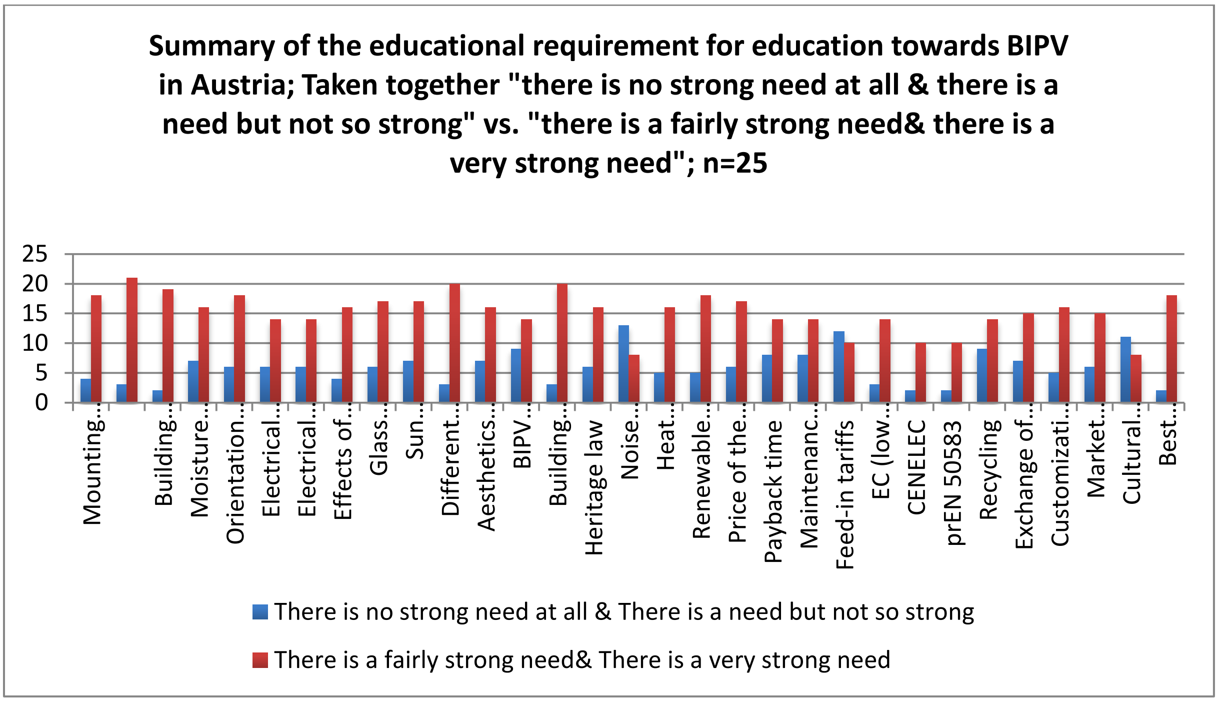


Annex Figure 62 *Summary of the barriers towards BIPV adoption for Austria, Cyprus, Germany and Netherlands using indexes for scale of educational needs; n= 34*

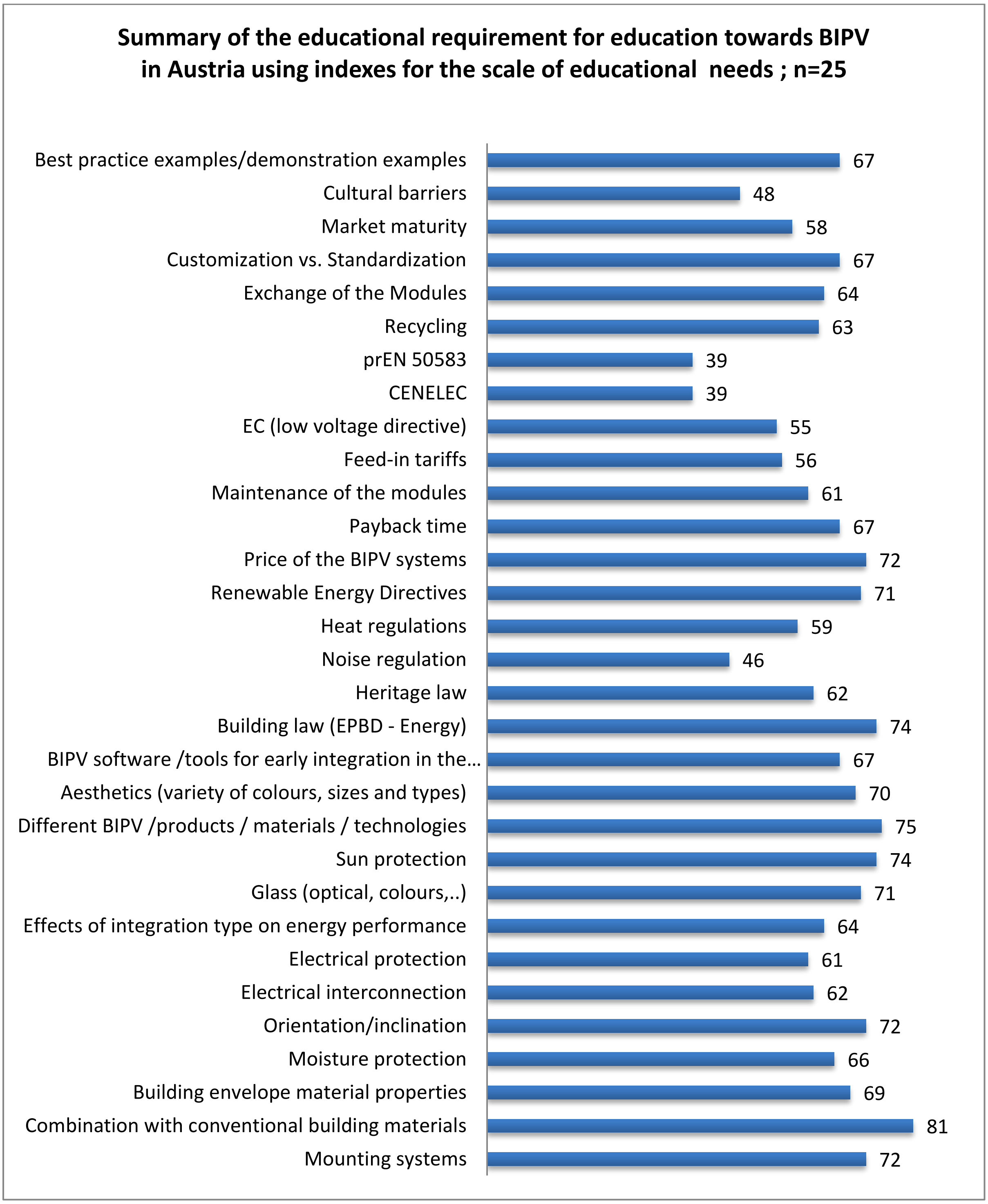
Annex 12.1 Austria



Annex Figure 63 *Austria: Sum of the educational requirement for education towards BIPV including only the groups (without sub-groups); n=25*

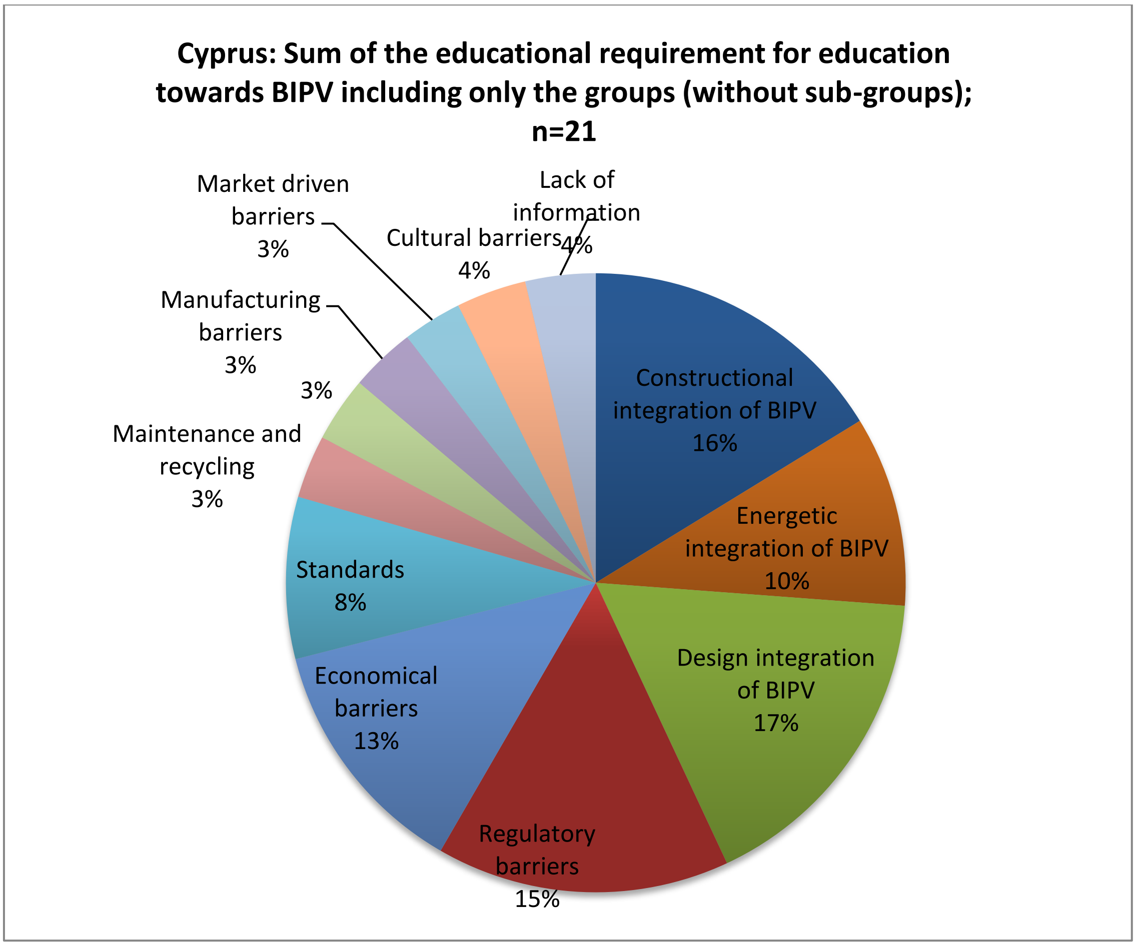


Annex Figure 64 *Summary of the educational requirement for education towards BIPV in Austria; Taken together "there is no strong need at all & there is a need but not so strong" vs. "there is a fairly strong need& there is a very strong need"; n=25*

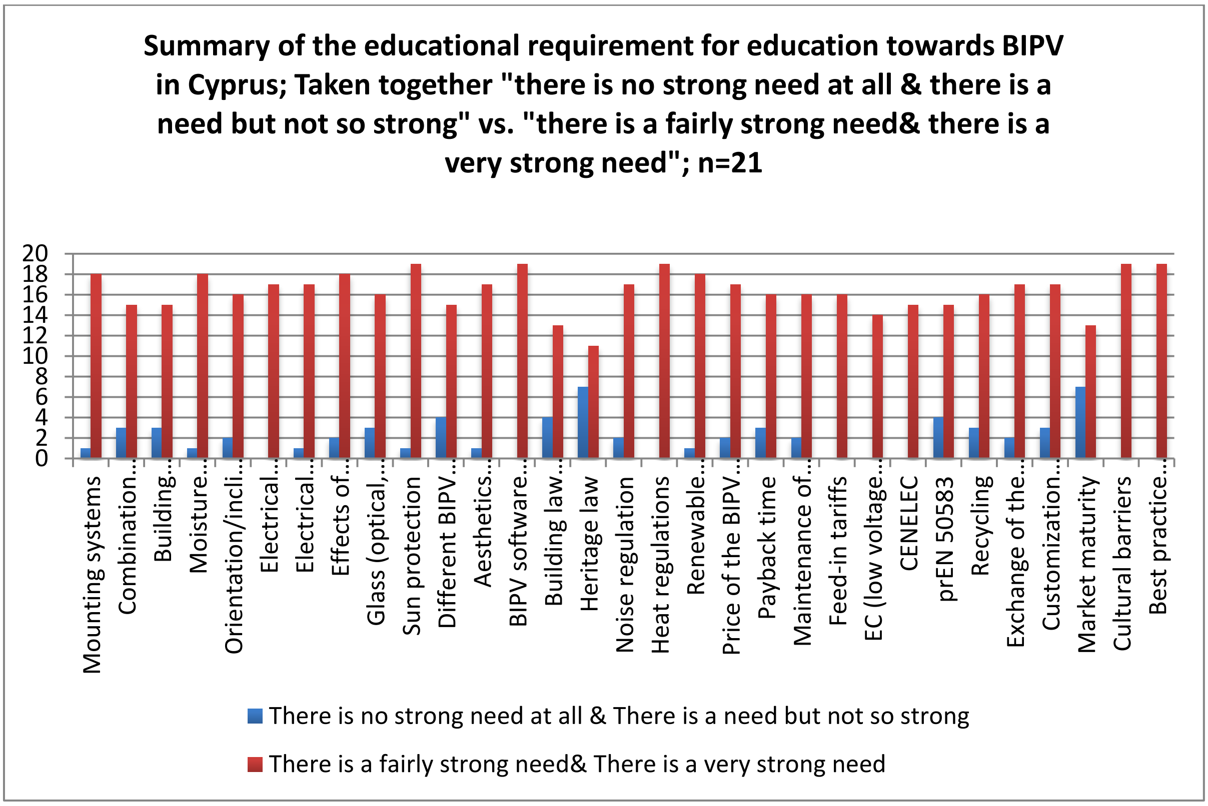


Annex Figure 65 *Summary of the educational requirement for education towards BIPV in Austria using indexes for the scale of educational needs ; n=25*

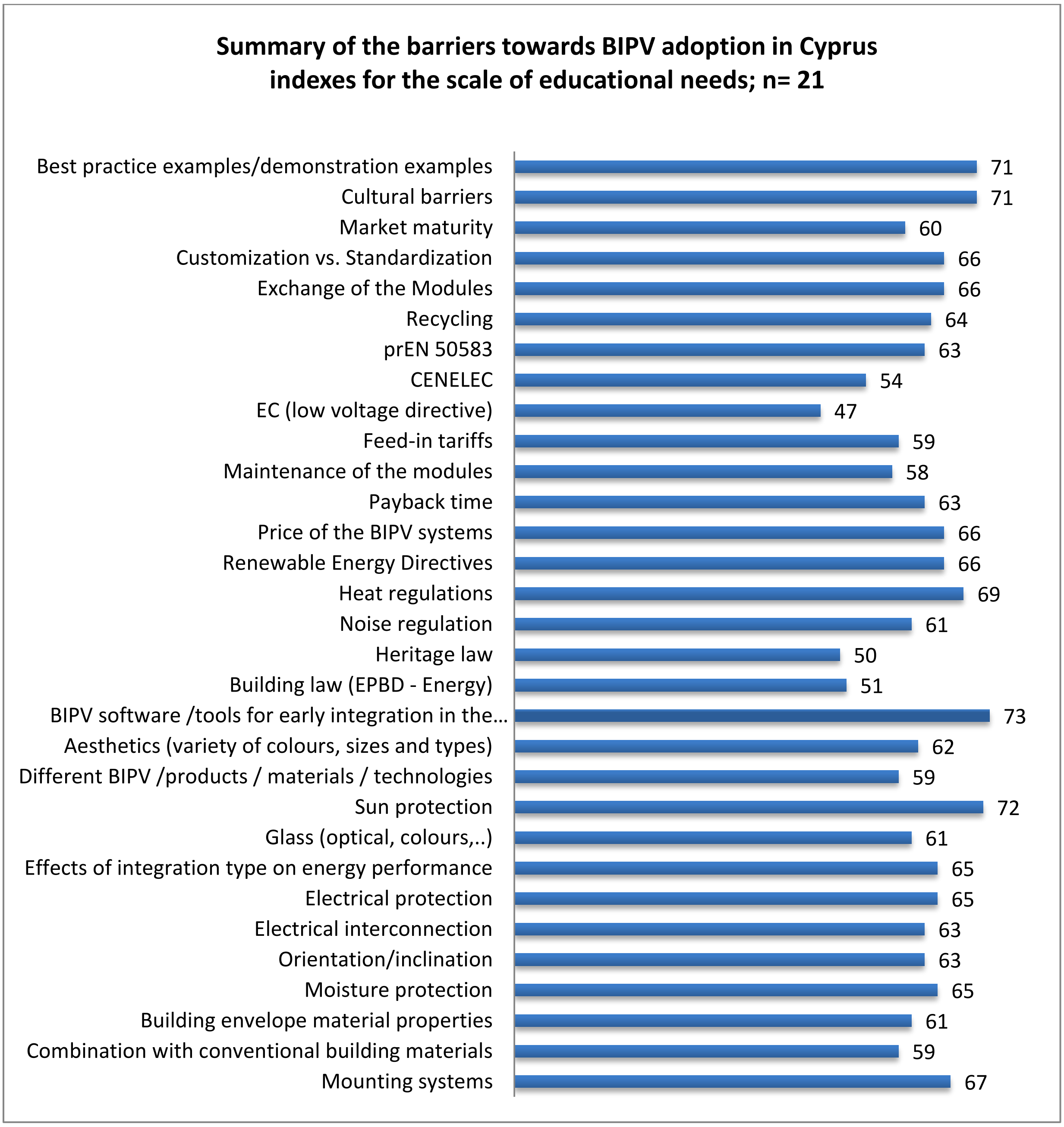
Annex 12.2: Cyprus



Annex Figure 66 *Cyprus: Sum of the educational requirement for education towards BIPV including only the groups (without sub-groups); n=21*

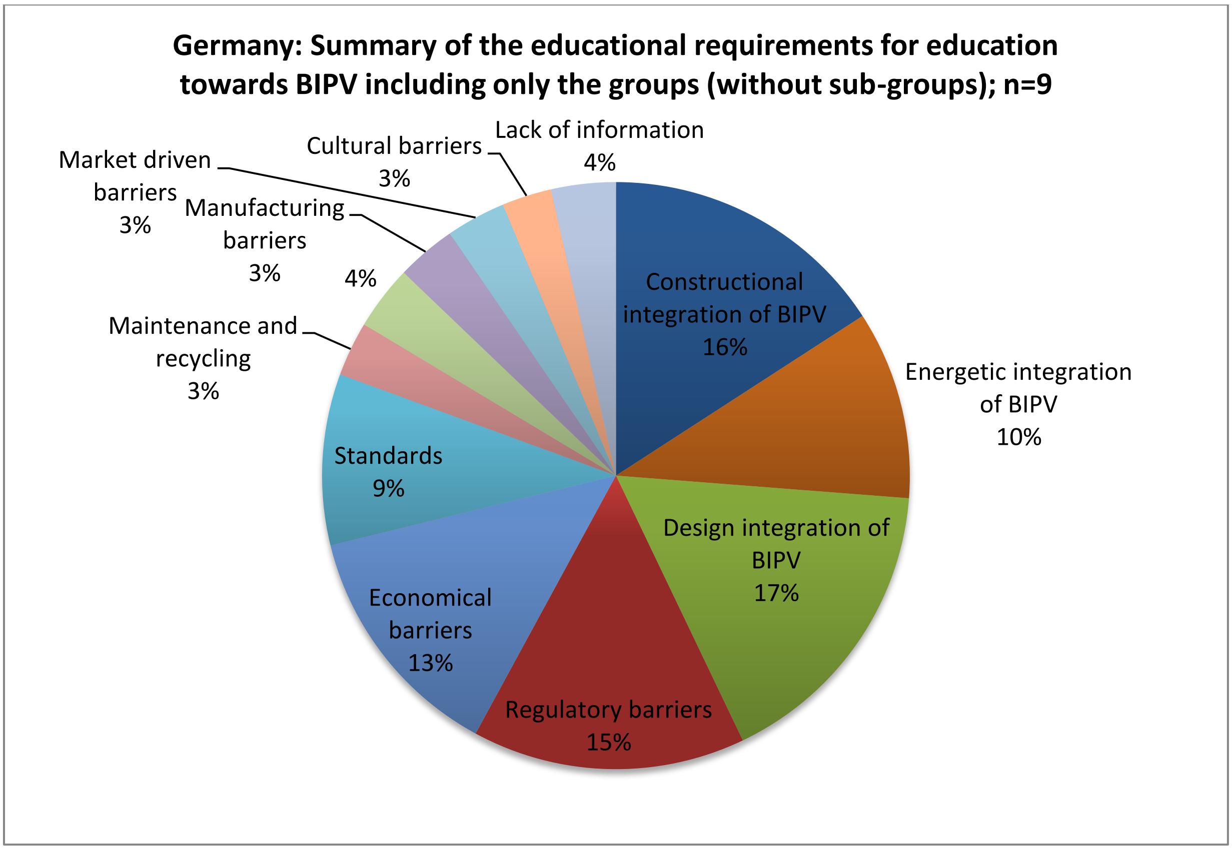


Annex Figure 67 *Summary of the educational requirement for education towards BIPV in Cyprus; Taken together "there is no strong need at all & there is a need but not so strong" vs. "there is a fairly strong need& there is a very strong need"; n=21*

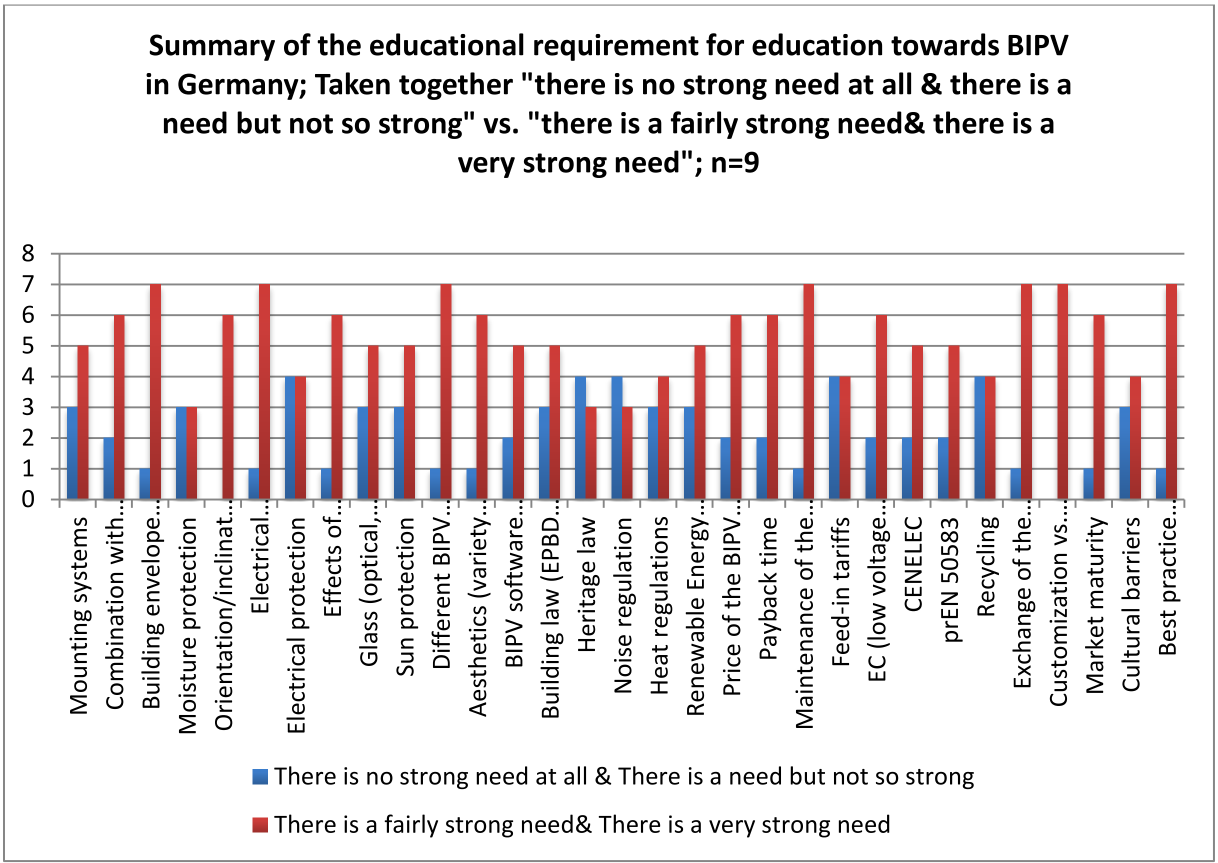


Annex Figure 68 *Summary of the barriers towards BIPV adoption in Cyprus indexes for the scale of educational needs; n= 21*

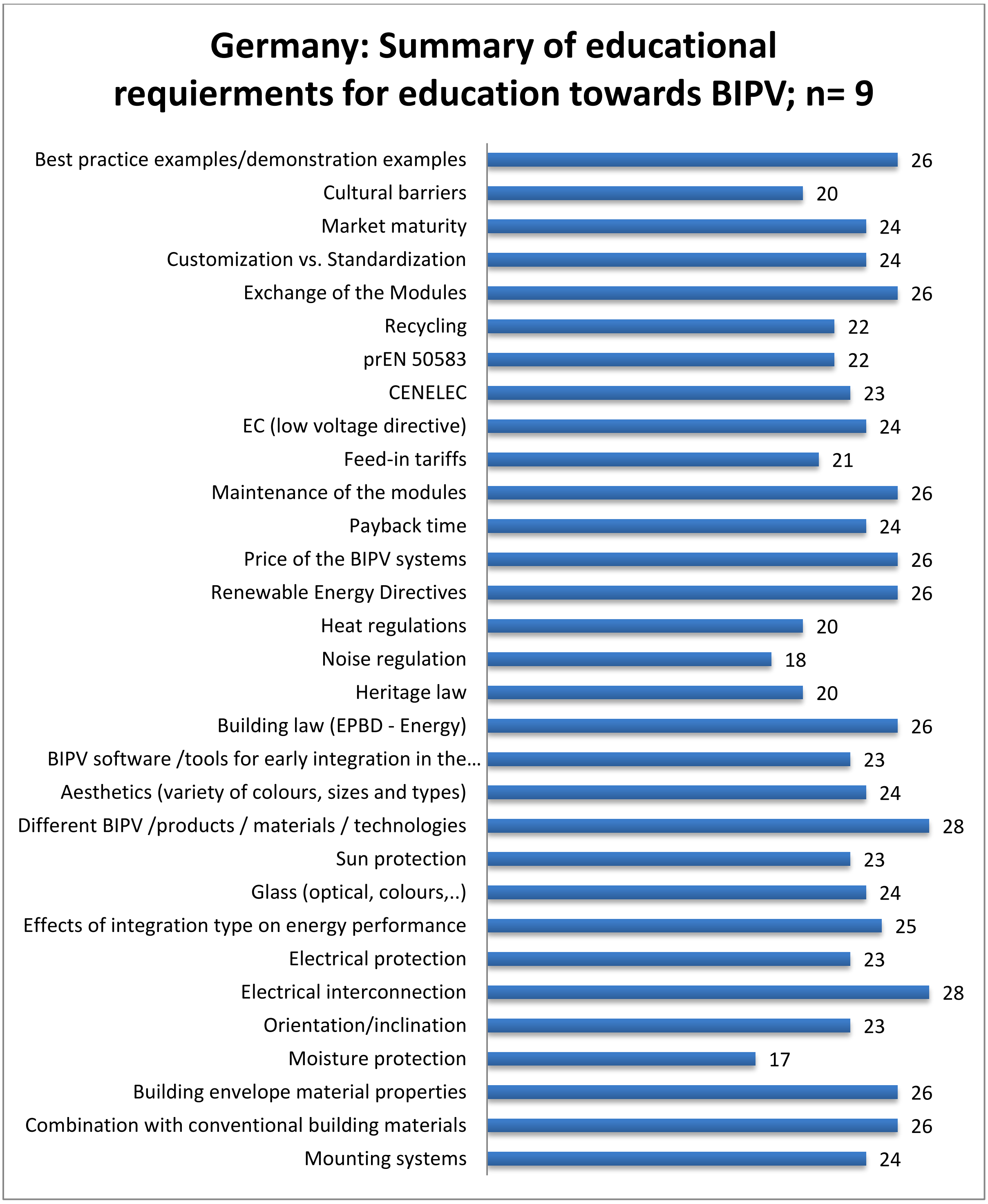
Annex 12.3: Germany



Annex Figure 69 *Germany: Summary of the educational requirements for education towards BIPV including only the groups (without sub-groups); n=9*

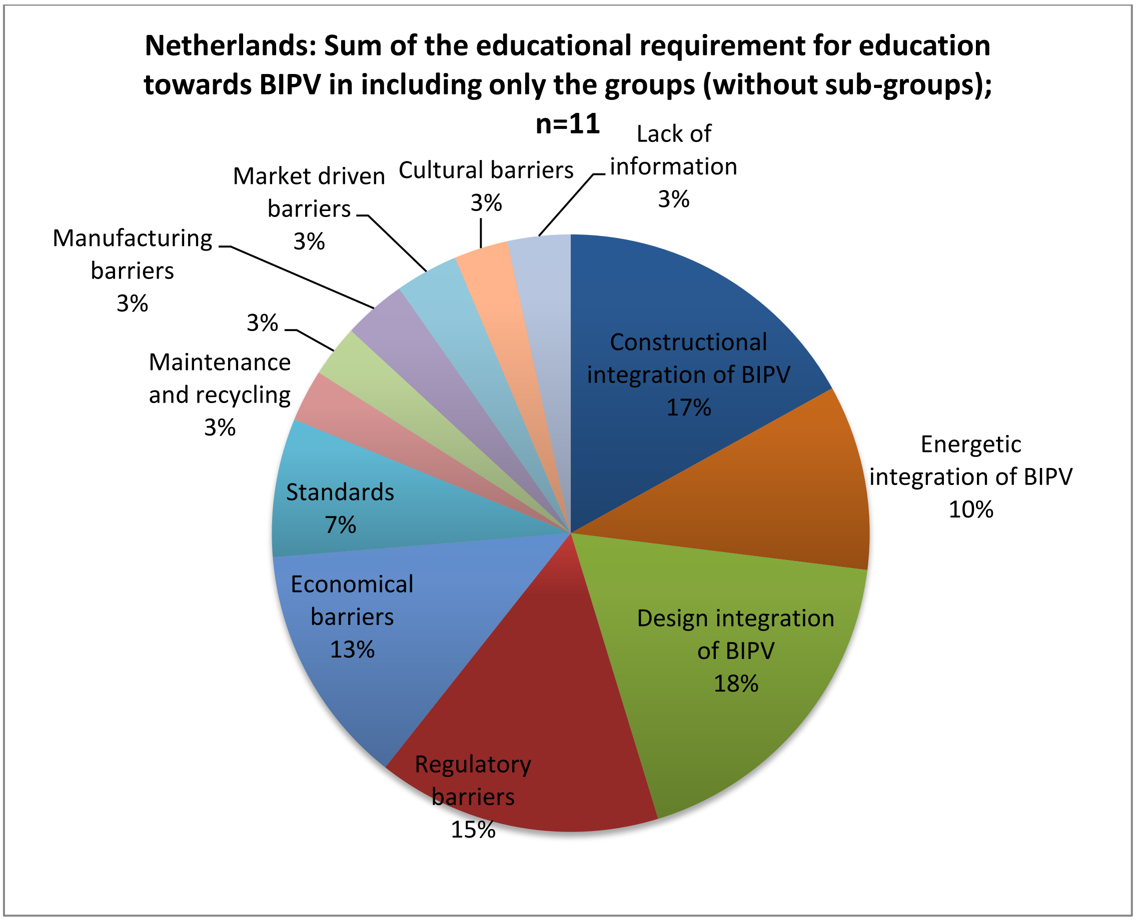


Annex Figure 70 *Summary of the educational requirement for education towards BIPV in Germany; Taken together "there is no strong need at all & there is a need but not so strong" vs. "there is a fairly strong need& there is a very strong need"; n=9*

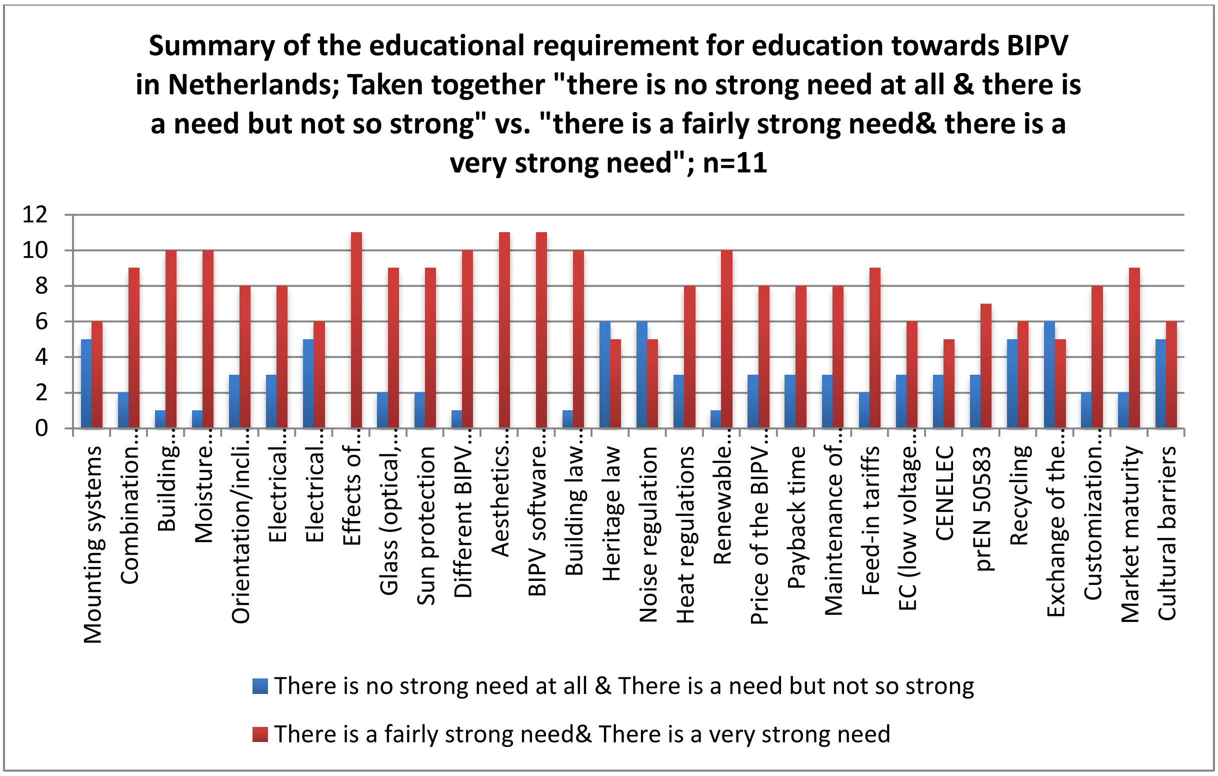


Annex Figure 71 *Germany: Summary of educational requierments for education towards BIPV; n= 9*

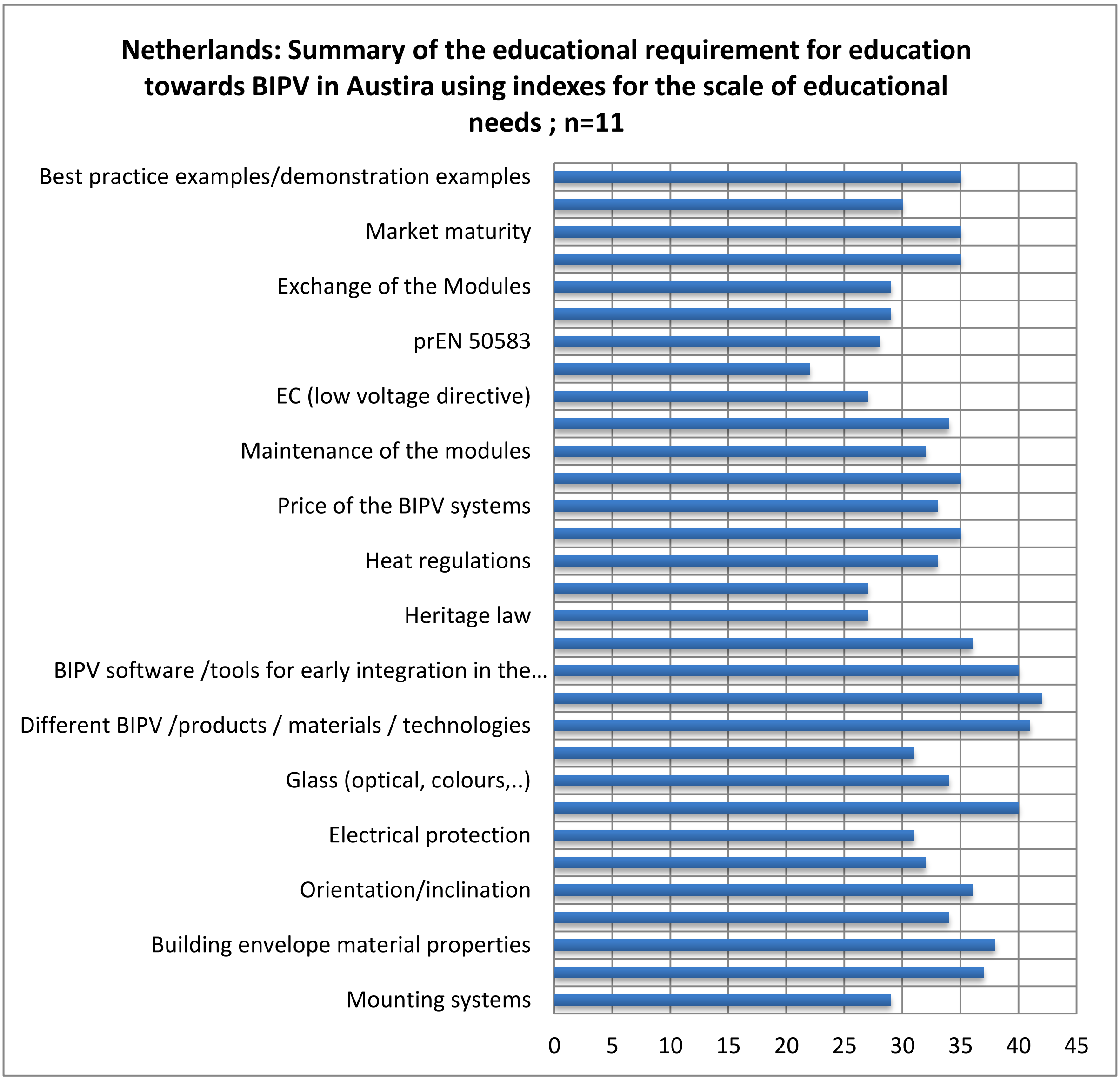
Annex 12.4: Netherlands



Annex Figure 72 *Netherlands: Sum of the educational requirement for education towards BIPV in including only the groups (without sub-groups); n=11*



Annex Figure 73 Summary of the educational requirement for education towards BIPV in Netherlands; Taken together "there is no strong need at all & there is a need but not so strong" vs. "there is a fairly strong need& there is a very strong need"; n=11



Annex Figure 74 *Netherlands: Summary of the educational requirement for education towards BIPV in Austira using indexes for the scale of educational needs ; n=11*

Annex 13: Other barriers mentioned from the stakeholders

- The high sun radiation and the temperatures
- Cultural barriers and the lack of knowledge/information
- People haven't understood yet the importance of using renewable resources and therefore there is lack of trust on new BIPV. I think it's more or less social a problem. The society must gain environmental consciousness. So, maybe we must integrate environmental and socio-economic education into all levels of education and then develop the education BIPV systems into a multidisciplinary (not only in the faculty of electrical engineering) framework at university level.
- Health Barriers. There is a need to include in the educating field for the BIPV subject whether the BIPV are safe and what effects they may have for the human health. There are already some barriers that conventional PV may be harmful if used in large numbers in a residential area.
- Lack of knowledge
- Bureaucracy, electricity monopoly
- Lack of specialise body
- The investors role
- Government Policies and Financial Support Mechanisms (professionals)
- Cost
- No awareness for an holistic approach
- Lack of will by the state to promote and force more actively the use of BIPV
- Professional bodies, universities
- The doubts related to the system cost-effectiveness.
- Awareness is very important. Good examples and believe in the product.
- Miniaturization
- The main barrier in Spain is in government laws, because they don't let to install BIPV for their our consumption. They don't promote with economic grants for this type of installation.

- BIPV is often assumed or directly compared with traditional solar pv panels and it supposes also a barrier (maybe cultural). Obviously it requires increased efforts on education at medium and higher levels.
- Price of BIPV panels; insurance and warranties, maintenance, lack of promotion and communication about this technology
- Local Building Codes
- Lack of communication between different stakeholder groups. Cannot be solved by means of more education, just do it.
- Traditional construction process
- The most important barrier in my opinion is knowledge of the possibilities of BIPV products on the prescriptors of buildings (architects, planners), at this moment they do not take it into account usually. Second is related to knowledge of the technology by constructors (from engineers to operators) but both things had been already mentioned
- Economical and performance barriers
- The insecurity that exists in architect and scholar works
- Generally underdeveloped regulation on PV in Sweden. Not subject to education.
- most important are Standards for bipv specially connectors and j-boxes. than the costs, the Goal will be same Price as air ventilated facade Systems.
- Trade-off Reliability/Performance vs Aesthetics for BIPV modules
- From technology push to market pull. Correct integration in EPBD. BIPV as a part of net-zero energy buildings
- Lack of funding; lack of environmental concern (architects and cutomers rather integrate energy wasting Illumination to the building that energy generating BIPV)
- We should move away from the comparison with standard PV Panels, the economics for BIPV will have to be worked out differently
- No suitable products for full BIPV integration available
- Strong need in education in general, from vocational (maily) to higher degrees
- cost and maintenance

- Lack of innovation in projects (AEC industry). Time to market (delay) regarding H2020/NZEB issues for small-medium sized projects (including housing)

- Storage / battery

- Pros and cons of BIPV compared to other renewable energy system such as solar water heating as well as other high efficiency energy conservation options.

- Integration of new materials

- PV module certification (IEC 60215/61646) requirement
  No criteria of energy saving performance calculation
  No similation tool of actual power genaration performance
  Low awareness of BIPV products

- Architect doesn't know about BIPV well (Concept / needs / characteristics etc.). So, It is needed first that proper information of BIPV shall be provided to architects.

- BIM level 3
  International BIPV standardisation
  Automized electrical design

- Role of BIPV in the integral design of the installation system - there is a very strong need

- Building value and building exploitation models

- The margins for builders are very low so they will not easily invest in BIPV. They will even discourage it as making the projects unnecessary complex. The almost exclusive focus of the European Technology Platform and the EC on the building sector is therefore a recipe for failure. The focus should be instead on the technology suppliers and project developers. However the ETP consists of academics mostly who do not understand these economic dynamics.
  Also information should be available for anyone who would like to build their own house or replace the roof with BIPV.

- Money

- Lack of information and lack of confidence in the reliability and the energy yield.
  Up front cost

- Lack of colours

- Clear and consistent (credible) legislation for the next 10 to 20 years

- There are only a few systems on the market
- According to the diffusion theory by Rogers each innovation - also BIPV - requires early adaptors, which may be difficult to find given the slow progress of innovations in the building sector and the high investments needed to realize or renovate a building.
- Building operations and maintenance
- Integration with the facades in an aesthetic way.
- -Ready to use BIM module/family with embedded performances - significant development is needed to back up this approach
  -architectural products designed as BIPV - education of new generation architects that understands multi-performance design, among others BIPV
  -education of professionals who make decisions on implementation of BIPV - more marketing and education
- Education of architects, collaboration willingness of building industry, etc.
- All barriers mentioned above
- Not only the economic pay-back time is an important parameter but in the same way the cost of an aesthetically/ functionally equivalent non-PV element. "Basic" costs should be subtracted from the PV system costs. Manufacturers should provide up-to-date "neutral" information about such competitive products.

  Ideally, every PV module would integrate an own highly reliable, efficient but low cost dc/ac inverter. -> Research required.
- Price, Price, Price
- Mainly different building laws in the countries
- Price / Wp
- In principal the younger generation has to be educated from the early beginning in primary school why it is necessary to change to renewable energy. With this knowledge all existing concerns could be solved.
- Less integration in law for building
  Less integration in funding scheme for Building

Annex Figure 75 *Other barriers mentioned from the stakeholders*

Annex 14: Questionnaire for Stakeholders

Please get access to the full questionnaire in the following **link**.