

PROFESSIONALS' AWARENESS ON THE APPLICATION AND USE OF BUILDING INTEGRATED PHOTOVOLTAIC SYSTEMS

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ABSTRACT

PROFESSIONALS' AWARENESS ON THE APPLICATION AND USE OF BUILDING INTEGRATED PHOTOVOLTAIC SYSTEMS

In this thesis research, broad definition of solar energy, photovoltaic systems and building integrated photovoltaic systems, their application forms, usage in building subcomponents and examples on the usage of building integrated photovoltaic systems are involved. By the application of the survey method, the awareness of professionals on the application and use of photovoltaic systems integrated into the building were examined.

This questionnaire consists of 3 sections: the general definition of solar energy (A), the general description of photovoltaics integrated into the building (B), and the application of integrated photovoltaics to the building (C). The survey questions consist of multiple choice, matching questions, true-false questions and interpretation questions. The responses given to the questionnaire were analyzed in terms of the number of participants and percentage based by comparing them tabularly and diagrammatically.

The importance of the study is to enable practitioners, academics, architects and engineers to realize their knowledge about BIPV systems, to understand the importance of these systems in terms of energy efficient design approach and to encourage them to use these systems in their projects. And thus, spreading the use of BIPV in our country and all over the world, leading them to realize the energy efficient design approach.

In the first chapter; after the general introduction of the subject of the thesis, problem description, research objective, thesis content and methodology are mentioned. In the second chapter; the definition and technical problems of BIPV systems, usage areas of BIPV, case buildings, performance evaluations, market opportunities and applicability are mentioned. In the third chapter; the methodology section is included that consist of general information about the survey, survey questions and content, preselected buildings for the survey, information about the participants. In the fourth chapter; the results and analysis of the questionnaire, the comparison of the responses of the participants and the evaluation of the results, the comparison of the participant information and the literature information, and the evaluation of the results are included. The fifth chapter is devoted to results and evaluations.

ÖZET

BİNAYA ENTEGRE FOTOVOLTAİK SİSTEMLERİN UYGULANMASI VE KULLANIMI KONUSUNDA PROFESYONELLERİN FARKINDALIĞI

Bu tez araştırmasında, güneş enerjisi, fotovoltaik sistemler ve binaya entegre fotovoltaik sistemlerin geniş tanımı, uygulama biçimleri, diğer yapı alt bileşenlerinde kullanılması, binaya entegre fotovoltaik sistemlerin kullanımına ilişkin örneklerine yer verilmiştir. Anket yöntemi uygulaması ile profesyonellerin binaya entegre fotovoltaik sistemlerin uygulanmasının ve kullanımının farkındalığı incelenmiştir.

Bu anket, güneş enerjisi genel tanımı (A), binaya entegre fotovoltaiklerin genel tanımı (B), binaya entegre fotovoltaiklerin uygulanması (C) olmak üzere 3 bölümden oluşmaktadır. Anket soruları, çoktan seçmeli, eşleştirme soruları, doğru-yanlış soruları ve yorum sorularından oluşmaktadır. Ankete verilen cevaplar tablolar ve grafikler yardımıyla karşılaştırmalar yapılarak katılımcı sayısı ve yüzde oran bazında analiz edilmiştir. Çalışmanın önemi, uygulamacı & akademisyen, mimarlar ve mühendislerin BIPV sistemler hakkındaki bilgilerini fark etmeleri, onların bu sistemlerin enerji verimli tasarım yaklaşımını adına önemini anlamalarını sağlamak ve onları projelerinde bu sistemleri kullanmalarına teşvik etmektir. Ve böylece BIPV kullanımını ülkemizde ve tüm dünyada kullanımının yayılmasını sağlayarak enerji verimli tasarım yaklaşımını gerçekleştirmelerine öncülük etmektir.

Tezin birinci bölümünde, tezin konusuna ait genel giriş yapıldıktan sonra) Sorun Tanımlama, Araştırmanın Amacı, Tez İçeriği ve Metodolojiden bahsedilmiştir. İkinci bölümünde, BIPV sistemlerin tanımı ve teknik sorunları, BIPV'nin kullanım alanları, vaka binaları, performans değerlendirmeleri, pazar fırsatları ve uygulanabilirliği 'ne yer verilmiştir. Üçüncü bölümünde, anket hakkında genel bilgi, anket soruları ve içerikleri, anket için seçilen yapılar, katılımcılara ait bilgiler, karşılaştırmalı değerlendirmeler içeren metodoloji kısmına yer verilmiştir. Dördüncü bölümde, anket sonuçları ve analizleri, katılımcıların cevaplarının birbirleri arasında kıyaslanması ve sonuçların değerlendirilmesi, katılımcıların bilgileri ve literatür bilgilerinin kıyaslanması ve sonuçlarının değerlendirilmesine yer verilmiştir. Beşinci bölüm ise sonuç ve değerlendirmelere ayrılmıştır.

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LIST OF ABBREVIATIONS

C°: Temperature

CO₂: Carbon dioxide

KWh: Kilowatt-hour

m²: Squaremeter

W / m²: Watt Per Square Meter

Wp: Watt Power



CHAPTER 1

INTRODUCTION

The energy by fossil fuel sources such as petroleum, coal and natural gas has become increased with the developing technology and increasing population. which are commonly of fossil source (Müller, D.& Dominique,N., 2002). However, the damages they cause to the environment and their high prices has led to an increase in the use of renewable and sustainable energy resources (Herzog, A., Lipman,T, Kammen, D., 2001).

Solar energy is a clean, sustainable and environmentally friendly renewable energy source (Jelle, B.P.; Hagen, G., 1999). It is used in electricity and energy production, medicine, agriculture and industry (Sakhuja, M.; Son, J.; Yang, H.; Bhatia, C.S.; Danner, A.J, 2014). To use it efficiently, photovoltaic solar cells and photovoltaic systems connected to these cells have been developed obtaining electrical energy from solar energy (Lampert, C.M., 2003). Photovoltaic systems have been applied initially on roofs and facades as separate systems; later they have been integrated into the building while generating electricity. So, the building envelope starts to become an energy-generating building component (Benson, D.K.; Branz, H.M., 1995)

In this thesis research, solar energy, photovoltaic systems and the broad definition of building integrated photovoltaic systems (BIPV), their applications, their use in other building sub-components, the examples of building integrated photovoltaic systems in the world and in Turkey are given. The awareness of professionals on the application and use of photovoltaic systems integrated into the building was examined with the application of the survey method.

1.1. Problem Identification

There have been many turning points in terms of discoveries and technological advancements throughout human history. Examples of these are the learning of agriculture, the invention of the wheel, writing and printing press, steam engine, lightbulb, telephone, radio, television, computer, internet. Energy has always existed in these processes and with each turning point, the energy need of people has increased, it

has provided its own change and development with different resources and methods (Peng J, Lu L, Yang H., 2013). Energy is one of the basic needs that humanity needs to continue its development and generation. Energy is an indispensable part of human life in terms of their survival in terms of determining the socio-economic level of the countries, their level of development, their location in areas such as industry, science, technology, security, etc (Müller, D.& Dominique, N., 2002). Recently it has been realized that energy has been increasingly consumed by the advancing and developing technology. As a result of this, studies have begun on how this energy we use can be more efficient in terms of building performance (Benson, D.K.; Branz, H.M., 1995).

Especially most of the need for energy is met by fossil fuels in the globalizing world conditions and as the fossil fuels cannot be consumed infinitely, alternative energy sources have become the considerations. The aim is to diminish the environmental hazard (global warming, melting glaciers, extinction of living species) caused by the use of these sources and eliminate the increased prices. Conducting scientific researches, the use of renewable energy resources has started with fast progressing processes and steps, although they do not produce definitive results as a result. (Müller, D.& Dominique, N., 2002) (Herzog, A., Lipman, T., Kammen, D., 2001).

Solar energy is a renewable energy source which is very accessible. Its energy potential is very high, it is abundant, nearly unlimited and continuous in nature. In short, this energy is environmentally friendly and sustainable (Jelle, B.P.; Hagen, G., 1999). This type of energy can be used in countless fields such as producing hot and cold water, producing clean water, solar cookers, agricultural irrigation, garden lighting, street, park and street lighting, traffic lights and signs, solar airplanes, homes without electricity, space and satellites, emergency telephone devices, mobile phone charging electricity and power generation, medicine, tourism, agriculture and industry, such as calculators, wrist watches (Sakhuja, M.; Son, J.; Yang, H.; Bhatia, C.S.; Danner, A.J, 2014).

As Turkey has a high potential in terms of solar energy due to its climate characteristics and geographical location, and is in need of using renewable energy resources, many feasibility and power plant installation work has started to be done (Koçaslan, 2006). Thus, photovoltaic solar cells, photovoltaic systems connected to these batteries have been developed to obtain electrical energy from solar energy like many other developed countries. Photovoltaic systems produce their own energy, without any need for a network; contains a smart energy management system that controls the production, storage and usage conditions to ensure the continuity of the energy. They

convert sunlight directly into electricity in the field. Its applications support the design of environmentally friendly and energy efficient buildings. The building itself can generate its own electricity and does not release CO₂ (Henemann, A., 2008), (Alsema, E.A.; Wild-Scholten, M.J.; Fthenakis, V.M., 2006).

They can mostly be used in buildings; started to be applied on roofs and facades. Since buildings which are architectural products are very effective in the pollution caused by the energy they consume and the depletion of the reserves and almost half of the energy used in the world is consumed in the buildings. Approximately this rate is 30% in all energies (A.K.Shukla, K.Sudhakar, P.Baredar., 2016). To use PV systems in the most efficient way, it is necessary to pay attention to the design criteria, to position the building in the most efficient way and to integrate them into the design. This phenomenon leads to a great responsibility for architects who are building designers. Today, although there are major advances in energy-conscious building design, it is known that the development process of passive and particularly active approaches in energy use is still in its early stages (Benson, D.K.; Branz, H.M., 1995). The integration of photovoltaic systems that produce electricity while increasing the energy efficiency of the buildings, takes building technology to an advanced stage. These systems are called Building Integrated Photovoltaic Systems (Saranti, Theocharis, & Maria, 2015).

Today, although there are great advances in energy conscious building design, it is known that the development process of passive and especially active approaches in energy use is at the beginning stage. Integrating photovoltaic systems that generate electricity while increasing the energy efficiency of buildings takes building technology to an advanced stage (A.K.Shukla, K.Sudhakar, P.Baredar., 2016).

The trend seen in photovoltaic systems and building technologies in recent years shows that photovoltaic panels will be a building element. With this approach, the building envelope ceases to be an energy-consuming building element and turns into an energy-generating building component (A.K.Shukla, K.Sudhakar, P.Baredar., 2016). The building façade has an important role both in the creation of the architectural form and in terms of control between the interior and exterior environment. Therefore, the design of the façade is of particular importance in order to provide the required comfort conditions, these features have more importance especially in the construction with integrated photovoltaic system. Because in integrated systems, in addition to providing these features, it is also possible to consider the properties of photovoltaic systems that affect the system options and facade design (A.K.Shukla, K.Sudhakar, P.Baredar., 2016).

Many types of BIPV systems are available in the construction sector. Their applicability, usability and performance measures should be very well known in terms of extending their use in buildings. For example, a very recent type is the photovoltaic glass (PV glass) integrated into the building. This is a technology by which the glass itself contains photovoltaic cells based on transparent semiconductors, known as solar cells (Cannavale, Ubaldo & Francesco, 2017). The thickness of the glass, the degree of transparency, color combinations and photovoltaic technology results in a variety of PV glasses (Lampert, C.M., 2003). Such systems may have problems or deficiencies as well as benefits. Higher construction costs, necessity of high quality materials, costs of generating electricity, or solar systems' performance depending on weather conditions or how energy can be stored are such challenges (Cannavale, Ubaldo & Francesco, 2017).

As the architects or designers have responsibilities to achieve the energy-efficient design approach, they should be aware of all these ongoing technological advances, their applications and challenges. In this context, it is also necessary to learn whether these professionals know them and their knowledge is at which degree. So, it will be possible to extend their use in the construction sector in our country.

1.2. Purpose of the Study

The purpose of this study is to explore the knowledge of the professionals involved in architectural and engineering disciplines that have many responsibilities in the construction sector. The intended knowledge to be inquired is about photovoltaic systems integrated into the building (BIPV), their application methods and usage areas. The aim is and to rise their awareness on the usability of these systems in our country while showing/and inquiring them some examples of buildings with BIPVs in the world through a questionnaire. The study also covers a wide and critical overview of recent applications and research in literature to understand how they affect thermal and daylighting strategies. Combining the results of the survey and literature review, the study introduces the importance of photovoltaic systems technologies for energy efficiency, emphasizes the significance of these strategies for photovoltaic systems in the context of integration of building systems and investigates the integration of photovoltaic systems into the building facade considering the professionals' point of view in terms of discussing comments from architects and engineers.

1.3. The Content and Methodology

In the thesis prepared for this purpose, the survey method was applied and the professionals' awareness about the application and use of photovoltaic systems integrated to the building was examined. The first chapter introduces the subject, the research problem, the importance and purpose of the research. The content and the methodology of the thesis are also mentioned. The second chapter involves basic information about the definition, properties, and the use of photovoltaic systems integrated in the building; their technical features, development from the past to the present, system elements, their use in the structure their advantages and disadvantages. Integration of these systems to the facade and their types are emphasized, detailed descriptions are given for each of them. The usability of the system as a building facade is examined within the glass facade. The third chapter explains the survey questions, participants profiles, and comparison evaluations. Finally, a comparison between the literature and the information obtained from the professionals participating in the survey. The forth chapter mentions the results and analysis of the survey in detail. The participants are evaluated among themselves, discussing the results of architects and engineers; and comparative evaluations are made about the definition, application of solar energy and photovoltaic systems integrated into the building. The fifth chapter is the conclusion part including the results and evaluations.

CHAPTER 2

LITERATURE REVIEW

2.1. Definition and Technical Issues of BIPV

BIPV system is composed of photovoltaic modules which are assembled with solar cells. It is the energy-generating system. The system collects certain amount of sunlight and convert it to alternating electricity current with an additional component named inverter. That can function electrical devices directly. Electricity can be stored in DC batteries (Rebecca Jing Yang & Patrick X.W. Zou, 2015).

“Building integrated photovoltaic system generates electricity using solar energy from sunlight while is applied onto the building envelope as a part of it; (Oduyemi and Okoroh, 2016) meaning that it is integrated to the building skin. It is composed of phovoltaic panels/solar cells.” (Peng et al., 2013).

In other words, building integrated photovoltaic systems (BIPV) are components like traditional building elements (such as facade, roof, window) in the building envelope which becomes energy generating component. Since, PV modules form an integral part of the building envelope. PV modules replace the traditional building covering material and power generator. BIPV is inversely related to temperature and PV power output (C.Y. Huang, H.J. Chen, 2011).

BIPV system includes, pv module, load regulator, power storage system, current changer, backup power supply and network. (Figure 1a) “PV modules can be thin film or crystalline, transparent, translucent or opaque. Load regulators provide a charge controller to regulate the power in and out of the battery storage bank in standalone systems. The power storage system, consists of the power grid in service-interactive systems or several batteries in stand-alone systems”. The current changer converts power to achieve the DC output of PV modules to grid-compatible AC. The back-up power supply is like diesel generators and cuts off the grid (Strong Steven, 2016).

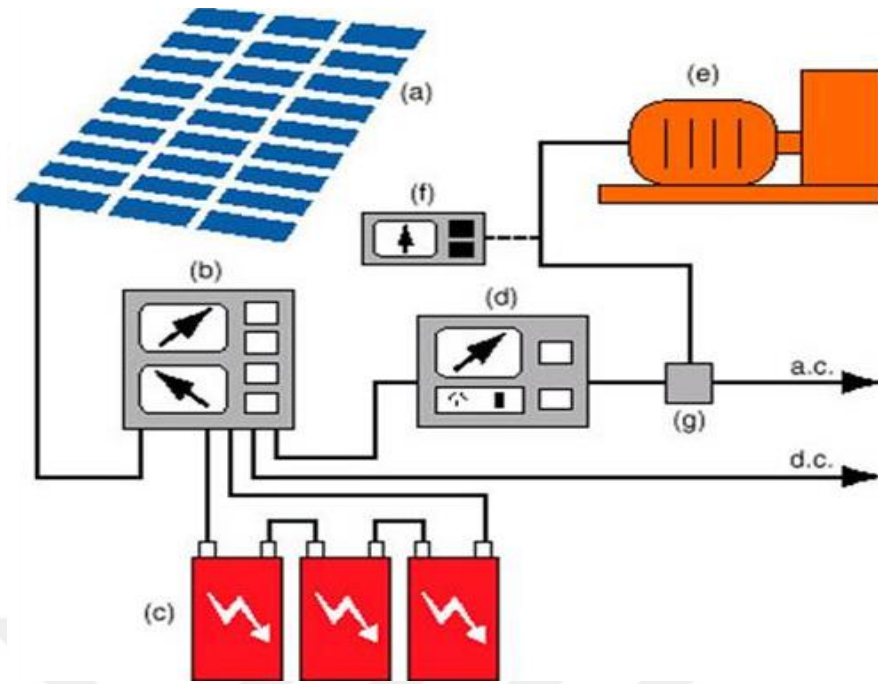


Figure 2.1. Components of a BIPV system (a-pv module; b-load regulator; c power storage system; d-current changer; e-backup power supply; f-network) (Strong Steven, 2016).

PV panels are integrated in the building envelope vertically (on the facade) or horizontally (on the roof). Their design varies in terms of their module sizes, geometry and colors (Roberts, S., Guariento, N., 2009). The aesthetic shapes of the photovoltaic cells, the variety of glasses and profiles, color alternatives and optical features provide modern appearance and creativeness to the buildings. Thus, buildings contribute to the environment producing clean energy (Polo C.S., Frontini F., 2014).

In BIPV systems, PV panels act as a direct shell element without the need for an additional coating material or suspension system on the building envelope. (Shukla et al., 2016).

BIPV systems have many basic functions in terms of efficiency, such as reducing energy losses during transmission, increasing energy quality and providing voltage control (Kang et al., 2016; Krawietz, 2011); in terms of building economy, such as reduction in construction material costs, reduction in building operating costs and labor costs, eliminating / reducing the space required for PV system installation (Gautam et al., 2015); in terms of socio-economy, such as creating a new market, providing new job opportunities, increasing public awareness about renewable resources in buildings, increasing educational opportunities, and adding prestige to the building (Ershad et al.,

2016); in terms of environmental, such as contributing to environmentally friendly green building design, providing carbon-independent energy production, and reducing the amount of greenhouse gases (Yoon et al., 2011); in terms of aesthetics, such as adaptation to architectural design, adding value to architecture, enabling innovative design and increasing design options (Shafii, 2011); in terms of architecture, as a building component; such as providing heat, water and sound insulation and solar control (Kang et al., 2016).

BIPV systems have some disadvantages as well as some advantages. One advantage of BIPV systems is to consist maintenance-free parts and not to require additional area for installation. Another advantage is to be easily connected to the electrical system of building. Transmission losses are at the minimum level due to energy consumption at the building site. As these systems are based on sunlight, any locations on earth receiving sunlight are appropriate for their use in buildings. Their existence in buildings offer value and prestige to the building and improves marketing opportunities of these buildings. Their disadvantages involve higher costs in design and installation, requirement of precise decisions of their and building design, immature and developing market movements, possibilities of affecting the physical structure and integration of the building with any bad design factors. They even can hold unwanted humidity and requires successful ventilation (Bıyık et. all, 2017). In BIPV systems, using PV modules as facade or roof components in the building has advantages such as; apart from the traditional function of the building envelope, it gains a system feature that can generate energy, adding a new dimension to building designs. Since PV modules can be produced in very variable sizes and structures, they can be designed in a wide variety of ways. To integrate PV modules into the structures, there is no need for an additional area or any mechanism to support the module (Verberne, Bonomo, Frontini and Donker, 2014).

PV modules are designed as transparent or semi-transparent, providing solar control of the building and contributing to gain passively, thus they can be produced in color, their visual effects make their use widespread. Since the PV modules integrated into the buildings are designed as a system connected to the grid, there are no battery costs that meet the storage need and these systems are seen as alternative systems in regions with high grid electricity transportation costs such as rural areas. (Jelle et al, 2012)

BIPV systems both should satisfy maximum efficiency for electricity generation and high architectural aesthetic values in building design at the same time. They formally, directly and visually affect the building components on the envelope. Their performance

depends on the direction and inclination angle of the PV panels. So, correct placement is the utmost concern by the professionals. The determination of the panel inclination angles and the final position of the BIPV on the façade are also the other criteria. Solar radiation falling on the panel surfaces is another item affecting the energy output of PV system (Zhang , Wang and Yang, 2018). So, professionals knowledge and awareness on these systems should be high enough to use them correctly and consciously.

Since the energy of the direct sunlight reaching the system is much higher than the diffused light coming from the sky, it is of great importance in terms of efficiency to be able to receive the direct sunlight as long as possible during the day and to ensure that the sun rays come at a right angle. For this reason, while choosing the appropriate place on the facade of the building, the geographical location of the building, the building form, the orientation of the building towards the sun, the direction of the PVs in the building shell, its slope (the angle it makes with the sunlight), the presence of natural and / or artificial obstacles that can cast a shadow on the system, etc. factors should be considered during design. The increase in panel temperature adversely affects the production of electrical energy. So, the prevailing wind can be used to reduce such temperatures (Shukla, A.K., Sudhakar, K., Baredar, P., 2016).

Common uses in building envelopes are generally roofs and facades. However, BIPV systems can be used in almost every part of the buildings depending on the building component and properties. Roofs are the most common areas for their application due to their high height and the low probability of having natural and / or artificial obstacles that can cast shadows around them. PV technology can be used directly as PV panels or it can be combined with classical roof coverings (tile, shingle, etc.) on both sloped and flat roofs. Facades are the vertical part of the building envelope, where glass, natural stone, ceramic, etc. can be used as PV panels instead of facing materials. The types of BIPV facade are; cladding systems, semi-transparent façade systems, louver systems and fenestration integrated systems. architectural elements suitable for BIPV use are; skylight, atrium, balcony, canopy, eaves, etc. can be listed as. (Verbene G. et al.,2014)

2.2. Roof Integrated BIPV

Rooftops are the best place in a building for BIPV systems. In roof applications of BIPV systems, the system is applied as roofing material as an integrated system on the roof (Wittkopf, Valliappan, Liu, Ang, Cheng, 2012). Almost 72 percent of roof products are made of crystalline type of pv panels as the technology and 8 percent of roof products are produced with thin-film panels. 20 percent of them involves an additional mounting system as the technology. (P. Bonomo 2015). In addition to the main purpose of roof applications being electricity generation to meet energy consumption, roof applications protect the building and roof against external weather conditions. It is generally easier and cheaper than facade applications. In roof applications, the intended angle of inclination can be reached much more easily without damaging the aesthetics and orientation can be achieved more easily unlike the facade applications. Another important advantage of roof applications compared to facade applications is that the heat created can be prevented more by ventilation of the back of the system panels more easily. (Verberne, Bonomo, Frontini, Donker, Chatzipanagi, Sinapis et al., 2014)

Roof applications of BIPV systems can be classified into 3 different types in terms of form: Flat roofs, Pitched roofs and Atriums/ Skylights (open space in the middle of the building, courtyard). Flat roof applications are systems that can be positioned with the intended angle of inclination, similar to open area applications. These systems are generally safer than small-scale open area applications and have lower values of shading factor effect. The suitability of physical and environmental conditions should be checked for the roof on which the installation is intended. (Wittkopf, Valliappan, Liu, Ang, Cheng, 2012) In Figure A, a flat roof BIPV system application in a library building at Fort Huachuca, AZ is shown (Abdallah, Delhotal and Holcomb, 2011).

For pitched roof BIPV applications, a different angle of inclination is generally not given, and roof slope is used. Today's latest technology is roof tiles (shingles) produced as solar cells. These PV tiles, which are more durable than traditional tiles, can generate electricity as a roof building element. In Figure B, pitched roof BIPV system application is shown. (Wittkopf, Valliappan, Liu, Ang, Cheng, 2012) In these systems integrated into the roof structure, waterproofing must be made under the PV modules.

Due to its slope, their efficiency is high, but in cold climates, calculations must be made in accordance with the snow load. (Sick and Erge 1996).



Figure 2.2. An example of a flat roof BIPV system (Abdallah, Delhotal and Holcomb, 2011).



Figure 2.3. The pitched roof BIPV system application (Source: URL 1).

The important point in atrium applications of BIPV roof systems is that the PV modules used as skylights on the roof should be designed with semi-transparent properties to provide indoor lighting. It is frequently applied in large shopping malls and hotels. PV modules can be designed as inclined to improve system efficiency. However, generally in atriums where steel structures are used, it is necessary to make structural calculations and take insulation measures against snow load in winter. Figure C shows an application of BIPV system in an atrium in Novartis Building (Wittkopf, Valliappan, Liu, Ang, Cheng, 2012) It is made of monocrystalline, semitransparent solar cells producing an energy output of 295 kilowatts (Hill, 2012).



Figure 2.4. Atrium BIPV system application (Djibo, 2018).

2.3. Façade Integrated BIPV

BIPV facade systems are useful and innovative solutions to provide active and passive benefits to buildings that are new construction or need to be strengthened. (Norton, Eames, Mallick, Huang, McCormack, Mondol and Yohanis, 2011). They basically provide many advantages to the building; such as, preventing losses in electricity generation. As the design of BIPV glass modifies, thermal envelope advantages can be achieved with energy savings of approximately 15–35%. (Jahanara, 2013). Depending on the illumination requirements, direct sunlight can be taken into the

building by using semi-transparent/translucent PV glass systems. Their acoustic performance is very similar to the performance of conventional facades in meeting the same standards for construction applications. Ventilated facade and double skin systems add aesthetic value to the building with the visual feature of silicone technology. Their installation is easy, they only need a simple mounting system consisting of aluminum staples, brackets and profiles. (Chatzipanagi, Frontini and Virtuani, 2016). Almost 34 percent of technology used in façade configuration is crystalline, 44 percent of them are made of thin films and percent of the technology is the mounting system (P. Bonomo 2017).

2.4. BIPV Types and Case Buildings

2.4.1. BIPV Facade Types and Case Buildings

2.4.1.1. Cladding Systems

Curtain wall systems are opaque, fully or partially glazed, non-ventilated and continuous building exterior systems consisting of panels supported by a substructure. The curtain wall system is an exterior building envelope system. It does not carry any load except its own weight. “A curtain wall is designed to resist air and water infiltration by dividing outdoor and indoor environments, and is typically designed with extruded aluminum frames (also steel, wood, etc.) filled with glass” (Passera, Lollini, Avesani and Marco, 2018).

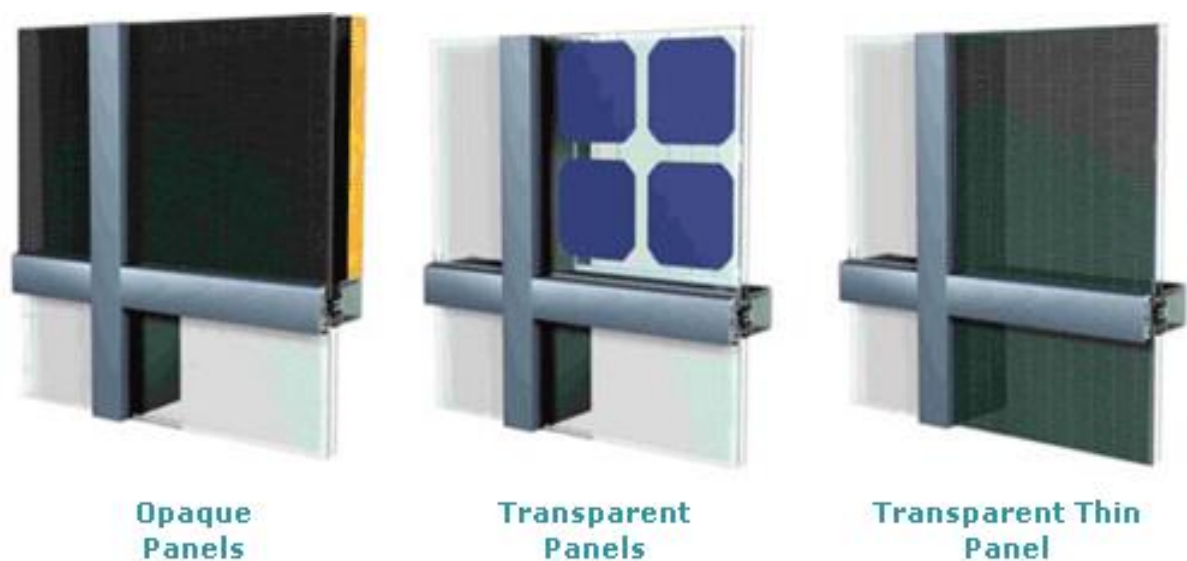


Figure 2.5. BIPV curtain wall systems (Passera, Lollini, Avesani and Marco, 2018).

Besides many advantages of these systems, there are some disadvantages as well. These systems maximize the performance of the facade wall for energy generation. Façade should meet all basic requirements such as; load-bearing function, acoustic and thermal insulation, light transmittance / balanced daylight reception, shading, waterproofing, etc. (Heinstein, Ballif and Perret-Aebi, 2013). It has to decrease solar heat gain during summer to balance the inside temperature (Montoro, Vanbuggenhout and Ciesielska, 2011). As a variety of colors can be used in BIPV cladding systems, the daylight quality inside the building is affected (Montoro, Vanbuggenhout and Ciesielska, 2011). On the curtain walls, residents inside can see outside; however, they are invisible from the outside, allowing the transmission of light without mirror-like coatings while providing complete privacy (Day and Night).

Installation costs of these systems can be high. Their design and construction is a complex task. Electric cables must be handled appropriately to prevent view obstruction. For this reason, opaque glazing is made in the column, beam fronts, parapet areas and the unwanted structure components behind are hidden (Heinstein, Ballif and Perret-Aebi, 2013). In Figure C, the schematic configuration of the BIPV curtain wall panel is given.

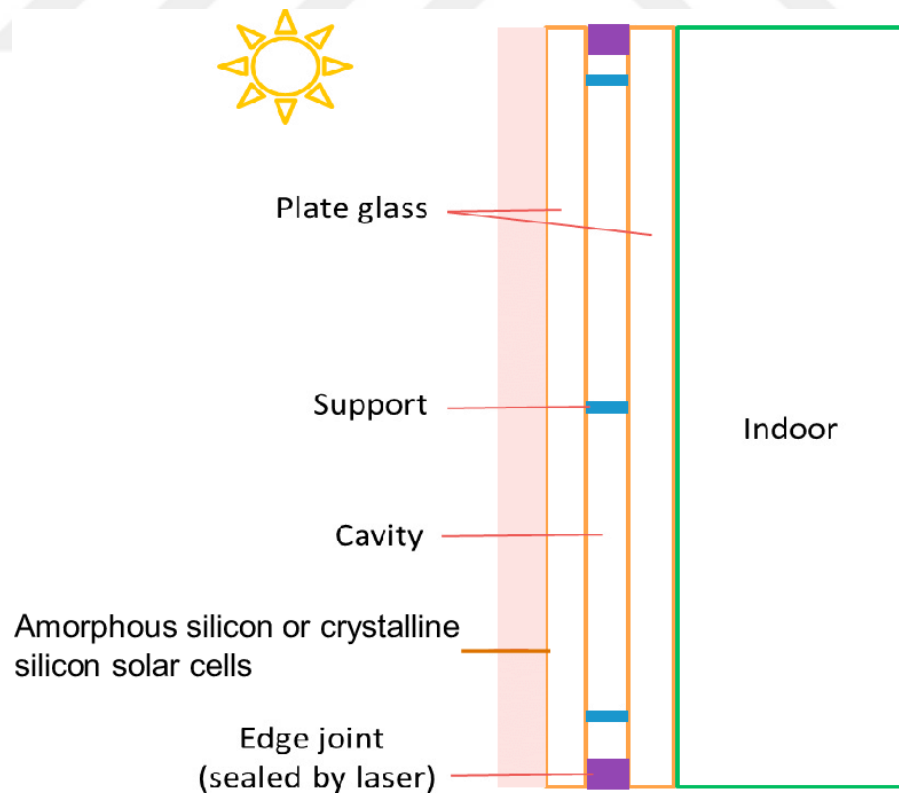


Figure 2.6. A schematic configuration of BIPV curtain wall panel (Xi Chen et al., 2019).

2.4.1.2. Semi-transparent Façade Systems

Transparent solar cells are installed as a part fenestration on the façade. They still provide view and daylight (Probst, Roecker, Frontini, Scognamiglio, Farkas, Maturi and Zanetti, 2013). Although the view provides a filtered vision, some types of pv cells act like thermal insulation layer in the glass pane (Montoro, Vanbuggenhout and Ciesielska, 2011) (Probst, Roecker, Frontini, Scognamiglio, Farkas, Maturi and Zanetti, 2013). They have additional functionality as a sunshade. Additional color and shading patterns may decrease the energy generation efficiency (Heinstein, Ballif and Perret-Aebi, 2013).

Transparency in these systems is achieved using some methods; The PV cell may be thin enough or laser-threaded to be visible. Translucent thin film modules or crystalline solar cells can be used in this laser process. The latter results in the color tones in the inside of the building to change continuously. The room remains shaded but not restricted. That affects the light quality inside the space. Being double or triple panes of glass together with these solar cells causes thermal and acoustic insulation. Some PV glass modules are competently multifunctional building components (Cannavale, Hörantner, Eperon, Snaith, Fiorito, Ayr and Martellotta, 2017).



Figure 2.7. Image of a structure with a semitransparent BIPV façade (Source: URL 2).

2.4.1.3. Louver Systems

Besides many advantages of these systems, there are also some disadvantages. They have the potential to minimize both building heat loads and energy consumption (Probst, Roecker, Frontini, Scognamiglio, Farkas, Maturi and Zanetti, 2013). They create interior comfort by refracting the disturbing light caused by the sun at certain hours with the vertical or horizontal sunshade provided on the windows (Montoro, Vanbuggenhout and Ciesielska, 2011). Building shading structure can be used as assembly to prevent additional load on the facade (Montoro, Vanbuggenhout and Ciesielska, 2011). They have potential properties as fixed or adjustable devices (Probst, Roecker, Frontini, Scognamiglio, Farkas, Maturi and Zanetti, 2013). (Montoro, Vanbuggenhout and Ciesielska, 2011). By allowing different shapes of PV modules, they add aesthetic value to the structure (Montoro, Vanbuggenhout and Ciesielska, 2011). However, the shadows falling from BIPV panels may need to be filtered to equalize the light distribution. If they are not transparent or translucent, they can obstruct the view.



Figure 2.8. Image of a structure with a sunshades/shading BIPV façade (Sheelamkhare, 2013).

In addition to aesthetic purposes, sunshades are also placed on the surfaces of the modern building to support the solar control glazing on the facade when the sun comes at right angles. Enriching the increasingly widespread solar shading systems with glazing containing solar cells enables both to reduce cooling loads and to obtain electrical energy. Heating with heat control or heat and solar control coated insulating glass units to be placed on the glass surface behind the sunshades minimizes cooling loads, and when the sun rays reach the building surface at right angles, sun breakers containing solar cells generate electrical energy while supporting cooling (Azadian F. et al., 2013).

2.4.1.4. Ventilated Facade in Eastern Bank, Dhaka, Bangladesh

The new corporate headquarters of Eastern Bank in Dhaka, Bangladesh features a slat-shaped amorphous silicon photovoltaic glass facade made by Onyx Solar. The facade sized around more than 500 m² consists of amorphous silicon glass modules with high transparency with low emission (low-e) placed with a lath system. While this provides thermal insulation, it ensures the uniform transmission of daylight to the building and prevents the undesired greenhouse effect inside. This glass is able to filter 99% of ultraviolet radiation and 85% of infrared radiation. It also has a Solar (g) factor between 5% and 40% depending on the degree of transparency. In the cities such as Dhaka where the temperature reaches 40 degrees, while allowing the transfer of daylight, it also balances the heat between inside & outside. The façade generates 22,600 kWh per year. That means a total of 1,300 lighting sources can operate and 15 tons of CO₂ released into the atmosphere are blocked. The total capacity of installed power is 12.5 kWp (<https://www.onyxsolar.com/eastern-bank>).

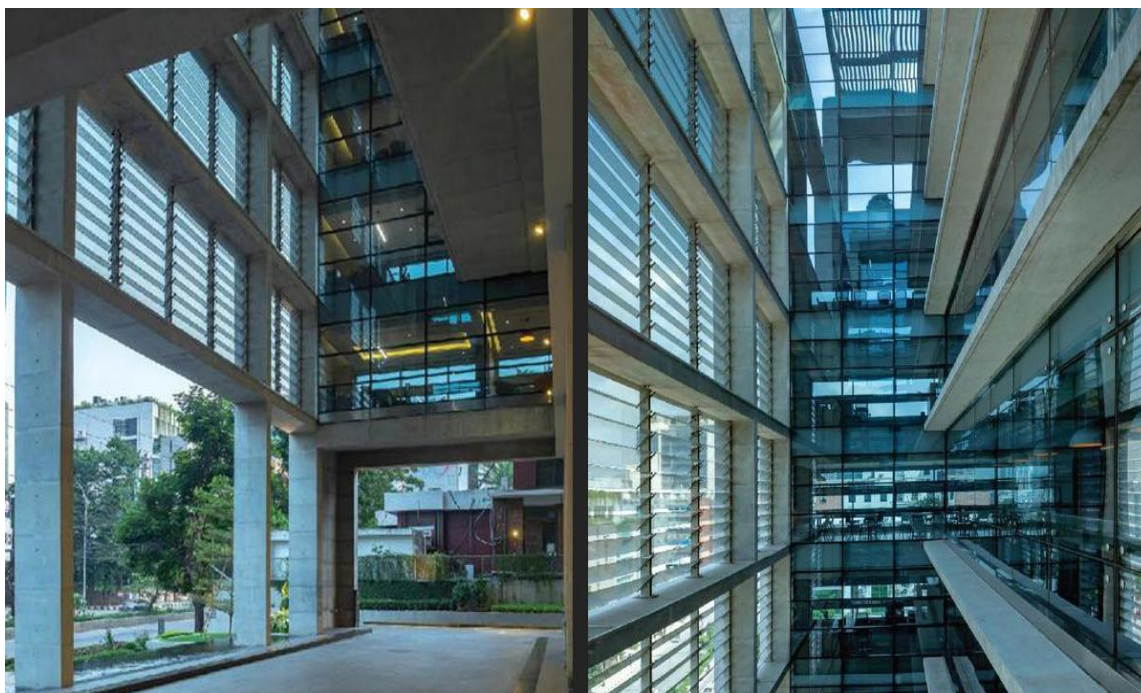


Figure 2.9. The image of Ventiladed Facade in Eastern Bank, Dhaka, Bangladesh
(Source: URL 3).

Table 2.1. The datas and feasibility studies of Ventiladed Facade in Eastern Bank, Dhaka, Bangladesh.

DATA:	
Total Area	476 m ²
Electricity generated in 35 years	656,530 kWh
Total lighting points operating 4 hours per day in 35 years	1,300 lighting points
CO₂ emmisions avoided in 35 years	440 tons of CO ₂
Barrels of oil saved in 35 years	386 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	< 0,01€
Reduction in HVAC energy demands	24%
Internal rate of return	57%
Payback	< 2 year

(Source: URL 3).

2.4.1.5 Ventilated Facade in Chamber of Commerce of Bolzano

This building is built in 2004-2006 in Bolzano; its architect is Wolfgang Simmerle. In terms of aesthetic integration, this building overlooking a central street of the city of Bolzano is characterized by the PV system forming a dark vertical band integrated into a highly visible façade, and by a variety of different façade materials marked with wire paths, creating a single surface, components such as sandblasted stainless steel panels, parapets, structural glazing, coupled windows and daylighting elements, creating a dynamic appearance.

In terms of energy integration, the energy produced in this building, which is CasaClima A + certified, is integrated in efficient thermal energy systems; such as heat pumps, boilers and cooling system. In terms of technology integration, these 13 modules of the Solarwatt (M234-108 GEG LK) type “are standard black glass-glass panels made of 108 monocrystalline cells. The PV plant is the top layer of an insulating element consisting of a metal sheet, an insulating layer and a concrete structure”. (<https://www.solarwatt.com/>). It provides natural ventilation and for this, 8 cm air gap is left between the panels and the sheet. These modules offer a holistic approach to the visual integration of the building by assembling as common curtain wall components.

“The integration of photovoltaic modules with the building facade represents a symbol of the Province of Bolzano for society and highlights the local energy policy aimed at sustainability through the use of renewable energy”. (<https://www.solarwatt.com/>)

Table 2.2. The datas and feasibility studies of Ventilated Façade in Chamber of Commerce of Bolzano Bangladesh.

PROJECT DATA	
Project type:	New construction
Building function:	Office
Integration system:	Ventilated Facade
BIPV SYSTEM DATA	
Module type:	Custom made modules
Solar technology:	Monocrystalline Silicum
System capacity [kWp]:	3.3

System size [m²]:	30
Module size [mm]:	1,290 x 1,775
Orientation:	South-West
Tilt [°]:	90
BIPV SYSTEM COSTS	
Total cost [€]:	26,800
€/m²:	890
€/kWp:	8,120

(Source: URL 4).



Figure 2.10. The image of Ventilated Façade in Chamber of Commerce of Bolzano Bangladesh (Source: URL 4).

2.4.1.6. Curtain Wall Facade in Heineken Factory, Mexico

Heineken Meoqui (Chihuahua, Mexico) factory is the greenest brewery in the world. The transparent photovoltaic glass of Onyx Solar used in the building generates clean electricity to feed the factory. In this building, the construction was completed in 2018 and by 2020, 66% of the energy comes from renewable sources. Transparent PV glass was assembled in the processing and office areas and provides the generation of the building's own energy. The glass has a perfect integration with the ability to customize in terms of shape, color, size, and degree of transparency (<https://www.onyxsolar.com/heineken-mexico>).



Figure 2.11. The image of Curtain Wall Facade in Heineken Factory, Mexico (Source: URL 5).

Table 2.3. The datas and feasibility studies of Curtain Wall in Heineken Factory, Mexio.

DATA:	
Total Area	2,365 m ²
Electricity generated in 35 years	862,273 kWh
Total lighting points operating 4 hours per day in 35 years	1,692 lighting points
CO₂ emmisions avoided in 35 years	578 tons of CO ₂
Barrels of oil saved in 35 years	386 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	< 0,01€
Reduction in HVAC energy demands	39%
Internal rate of return	110%
Payback	< 1 year

(Source: URL 3).

2.4.1.7. Curtain Wall Facade in Brynseng Primary School, Oslo, Norway

The construction of the primary school in Brynsengfare 10, 0667 Oslo, Norway was completed in 2013. In terms of aesthetic integration, this school with a capacity of 840 students, is a new building with a net area of approximately 11,600 m² and a six-storey multi-purpose sports hall on the upper floor. The system is applied into the south-facing façade and covers 37% of the school façade area. This PV coating is visible from afar and this feature gives it a demonstration value. Students and teachers can follow the power generation and consumption in the building. This follow up provides a pedagogical dimension feature between students and their teachers. The BIPV façade has a unique design, consisting of all black modules and using the fixing bracket. The PV module sizes and formats used in the project adapt to the entire building and give a holistic architectural impression. In terms of energy integration, the heat pump and ground well system meet 90% of the heating and hot water, the PV system meets 25% of the electricity consumption. The estimated annual PV production is 105 MWh (633 kWh / kWp). On weekdays all PV electricity is consumed while the school is in use. (<http://issol.eu>)

Table 2.4. The datas and feasibility studies of Curtain Wall Facade in Brynseng Primary School, Oslo, Norway.

PROJECT DATA	
Project type:	New construction
Building function:	Public
Integration system:	Curtain Wall façade
BIPV SYSTEM DATA	
Module type:	Custom made modules
Solar technology:	Monocrystalline Silicum
System capacity [kWp]:	166

System size [m²]:	1,046
Module size [mm]:	26 different, fr 400x664 to 2,760x980
Orientation:	South
Tilt [°]:	90
BIPV SYSTEM COSTS	
Total cost [€]:	828,000
€/m²:	792
€/kWp:	5,000

(Source: URL 6).

In terms of technology integration, frameless ISSOL CENIT220-6112 type PV modules consisting of standard black mono-crystalline silicon solar cells consist of 4 mm building approved safety glass and are specially produced in 26 different sizes. Modules are water insulated and ventilated. The initiative to implement a PV system in the building was taken by Undervisningsbygg Oslo KF, a real estate company owned by the municipality of Oslo (<http://issol.eu>).



Figure 2.12. The image of Curtain Wall Facade in Brynseng Primary School, Oslo, Norway (Source: URL 6).

2.4.2. BIPV Roof Types and Case Buildings

2.4.2.1. Flat Roof in Dongen Town Hall, Germany

This building is a town hall in Dongen, Germany. 288 customized semi-transparent PV modules are used on the roof of this building, which has a surface of 545 m² and a slope that starts at 5 degrees and ends at 10 degrees. These photovoltaic modules are made by Scheuten Solar Technology. There are insulation gaps and safety glass in the modules. “Each module has a surface of 1.8 m², a power output of 184 Wp and a weight of 100 kg”(https://www.enfsolar.com/scheuten-solar).

Table 2.5. The datas and feasibility studies of Flat Roof in Dongen Town, Germany.

DATAS	
Project Name:	Town Hall
Location:	Dongen -GERMANY
Latitude/Longitude:	51°37'56.27"N 4°57'32.23"E
PV power total:	53 kWp
PV application:	Integration of customized semi-transparent PV-modules

(Source: URL 7).



Figure 2.13. The image of Flat Roof in Dongen Town Hall, Germany (Source: URL 7).

2.4.2.2. Pitched roof in Folzano Kindergarten

The construction of this kindergarten, located in Via della Palla 11, Folzano (BS), Italy, started in 2008 and was completed in 2010. The Architectural Studio Pietrobelli and Zizioli Associated Architecture is responsible for the architectural project. And in the project, DAS Energy GmbH, Kalzip supplied photovoltaic modules integrated into the roof system. In terms of aesthetic integration, Folzano kindergarten is part of a large garden that connects it to nearby pre-existing buildings (the elementary school and the church). It has an oval planimetric conformation reflected on the roof where the photovoltaic system is located. The modules are integrated on metal plates arranged in a radial pattern that follows the geometry of the solar path. Other modules are also available on the roof of the bioclimatic greenhouse, a south facing area as a filter area close to the classrooms. The photovoltaic system can be seen from the surrounding town through the change in the height of the water table. (<https://www.kalzip.com/>)

Table 2.6. The datas and feasibility studies of Pitched roof in Folzano Kindergarten

PROJECT DATA	
Project type:	New construction
Building function:	Public
Integration system:	Opaque pitched roof
BIPV SYSTEM DATA	
Module type:	Custom made modules
Solar technology:	Amorphous silicon
System capacity [kWp]:	10.4
System size [m²]:	168
Module size [mm]:	5486x394
Orientation:	southeast
Tilt [°]:	5-40
BIPV SYSTEM COSTS	
Total cost [€]:	170 000
€/m²:	-
€/kWp:	-

(Source: URL 8).

In terms of energy integration, the building has reached Energy Class A. The installation of a photovoltaic system, along with other actions such as connection to the local district heating system that guarantees domestic hot water and heating, helped to minimize the energy needs of the building. Photovoltaic modules meet the majority of the electricity needs of the building with an annual production of approximately 12,000 kWh (<https://www.kalzip.com/>).



Figure 2.14. The image of Pitched roof in Folzano Kindergarten (Source: URL 8).

In terms of technology integration, Amorphous silicon photovoltaic modules are placed on metal roofing plates according to the Kalzip® AluPlusSolar system. The system, which also integrates an underlying insulation layer, does not require fixing components for the modules and guarantees protection for electrical cables that are positioned and inspected on the bottom surface. The single pitched roof, which is also the subject of an analytical study of climate and energy resources, has an increasing slope until it is exposed towards the sun. The main purpose of the project is to build an environmentally sustainable architecture by paying attention to energy saving, bioclimatic and the quality of life of the child. The morphology and orientation of the building was defined by the design team to make the most of the site's sunlight dynamics and less exposure to prevailing winds; the roof system follows the geometry of the solar path and transforms itself into a generative element of interior and exterior spaces. (<https://www.kalzip.com/>)

2.4.2.3 Skylight in Bell Works, New Jersey/ USA

This is a mixed used building restored to preserve its own characteristics. “It involves amorphous silicon photovoltaic glass panels with a total area of 60,000 ft². Glass modules installed in the skylight provide the building with plenty of daylight and also generate electricity without CO₂ emissions. It reduces the carbon footprint by preventing” approximately 60 tons of CO₂ from being released into the atmosphere annually (<https://www.onyxsolar.com/bell-works>).



Figure 2.15. The image of Skylight in Bell Works, New Jersey/ Usa (Source: URL 9).

Table 2.7. The datas and feasibility studies of Skylight in Bell Works, New Jersey/ USA.

DATA:	
Total Area	5,575 m ²
Electricity generated in 35 years	2,601,486 kWh
Total lighting points operating 4 hours per day in 35 years	5,111 lighting points
CO₂ emmisions avoided in 35 years	1,743 tons of CO ₂
Barrels of oil saved in 35 years	1,531 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	< 0,01€
Reduction in HVAC energy demands	19%
Internal rate of return	55%
Payback	< 2 year

(Source: URL 9).

The roof window contains a total of 24 types of glass modules, all of which are state-of-the-art, used in different parts of the building designed by Eero Saarinen. Each module is made of amorphous silicon thin film photovoltaic (a-Si PV) activated glass placed between two toughened safety glass. The modules transmit 20% Visual light (VLT) to reduce the heating of the windows while generating electricity. Built between 1959 and 1982, this building incorporated over 6000 engineers and researchers. The facility and its location have been studied as models of modernist architecture in universities. (<https://www.onyxsolar.com/bell-works>).

2.4.2.4 Skylight in Bejar Market, Salamanca/Spain

Food Market Bejar in Salamanca, Spain, has a 176 m² photovoltaic skylight made of amorphous silicon modules with different transparencies. It creates a mosaic inspired by Piet Mondrian's neoplasticism. In addition, due to its 6.7 kWp installed power capacity, it can produce approximately 9,000 kWh of energy per year and prevent 6 tons of CO₂ emission. Batteries store some energy and the rest is used for the energy needs of the building. (<https://www.onyxsolar.com/bejar-market>).





Figure 2.16. The image of Skylight in Bejar Market, Salamanca/Spain (Source: URL 10).

Table 2.8. The datas and feasibility studies of Skylight in Bejar Market, Salamanca/Spain.

DATA:	
Total Area	176 m ²
Electricity generated in 35 years	255,960 kWh
Total lighting points operating 4 hours per day in 35 years	502 lighting points
CO2 emmissions avoided in 35 years	171 tons of CO ₂
Barrels of oil saved in 35 years	151 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,02€
Reduction in HVAC energy demands	34 %
Internal rate of return	55 %
Payback	<2 year

(Source: URL 10).

2.4.3. Other Applications of BIPV and Case Buildings

2.4.3.1. Canopy in Beneteau Building Givrand

Beneteau Building, a shipping company, is located in Givrand - West Coast of France and was built in 2012 and completed in 2013. The architecture of the building belongs to F Periot Architect. In terms of aesthetic integration, the “two rectangular volumes are linked by a passage that defines a Zen garden. The main volume”, which expands to the south, is realized by a customized double skin. This is made of white acrylic stone, has special shading device panels mounted with 50% perforations and invisible connections. The texture of the panels put their signature on the project by redesigning the company logo. (<https://bipv.eurac.edu/it>)

Table 2.9. The datas and feasibility studies of Canopy in Beneteau Building Givrand.

PROJECT DATA	
Project type:	New construction
Building function:	The headquarter of the nautical company
Integration system:	Canopy
BIPV SYSTEM DATA	
Module type:	Custom made modules
Solar technology:	Monocrystalline Silicum
System capacity [kWp]:	36
System size [m²]:	435
Module size [mm]:	-
Orientation:	South
Tilt [°]:	90

(Source: URL 6).

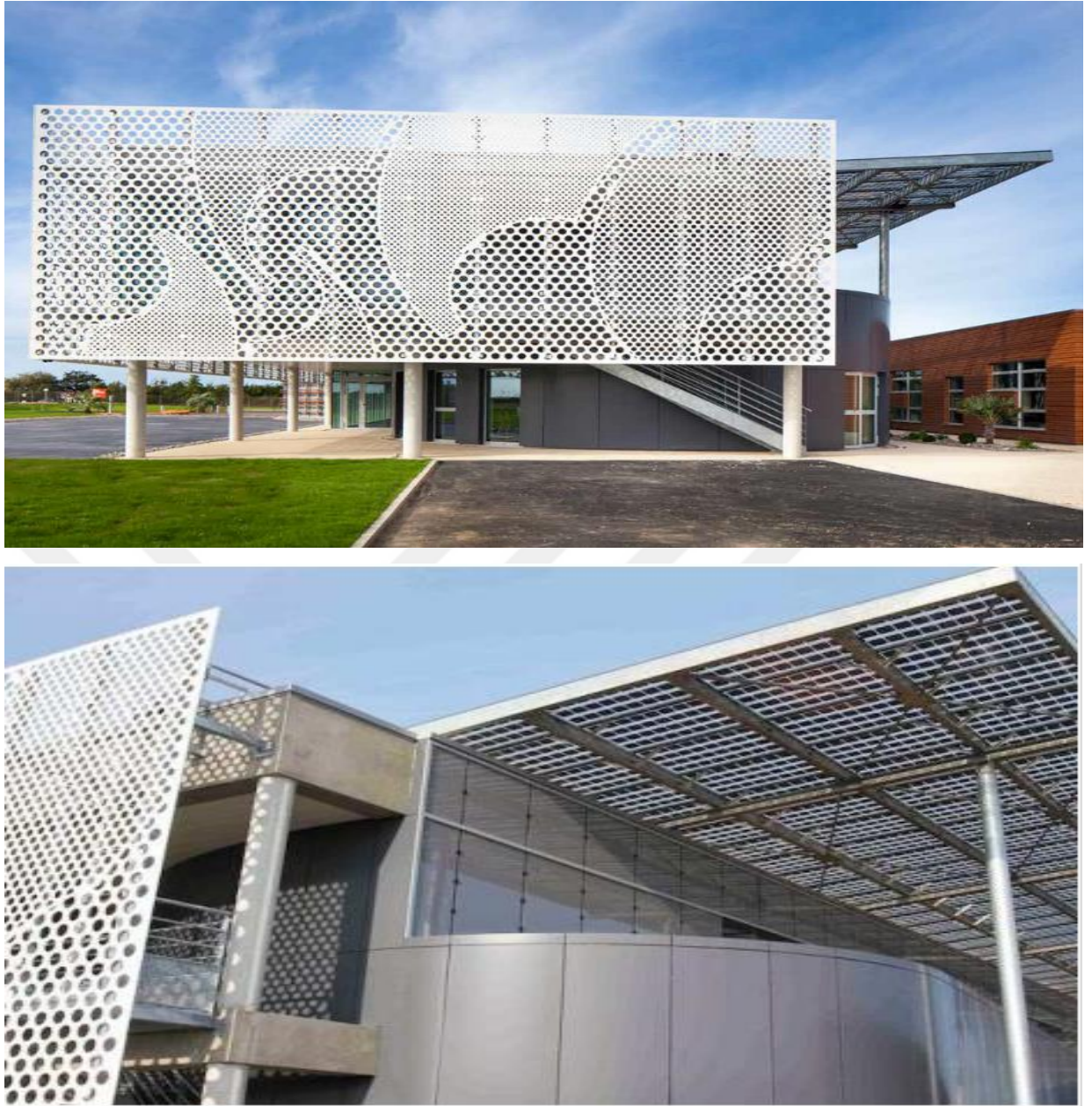


Figure 2.17. The image of Canopy in Beneteau Building Givrand (Source: URL 4).

In terms of energy and technological integration, “the back side of main building, overlooking the internal garden, is covered with a solar canopy emerging among the flat roofs. And it is a 64-meter continuous canopy realized with double glazed semitransparent solar panels installed on a steel structure”. Multicrystalline canopy PV modules, which have a deep black color, are produced by ISSOL. It covers a total area of 435 m² and its installed capacity is 36 kWp (<https://bipv.eurac.edu/it>).

2.4.3.2. Canopy in Mohammed VI University, Marrakech/ Morocco

Mohammed VI Polytechnic University is located close to Marrakech. The project was written by two world-renowned architects, Ricardo Bofill and Elie Mouyal. This 600 m² photovoltaic canopy was installed at the entrance of the building by OnyxSolar.

This canopy is made of glass modules of crystalline silicon. They are large in size. A single module contains 144 photovoltaic cells and is 626 Wp. This initiative is the firm's first project in Morocco and has been included in the "Green Cities" development plan by OCP. The new city has a surface area of 1,000 hectares and has a green area ratio of 20 m² per person (<https://www.onyxsolar.com/mohamed-vi-university>).



Figure 2.16. The Image of Canopy In Mohammed VI University, Marrakech/ Morocco (Source: URL 11).

Table 2.10. The datas and feasibility studies of Canopy In Mohammed Vi University, Marrakech/ Morocco.

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,01€
Reduction in HVAC energy demands	75 %
Internal rate of return	62 %
Payback	<2 year

DATA:	
Total Area	562 m2
Electricity generated in 35 years	3,921,750 kWh
Total lighting points operating 4 hours per day in 35 years	7,693 lighting points
CO2 emmissions avoided in 35 years	2,628 tons of CO2
Barrels of oil saved in 35 years	2,308 barrels per m2

(Source: URL 11).

2.4.3.3 Canopy in Boat on The Lake of Sanabria, Zamora, Spain

"Helios-Sanabria" is the world's first wind and solar powered catamaran. Spain has the latest technology for taking "excursions on Lake Sanabria in Zamora. The catamaran has several green crystalline silicon photovoltaic glass modules manufactured by Onyx Solar® with a 38% translucency rating. This ship is 100% environmentally friendly, with zero emission, waste, waste water and environmental noise rating with zero decibels" (<https://www.onyxsolar.com/photovoltaic-boat-sanabria>).



Figure 2.18. The image of Canopy in Boat on the lake of Sanabria, Zamora, Spain.

(Source: URL 12).

Table 2.11. The datas and feasibility studies of Canopy in Boat on the lake of Sanabria, Zamora, Spain.

DATA:	
Total Area	3 m ²
Electricity generated in 35 years	32,246 kWh
Total lighting points operating 4 hours per day in 35 years	63 lighting points
CO2 emmissions avoided in 35 years	22 tons of CO ₂
Barrels of oil saved in 35 years	19 barrels per m2

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,01€
Reduction in HVAC energy demands	77 %
Internal rate of return	51 %
Payback	<2 year

(Source: URL 12).

2.4.3.4. Photovoltaic Floor in Manhattan Penthouse, Manhattan

A photovoltaic walkable floor was installed in the penthouse renovation in this residence. The project was created together with Solar Deck combining different and sized pieces of photovoltaic glass in the outdoor area of the terrace. Up to 50 pavers of different sizes are placed on a surface of 20 square meters (215 square feet). LED lighting intensifies the vibrant colors of the units. It successfully satisfies design norms of safety and anti-slip regulations and is visually integrated into the building design (<https://www.onyxsolar.com/manhattan-penthouse>).

Table 2.12. The datas and feasibility studies of Photovoltaic Floor In Manhattan Penthouse, Manhattan.

DATA:	
Total Area	20 m ²
Electricity generated in 35 years	21,003 kWh
Total lighting points operating 4 hours per day in 35 years	41 lighting points
CO2 emmissions avoided in 35 years	14 tons of CO ₂
Barrels of oil saved in 35 years	12 barrels per m2

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,01€
Reduction in HVAC energy demands	19%
Internal rate of return	55%
Payback	<5 year

(Source: URL 13).



Figure 2.19. The images of Photovoltaic Floor In Manhattan Penthouse, Manhattan (Source: URL 13).

2.5. Application Criteria of BIPV

There are some factors to consider such as field analysis, technology analysis and product selection in addition to installation criteria of BIPV systems which affect the performance of PV modules and the appearance of the structure (Bulut, 2019). Location and direction selection, climate data analysis, shading analysis are performed in field analyses.

Location and direction of photovoltaic materials are carefully considered since the intensity of the radiation and the angle of arrival are the initial parameters required for a PV system to generate electricity. As part of the design process, we can consider the inclination and orientation of the facades that will contain PV modules as the start of the project. The maximum efficiency direction that the building can achieve on the land should be determined and the structure should be directed accordingly. For installations

in the northern hemisphere, facing south is the first priority for photovoltaic applications. Generally, it is said that 10° below the latitude degree can be taken for the most suitable angle of inclination in PV systems. (Simon & Guariento, 2009; Thomas et.al, 1999).

Radiation and temperature affects the performance in terms of climate data analysis. Power of PV modules is directly proportional to radiation. In terms of shading analysis, roofs and facades are areas with high shading rates. Many factors, such as any chimney on the roof, concrete ledges, shadows that other buildings drop on the facade, prevent the PV system from working at optimal performance. Planning as much as possible by placing PV systems on the south facade of the building and planning other buildings with higher floors to the north of the building in front of it will minimize shading. (Simon & Guariento, 2009; Thomas et.al, 1999).

There are many PV module technologies and each of these PV modules has different features in terms of technology analysis. PV characteristics should also be included in the calculations. For example; although the efficiency of PV modules with crystal technology is higher, their performance under shadow is lower than PV modules with thin-film technology. To obtain the best performance, many different PV module technologies and the design should be chosen according to the different features of each of these PV modules (Simon & Guariento, 2009; Thomas et.al, 1999).

2.6. Performance Evaluations

An example of the performance analysis of BIPV systems is presented here. The ATC office building in Turin, Italy, built between 1969 and 1972, is considered. This building has 10 floors (without with 2 basement floors) approximately 35m high and 6840 m² net area. The building has an online electricity consumption metering system set up as part of the EU-funded Policy project, including Politecnico di Torino. The purpose of this project is a detailed analysis of the electrical energy consumption of buildings. (Masoero, Silvi and Toniolo, 2010) To explain the effect of BIPV systems in cooling-heating and lighting, PV arrays were mounted on south facing floors and 7 floors on the southwest side and calculations were made with the DesignBuilder simulation programme. (Erdoğan, 2009) (Figure 2.17.)

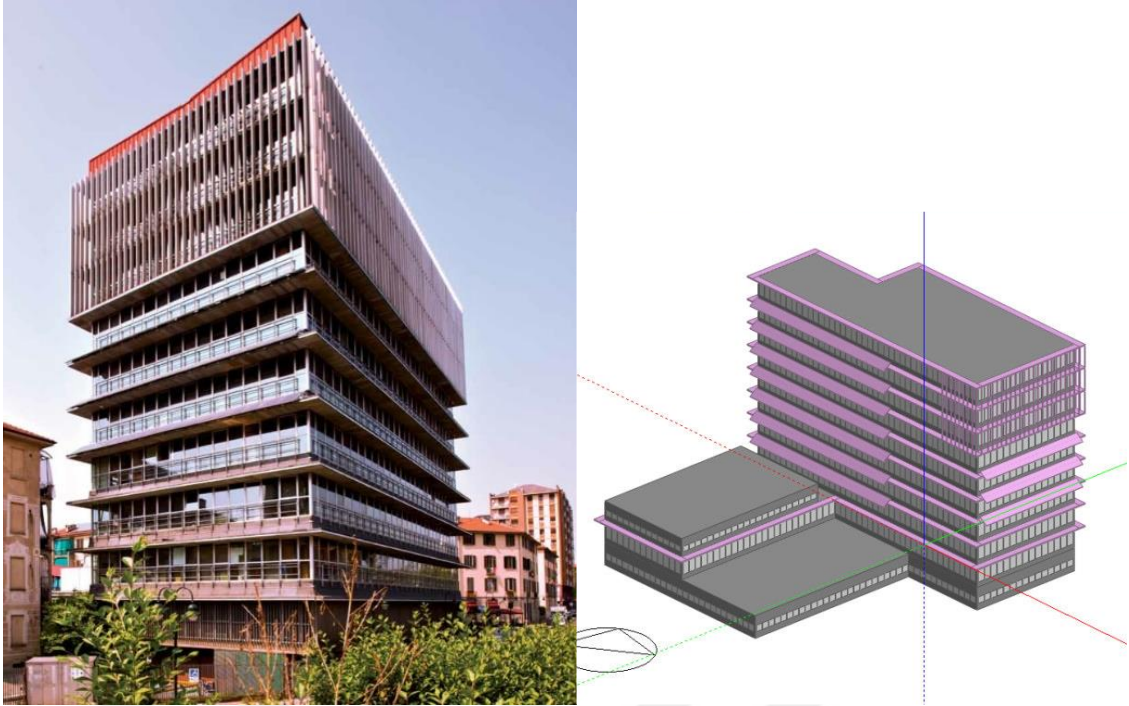


Figure 2.20. Image of ATC Office Building (Masoero, Silvi and Toniolo, 2010) and its model with PVs (Erdoğan, 2009).

The ATC office building, which is considered within the content of performance analysis, includes the results of changing rates by comparing heating & cooling loads, lighting loads and annual electricity consumption, PV electricity generation, total consumption, PV panels impact rate, usage rate of PV panels with and without PV system are given. The rate of change of values resulting from PV-free and PV-based cooling, heating and lighting loads and the shading effect of PV panels are calculated in the simulation. The benefit for the cooling loads have become 1.49 % ; on the other hand, increase in heating load has been 0.63 %. Similarly, lighting loads have changed with a ratio of 1.27 % (Erdoğan, 2009).

In Table 2.17, annual electricity consumption without and with PV, PV electricity generation, total consumption, PV panels effect rate, usage rate of PV panels are given. PV panels satisfy almost 10.14 % of the annual energy needs and electricity consumption is decreased almost 11.41 %. According to this, as the PV panels are on 3th and 7th floors only, researchers concluded that the benefit ratio of PV panels to electricity generation and cooling, heating and lighting loads is much higher (Erdoğan, 2009).

Table 2.13. Performance table calculated by the researchers

ATC BUILDING	WITHOUT PV CONDITION	WITH PV CONDITION	CHANGE RATIO
ANNUAL ELECTRICITY CONSUMPTION (kWh/m ²)	65,52	65,45	
PV ELECTRICITY PRODUCTION (kWh/m ²)	0	7,41	
TOTAL CONSUMPTION (kWh/m ²)	65,52	58,04	- 11,41 %
EFFECT RATIO OF THE PV PANELS	-	-	+ 1,27 %
UTILITY RATIO OF THE PV PANELS : - 10,14 %			

(Erdoğan, 2009).

2.7. Market Opportunities and Their Applicability

The BIPV market has been growing rapidly in recent years. The reason for this growth is the introduction of new environmental regulations which aim to minimize energy consumption and increase energy efficiency with increasing pressures in the building sector in order to reduce CO₂ emissions (Petter Jellea B. et al, 2012). The countries in Europe and the United States, dominate the BIPV market. They recently generate for around 70% of the worldwide market share. (Verbene G. et al., 2014).

Market growth at the country level depends mainly on regional and national policies. Some European countries such as Spain, France, Italy, Germany, Austria and Greece introduced their own tariff-guaranteed systems to increase the BIPV installation in their respective countries (Petter Jellea B. et al, 2012). “The percentage share of the global BIPV market is estimated to be 44% in Europe, 28% in Asia-Pacific and 16% in the USA in 2020”. For other regions such as China and Japan, investment growth will be slower but will still represent attractive markets (European Commission as Project Deliverable D1.1, 2016). BIPV market share by region is shown in Figure 2.8. In Table 2.10, the information of BIPV application capacities according to the countries between the years of 2014-2020 are shown.

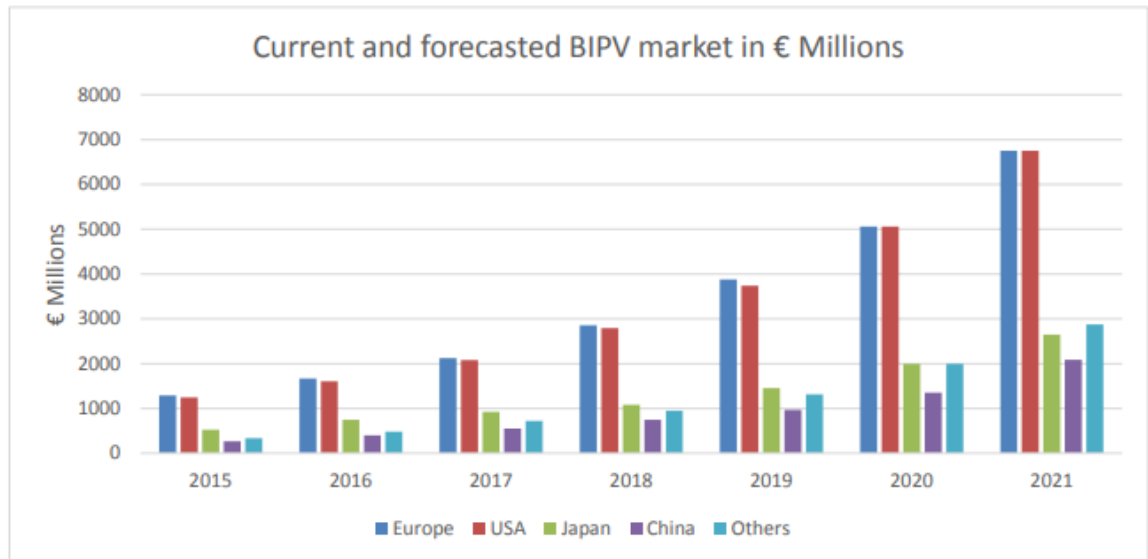


Figure 2.21. Current and forecasted BIPV market by region in € million.
(European Commission as Project Deliverable D1.1 in October 2016).

The growth of BIPV market continues because of developments in construction works.. The demands among residential and commercial owners to “go green” and achieve “national energy efficiency” targets are also factors that support this growth. (Nallapaneni Manoj Kumar, K. Sudhakar & M. Samykano, 2018). Changes and developments in market factors leads to intensive research and development aimed at creating BIPV products of various colors and sizes. (Bonomo P. et al., 2014). Working applications of BIPV components in the construction industry should ideally be produced as similar as possible to existing building components and conformed to their requirements (Bonomo P. et al., 2015).

Table 2.14. Global BIPV Market perspective and the recent past of annual installation capacity (in kW) from 2014 to 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

(Global Industry Analysts 2015).

Multi-storey buildings (such as multi-storey buildings or residential blocks) affect the application potential of PVs because of less roof space to satisfy energy performance needs. So, façade applications should be dominant. (Marek Kryszak & Lai Wang Wang, 2020) In relation to that, benefits of BIPV market growth might be reductions installation cost, improved aesthetics, higher technical potential, solar industry interest and better government support. Figure 2.19 shows a market perspective about roof, façade and glass applications through years. This graph also shows that the market will increase by 40% in the next ten years (Ballif et al, 2018).

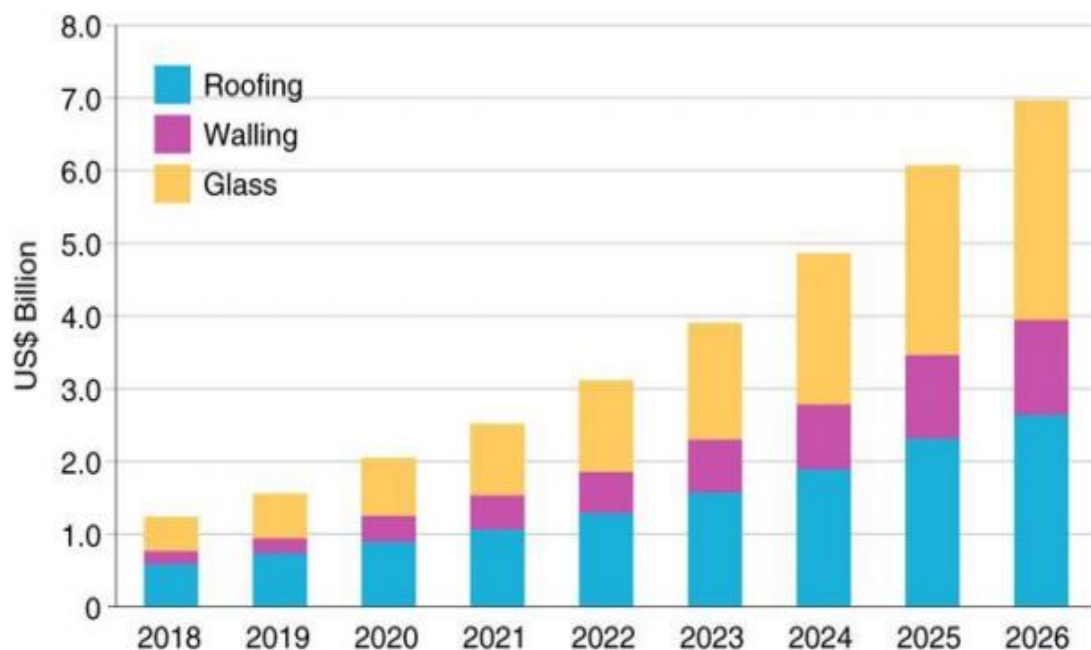


Figure 2.22. Global BIPV market perspective (2018 – 2026); from: Integrated thinking for photovoltaics in buildings, (Ballif et al, 2018).

CHAPTER 3

THE METHODOLOGY

This section includes the methodology of four subsections: survey questions, BIPV and sample buildings, participants and benchmarks. First, the purpose of this survey, what type of questions it contains, and the approximate response time were mentioned. And detailed information is given about the contents of the questionnaire, which consists of 3 parts. Then, by giving information about the sample buildings related to the BIPV system used in the questionnaire, the application methods of these buildings and the reasons for choosing them as examples were explained. In the next section, the answers to the survey questions are analyzed according to what criteria they are evaluated according to.

3.1. Questionnaire

This survey assesses the awareness of the application and usage of photovoltaic systems integrated into the building by professionals with professional identities of practitioners and academicians in professional groups of architectural and engineering disciplines. Participants were asked 35 main questions about solar energy, BIPV systems and applications, including multiple choice, matching, true-false questions and comments, taking into account their gender, age, eye defects and the visual aids they use. Sub-questions were also asked to support some of the questions. The questionnaire consists of a total of 57 questions, 24 of which are multiple-choice, 27 of which are comments, 4 are matched, and 2 are true / false questions. In this survey, an online survey system named “Surveyey” was used, where single and multi-question (Multiple choice, matrix, text, form, e-mail, ready list etc.) surveys can be created, time and quantity limits can be set for surveys, and various visual templates can be selected while creating the survey.

In this survey, the responses of the professionals to the multiple-choice questions were proportionally graphed, while their responses to the interpretive questions were tabulated. These tabulated responses were then compared between architecture and

engineering groups, practitioners and academicians, and more detailed tables were created. By comparing the answers given by the participants and the information contained in the scientific explanations, it was measured whether the participants knew the BIPV systems and how much they had commanded them.

3.1.1 Questions

The questionnaire consists of 3 sections (Appendix A), which include the general definition of solar energy, the general definition of photovoltaics integrated into the building, and the application of integrated photovoltaics to the building.

The general definition of solar energy in Section (A), by the general definition of solar energy (Shuklaa et.al, 2018), according to the participants made this recognition, whether Turkey is eligible to use the sun's energy, in which areas solar energy is used (Henemann, 2008), application / tools that use solar energy in Turkey, how solar energy is used, expectations from solar energy in building design, what needs to be done to effectively start solar architecture (Henemann, 2008), and applications of solar energy technologies were asked (Henemann, 2008) (Question 1 - 6).

In the general definition of photovoltaic integrated into the building section (B), before defining BIPV systems, participants were first asked if they had heard of the BIPV system before, and awareness of this system was measured in a general sense, as a percentage (Question 7-19). Then, a general definition of BIPV systems is made by using the relevant literature (Oduyem and Okoroh, 2016; Peng, 2013), and to the participants, whether they know any examples of BIPV systems implemented in the world and in Turkey, whether there are projects for which they have implemented BIPV system, general application areas of BIPV (Yang and Athienitis, 2016), building-based application areas (Vats and Tiwari, 2012), usage areas of facade and roof BIPV product group / system group (Zanetti and Donker, 2017), photovoltaic glass types related to application details and optical properties (Skandalos, Karamanis, 2015), classification of BIPV products as market names (Joseph, Pogrebnaya and Kichonge, 2019), and the obstacles and strategies (Jelle, Breivik and Rokenes, 2012) to BIPV development were asked.

By asking question 18 to match the names of BIPV products (foil, tile, glass, module) with their visuals, it was asked to evaluate whether the participants had correct

information about these products and their visuals in the main elements of the building. Figure 3.1 in these images showing the different facade applications of BIPV systems which building is not known, the option "a" shows building foil applications made of thin-film cells with low efficiency and low installation cost, light and flexible, adhesively mounted and suitable with large roof openings. The option "b" shows the tile application with an integrated panel of poly or monocrystalline cells, which are usually installed on roofs or parts of the roof and are suitable for retrofitting. The "c" option shows the glass application that is used in windows, glazed or tile facades and roofs, can transmit daylight for the options of using natural lighting while generating electricity, and offers aesthetic options with customized modules regarding the shape, cell material, color and transparency level in its production. The option "d" shows the module application, which is similar to conventional PV modules and is an opaque, cheapest form of integration made with weatherproof skin solutions commonly used in roofing, and looks better than external frames.

In the application of photovoltaic integrated into the building Section (C), information about the basic functions of BIPV systems (Kang et al. 2016; Krawietz, 2011; Gautam et al. 2015; Ershad et al. 2016; Yoon et al. 2011; Shafii, 2011) is given, as well as generating electrical energy. In order to measure the differences in application of BIPV systems, which of the visuals with BIPV (photovoltaic integrated into the building) and BAPV (photovoltaic attached to the building) system is BIPV system (Joseph, Pogrebnaya and Kichonge, 2019), identification with BIPV facade types and matching the visuals (Attoye, Anissa, Kheira and Hassan, 2017), curtain wall facade example, ventilated facade example and ceiling lighting sample (<https://www.onyxsolar.com/>) was asked which of the images is the correct option (Question 20-25).

For example, with these images selected for question 20, participants were evaluated whether they knew the separation of photovoltaic systems, which were performed in two separate forms: adding to an existing building afterwards (Building Added PV, BAPV) or integration with the building during the design phase (Building Integrated PV, BIPV). In option "a", adding to an existing building afterwards (Building Added PV, BAPV) is included, as well as in option "b", building during the design phase (Building Integrated PV, BIPV) (Figure 3.2).

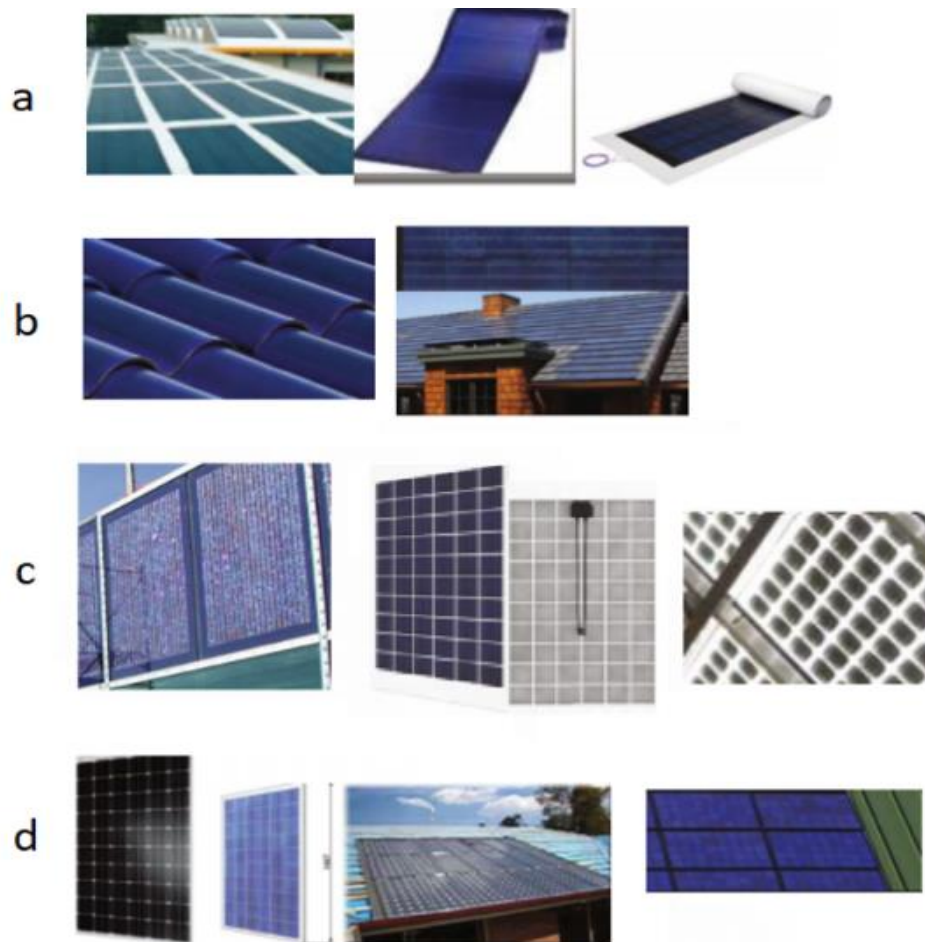


Figure 3.1 Images for Question 18.; Market names according to the products of BIPV systems (Joseph, B., Pogrebnaya, T., Kichonge, B., 2019).



Figure 3.2 Images for Question 20; Differences between BIPV and BAPV system (Joseph, B., Pogrebnaya, T., Kichonge, B., 2019).

BIPV facade type names (sun glasses and windows, curtain wall / cladding systems, advanced / innovative building envelope systems, external devices / accessories) and visuals were requested to be matched from the participants and it was aimed to evaluate the ways in which BIPV facade types are used and whether they know the images of these uses correctly from them (Figure 3.3). In these images selected for question 22 in section (C) of the application of integrated photovoltaics to the building, the building in option “a” is the Hanergy Office (Attoye, Aoul and Hassan, 2017) building in Guangdong China, and it indicates the cladding systems with integrated solar panels as a traditional cladding system for single-layer facades or curtain walls. The option “b” indicates solar glazing and windows, with translucent or translucent parts of the facade applied depending on solar cell transparency, integrated into windows, glass panels for visibility or daylight. The building is the KTH Executive School AB built in Sweden (Attoye, Aoul and Hassan, 2017).

The option “c” (Kingsgate House London, UK) indicates sunscreens and blinds, spandrels, balcony railings, external devices/accessories consisting of visual and acoustic shield elements. The option "d" (Hanergy Headquarters, Beijing, China) shows advanced/innovative building envelope systems consisting of components such as double-skin facades, active facades, rotating or moving facade parts.

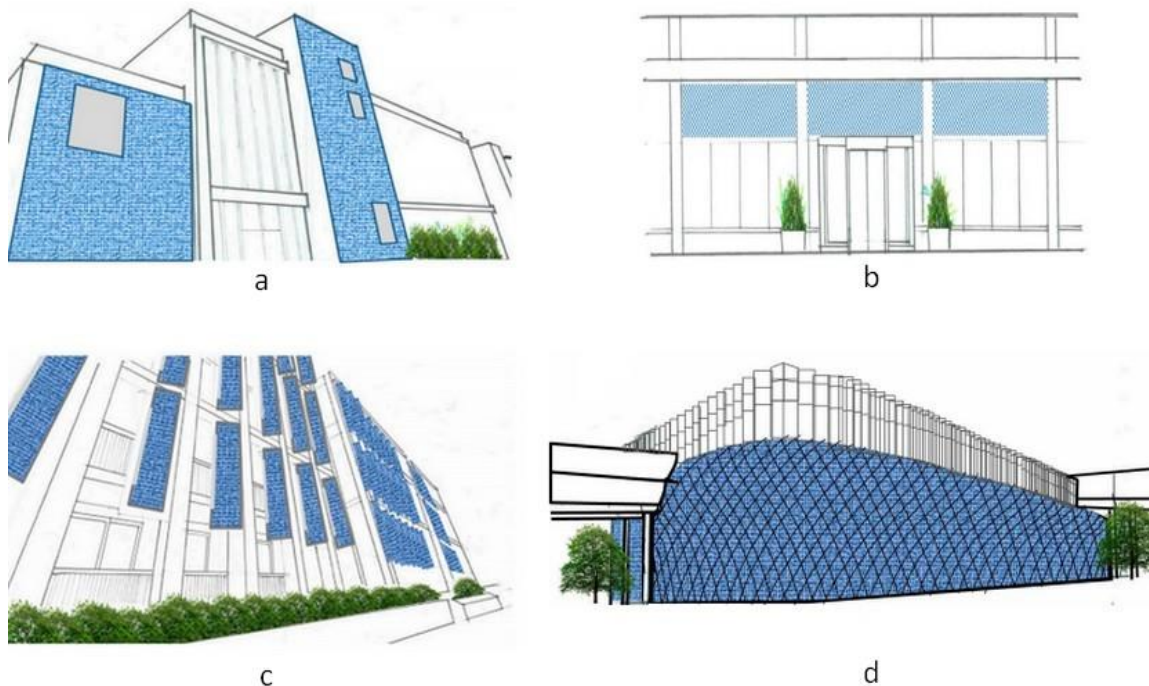


Figure 3.3 Images for Question 22; BIPV façade type (Attoye, Aoul and Hassan, 2017).

In the last questions (Questions 26 - 35), some building visuals were selected, question groups were formed about these visuals, and the participants were expected to comment on BIPV systems by making pairwise comparisons.

With these visuals given in the first question group, the participants were asked in which building or buildings BIPV was applied and whether the information given about these buildings (translucent module / thin film module, BIPV window arrangement / BIPV facade part) was correct. At the same time, whether they observe any difference in terms of visual integration of BIPV in these buildings, to be able to define these differences according to aesthetic reasons or material combinations, how these buildings look different from other traditional buildings, what they think about the facades of these buildings, which facade they prefer to construct / design has been asked. In addition, the reasons for their preferences in terms of electricity generation, visual or aesthetic issues / or physical application technique, whether roof or facade application is better in terms of energy generation efficiency, what they think about the cost-effectiveness of BIPV systems, which building provides us more benefits and the reason, in which building and why they want to live / work has been asked.

With these visuals given in the second question group to the participants, in which building or buildings BIPV is applied, whether the information given about these buildings (thin film modules / translucent modules attached to the roof light / facade) is correct, how they find the visual integration of BIPV in these buildings, to evaluate both buildings in terms of indoor lighting quality and visual comfort, in which interior space and why they want to live / work were asked.

In the third group of questions with an interior visual given to the participants, what color photovoltaic glass modules are used in this building, how they find the visual integration of BIPV in the interior volume of this building, evaluation of the interior of this building in terms of lighting quality and visual comfort of the interior, whether they would like to live/work in this place, whether a glass module produced in a color other than the color used on the facade of this building is used, whether there will be a change in the lighting / light quality of the interior, if there will be a change, whether they think that the color change will affect the energy efficiency of the photovoltaic module, the advantages and disadvantages of BIPV systems were asked.

3.1.2. Sample Buildings with BIPV

For the survey questions, various examples suitable for these topics were selected to measure their knowledge of the general definition of solar energy (A), general description of building integrated systems (B), and application of integrated photovoltaics to the building (C) the participants' knowledge of these topics and their contents was tested.

In the question in Part C (Question 23), 4 images that are very similar to each other in terms of facade application were given, and it was asked which building was a sample of curtain wall facade and whether the facade applied was a BIPV system sample. In this way, it was willed to evaluate whether BIPV facade systems look different from traditional buildings.

In the table of information for these buildings where the BIPV system is applied, the total area covered by the BIPV system, the electricity produced in 35 years, the total number of lighting points operating 4 hours a day in 35 years, the amount of CO₂ emission avoided in 35 years and the amount of oil barrel savings in 35 years are given. In the feasibility study tables, the energy cost calculation, the amount of reduction in HVAC energy demands, the present value of the net cash inflows to be provided during the economic life of a project, the internal profitability ratio that equates the current value of investment expenditures, and the payback year information indicating how many years the spent cost will be recovered are given.

The examples in “a”, “b”, “d” options are an example of a BIPV system with a curtain wall facade. The “c” option is a curtain wall facade application belonging to the traditional building "Core Bank Headquarters". The structure in option a is "The Life Science Building, University of Washington". Information on the structure is as in the table given below;

Table 3.1. Information About The Life Science Building, University of Washington.

DATA:	
Total Area	650 m ²
Electricity generated in 35 years	496,885 kWh
Total lighting points operating 4 hours per day in 35 years	975 lighting points
CO₂ emmissions avoided in 35 years	333 Tons of CO ₂
Barrels of oil saved in 35 years	292 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,04€
Reduction in HVAC energy demands	18%
Internal rate of return	35%
Payback	<2 year

(Source: URL 14).

The College of Arts and Sciences at the University of Washington is a 170,000 square meters of open and flexible laboratory space, designed by the architects Perkins + Will. It involves a combined 100 kW solar system and photovoltaic fin system on south facing façade. PV fins made by amorphous silicon solar cells are translucent and triple layered glass of 20% visible transmittance. Each fin offers 3.15 Watts per square foot. They are installed with junction boxes and cables without frames. (<https://www.onyxsolar.com/the-life-science>).

The structure in option “b” is " Brunel University London ". Information of the structure is as in the table given below;

Tablo 3.2. The information about Brunel University London.

DATA:	
Total Area	68 M2
Electricity generated in 35 years	38,063 kWh
Total lighting points operating 4 hours per day in 35 years	75 lighting points
CO2 emmisions avoided in 35 years	26 Tons of CO2
Barrels of oil saved in 35 years	22 barrels per m2

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,08€
Reduction in HVAC energy demands	15%
Internal rate of return	-
Payback	<4 year

(Source: URL 15).

Brunel University in London, is a 4,710 square meter building, founded in 1966. Transparent photovoltaic glass was installed in the curtain wall of the Brunel University Wilfred Brown Building. There are 42 pieces of PV glass in different sizes in the building; some reach up to 2.6 m wide. These glasses provide the transmission of light to the interior and also the clear view. Thermal interior comfort filtering has multifunctional passive bioclimatic properties of UV and infrared radiation from the sun. In this way, clean electricity is produced for the building by taking advantage of solar energy, which is one of the cleanest energy resources on earth (<https://www.onyxsolar.com/brunel-university>).

The structure in option “d” is "Seneca College - Center for Innovation, Technology". Information of the structure is as in the table given below;

Tablo 3.3. The information about Seneca College - Centre for Innovation, Technology

DATA:	
Total Area	47,4 m ²
Electricity generated in 35 years	34,570 kWh
Total lighting points operating 4 hours per day in 35 years	6,870 lighting points
CO2 emmissions avoided in 35 years	23 Tons of CO ₂
Barrels of oil saved in 35 years	20 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,05€
Reduction in HVAC energy demands	14%
Internal rate of return	15%
Payback	<6 year

(Source: URL 16).

The Innovation, Technology and Entrepreneurship Center (CITE) at Seneca College is a five-storey building designed by Perkins + Will Architects, started in 2016 and completed at the end of 2018, three floor for academic areas and two floor for administrative offices.

Transparent photovoltaic solar glass has been integrated into the 47.4 m² (510-sf) curtain wall on southwest facing facade. It consists of 18 PV glass panels made of amorphous silicon (a-Si) material. They are insulated in terms of thermal and acoustic issues and their transparency is defined as medium. “It can generate clean and free electricity to power 6,870 light points over 35 years. This 1.29 KWp capacity facility will produce 34,570 Kwh over 35 years and prevent 23 tons of CO₂ emission into the atmosphere” (<https://www.onyxsolar.com/seneca-college>).



Figure 3.4 Images for Question 23.

Fig. 23.a : (Source: URL 14).

Fig. 23.b : Source: URL 17).

Fig. 23.c : (Source: URL 15).

Fig. 23.d : (Source: URL 16).

In question 24, 4 visuals that are very similar to each other in terms of facade application were given, and it was asked which facade sample was applied with ventilation, whether it was a BIPV system or not. In this way, it was willed to evaluate whether BIPV facade systems look different from traditional buildings. The examples in the “a”, “b”, “c” option are the example of the BIPV system with curtain wall facade, while the “d” option is a curtain wall facade application of the traditional building " Gallery of Revival of the Casino of Montréal ".

The structure in option a is "DEWA - R&D Center in Dubai". Information of the structure is as in the table given below;

Table 3.4. The information about DEWA - R&D Centre in Dubai.

DATA:	
Total Area	1,000 m ²
Electricity generated in 35 years	490,597 kWh
Total lighting points operating 4 hours per day in 35 years	963 lighting points
CO₂ emissions avoided in 35 years	329 Tons of CO ₂
Barrels of oil saved in 35 years	289 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,01€
Reduction in HVAC energy demands	37%
Internal rate of return	22%
Payback	<5 year

(Source: URL 18).

This Research and Development Center is located in Dubai, designed by Stantec International and opened in 2014. As part of DEWA's commitment to sustainability, the building contains 1000 m² of photovoltaic glass manufactured by the Onyx Solar company. Onyx Solar amorphous silicon glass was applied on four facades of the building. The façade made of these many colored panels has been created, giving the building a unique effect. The glass is three layered with 30% visible transmittance.

“PV glass offers 28 Wp rated power per square meter and is installed in the façade with a frameless system. Each fin consists of several photovoltaic glasses of fixed width size of 800 mm and variable length, adapting each fin to the design of the facade. The PV fins are fixed to the facade with a steel tubular structure with a punch system supplied by Lilli Systems. The fins are tilted and rotated 31° from the vertical frontage to optimize the performance of the system and to avoid spontaneous shadowing situations. The location of the junction boxes is designed to ease the electrical installation of the system. The two entrance canopies on the north and west facades, the Onyx Solar company also integrated translucent glass to ensure visual continuity throughout the building. Due to the multiple irregular glass sizes that build the canopies, the glass is immobile but maintains the same aesthetic appearance with active units” (<https://www.onyxsolar.com/dewa-dubai>).

The structure in option “b” is " BURSAGAZ ". Information of the structure is as in the table given below;

Table 3.5. The information about BURSAGAZ.

DATA:	
Total Area	110 m ²
Electricity generated in 35 years	98,770 kWh
Total lighting points operating 4 hours per day in 35 years	194 lighting points
CO₂ emmissions avoided in 35 years	66 Tons of CO ₂
Barrels of oil saved in 35 years	58 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,03€
Reduction in HVAC energy demands	28%
Internal rate of return	19%
Payback	<6 year

(Source: URL 19).

Bursagaz is the company that leading the natural gas sector in Turkey, is expected to receive LEED Gold Certification for the new headquarters building, designed by 'Tago Architects'. Onyx Solar Energy company has provided an aesthetic sense to the building by placing double-layer photovoltaic glasses on the facade of the building in a mosaic manner. This glass that designed from amorphous silicon, consists of 315 amorphous modules measuring 500 mm x 700 mm (1.6 x 2.3 Ft). It has a translucency of 20%, which allows light to enter the building evenly and reduces the need for artificial light. Sunvital Energy company will be responsible for the installation of photovoltaic glasses on the front facade. This installation produces approximately 4.2 kWp to 5000 kWh per year. Bursagaz, the natural gas distributor of Bursa, develops innovative projects that contribute to a more sustainable future with the BIPV system application and ensures that the company is more preferred in the market (<https://www.onyxsolar.com/bursagaz-headquarters>).

The structure in option “c” is "Cyprus International University". Structure information is as given in the table below.

Table 3.6. The information about Cyprus International University

DATA:	
Total Area	938 m ²
Electricity generated in 35 years	967,689 kWh
Total lighting points operating 4 hours per day in 35 years	1,899 lighting points
CO2 emmissions avoided in 35 years	648 Tons of CO ₂
Barrels of oil saved in 35 years	569 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,02€
Reduction in HVAC energy demands	36%
Internal rate of return	43%
Payback	<3 year

(Source: URL 20).

The Science and Technology Center in Cyprus involves Building Integrated PV System, installed in a uniform plan configuration. In addition, photovoltaic glass units are mounted on the façade. They are made of crystalline silicon and has a size of 1.245x1.849 mm, a high degree of transparency. The total installation area installed on a facade with a total power capacity of 21.4 KWp is approximately 1,000 m². With this sustainable project, a sustainable education is promoted from the university. (<https://www.onyxsolar.com/ciprus-international-university>).

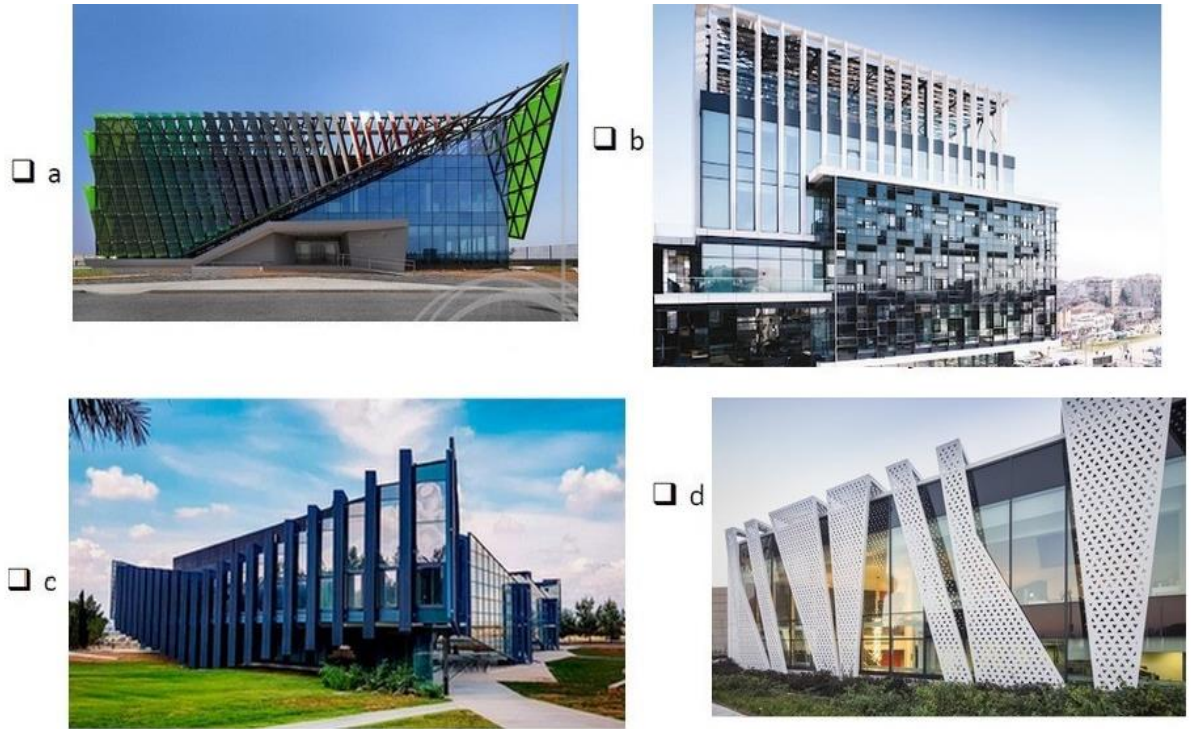


Figure 3.5 Images for Question 24.

Fig. 24.a: (Source: URL 18).

Fig. 24.b: (Source: URL 19).

Fig. 24.c: (Source: URL 20).

Fig. 24.d : Source: URL 21).

In question 25, 4 visuals that are very similar to each other in terms of roof application were given, and it was asked whether the roof (skylight is applied) of which building is a BIPV system sample. In this way, it was willed to evaluate whether the BIPV roof systems look different from traditional buildings.

The examples in” a”, “c”, “d” options are an example of a curtain wall facade applied BIPV system, the “d” option is a curtain wall facade application of "The Hague City Hall & Central Library", a traditional building designed by Richard Meier.

The structure in option “a” is "Headquarters of Novartis". Information of the structure is as in the table given below;

Table 3.7. The information about Headquarters of Novartis

DATA:	
Total Area	2,576 m ²
Electricity generated in 35 years	7,930,650 kWh
Total lighting points operating 4 hours per day in 35 years	15,582 lighting points
CO2 emissions avoided in 35 years	5,314 tons of CO ₂
Barrels of oil saved in 35 years	4,667 barrels

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,01€
Reduction in HVAC energy demands	26%
Internal rate of return	74%
Payback	<1 year

(Source: URL 22).

The NOVARTIS Headquarters building, located in New Jersey, United States, is the world's largest photovoltaic skylight sized 2,500 m² (26,909 sqft). This glass is installed as a second layer on top of the traditional roof glass that is already on the roof of the building. The skylight system consists of 820 photovoltaic glass units with perforated crystalline cells produced by following the demands of the customer. These skylights are convenient for maintenance operations and can be opened and closed.

The inclusion of this innovative technology allows the company to generate 273,000 kWh of energy per year equivalent to the energy used to light more than 600 homes per year, and avoid the emission of 186 tons of CO₂ into the atmosphere.

With more than 120,000 employees, Novartis is a worldwide reference for its sustainable practices and a leader among pharmaceutical companies in the Dow Jones European and World Sustainability Indices. And by creating job opportunities for 1600 people, The New Jersey campus, which supports research on the oncology field, promotes research and is one of the biggest references at the architectural level due to the efficiency of its buildings. The building was named Best Sustainable Project in New York in 2014 by Engineering NewsRecord (ENR), the leading global construction magazine of

McGraw Hill and the Standard & Poor's group (<https://www.onyxsolar.com/novartis-headquarters>).

The structure in option “c” is “ San Diego University - Center for Novel Therapeutics. Information of the structure is as in the table given below;

Table 3.8. The information about San Diego University - Center for Novel Therapeutics

DATA:	
Total Area	126 m ²
Electricity generated in 35 years	193,531 kWh
Total lighting points operating 4 hours per day in 35 years	380 lighting points
CO₂ emmissions avoided in 35 years	130 tons of CO ₂
Barrels of oil saved in 35 years	114 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,01€
Reduction in HVAC energy demands	43%
Internal rate of return	170%
Payback	<1 year

(Source: URL 23).

The New Treatment Center in the University of California, San Diego is built, designed by Perkins + Will, involves the photovoltaic skylight. It consists of amorphous silicon PV glass. It provides permanent protection against sunlight, UV and infrared radiation filters and weather conditions. The building has LEED Gold certification regarding its sustainable architectural features (<https://www.onyxsolar.com/center-for-novel-therapeutics>).

The structure in the “d” option is “ING DIRECT BANK”. Information of the structure is as in the table given below;

Table 3.9. The information about ING DIRECT BANK

DATA:	
Total Area	223 m ²
Electricity generated in 35 years	364,578 kWh
Total lighting points operating 4 hours per day in 35 years	715 lighting points
CO₂ emissions avoided in 35 years	244 tons of CO ₂
Barrels of oil saved in 35 years	215 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,02€
Reduction in HVAC energy demands	34%
Internal rate of return	55%
Payback	<2 year

(Source: URL 24).

ING Headquarters Building in Madrid integrated a photovoltaic skylight consisting of 78 amorphous silicon glass modules with a 20% of transmittance. It covers a surface area of over 200 m² (2.152 SqFt) with a power capacity of 7 kWp and can generate around 13,000 kWh of clean and free energy per year. That means it supports to operate around 700 lights in the building, preventing approximately 9 tons of CO₂ emission into the atmosphere.

The photovoltaic skylight filters 99% of ultraviolet radiation and 95% of infrared light, avoiding greenhouse effect. Its G value is between 20% and 40%, depending on the degree of translucency. This type of photovoltaic glass panels can support sustainable architecture and heals the environment (<https://www.onyxsolar.com/ing-direct-bank>).



Figure 3.6 Images for Question 25.

Fig. 25.a: (Source: URL 22).

Fig. 25.b: (Source: URL 23).

Fig. 25.c : Source: URL 25).

Fig. 25.d : (Source: URL 24).

In the first question group of the last interpretation questions that are expected to be commented by the participants about BIPV systems, by creating question groups with selected visuals and making comparisons between architects and engineers (Figure 3.7).

Option “A” is the state building named "Kulturhaus Milbertshofen" in Munich, Germany. The design company of this building, whose foundation was laid in 2002 and opened in 2004, is RPM-Architekten in Munich. Black micromorph and translucent thin film modules were applied on the facade of this building. The system provider for this photovoltaic application is 'VOLTARLUX', an international photovoltaic glass company. Photovoltaic modules are transformed into roof and facade solar power plants, while the translucent feature allows light to pass through, extremely low cost and high-performance thin-film elements fulfill all the functions of a modern outer shell. In this system, the energy output is 3 kWp. (Heinstein, Ballif and Perret-Aebi, 2013);

Option “B” is an award-winning pilot project named "Solar Haus Darmstadt (Germany)". This solar-powered house is a project created by Technische Universität Darmstadt students in Germany, which won the grand prize in the Solar Decathlon competition. A team of 24 architects and students used 40 single-crystalline silicon panels on the roof and facade and about 250 black CIGS thin-film modules for this two-story, cube-shaped house. This eco house design is also highly insulated and equipped with automated bright window shades to reduce unwanted heat gain. With these features, the structure provides 200% Plus Energy gain (Heinstein, Ballif and Perret-Aebi, 2013).

The purpose of our selection of these buildings is to show two different examples of BIPV applications that have become part of the facade. One is a black semi-transparent module curtain wall in the glazed area of the facade, and the other is applied in the form of coating panels of the curtain wall with thin-film modules. In short, the difference between the two structures is that structure A is curtain wall and structure B is the exterior siding. To the participants; defining these differences according to aesthetic reasons or material combinations, how these buildings look different from other traditional buildings, what they think about the facades of these buildings, which facade they prefer to construct / design, their preferences in terms of electricity generation, visual or aesthetic issues / or physical application technique, whether roof or façade application is better in terms of energy generation efficiency, what they think about the cost-effectiveness of BIPV systems, which building provides us more benefits and the reason of this, in which building and why they want to live / work topics were asked.



(A)



(B)

Figure 3.7 Images for Questions 26, 27, 28 (Heinstein, Ballif and Perret-Aebi, 2013)

(Fig. Left : Kulturhaus Milbertshofen, Germany: façade with black micromorph and semi-transparent thin-film modules, Energy output: 3 kWp, RPM-Architekten, System provider: Voltarlux, 2008. ; Fig. Right: Solarhaus Darmstadt, Germany: prize-winning pilot project from the Technische Universität Darmstadt with a 200% PlusEnergy gain. The façade is covered with black CIS thin-film modules, System provider: Würth-Solar, 2009.)

In the second group of questions, the selected “A” image belongs to "ECN, building 42 (Petten, The Netherlands)" and the “B” image belongs to "Boading (China 2012)" buildings. In structure A, semi-transparent and sloping c-Si-skylight roof, and in structure B semi-transparent a-Si modules containing colored polymers are used.

The "ECN, building 42 (Petten, The Netherlands)" structure is a new building complex next to Building 31, established in 1963 to meet the empty space requirement of the Netherlands Energy Research Institute in 1996. This structure is planned as the modular extension of the building 31, which has been renovated for the usage of solar energy. These two buildings are connected to each other by a greenhouse. Building 42 consists of three blocks grouped around the glazed greenhouse and constructed in three steps. The aim of the project is to design a multifunctional office and laboratory area. The design company of the building is Bear Architecten. Translucent and inclined c-Si PV modules are used on the roof of the building. Batteries of 26.73 kWp were used in the 1st block and 16.31 kWp batteries in the 2nd block. The batteries used are single-crystal cells with 16.5% efficiency. Corrugated recessed grid-shaped batteries are sized 125 mm x 125 mm. 32 PV-batteries of 575mm x 1175mm size are used for each module. Frameless modules are in the form of overlapped glass plates. There is 3 mm toughened white glass on the front surface, PV batteries in between and 4 mm glass on the back surface.

Greenhouse PV roof glass is made of standard greenhouse glass profile. ECN-adjusted solar energy cells and heat sensors, which enable the evaluation of the performance efficiency of the data measured with the PV system, are included in nine of the PV modules. By PV's, 40,000 kWh of energy is generated annually (Bear Architecten, 2001).

The purpose of our selection of these buildings is to show their application in different parts of the building, that BIPV systems, which are part of the facade and roof whose applications are similar to each other. To the participants, In which building or buildings BIPV is applied, whether the information given about these buildings (thin-film modules / translucent modules attached to the roof light/facade) is correct, how they find the visual integration of BIPV in these buildings, evaluation of both buildings in terms of lighting quality and visual comfort of the interior, in which interior space and why they want to live/work were asked.



A)



(B)

Figure 3.8 Images for Questions 29, 30.

(Fig. Left: ECN, building 42, Petten, The Netherlands: Semi-transparent and curved c-Si-skylight roof (Bear Architecten, 2001); Fig. Right: Boading, China 2012: Semi-transparent a-Si modules with coloured polymers Courtesy: Tianwei Solar Films; Photo: P. Heinsteinst (Heinsteinst, Ballif and Perret-Aebi, 2013).

In the third group of questions, an interior image with a blue crystal silicon glass designed by Onyx Solar (Miami, USA) was selected (Figure 3.9). The purpose of our selection of this interior is to evaluate the BIPV systems in terms of the interior lighting quality and visual comfort of the interior.

To the participants, what color photovoltaic glass modules are used in this building, how they find the visual integration of BIPV in the interior of this building, how they evaluate the interior of this building in terms of lighting quality and visual comfort, whether they want to live / work in this building, and the color used on the facade of this building. If a glass module produced in a different color is used, whether there will be a change in the lighting / light quality of the interior, if there will be a change, whether they think that the color change will affect the energy efficiency of the photovoltaic module, how it will affect the energy efficiency of the photovoltaic module, and the advantages and disadvantages of BIPV systems were asked.

This structure is the Balenciaga store, located in the Miami Fashion District, one of the most well-known fashion brands and part of the multinational Kering luxury company based in France. Photovoltaic glass has been applied to the facade of this store by the Onyx Solar company, and this facade is decorated with a design that combines beauty, innovation and sustainability.

Each of the 42 glass units (dimensions 2804 x 1388 mm and 2808 x 1413 mm) has a maximum power of 338 Wp. The installation produces 7700 kW per year. Polycrystalline PV glass has a blue color on the outside of the laminate. Its configuration is hurricane proof and each glass is heat strengthened. It has an optimized solar factor that improves thermal comfort inside the building.



Figure 3.9 Images for Questions 31, 32, 33, 34. (Source: URL 26).

Some information about this structure with curtain wall application is given in the table below;

Table 3.10. The information about Balenciaga Miami Fashion Store

DATA:	
Total Area	165 m ²
Electricity generated in 35 years	223,685 kWh
Total lighting points operating 4 hours per day in 35 years	439 lighting points
CO2 emmissions avoided in 35 years	150 Tons of CO ₂
Barrels of oil saved in 35 years	132 barrels per m ²

FEASIBILITY STUDY OF AMORPHOUS SILICON PHOTOVOLTAIC SKYLIGHT IN SINGAPORE:	
Energy cost	<0,01€
Reduction in HVAC energy demands	44%
Internal rate of return	77%
Payback	<1 year

(Source: URL 26)

3.1.3 The Participants

Survey questions were directed to professionals with professional identities of practitioners and academics in the profession groups of architecture and engineering disciplines. This questionnaire was applied to 50 participants, 25 of whom were architects and 25 were engineers. Their average age is 35. 80% of the participants are male and 20% female, half of them are practitioners and the other half continues their working life as academicians. Although 25 of these 50 participants had no eye defects, 18 had myopia, 11 had astigmatism, and the rest had hyperopia. The number of those who do not wear glasses and contact lenses is 27.

3.2. Comparative Evaluations

While the responses of professionals to the multiple choice questions were proportionally graphed, their responses to the interpretive questions were tabulated. These tabulated responses were then compared between architecture and engineering groups, practitioners and academicians, and more detailed tables were created. By comparing the answers given by the participants and the information contained in the scientific explanations, it was measured whether the participants knew the BIPV systems and how much they had command.

CHAPTER 4

RESULTS AND ANALYSIS

In this chapter, the comments of practitioners & academicians, architects and engineers were compared with the tables created in the questions containing comments with comparative evaluations. By determining true-false ratios with multiple choice questions, tables and graphs were created according to these percentile.

4.1. Regarding Information About Solar Energy and BIPV

When considering group (A) questions aiming to measure awareness and knowledge about solar energy concept, for the questions asked "According to this definition, is Turkey suitable for using solar energy?" (Question 1), after giving a general definition of solar energy, all participants answered "Yes". Thus, it has been understood that all participants agreed that solar energy is a very suitable energy source for our country.

In the multiple choice question (Question 2), which is asked " In which type of building / facility or tools solar energy can be used ", all areas of use, such as residential and business places, rural and agricultural technologies, industry, transportation vehicles, communication tools (radio, television, telephone), signaling and automation, electrical energy generation and part of energy demand, special purposes in the military field, are marked by the participants. And thus, it has been concluded that the knowledge level of the participants about the areas where solar energy is used is high (Figure 4.1).

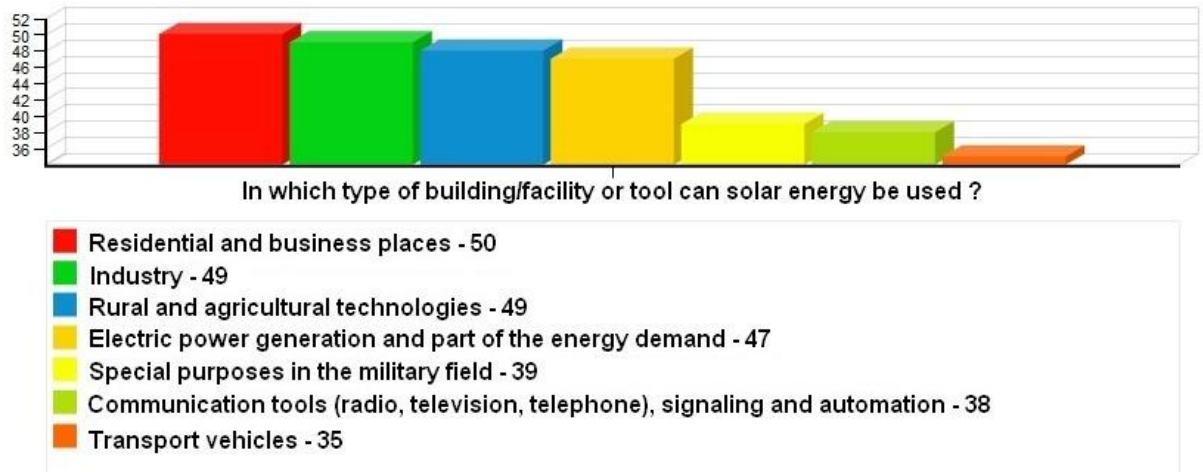


Figure 4.1 Distribution of responses about the use of solar energy (Question 2).

Apart from these usage areas, architect and engineer participants gave examples of many different areas (Question 2.a) (Table 4.1). The common examples of both groups are electricity generation, heating and cooling systems, urban furniture and urban lighting, space technologies and vehicles, and examples applied on a building and urban scale. (PA 4), (PA 7), (PA 11), (PA 24), (PE 2), (PE 4), (PE 7), (PE 17), (PE 20), (PE 21), (PE 25). In both groups, there are participants who comment that solar energy can be used in all areas. This shows that each participant has comprehensive knowledge of this subject. Apart from these common examples, architectural group gave examples such as systems in which the sun's rays reflected by special mirrors create high temperatures by focusing on a single point and allow the rapid conversion of solar energy into thermal energy (P.A 1), solar cookers, water heating systems, wrist watches, calculators (P.A 12), automobiles (P.A 18), parking lots and building facades (P.A 23) and architectural group gave examples such as all kinds of remote and singular structures and devices (PE 8), agricultural areas (PE 9), floating vehicle (PE 11), mountain, vineyard houses, camping tents (PE 18), azimuth (south angle) with solar tracking system in rural areas anywhere along the axis (PE 22).

In question (Question 3), which is asked " Do you know any building (or application / vehicle) that uses solar energy in Turkey? If yes, in what way is solar energy used? ", 78% of the participants answered "Yes". All participants, consisting of architects and engineers, are of the common opinion that solar energy is used by different methods (with wind energy, photovoltaic panels, facade systems) in electrical energy production, in heating-cooling systems, and in obtaining hot water. They know these systems

substantially. In this question, engineers commented more than architects. And apart from these examples and besides common opinions, as different examples; they gave examples such as illumination, some electronic devices (P.E 15), Both electricity and hot water in the same collectors combined with PV-T systems, which are mostly used in Europe (P.E 19), electric vehicle charging stations (P.E 23). (Question 3a) (Table 4.2). From this result, we can conclude that engineers have more comprehensive knowledge of the areas where solar energy is used than architects.

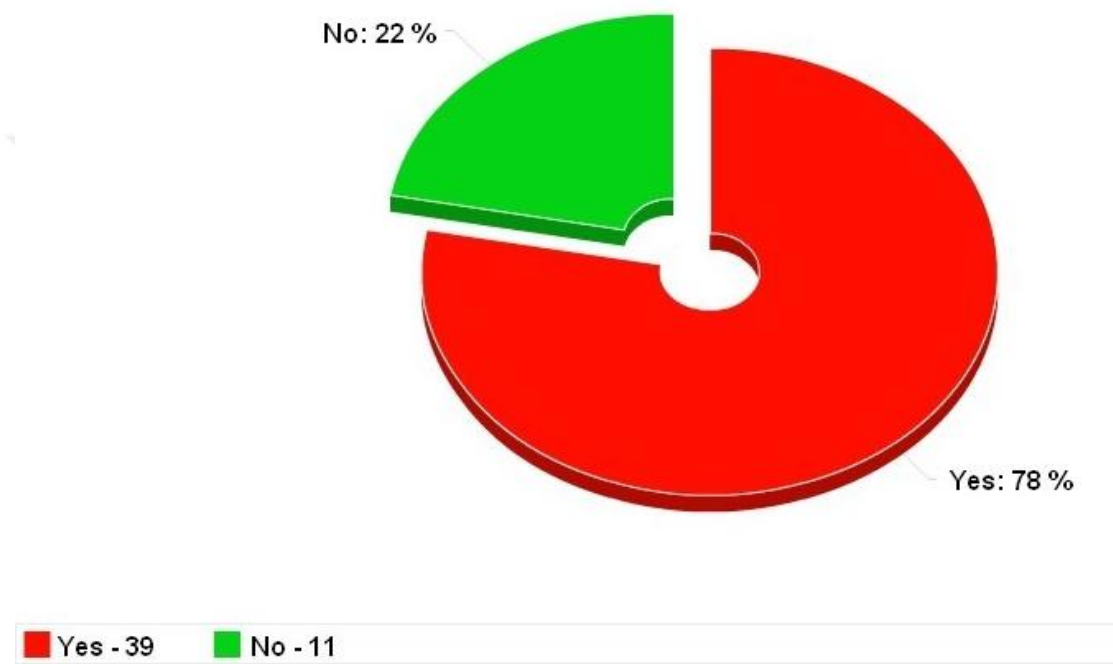


Figure 4.2 Distribution of responses about any building (or application/tool) which uses solar energy in Turkey (Question 3).

Table 4.1. Comparative responses of architects and engineers for Question 3.

3. Do you know any building (or application/tool) which uses solar energy in Turkey? If it is yes, in which way the solar energy is used?	
ARCHITECTS	ENGINEERS
- It is used by covering the building shell completely or partially with solar panels in order to meet the energy need of the building partially or completely and to transfer the excess energy produced to the electricity network. (P.A 1) - I know that it is used in a textile factory to meet a certain amount of energy needs, but even the use of the whole building area is not enough to meet all of the energy need. (P.A 2) - It is used in electricity generation by photovoltaic panels. (P.A 5) - Its simplest use is to meet the need for hot water with panels placed on roofs. (P.A 6) - Electricity is generated from solar energy along with wind in residential buildings far from the city center. (P.A 7) - Solar energy is used for heating energy required for residential buildings with photovoltaic panels, to provide electrical energy in rural areas, and for solutions related	- It is used in heating and cooling systems, generating hot water and electricity. (P.E 1, 3) - It is mostly used to generate hot water. (P.E 4) - Solar energy is used to generate electricity. It can be said that the field where solar energy is most commonly used is electricity today. For this purpose, photovoltaic solar panels are used. (P.E 5) - It is used for hot water production. (P.E 6) - It is used for energy production and heating & cooling. (P.E 8) - The common application is hot water production. In recent years, the development of photovoltaic technology can compete with the development of other energy systems. As solar energy systems reach economic values, their use in electricity production has become widespread. (P.E 10) - It can be used to generate electricity, heat the building and get hot water. I have a

to solar energy intake on the facade for passive heating. (P.A 9)	colleague in Antalya who produces and sells electricity by applying these systems to glass. (P.E 11)
- Solar energy is used for water heating, electricity generation, heating & cooling in buildings. (P.A 10) - Solar energy is used as panels used for the generation of electricity applied to the roof. I can give an example of “BFB building”. (P.A 12) - It is used to supply the electricity needs. (P.A 13) - It is used in electricity generation or heating systems. (P.A 19) - It is used as a panel in energy production. (P.A 20) - It is used to transform radiation from the sun into energy through panels. (P.A 22) - It is used to obtain heat energy. (P.A 23) - It is used to generate electrical energy. (P.A 24) - It is used in electricity generation. (P.A 25)	- It is used in energy generation as a panel. (P.E 13) - It is used in lighting, water heating, electricity generation and some electronic devices. (P.E 15) - It is used in the production of thermal energy and electrical energy. (P.E 16) - Since I am an energy systems engineer, I installed a solar energy system in many residential and industrial facilities in the energy company I worked for before. In this way, electrical energy was produced and the heating and cooling system of the building was installed in these facilities. (P.E 18) - PV systems, which are solar energy technology, can be used on the roof to generate electricity. Or it can be used in hot water production with thermal collectors. In combination with PV-T systems, which are mostly used in Europe, both electricity and hot water can be produced with the same collectors. (P.E 19)

	• It is used in electricity generation, passive heating, domestic water heating. (P.E 20) It is used in heating, solar cooling, electricity generation. (P.E 22) • It is used for water heating in buildings and for electricity generation in electric vehicle charging stations. (P.E 23) • It is used on roofs with large surfaces such as shopping malls, to provide the building's own energy production. (P.E 25)
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In the question of expectations from solar energy in building design (Question 4), both groups gave examples of obtaining energy actively and passively, providing electricity generation, supplying hot water, heating & cooling, lighting. They expected them to achieve maximum efficiency and savings as an environmentally friendly, clean and sustainable energy source, while providing them. The expectations of the architects have been focused especially on design and comfort, although they are mostly about generating energy. In detail, has been requested to provide indoor comfort conditions together with energy need and sustainability, to be considered together with design areas and design parameters and thus, to apply sun orientation, sunshades, light shelves. The expectations of the engineers have been based on technical objectives such as providing energy production and needs, efficiency and reducing energy costs. Their greatest expectation is to design a building that produces its own energy and is self-sufficient in terms of energy. (Table 4.3)

In the question of what needs to be done to start solar architecture effectively (Question 5), both groups; They agree that the awareness of solar energy should be raised, trainings should be given to raise awareness, legal legislation and the implementation of various sanctions (making these systems mandatory under certain conditions, etc.) (Figure 4.4). Apart from these ideas (Question 5a), the architectural group gave examples of carrying out international project activities (P.A 4), raising the awareness of these professional groups by preparing seminars on solar architecture, energy efficient building systems and encouraging their use (P.A 11). The engineering group thinks that the application should be widespread in state buildings without considering the cost much (P.E 8) and Micro GES should be established in our country (P.E 21).

The engineering group focused on the costs of these systems, unlike the architects' comments and 3 engineers made comments on this subject such as; "It is necessary to expand the application without considering the cost in state structures." (P.E 8), "Photovoltaic cells must be produced domestically. In an İZKA project we did as DEÜ, a working group also did EMUM, but it was working with 5% efficiency. As long as these cells are not domestic, that is, we are dependent on the outside, we will be an importer country instead of producing technology." (P.E 11), "The prices of solar panels are still at a level that can prevent their application. This practice should not be expected to increase much before the prices reach a certain level." (P.E 17).

An engineer from the engineering group also had a specific suggestion and said “Moveable solar energy systems should be developed in order to make maximum use of the sun, which constantly changes position during the day. Working on the architecture of the most ideal mounting system for these systems to be developed will create a new workingarea” (P.E 18)



Table 4.2. Comparative responses of architects and engineers for Question 4.

4. What are your expectations from solar energy in building design?	
ARCHITECTS	ENGINEERS
• In building design, I expect that the energy need required to provide the visual, auditory and sensory comfort conditions required by the structure will be fully or partially provided. (P.A 1) • My expectation is that solar energy, as an environmentally friendly, clean energy source, meets the energy needs of the building at the possible maximum level. (P.A 2) • Active and passive energy generation. (P.A 3) • In addition to creating an energy source, consideration of suitable spaces in design. (P.A 4) • Contributing to the heating of the building in winter and cooling of the building in summer. (P.A 5) • The design features that come to my mind are solar racking design applications that will not increase the mechanical load of the building, orientation towards the sun, which does not increase the mechanical load of the building, provides extra cooling in summer and does not require extra heating in	• It should limit the use of fossil fuels that harm the environment. (P.E 1) • With the knowledge and technology we have, we should try to incorporate it into the design in every structure that we can use with the maximum level and with maximum efficiency. We should try to use, make it use of all sustainable and renewable energy sources. (P.E 2) • Supplying all energy needs. (P.E 3) • Providing electricity generation. (P.E 4) • Supplying the majority or a certain part of the electricity requirement in the building, ensuring a high rate of reduction in the financial burden due to hot water supply and heating. (P.E 5) • Supplying the electricity need of common areas. (P.E 6) • In building designs, instead of building materials as bricks etc. which is used in roof designs, solar panels can be used to supply the building's needs. (P.E 7)

winter, solar shades for solar control, allowing light to be transmitted deep into the building for illumination. (P.A 6) • Heating water, generating electricity, heating and cooling of the building. (P.A 7) • I think that solar energy should be in every building in a way that does not adversely affect the comfort of human use of the design and the building and therefore, I think it will significantly reduce the energy consumption of the building. (P.A 8) • Providing sustainable energy. (P.A 9) • Not using electricity and natural gas while providing water heating, generating electricity, heating for the building. (P.A 10) • Energy saving, environmental friendliness, renewable. (P.A 11) • Reducing carbon emissions by minimizing the energy used in the building. (P.A 12) • Meeting the energy needs of the building. (P.A 13) • Meeting the electricity need of the building. (P.A 14)	• My expectation in building designs using solar energy; it is a completely sun-sourced, fully independent, self-sufficient building. (P.E 8) • Solar energy should be provided uninterrupted energy. It should be more comfortable and its MegaWatt should be higher for us to use actively. (P.E 9) • My expectation from solar energy is that it can provide enough energy for the systems used in the building. And in cases where the energy is not enough or too much, it should be able to work in connection with the electricity distribution network. (P.E 10) • I believe that in the future we will use it too much. Our expectations on this are high. (P.E 11) • In addition to generating electricity, I think solar energy should also be used in building heating. (P.E 12) • Visuality and amortization (P.E 13) • To supply the necessary electricity expenses. (P.E 14) • Lighting, hot water and heating. (P.E 15)
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• Flexibility in application, availability in cost. (P.A 15) • Energy generation, water heating. (P.A 16) • Effective functioning of the structure with other energy systems. (P.A 17) • It can be used to meet all energy needs. (P.A 18) • Meeting daily energy needs. (P.A 19) • Being able to produce its own energy. (P.A 20) • Energy and cost savings. (P.A 21) • I think that low-cost and environmentally friendly architectural approach is important by using solar energy, which is renewable resource, rather than using non-renewable fossil-based resources with limited reserves such as coal, oil and natural gas in building design. (P.A 22) • Providing the thermal balance of the building, obtaining the necessary hot water and transforming it into energy for lighting. (P.A 23)	• Passively reducing the heating load in winter, and reducing the cooling load in summer as much as possible. And actively using in heating and electricity generation. (P.E 16) • In the building design, heat inputs are prevented with solar panels inside the building. Using special panels that pass only some wavelengths are used instead of glass, light input can be provided while heat input can be prevented. (P.E 17) • High efficiency, low loss, maximum gain and shortest amortization time. (P.E 18) • Contributing to the production of electricity and meeting the need for domestic hot water without fossil fuel consumption. (P.E 19) • Using as little as possible from non-solar energy sources for domestic water and building heating. (P.E 20) • Providing energy saving and reducing carbon emissions. (P.E 23) • Because energy is one of the major problems of Turkey, made considering the use of solar energy in building design is very important. (P.E 24)
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• Maximum efficiency and savings. (P.A 24) • Providing the heating and electrical energy needs of the building as much as possible with optimum design. (P.A 25)	• Minimizing electricity consumption. (PA 25)
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Figure 4.3. Distribution of responses about things to do to start Solar Architecture effectively. (Question 5).

In the question of the applications of solar energy (Question 6), 49 of the participants gave examples of solar water heaters of solar energy technology, 45 of the participants gave examples of solar thermal power plants and solar cells / photovoltaic power plants, 36 of the participants gave examples of solar energy building and other thermal systems, and 28 of the participants gave examples of solar cooling systems. Apart from these (Question 6a), the architecture group gave examples such as focusing spherical mirrors (P.A 2) and the engineering group gave examples of many different areas such as hot water supply (PE 4), land, sea and lake transport vehicles, space applications (PE 10), boat propulsion systems (PE 11), solar chimney, or solar wall (PE 19) (Table 4.5).

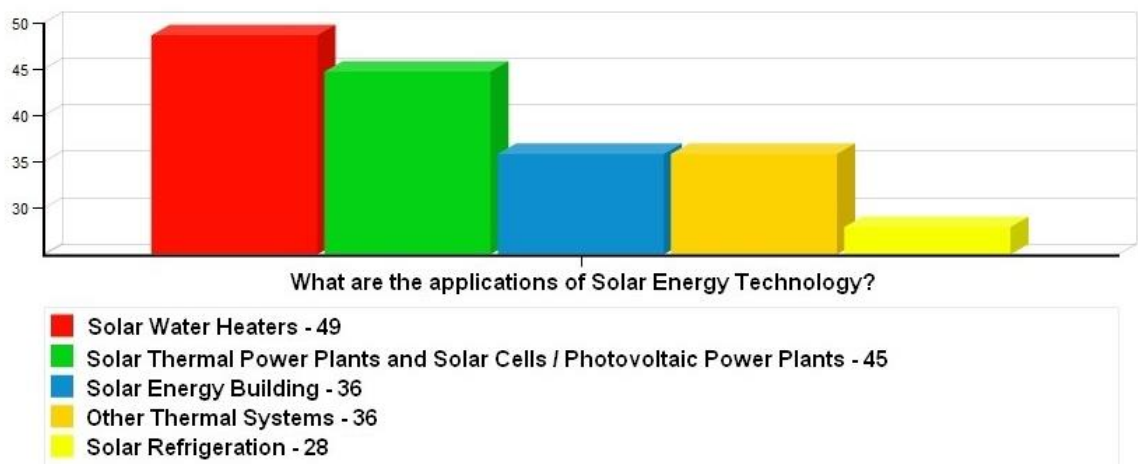


Figure 4.4. Distribution of responses about the applications of Solar Energy Technology. (Question 6).

In question (Question 7), which is asked “ Have you heard or heard of a building integrated photovoltaic (BIPV) system?”, the majority of the participants, in other words, 74% (37 participants) answered “ Yes ”. Accordingly, it was aimed to measure their knowledge level about the BIPV examples and the names of the building samples were asked.

In question (Question 8), which is asked “ Do you know any examples of BIPV systems applied in the world?? ”, 40% of the participants answered “Yes ”, 60% of the participants answered “ No ” and they wrote the names of many building examples they knew and visited (Ouestion 8a) . (Table 4.6.). The architects gave examples of CIS tower, Manchester (P.A 1), Expo Guadalajara building (PA 2) built in 1987 and integrated photovoltaic system in 2017, Center for Interactive Research on Sustainability (CIRS) located at the University of British Columbia, Vancouver, Canada) and Fred Kaiser building annex (P.A 6), BMW WELT (P.A 9), (P.A 13), Science Pyramid, Denver Botanic Garden (P.A 12), Intercultural Center, Georgetown University, Washington (PA 25). The engineers gave examples of facades of some skyscrapers (PE 1), University of Alberta (P.E 2), night lighting and prevention of road icing with solar energy panel installed on the highway in South Korea (PE 5), Voltimum (P.E 8), many areas in the region where he lives (Switzerland) such as housing, farms which state-supported and fast-applied system recommended by energy companies as an integrated system with the grid system (PE 10), Apple's building, General Electric Boston. (P.E 11), German houses, industrial facilities (P.E 12), Solar Living Institute (P.E 16), various examples in Europe, especially Germany and the USA (P.E 20).

However, it was seen that only a few of the responses given by the participants were Building Integrated Photovoltaic Systems. Most of the answers given by the participants belong to Photovoltaic Systems. Example buildings of BIPV systems are Apple's building, BMW WELT and Denver Botanic Garden. From this result, it is seen that BIPV (Building Integrated Photovoltaic) systems are confused with the BAPV (Building Attached Photovoltaic) systems and PV (Photovoltaic) systems. The architects and engineers do not have a clear knowledge about these systems yet.

In question (Question 9), which is asked “ Do you know any examples of BIPV systems applied in Turkey?? ”, 30% of the participants answered “Yes ”, 70% of the participants answered “ No ” and they wrote the names of many building examples they knew and visited (Ouestion 9a) (Table 4.7.). The architects gave examples of Melikgazi Municipality Building T-House (P.A 8), Konya Science Center (P.A 9), Izmir Chamber

of Commerce New Building (P.A 11), Bioev (P.A 19), Diyarbakır Solar House (P.A 25). The engineers gave examples of, Istanbul Metropolitan Municipality, Turkey's first floating solar power plant. (P 5), Institute of Ege University Solar Energy (PA 11, PA 16), several factories in Manisa Organized Industrial (PA 12), CW energy project (Turkey's and Europe's largest solar panel manufacturing company) (PE 18) , Muğla Bus Terminal (PE 20), Aydın Municipality Building. (P.E 22). However, it was seen that none of the answers given by the participants had Building Integrated Photovoltaic Systems, the answers given by the participants belong to Photovoltaic Systems. From this result, as in the previous question, it is seen that BIPV (Building Integrated Photovoltaic) systems are confused with the BAPV (Building Attached Photovoltaic) systems and PV (Photovoltaic) systems. The architects and engineers do not have a clear knowledge about these systems yet.

In question (Question 10), which is asked “ Do you know the biggest BIPV project in Turkey ? ”, While the architects could not give any answer, two of the engineers gave the example of the Muğla Bus Station and the solar power plant built in Konya (Question 10a). It was observed that one of the participants answered this question correctly by giving the example of Muğla Bus Terminal. Muğla Menteşe Bus Terminal is Turkey's first solar-powered bus station and is Turkey's largest building integrated solar energy (BIPV). The solar panels with special features used in the project were produced by Ankara Solar. It meets 80% of the electricity requirement of all service areas of the bus station with 1760 solar panels placed on the roof of 3840 square meters (<http://solarexmagazine.com/turkiyenin-en-buyuk-bipv-projesi-acildi/>).

In question (Question 10), which is asked “Have you ever used BIPV systems in your? ”, It is seen that the number of architects and engineers using these systems in their projects is very less. Two of the architects gave an example of their graduation project (PA 8), (PA 12), and another architect gave an example of his project in Eko-village Seferihisar in order to fully integrate the PV system into the roof surface, to hide the PV system as much as possible and to ensure maximum efficiency from the system. And he explained that the back part of the V-shaped roof of that building is completely reserved for PV and it is designed based on the optimum angle for Izmir climate. (P.A 25). The other architect specified that she did not applied BIPV system in any of her projects before, but she wanted to applied it very much. (P.A 11) One of the engineers said that he applied these systems in boats, not in the building. (P.E 11). (Question 11a).

In the question of BIPV's building main application areas (Question 12), 47 of the participants gave the example of roofs, while 43 of the participants gave the example of facades. In the comprehensive question of BIPV application areas (Question 13), 48 of the participants gave the example roofs (flat and pitched), 35 of them cladding systems, 33 of them canopy and car parks, 32 of them, semitransparent facade systems, curtain walls and spandrels, 24 of them louver systems and 16 of them, skylight and floor.

From this result, it is concluded that approximately 1/3 of the participants know about coating systems, canopy and parking lots, semi-transparent facade systems, curtain walls and spandrels, almost half of the participants, louver systems and a small number of participants, skylights and floor systems.

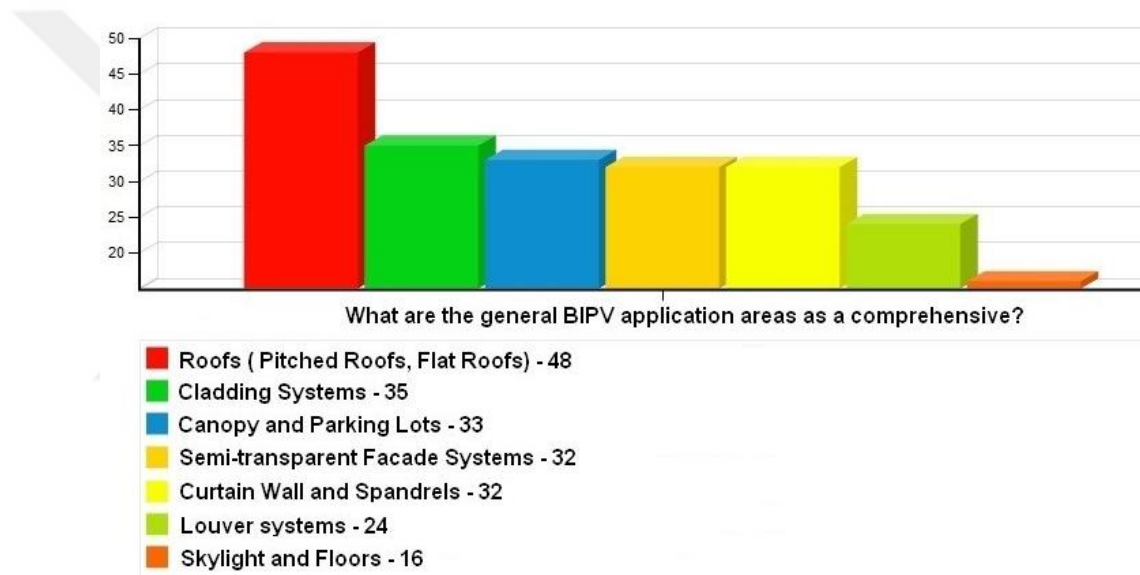


Figure 4.5. Distribution of responses about the general BIPV application areas as a comprehensive (Question 13).

In the question of usage areas of the facade BIPV product group / system group (Question 14), 46 of the participants gave examples of curtain wall (warm) facades, 34 of them sun glazing / skylight, 19 of them rain-screen (cold) facades, 13 of them accessories.

In the question of the usage areas of the roof BIPV product group / system group (Question 15), 43 of the participants gave the example of full roof BIPV solution, 38 of them solar tiles / shingles, 29 of them solar glazing / skylight, 26 of them in-roof mounting systems 25 of them PV membranes and of them 24 metal panels.

In the question of "Photovoltaic Glass" types (Question 16) related to application details and optical properties, 47 of the participants gave examples of 100% customized photovoltaic glass, 37 colored photovoltaic glass, 36 photovoltaic transparent glass, 24 laminated safety photovoltaic glass, 23 of them double / triple glazed photovoltaic glass.

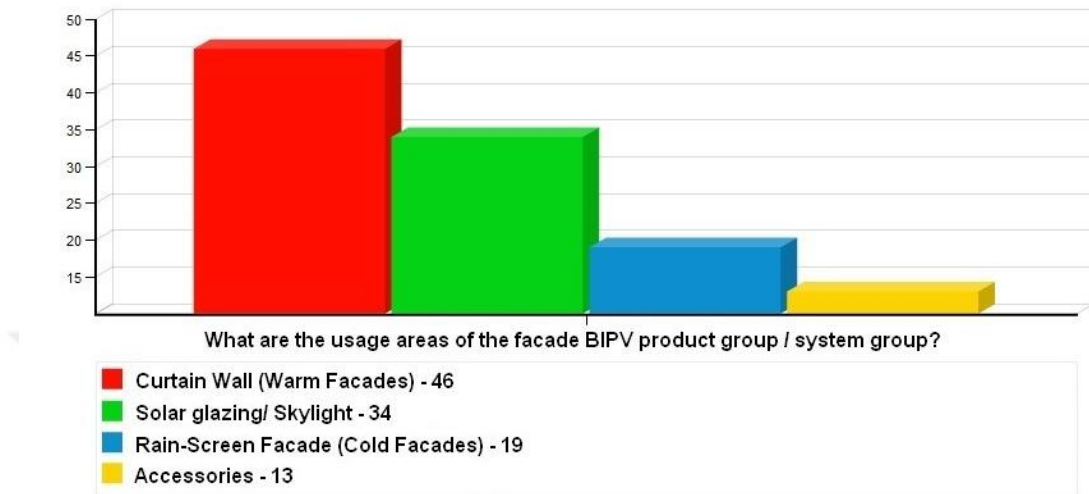


Figure 4.6. Distribution of responses about the usage areas of the facade BIPV product group / system group (Question 14).

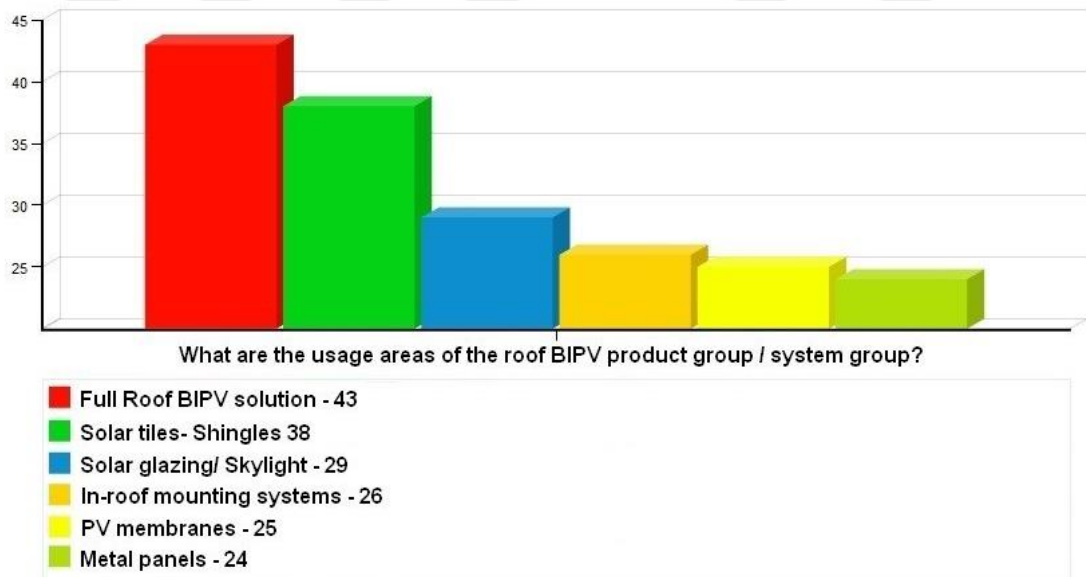


Figure 4.7. Distribution of responses about the usage areas of the roof BIPV product group / system group (Question 15).

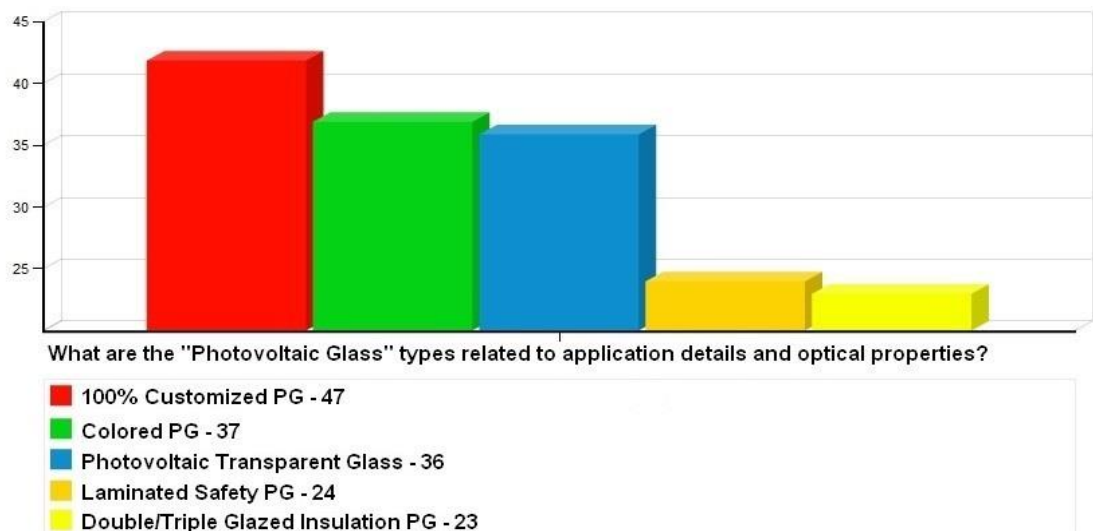


Figure 4.8. Distribution of responses about the "Photovoltaic Glass" types related to application details and optical properties? (Question 16).

In the question of matching the market classifications of BIPV products with their names (Question 17), only 6 participants answered the correct order of folio-b, tile-a, cam-d, module-c. From this result, it can be concluded that very few participants were able to match these classifications correctly. From the participants, 33 participants (66%) marked the foil answer (b) which is correct answer and, 8 participants (16%) tile answer (a), 33 participants (66%) glass (d) answer, and 12 participants (24%) module (c) answer. The conclusion is that while the participants, consisting of architects and engineers, know the foil and glass with a high rate of 66%, they do not have a good command of the concepts of tiles and modules or they may have confused both of these concepts.

Tiles are BIPV products with integrated panel of poly or monocrystalline cells, usually installed on roofs or parts of the roof, and suitable for later addition. Foils are lightweight and flexible BIPV products made from thin film cells with low efficiency and low installation cost. They are mounted with glue and do not require a frame. They are suitable for building applications with large roof openings. Modules are opaque BIPV products made with weatherproof skin solutions, similar to conventional PV modules and often used in roofing. It is the cheapest form of integration and has a better look than the outer frames. Glazing are BIPV products that can transmit daylight for options to use natural lighting while generating electricity, used in windows, tiled facades and roofs. It offers aesthetic options with customized modules related to the shape, cell material, color and transparency level in its production.

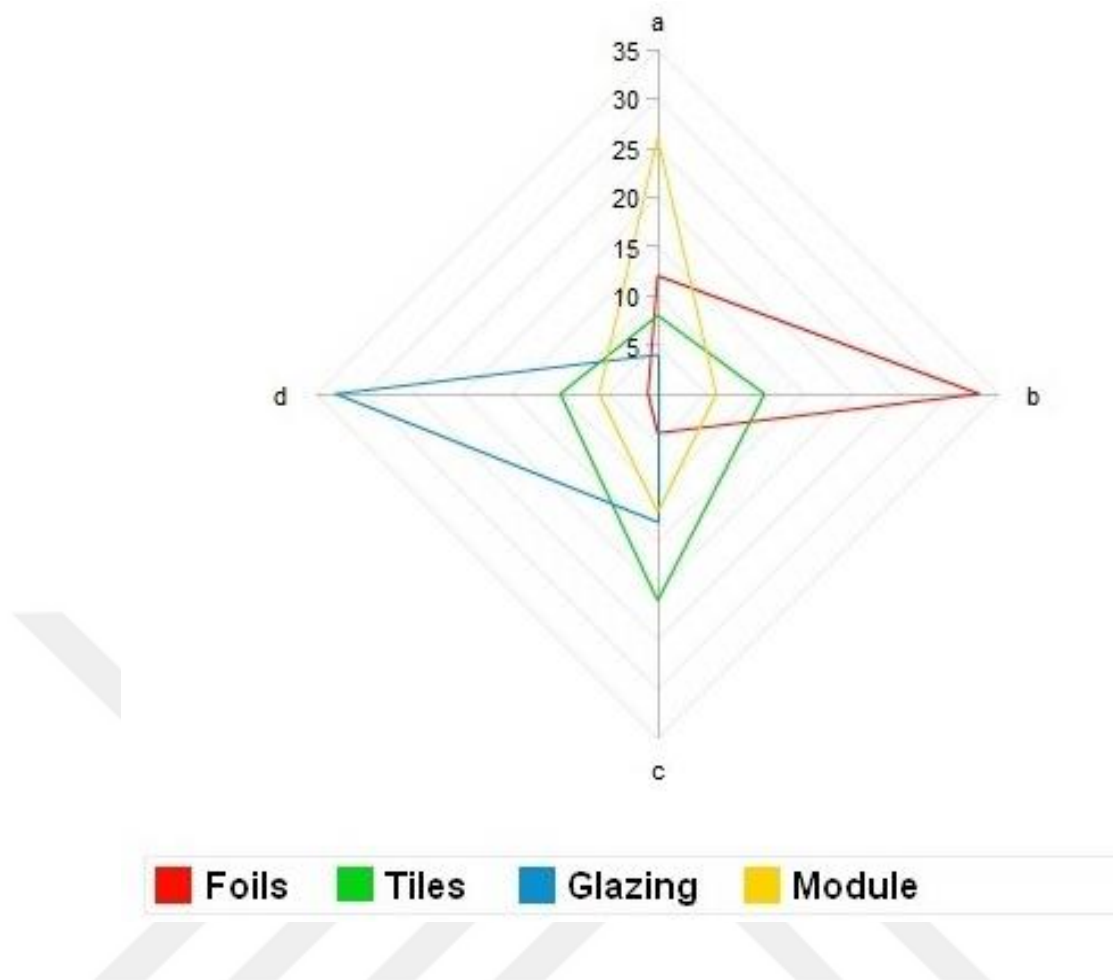


Figure 4.9. Distribution of responses about the description and their explanation of type of BIPV product. (Question 17).

In the question of matching BIPV products with their names (Question 18), 24 participants answered the correct order of foil-a, tiles-b, glass-c, module-d. From this result, it is concluded that almost half of the participants were able to match the images and classifications correctly. From the participants, 46 participants (92%) marked the foil (a) answer which is correct answer and, 31 participants (62%) tile (b) answer, 27 participants (54%) glass (c) answer, and 26 participants (52%) module (d) answer.

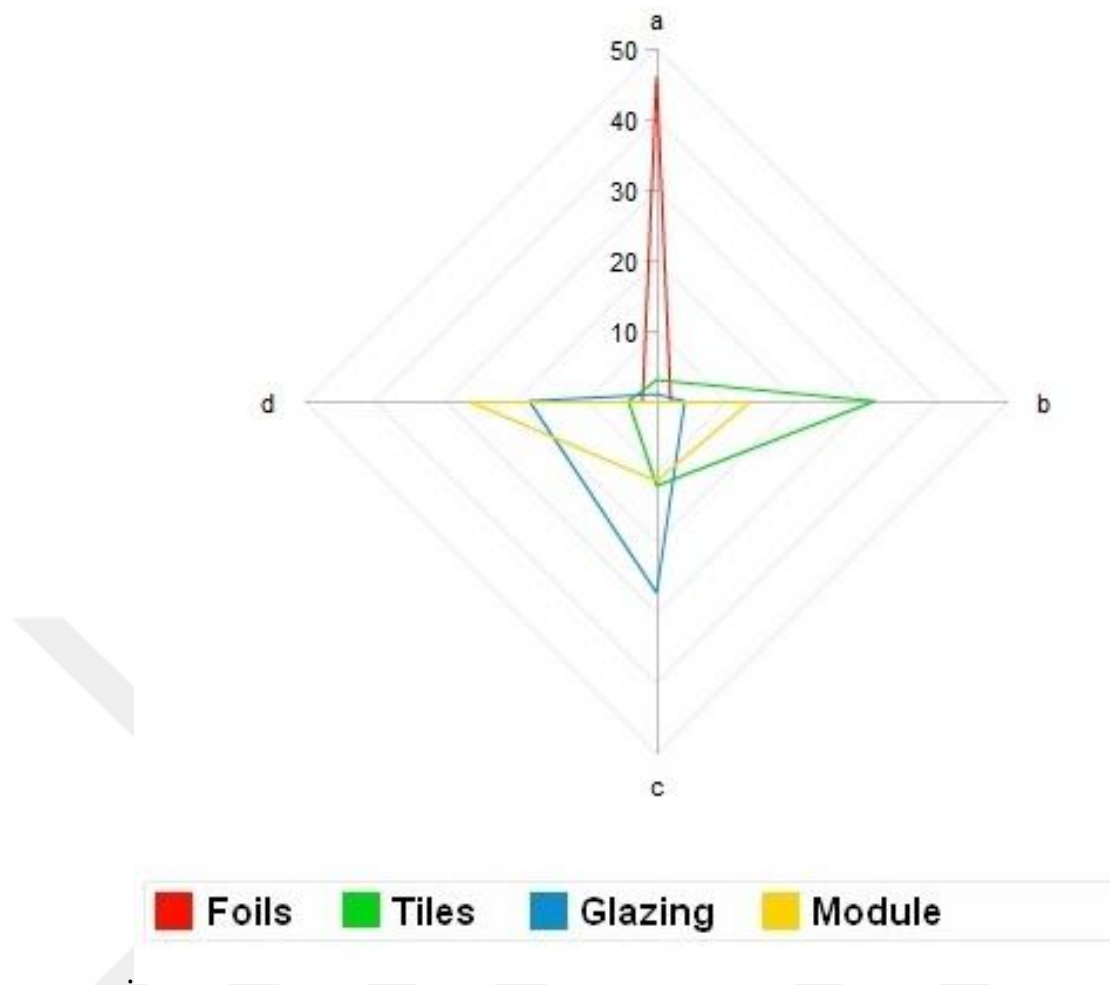


Figure 4.10. Distribution of responses about description and images of type of BIPV product (Question 18).

In the question of barriers and strategies for BIPV development (Question 19), 45 of the participants gave examples of political obstacles such as lack of government support, 38 of them perceptual barriers such as lack of public understanding, 33 of them economic barriers such as high cost of BIPV modules, designs and constructions, 31 of them technical obstacles such as lack of standards, low power efficiency and power reliability. From this result, it can be concluded that almost all architects and engineers consider political barriers, such as the lack of government support, to be the most important factor in barriers and strategies to BIPV development.

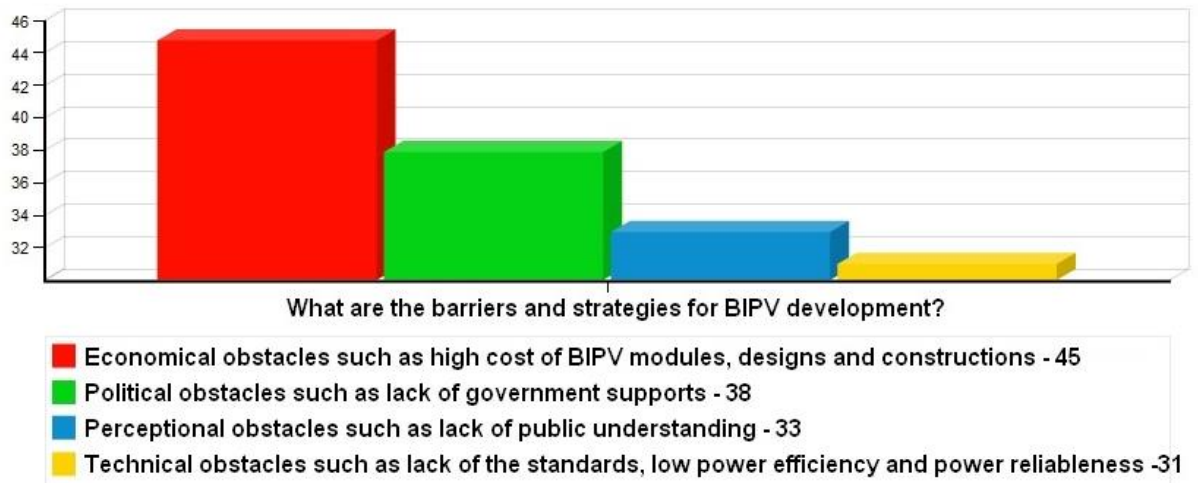


Figure 4.11. Distribution of responses about the barriers and strategies for BIPV development (Question 19).

4.2. Regarding Matching Information of BIPV Buildings

In the question of which of the two buildings with PV visuals applied on the roof is the BIPV application which is in the part of applying integrated photovoltaics to the building (part C), 94% of the participants (47 participants) gave the answer B and answered correctly. The definition of the systems on the roof can be made better based on the images.

In the question of matching the BIPV facade type names given with their explanations (Question 21), 15 participants answered the correct order of Solar Glazing and Windows - b, Curtain Wall / Cladding Systems - d, Advanced / Innovative Building Envelope Systems - a, External Devices / Accessories – c. From the participants, 31 participants (62%) marked Solar Glasses and Windows answer which is correct answer and, 23 participants (46%) Curtain Wall / Cladding Systems answer, 22 participants (44%) Advanced / Innovative Building Envelope Systems, and 28 participants (56%) External Devices and Accessories. From this result, like the previous question (Question 17), it can be concluded that few participants can answer correctly or match; the participants do not know much about the PV systems applied to the facade or the PV systems integrated to the facade.

Curtain Wall / Cladding Systems include integrated solar panels as a traditional cladding system for single-layer facades or curtain walls. Solar Glazing and Windows are

applied on the translucent or translucent parts of the facade depending on the transparency of the solar cell. It is integrated into windows, glass panels for view or daylight. External Devices / Accessories consist of sunscreens and blinds, spandels, balcony railings, visual and acoustic shield elements. Advanced / Innovative Building Envelope Systems consist of components such as double skin facades, active claddings, rotating or moving façade parts.

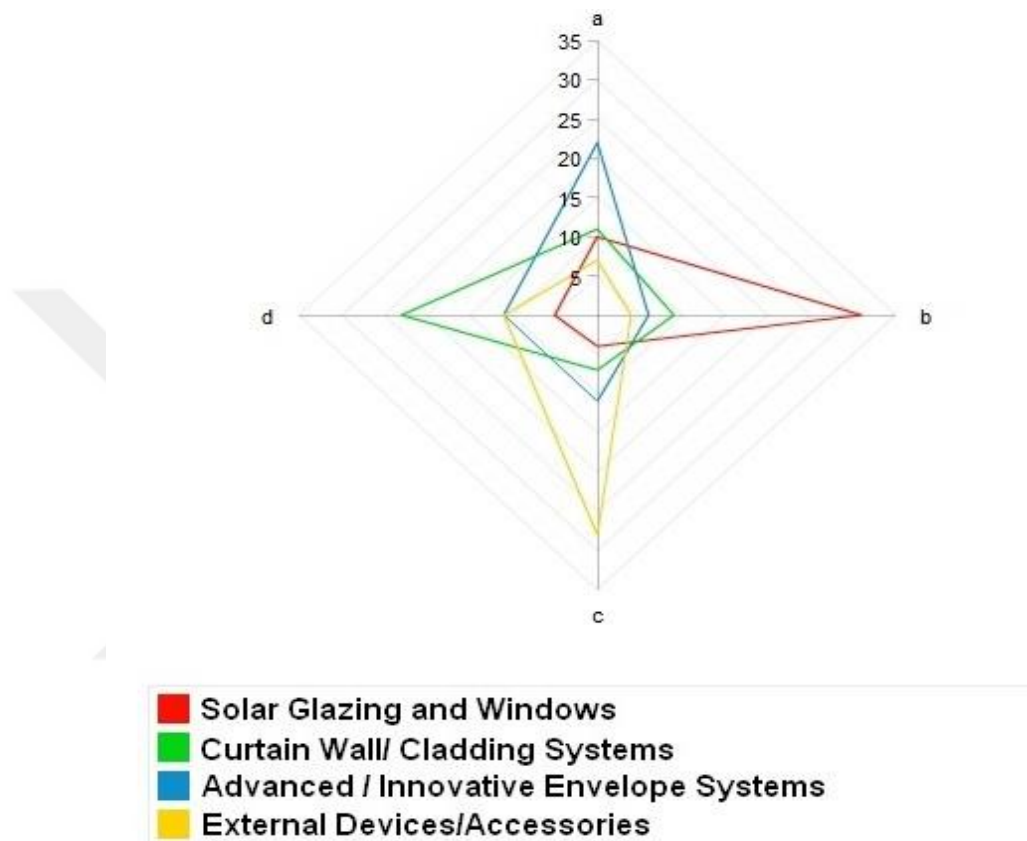


Figure 4.12. Distribution of responses about the BIPV facade type and their explanations. (Question 21).

In the question of matching BIPV facade type names and their images (Question 22), 35 participants answered the correct order of Curtain Wall / Cladding Systems - a, Solar Glasses and Windows - b, External Devices / Accessories - c, Advanced / Innovative Building Envelope Systems – d. From the participants, 43 participants (86%) marked Curtain Wall / Cladding Systems, 41 participants (82%) marked Sun Glasses and Windows, 40 participants (80%) External Devices / Accessories and 43 participants (86%) Advanced / Innovative Building Shell Systems. From this result, it can be concluded that the more participant can match these facade types and their images correctly.

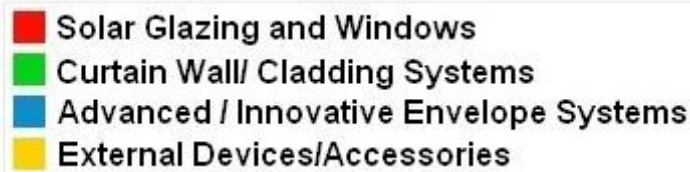
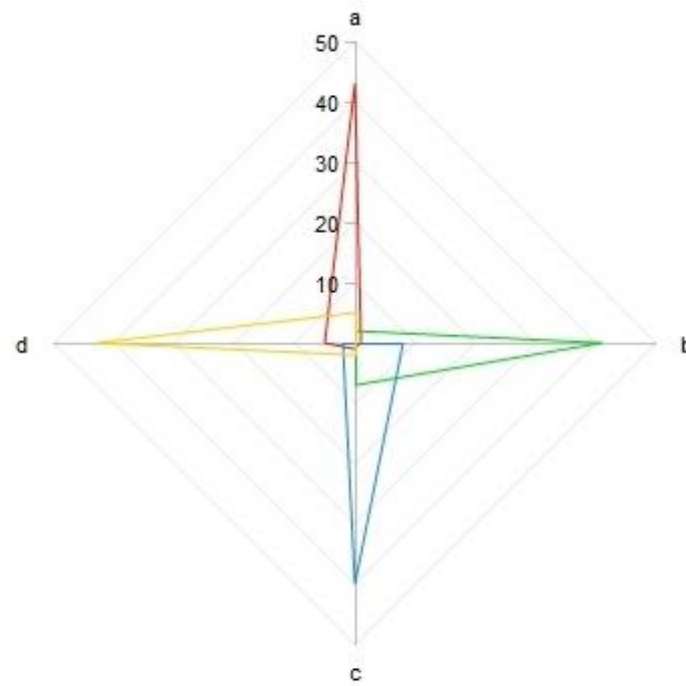


Figure 4.13. Distribution of responses about the BIPV facade type and their images of type of BIPV product. (Question 22).

In the question of which curtain wall facade example is not an example of BIPV system (Question 23), by giving four sample building examples of curtain wall facade, 32 participants (64%) marked d, 7 participants (14%) b, 6 participants (12%) c, 5 participants (10%) a. It was observed that the participants who gave correct answer (b) to this question are very less. With this result, it can be concluded that the curtain wall facade application of photovoltaic systems integrated into the building cannot be distinguished from the facade application of other traditional buildings or that the participants, consisting of architects and engineers, cannot distinguish this difference.

In the question of which ventilated facade example is not an example of BIPV system (Question 23), by giving four sample building examples of ventilated facade, 37 participants (74%) marked d, 5 participants (10%) c, 4 participants (8%) a and b. It was observed that the participants who gave correct answer (d) to this question are very more.

In the question of which skylight example is not an example of BIPV system (Question 23), by giving four sample building examples of skylight, 25 participants (50%) marked c, 9 participants (18%) b and d, 7 participants (14%) a and b. It was observed that half of the participants gave the correct answer (c).

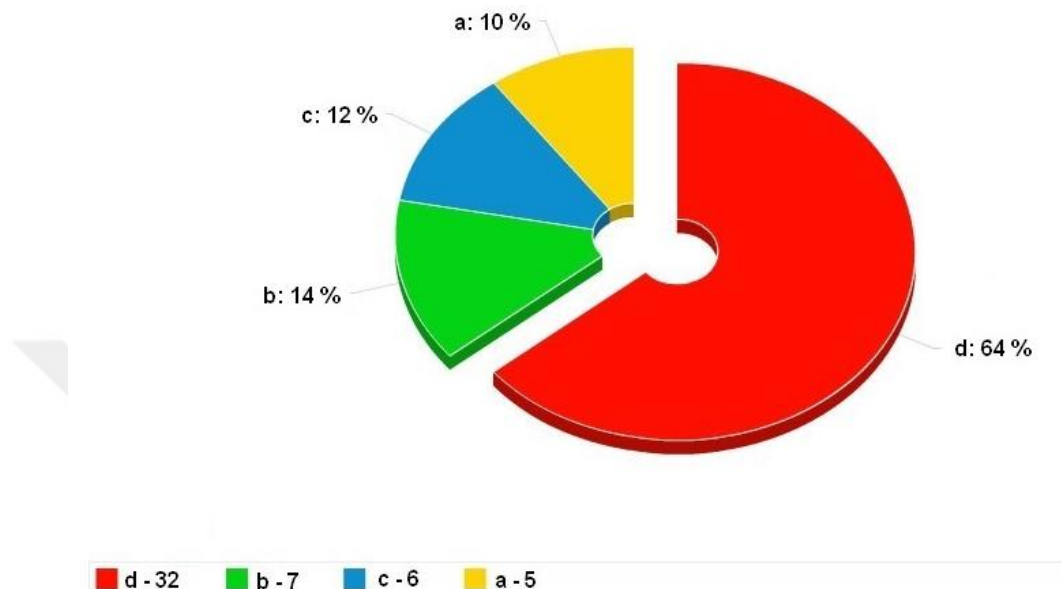


Figure 4.14. Distribution of responses about the curtain wall facade sample are not example of BIPV system applied. (Question 23)

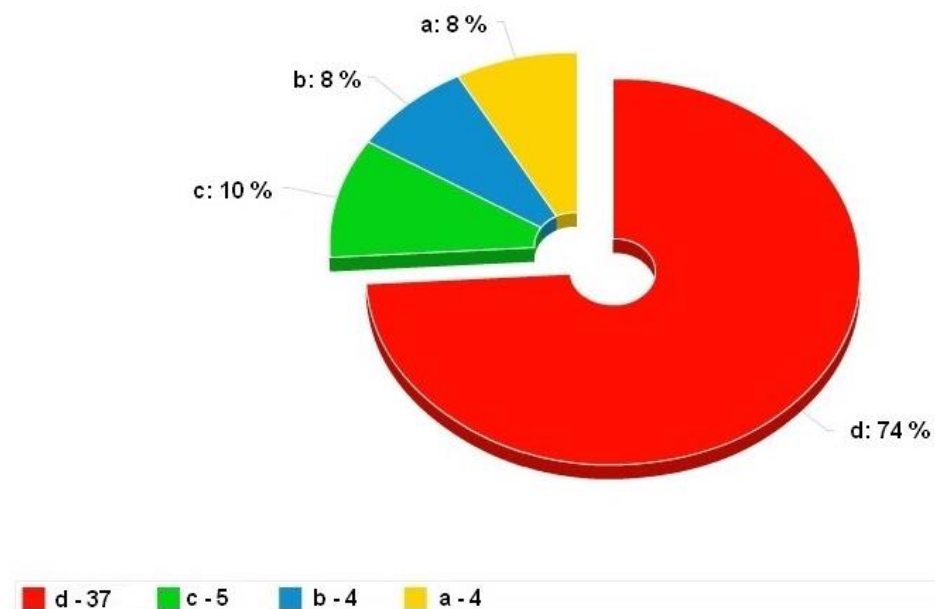


Figure 4.15. Distribution of responses about the ventilated facade sample are not example of BIPV system applied. (Question 24).

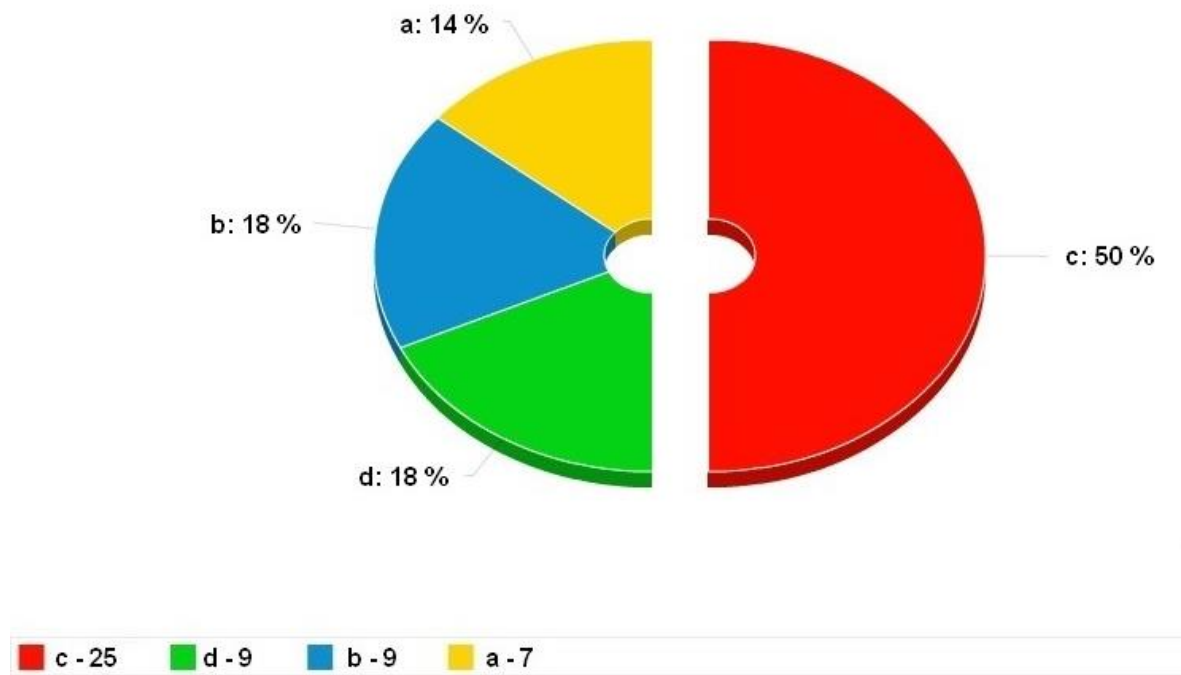


Figure 4.16. Distribution of responses about the skylight sample are not example of BIPV system applied. (Question 25).

4.3. Regarding Comparisons of BIPV Buildings

In the question of which building or buildings BIPV was applied, which is the first question of the first group of the last questions part, where the participants are expected to comment on the BIPV systems, by making pairwise comparisons with selected images (Question 26), 37 of the participants (74%) marked both of them, 11 of the participants (22%) marked B, and 2 of the participants (4%) marked A. Although the correct answer is “both of them”, it is seen that the majority of the participants gave the correct answer.



(A)



(B)

Figure 4.17. The images for Questions 26- 29.

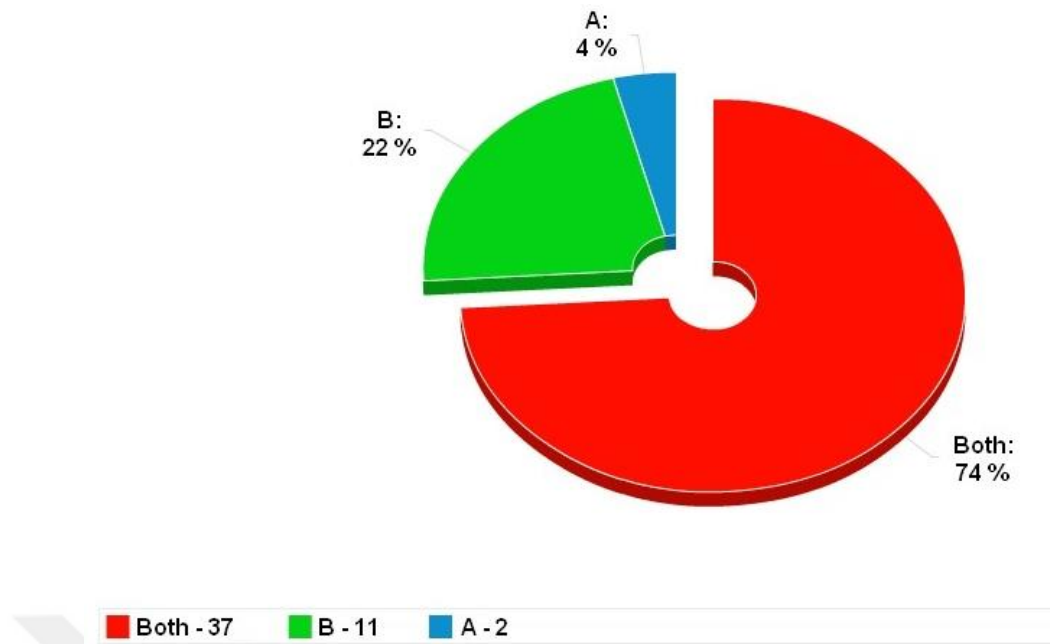


Figure 4.18. Distribution of responses about in which building has BIPV applied.
(Question 26).

In true-false questions whether semi-transparent modules and thin film modules are attached to building A and B, whether the fenestration system and the façade are a part of buildings A and B, (Question 26.a), None of the participants, consisting of architects and engineers, could answer the correct order of “ Yes, No, Yes, Yes, No, Yes, Yes, No ”,

In the question that semi-transparent modules are attached in building A, 34 participant (68%) answered yes and 16 participant (32%) answered no. In the question that semi-transparent modules are attached in building B, 22 participant (44%) answered yes, and 28 participant (56%) answered no. In the question that thin film modules are attached in building A, 35 participant (70%) answered yes and 15 participant (30%) answered no. In the question “Thin film modules are attached in building B”, 22 participant (44%) answered yes and 28 participant (56%) answered no. In the question that BIPV is applied as apart of fenestration in building A, 33 participant (66%) answered yes and 17 participant (34%) answered no. In the question that BIPV is applied as apart of fenestration in building B, 20 participant (40%) answered yes and 30 participant (60%) answered no. In the question that BIPV is applied as apart of facade in building A, 20 participant (40%) answered yes, 30 participant (60%) answered no. In the question that BIPV is applied as apart of facade in building B, 43 participant (86%) answered yes, 7 participant (14%) answered no.

 Semi transparent modules are attached in building A.	Evet
 Semi transparent modules are attached in building B.	Hayır
 Thin-film modules are attached in A building.	Evet
 Thin-film modules are attached in building B.	Evet
 BIPV is applied as apart of fenestration in building A.	Hayır
 BIPV is applied as apart of fenestration in building B.	Evet
 BIPV is applied as apart of facade in building A.	Evet
 BIPV is applied as apart of facade in building B.	Hayır

Figure 4.19. Distribution of responses about which of the following information is correct (Question 26.a).

In the question which is asked "Do you feel any difference in terms of visual integration of BIPV in these buildings? " (Question 27), 30 participants answered "Yes", 14 participants answered "No", 6 participants answered "I do not know".

In the question asked about differences in terms of visual integration of BIPV according to aesthetic reasons or material combinations (Question 27.a), while architects generally commented design-driven, engineers commented structurally. Both groups agreed that these differences are the dimensions, transparency, colors and visual structure combinations of the BIPV modules, that building A is a curtain wall, building B is an exterior wall, and in general, both groups believe that building B is more aesthetic than the building A building as a structure and material combination. There are 5 architects and 1 engineer who found the B building more successful than the A structure in terms of design (P.A 8, P.A 9, P.A 12, P.A 14, P.A 18, P.E 25). There are 1 architect and 1 engineer who think that more BIPV modules are used in structure B. (P.A 20, P.E 12).

Apart from these comments, there are architects who think that the facade cladding system in building B contains a monotonous repetition (PA 1), who does not see any tectonic attitude to separate building A from traditional buildings, and who think that artistic expression in building B is due to a technological rationality and simplicity and not from any concern for visual stylization. (PA 2), believes that building B is intended to emphasize products aesthetically, while building A gives the impression that it was

built for needs rather than aesthetic concerns. (PA 6), who does not feel any difference in terms of integration (PA 13), who thinks that building B is more rigid (PA 16). (PA 22) who think that the BIPV system parts used in building A system are integrated more homogeneously than building B. And there are engineers who think that transparent and translucent BIPV modules are used in building A, opaque BIPV modules are used in building B (P.E 3) and who think that the usage purposes of the spaces are different (P.E 11).



Table 4.3. Comparative responses of participants for Question 27 a.

27. Do you feel any differences in terms of visual integration of BIPV in these buildings? 27.a. Can you explain these differences according to any aesthetic reasons or material combinations?	
  (A) (B)	
ARCHITECTS	ENGINEERS
- I think the cladding system in building B involves a monotonous repetition. (P.A 1) - I cannot see any tectonic attitude that would distinguish building A from traditional buildings. It is understood that the artistic expression in building B results from a technological rationality and simplicity and not from any visual stylization concerns. (P.A 2) - BIPV modules differ in size and transparency. (P.A 3) - Building A looks like an addition. Building B has become part of the design. (P.A 5)	- Building A doesn't look very different from the buildings currently being built. Transparent / translucent BIPV may have been used in building A. Exterior cladding application has been made in building B. In building A, transparent and semi-transparent BIPV modules are used and in building B, opaque BIPV modules are used. (P.E 3) - BIPV modules differ in size, transparency and color. (P.E 7) - Cladding application styles are different. (P.E 8) - The usage purposes of the places are different. (P.E 11)

- Building B wanted to emphasize the product aesthetically, building A gives the impression of need, rather than aesthetic concern. (P.A 6) - In the building in B, the façade design is in unity with the form of the building, and in the building A, there is a separation between the facade cladding and panels rather than this unity. (P.A 8) - Building B is more successful than building A due to the integrative application and the balance of opacity / permeability. (P.A 9) - BIPV modules have different combinations of shape, size, color and visual structure. (P.A 11) - In terms of design, building A has been applied to a conventional composite cladding design. Building B emphasised photovoltaic elements and has a more aesthetic appearance. (P.A 12) - I don't feel any difference. (P.A 13) - In building B, the material found an aesthetic expression in accordance with its nature. (P.A 14) - Building B looks more rigid. (P.A 16)	- It feels like more BIPV modules have been applied in building B than in building A. (P.E 12) - Building A is a curtain wall, building B is exterior cladding. (P.E 15) - They have differences such as PV density, openness - closeness, color contrast, solid & void for aesthetic reasons or material combinations. (P.E 16) - The permeable / semi-permeable BIPV modules, which are applied as curtain walls in the A structure, are integrated with the wooden facade cladding. But in the structure B ,they are used as semi-permeable or opaque BIPV modules applied only as exterior cladding. (P.E 18) - Building B is more aesthetic than building A due to its structure and material combination. (P.E 25)
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• In terms of material language and use, building B looks more innovative. (P.A 18) • BIPV system usage seems to be more in building B. (P.A 20) • The BIPV system components used in building A system are more homogeneously integrated than building B. (P.A 22) • Due to the different spatial usage purposes, the dimensions, permeability and colors of the modules used may be different. (P.A 23) • PV density ratios are different. While it is used more homogeneously in building A, it is used more heterogeneously in building B. (P.A 24) • While PV is used as a facade element in structure A, it is used as a second layer placed on the facade in structure B. (P.A 25)	
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In the question of how these buildings look different from other traditional buildings (Question 27.b), although there are participants in both groups who think that buildings with BIPV technology are not different than traditional buildings (PA 5, PA 13, PA 19, PE 15), Both groups consider that BIPV systems look different, especially because of the cladding materials and cladding systems for the exterior, that the material has more variety in color, texture, size and transparency, and that they are more modern, more technological and more progressive systems (PA 1, PA 3, PA 6, PA 8, PA 11, PA 14, PA 15, PA 16, PA 17, PA 18, PA 20, PA 21, PA 25, PE 1, PE 2, PE 3, PE 6, PE 7, PE 10, PE 13, PE 14, PE 16, PE 18, PE 19, PE 25).

Also, there are participants who think these buildings are more functionally efficient, although BIPV building are more aesthetic visually or not much different than traditional buildings (P.E 8, P.E 9, P.E 12, P.E 24). It has been observed that engineers make more comments on functionality rather than on the aware aesthetics of BIPV systems and traditional buildings than architects.

Apart from these comments, there are also architects who made specific comments by making different and more evaluations from the engineers. They are architects who does not see any tectonic attitude to separate building A from traditional buildings, and who think that artistic expression in building B is due to a technological rationality and simplicity and not from any concern for visual stylization. (PA 2), who thinks that functionally photovoltaic materials do not harm nature while generating electricity, do not generate noise, do not require an additional energy source, have no moving parts, have no maintenance costs, and that it is sufficient to clean the dust accumulated on them periodically with water. (P.A 4), who think that the building protects the appearance of both day and night façade, and that the digital facades we come across in the examples collect daytime energy on the façade and provide lighting on the façade in the evening, in some buildings with BIPV system applied (P.A 9), who think that BIPV systems have more angular and shiny and smooth surfaces in terms of material than traditional buildings (P.A 12), who think that BIPV systems are artificial looking and there is no naturalness than traditional buildings (PA 23), who think this visual difference depends completely on the architect's design and factors such as the geographical location of the building, the building form, the orientation of the building in relation to the sun, the direction of the PVs in the building envelope, the slope (the angle it makes with the sunlight), the presence of natural and / or artificial obstacles that can cast a shadow on the system (PA 24).

Table 4.4. Comparative responses of participants for Question 27 b.

27.b. How do these buildings look different from other conventional buildings?	
ARCHITECTS	ENGINEERS
• They look different, especially due to cladding materials and cladding systems for exterior facade. (P.A 1) • (Look 45.) I can not see any tectonic attitude that will separate the A example from traditional buildings. In example B, it is understood that artistic expression is caused by a technological rationality and simplicity, and not from any visual stylization concern. (P.A 2) • The curtain wall and cladding systems applied in BIPV systems are more elit, more modern and more various than traditional buildings. (as color, size, shape, transparency / permeability). (P.A 3) • BIPV systems are much more successful than traditional buildings visually and functionally. Like traditional buildings, they can be used as facade cladding material in front of the wall, as a curtain wall. However, BIPV modules have much more facade variation than traditional buildings with their features such as color, size, shape, and transparency. Functionally, the photovoltaic material does not harm the nature while generating electricity, does not generate noise, does not require an additional energy source, has no moving parts, no maintenance costs. It is sufficient to clean the dust accumulated on it periodically with water. (P.A 4) • They are not much different from traditional buildings. (P.A 5)	• They look more modern than traditional buildings. (P.E 1) • Traditional and modern definitions show relativity and differ from person to person. (P.E 2) • Look 44. Building A doesn't look much different from the buildings. Building B has a more modern look than traditional buildings. (P.E 3) • I think they provide a more modern look. (P.E 6) • They look different from the exterior cladding we are used to today. With solar energy systems, buildings look more aesthetic, more modern and more compact. (P.E 7) • Although they have functional differences from traditional buildings, they are not aesthetically different. (P.E 8) • Although not very different in appearance, BIPV systems are much more efficient systems functionally. (P.E 9) • They have a more modern looking. (P.E 10) • They are more modern, more prismatic. (P.E 11) • They have more structural / aesthetic options in appearance, and they provide energy efficiency functionally. (P.E 12) • Their glass / permeable surface ratio is higher than traditional buildings. In this way, it provides higher quality

• Building A looks traditional, building B seems to have a technological emphasis. (P.A 5) • Building A looks traditional, building B seems to have a technological emphasis. (P.A 6) • They are more modern looking. (P.A 7) • It looks different from the facade cladding of traditional buildings. It has differences in the colors of the glasses applied to the openings. (P.A 8) • It increases the aesthetic value of the building by giving the building a more modern appearance. In some buildings with BIPV system applied, it protects the appearance of the building both day and night. The digital facades we come across in the examples collect energy on the façade during the day and provide lighting on the façade in the evening. (P.A 9) • These buildings are not visually different from other traditional buildings. So, this difference depends completely on the functional and aesthetic ability of the architect who designed the building. Apart from that, BIPV systems and other traditional buildings are not different in appearance and cannot be distinguished from the facade or roof. (P.A 11) • I do not know if a curvilinear design can be made on facades with BIPV systems, but they are more angular than traditional buildings and materials have shiny and smooth surfaces. (P.A 12) • They don't look very different. (P.A 13)	lighting indoors, while also providing energy production. (P.E 13) • They look more aesthetic than traditional buildings. (P.E 14) • They are not much different than traditional buildings. (P.E 15) • They differ from traditional structures with the much usage of semi-permeable materials. (P.E 16) • They look more technological. (P.E 18) • They have different style facades than traditional structures. The color, texture, size and transparency of the material have more variety. (P.E 19) • They are not much different from traditional facades in appearance, but they are more useful functionally. (P.E 24) • They are more modern and technological. (P.E 25)
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• It looks modern and progressive. (P.A 14) • There are only material differences. (P.A 15) • It looks more modern and smart system. (P.A 16) • Following the information included in the survey, it has the features of harmonizing with architectural design aesthetically, adding value to architecture, enabling innovative design and increasing design options. And with these features, they differ from traditional buildings. (P.A 17) • They seem to have been interpreted in a more innovative language. (P.A 18) • They don't look different from traditional buildings. (P.A 19) • They differ from traditional structures with the excess of transparent parts on their facades. (P.A 20) • It is no different from traditional buildings in terms of appearance. BIPV facades can be used instead of facing materials such as glass, natural stone and ceramic. And just like traditional facades, it consists of transparent and / or non-transparent sections. (P.A 21) • They look artificial than traditional buildings, there is no naturalness. (P.A 23) • This visual difference depends completely on the architect's design and factors such as the geographical location of the building, the building form, the orientation of the building in relation to the sun, the direction of the PVs in the building envelope, its inclination (the angle it makes with	
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the sunlight), the presence of natural and / or artificial obstacles that can shade the system. (P.A 24) • With its applications integrated into the building, glass goes beyond its traditional function and creates opportunities for contemporary applications. (P.A 25)	
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In the question about the facades of buildings (Question 27.c), both groups who find the façade designs of structures A and B generally successful, agree that the facade of structure A is similar to traditional facades and that the facade of structure B is designed better than the facade of structure A.

Apart from these comments, there are architects who think that the buildings whose facades are completely covered with panels do not offer a wide variety of colors and textures due to the nature of the coating material (P.A 1), who does not see any tectonic attitude to separate building A from traditional buildings, and who think that artistic expression in building B is due to a technological rationality and simplicity and not from any concern for visual stylization. (P.A 2), who think that especially the panels in building B are significantly integrated with the façade design (P.A 8), who do not like the color and material selection of the curtain wall of building A, but prefer building B more due to the holistic application and the balance of opacity / permeability (P.A 9), who do not like the façade of building A, do not find the combination of wood and glass as successful in terms of ratio and color harmony, and that the building has a very traditional identity, while building B is more intimate and tasteful despite the intensity of the cold colors used on the facade (P.A 11), who cannot match these designs with his own design approach (P.A 16), who thinks that energy panels are designed according to their usage logic (P.A 18), who thinks that it looks like the glass-faced buildings we are used to (P.A 20), who thinks that the facades are a bit colder and foreign, they seem to have masks on their faces, but that is not a problem (P.A 21), who thinks that the facades are beautiful, but that they may have cleaning problems (P.A 23), who thinks that the purpose of building B's façade involves a concern for better design rather than system efficiency, that PV is brought to the fore by creating a contrast between the building facade and the color of the PV, and that building A is designed by integrating the need for joinery with the use of PV. And there are engineers who think that building A has a cold appearance and building B has a warm / friendly appearance (P.E 11), who think that the aesthetic shapes of photovoltaic cells, the variety of glasses and profiles, color alternatives and optical properties give the buildings both modern and creative features in BIPV systems (P.E 16).

In the question which is asked " Which facade do you prefer to build / design? " (Question 28), 40 participants answered "B", 6 participants answered "both", 2 participants answered "A" and 1 participant answered "none".

In the question asked about the reasons for their choice in terms of electricity generation (Question 28.a), both groups generally do not have sufficient knowledge about

electricity generation and application technique, but they believe that building B is more successful than building A in terms of visual and aesthetic issues.

In the question of comparing the energy production efficiencies of photovoltaic applications on the roof and the facade (28.b.), 11 engineers in the group of engineers think that energy production efficiencies in roof photovoltaic applications are more efficient (P.E 1, P.E 5, P.E 7, P.E 8, P.E 14, P.E 15, P.E 16, P.E 17, P.E 18, P.E 19, P.E 25), only 2 engineer think that energy production efficiencies in façades photovoltaic applications are more efficient (P.E 2, P.E 9). And from the group of architects who respond almost equally to the energy efficiency of the façade and roof, 6 architects think that energy production efficiencies in roof photovoltaic applications are more efficient (P.A 1, P.A 12, P.A 17, P.A 18, P.A 20, P.A 25) , 7 architects think that energy production efficiencies in façades photovoltaic applications are more efficient (P.A 4, P.A 5, P.A 7, P.A 13, P.A 15, P.A 16, P.A 24). Participants who think that roofs are more efficient, think that they are more efficient due to the fact that the angle and duration of sunlight are more, and they are not exposed to shading. Other participants also think that it is not correct to comment without providing these informations (P.A 6, P.E 10, P.E 12, P.A 8, P.A 9, P.A 11). In short, only 2 engineers and 7 architects gave the correct answer, facades. The conclusion is that very few participants know about BIPV roof and facade applications and their energy efficiency.

Table 4.5. Comparative responses of participants for Question 27 c.

27.c. What do you think about the facades of these buildings?	
ARCHITECTS	ENGINEERS
• I believe that the buildings, whose facades are completely covered with panels, do not offer a wide variety of colors and textures due to the nature of the coating material. (P.A 1) • (Look 45.-46.) I can not see any tectonic attitude that will separate the A example from traditional buildings. In example B, it is understood that artistic expression is caused by a technological rationality and simplicity, and not from any visual stylization concern. (P.A 2) • Both structures are successful with their integrated structure. (P.A 3) • Building A is simple and building B has a elegant design.(P.A 4) • (Look 46) A seems traditional, B seems to have a technological emphasis. I liked building B more than building A. (P.A 6) • Both of them are nice. (P.A 7, P.A 13) • Especially in the B structure, I think the panels are significantly integrated with the facade design. (P.A 8) • I did not like the choice of curtain wall color and material of the building A. (Look 45) I like the building B more because of the ingetrative application and the opacity / permeability balance. (P.A 9) • I did not like the facade of building A very much, the wood-glass combination is not good in proportion and color harmony, and the structure	• The designs of both are nice. (P.E 3) • They are aesthetically and costly very different from each other. (P.E 5) • Building A looks like a standard facade, but building B has a more modern look. (P.E 6) • Both structures look aesthetic and modern. (P.E 7) • They are very practical and aesthetic. (P.E 8) • I do not know the purpose of use of the buildings. However, Building A has beautiful designs for offices / workplaces and building B has beautiful designs for living spaces. (P.E 9) • Building A has a cold, building B has a warm / friendly appearance. (P.E 11) • Building A looks like traditional building and government offices in Turkey and it looks like cheaper material has been used. However, building B looks more modern. (P.E 12) • They are elegant. (P.E 13) • They are nice. (P.E 14) • Building B looks nicer than building A. (P.E 15) • In BIPV systems, the aesthetic shapes of photovoltaic cells, the variety of glasses and profiles, color

seems to have a very corporate identity. Building B seems more intimate and enjoyable despite the intensity of the cold colors used on the facade. (P.A 11) • Building A has a traditional look and building B has a modern look. (P.A 12, P.A 15) • The facade of building B is better designed than the facade of building A. (P.A 14) • They don't match my design understanding. (P.A 16) • The facade of building B looks simpler and more modern than the facade of building A. (P.A 17) • Since energy panels are intended to be used, they are designed according to their usage logic. (P.A 18) • Building A looks like any business facade we can always see. Building B is better designed. (P.A 19) • They look like glass-faced buildings that we're used to. (P.A 20) • They look a little colder and stranger. It looks like they have masks on their faces. But I don't think this is a problem. (P.A 21) • They are beautiful facades, but there may be cleaning problems. (P.A 23) • The purpose on the facade of Building B is more about good design than system efficiency. By creating a contrast between the facade of the building and the color of the PV, the PV was brought to the fore. Building A is designed by integrating the need for joinery with the use of PV. (P.A 25)	alternatives and optical features add modern and creative features to the buildings. (P.E 16) • The facade design of both are nice. (P.E 21) • Both structures look aesthetic. (P.E 24)
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Table 4.6. Comparative responses of participants for Question 28 a.

28. Which facade would you prefer to build / design ?	
28.a. Can you explain the reasons for your preference in terms of electricity production? / visual or aesthetic issues? / or physical application technique?	
ARCHITECTS	ENGINEERS
- I think the application of this system will create a monotonous and boring effect visually and aesthetically. (P.A 1) - Every technological and rational necessity creates its own aesthetics. Therefore, the reasons for physical application have priority. The fact that the application of BIPV systems is practical is one of reason for my preference. (P.A 2) - Building B looks better in terms of its facade in terms of solid / void relationship. But I have no idea in terms of electricity generation and application practice, it requires an account. (P.A 4) - Building A has more facade area. It looks like an industrial structure, the need for energy may be more. In building A, different materials end in the same line on the facade, therefore application may be more difficult. Building B is smaller in scale and looks like a residential building. Energy needs may be less. Building B has fewer different facade materials, therefore application can be easier. (P.A 6) - Building B is a more elegant, but building A seems to be able to generate more electricity because it has more glass surfaces. (P.A 7) - In building B, I think the cladding system takes up more space and	- Aesthetic issues can vary. Because module sizes, forms and colors are features that affect the design. In terms of electricity generation, these systems not only generate electricity but also allow the building's thermal and acoustic insulation to improve. I prefer building B visually / aesthetically from the two examples given. (P.E 1) - As I mentioned before, issues such as customer requests, project requirements or functionality will affect priorities regarding energy savings or aesthetics. (P.E 2) - The visual difference of these two structures is that the light transmittance (opacity) of the cells formed by the photovoltaic modules integrated into the building is different. Since transparent and opaque panels can be used on the same facade in building A, the desired effect is easily achieved in the building. I think building A is better in terms of efficiency. However, visually / aesthetically, I liked building B more. (P.E 3) - Building B is better in terms of aesthetics and application cost. As the application technique, building B is easier to apply than building A, which has a curtain wall system, since it has a coating system. (P.E 5) - Visual or aesthetic issues can change according to the pleasure of the

therefore it can generate more electricity. In addition, the facade design is in harmony with the form of the building. In building A, there is a separation between facade cladding and panels rather than this unity. (P.A 8) - It is very logical to choose these systems as they provide efficiency in terms of electricity generation, have the same features as traditional structures in terms of visual / aesthetic issues and can be easily applied in terms of application technique. (P.A 11) - It is necessary to determine the need according to the function of the building, by using panels on the surface to supply the minimum need, by correlating the cost and visuality correctly. (P.A 12) - I prefer building B because it looks more aesthetic and more efficient. (P.A 13) - I prefer Building B, because it is innovative and in search of an aesthetic understanding suitable for new material. (P.A 14) - A more efficient system can be achieved in the future by intelligently configuring the piecemeal system. (P.A 16) - In order to know which building generates more electricity, the number of batteries, AD / DC online quantity and storage area must be known. (P.A 17) - I totally think the world should use this energy system, therefore there	employer and the design understanding of the architect. The aesthetic shapes of the photovoltaic cells, the variety of glasses and profiles, color alternatives and optical features add modern and creative features to the buildings. In this way, the buildings both gain a modern appearance and make an ecological contribution to the environment by producing clean energy. My choice is building B visually / aesthetically. (P.E 6) - The reason why I prefer BIPV systems in terms of electricity generation is that it is always profitable to produce our own electricity. Because we are not affected by tariff changes in electricity prices. When the electricity obtained by this system is consumed at the place where it is produced, transmission losses due to long distance do not occur. As long as the radiation is sufficient, it can generate electricity in all weather conditions (rain, snow, cloudy weather). The energy required can be found everywhere, in every region and in all seasons. Building B is my preference as building B is more aesthetic and it produces more solar energy. (P.E 7) - I think buildings designed by architects must be functional and economical. For me, aesthetic concerns are secondary. BIPV systems can be installed instead of building materials, in this way, savings in construction are achieved. For this reason, I prefer BIPV systems. (P.E 8) - I think building A can take more light and thus generate more energy, as it is more transparent in terms of solar taking capacity. (P.E 9)
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can be no visual or aesthetic priority, saving energy is a priority. (P.A 18) • The aesthetics and efficiency of the building is my design priority. Aesthetically, I prefer structure B, but I have no idea which building is better in terms of electricity generation and efficiency. (P.A 20) • Each architectural structure has a different appearance and aesthetic structure, and electrical infrastructure designs should not affect this aesthetics. These are factors that make project designs difficult and increase costs. For this reason, each BIPV system applied structure has different visual / aesthetic, application technique and electricity generation / energy efficiency. (P.A 21) • BIPV systems can be evaluated in different ways in terms of economic and technological competence, structure features, awareness and knowledge level of the user and the user. (P.A 23) • Its application on the roof may be more suitable for electricity generation. But aesthetically, it is better to apply on the facade. (P.A 24) • I think the efficiency will be higher in building A. However, it requires more precision in the application phase. Building B is more visually aesthetic and easier to implement. (P.A 25)	• I think aesthetics is an important issue. Flat areas are needed to generate electricity, but the design of the facade is also important for aesthetic factors. Building B looks more aesthetic and seems to have used more photovoltaic modules, so the rate of heat transmission may be different (heat losses, etc.) and may be generating more electricity. (P.E 11) • As an engineer, I would like to work / live in building B since it has a different architecture. But I prefer building A as an employer. Because it may provide more energy efficiency than building B in terms of the surface area it has. (P.E 12) • Using BIPV is much more cost effective than building a structure and adding photovoltaic arrays then. Because BIPV is part of the initial construction spending and they replace traditional materials rather than build on expensive building materials. Using systems integrated into the building can be more aesthetically attracting. Because these systems can be designed to adapt to the building and added architecturally. In addition to being environmentally friendly and cost-effective by nature, photovoltaics integrated into the building can also be used for dual purposes. For example, windows with solar cells collect and convert solar energy, but also cool rooms and reduce the need to use a special cooling system. (P.E 13) • It is enough to produce at least the minimum level of electricity. Because none of the traditional buildings have a system to generate their own electricity. (P.E 14)
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	• I prefer the more economical one. (P.E 15) • Aesthetically, I prefer structure B because of the harmony of its size and shape with the overall integrity of the building, and the harmony of its color and textural features with other elements of the building. I do not know about electricity generation and application technique. (P.E 16) • In order to know how efficient BIPV systems provide, we need to know the amount of solar radiation such as geographical factors, geometric features (direction, slope), shading factors (structure density, topography), vegetation and the climatic characteristics such as wind load, precipitation rate / snow load, outside temperature. (P.E 18) • Electricity generation, visual or aesthetic issues, physically application technique varies depending on the investor and the concept. (P.E 19) • I prefer photovoltaic systems because they generate electricity from the sun, which is the easiest, most abundant and cleanest of all energy sources. (P.E 23) • I have no idea about electricity generation and application technique. But aesthetically, I prefer building B. (P.E 24) • As energy production, I prefer the building which is more efficient, more reliable, more continuous and more sufficient. (P.E 25)
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Table 4.7. Comparative responses of participants for Question 28 b.

28.b. Do you think energy efficiency efficiencies are better or worse than rooftop photovoltaic applications? Can you explain why?	
ARCHITECTS	ENGINEERS
• I think that the roofs have more energy access than the facades. Therefore, I do not think that the façade photovoltaics provide sufficient energy production efficiency, especially in crowded urban texture. (P.A 1) • I think it can change depending on the situation due to reasons such as usage, maintenance, insolation, surface area. (P.A 2) • Since the surface area is bigger, the facades can be more efficient if the building location is also suitable. (P.A 4) • I think the application on the roofs is worse because they cannot be at the most efficient angle like those in the facades. (P.A 5) • In order to answer this question correctly, we need to know the orientation of the building according to the sun, the coordinates of the building and other structures around the building. It also changes depending on whether the roof panels are stable or moving. It is necessary to calculate whether the maximum efficiency can be took from the facade or the roof at the location of the building. If the same efficiency is to be took, then I prefer the one with more m2 so that I have the capacity to generate more energy. (P.A 6)	• Efficiency varies according to the time of sun exposure. Roof panels can get sun all day long. Facade panels may not get sun all day depending on the building direction. (P.E 1) • Facades are better. (P.E 2) • Roofs are better. Electricity generation is better in roofs, because it gets more sun. (P.E 5) • Energy production efficiency on the roof is higher as it is more exposed to solar energy. (P.E 7) • Application on roofs is better than facades because of the azimuth. (P.E 8) • It is better to apply on the facade. Since the facades are transparent (glass), their capacity to take the sun is higher. (P.E 9) • This is related to the angle. It relates to the geographical location and azimuth of the building. In general, roof efficiency can be better as it can be applicated more flexibly in roof applications. (P.E 10) • Roofs are always better. (P.E 11) • Since it is related to getting sunlight, I cannot comment without a visual. (P.E 12)

• It is worse on roofs because the roof gets the sun at more perpendicular angles. (P.A 7) • I think it can change according to the amount of sun exposure and azimuth. Therefore, I cannot answer this question clearly. (P.A 8) • Efficiency changes depending on surface area, angle of sun exposure, shading time. (P.A 9) • Photovoltaic applications on the roof are used more than applications on the facades. Because, facade BIPV systems are not unknown in Turkey yet. It is not right to comment on this in terms of energy production efficiency. Because this changes according to the size and height of the building. If the facade surface is more than the roof surface, of course energy production and efficiency is higher. (P.A 11) • Roofs take daylight longer than facades, therefore it is more efficient. (P.A 12) • The roofs can be worse due to the angle of sun exposure. (P.A 13) • Its application on roofs is worse. (P.A 15) • The roof can be worse because it can take longer sun. (P.A 16) • Roofs are better because they generate energy directly from a renewable source. (P.A 17)	• Roofs are better. (P.E 14) • Although it is not as much as on the roof, it is good to apply in terms of efficiency and aesthetics. (P.E 15) • Roof application is better because it has the potential to take the sun rays more perpendicularly. (P.E 16) • Roof panels are more efficient applications since their azimuth angle and duration are more. (P.E 17) • The roof is better unless there is a shade. (P.E 18) • It is better on roofs. Because it is not exposed to shading. (P.E 19) • The efficiency on the facades is lower, as the sun's rays do not come constantly like on the roofs. (P.E 25)
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• I think roofs are better. When used on the roof, it can be used continuously and it can be used on wider surfaces. (P.A 18) • Roofs can be better. Because the application area is more. (P.A 20) • It is useful to know their location, therefore I do not know. (P.A 21) • I think it's better on roofs. (P.A 23) • I think roof applications are worse. Because we can give the right angle and increase the efficiency according to sun's angle of incidence, but in these systems, the angle is usually 90 degrees. The architecture of the building can be designed according to high production efficiency, but it can not be aesthetic. (P.A 24) • Considering the angle of incidence of the sun to integrate PV to the facade, although it shows good efficiency in winter, it decreases in summer. For this reason, its efficiency is lower than the applications mounted on the roof. (P.A 25)	
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In the question of applicability in terms of cost (Question 28.c), both groups, thinking that the initial investment costs of BIPV systems and the cost in the production phase may be high, agree that these systems can meet the production cost in the long term with the energy savings they will provide and can spend return to profitability themselves over time.

As specific comments, there are architects who think that the cost can change depending on the situation due to reasons such as usage, maintenance, sunbathing, surface area (P.A 2), who think that it is possible to keep the cost to a minimum by raising a building according to the needs of the building, that the costs are decreasing with the progress of technology day by day, but it is an issue that should be considered in the long term and it is already an efficient application in the long term (P.A 12), who thinks that it will change according to the technology used in the building and finds the part system in building A more applicable (P.A 16), who thinks that the building will differ according to the details, especially the PV on the A facade can be more economical than the Building + PV cost because it replaces the joinery (P.A 25). There are engineers who think that some features should be taken into consideration such as materials, joinery details, usage, sunbathing-shading, maintenance / cleaning etc. on facades or roofs, during and after the application; who think that it can be found which system will be more costly, by comparing BIPV systems with these features with traditional systems (P.E 1), who think that a feasibility study should be done about the cost over time to interpret the cost (P.E 2), who thinks that it is necessary to examine the future profit share it will bring (P.E 8), who thinks that the roof can be less costly because it can be solved with less detail by comparing the roof / facade (P.E 10), who thinks that the building will change according to the budget of the builder (P.E 11), and the installation and maintenance of solar panels on the roof will be more affordable, so the application area of the roof is more frequent (P.E 12), who thinks that roofs will pay off shorter than facades (P.E 18).

In the question asked which structure provided more benefit for us (28.d), the architect and engineer participants who think that both structures benefit as systems that can generate electricity, think that structure B can produce more energy in terms of its structural installation, and therefore, it provides more benefits. In the question asked which structure do you want to live or work (Question 28.e.), although the architect and engineer participants find building B more successful due to its architectural design, they generally prefer building A for working and building B for living.

Table 4.8. Comparative responses of participants for Question 28 c.

28.c. What do you think about their cost-effectiveness?	
ARCHITECTS	ENGINEERS
• Whichever method is used, I see its applicability low because its cost is high in our country. (P.A 1) • Look 50. (I think it may change depending on the situation due to reasons such as usage, maintenance, sunbathing, surface area.) (P.A 2) • Its cost is high. (P.A 4) • I think it's too costly for now. (P.A 5) • Since there are very expensive facade materials in the market, materials with this feature may not cost more than usual. (P.A 6) • It depends on the properties of the building. For example, I guess that the joint details of the building of the structure in B is more detailed. Therefore, I think these materials will be more expensive to manufacture. (P.E 8) • I think it is more costly than traditional buildings. (P.A 9) • It is possible to keep the cost to a minimum by making it according to the needs of the building. As technology advances day by day, costs are also decreasing. But it is an issue that should be considered in the long term and it is already an efficient application in the long term. (P.A 12) • It depends on the long term efficiency. (P.A 13)	• It is necessary to look at the properties such as material, joinery details, usage, sunbathing-shading, maintenance / cleaning during and after the application on the facades or roofs. By comparing BIPV systems and traditional systems with these features, it can be determined which system may be more costly. (P.E 1) • A feasibility study should be done on the cost over time. (P.E 2) • Although the costs are high in terms of application, it can pay for itself in a short time. (P.E 5) • I think the initial investment costs may be high, but the electrical energy costs during building use may be low. (P.E 6) • Considering the monthly energy consumption, although it is a little more costly during the construction phase, I think it will be suitable over time. (P.E 7) • It is necessary to examine the prospective profit share. (P.E 8) • Since the roof can be solved with less detail, it can be less costly. (P.E 10) • It depends on the budget of the builder. (P.E 11) • Since the installation and maintenance cost of solar panels on the roof will be more affordable, the application area of the roof will be

• I think, they are applicable systems. (P.A 15) • It depends on the technology used in the building. For example, I find the part system in building A more applicable. (P.A 16) • Costs may be high during the production phase. However, it can meet the production cost with the energy savings it will provide in the long term. (P.A 17) • As recycling speeds up, people will want to use it. (P.A 18) • They're expensive systems. (P.A 23) • I do not care about the cost as it will provide savings over time. (P.A 24) • It depends on the details of the building. Especially on the facade A, since the PV replaces the joinery, it may be more economical than the Building + PV cost. (P.A 25)	more than facade application. (P.E 12) • They are applicable. (P.E 13) • Over time, it makes a profit. (P.E 14) • It has a return on investment period, such as 5-7 years. (P.E 16) • I think roofs will pay off shorter than facades. (P.E 18) • They're expensive systems. (P.E 19) • They are difficult to apply in terms of cost. (P.E 25)
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Table 4.9. Comparative responses of participants for Question 28 d.

28.d. Which one gives us more benefits? Why is that?	
ARCHITECTS	ENGINEERS
• In photovoltaic systems, reaching the most solar reach means the highest efficiency. For this reason, more uninterrupted and highly efficient energy production may be possible on roofs. However, in terms of surface, facade coverings can be more efficient in cases where the facade surfaces are more than the roof. (P.A 1) • (Look 50.) I think it can change depending on the situation due to reasons such as usage, maintenance, insolation, surface area. (P.A 2) • Building B, because it seems to have a larger surface area with PV. (P.A 4) • Applications on the roof, because I think it generates more electricity and I don't like the visual effect of the panels on the facade. (P.A 5) • I think the photovoltaic panels in building B can generate more energy because they take up more space. It will provide more benefits in terms of design and energy efficiency. (P.A 8) • The efficiency of energy production in the BIPV system used is greater in which building, this building provides us more benefits. (P.A 11) • Which building is a more sustainable design, that building provides more benefits. (P.A 12) • Both are useful. (P.A 13)	• The building, which has more efficiency economically, benefits us more. (P.E 1) • Feasibility results should be evaluated. (P.E 2) • Building B provides us more benefits. Because cost is very important in design. (Look 49.) Building B is better in terms of aesthetics and application cost. As the application technique, building B is easier to apply than building A, which has a curtain wall system, since it has a coating system. (P.E 5) • Both are useful as systems that can generate electricity. (P.E 6) • Building B may have more benefits because it contains more solar cells. (P.E 7) • Building B may be generating more electricity than the number of modules it contains. (P.E 11) • I cannot comment as it is related to sunlight taking and surface area. (P.E 12) • Both of them. (P.E 13) • They benefit us as they both generate electricity. (P.E 14) • The more economical building benefits us. One of the most

• B provides a more efficient energy production. (P.A 17) • The building, which is more economical in terms of before and after design costs, provides us more benefits. (P.A 18) • Building B, we get energy from natural ways. (P.A 23) • Both buildings can provide more benefits according to according to their purpose of use. (P.A 24) • Building B, provides more benefits as it aims to use the PV system without sacrificing design concern. (P.A 25)	important factors in a building is cost. (P.E 15) • Roof application. (P.E 16) • Roof applications provide more electricity generation. (P.E 18) • The building with low construction cost and high efficiency benefits us. (P.E 25)
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Table 4.10. Comparative responses of participants for Question 28 d.

28. e. In which building would you like to live / work?	
ARCHITECTS	ENGINEERS
• I wouldn't prefer to live in either building. But I prefer building B to work, it looks peaceful for the office environment. (P.A 1) • Building B. See 45. (In example B, it is understood that artistic expression is caused by a technological rationality and simplicity, and not from any visual stylization concern.) (P.A 2) • Building B (P.A 3) • I don't want either. (P.A 4) • I prefer building B because it looks more modern than building A. (P.A 5)	• I would prefer building A to work and building B to live. (P.E 1) • I think it would not be right for me to answer this question without seeing the interior architecture, location and office layout plans of the buildings. (P.E 2) • I would prefer building A because of the better indoor lighting quality. (P.E 3) • I would prefer building B because it is better in terms of aesthetics and application cost. (P.E 5) • In building B, because its modular design looks nice. (P.E 6)

• I would like to live in B, and A looks like a building to work in. But there is no clue that A is an attractive working building in its appearance. (P.A 6) • I think building A can use to the roof. That's why I prefer it. (P.A 7) • I prefer building B. Because (Look 52).I think the photovoltaic panels in building B can generate more energy because they take up more space. It will provide more benefits in terms of design and energy efficiency. (P.A 8) • Look 45.) I like the building B more because of the ingetrative application and the opacity / permeability balance. (P.A 9) • In building B. Because, as I explained before, building B feels more intimate, warm and enjoyable despite the intensity of the cold-toned colors used on the facade. (P.A 11) • Building B looks more modern and technological. (P.A 12) • Both of them. (P.A 13) • Building B because it looks more modern and meaningful. (P.A 14) • I prefer building B because it looks different from traditional buildings. (P.A 15) • None of them. They are not the style of buildings I would like to live or work in. (P.A 16) • Building A seems suitable for working, building B seems suitable for living. (P.A 17)	• I would like to live / work in building B. The lower floor is suitable for the working area with natural lighting, and the upper floor is suitable for the resting / sleeping area by providing shading with its colored photovoltaic glass design. (P.E 7) • I prefer building B in terms of efficiency and aesthetics. (P.E 8) • I would like to live or work in building A due to its high capacity to take the sun and its large amount of transparent structures. (P.E 9) • I would like to live or work in both buildings. Building A is suitable for working and building B is suitable for living. (P.E 10) • I prefer building B. Because (Look 47) Building A has a cold, building B has a warm / friendly appearance. (P.E 11) • I would like to live or work in building B. Because (Look 47) Building A looks like traditional building and government offices in Turkey and it looks like cheaper material has been used. However, building B looks more modern. (P.E 12) • Building B because it is more aesthetically successful. (P.E 13) • In both of them. (P.E 14) • I choose building B as it has a more modern and technological design. (P.E 15) • I would prefer the structure in which passive energy efficient solutions are
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• I would choose building B because it is a more innovative and progressive building. (P.A 18) • I prefer building B for design reasons. (P.A 19) • Building A, because its interior looks brighter. (P.A 20) • I have no idea. It's hard to tell without seeing the interior. (P.A 21) • Building A is suitable for the working, building B is suitable for both the working and living. (P.A 22) • I wouldn't prefer any of them. Neither of them are my style. (P.A 23) • I like the cubic design of B structure. (P.A 24) • Building B, because structure B is suitable for both working and living. (P.A 25)	made so that the low energy requirement of the building can be supplied from renewable sources. (P.E 16) • I prefer building B because of its successful architectural design. (P.E 18) • I would like to work / live in the more energy efficient building. (P.E 19) • I choose building B because it is aesthetically better. (P.E 23) • I would prefer whichever is more efficient in the long term. (P.E 24) • Building B, because it looks more modern. (P.E 25)
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In the first question in the second group of interpretation questions which is asked “In which building or buildings were translucent photovoltaic glass modules applied?” 22 participants answered 'both', 15 participants answered 'A' and 13 participants answered 'B'.

In the right-wrong question after giving the information about these structures (Question 29.a.), only 1 participant know the correct order of “ Yes- Yes- Yes- No- Yes- Yes- No- No ”

In the question that translucent modules are installed in the roof light of building A, 34 participant (68%) answered yes and 16 participant (32%) answered no. In the question that translucent modules are installed in the roof light of building B, 32 participant (64%) answered yes and 18 participant (36%) answered no. In the question that thin film modules are installed in the roof light of building A, 28 participant (56%) answered yes and 22 participant (44%) answered no. In the question that thin film modules are installed in the roof light of building B, 30 participant (60%) answered yes and 20 participant (40%) answered no. In the question that translucent modules are installed on the facade of building A, 18 participant (36%) answered yes and 32 participant (64%) answered no. In the question that translucent modules are installed on the facade of building B, 23 participant (46%) answered yes and 27 participant (54%) answered no. In the question that thin film modules are installed on the facade of building A, 19 participant (38%) answered yes and 31 participant (62%) answered no. In the question that thin film modules are installed on the facade of building B, 25 participant (50%) answered yes and 25 participant (50%) answered no.

	Translucent modules are installed in the rooflight of the building in building A.	Evet
	Translucent modules are installed in the rooflight of the building in building B.	Evet
	Thin film modules are installed in the rooflight of the building in building A.	Evet
	Thin film modules are installed in the rooflight of the building in building A.	Hayır
	Translucent modules are installed on the facade of the building in building A.	Evet
	Translucent modules are installed on the facade of the building in building B.	Evet
	Thin film modules were installed on the facade of the building in building A.	Hayır
	Thin film modules were installed on the facade of the building in building B.	Hayır

Figure 4.20. Distribution of responses about which of the following information is correct (Question 29. a).

In the question of the visual integration of BIPV (Question 30), the two groups who found both buildings successful in terms of visual integration, mostly found the visual integration of building A more successful than building B, mostly because of the control of the light coming from the roof and the control of the space (P.A 1 P.A 7, P.A 8, P.A 12, P.E 5, P.E 7, P.E 11, P.E 12). Only one participant think that the visual integration in building B was better than in building A (P.E 6). Apart from these comments, there are participants who think that this question should be commented on considering the climate zone where the buildings are located (P.A 11, P.A 21, P.E 16).

Table 4.11. Comparative responses of participants for Question 30.

30. How do you find the visual integration of BIPV in these buildings?	
  (A) (B)	
ARCHITECTS	ENGINEERS
• I find the visual integration positive in building A, as the light coming from the roof is controlled and given to the space. I did not find any visual integration in building B. (P.A 1) • Successful (P.A 2) • Suitable (P.A 3) • Fine (P.A 4) • Not bad (P.A 5) • While it's a relative concept, I think both buildings are successful integrations. (P.A 6) • The visual integration of building A looks more successful. (P.A 7) • I find the visual integration of building A more successful, while the translucent modules on the roof provide control at the rate of taking light, it enriches the user's relationship with the outside by presenting a brighter environment. As far as I understand, photovoltaic film is used in building B. Therefore, I	• In both buildings, BIPV modules are used instead of the traditional building elements such as façade and roof, and naturally integrated into the building envelope. (P.E 1) • The color / material combinations and the size of the BIPV modules / facade combination are very successful. (P.E 2) • Beautiful (P.E 3) • Building A is more successfully integrated than building B. (P.E 5) • The visual integration in building B is better than building A. (P.E 6) • The material / structure integrity in building A looks more aesthetic than building B. (P.E 7) • Both are successful. (P.E 8) • Beautiful (P.E 9)

think it may affect the light inside and the user's relationship with the outside negatively. (P.A 8) • Aesthetic and functional (P.A 9) • They are very successful in terms of light taking. However, building B may require a shading system according to certain months of the year, certain days of the month and certain times of the day. (P.A 11) • Building A is a successful application with its visually translucent roof, building B is a unclear and unsuccessful application with thin films. (P.A 12) • The visual integrations of BIPV seem to be compatible with the whole building. (P.A 13) • Successful (P.A 14, 15) • PV building components are in harmony with the other components of the building. (P.A 16) • They are very successful. They don't look like they were added to the structure later. (P.A 17) • Successful (P.A 18, 25) • Good (P.A 19, 20, 24) • After field analyzes such as location / direction selection, climate data analysis, shading analysis, the success of the visual integration of the applied design should be commented on. (P.A 21)	• Building A has better visual integration than building B. (P.E 11) • Building A is not integrated with the entire building. Building B has become a part of the building. (P.E 12) • Beautiful (P.E 13) • Fine (P.E 14) • Successful (P.E 15) • The interpretation should be made considering the climate zone where the buildings are located. (P.E 16) • Successful (P.E 18) • Good (P.E 19) • They are compatible with construction and function. (P.E 25)
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In question which is asked “Can you evaluate both buildings in terms of lighting quality and visual comfort of the interior?” (Question 30.a), The two groups who find both buildings successful in terms of lighting quality and visual comfort of the interior generally believe that although the amount of light that needs to be taken inside may change depending on the function of the space, they think that the amount of light in building A is healthy and that building B is not bright enough. There are also participants who find building B more successful than building A (P.A 14, P.E 6, P.E 9, P.E 15, P.E 1) and who think that there is no difference between the two buildings. Apart from these comments, there is an engineer who thinks that if there is clear skies climatically for most of the year, there may be more uncomfortable periods indoors. (P.E 16)

In question which is asked “In what interior would you like to live / work?” (Question 30.b), Although there are participants who want to work or live in both buildings and do not want to work or live in both buildings, building A was generally preferred for different reasons (lighting quality, visual comfort and shading system, building form). The architect participants who preferred building A suggested that this space is bright and spacious due to natural lighting, it has a good quality of light, and it is a transition space. They said that the visual comfort of building B would be impaired due to the color film and that there is a window system that negatively affects lighting and that shading elements are needed. Engineers said that building A has good natural light quality and good visual comfort. They made similar comments about building B.

Table 4.12. Comparative responses of participants for Question 30.a.

30. a. Can you evaluate both buildings in terms of lighting quality and visual comfort of the interior?	
ARCHITECTS	ENGINEERS
• Building A has a much more natural lighting. Building B has less access to daylight. (P.A 1) • (Look 56.) I can say that building B is more successful in terms of its effect on the visual interior quality. (P.A 2) • The amount of light in building A is quite healthy. The interior looks darkened due to the color of the glass in building B. It can be irritating. (P.A 4) • They're both fine. (P.A 5) • I need to know the space functions to evaluate the lighting quality and visual comfort. However, I find building B more successful than building A. (P.E 6) • Both buildings take light from the roof and facade in a controlled and successfully. (P.A 7) • Look 56) I find the visual integration of building A more successful, while the translucent modules on the roof provide control at the rate of taking light, it enriches the user's relationship with the outside by presenting a brighter environment. As far as I understand, film is used in building B. Therefore, I think it may affect the light inside and the user's relationship with the outside negatively. (P.A 8)	• There is no difference. (P.E 1) • Building A has more successful lighting quality and visual comfort. (P.E 2) • Building A has a brighter interior. (P.E 3) • Building A is more successful than building B. (P.E 5) • The lighting quality of building B is more successful and the space looks more spacious. (P.E 6) • Due to the oval roof structure in building A, I think the interior lighting and sunlight will have more effect. (P.E 7) • I think they're the same. (P.E 8) • In terms of visual comfort, B is more successful. (P.E 9) • Building A has better lighting quality and visual comfort. (P.E 11) • Building A is brighter and has better visual comfort. (P.E 12) • Both are great. (P.E 13) • Beautiful (P.E 14)

• I prefer building A. I think color films in building B may disturb my interior comfort. (P.A 9) • Building A is more advantageous in terms of both lighting quality and visual comfort by including shading system together with the modules used on the roof. However, although the lighting quality is good for building B, a shading system may be required according to certain time periods in terms of visual comfort. (P.A 11) • I do not know the climatic conditions of building A, but in terms of light transmittance, it created useful areas that are half shadow and shadow. The wall of building B takes good light; but indoors do not seem to take enough sunlight. (P.A 12) • Both of them look comfortable. (P.A 13) • Building B is more successful. (P.A 14) • It is necessary to evaluate the spaces according to the purpose of use. (P.A 15) • Building A is brighter and more spacious. Building B is darker. (P.A 16) • The interior of building A has a spacious / peaceful ambiance. However, the direct diffusion of sunlight to the interior may create problems in indoor comfort. The different colors used in the films in the building B have created a moderate and warm ambiance in the interior atmosphere. (P.A 17)	• If the shading system applied to the roof is insufficient, building A can be exposed to a lot of daylight. The irritating effect of sunlight was prevented by using window films in building B. For this reason, I prefer building B. (P.E 15) • If there is clear skies for a significant part of the year climatically, there may be periods of uncomfortable indoors. (P.E 16) • Both are bright and beautiful. (P.E 17) • Building A is very successful, building B is not bright enough. (P.E 18) • The photos don't look like they were taken at the same time; but if the photos were taken at the same time, building A is better. (P.E 24) • Building A takes daylight more clearly inside (P.E 25).
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• Indoor / outdoor relationships are strong. However, the surfaces are too transparent, they have a successful designs except for too much transparency. (P.A 18) • In terms of lighting quality, Building A is better. But in terms of visual comfort, building B is better. (P.A 19) • I think they're quite fine. (P.A 20) • While trying to gain energy by decreasing from the indoor lighting quality and visual comfort of building B, the opposite logic was applied in building A. (P.A 21) • Of course building A (P.A 23) • Building A is better of course, there is a dim pink light in B inside. (P.A 24) • In building A, sunlight filters well and offers better visual comfort. (P.A 25)	
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In the last question in the second group of interpretation questions , which is asked “ What color photovoltaic glass modules are used in this building? ” In the question (Question 31), 32 participants answered "blue", 12 participants "black", 5 participants "gray" and 1 participant "red". In the question of visual integration of the fashion store where the BIPV curtain wall was applied (Question 32), very few participants from both groups found the visual integration of BIPV in this building poor in terms of lighting quality of the interior and mixed in terms of visual comfort. Mostly, they found both buildings successful in terms of indoor lighting quality and visual comfort. Two of the 21 architects made the comments that the use of the space should be known in order to answer this question, and the other two architects commented that this system also acts as a sunscreen and blocks the light. The other 13 architects found it successful. Another architect commented that “To what extent did this design, which suggests that a certain visual stylization was not attained by chance and thought over, reached the art-deco effect it reached in terms of visual language with the internal technological procedures of BIPV? I am of the opinion that there is no observable structural process in this matter. I cannot predict how much this aesthetic expression, which you think is confined to randomness or at least limited visual language, will diversify under other circumstances and conditions ” (P.A 2).

In the question of evaluating the interior of the building in terms of lighting quality and visual comfort of the interior, few architects and engineers found this building a bit dark, while many architects and engineers found it successful, beautiful and stylish. It can be think that architects are more knowledgeable and conscious about relating lighting and space. Because the comments came as follows; " Depending on the usage of the place, it may be good as a resting place, but not as a working place." ; “Visual comfort is low if it is a workspace. There is no homogeneous spread.” (P.A 4); and “I find it unsuccessful. Although the way of receiving light provides a significant amount of liveliness in the interior, I think that getting light in such a way that emphasizes clear patterns in order to work or live for a long time will negatively affect comfort. ” (P.A 8). It can be said that the architects who say that the PV system acts as a shading element that blocks the light on the facade, are more conscious and aware of the effects of the system on the quality of the interior environment. 9 engineers from 19 engineers found it successful in terms of lighting, one of the engineers described it as changing according to the purpose of use, while the other engineer described the environment as dark, dim, tiring and inadequate.

Table 4.13. Comparative responses of participants for Question 32.a.

32. How do you find the visual integration of BIPV in this building?	
32. a. Can you evaluate both buildings in terms of lighting quality and visual comfort of the interior?	
	
ARCHITECTS	ENGINEERS
• It is not correct to comment without knowing the purpose of use. (P.A 1) • (Look 60.) To what extent did this design, which suggests that a certain visual stylization was not attained by chance and thought over, reached the art-deco effect it reached in terms of visual language with the internal technological procedures of BIPV? I am of the opinion that there is no observable structural process in this matter. I cannot predict how much this aesthetic expression, which you think is confined to randomness or at least limited visual language, will diversify under other circumstances and conditions. (P.A 2) • Visual comfort is low if it is a workspace. There is no homogeneous spread. (P.A 4) • A bit dark (P.A 5)	• It looks very good. (P.E 1) • The answer to this question changes depending on the purpose of usage of the place and the demand of the user. (P.E 2) • It is a bit dark, artificial lighting was needed. However maybe, according to the usage purpose of the place, it is not desired to benefit from natural light and shading effect was applied with colored fovotoltaic glass technology. (P.E 3) • I do not know much about BIPV. But if I comment as the user of the place, this place has a peaceful atmosphere. (P.E 4) • It is quality in terms of aesthetics and lighting. (P.E 5)

• I need to know the function of the place to evaluate. (P.A 6) • So elegant (P.A 7) • (Look 60) I find it unsuccessful. Although the way of receiving light provides a significant amount of liveliness in the interior, I think that getting light in such a way that emphasizes clear patterns in order to work or live for a long time will negatively affect comfort. (P.A 8) • Shadow and light balance is satisfactory. (P.A 9) • It is very successful in terms of lighting quality and visual comfort. (P.A 11) • It broke off the relationship of the interior with the outside and prevented the daylight. (P.A 12) • I think it looks successful and comfortable. (P.A 14) • Successful. The light was taken in a very controlled way, and the material was also used well. (P.A 18) • Visual comfort is fine, I think it has been done consciously that it partially blocked the lighting. In order to protect from the sun in the interior, shading system is used. (P.A 19) • Successful (P.A 13, 16,17, 20, 23, 24) • The interior is exposed to sunlight too much. That's why shading system is used. . (P.A 25)	• It is tiring eyes, as if there is not enough lighting. (P.E 6) • Due to the material that cuts off sunlight in the interior, the lighting quality is low, but the aesthetic quality is high. (P.E 7) • Very good (P.E 8) • The visual comfort is good and the lighting is successful. (P.E 9) • Tiring (P.E 10) • Good (P.E 11) • Weak (P.E 12) • Wonderful (P.E 13) • A little dark (P.E 15) • Depending on the usage of the place, it may be good as a resting place, but not as a working place. (P.E 16) • Lighting is low, but there is a dim atmosphere. Perhaps this may have been intended. (P.E 18) • Successful (P.E 23) • Lighting in the building is insufficient. (P.E 24) • The lighting is low. (P.E 25)
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Although there are very few participants in both groups who think that if a glass module produced in a color other than the color used on the facade of this building is used, there will be no change in the lighting / light quality of the interior (PA 4), (PA 18), (PA 25), (PE 12), (PE 14), (PE 16), participants generally think that it can change with color and opacity. (PA 1), (PA 2), (PA 5), (PA 7), (PA 8), (PA 9), (PA 12), (PA 13), (PA 14), (PA 21), (PA 22), (PA 23), (PE 3), (PE 5), (PE 6), (PE 11), (PE 18), (PE 23), (PE 24).

Apart from these comments, as specific comments, there are architects who think that in order to answer this question, it should be evaluated using simulation tools (P.A 6), who think that a glass module produced in blue color is very good to give peace, confidence, serenity and energy, and that a glass module with a warm tone in red can affect the atmosphere and light quality in the oppositely direction (P.A 11), who give examples of this change in the effect of colors on psychology (P.A 16), who commented that the shadows created by the light can create a different feeling in the interior (P.A 17), who think that there will be a change in light quality according to color, but this change will change according to the purpose of use of the space and the pleasure of the user, if it is a residential building, it is desired to create a dimmer environment, if it is a workplace / office, a brighter environment can be needed (P.A 24). And, there are engineers who think that there will be no change in lighting quality; but there will be an improvement in light quality (P.E 7), who commented that changing the wavelength does not change the color of the light, only changing the frequency will change the color, therefore, if a color with a different frequency is used, there will be a change in the interior lighting or light quality (P.E 1), who thinks that this change depends on frequency (P.E 9), and in contrast to this idea, who thinks that since the wavelengths show different conductivity in each color, when different colored glass is used, the quality of the incoming light will change (P.E 25).

In the question about the effect of color change on the energy efficiency of the photovoltaic module (Question 34), although there are very few participants in both groups who think that the color change has no effect on the energy efficiency of the photovoltaic module (PA 4), (PA 13), (PA 17), (PA 18), (PE 14), most of the participants are of the opinion that efficiency may decrease or increase in terms of reflecting or absorbing the sun in general. There are many architects and engineers who think dark colors will be more efficient. (P.A 1), (P.A 2), (P.A 5), (P.A 6), (P.A 8), (P.A 21), (P.E 5), (P.E 18).

Apart from these comments, as a specific comments, there are architects who does not know whether the color change has an effect on the energy efficiency of the photovoltaic module, but that the energy efficiency changes according to the refractive index and values of the light (P.A 11), who thinks that there will be change because the refractive index of each color is different (P.A 23). And there are engineers who thinks that if the wavelengths of colors affect the transmission of sunlight, the efficiency can change (P.E 1), who thinks that the fragility of the light can change with the prism effect and wavelength (P.E 11), (P.E 16), (P.E 17) and who thinks that it will change because it works on the same principles as photosynthesis in leaves.

Although there are very few participants in both groups who think that the color change has no effect on the energy efficiency of the photovoltaic module, participants are of the opinion that efficiency may decrease or increase in terms of reflecting or absorbing the sun in general.

Table 4.14. Comparative responses of participants for Question 33.

33. If a glass module produced in a color other than the one used is used, is there any change in the lighting / light quality of the interior? If it is yes, what kind of change does happen?	
ARCHITECTS	ENGINEERS
• The color used will have a positive or negative effect both on the entering light and on the observation from inside to outside. (P.A 1) • I know that the concepts of color and opacity are different things. A white and completely opaque surface can have a black effect on the interior, while colors that are closer to black may have a negative effect on brightness. (P.A 2) • It does not change. (P.A 4) • The quality of light in the interior changes not with color, but with transparency. If it is completely transparent, there may be a change in the quality of the light. (P.A 5) • It should be evaluated using simulation programmes. (P.A 6) • Of course, it changes. (P.A 7, 13, 22) • If the use of color was a color other than black, it would have allowed the light to be absorbed more homogeneously and without creating contrast. Thus, it could provide the light to be spreaded more evenly in the space. (P.A 8) • The light / illumination quality of the environment changes according to the light transmittance of the glass color used. (P.A 9) • A glass module produced in blue is very good in terms of peace, security, calmness and energy. For example, a	• The color of light depends on its frequency. Changing the wavelength does not change the color of the light. Only changing the frequency changes the color. For this reason, if a color with a different frequency is used, there will be a change in the lighting or the quality of the interior. (P.E 1) • There will definitely be change. According to the colors used in warm or cold tones, there is a different ambient atmosphere and light quality. (P.E 2) • It becomes a lighter or darker interior according to the color and color tone used. (P.E 3) • Yes, there will be change. However, I think this example is a color that does not tire the eyes and provides the best interior and light quality. (P.E 5) • Yes, if a colorless glass is used, the sunlight will spread more into the interior. (P.E 6) • I do not think there will be any change in the quality of lighting; but I think there will be an improvement in light quality. (P.E 7) • The color in this example looks like the best. (P.E 8) • Yes, it changes. Depending on the frequency of the color used, the color of the light and the quality of the light change. (P.E 9)

warm-toned glass module, such as yellow, orange, and red, would affect the atmosphere and light quality of the interior in the opposite way. (P.A 11) • Color changes the light quality. The function of the interior is important; but colors close to daylight increase comfort. (P.A 12) • Yes, the quality of the light changes according to the light and dark color tones. (P.A 14) • Yes. We can give an example of this change in the effect of colors on psychology. (P.A 16) • Yes, maybe. Shadows created by light can create a different feeling in the interior. (P.A 17) • I don't think so. (P.A 18, 25) • It can make a difference in reflecting or absorbing sunlight. (P.A 19) • Yes, light quality changes by color. As the color gets darker, there is a decrease in lighting and thermal radiation and thereby visual comfort decreases. (P.A 21) • Of course it changes. I know that the refractive index of each color is different. (P.A 23) • Light quality changes according to the color. But this change depends on the purpose of the place and the pleasure of the user. If it is a residence, it may be desirable to create a dim environment, if it is a workplace / office, a lighter environment can be needed. (P.A 24)	• Yes, if it is close to transparent or blue would have a better light quality. (P.E 11) • No, I don't think so. (P.E 12) • Yes, it changes, but these colors are suitable. (P.E 13) • No, the colors used do not affect the quality of the light. (P.E 14) • Yes, it can change. (P.E 15) • I don't think there will be change. (P.E 16) • If lighter colors and tones are used, a lighter environment is created. (P.E 18) • Yes it does. If it is white, it becomes brighter. (P.E 23) • Of course it changes. With a lighter glass, the interior light can be brighter. (P.E 24) • Yes, since the wavelengths of the sun show different conductivity in each color, the quality of the light changes inside when different color glass is used. (P.E 25)
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Table 4.15. Comparative responses of participants for Question 34.

34. Do you think that the color change has an effect on the energy efficiency of the photovoltaic module? If yes, how does it affect?	
ARCHITECTS	ENGINEERS
• The photovoltaics I saw in the examples were usually black. Since black has the potential to absorb the most light, I think it is more efficient than other colors. (P.A 1) • I only know that darker colors absorb more light. (P.A 2) • No, it cannot change. (P.A 4) • I think that dark colors work more efficiently. (P.A 5) • I think that dark colors have better energy efficiency. (P.A 6) • I think it can have an effect based on the knowledge that black color absorbs more light which is a simple information. The rate of absorbing light and heat can increase. But I do not have enough information about the latest technological developments. (P.A 8) • Yes, there are colors that absorb and reflect the light more. (P.A 9) • I do not have detailed information about whether the color change affects the photovoltaic module's energy efficiency. However, I think the energy efficiency changes according to the refractive index and values of the light. (P.A 11) • No, I don't think so it changes. (P.A 13)	• If the wavelengths of colors affect the transmission of sunlight, the efficiency can change. (P.E 1) • Yes it can be. It decreases or increases according to the color and color tone. (P.E 3) • Yes. Sunlight has more effect on dark colors. Accordingly, energy efficiency can also change. (P.E 5) • Yes. I think that the effect of sunlight on the interior decreases as the module is colored. (P.E 6) • Of course, it can decrease. (P.E 8) • I think it affects. Efficiency decreases or increases depending on the color tone of the module color. (P.E 10) • Sure. The refraction of light, prism effect, wavelength can change. (P.E 11) • Yes I think. In the same principles as photosynthesis in leaves. (P.E 12) • No, I do not think so. (P.E 14) • Yes, color affects it. (P.E 15) • There can be minor differences depending on the spectrum of the sunlight. (P.E 16)

• Yes. The effect of colors on psychology. (P.A 16) • There can be no change. (P.A 17) • I think it has no effect; but it can be the way I don't know. (P.A 18) • Maybe it can differ in terms of colors reflecting or absorbing the sun. (P.A 19) • I think that the performance increases as the color gets darker. (P.A 21) • Of course it changes. As I said before, I know that the refractive index of each color is different. (P.A 23) • Yes, the effect changes. I think the blue and dark blue color in the crystals of the panels is probably the most efficient color. (P.A 24) • Efficiency can change depending on the rate of light absorption. (P.A 25)	• Yes. Energy efficiency should be directly related to the absorbed wavelength. (P.E 17) • The important thing is the cell feature; but darker colors are more effective because of absorbing the sun's rays. (P.E 18) • I think absolutely. Absorption of light will decrease as the color gets lighter. (P.E 24) • Yes, of course it changes. (P.E 25)
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In the question of what are the advantages and disadvantages of BIPV systems (Question 35), except for some participants who think that BIPV systems have no disadvantages, there are many participants who comment that they have some disadvantages as well as many advantages. These participants generally agree that the advantage of these systems is energy efficiency, the disadvantage is the cost of installation and maintenance, and that it is an unknown system in our country (P.A 1), (P.A 2), (P.A 4), (P.A 5), (P.A 7), (P.A 9), (P.A 11), (P.A 12), (P.A 19), (P.E 2), (P.E 8), (P.E 9).

Apart from these comments, as specific comments, there are architects who does not think that BIPV systems have a disadvantage as long as the material and technique used do not negatively affect the design and user comfort and thinks that even if the cost is high, by reducing energy consumption over time, this expenditure can turn into profit and that it will contribute greatly to the environment (P.A 8), who thinks that it is the greatest advantage that it does not look like it is added to the facade after (P.A 13), who thinks that the advantage is that it is an integrated part of the building and is not considered as an additional cost, the disadvantage is that it may be more expensive than traditional shell materials (P.A 14), who think that price and performance are BIPV's advantages, in contrast to other negative comments on cost (P.A 16), who thinks that it contributes to efficient use of energy and sustainable living spaces (P.A 17), who thinks that the system performance and comfort are inversely proportional to the facade, the comfort decreases as the performance increases, and for this reason, architects should consider the performance / comfort balance, that these difficulties can be the disadvantage of the system, and the biggest advantage of the system is that it uses solar energy, which is a renewable, clean and endless energy source (P.A 21), who cannot comment because he does not know the cost (P.A 23). And there are engineers who think that the advantages of BIPV systems are that the life of the PV systems is long enough to pay off the cost, their maintenance is easy and their maintenance costs are very low, they do not have fuel purchasing and transportation costs because they use solar energy as fuel, they do not leave any harmful waste to the environment, they work silently and think that the disadvantages of the system are the high initial investment cost, it is not economical for engines and heating systems that require high power, the rate of converting solar energy to electricity is low, and therefore they need large areas, the production potential of the system is affected by seasonal and daily weather changes (P.E 1), who thinks that it has no disadvantages and that design flexibility is the advantage of the system (P.E 3), who thinks that its advantages, the sun will be an unlimited light source until the end of the

world. Solar energy will always take its place in our lives as renewable and sustainable energy. This clean energy is a great convenience for people living in rural areas to obtain electrical energy. Once the solar technology equipment is in place, solar energy does not require any fuel to operate. In addition, as a clean energy source, it does not emit greenhouse gases or toxic substances to the environment. Using solar energy can greatly reduce our impact on the environment. The excess electricity generated can be stored and used again in the electricity grid, and thus, monthly electricity bills can be saved. Solar energy is silent and does not create pollution. This is one of the biggest reasons why it is preferred by many people around the world. When we compare solar power plants with other energy facilities, maintenance and operating costs are low. It may only require maintenance a few times a year, and thinks that a system using solar energy don't have any disadvantages (P.E 5), who thinks that profit can be achieved by compromising variables (P.E 11), who thinks that it will be a much more useful system when the efficiency of solar cells is increased (P.E 12), who thinks that energy saving is its advantage, the initial installation cost is its disadvantage (P.E 13), who thinks that as an advantage, it has an innovative and modern understanding in design, but think it has not any disadvantage (P.E 15), who thinks that the building's integrity as a structural element offers design advantages and contributes to energy production. Directions and climatic features should be considered and does not know about the disadvantages (P.E 16), who thinks that its only disadvantage is its cost. Its advantages are generating electricity and providing the heating-cooling system in the buildings (P.E 17), who thinks that its advantages are that it is an innovative sector and provides existing building integration. Its disadvantages are its high cost and administrative difficulties (P.E 18), who think that as a disadvantage; building strength can drop. It can be more undurable in any natural disaster. Heating can be more difficult, as it has greater permeability. (I have no knowledge, just my guesses), as an advantage; they provide energy production, aesthetic appearance. (P.E 24), who thinks that its advantage; it provides savings since it is renewable energy. Its disadvantages; since these systems are still produced at high costs, there may be problems with their application (P.E 25).

Table 4.16. Comparative responses of participants for Question 35.

35. What could be the advantages and disadvantages of BIPV systems? Would you evaluate it?	
ARCHITECTS	ENGINEERS
• Its advantages; sustainable energy, infrastructure independence, low cost in use. Its disadvantages; high cost in installation and maintenance, insufficient raw materials required for production, foreign dependent industry. (P.A 1) • I don't think it has a disadvantage. Energy efficiency is its biggest advantage. (P.A 2) • I think the biggest advantage of the system is that it has a sustainable energy source. Facade and roof applications enable these surfaces, which take light throughout the day, to work as energy generators. It also forms a shell on the building. The disadvantage of the system is the increase in construction cost. (P.A 4) • Its advantages are electricity generation, the disadvantages are the lack of workman in application and its cost. (P.A 5) • Energy production is its advantage, the first cost is its disadvantage. (P.A 7) • I do not think that BIPV systems will have disadvantages unless the design of the material and technique used affects the design and the comfort of the user. Even if the cost is high, this spending can turn into profit by reducing energy consumption over time. It will also have a great positive contribution to the environment. (P.A 8)	• Its advantages; The lifetime of PV systems is long enough to pay for its cost. They are easy to maintain and very low maintenance costs. Since it uses solar energy as fuel, there is no fuel purchase and transportation cost. They do not leave any harmful waste to the environment and they work quietly. Its disadvantages; the initial investment cost is high. They are not economical for engines and heating systems that require high power. The rate of converting solar energy into electricity is low, so it needs large areas. The production potential of the system is affected by seasonal and daily weather changes. (P.E 1) • As a disadvantage, I think it may be an inability to provide sufficient flexibility in the architectural framework due to some system imperatives. As an advantage, its contribution to energy production and efficiency, which is the most important, can be said. (P.E 2) • Its advantages are design flexibility and energy efficiency. I don't think it has any disadvantages. (P.E 3) • Its advantages; The sun will be an unlimited light source until the end of the world. Solar energy will always take its place in our lives as renewable and sustainable energy. This clean energy is a great convenience for people living in rural areas to obtain electrical energy. Once the solar technology equipment is in place, solar energy does not require any fuel to operate. In addition, as a clean energy source, it does not emit

• Its advantage is energy efficiency, its disadvantage is their cost. (P.A 9) • Its advantages are providing energy efficiency, being environmentally friendly and using in different aesthetic and functional areas. Its disadvantages are that it is a system that is unknown and not trained in our country, and there may be a lack of workman for its applications. (P.A 11) • A great advantage for energy efficiency. Application, cost and design difficulties as a building element may be its disadvantages. (P.A 12) • I think the biggest advantage is that it does not seem to integrated with the facade later. I do not know about its disadvantages. (P.A 13) • The advantage is that it is an integrated part of the building and is not considered as an additional cost. The disadvantage is that it can be more expensive than conventional shell materials. (P.A 14) • Price and performance can be its advantages. (P.A 16) • It can contribute to effective energy use and sustainable living spaces. (P.A 17) • I don't think it has any disadvantages, some problems can be solved by design. (P.A 18) • It can provide advantage in terms of clean energy; however, it is disadvantageous in terms of cost. (P.A 19)	greenhouse gases or toxic substances to the environment. Using solar energy can greatly reduce our impact on the environment. The excess electricity generated can be stored and used again in the electricity grid, and thus, monthly electricity bills can be saved. Solar energy is silent and does not create pollution. This is one of the biggest reasons why it is preferred by many people around the world. When we compare solar power plants with other energy facilities, maintenance and operating costs are low. It may only require maintenance a few times a year. I don't think a solar energy system will have any disadvantages. (P.E 5) • Energy efficiency is its advantage. The high initial investment is its disadvantage. However, when these systems are preferred in the long term, they make this initial investment cost insignificant by providing efficiency. (P.E 8) • Its advantages are that it gives aesthetic quality to the structure and provides us to gain higher energy. I don't think it has a disadvantage. (P.E 9) • Its disadvantages are its cost, not being continuous, and therefore the need for storage (battery, etc.). Since it is a renewable energy source based on solar energy, having a sustainable approach is its biggest advantage. (P.E 10) • Profit can be achieved by compromising variables. (P.E 11) • I think it will be a much more useful system when the efficiency of solar cells is increased. (P.E 12)
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• Its contribution to energy production is its advantage, price performance is its disadvantage. (P.A 20) • Generally, I think that the performance of the system and comfort are inversely proportional to the facade. Comfort decreases as performance increases. For this reason, it is up to the designers to adjust the performance / comfort balance. This difficulty may be the disadvantage of the system. The biggest advantage of the system is that it uses solar energy, which is a renewable, clean and endless energy source. (P.A 21) • I can't comment because I don't know their cost. (P.A 23) • Its advantages are obtaining energy and saving energy. The disadvantage is that construction techniques can be difficult. For this reason, its architecture and aesthetics should be designed very well. (P.A 24) • As a disadvantage, it requires high cost and quality workmanship. On the other hand, each part should be solved during the building planning and design phase. (P.A 25)	• Energy saving is its advantage, the initial installation cost is its disadvantage. (P.E 13) • As an advantage, it has an innovative and modern understanding in design. I don't think it has a disadvantage. (P.E 15) • The building's integrity as a structural element offers design advantages and contributes to energy production. Directions and climatic features should be considered. I do not know about the disadvantages. (P.E 16) • I think its only disadvantage is its cost. Its advantages are generating electricity and providing the heating-cooling system in the buildings. (P.E 17) • Its advantages are that it is an innovative sector and provides existing building integration. Its disadvantages are its high cost and administrative difficulties. (P.E 18) • I don't know much; but as a disadvantage; building strength can drop. It can be more undurable in any natural disaster. Heating can be more difficult, as it has greater permeability. (I have no knowledge, just my guesses). As an advantage; they provide energy production, aesthetic appearance. (P.E 24) • Its advantage; it provides savings since it is renewable energy. Its disadvantages; since these systems are still produced at high costs, there may be problems with their application. (P.E 25)
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CHAPTER 5

DISCUSSIONS AND CONCLUSIONS

This thesis discusses and explores the knowledge of practitioners and academics, architects and engineers in the construction sector, who have the responsibilities of realizing the energy efficient design approach, about the broad definition, application and use of BIPV systems. It aims to raise their level of awareness by asking questions about solar energy and BIPV systems and by getting comments on their visual integration and application. To achieve this, the survey was prepared in three part as solar energy, BIPV system broad definition and BIPV system applications in order to meet multiple goals. Survey questions consist of multiple choice questions, matching questions, true-false questions and comment questions.

The answers were analyzed by making comparisons using tables and graphs. The responses of professionals to multiple-choice questions, matching questions, and true-false questions were graphed with percentages, while their responses to interpretive questions were tabulated. Detailed tables were created by comparing these answers, which were tabulated in the interpretation questions, between the architecture and engineering groups. By comparing the answers of the participants and the information contained in the scientific explanations, the participants' knowledge of solar energy, BIPV system broad definition and BIPV system applications, in short, BIPV systems and technologies, and their mastery of these issues were obtained.

In part A, where questions about the general definition of solar energy, in line with the rates of the answers given to the questions, it has been observed that all participants consisting of architects and engineers know about the definition of solar energy, the majority of the participants can give examples of the areas of solar energy, solar energy buildings (or applications / tools) in Turkey, solar energy technologies and they can make detailed comments about the expectations from solar energy for building design, about what to do to effectively start solar architecture. Therefore, it is concluded that the participants have high knowledge about the general definition of solar energy.

In part B, where questions about the definition of BIPV, it has been observed that the majority of the participants heard about BIPV systems before, less than half of the participants know the examples of BIPV system in Turkey and the world, very few of the

participants (less than 10%) have implemented BIPV systems in their projects before. Thus, it is concluded that although BIPV systems are known by name, BIPV system building examples are not well known and BIPV systems are not used by architects and engineers in projects. In addition to these, with high-rate answers to questions, the participants have high knowledge about the definitions and terms of the main application areas of BIPV systems in buildings, general usage areas of BIPV systems, product / system groups of BIPV facades and roofs, application details and optical properties of photovoltaic glass. In the questions where the description and visuals of the BIPV products are requested by giving their names, it is observed that while very few of the participants (less than 10%) could make definition matching, almost half of them could make a visual comparison. Thus, it is concluded that they had a better understanding of this subject visually rather than a definition, or that the participants were able to answer questions with visual content rather than definition questions at a higher rate.

In part C, where questions about the application of BIPV, it has been observed that the majority of the participants know which of the BIPV and BAPV systems whose visuals are given belong to the BIPV system. Thus, it is concluded that the participants have a high level of knowledge about the application image of BIPV systems and the differences between the building integrated photovoltaic systems (BIPV) and building attached photovoltaic systems (BAPV). In the questions where the definition and visuals of the BIPV facade types are given by giving their names, it is observed that while a few of the participants could make definition matching, most of the participants could make visual comparison. Thus, it is concluded that they had a better understanding of this subject visually rather than definition, or that the participants were able to answer questions with visual content rather than definition questions at a higher rate. In the curtain wall, ventilated façade and skylight questions, whose visuals are given and are asked which one does not belong to the BIPV system, it is observed that very few (less than 15%) of the participants gave correct answers to the question of curtain wall, half of them (25%) gave correct answers to the question of skylight and most of them (close to 75%) gave correct answers to the question of ventilated façade. Thus, it is concluded that the facade and roof applications of BIPV systems and the facade and roof applications of traditional buildings cannot be visually distinguished.

In the comments questions section of part C where the answers of architects and engineers are compared by giving example buildings, aesthetic reasons or material combinations, interior visual integration (lighting quality and visual comfort), suitability for living or working, differences from traditional facades of BIPV, it has been observed that the comments of the architects have more visual / aesthetic content, the comments of the engineers have the content of function and usefulness, and the architects make more detailed comments, while the engineers make brief and concise comments. Thus, it was concluded that architects are design-driven focused, engineers structurally focused, and that architects have aesthetic knowledge about BIPV systems, and engineers have functional knowledge about BIPV systems. In addition, with answers to other questions about energy efficiency, electricity generation, application, advantages and disadvantages of BIPV systems, it is concluded that architects and engineers do not have much knowledge of BIPV in terms of electricity production and physical application technique, but they are well informed about the advantages and disadvantages of BIPV.

The importance of the study is to enable practitioners and academicians, architects and engineers to make them realize the importance of their knowledge about BIPV systems and technologies and the importance of these systems in terms of energy efficient design approach, to encourage them to use these systems in their project with their answers. By showing / questioning some examples of BIPV structures in the world through a survey, and by showing / questioning some examples of BIPV structures in the world through a survey, it is to increase their awareness of the usability of these systems in our country.

As a result of this qualitative methodology, this survey compares the responses given by the participants and the information contained in the scientific explanations, the knowledge of the practitioners & academics, architects and engineers about solar energy, BIPV system, BIPV system applications. It was ensured that the participants were informed about the importance of these systems. In this regard, architects and engineers, who are building designers who have great duties, should know BIPV systems well and have a good command of their technological developments, applications and challenges. In order to use BIPV systems in the most efficient way, they must pay attention to the design criteria, position the building in the most efficient way and integrate it into the design. In this way, it will be possible to expand the use of these systems in the construction industry in our country and in the world.

REFERENCES

- Abdoul Nasser Zakou Djibo. 2018. "Use of Building Integrated PV panels (BIPV) as shading device over roof of atrium in temperate and hot humid climates." *International Journal of Scientific & Engineering Research* 9,12.
- Alessandro Cannavale, Maximilian Hörantner, Giles E. Eperon, Henry J. Snaith, Francesco Fiorito, Ubaldo Ayr and Francesco Martellotta. 2017. "Building integration of semitransparent perovskite-based solar cells: Energy performance and visual comfort assessment.", *Applied Energy* 194, 94-107.
- Alessio Passera, Roberto Lollini, Stefano Avesani, Marco Lovati. 2018. "BIPV Facades: Market potential of retrofit application in the European building stock." *ResearchGate*, <https://doi.org/10.13140/RG.2.2.24051.63528>.
- Alsema, E.A., Wild-Scholten, M.J., and Fthenakis, V.M. 2006. "Environmental impacts of PV electricity generation—A critical comparison of energy supply options." In *Proceedings of the 21th European Photovoltaic Solar Energy Conference*, , 4–8. Dresden, Germany.
- Akash Kumar Shukla, K. Sudhakar, Prashant Baredar and Rizalman Mamat. 2018. "Solar PV and BIPV system: Barrier, challenges and policy recommendation in India." *Renewable and Sustainable Energy Reviews* 82, 3, 3314-3322.
- Attoye Daniel, Anissa, Kheira, A.T.A, and Hassan Ahmed. 2017. "A Review on Building Integrated Photovoltaic Façade Customization Potentials. ", *Sustainability* 9(12):2287, <https://doi.org/doi: 10.3390/su9122287>.
- Benedicto Joseph, Tatiana Pogrebnaya, and Baraka Kichonge. 2019. "Semitransparent Building-Integrated Photovoltaic: Review on Energy Performance, Challenges, and Future Potential." *International Journal of Photoenergy* 2019(3):1-17, <https://doi.org/10.1155/2019/5214150>.
- Benson, D.K., and Branz, H.M. 1995. "Design goals and challenges for a photovoltaic-powered electrochromic window covering." *Solar Energy Mater, Solar Cells* 39, 203–2011.
- BIPV market and stakeholder analysis and needs, European Commission as Project Deliverable D1.1 in October 2016, Members of the PVSITES Consortium.
- Bıyık et. all. 2017. "A key review of building integrated photovoltaic (BIPV) systems." *Engineering Science and Technology: An International Journal* 20, 833-858.
- Bjørn Petter Jelle, Christer Breivik. 2012. "Building integrated photovoltaic products: A state-of-the-art review and future research opportunities.", *Solar Energy Materials and Solar Cells* 100:69-96, <https://doi.org/10.1016/j.solmat.2011.12.016>.

Bjørn Petter Jelle. 2016. “Building Integrated Photovoltaics: A Concise Description of the Current State of the Art and Possible Research Pathways.” *Energies* 9(1), 21, <https://doi.org/10.3390/en9010021>.

Bonomo Pierluigi, 2015. “Overview and analysis of current BIPV products: new criteria for supporting the technological transfer in the building sector.” *VITRUVIO - International Journal of Architectural Technology and Sustainability*, <https://doi.org/10.4995/vitruvio-ijats.2015.4476>.

Bonomo P. et al. 2014. “BIPV in a multicriteria assessment of building envelope solutions-Considerations on economic aspects.” In: *Energy Forum on Solar Building Skin*.

Bonomo P. et al. 2015. “Building Integrated Photovoltaics and Innovation in Architectural technology: in review.”

Brian Norton, Philip C Eames, Tapas K Mallick, Ming J Huang, Sarah J McCormack, Jayanta Deb Mondol, and Yigzaw G Yohanis. 2011. “Enhancing the performance of building integrated photovoltaics.” *Solar Energy* 85, 8,1629-1664.

Bulut Hüsametlin. 2019. IX. National Plumbing Engineering Congress, Building Coming to Curved Surfaces for Energy Analysis and Solar Energy Systems Calculation of Total Solar Irradiance Values, Symposium Declaration

Cannavale Alessandro, Ayr Ubaldo, and Martellotta Francesco. 2017. “ Energetic and visual comfort implications of using perovskite-based building-integrated photovoltaic glazings. ” *ResearchGate* 126:636-643, <https://doi.org/10.1016/j.egypro.2017.08.256>.

Chatzipanagi, A., Frontini, F., and Virtuani, A. 2016. “BIPV-temp: A demonstrative Building Integrated Photovoltaic installation.” *Appl. Energy* 173, 1–2, <https://doi.org/10.1016/j.apenergy.2016.03.097>.

Christophe Ballif, Laure-Emmanuelle Perret-Aebi, Sophie Lufkin, and Emmanuel Rey. 2018. “Integrated thinking for photovoltaics in buildings.”, *Nature Energy* 3(6), <https://doi.org/10.1038/s41560-018-0176-2>.

C.Y. Huang, H.J. Chen , C.C. Chan , C.P. Chou , and C.M. Chiang. 2011. “Thermal Model Based Power-Generated Prediction by Using Meteorological Data in BIPV System.” *Energy Procedia* 12 (2011) 531 – 537.

Ed: Sick, F., and Erge, T. 1996. “Photovoltaics in Buildings - A Design Handbook for Architects and Engineers” The Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, Germany.

Erdoğan Deniz. 2009. “ Research on building integrated photovoltaic systems and their performance evaluation ”, M.Sc. Thesis, Istanbul Technical University/ Institute of Science and Technology.

Ershad, A.M., Brecha, R.J., and Hallinan, K. 2016. “Analysis of solar photovoltaic and wind power potential in Afghanistan.” *Renew. Energy* 85, 445–453.

- Farshad Azadian , and M.A.M. Radzi. 2013. “A general approach toward building integrated photovoltaic systems and its implementation barriers: A review.” *Renewable and Sustainable Energy Reviews* 22:527-538, <https://doi.org/10.1016/j.rser.2013.01.056>.
- Gautam, B.R., Li, F., and Ru, G. 2015. “Assessment of urban roof top solar photovoltaic potential to solve power shortage problem in Nepal.” *Energy Build* 86, 735–744.
- G. Verberne, Pierluigi Bonomo, Francesco Frontini, and M.N. van den Donker. 2014. “BIPV Products for Façades and Roofs: a Market Analysis.” In *29th European Photovoltaic Solar Energy Conference and Exhibition*, <https://doi.org/10.4229/EUPVSEC20142014-6DO.7.6>.
- Henemann, A. 2008. “BIPV: Built-in solar energy.” *Renew Energy Focus* 9:14,16–9. [https://doi.org/10.1016/S1471-0846\(08\)70179-3](https://doi.org/10.1016/S1471-0846(08)70179-3).
- Herzog, A., Lipman, T., Kammen, D. 2001. “Perspectives and Overview of Life Support Systems and Sustainable Development”. *Renewable energy sources*, encyclopedia of life support systems (eolss) forerunner.
- I.Zanetti, P. Bonomo, F. Frontini, E. Saretta, M.N. van den Donker, G. Verberne, K. Sinapis, W. Folkerts, and F. Vossen. 2017. “Building Integrated Photovoltaics.” *Status Report*.
- Jahanara, A. 2013. “Strategy towards Solar Architecture by Photovoltaic for Building Integration.” Ph.D. Thesis, Eastern Mediterranean University (EMU), Famagusta, Turkey.
- Jelle, B.P., and Hagen, G. 1999. “Performance of an electrochromic window based on polyaniline, prussian blue and tungsten oxide.” *Solar Energy Mater, Solar Cells* 58, 277.
- Joseph, B., Pogrebnaya, T., and Kichonge, B. 2019. "Semitransparent Building-Integrated Photovoltaic: Review on Energy Performance, Challenges, and Future Potential." *International Journal of Photoenergy*, p. NA. Gale Academic OneFile, 17., <https://doi.org/10.1155/2019/5214150>.
- Kanchan Vats, and G. N. Tiwari. 2011. “Performance evaluation of a building integrated semitransparent photovoltaic thermal system for roof and façade.”, *Energy and Buildings* 45, <https://doi.org/10.1016/j.enbuild.2011.11.008>.
- Kang, H., Lee, Y., and Kim, S. 2016. “Sustainable building assessment tool for project decision makers and its development process.” *Environ. Impact Assess. Rev.* 58, 34–47.
- Koçaslan, Gelengül .2006. “ Türkiye’nin enerji kaynakları ve alternatif bir kaynak olarak rüzgar enerjisinin değerlendirilmesi ”, Master's Thesis, T.R. Istanbul University Institute of Social Sciences, Department of Economics, Department of Economic Policy.
- Krawietz, and Arch. Silke A. 2011. “Sustainable buildings and BIPV: An international perspective.” *SETA Network*.

Lampert, C.M. 2003. “Large-area smart glass and integrated photovoltaics.” *Solar Energy Mater, Solar Cells* 76, 489–499.

Marek Kryszak and Lai Wang Wang. 2020. “The value of aesthetics in the BIPV roof products segment: a multiperspective study under European market conditions.” *Journal* , <https://doi.org/10.1080/15567036.2020.1807656>.

Munari Probst, Maria Cristina ; Roecker, Christian ; Frontini, Francesco ; Scognamiglio, Alessandra ; Farkas, Klaudia ; Maturi, Laura ; Zanetti, Isa. 2013. “ Solar energy systems in architecture - Integration criteria and guidelines ”, *Solar Energy and Architecture/International Energy Agency Solar Heating and Cooling Programme*.

Müller, D.& Dominique, N. 2002. *Sustainable Architecture and Urbanism: Concepts, Technologies, Examples*. Berlin: Birkhäuser

Montoro, D. F., Vanbuggenhout, P., & Ciesielska, J. 2011. “Building integrated photovoltaics: An overview of the existing products and their fields of application.” *European Photovoltaic Industry Association*.

Nallapaneni Manoj Kumar, K. Sudhakar and M. Samykano. 2018. “BIPV Market Growth: SWOT Analysis and Favorable Factors” In *4th IEEE International Conference on Electrical Energy Systems (ICEES)*, Al-Ameen College, Edathala, Kerala, India, <https://doi.org/10.1109/ICEES.2018.8443227>

Nanomarkets , “Nanomarkets report BIPV Market Analysis and Forecast 2014-2021,” 2015.

Nikolaos Skandalos, and Dimitris Karamanis. 2015. “PV glazing Technologies” *Renewable and Sustainable Energy Reviews* 49, <https://doi.org/10.1016/j.rser.2015.04.145>.

n-tech Research, “BIPV Technologies and Markets: 2015-2022,” 2015.

Olufolahan Oduyemia, and Michael I. Okorohb. 2016. “Building performance modelling for sustainable building design. ” *International Journal of Sustainable Built Environment* 5, 2, 461-469, <https://doi.org/10.1016/j.ijbsbe.2016.05.004>.

Patrick Heinsteins, Christophe Ballif, and Laure-Emmanuelle Perret-Aebi. 2013. “ Building Integrated Photovoltaics (BIPV): Review, Potentials, Barriers and Myths”, *Green* 3,2, <https://doi.org/10.1515/green-2013-0020>.

Peng J, Lu L, and Yang H. 2013. “Review on life cycle assessment of energy payback and greenhouse gas emission of solar photovoltaic systems.” *Renewable and Sustainable Energy Reviews* 19:255–74.

Petter Jelle B. et al. 2012. “Building integrated photovoltaic products: A state-of-the-art review and future research opportunities” *Solar Energy Materials & Solar Cells* 100, 69–96, <https://doi.org/10.1016/j.solmat.2011.12.016>.

Polo Cristina S, and Frontini Francesco. 2014. “Energy Efficiency and Renewable Solar Energy Integration in Heritage Historic Buildings.” *Energy Procedia* 48, 2014:1493–1502, <https://doi.org/10.1016/j.egypro.2014.02.169>.

Rebecca Jing Yang and Patrick X.W. Zou. 2015. “Building integrated photovoltaics (BIPV): costs, benefits, risks, barriers and improvement strategy.” *International Journal of Construction Management* 16 (1): 39-53. <https://doi.org/10.1080/15623599.2015.1117709>.

Roberts Simon & Guariento Nicolò. 2009. “ Building integrated photovoltaics ”, A handbook.

Sakhuja, M., Son, J., Yang, H., Bhatia, C.S., and Danner, A.J. 2014. “Outdoor performance and durability testing of antireflecting and selfcleaning glass for photovoltaic applications.” *Solar Energy* 110,231–238.

Saranti Alexandra, Tsoutsos Theocharis, and Mandalaki Maria. 2015. “Sustainable energy planning. Design shading devices with integrated photovoltaic systems for residential housing units.” *ScienceDirect, In Creative Construction Conference* 123, 479 – 487.

Shafii, F. 2011. “Status of Sustainable Building in South-East Asia”, Report prepared for SB08, Melbourne.

Sheelamkhare. 2013. “Shading analysis for Building Integrated Photovoltaic (BIPV), *Building Efficiency , Solar Energy*.

Shukla, A.K., Sudhakar, K., and Baredar, P. 2016. “A comprehensive review on design of building integrated photovoltaic system.” *Energy Build* 128, 99–110.

Strong Steven. 2016. “Building Integrated Photovoltaics (BIPV).”, *Solar Design Associates, Whole Building Design Gate*

Simon Roberts, and Nicolò Guariento. 2009. “Building Integrated Photovoltaics: A Handbook.” *ResearchGate*, <https://doi.org/10.1007/978-3-0346-0486-4>.

Tarek Abdallah, Jarod Delhotal and Franklin Holcomb. 2011. “Feasibility of Renewable Energy Technology at the Afghanistan National Security University: A Site-Specific Study Focused on Potential Renewable Energy Technologies in Northwest Kabul, Afghanistan”, *ResearchGate*.

Ted James, Alan Goodrich, Michael Woodhouse, Robert Margolis, and Sean Ong. 2011. “Building-Integrated Photovoltaics (BIPV) in the Residential Sector: An Analysis of Installed Rooftop System Prices”, NREL (A national laboratory of the U.S. Department of Energy), Office of Energy Efficiency & Renewable Energy.

Tiantian Zhang , Meng Wang, and Hongxing Yang. 2018. “A Review of the Energy Performance and Life-Cycle Assessment of Building-Integrated Photovoltaic (BIPV) Systems” *Energies* 11(11):3157. <https://doi.org/10.3390/en11113157>.

Tingting Yang, and Andreas Athienitis. 2016. “ A review of research and developments of building-integrated photovoltaic/thermal (BIPV/T) systems.”, *Renewable and Sustainable Energy Reviews* 66:886-912, <https://doi.org/10.1016/j.rser.2016.07.011>.

Thomas, R., Grainger T., Gething, B. ve Keys, M. 1999. “ Photovoltaic in buildings-a design guide ”, ETSU, DTI, Report S/P2/00282/REP, London.

URL 1: <https://www.esi-africa.com/magazine-article/design-engineering-and-construction-of-bipv/>, Son Erişim Tarihi: 24.09.2020.

URL 2: <https://www.solarpowerworldonline.com/2014/12/quick-run-bipv/> Son Erişim Tarihi: 10.09.2020.

URL 3: <https://www.onyx-solar.com/eastern-bank>, Son Erişim Tarihi: 15.08.2020.

URL 4: <https://bipv.eurac.edu/it>, Son Erişim Tarihi: 10.08.2020.

URL 5: <https://www.onyx-solar.com/heineken-mexico>, Son Erişim Tarihi: 10.08.2020.

URL 6: <http://issol.eu>, Son Erişim Tarihi: 12.08.2020.

URL 7: <https://www.enf-solar.com/scheuten-solar>, Son Erişim Tarihi: 14.08.2020.

URL 8: <https://www.kalzip.com/>, Son Erişim Tarihi: 15.08.2020.

URL 9: <https://www.onyx-solar.com/bell-works>, Son Erişim Tarihi: 12.08.2020.

URL 10: <https://www.onyx-solar.com/bejar-market>, Son Erişim Tarihi: 12.08.2020.

URL 11: <https://www.onyx-solar.com/mohamed-vi-university>, Son Erişim Tarihi: 11.08.2020.

URL 12: <https://www.onyx-solar.com/photovoltaic-boat-sanabria>, Son Erişim Tarihi: 16.08.2020.

URL 13: <https://www.onyx-solar.com/manhattan-penthouse>, Son Erişim Tarihi: 16.08.2020.

URL 14: <https://www.onyx-solar.com/the-life-science>, Son Erişim Tarihi: 17.08.2020.

URL 15: <https://www.onyx-solar.com/brunel-university>, Son Erişim Tarihi: 17.08.2020.

URL 16: <https://www.onyx-solar.com/seneca-college>, Son Erişim Tarihi: 17.08.2020.

URL 14: <https://www.onyx-solar.com/the-life-science>, Son Erişim Tarihi: 17.08.2020.

URL 15: <https://www.onyx-solar.com/brunel-university>, Son Erişim Tarihi: 17.08.2020.

URL 16: <https://www.onyx-solar.com/seneca-college>, Son Erişim Tarihi: 17.08.2020.

URL 17: <https://www.morrisseyengineering.com/experience/5/170/professional/core-bank-headquarters>, Son Erişim Tarihi: 17.08.2020.

URL 18: <https://www.onyx-solar.com/dewa-dubai>, Son Erişim Tarihi: 20.08.2020.

URL 19: <https://www.onyx-solar.com/bursagaz-headquarters>, Son Erişim Tarihi: 20.08.2020.

URL 20: <https://www.onyxsolar.com/ciprus-international-university>, Son Erişim Tarihi: 20.08.2020.

URL 21: <https://www.prixdesign.com/en/portfolio/casino-de-montreal-2/>, Son Erişim Tarihi: 20.08.2020.

URL 22: <https://www.onyxsolar.com/novartis-headquarters>, Son Erişim Tarihi: 22.08.2020.

URL 23: <https://www.onyxsolar.com/center-for-novel-therapeutics>, Son Erişim Tarihi: 22.08.2020.

URL 24: <https://www.onyxsolar.com/ing-direct-bank>, Son Erişim Tarihi: 22.08.2020.

URL 25: <https://www.richardmeier.com/projects=the-hague-city-hall-central-library-2>, Son Erişim Tarihi: 22.08.2020.

URL 26: <https://www.onyxsolar.com/balenciaga-store-miami>, Son Erişim Tarihi: 27.08.2020.

Verbene G. et al. 2014. “BIPV Products for Facades and Roofs: a Market Analysis.” In *29th European Photovoltaic Solar Energy Conference and Exhibition*, pp 3630-3636, 20-25, Amsterdam - The Netherlands.

Yoon, J.H., Song, J., Lee, and S.J. 2011. “Practical application of building integrated photovoltaic (BIPV) system using transparent amorphous silicon thin-film PV module.” *Solar Energy* 85, 723–733.

Wittkopf, S., Valliappan, S., Liu, L., Ang, K.S., and Cheng, S.C.J. 2012. “Analytical performance monitoring of a 142.5 kWp grid- connected rooftop BIPV system in Singapore.” *Renewable Energy* 47, 9-20.

Xi Chen, Junchao Huang, Weilong Zhang and Hongxing Yang. 2019. “Exploring the optimization potential of thermal and power performance for a low-energy high-rise building.”, *ScienceDirect, Energy Procedia* 158, 2469–2474.

APPENDICES

APPENDIX A. QUESTIONNAIRE

PROFESSIONALS' AWARENESS ON THE APPLICATION AND USE OF BUILDING INTEGRATED PHOTOVOLTAIC SYSTEMS

Personal Information

Gender (W/M)		Age		Profession	
Tools used to see		Glasses	Lens	I don't use	Other (please specify)
Vision Defects	Myopic	Hypermetropic	Astigmatism	No any defect	Other (please specify)

A. GENERAL DESCRIPTION OF SOLAR ENERGY

" Solar energy is a renewable energy source which comes from the sun and has a constant intensity outside the world atmosphere, and which can be used in various thermal applications and electricity generation, with an intensity varying between 0 and 1370 W / m² on earth. " (Shukla et.al, 2018).

1. According to this definition, is Turkey appropriate to use Solar Energy?

(Mark only one option, please)

- ☐ Yes
- ☐ No

2. In which type of building/facility or tool can solar energy be used ?

(Mark one or more, please.)

- ☐ Residential and business places
- ☐ Rural and agricultural technologies
- ☐ Industry
- ☐ Transport vehicles
- ☐ Communication tools (radio, television, telephone), signaling and automation
- ☐ Electric power generation and part of the energy demand
- ☐ Special purposes in the military field

(Henemann, 2008)

If you have examples of other areas where solar energy is used, please write

3. Do you know any building (or application/tool) which uses solar energy in Turkey?

.....

If it is yes, in which way the solar energy is used?

.....

4. What are your expectations from solar energy in building design?

.....

5. Which ones should be done in order to start the Solar Architecture effectively?

(Mark one or more, please.)

- ☐ Preparing a suitable infrastructure
- ☐ Creating the appropriate technology
- ☐ Organizing Research and Development activities
- ☐ Establishing research and application centers for the execution of such applications
- ☐ Inclusion of these issues in education
- ☐ Making sample applications
- ☐ Regulation of legal legislation
- ☐ Providing incentives and loans for such practices
- ☐ Supporting the establishment and work of non-governmental organizations

(Henemann, 2008)

If you have any other comments, please write

6. What are the applications of Solar Energy Technology?

(Mark one or more, please.)

- ☐ Solar Water Heaters
- ☐ Solar Energy Building

- ☐ Other Thermal Systems
- ☐ Solar Refrigeration
- ☐ Solar Thermal Power Plants and Solar Cells / Photovoltaic Power Plants

(Henemann, 2008)

If you have examples of Solar Energy Technology applications, please write

B. GENERAL DESCRIPTION OF BUILDING INTEGRATED PHOTOVOLTAICS

7. Have you heard of the BIPV system before?

(Mark only one option, please.)

- ☐ Yes
- ☐ No

“Building integrated photovoltaic system generates electricity using solar energy from sunlight while is applied onto the building envelope as a part of it; (Oduyemi and Okoroh, 2016) meaning that it is integrated to the building skin. It is composed of photovoltaic panels/solar cells.” (Peng et al., 2013).

8. According to the definition , do you know any BIPV system applied examples in the world?

(Mark only one option, please.)

- ☐ Yes
- ☐ No

If it is yes, please name it

9. Do you know any BIPV system applied examples in Turkey?

(Mark only one option, please.)

- ☐ Yes
- ☐ No

If it is yes, please name it

10. Do you know the biggest BIPV Project in Turkey?

(Mark only one option, please.)

- ☐ Yes
- ☐ No

If it is yes, please name it

11. Do you have projects where you have applied BIPV system in your projects?

(Mark only one option, please.)

- ☐ Yes
- ☐ No

If it is yes, please give detailed information about your BIPV project

12. What are the main application areas of BIPV in buildings?

(Mark one or more, please.)

- ☐ Facades
- ☐ Roofs

(Vats, and Tiwari, 2012)

13. What are the general BIPV application areas as a comprehensive?

(Mark one or more, please)

- ☐ Roofs (Pitched Roofs, Flat Roofs)
- ☐ Cladding Systems
- ☐ Semi-transparent Facade Systems
- ☐ Louver systems
- ☐ Skylight and Floors
- ☐ Curtain Wall and Spandrels
- ☐ Canopy and Parking Lots

(Yang, and Athienitis, 2016)

14. What are the usage areas of the facade BIPV product group / system group?

(Mark one or more, please.)

- ☐ Curtain Wall (Warm Facades)
- ☐ Rain-Screen Facade (Cold Facades)
- ☐ Accessories

- ☐ Solar glazing/ Skylight

(Zanetti, and Donker, 2017)

15. What are the usage areas of the roof BIPV product group / system group?

(Mark one or more, please.)

- ☐ In-roof mounting systems
- ☐ Full Roof BIPV solution
- ☐ Solar tiles- Shingles
- ☐ PV membranes
- ☐ Metal panels
- ☐ Solar glazing/ Skylight

(Zanetti, and Donker, 2017)

16. What are the "Photovoltaic Glass" types related to application details and optical properties?

(Mark one or more, please.)

- ☐ 100% Customized PG
- ☐ Photovoltaic Transparent Glass
- ☐ Colored PG
- ☐ Laminated Safety PG
- ☐ Double/Triple Glazed Insulation PG

(Skandalos, and Karamanis, 2015)

17. Can you fill of description and their explanation of type of BIPV product ?

- a. Foils
- b. Tiles
- c. Glazing
- d. Module

- ❑ They are BIPV products with an integrated panel of poly or monocrystalline cells, usually mounted on roofs or parts of the roof and suitable for retrofitting.
- ❑ They are lightweight and flexible BIPV products made of thin film cells, with low efficiency and low installation cost. They are mounted adhering and do not require a frame. It is suitable for building applications with large roof expanses.
- ❑ They are opaque BIPV products made with weather skin solutions, similar to traditional PV modules and often used for roofing. It is the cheapest form of integration and has a better view than the external frames.
- ❑ They are BIPV products that are capable of transmitting daylight for options to use natural lighting when generating electricity, used in windows, glazed or tile facades and roofs. It offers aesthetic options with its customized modules related to the shape, cell material, color and transparency level in its production.

(Joseph, Pogrebnaya and Kichonge, 2019)

18. Can you fill of description and images of type of BIPV product ?

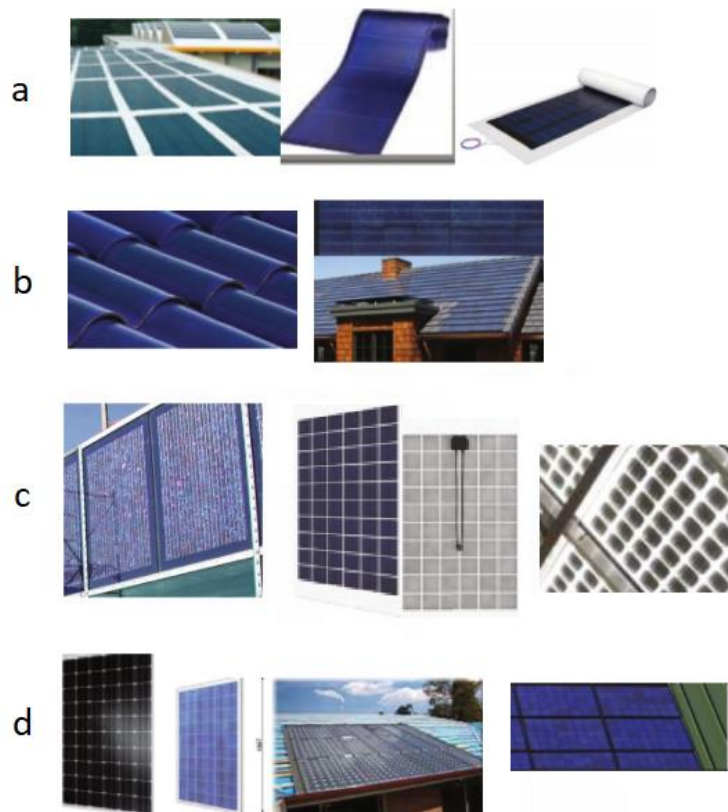


Fig A.1. Market names according to the products of BIPV systems.

(Joseph, Pogrebnaya and Kichonge, 2019).

- ☐ Foils
- ☐ Tiles
- ☐ Glazing
- ☐ Module

19. What are the barriers and strategies for BIPV development?

(Mark one or more, please.)

- ☐ Political obstacles such as lack of government supports.
- ☐ Perceptual obstacles such as lack of public understanding.
- ☐ Economical obstacles such as high cost of BIPV modules, designs and constructions.
- ☐ Technical obstacles such as lack of the standards, low power efficiency and power reliableness.

(Jelle, Breivik and Rokenes, 2012)

C. APPLICATION OF INTEGRATED PHOTOVOLTAICS IN THE BUILDING

In addition to producing electrical energy, the main functions of BIPV systems are: (Shukla et al., 2016):

Efficiency: As a system with minimal transmission losses due to energy production on the construction site, to reduce energy losses, increase energy quality and ensure voltage control during transmission. (Kang et al., 2016; Krawietz, 2011).

Building Economy: As a system that does not consist of moving parts that require maintenance, no additional land is required for its installation, it can be easily connected to the building's electrical system during installation, to reduce building material costs, to protect / reduce building operating costs and labor costs, to eliminate reduce the needs for PV system installation. (Gautam et al., 2015).

Socio-economy: As a system that increases the value and prestige of a building, creating a new market, developing marketing opportunities and equality value of the property, providing new business opportunities, creating public awareness about edible resources by using in buildings and increasing education opportunities. (Ershad et al., 2016).

Environmental: As an environmentally friendly system that can be used almost anywhere where there is sunlight and does not contain harmful greenhouse gas emissions, contributing to the environmentally friendly green building design, providing energy independent of carbon and reducing the amount of greenhouse gases. (Yoon et al., 2011).

Aesthetical: As a system that can be integrated in many innovative ways with various building types and diverse / flexible applications such as size, format, design, and providing functional and aesthetically innovative and modern design solutions, harmony with architectural design, adding value to architecture, innovative enabling design and increasing design options. (Shafii, 2011).

Architectural: As a building component; as a system that does not need an additional structure, replaces traditional building envelopes, is quiet and noise-free, safe against theft and damage, rain / snow / hail / wind etc. to provide primary protection against weather conditions, heat (heating / cooling), water and sound insulation, to provide solar control and shading, to provide mechanical strength / structural integrity and aesthetic quality. (Kang et al., 2016).

20. Which one is BIPV system application ?

(Mark only one option, please.)



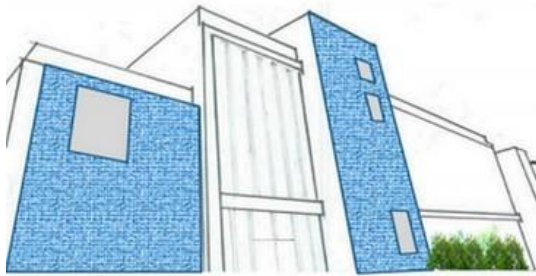
Fig. A.2. Differences between BIPV and BAPV systems.

(Joseph, Pogrebnaya, and Kichonge, 2019).

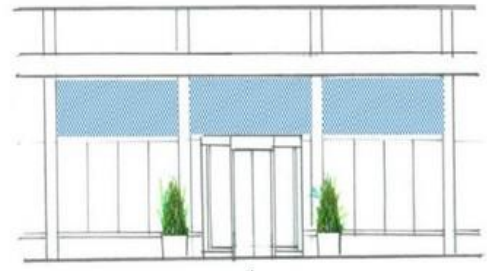
21. Can you match BIPV facade type and their explanations?

- ☐ Solar Glazing and Windows
 - ☐ Curtain Wall/ Cladding Systems
 - ☐ Advanced/ Innovative Envelope Systems
 - ☐ External Devices/Accessories
-
- ☐ These types of BIPV façade types consist of components such as double skin facades, active coatings, rotating or moving façade parts.
 - ☐ These BIPV facade types are applied as translucent or translucent parts of the facade depends on solar cell transparency. They are integrated into windows, glass panels for vision or daylight.
 - ☐ These BIPV façade types consist of sunscreens and sunshades, spandrels, balcony railings, visual and acoustic shield elements.
 - ☐ These types of BIPV façade types include integrated solar panels as a traditional cladding system for single-layer facades or curtain walls.
(Attoye, Anissa, Kheira and Hassan, 2017).

22. Can you match of BIPV facade type and their images of type of BIPV product ?



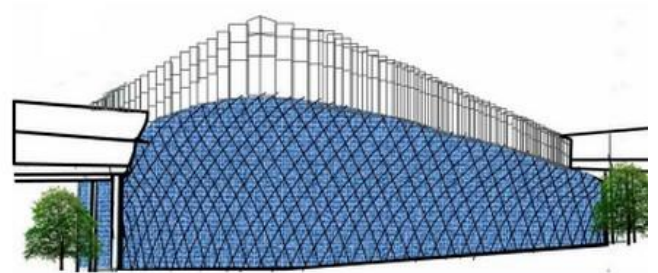
a



b



c



d

- ☐ Curtain Wall/ Cladding Systems
- ☐ Solar Glazing and Windows
- ☐ External Devices/ Accessories
- ☐ Advanced/ Innovative Envelope Systems

Fig A.3. BIPV façade type.

(Attoye, Anissa, Kheira and Hassan, 2017).

23. Which *curtain wall facade* sample are not example of BIPV system applied ?

(Mark only one option, please.)

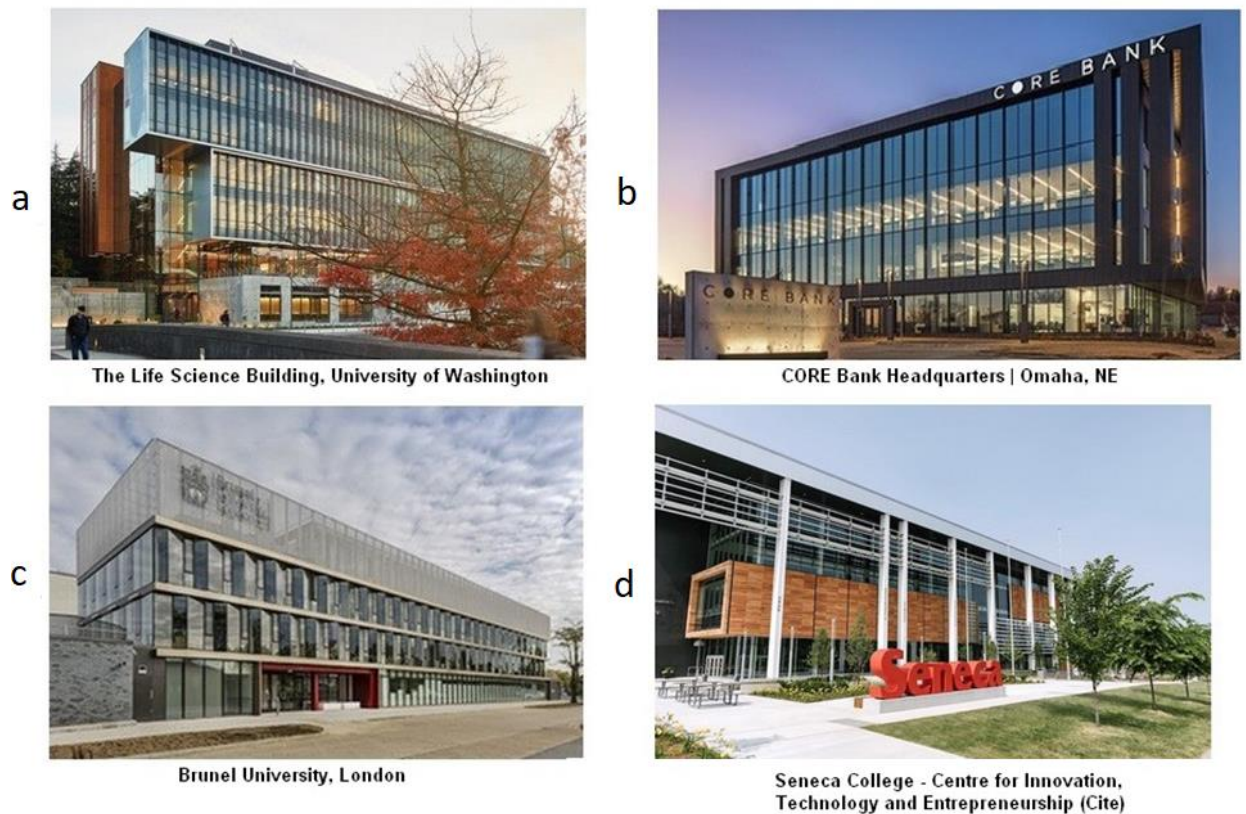


Figure A.4. Images for Question 23.

Fig. 23.a : (Source: URL 14).

Fig. 23.b : Source: URL 17).

Fig. 23.c : (Source: URL 15).

Fig. 23.d : (Source: URL 16).

24. Which *ventilated facade* sample are not example of BIPV system applied ?

(Mark only one option, please.)



Figure A.5. Images for Question 24.

Fig. 24.a: (Source: URL 18).

Fig. 24.b: (Source: URL 19).

Fig. 24.c: (Source: URL 20).

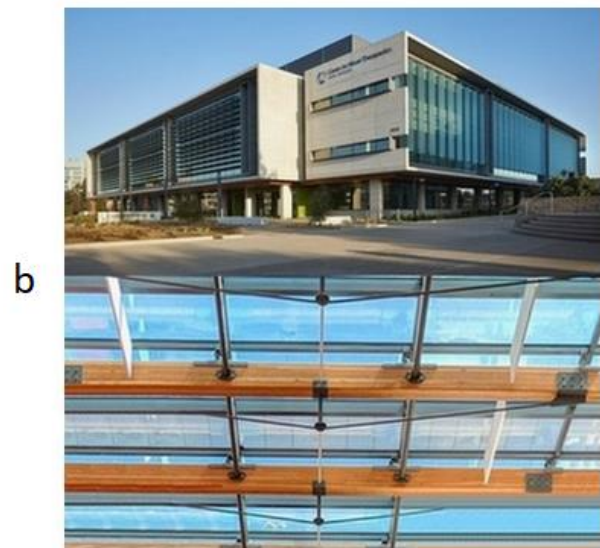
Fig. 24.d : Source: URL 21).

25. Which *skylight* sample are not example of BIPV system applied ?

(Mark only one option, please.)



Novartis Pharmaceutical Company,
New Jersey, USA.



The University of California, San Diego



The Hague, Netherlands, City Hall and Library



ING Direct Bank, in Las Rozas, Madrid

Figure A.6. Images for Question 25.

Fig. 25.a: (Source: URL 22).

Fig. 25.b: (Source: URL 23).

Fig. 25.c: Source: URL 25).

Fig. 25 d: (Source: URL 24).

* Answer the 26th-27th and 28th questions according to the image below.



(A)



(B)

Figure A.7. Images for Questions 26, 27, 28 (Heinstein, Ballif and Perret-Aebi, 2013)

(Fig. Left : Kulturhaus Milbertshofen, Germany: façade with black micromorph and semi-transparent thin-film modules, Energy output: 3 kWp, RPM-Architekten, System provider: Voltarlux, 2008.

; Fig. Right: Solarhaus Darmstadt, Germany: prize-winning pilot project from the Technische Universität Darmstadt with a 200% PlusEnergy gain. The façade is covered with black CIS thin-film modules, System provider: Würth-Solar, 2009.)

26. In which building, BIPV is applied.

- a) A b) B c) Both of them d) None of them

26.a. Which of the following information is correct?	Yes	No
Semi transparent modules are attached in building A.		
Semi transparent modules are attached in building B.		
Thin-film modules are attached in building A.		
Thin-film modules are attached in building B.		
BIPV is applied as apart of fenestration in building A.		
BIPV is applied as apart of fenestration in building B.		
BIPV is applied as apart of facade in building A.		
BIPV is applied as apart of facade in building B.		

27. Do you feel any differences in terms of visual integration of BIPV in these buildings?

a. Can you explain these differences according to any aesthetic reasons or material combinations?

b. How do these buildings look different from other conventional buildings?

c. What do you think about the facades of these buildings?

28. Which facade would you prefer to build / design ?

a. Can you explain the reasons for your preference in terms of electricity production? / visual or aesthetic issues? / or physical application technique?

b. Do you think energy efficiency efficiencies are better or worse than rooftop photovoltaic applications? Can you explain why?

c. What do you think about their cost-effectiveness?

d. Which one gives us more benefits? Why is that?

e. In which building would you like to live / work?

*** Answer the 29th and 30th questions according to the image below.**



(A)

(B)

Figure A.8 Images for Questions 29, 30.

(Fig. Left: ECN, building 42, Petten, The Netherlands: Semi-transparent and curved c-Si-skylight roof (Bear Architecten, 2001);

Fig. Right: Boading, China 2012: Semi-transparent a-Si modules with coloured polymers Courtesy: Tianwei Solar Films; Photo: P. Heinstei (Heinstei, Ballif and Perret-Aebi, 2013)

29. In which building are translucent photovoltaic glass modules applied?

- a) A b) B c) Both of them d) None of them

29.a. Which of the following information is correct?	Yes	No
Translucent modules are installed in the rooflight of the building in building A.		
Translucent modules are installed in the rooflight of the building in building B.		
Thin film modules are installed in the rooflight of the building in building A.		
Thin film modules are installed in the rooflight of the building in building B.		
Translucent modules are installed on the facade of the building in building A.		
Translucent modules are installed on the facade of the building in building B.		
Thin film modules were installed on the facade of the building in building A.		
Thin film modules were installed on the facade of the building in building B.		

30. How do you find the visual integration of BIPV in these buildings?

a. Can you evaluate both buildings in terms of lighting quality and visual comfort of the interior?

b. In which interior do you want to live / work?

*** Answer the 31st, 32nd, 33rd and 34th questions according to the image below.**



Figure A.9 Images for Questions 31, 32, 33, 34. (Source: URL 26).

31. Which color photovoltaic glass modules are used in the building on the right?

- a. Black b. Gray c. Blue d. Red

32. How do you find the visual integration of BIPV in this building?

a. Can you evaluate both buildings in terms of lighting quality and visual comfort of the interior?

b. In which interior do you want to live / work?

33. If a glass module produced in a color other than the one used is used, is there any change in the lighting / light quality of the interior? If it is yes, what kind of change does happen?

34. Do you think that the color change has an effect on the energy efficiency of the photovoltaic module? If yes, how does it affect?

35. What could be the advantages and disadvantages of BIPV systems? Would you evaluate it?

THANK YOU FOR YOUR PARTICIPATION.

APPENDIX A. QUESTIONNAIRE (TURKISH)

BİNA ENTEGRE FOTOVOLTAİK SİSTEMLERİN UYGULANMASI VE KULLANIMI KONUSUNDA PROFESYONELLERİN FARKINDALIĞI

Kişisel Bilgiler

Cinsiyet (K/E)		Yaş		Meslek	
Kullanılan görmeye yardımcı araçlar		Gözlük	Lens	Kullanmıyorum	Diğer (lütfen belirtiniz)
Görme Kusurları	Miyop	Hipermetrop	Astigmat	Kusur yok	Diğer (lütfen belirtiniz)

A. GÜNEŞ ENERJİSİ GENEL TANIMI

"Güneş enerjisi, güneşten gelen ve dünya atmosferi dışında sabit bir yoğunluğa sahip olan ve yeryüzünde bu yoğunluğu yaklaşık 0 ile 1370 W/m² arasında değişen, çeşitli termal uygulamalarda ve elektrik üretiminde kullanılabilen yenilenebilir bir enerji kaynağıdır. " (Shukla et.all, 2018).

1. Bu tanıma göre, Türkiye Güneş Enerjisini kullanmaya uygun mu?

(Lütfen yalnızca bir seçeneği işaretleyin.)

- ☐ Evet
☐ Hayır

2. Güneş enerjisi hangi tip bina / tesis veya araçlarda kullanılabilir?

(Lütfen bir ya da daha fazlasını işaretleyiniz.)

- ☐ Konut ve İş Yerleri
☐ Kırsal ve Tarım Teknolojileri
☐ Sanayi
☐ Taşıma araçları

- ☐ İletişim Araçları (Radyo, Televizyon, Telefon), Sinyalizasyon ve Otomasyon
- ☐ Elektrik Enerjisi Üretimi ve Enerji Talebinin Bir Parçası
- ☐ Askeri Alanda Özel Amaçlar

(Henemann, 2008)

Güneş enerjisinin kullanıldığı diğer alanlara örnekleriniz varsa, lütfen yazınız.....

3. Türkiye'de güneş enerjisi kullanan herhangi bir bina (veya uygulama / araç) biliyor musunuz?

.....

Evet ise, güneş enerjisi hangi şekilde kullanılır?

.....

4. Bina tasarımında güneş enerjisinden beklentileriniz nelerdir?

.....

5. Güneş Mimarisini etkili bir şekilde başlatmak için hangileri yapılmalıdır?

(Bir ya da daha fazlasını işaretleyiniz.)

- ☐ Uygun bir altyapının hazırlanması
- ☐ Uygun teknolojinin oluşturulması
- ☐ Araştırma ve Geliştirme faaliyetlerini organize etmek
- ☐ Bu tür uygulamaların yürütülmesi için araştırma ve uygulama merkezlerini kurulması
- ☐ Bu konuların eğitime dahil edilmesi
- ☐ Örnek uygulamaların yapılması
- ☐ Yasal mevzuatın düzenlenmesi
- ☐ Bu tür uygulamalar için teşvik ve kredilerin sağlanması
- ☐ Sivil toplum kuruluşlarının oluşturulması ve çalışmalarının desteklenmesi

(Henemann, 2008)

Başka önerileriniz varsa, lütfen yazınız.....

6. Güneş Enerjisi Teknolojisinin uygulamaları nelerdir?

(Bir ya da daha fazlasını işaretleyiniz.)

- ☐ Güneş Enerjili Su Isıtıcıları
- ☐ Güneş Enerjisi Binası
- ☐ Diğer Termal Sistemler
- ☐ Solar Soğutma
- ☐ Güneş Termik Santralleri ve Güneş Pilleri / Fotovoltaik Enerji Santralleri

(Henemann, 2008)

Güneş enerjisi teknolojisinin farklı uygulamalarını biliyorsanız lütfen belirtiniz.....

B. BİNAYA ENTEGRE FOTOVOLTAİKLERİN GENEL TANIMI

7. Binaya entegre fotovoltaik (BIPV) sistemini daha önce duydunuz mu?

(Lütfen yalnızca bir seçeneği işaretleyin.)

- ☐ Evet
- ☐ Hayır

“Binaya entegre fotovoltaik sistem (BIPV), güneş ışığından güneş enerjisini kullanarak elektrik üretirken binanın dış yüzeyinin bir parçası olarak uygulanır; ; (Oduyemi and Okoroh, 2016) yani binanın dış kabuğuna entegre edilmiştir. Fotovoltaik panellerden / güneş pillerinden oluşur. ” (Peng et al., 2013).

8. Bu tanıma göre, dünyada uygulanan herhangi bir BIPV sistemi örneği biliyor musunuz?

(Lütfen yalnızca bir seçeneği işaretleyin.)

- ☐ Evet
- ☐ Hayır

Evetse, lütfen adlandırınız

9. Türkiye’de uygulanan herhangi bir BIPV sistemi örneği biliyor musunuz?

(Lütfen yalnızca bir seçeneği işaretleyin.)

- ☐ Evet
- ☐ Hayır

Evetse, lütfen adlandırınız

10. Türkiye'nin en büyük BIPV projesini biliyor musunuz?

(Lütfen yalnızca bir seçeneği işaretleyin.)

☐ Evet

☐ Hayır

Evitse, lütfen adlandırın

11. Projelerinizde BIPV sistemini uyguladığınız projeler var mı?

(Lütfen yalnızca bir seçeneği işaretleyin.)

☐ Evet

☐ Hayır

Evitse, lütfen BIPV projeniz hakkında detaylı bilgi veriniz

12. BIPV'nin ana uygulama alanları nelerdir?

(Bir ya da daha fazlasını işaretleyiniz.)

☐ Cepheler

☐ Çatılar

(Vats, and Tiwari, 2012)

13. Kapsamlı olarak BIPV uygulama alanları nelerdir?

(Bir ya da daha fazlasını işaretleyiniz.)

☐ Çatı (Eğimli Çatılar, Düz Çatılar)

☐ Kaplama Sistemleri

☐ Yarı Saydam Cephe Sistemleri

☐ Panjur Sistemleri

☐ Işıklık ve Zemin

☐ Giydirme Cephe ve Spandeller

☐ Gölgelek ve Otoparklar

(Yang, and Athienitis, 2016)

14. Cephe BIPV ürün grubu / sistem grubunun kullanım alanları nelerdir?

(Bir ya da daha fazlasını işaretleyiniz.)

☐ Giydirme Cephe (Sıcak Cepheler)

☐ Yağmur Perdesi Cephe (Soğuk Cepheler)

- ☐ Aksesuarlar
- ☐ Güneş camı / Işıklık

(Zanetti, and Donker, 2017)

15. Çatı BIPV ürün grubu / sistem grubunun kullanım alanları nelerdir?

(Bir ya da daha fazlasını işaretleyiniz.)

- ☐ Çatı içi montaj sistemleri
- ☐ Tüm çatı için BIPV çözümü
- ☐ Güneş fayansları – Çatı kiremitleri
- ☐ PV membranlar
- ☐ Metal paneller
- ☐ Güneş camı / Işıklık

(Zanetti, and Donker, 2017)

16. Uygulama detayları ve optik özelliklerle ilgili Fotovoltaik Cam türleri nelerdir?

(Bir ya da daha fazlasını işaretleyiniz.)

- ☐ 100% Özel Fotovoltaik Cam
- ☐ Fotovoltaik Şeffaf Cam
- ☐ Renkli Fotovoltaik Cam
- ☐ Lamine Güvenlik Fotovoltaik Cam
- ☐ Çift / Üçlü Yalıtım Fotovoltaik Cam

(Skandalos, and Karamanis, 2015)

17. BIPV ürününün pazar isimleri olarak sınıflandırması ve açıklamalarını doldurabilir misiniz?

- ☐ Folyolar
- ☐ Fayans
- ☐ Cam
- ☐ Modül

- ❑ Genellikle çatılar veya çatının parçaları üzerine monte edilen ve sonradan takılmaya uygun, poli veya monokristalin hücrelerin entegre paneline sahip BIPV ürünleridir.
- ❑ İnce film hücrelerinden düşük verimlilik ve düşük kurulum maliyeti ile yapılmış hafif ve esnek BIPV ürünleridir. Yapıştırıcıyla monte edilirler ve çerçeve gerektirmezler. Büyük çatı açıklıklarına sahip bina uygulamaları için uygundur.
- ❑ Geleneksel PV modüllerine benzeyen ve genellikle çatı kaplamada kullanılan, hava koşullarına dayanıklı cilt solüsyonlarıyla yapılan opak BIPV ürünleridir. En ucuz entegrasyon şeklidir ve dış çerçevelerden daha iyi bir görünüme sahiptir.
- ❑ Pencereler, sırlı veya fayans cephelerinde ve çatılarda kullanılan, elektrik üretirken doğal aydınlatmayı kullanma seçenekleri için gün ışığı iletebilen BIPV ürünleridir. Üretimindeki şekil, hücre malzemesi, renk ve şeffaflık düzeyiyle ilgili özelleştirilmiş modülleriyle estetik seçenekler sunmaktadır.

(Joseph, Pogrebnaya and Kichonge, 2019)

18. BIPV ürünün adları ile resimleri eşleştirir misiniz?

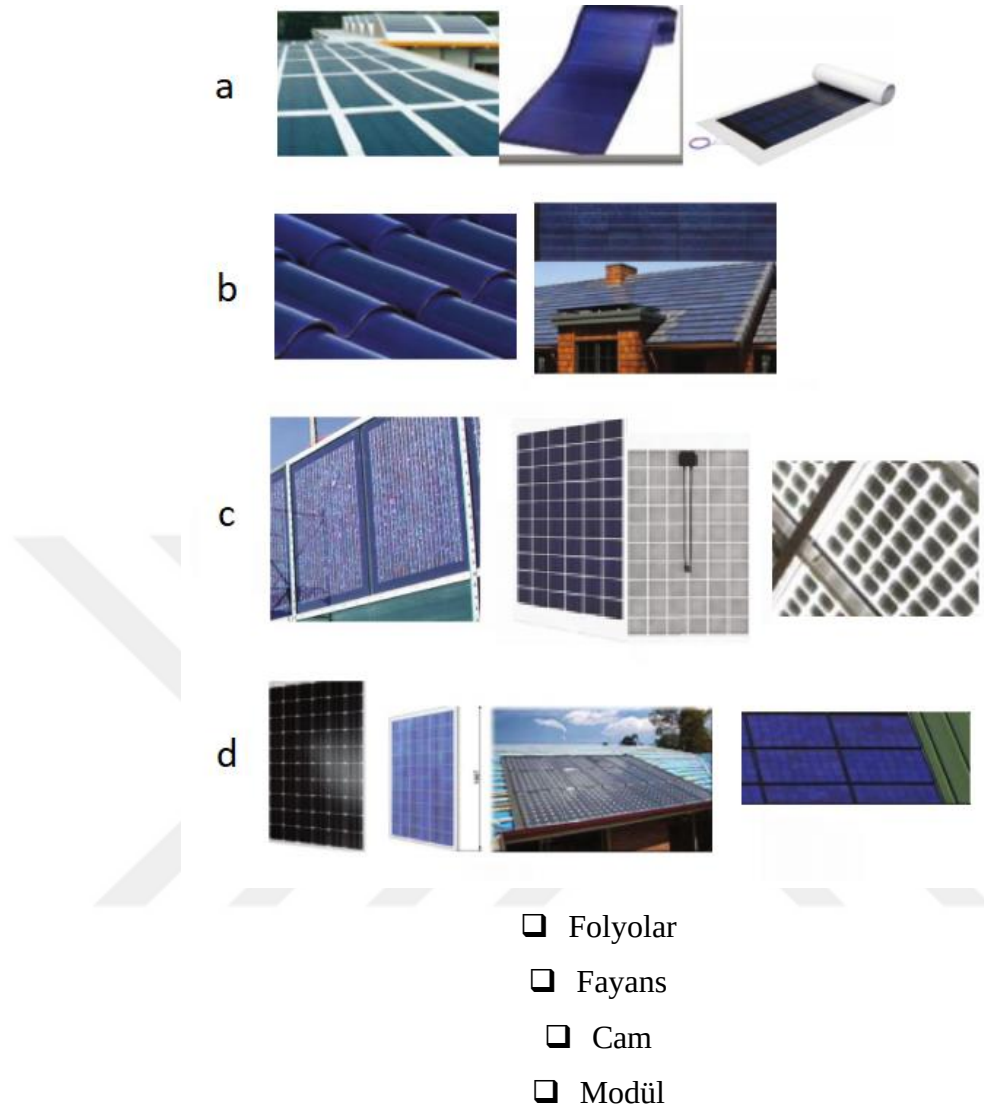


Fig 19 : BIPV sistemlerinin ürünlerine göre pazar isimleri
(Joseph, Pogrebnaya and Kichonge, 2019)

19. BIPV gelişiminin önündeki engeller ve stratejiler nelerdir?

(Bir ya da daha fazlasını işaretleyiniz.)

- ☐ Devlet desteklerinin eksikliği gibi politik engeller.
- ☐ Kamusal anlayış eksikliği gibi algısal engeller.
- ☐ BIPV modüllerinin yüksek maliyeti, tasarımları ve konstrüksiyonları gibi ekonomik engeller.
- ☐ Standartların eksikliği, düşük güç verimliliği ve güç güvenilirliği gibi teknik engeller.

(Jelle, Breivik and Rokenes, 2012)

C. BİNAYA ENTEGRE FOTOVOLTAİKLERİN UYGULANMASI

Elektrik enerjisi üretmenin yanı sıra BIPV sistemlerinin temel işlevleri şunlardır;

Verimlilik: *İletim sırasında enerji kayıplarını azaltmak, enerji kalitesini artırmak, voltaj kontrolü sağlamak; (Kang et al., 2016; Krawietz, 2011).*

Bina Ekonomisi: *İnşaat malzemesi maliyetlerinde azalma, bina işletme maliyetlerinde ve işçilik maliyetlerinde azalma, PV sistemi kurulumu için gerekli alanın ortadan kaldırmak / azaltmak; (Gautam et al., 2015).*

Sosyo-ekonomi: *Yeni bir pazar yaratmak, yeni iş olanakları sağlamak, yenilebilir kaynaklar hakkında binalarda kullanarak kamu bilincini artırmak ve eğitim fırsatlarını arttırmak, binaya prestij kazandırmak; (Ershad et al., 2016).*

Çevre: *Çevre dostu yeşil bina tasarımına katkıda bulunmak, karbondan bağımsız enerji üretimi sağlamak, sera gazı miktarını azaltmak; (Yoon et al., 2011).*

Estetik: *Mimari tasarıma uyum, mimariye değer katan, yenilikçi tasarımı mümkün kılan ve tasarım seçeneklerini artırmak; (Shafii, 2011).*

Mimarlık: *Bir yapı bileşeni olarak; ısı, su ve ses yalıtımı sağlamak, güneş kontrolü sağlamak; (Kang et al., 2016).*

20. Hangisi BIPV sistem uygulamasıdır?

(Lütfen yalnızca bir seçeneği işaretleyiniz.)



Fig 20: BIPV ve BAPV sistemleri arasındaki farklar

(Joseph, Pogrebnaya, and Kichonge, 2019)

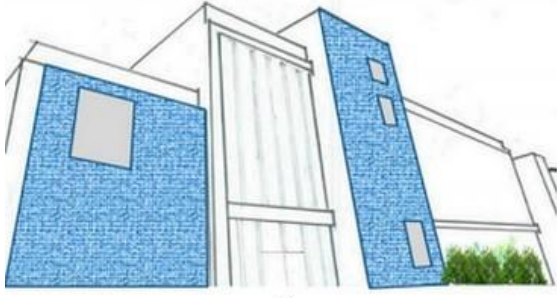
21. BIPV cephe tipini ve tanımlamalarını eşleştirebilir misiniz?

- a) Giydirme Cephe / Kaplama Sistemleri
- b) Güneş Camları ve Pencereler
- c) Harici Aygıtlar / Aksesuarlar
- d) Gelişmiş / Yenilikçi Bina Kabuğu Sistemleri

- ☐ Bu tip BIPV cephe tipleri, çift cidarlı cepheler, aktif kaplamalar, dönen veya hareketli cephe parçaları gibi bileşenlerden oluşur.
- ☐ Bu BIPV cephe tipleri, cephenin yarı saydam veya yarı saydam kısımları güneş pili şeffaflığına bağlı olarak uygulanır. Görüş veya gün ışığı için pencerelere, cam panellere entegre edilmiştir.
- ☐ Bu BIPV cephe tipleri güneşten koruyucular ve güneşlikler, spandeller, balkon korkulukları, görsel ve akustik kalkan elemanlarından oluşur.
- ☐ Bu tip BIPV cephe tipleri, tek katmanlı cepheler veya perde duvarlar için geleneksel bir kaplama sistemi olarak entegre güneş panelleri içerir.

(Attoye, Anissa, Kheira and Hassan, 2017)

22. BIPV cephe tipi isimlerini ve görsellerini eşleştirebilir misiniz?



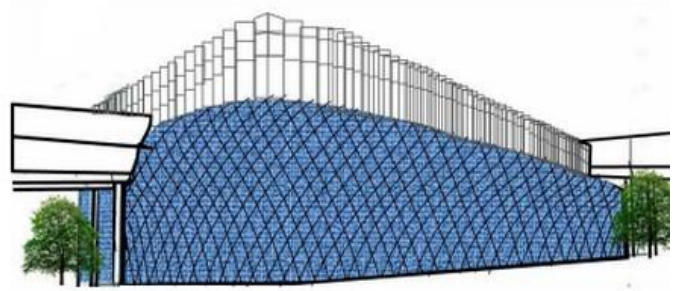
a



b



c



d

- ☐ Güneş Camları ve Pencereleeri
- ☐ Giydirme Cephe / Kaplama Sistemleri
- ☐ Gelişmiş / Yenilikçi Bina Kabuğu Sistemleri
- ☐ Harici Aygıtlar / Aksesuarlar

Figure 22: BIPV cephe çeşitleri
(Attoye, Anissa, Kheira and Hassan, 2017)

23. Hangi perde duvar cephe örneği uygulanan cephe BIPV sistemi örneği değildir?
(Lütfen yalnızca bir seçeneği işaretleyin.)



The Life Science Building, University of Washington



CORE Bank Headquarters | Omaha, NE



Brunel University, London



Seneca College - Centre for Innovation,
Technology and Entrepreneurship (Cite)

Figure A.4. Soru 23 için görsel.

Fig. 23.a : (Source: URL 14).

Fig. 23.b : Source: URL 17).

Fig. 23.c : (Source: URL 15).

Fig. 23.d : (Source: URL 16).

24. Hangi havalandırmalı cephe örneği uygulanan cephe BIPV sistemine örnek değildir?

(Lütfen yalnızca bir seçeneği işaretleyin.)



Figure A.5. Soru 24 için görsel.

Fig. 24.a: (Source: URL 18).

Fig. 24.b: (Source: URL 19).

Fig. 24.c: (Source: URL 20).

Fig. 24.d : Source: URL 21).

25. Hangi tavan aydınlatması örneği uygulanan cephe BIPV sistemine örnek değildir?

(Lütfen yalnızca bir seçeneği işaretleyin.)



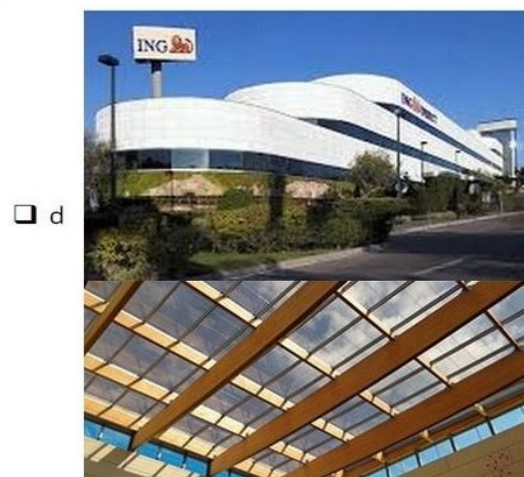
Novartis Pharmaceutical Company,
New Jersey, USA.



The University of California, San Diego



The Hague, Netherlands, City Hall and Library



ING Direct Bank, in Las Rozas, Madrid

Figure A.6. Soru 26 için görsel.

Fig. 25.a: (Source: URL 22).

Fig. 25.b: (Source: URL 23).

Fig. 25.c : Source: URL 25).

Fig. 25.d : (Source: URL 24).

26.-27 ve 28. soruyu aşağıdaki görsele göre yanıtlayınız.



(A)



(B)

26. Hangi binada BIPV uygulanmıştır?

a)A b) B c) İkisi de d) Hiçbiri

(Fig. Sol : Kulturhaus Milbertshofen (Germany): façade with black micromorph and semi-transparent thin-film modules (Energy output: 3 kWp), RPM-Architekten, System provider: Voltarlux, 2008));

Fig. Sağ: Solarhaus Darmstadt (Germany): prize-winning pilot project from the Technische Universität Darmstadt with a 200% PlusEnergy gain. The façade is covered with black CIS thin-film modules (System provider: Würth-Solar, 2009))

Aşağıdaki bilgilerden hangileri doğrudur?	Evet	Hayır
A binasına yarı saydam modüller takılmıştır.		
B binasına yarı saydam modüller takılmıştır.		
A binasına ince film modülleri takılmıştır.		
B binasına ince film modülleri takılmıştır.		
A binasında BIPV pencere düzenlemesi olarak uygulanmıştır.		
B binasında BIPV pencere düzenlemesi olarak uygulanmıştır.		
A binasında BIPV cephe parçası olarak uygulanmıştır.		
B binasında BIPV cephe parçası olarak uygulanmıştır.		

27. Bu binalarda BIPV'nin görsel entegrasyonu açısından herhangi bir fark hissediyor musunuz?

- a. Bu farklılıkları estetik nedenlere veya malzeme kombinasyonlarına göre tanımlayabilir misiniz?
- b. Bu binalar diğer geleneksel binalardan nasıl farklı görünüyor?
- c. Bu binaların cepheleri hakkında ne düşünüyorsunuz?

28. Hangi cepheyi inşa etmeyi / tasarlamayı tercih edersiniz?

- a. Elektrik üretimi açısından tercihinizin nedenlerini açıklayabilir misiniz? / görsel veya estetik konular? / veya fiziksel olarak uygulama tekniği?
- b. Çatıdaki fotovoltaiik uygulamalara göre sizce enerji üretim verimlilikleri daha mı iyidir yoksa daha mı kötüdür? Nedenleriyle açıklar mısınız?
- c. Maliyet açısından uygulanabilirlikleri hakkında ne düşünüyorsunuz?
- d. Hangisi bize daha fazla fayda sağlıyor? Neden?
- e. Hangi binada yaşamak / çalışmak istersiniz?

29. ve 30. soruyu aşağıdaki görsele göre yanıtlayınız.



(A)

(B)

(Fig. Sol: ECN, building 42 (Petten, The Netherlands): Semi-transparent and curved c-Si-skylight roof (Bear Architecten, 2001));

(Fig. Sağ: Boading (China 2012) semi-transparent a-Si modules with coloured polymers (Courtesy: Tianwei Solar Films; Photo: P. Heinstei))

29. Hangi binada yarı saydam fotovoltaik cam modüller uygulanmıştır?

a)A b) B c) İkisi de d) Hiçbiri

Aşağıdaki bilgilerden hangileri doğrudur?	Evet	Hayır
A binasının çatı ışıklığına yarı saydam modüller takılmıştır.		
B binasının çatı ışıklığına yarı saydam modüller takılmıştır.		
A binasının çatı ışıklığına ince film modülleri takılmıştır.		
B binasının çatı ışıklığına ince film modülleri takılmıştır.		
A binasının cephesine yarı saydam modüller takılmıştır.		
B binasının cephesine yarı saydam modüller takılmıştır.		
A binasının cephesine ince film modülleri takılmıştır.		
B binasının cephesine ince film modülleri takılmıştır.		

30. Bu binalardaki BIPV'nin görsel entegrasyonunu nasıl buluyorsunuz?

a. İç mekanın aydınlatma kalitesi ve görsel konfor açısından her iki binayı değerlendirir misiniz?

b. Hangi iç mekanda yaşamak / çalışmak istersiniz?

31., 32., 33. ve 34. soruyu aşağıdaki görsele göre yanıtlayınız.



Figure A.9. Soru 31, 32, 33, 34 için görsel. (Source: URL 26)

31. Bu binada hangi renkte fotovoltaik cam modüller kullanılmıştır?

a. Siyah b. Gri c. Mavi d. Kırmızı

32. Bu binadaki BIPV'nin görsel entegrasyonunu nasıl buluyorsunuz?

a. İç mekanın aydınlatma kalitesi ve görsel konfor açısından her iki binayı değerlendirir misiniz?

b. Hangi iç mekanda yaşamak / çalışmak istersiniz?

33. Kullanılan renk dışında başka bir renkte üretilmiş cam modül kullanılırsa iç mekanın aydınlatma/ışık kalitesinde bir değişim olur mu? Evetse nasıl bir değişim olur?

34. Renk değişiminin fotovoltaik modülün enerji verimliliğine etkisi olduğunu düşünüyor musunuz? Evetse nasıl etkiler?

35.BIPV sistemlerin avantajları ve dezavantajları neler olabilir? Değerlendirir misiniz?

KATILIMINIZ İÇİN TEŞEKKÜR EDERİZ.

APPENDIX B. COMPARATIVE RESPONSES

Table B.1 Comparative responses of architects and engineers for Question 2.

In which type of building/facility or tool can solar energy be used ? If you have examples of other areas where solar energy is used, please write.	
ARCHITECTS	ENGINEERS
• There are systems in which the solar rays reflected by special mirrors focus on a single point and generate high temperatures. These systems allow the transformation of solar energy into thermal energy. (P.A 1) • It is used in urban furniture and urban lighting. (P.A 4) • It's used in space vehicles. (P.A 7) • I know examples that are applied on a building scale and urban scale. (P.A 11) • It is used in vehicles such as solar cookers, water heating systems, wristwatches, calculators etc. (P.A 12) • It can be used in all areas such as cars and residences. (P.A 18) • It is used in parking lots, building facades. (P.A 23)	• I know it is used in residential, business and some industrial buildings. (P.E 2) • I recommend you to research the organization 'Heliac' which is hot water supply known as district-heating. (P.E 4) • Solar energy can be used to generate electricity and hot water in education, health, accommodation, religious, commercial, social, transportation, sports, industrial structures and residences. (P.E 7) • It is used for remote and singular all kinds of structures and devices. (P.E 8) • It is used in agricultural fields. (P.E 9) • It is used in floating vehicles. As Dokuz Eylül University Maritime Faculty, we are experimenting with solar energy technologies. My PhD student is working on Hydrogen Energy. My graduate student worked on the systems of cooling the

• It is used in heating and cooling systems. (P.A 24)	photovoltaic cells used in boats with sea water and increasing their efficiency. We also worked on solar tracking systems. We built electric powered boats. We received many awards in the "Solar Splash" competition in the USA. (P.E 11) • It is used in the wide roofing of an industrial facility. (P.E 17) • It is used in public buildings, institution's buildings, mountain shelters, vineyard houses, camping tents. (P.E 18) • It can be used in most areas where electricity and thermal energy are needed. (P.E 20) • It is used in space technologies and vehicles. (P.E 21) • It can be used anywhere in rural areas along the azimuth (south angle) axis with solar tracking system. (P.E 22) • It is used in Street lights and traffic lights. (P.E 25)
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Table B.2 Comparative responses of architects and engineers for Question 5.

5. Which ones should be done in order to start the Solar Architecture effectively? If you have any other comments, please write.	
ARCHITECTS	ENGINEERS
• Conducting international project activities. (P.A 4) • Awareness creating; different scales such as society, education, industry. (P.A 6) • It is necessary to carry out inspections of buildings during the construction phase by Environmental Consulting Companies, and various sanctions should be applied to buildings that are not panels. (P.A 8) • It is necessary to raise awareness and encourage the use of these professions by preparing seminars on architects, engineers and other disciplines about solar architecture and energy efficient building systems. (P.A 11) • It should include compulsory renewable energy solutions for structures larger than certain m2. (P.A 12)	• Dissemination of the application in the government buildings without excessive consideration of cost. (P.E 8) • Photovoltaic cells need to be produced locally. In an İZKA project we have done as Dokuz Eylül University, a working group has also made EMUM; but it was working with 5% efficiency. Unless these cells are local; that is, as long as we are foreign-dependent, we cannot become a technology producing country, we become an importing country. (P.E 11) • If the green energy awareness is created in kindergarten and primary school children, all of the above items will be realized. (P.E 12) • The prices of solar panels are still at a level to prevent their application. This application should not be expected to increase much before the prices reach a certain level. (P.E 17)

• Providing trainings to raise awareness that it is a renewable energy source for sustainability. (P.A 23)	• In order to take maximum advantage of the sun, which constantly changes position during the day, moveable solar energy systems should be developed. For these systems, working on the architecture of the most ideal mounting system will create a new new workspace. (P.E 18) • In our country, it is necessary to establish Micro GESs and provide legal legislation to this. Entrepreneurs such as Aunt Kezban, who is an Internet phenomenon, should be supported by the government and turned into a project. https://www.youtube.com/watch?v=_72a9vjan3 (P.E 21) • By giving detailed information about legal regulations. (P.E 24) • Making these systems compulsory after the necessary infrastructure preparation in areas where solar energy can be used in order to use renewable energies effectively. (P.E 25)
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Table B.3. Comparative responses of architects and engineers for Question 8.

8. According to the definition , do you know any BIPV system applied examples in the world? - If it is yes, please name it.	
• ARCHITECTS	• ENGINEERS
- CIS kulesi, Manchester (P.A 1) - The photovoltaic system was integrated in the Expo Guadalajara building which built in 1987. (P.A 2) - Center for Interactive Research on Sustainability (CIRS) building, Fred Kaiser building annex. Both buildings are located in the University of British Columbia, Vancouver, Canada. (P.A 6) - BMW WELT that I traveled and saw. (P.A 9) - Science Pyramid, Denver Botanic Garden (PA 12) - Bmw Welt (P.A 13) - Intercultural Center, Georgetown University, Washington (P.A 25)	- I do not remember the names of the buildings built; but I know that BIPV systems are used on the facades of some skyscrapers. (P.E 1) - University of Alberta (P.E 2) - In South Korea, night lighting is made with the solar energy panel on the highway. Also, the roads are prevented from icing. (P.E 5) - Voltimum (P.E 8) - BIPV systems are used everywhere (in residences, farms) in the region where I live (Switzerland). Energy companies recommend such applications as an integrated system with the grid system. These systems are being promoted with government support. BIPV applications are becoming widespread quickly. (P.E 10) - Apple's building, General Electric Boston. (P.E 11)

	• In residential buildings and industrial facilities in Germany. (P.E 12) • Solar Living Institute (P.E 16) • Various examples are actively used in Europe, especially Germany and the USA. (P.E 20)
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Table B.4. Comparative responses of participants for Question 30.b.

30. b. In which interior do you want to live / work?	
ARCHITECTS	ENGINEERS
• Building A; because it has an extremely spacious and natural light level. (P.A 1) • I would like to live / work in building B. (Look 56.) I can say that building B is more successful in terms of its effect on the visual interior quality. (P.A 2) • I choose building A because the sense of openness is more prominent. (P.A 4) • I prefer building A because of the building form. (P.A 5) • I think both spaces as transition areas, not living or working spaces. For this reason, I wouldn't want to live or work in either place. (P.A 6) • It is very difficult to decide. I think I prefer building A. (P.A 7) • I would like to live or work in building A, as it is brighter and more spacious. (P.A 8) • Building A is suitable for work / office, building B is suitable for living. (P.A 9) • I prefer building A in terms of lighting quality, visual comfort and strong shading system. (P.A 11) • I prefer building A; because it has better indoor and outdoor relationship and transitions. (P.A 12)	• I prefer building A because it is higher, more spacious and brighter. (P.E 1) • I can work in building A, but as I said before, it is necessary to pay attention to other factors (purpose of the design, requirements, functionality and interior architecture, location and office layout). (P.E 2) • I prefer building A because it is brighter. (P.E 3) • I would choose building A because it has better visuality and lighting. (P.E 5) • B, because the interior looks fresh. (P.E 6) • A (P.E 7, P.E 10, P.E 11) • I prefer both. (P.E 8) • B, because it is more aesthetic. (P.E 9) • I choose building A because it is brighter and has a larger interior space. (P.E 12) • B (P.E 13,P.E 14) • B, (Look 5.) If the shading system applied to the roof is insufficient, building A can be exposed to a lot of daylight. The irritating effect of

• Both of them. (P.A 13, P.A 15) • In building A because it has better light quality. (P.A 14) • None of these. They are not buildings that match my understanding of design. (P.A 16) • B (P.A 17,P.A 19) • I would like to work or live in both buildings. (P.A 18) • A (P.A 20,P.A 23) • Building B may have a better performance in terms of energy gain, but it would be a low-efficiency working environment because the lighting of the incoming light would be both low and different in color. It is difficult to answer without knowing the location of building A. Depending on the location, glow and heat radiation can become unbearable. My answer is a questionable A. (P.A 21) • I choose building A because of the more spacious interior and better light quality. (P.A 24) • I would like to live / work in building A because it has better architectural design and a successful BIPV A application has been made. (P.A 25)	sunlight was prevented by using window films in building B. For this reason, I prefer building B. (P.E 15) • I choose building A, building B's daylight taking seems poor. (P.E 16) • I would like to live or work in building A, as it is brighter and more spacious. (P.E 17) • I prefer building B as it is more aesthetically successful. (P.E 23) • I choose building A because it has better interior lighting. (P.E 24) • I prefer building A because it looks more spacious. (P.E 25)
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Table B.5. Comparative responses of participants for Question 32.

32. How do you find the visual integration of BIPV in this building?	
	
ARCHITECTS	ENGINEERS
- Although I don't know the purpose of use of the place, I see that the interior lighting has been successfully designed. (P.A 1) - To what extent did this design, which suggests that a certain visual stylization was not attained by chance and thought over, reached the art-deco effect it reached in terms of visual language with the internal technological procedures of BIPV? I am of the opinion that there is no observable structural process in this matter. I cannot predict how much this aesthetic expression, which you think is confined to randomness or at least limited visual language, will diversify under other circumstances and conditions. (P.A 2) - It caused visual confusion. (P.A 4) - It's a little dark. But if the dim inside is designed for a specific purpose, it's a different situation. (P.A 5)	- It is very beautiful. (P.E 1) - It's a little complicated. (P.E 2) - Successful (P.E 5, P.E 18) - A little dim (P.E 6) - The visual integration of the building is aesthetic. However, the building is not exposed to sunlight much. (P.E 7) - Very good (P.E 8) - Beautiful, successful (P.E 9) - A little complicated. (P.E 10) - An innovative and progressive design. (P.E 11) - Beautiful (P.E 12, P.E 15, P.E 23)

- If the atmosphere I like inside is created intentionally, it is very successful. (P.A 6) - So elegant design (P.A 7, 24) - I find it unsuccessful. Although the way of taking light provides a significant amount of liveliness in the interior, I think that getting light in such a way that emphasizes clear patterns in order to work or live for a long time will negatively affect comfort. (P.A 8) - Balanced (P.A 9) - The visual integration in this building is very successful. In addition to giving people peace, confidence and tranquility, it also keeps the energy high. (P.A 11) - Visuality comes into prominence and prevents daylight too much. (P.A 12) - Successful (P.A 13, P.A 14, P.A 17, P.A 18, P.A 20) - Bright, beautiful (P.A 16) - Well designed for the purpose of the place. (P.A 19) - The lights filtering from the facade of the building and hue give calmness. (P.A 23) - It is innovative and modern. (P.A 25)	- Nice (P.E 13) - It depends on the usage purpose of the place. But if it has a goal that does not want sunlight too much, it is successful. Because it almost destroyed the sunlight. (P.E 14) - Very successful (P.E 16) - Well designed (P.E 19) - Compatible with the construction (P.E 25)
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APPENDIX B. COMPARATIVE RESPONSES (TURKISH)

Table 4.1. Comparative responses of architects and engineers for Question 3.

2. Güneş enerjisi hangi tür bina / tesis veya araçlarda kullanılabilir? Güneş enerjisinin kullanıldığı diğer alanlardan örnekleriniz varsa lütfen yazın.	
MİMARLAR	MÜHENDİSLER
- Özel aynalar yardımıyla yansıtılan güneş ışınlarının tek bir noktaya odaklanarak yüksek ısılar oluşturduğu sistemler mevcuttur. Bu sistemler güneş enerjisinin termal enerjiye hızlıca dönüşümüne olanak sağlar. (P.A 1) - Kent mobilyaları ve kent aydınlatmalarında kullanılır. (P.A 4) - Uzay araçlarında kullanılır. (P.A 7) - Bina bazında ve kentsel ölçekte uygulanan örnekler biliyorum. (P.A 11) - Güneş ocakları, su ısıtma sistemleri, kol saatleri, hesap makineleri vb. araçlarda kullanılır. (P.A 12) - Tüm alanlarda kullanılabilir. Arabalarda ve konutlarda... (P.A 18) - Açık otoparklarda, bina cephelerinde kullanılır. (P.A 23)	- Konut, işyerleri ve bazı sanayi yapılarında kullanıldığını biliyorum. (P.E 2) - District-heating olarak bilinen sıcak su temini – “ Heliac ” isimli kuruluşu incelemenizi tavsiye ederim. (P.E 4) - Eğitim, sağlık, konaklama, dini, ticaret, sosyal, ulaştırma, su, spor, endüstri yapı/yapılarında, konutlarda elektrik ve sıcak su elde etmek için güneş enerjisi kullanılabilir. (P.E 7) - Remote ve tekil her türlü yapı ve cihaz için kullanılır. (P.E 8) - Ziraat alanlarında kullanılır. (P.E 9) - Yüzen taşıtlarda kullanılır. Biz Dokuz Eylül Üniversitesi Denizcilik Fakültesi olarak güneş enerjisi teknolojileri hakkında denemeler yapıyoruz. Bir doktora öğrencim Hidrojen Enerjisi çalışıyor. Mezun

Isıtma ve soğutma sistemlerinde kullanılır. (P.A 24)	olan bir yüksek lisans öğrencim teknelerde kullanılan fotovoltaik hücreleri deniz suyu ile soğutma ve verimini artırma sistemleri üzerine çalıştı. Ayrıca güneş takip sistemleri üzerine de çalışmalar yaptık. Elektrik tahrikli tekneler inşa ettik. ABD’de “ Solar Splash ” yarışmasında birçok ödül aldık. (P.E 11) - Kent mobilyaları ve kent aydınlatmalarında kullanılır. (P.E 17) - Kamu, kurum, kuruluş binaları ve dağ, bağ evleri, kamp çadırlarında kullanılır. (P.E 18) - Elektrik ve termal enerjiye ihtiyaç duyulan alanların büyük kısmında kullanılabilir. (P.E 20) - Uzay teknolojileri ve araçlarında kullanılır. (P.E 21) - Kırsal alanlarda güneş takip sistemi ile azimuth (güney açısı) eksenini boyunca istenilen her yerde kullanılabilir. (P.E 22) - Sokak ve trafik lambalarında kullanılır. (P.E 25)
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Table 4.1. Comparative responses of architects and engineers for Question 3.

3. Türkiye'de güneş enerjisi kullanan herhangi bir bina (veya uygulama / araç) biliyor musunuz?	
Evet ise güneş enerjisi ne şekilde kullanılıyor?	
MİMARLAR	MÜHENDİSLER
- Yapının enerji ihtiyacının kısmen ya da tamamen sağlanması ve elde edilen enerji fazlasının elektrik şebekesine aktarılması için yapı kabuğunun tamamen ya da kısmen güneş panelleri ile kaplanması şeklinde kullanılır. (P.A 1) - Bir tekstil fabrikasında belirli miktardaki enerji ihtiyacını karşılayacak şekilde kullanıldığını, ancak tüm bina alanının kullanılmasının dahi enerji ihtiyacının tamamını karşılamaya yetmediğini biliyorum. (P.A 2) - Fotovoltaik paneller ile elektrik üretiminde kullanılır. (P.A 5) - En basit kullanım şekli, çatılara yerleştirilen panellerle sıcak su ihtiyacının karşılanması içindir. (P.A 6) - Şehir merkezinden uzak konutlarda rüzgar ile beraber güneş enerjisinden elektrik üretiliyor. (P.A 7)	- Isıtma-soğutma sistemlerinde, sıcak suyu elde etmede, elektrik enerjisi üretiminde kullanılır. (P.E 1) - Çoğunlukla sıcak su elde etmek amacıyla kullanılıyor. (P.E 4) - Güneş enerjisi elektrik üretmek amacıyla kullanılır. Günümüzde güneş enerjisinin en yaygın kullanıldığı alanın elektrik olduğu söylenebilir. Bu amaçla fotovoltaik güneş panelleri kullanılır. (P.E 5) - Sıcak su üretimi maksadıyla kullanılır. (P.E 6) - Su ısıtma, elektrik üretme, binalarda ısıtma&soğutma. (P.E 8) - Yaygın uygulama sıcak su üretimidir. Son yıllarda fotovoltaik teknolojinin gelişmesi ve diğer enerji sistemleri ile rekabet edebilir. Ekonomik değerlere gelmesi ile elektrik üretiminde kullanılması yaygınlaşmıştır. (P.E 10)

- Fotovoltaik paneller aracılığıyla konut için gerekli ısıtma enerjisi, kırsal alanda elektrik enerjisi sağlamak için ve pasif ısıtma amacıyla cephede güneş enerjisi alımı ile ilgili çözümler için kullanılır. (P.A 9) - Su ısıtmada, elektrik üretiminde, binalarda ısıtma&soğutma sistemlerinde kullanılır. (P.A 10) - Çatıya uygulanan elektrik üretimi için kullanılan paneller. Örnek: “ BFB binası ”. (P.A 12) - Elektrik ihtiyacını karşılamak. (P.A 13) - Elektrik üretimi ya da ısıtma sistemlerinde. (P.A 19) - Fotovoltaik panel olarak elektrik üretmek için. (P.A 20) - Güneşten gelen radyasyonları paneller aracılığıyla enerjiye çevirmekte kullanılır. (P.A 22) - Isı enerjisi elde etmek için. (P.A 23) - Elektrik enerjisi üretmek için. (P.A 24)	- Elektrik üretmek için, su ısıtmak yani binayı ısıtmak ya da sıcak su sağlamak için kullanılabilir. Camlara uygulanmış ve Antalya da satışını da yapan meslektaşım var. Pencerelerden/camlardan elektrik üretiliyor. (P.E 11) - Panel olarak enerji üretiminde kullanılıyor. (P.E 13) - Aydınlatma, su ısıtma, bazı elektronik cihazlar, elektrik üretiminde. (P.E 15) - Isıl enerji ve elektrik enerjisi üretimi. (P.E 16) - Enerji sistemleri mühendisi olduğum için daha önce çalıştığım enerji firmasında, pek çok konut ve sanayi tesisine güneş enerji sistemi kurulumu gerçekleştirdim. Bu sayede bu tesislerde elektrik enerjisi üretildi ve binanın ısıtma-soğutma sistemi oluşturuldu. . (P.E 18) - Pv sistemler ile çatıda kullanılarak elektrik enerjisi üretilir. Ya da termal kolektörler ile sıcak su üretiminde kullanılabilir. Avrupa'da daha çok kullanılan PV-T sistemler ile kombine şekilde hem elektrik hem
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• Elektrik üretimi. (P.A 25)	sıcak su aynı kolektörler ile üretilebilmektedir. (P.E 19) • Elektrik üretimi, pasif ısıtma, kullanım suyu ısıtılması. (P.E 20) • Isıtma, solar soğutma, elektrik elde etmede kullanılır. (P.E 22) • Binalarda su ısıtma için ve elektrikli araç şarj istasyonlarında kullanılır. (P.E 23) • Alışveriş merkezleri gibi geniş yüzeylere sahip çatılarda, yapının kendi enerji üretimini kendisinin sağlaması için kullanılır. (P.E 25)
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Table 4.2. Comparative responses of architects and engineers for Question 4.

4. Bina tasarımında güneş enerjisinden beklentileriniz nelerdir?	
MİMARLAR	MÜHENDİSLER
- Yapının ihtiyaç duyduğu görsel, işitsel ve duyuşsal konfor şartlarının sağlanmasında gerekli olan enerji ihtiyacının mümkünse tamamen, değilse kısmen sağlanmasını beklerim. (P.A 1) - Çevreye duyarlı, temiz bir enerji kaynağı olarak mümkün olan en yüksek oranda enerji ihtiyacını karşılamasıdır. (P.A 2) - Aktif ve pasif olarak enerji elde edilmesi. (P.A 3) - Bir enerji kaynağı oluşturmasının yanı sıra, tasarımda uygun alanların düşünülmesi. (P.A 4) - Kışın binanın ısınmasına, yazın binanın soğutmasına katkı sağlaması. (P.A 5) - Binanın mekanik yükünü arttırmayacak, yazın ekstra soğutma, kışın ekstra ısıtma gerektirmeyecek şekilde güneşe göre yönelme, güneş kontrolü için güneş kırıcıları, aydınlatma için ışığın binanın derinliklerine iletilmesini sağlamak	- Çevreye zarar veren fosil yakıtların kullanımını sınırlamak. (P.E 1) - Elimizdeki bilgi birikimi ve teknolojiyle, azami seviyede ve yine azami verimlilik ile kullanabildiğimiz her yapıda tasarıma dahil etmeye çalışmalı, sürdürülebilir ve yenilenebilir tüm enerji kaynaklarını kullanmaya ve kullandırmaya çalışmalı ve çaba göstermeliyiz. (P.E 2) - Tüm enerji ihtiyaçlarını karşılamak. (P.E 3) - Elektrik üretimini sağlaması. (P.E 4) - Binanın içerisinde gerekli olan elektrik ihtiyacının büyük çoğunluğunun ya da belli bir bölümünün karşılanması, sıcak su temini ve ısıtmaya bağlı olarak oluşan maddi yüklerin yüksek oranda azalmasının sağlanması. (P.E 5) - Ortak alanların elektrik ihtiyacının karşılanması vb. (P.E 6)

için güneş rafları tasarımı uygulamaları aklıma ilk gelen tasarım özellikleridir. (P.A 6) - Su ısıtmak, elektrik üretmek, evi ısıtması-soğutması. (P.A 7) - Tasarımın ve binanın insan tarafından kullanım konforunu olumsuz bir şekilde etkilemeyecek biçimde, her binada olması gerektiğini ve bu şekilde binanın enerji tüketimini önemli ölçüde azaltacağını düşünüyorum. (P.A 8) - Sürdürülebilir enerji sağlaması. (P.A 9) - Su ısıtma, elektrik üretme, ısınma sağlarken elektrik veya doğalgaz kullanmamak. (P.A 10) - Enerji tasarrufu sağlaması, çevre dostu olması, yenilenebilir olması. (P.A 11) - Binada harcanan enerjiyi minimize ederek, karbon salınımını düşürmek. (P.A 12) - Binanın enerji ihtiyacını karşılaması. (P.A 13)	- Bina tasarımlarında çatı imalatlarında kullanılan tuğla vb. yapı malzemeleri yerine bina ihtiyacını karşılayacak miktarda güneş enerjisi panelleri kullanılabilir. (P.E 7) - Tamamen güneş kaynaklı, tam bağımsız, kendine yeterli yapı. (P.E 8) - Kesintisiz enerji sağlanmalı ve daha rahat, aktif kullanmamız için MW'ı yüksek olmalı. (P.E 9) - Binada kullanılan sistemler için yeterli enerji sağlayabilmesi. Yetmediği veya fazla geldiği durumlarda elektrik dağıtım şebekesi ile bağlantılı olarak çalışabilmesi. (P.E 10) - İleride büyük bir oranda kullanılacaktır. Bu konudaki beklentimiz yüksektir. (P.E 11) - Güneş enerjisi elektrik üretmenin dışında bence bina ısıtmasında da kullanılmalıdır. (P.E 12) - Görsellik ve amortisman (P.E 13) - Gerekli elektrik giderlerini karşılayabilmesi. (P.E 14)
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• Bina elektrik ihtiyacının karşılanması. (P.A 14) • Uygulamada esneklik, maliyet olarak ulaşılabilirlik. (P.A 15) • Enerji üretimi, su ısıtılması. (P.A 16) • Yapının diğer enerji sistemleri ile efektif bir biçimde işleyiş göstermesi. (P.A 17) • Tüm enerji ihtiyacını karşılamak için kullanılabilir. (P.A 18) • Günlük enerji ihtiyacının karşılanması. (P.A 19) • Kendi enerjisini kendisinin üretebilmesi. (P.A 20) • Enerji ve maliyet tasarrufu. (P.A 21) • Yenilenemeyen fosil kaynaklı kömür, petrol, doğalgaz gibi sınırlı rezervleri olan kaynaklar kullanmaktansa çevre dostu ve yenilenebilir kaynak olan güneş enerjisinin bina tasarımında kullanılması ile düşük maliyetli ve çevre dostu mimari yaklaşımın önemli olduğunu düşünüyorum. (P.A 22)	• Aydınlatma, sıcak su ve ısıtma. (P.E 15) • Pasif olarak kışın ısıtma yükünü azaltması, yazın soğutma yükünü mümkün olabildiğince artırmaması. Aktif olarak da ısıtma ve elektrik üretiminde. (P.E 16) • Bina tasarımında güneş panelleri ile hem bina içine ısı girişi engellenir. Sadece bazı dalga boylarını geçiren özel paneller cam yerine kullanılarak ışık girişi sağlanırken, ısı girişi engellenebilir. (P.E 17) • Yüksek verim, düşük kayıp, maksimum kazanç ve en kısa amorti süresi. (P.E 18) • Elektrik enerjisi üretimine katkı sağlaması ve kullanma sıcak suyu ihtiyacının fosil yakıt tüketimi olmadan sağlanmasıdır. (P.E 19) • Kullanım suyu ve bina ısıtılması için güneş harici enerji kaynaklarından olabildiğince az kullanılması. (P.E 20)
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• Yapının ısıl dengesini sağlaması, gerekli sıcak su elde etmesi ve aydınlatma için enerjiye dönüştürülmesi. (P.A 23) • Maksimum verimlilik ve tasarruf. (P.A 24) • Binanın mümkün olduğunca ısıtma ve elektrik enerjisi ihtiyacının optimum tasarımla temin edilmesi. (P.A 25)	• Enerji tasarrufu sağlaması ve karbon salınımını azaltması. (P.E 23) • Türkiye'nin büyük sorunlarından biri enerji olduğu için, bina tasarımında elbette güneş enerjisinin kullanımını dikkate alarak yapılması çok önemlidir. (P.E 24) • Elektrik tüketimini minimize etmek. (PA 25)
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Table B.2 Comparative responses of architects and engineers for Question 5.

5. Güneş Mimarisini etkin bir şekilde başlatmak için hangileri yapılmalıdır? Başka yorumlarınız varsa lütfen yazın.	
MİMARLAR	MÜHENDİSLER
- Uluslararası proje faaliyetlerinin yürütülmesi. (P.A 4) - Farkındalık yaratılması: toplum, öğretim, endüstri gibi farklı ölçeklerde. (P.A 6) - Çevre Danışmanlık Şirketleri tarafından binaların yapım aşamasında kontrollerin yapılması, panel olmayan binalara ise çeşitli yaptırımların uygulanması gerekmektedir. (P.A 8) - Güneş mimarisi ve enerji etkin yapı sistemleri hakkında mimarlar odası, mühendisler odası ve diğer disiplinlere ait odalar seminerler hazırlayarak bu meslek gruplarının bilinçlendirilmesi ve kullanılmaya teşvik edilmesi gereklidir. (P.A 11) - Belli m2’den büyük yapılar için zorunlu yenilenebilir enerji çözümleri içermeli. (P.A 12) - Sürdürülebilirlik adına yenilenebilir bir enerji kaynağı olduğu bilincini kazandırmak için eğitimlerin verilmesi. (P.A 23)	- Devlet yapılarında maliyet fazla gözetilmeden uygulamanın yaygınlaştırılması. (P.E 8) - Fotovoltaik hücrelerin yerli olarak üretilmesi gerekiyor. DEÜ olarak yaptığımız bir İZKA projesinde, bir çalışma grubu EMUM da yaptı ama %5 verimle çalışıyordu. Bu hücreler yerli olmadıkça yani dışa bağımlı olduğumuz müddetçe teknoloji üreten değil ithal eden ülke oluruz. (P.E 11) - Anaokulu ve ilkokul çağındaki çocuklarda yeşil enerji bilincinin oluştursa yukarıdaki maddelerin hepsi gerçekleşecektir. (P.E 12) - Güneş panellerinin fiyatları halen bunların uygulamasını engelleyebilecek düzeydedir. Fiyatların belli bir seviyeye gelmeden, bu uygulamanın çok artması beklenmemelidir. (P.E 17) - Gün içerisinde sürekli konum değiştiren güneşten maksimum faydalanmak için hareketli güneş enerji sistemleri geliştirilmelidir. Bu geliştirilecek sistemler için en ideal montaj sisteminin

	mimarisi üzerine çalışmak yeni bir çalışma alanı oluşturacaktır. (P.E 18) - Ülkemizde Micro GES'lerin kurulması ve buna yasal mevzuatın sağlanması gereklidir. İnternet fenomeni olan Kezban Teyze gibi girişimcilerin devlet eli ile desteklenerek projeye dönüştürülmesi gereklidir. https://www.youtube.com/watch?v=_72A9vJan3U (P.E 21) - Yasal mevzuatlar hakkında detaylı bilgilendirmeler yapılarak. (P.E 24) - Yenilebilir enerjileri efektif kullanmak adına, güneş enerjisi kullanılabilecek alanlarda gerekli altyapı hazırlığından sonra bu sistemleri zorunlu hale getirmek. (P.E 25)
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Table B.3. Comparative responses of architects and engineers for Question 8.

8. Tanıma göre dünyada BIPV sistemi uygulanan herhangi bir örnek biliyor musunuz? Evet ise, lütfen adlandırın.	
MİMARLAR	MÜHENDİSLER
- CIS kulesi, Manchester (P.A 1) 1987 yılında yapılan Expo Guadalajara binasına 2017 yılında fotovoltaik sistem entegre edilmiştir. (P.A 2) - Center for Interactive Research on Sustainability (CIRS) binası, Fred Kaiser binası eki. İki bina da University of British Columbia, Vancouver, Kanada’da yer almaktadır. (P.A 6) - Gezip yerinde gördüğüm BMW WELT. (P.A 9) - Science Pyramid, Denver Botanic Garden (PA 12) - Bmw Welt (P.A 13) - Intercultural Center, Georgetown Üniversitesi, Washington (P.A 25)	- İnşa edilen yapıların isimlerini hatırlamıyorum fakat bazı yüksek yapıların cephelerinde kullanıldığını biliyorum. (P.E 1) - Alberta Üniversitesi (P.E 2) - Güney Kore’de otobana yapılan güneş enerji paneli ile gece aydınlatması yapılıyor. Ayrıca yolların buzlanması önleniyor. (P.E 5) - Voltimum (P.E 8) - Yaşadığım bölgede (İsviçre) her yerde var. Konutlarda, çiftliklerde... Enerji şirketleri bu tür uygulamaları şebeke sistemi ile entegre sistem olarak öneriyorlar. Devlet desteği ile bu sistemler teşvik ediliyor. Hızlı bir şekilde uygulamalar yaygınlaşıyor. (P.E 10) - Apple’ın binası, General Electric Boston. (P.E 11) - Almanya’da evlerde, sanayi tesislerinde... (P.E 12)

	- Solar Living Enstitüsü (P.E 16) - Avrupa, özellikle Almanya ve ABD de çeşitli örnekleri aktif olarak kullanılıyor. (P.E 20)
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Table 4.3. Comparative responses of participants for Question 27 a.

27. Bu binalarda BIPV'nin görsel entegrasyonu açısından herhangi bir farklılık hissediyor musunuz? 27.a. Bu farklılıkları herhangi bir estetik nedene veya malzeme kombinasyonuna göre açıklayabilir misiniz?	
  (A) (B)	
MİMARLAR	MÜHENDİSLER
- B binasında cephe kaplama sisteminin monoton bir tekrar içerdiğini düşünüyorum. (P.A 1) - A binasını geleneksel binalardan ayıracak herhangi bir tektonik tutum göremiyorum. B binasında artistik ekspresyonun teknolojik bir rasyonellik ve yalnlıktan kaynaklandığı ve herhangi bir görsel stilizasyon kaygısından kaynaklanmadığı anlaşıyor. (P.A 2) - BIPV modüllerinin boyutları ve saydamlıkları farklıdır. (P.A 3)	- A binası şu anda inşa edilen binalardan çok farklı görünmüyor. Saydam/yarısaydam BIPV kullanılmış olabilir. B binasında dış cephe uygulaması yapılmış. A binasında saydam ve yarısaydam BIPV modülleri kullanılmış. B binasında opak BIPV modülleri kullanılmıştır. (P.E 3) - BIPV modüllerinin boyutları, saydamlıkları ve renkleri farklıdır. (P.E 7) - Kaplama ve giydirme biçimleri farklıdır. (P.E 8)

- A'deki bina ekleme gibi duruyor. B'deki bina tasarımının bir parçası haline gelmiş. (P.A 5) - B binası sanki estetik olarak ürün vurgulanmak istenmiş, A binası ise estetik kaygıdan ziyade, ihtiyaçtan dolayı inşa edilmiş izlemi veriyor. (P.A 6) - B'deki binada cephe tasarımı binanın formu ile bir bütünlük içinde, A'daki örnekte ise bu bütünlükten ziyade cephe kaplamaları ve paneller arasında bir ayrılmış olma hali söz konusu. (P.A 8) - Bütüncül uygulama sebebiyle ve opaklık / geçirgenlik dengesi açısından B binası, A binasından daha başarılıdır. (P.A 9) - BIPV modülleri; farklı şekil, boyut, renk ve görsel yapı kombinasyonlarına sahiptir. (P.A 11) - Tasarım yönünden A binası daha alışagelmış kompozit kaplama tasarımı uygulanmış. B binası fotovoltaiik elemanları öne çıkarmıştır ve daha estetiksel bir görünüme sahip olmuştur. (P.A 12)	- Mekanların kullanım amaçları farklıdır. (P.E 11) - B binasında, A binasına göre daha fazla BIPV modülü uygulanmış gibi geliyor. (P.E 12) - A yapısı giydirme cephe, B yapısı ise dış cephe kaplamasıdır. (P.E 15) - PV yoğunluğu, açıklık-kapalılık, renk kontrastı, boşluk- doluluk gibi farklılıkları estetik nedenler veya malzeme kombinasyonları farklarına sahiplerdir. (P.E 16) - A yapısında giydirme cephe olarak uygulanan geçirgen/ yarı geçirgen BIPV modülleri, ahşap cephe kaplaması ile bütünleşmiştir. Fakat B yapısında sadece dış cephe kaplaması olarak uygulanan yarı geçirgen ya da opak BIPV modülleri olarak kullanılmıştır. (P.E 18) - B binası, yapısı ve malzeme kombinasyonu gereği A binasına göre daha estetik. (P.E 25)
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- Farklılık hissetmiyorum. (P.A 13) - B binasında malzeme, doğasına uygun olarak estetik bir ifade bulmuş. (P.A 14) - B binası daha rijit görünüyor. (P.A 16) - Malzeme dili ve kullanımı açısından, B binası daha yenilikçi gözüküyor. (P.A 18) - B binasında BIPV sistem kullanımı daha yoğun gözüküyor. (P.A 20) - A binası sisteminde kullanılan BIPV sistem parçaları, B binasına göre daha homojen bir şekilde entegre edilmiş. (P.A 22) - Mekansal kullanım amaçlarının farklı olabilmesi sebebiyle, kullanılan modüllerin boyutları, geçirgenlikleri ve renkleri farklı olabilir. (P.A 23) - PV yoğunluk oranları farklıdır. A binasında daha homojen kullanılırken, B binasında daha heterojen kullanılmıştır. (P.A 24) - A yapısında PV cephe elemanı olarak kullanılırken, B yapısında cepheye	
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yerleştirilmiş ikinci bir katman olarak kullanılmaktadır. (P.A 25)	
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Table 4.4. Comparative responses of participants for Question 27 b.

27.b. Bu binalar diğer geleneksel binalardan nasıl farklı görünüyor?	
MİMARLAR	MÜHENDİSLER
- Özellikle dış cephe için kaplama malzemeleri ve kaplama sistemleri nedeniyle farklı görünüyorlar. (P.A 1) (Bkz. 45.) A örneğini geleneksel binalardan ayıracak herhangi bir tektonik tutum göremiyorum. B örneğinde artistik ekspresyonun teknolojik bir rasyonellik ve yalınlıktan kaynaklandığı ve herhangi bir görsel stilizasyon kaygısından kaynaklanmadığı anlaşıyor. (P.A 2) - BIPV sistemlerde uygulanan giydirme cephe, kaplama sistemleri geleneksel binalara göre daha şık, daha modern ve daha çeşitli. (renk, boyut, şekil, saydamlık/geçirgenlik olarak). (P.A 3) - BIPV sistemler, geleneksel binalara göre görsel ve işlevsel olarak çok daha başarılılardır. Geleneksel binalar gibi, cephede kaplama malzemesi olarak duvar önüne, giydirme cephe şeklinde kullanılabilirler. Fakat BIPV modüller sahip olduğu renk, boyut, şekil, saydamlık gibi özellikleri ile geleneksel binalara göre çok daha fazla cephe çeşitliliğine sahiptirler.	- Geleneksel binalar göre daha modern görünüyorlar. (P.E 1) - Geleneksel ve modern tanımlamaları görecelik gösterir, kişiden kişiye farklılık gösterir. (P.E 2) - Bkz. 44. A binası şu anda inşa edilen binalardan çok farklı görünmüyor. B yapısı ise geleneksel binalardan daha modern bir görünüme sahip. (P.E 3) - Daha modern görünüş sağladığını düşünüyorum. (P.E 6) - Günümüzde alışıktığımız dış cephe kaplamalarından daha farklı gözüküyor. Güneş enerji sistemleri ile binalar daha estetik, daha modern ve daha kompakt görünüyor. (P.E 7) - Fonksiyonel olarak farklı olsalar da geleneksel binalardan estetik olarak bir farkı yok. (P.E 8) - Görünüş olarak çok farklı olmasa da, BIPV sistemler işlevsel olarak çok daha verimli sistemler. (P.E 9) - Daha modern görünüme sahipler. (P.E 10)

İşlevsel olarak, fotovoltaik malzeme, elektrik üretirken doğaya zarar vermez, gürültü çıkarmaz, ek bir enerji kaynağı istemez, hareketli parçası yoktur, bakım masrafları yoktur. Sadece üzerinde biriken tozun belirli aralıklarla suyla temizlenmesi yeterlidir. (P.A 4) - Geleneksel binalardan çok da farklı değiller. (P.A 5) - A binası geleneksel görünüyor, B binasında teknolojik bir vurgu / arayış var gibi. (P.A 5) - A binası geleneksel görünüyor, B binasında teknolojik bir vurgu / arayış var gibi. (P.A 6) - Daha modern görünümlüler. (P.A 7) - Geleneksel binaların cephe kaplamalarından farklı şekilde ele alınmış. Açıklıklara uygulanan camların renkleri açısından farklılık barındırıyor. (P.A 8) - Yapıya daha modern bir görünüş kazandırarak, yapının estetiksel değerini arttırmaktadır. Uygulanan bazı BIPV sistemli binalarda, yapının hem gündüz, hem de gece cephe görünümünü korumaktadır. Örneklerde rastladığımız digital	- Daha modern, daha prizmatikler. (P.E 11) - Görünüş olarak daha çok yapısal/estetiksel opsiyonlara sahipler, işlevsel olarak da enerji verimliliği sağlıyorlar. (P.E 12) - Sahip oldukları cam/geçirgen yüzey oranları geleneksel binalardan daha fazla. Bu sayede iç mekanda daha kaliteli aydınlatma sağlarken, bir yandan da enerji üretimi sağlıyor. (P.E 13) - Geleneksel binalara göre daha estetik duruyorlar. (P.E 14) - Geleneksel binalardan pek farkları yok. (P.E 15) - Yarı geçirgen malzeme kullanım yoğunluğunun fazla olmasıyla geleneksel yapılardan ayrılıyorlar. (P.E 16) - Daha teknolojik görünüyorlar. (P.E 18) - Geleneksel yapılara göre daha farklı tarz cepheleri var. Malzemenin renk, doku, boyut ve şeffaflıkları daha fazla çeşitliliğe sahip. (P.E 19)
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cepheler, gündüz enerjiyi cephede toplayarak, akşam cephede ışıklandırma sağlamaktadır. (P.A 9) - Bu binaların görsel olarak diğer geleneksel binalardan farkı yok. Yani, bu fark tamamen binayı tasarlayan mimarın işlevsel ve estetik yeteneğine bağlı. Onun dışında, BIPV sistemler ve diğer geleneksel binalar dış görünüş olarak farklı değiller ve dışarıdan ayırt edilmeleri pek mümkün değil. (P.A 11) - BIPV sistemlere sahip cephelerde eğrisel bir tasarım yapılabilir mi bilmiyorum fakat geleneksel binalara göre daha köşeli ve malzeme olarak parlak ve pürüzsüz yüzeylere sahip. (P.A 12) - Çok farklı görünmüyorlar. (P.A 13) - Modern ve ilerici görünüyor. (P.A 14) - Sadece malzeme farklılıkları var. (P.A 15) - Daha modern ve akıllı sistem görünüyor. (P.A 16) - Anket içerisinde de yer alan bilgiyi takiben, estetiksel olarak mimari	- Görünüş olarak geleneksel cephelerden pek farklı değil, ama işlevsel olarak daha faydalılar. (P.E 24) - Daha modern ve teknolojikler. (P.E 25)
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tasarım ile uyum, mimariye artı değer katma, yenilikçi tasarıma olanak sağlama ve tasarım seçeneklerini arttırması özelliklerine sahiptir. Ve sahip olduğu bu özelliklerle geleneksel binalardan farklılaşırlar. (P.A 17) - Daha yenilikçi bir dille yorumlanmış gözüküyorlar. (P.A 18) - Geleneksel binalardan farklı görünmüyor. (P.A 19) - Cephelerinde şeffaf kısımlarının fazlalığı ile geleneksel yapılardan farklılaşıyorlar. (P.A 20) - Geleneksel binalardan görünüş olarak bir farkı yoktur. BIPV cepheler, cam, doğal taş, seramik gibi cephe kaplama malzemeler yerine kullanılabilir. Ve tıpkı geleneksel cepheler gibi saydam ve/veya saydam olmayan bölümlerden oluşur. (P.A 21) - Geleneksel binalara göre yapay görünümlüler, doğallık yok. (P.A 23) - Bu görsel farklılık tamamen mimarın tasarımına ve binanın coğrafi konumu, bina formu, binanın güneşe göre yönelimi, PV'lerin bina kabuğundaki yönü, eğimi (güneş ışını ile yaptığı açı), sisteme gölge	
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atabilecek doğal ve/veya yapay engellerin varlığı gibi etkenlere bağlı olarak değişir. (P.A 24) • Binaya bütünleşik uygulamaları ile cam, geleneksel işlevinin çok ötesine geçerek, çağdaş uygulamalar için imkan yaratmaktadır. (P.A 25)	
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Table 4.5. Comparative responses of participants for Question 27 c.

27.c. Bu binaların cepheleri hakkında ne düşünüyorsunuz?	
MİMARLAR	MÜHENDİSLER
- Cepheleri tamamen panellerle kaplanan binaların, kaplama malzemesinin doğası gereği çok çeşitli renk ve dokular sunmadığını düşünüyorum. (P.A 1) (Bkz 45.-46.) A örneğini geleneksel binalardan ayıracak herhangi bir tektonik tutum göremiyorum. B örneğinde artistik ekspresyonun teknolojik bir rasyonellik ve yalınlıktan kaynaklandığı ve herhangi bir görsel stilizasyon kaygısından kaynaklanmadığı anlaşıyor. (P.A 2) - Her iki yapı da bütünleşik yapısıyla başarılılar. (P.A 3) - A binası basit, B binası şık bir tasarım. (P.A 4) - BIPV sistemlerde fotovoltaik hücrelerin estetik şekilleri, camların ve profillerin çeşitliliği, renk alternatifi ve optik özellikleriyle yapılara hem modern hem de yaratıcı özellikler kazandırmaktadır. (P.A 5) (Bkz. 46) A geleneksel görünüyor, B de teknolojik bir vurgu / arayış var	- İkisinin tasarımı da güzel. (P.E 3) - Estetikselsel ve maliyetsel olarak birbirlerinden çok farklılar. (P.E 5) - A binası standart bir cephe gibi gözüküyor, fakat B binası ise daha modern bir görünüme sahip. (P.E 6) - İki yapı da estetik ve modern gözüküyor. (P.E 7) - Gayet pratik ve estetikler. (P.E 8) - Kullanım amaçlarını bilmiyorum. Fakat A binası ofis/işyerleri olarak, B binası ise yaşama ortamları için güzel tasarımlara sahip. (P.E 9) - A yapısı soğuk, B yapısı ise sıcak/samimi bir görünüme sahip. (P.E 11) - A yapısı, klasik/ basmakalıp binalar, Türkiye'deki devlet daireleri gibi gözüküyor ve daha ucuz malzeme kullanılmış gibi. Fakat, B binası ise daha modern gözüküyor. (P.E 12) - Şık (P.E 13) - Güzel (P.E 14)

gibi. B binasını, A binasından daha fazla beğendim. (P.A 6) - İkisi de güzel. (P.A 7) - Özellikle B yapısındaki panellerin cephe tasarımıyla önemli ölçüde entegre olduğunu düşünüyorum. (P.A 8) - A yapısının giydirme cephe renk ve malzeme seçimini beğenmedim. Bkz. 45. Bütüncül uygulama sebebiyle ve opaklık / geçirgenlik dengesi açısından B binasını daha çok beğendim. (P.A 9) - A binasının cephesini çok beğenmedim, ahşap ve cam birleşmesi oran olarak ve renk uyumu olarak iyi değil ve yapı çok kurumsal kimlikte duruyor. B binası ise cephede kullanılan soğuk renklerin yoğunluğuna rağmen daha daha samimi ve zevkli geliyor. (P.A 11) - A yapısının kurumsal ve B yapısının modern bir görünümü var. (P.A 12) - İyi görünüyorlar. (P.A 13) - B yapısının cephesi, A yapısının cephesinden daha iyi tasarlanmış. (P.A 14)	- B binası, A binasına göre daha hoş görünüyor. (P.E 15) - BIPV sistemlerinde fotovoltaik hücrelerin estetik şekilleri, cam ve profil çeşitliliği, renk alternatifleri ve optik özellikleri binalara modern ve yaratıcı özellikler katmaktadır. (P.E 16) - İkisinin de cephe tasarımı güzel. (P.E 21) - İki yapı da estetik görünüyor. (P.E 24)
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• A yapısı standart, B yapısı zorlayıcı gözüküyor. (P.A 15) • Tasarım anlayışım ile örtüşmüyorlar. (P.A 16) • B binasının cephesi, A binasının cephesinden daha yalın ve modern görünüyor. (P.A 17) • Enerji panelleri kullanılmak istendiği için onların kullanım mantıklarına göre tasarlanmış. (P.A 18) • A seçeneğindeki bina her zaman görebileceğimiz herhangi bir işyeri cephesi. B seçeneğindeki bina daha iyi tasarlanmış. (P.A 19) • Alışık olduğumuz cam cepheli binalara benziyorlar. (P.A 20) • Biraz daha soğuk ve yabancılar. Yüzlerinde maske var gibi. Fakat bunun bir sorun olduğunu düşünmüyorum. (P.A 21) • Güzel cepheler, fakat temizlenme sıkıntıları olabilir. . (P.A 23) • Çok güzel cepheler. (P.A 24) • B binasının cephesindeki amaç, sistem verimliliğinden daha çok iyi tasarım kaygısı içeriyor. Bina cephesi	
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ile PV rengi arasında kontrast oluşturularak PV ön plana çıkarılmış. A binası, PV kullanımıyla doğrama ihtiyacını entegre ederek tasarlanmıştır. (P.A 25)	
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Table 4.6. Comparative responses of participants for Question 28 a.

28. Hangi cepheyi inşa etmeyi / tasarlamayı tercih edersiniz?	
28.a. Elektrik üretimi açısından tercihinizin nedenlerini açıklar mısınız? / görsel veya estetik sorunlar? / veya fiziksel uygulama tekniği?	
MİMARLAR	MÜHENDİSLER
- Yapılacak uygulamanın görsel ve estetik açıdan monoton ve sıkıcı bir etki yaratacağını düşünüyorum. (P.A 1) - Her teknolojik ve rasyonel gereklilik kendi estetiğini yaratır. Dolayısıyla fiziksel uygulamaya dönük nedenler önceliklidir. BIPV sistemlerin uygulaması pratik olduğu olması tercih sebeplerimin arasında yer almaktadır. (P.A 2) - B binası dolu/ boş ilişkisi açısından cephe anlamında daha iyi duruyor. Fakat elektrik üretimi ve uygulama pratiği açısından herhangi bir fikrim yok, bunun için hesap gerekiyor. (P.A 4) - A binasının cephe alanı daha fazla. Bir sanayi yapısı gibi görünüyor, enerji ihtiyacı daha fazla olabilir. A binasında farklı malzemeler, cephede aynı hizada bitiyor, uygulama daha zor olabilir. B binası nispeten daha küçük ölçekli, konut yapısı gibi görünüyor. Enerji ihtiyacı daha az	- Estetiksel konular değişkenlik gösterebilir. Çünkü, modül ebatları, formları ve renkleri, tasarımı etkileyen özelliklerdir. Elektrik üretimi açısından, bu sistemler sadece elektrik üretmekle kalmaz, binanın termal ve akustik izolasyonunun iyileşmesine de olanak sağlar. Verilen iki örnekten görsel/estetik olarak B binasını tercih ederim. (P.E 1) - Daha önce de bahsettiğim gibi müşterinin istekleri, proje gereklilikleri veyahut fonksiyonellik gibi konular enerji tasarrufu veya estetik ile ilgili öncelikleri etkileyecektir. (P.E 2) - Bu iki yapının sahip olduğu görsel fark, binaya entegre fotovoltaik modüllerin oluşturduğu hücrelerin ışık geçirgenliğinin (opasitenin) farklı olmasıdır. A binasında, saydam ve opak paneller aynı cephede kullanılabildiği için binada istenilen etki rahatlıkla sağlanmış. Verim açısından A binasının daha iyi

olabilir. B binasında daha az sayıda farklı cephe malzemesi var, bu yüzden uygulama daha kolay olabilir. (P.A 6) - Bina B daha zarif, ancak A binası daha fazla cam yüzeye sahip olduğu için daha fazla elektrik üretebiliyor gibi görünüyor. (P.A 7) - B binasında, kaplama sistemin daha fazla yer kapladığını ve buna bağlı olarak daha fazla elektrik üretebileceğini düşünüyorum. Ayrıca cephe tasarımı binanın formu ile bir bütünlük içinde. A binasında, bu bütünlükten ziyade cephe kaplamaları ve paneller arasında bir ayrılmış olma hali söz konusudur. (P.A 8) - Elektrik üretimi bakımından verimlilik sağladığı için, görsel/estetik konular bakımından geleneksel yapılarla aynı özelliklere sahip olduğu için ve uygulama tekniği bakımından da kolay uygulanabildiğini için bu sistemleri tercih etmek çok mantıklı. (P.A 11) - Binanın fonksiyonuna göre ihtiyacı belirlenerek, minimum ihtiyacı karşılayabilecek kadar yüzey	olduğunu düşünüyorum. Fakat, görsel/estetiksel açıdan B binasını daha çok beğendim. (P.E 3) - B binası, estetiksel ve uygulama maliyeti açısından daha iyidir. Uygulama tekniği olarak da B binası, kaplama sistemi olduğu için uygulaması, giydirme cephe olan A binasına göre daha kolaydır. (P.E 5) - Görsel veya estetiksel konular işverenin zevkine ve mimarın tasarım anlayışına göre değişir. Fotovoltaik hücrelerin estetik şekilleri, camların ve profillerin çeşitliliği, renk alternatifi ve optik özellikleriyle yapılara hem modern hem de yaratıcı özellikler kazandırmaktadır. Bu sayede binalar hem modern bir görünüme kavuşmakta hem de temiz enerji üreterek çevreye ekolojik katkı sağlamaktadır. Benim tercihim görsel/estetiksel açıdan B binasıdır. (P.E 6) - Elektrik üretimi açısından BIPV sistemleri tercih etmemin sebebi, kendi elektriğimizi üretmemiz daima kazançlıdır. Çünkü, elektrik fiyatlarındaki tarife değişimlerinden etkilenmeyiz. Bu sistemle elde edilen elektrik, üretildiği yerde tüketildiği
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üzerinde paneller kullanılarak, maliyet ve görselliğin doğru ilişkilendirilerek yapılması gereklidir. (P.A 12) • Daha estetik ve daha verimli gibi gözüktüğü için B binasını tercih ederim. (P.A 13) • Yenilikçi olduğu ve yeni malzemeye uygun bir estetik anlayış arayışı içinde olduğu için Bina B'yi tercih ediyorum. (P.A 14) • Parçalı sistemi, akıllıca kurgulayarak ileri vadede daha verimli bir sistem sağlanabilir. (P.A 16) • Hangi binanın daha fazla elektrik ürettiğini bilmek için, pil adetleri, AD/DC çevrimiçi adeti ve depolama alanının bilinmesi gerekir. (P.A 17) • Tamamıyla dünyanın bu enerji sistemine dönmesi gerektiğini düşünüyorum, bu sebeple herhangi bir görsel veya estetik öncelik olamaz, enerji tasarrufu sağlamak önceliktir. (P.A 18) • Bina estetik ve verimli olması benim tasarım önceliğim. Estetik olarak B yapısını tercih ederim, fakat	zaman, uzun mesafeden kaynaklanan iletim kayıpları oluşmaz. Işınım yeterli olduğu sürece, her hava koşulunda (yağmur, kar, bulutlu hava) elektrik üretebilir. Gereken enerji her yerde, her bölgede ve her mevsimde bulunabilir. B binası daha estetik ve güneş enerjisi üretimi daha fazla olduğundan tercihim olur. (P.E 7) • Bence mimarlar tarafından tasarlanan binalar, mutlaka fonksiyonel ve ekonomik olmalıdır. Benim için estetiksel kaygılar ikinci plandadır. BIPV sistemler, normal yapı malzemeleri yerine monte edilebilir, böylece inşaatla tasarruf sağlanır. Bu sebeple BIPV sistemleri tercih ederim. (P.E 8) • A binasının, güneş alma kapasitesi olarak daha saydam olduğu için, daha fazla ışık alabileceğini ve böylece daha fazla enerji üretebileceğini düşünüyorum. (P.E 9) • Bence estetik önemli bir konu. Elektrik üretmek için düz alanlara ihtiyaç var ama estetik unsurlar için de özellikle dış cephenin tasarımı önemli. B binası daha estetik gözüküyor ve B binasında,
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elektrik üretimi ve verimlilik açısından hangi binanın daha iyi olduğu hakkında bir bilgim yok. (P.A 20) • Her mimari yapının farklı bir görünümü ve estetik yapısı vardır ve elektrik altyapı tasarımlarının da bu estetiği bozmaması gerekir. Bu etmenler, proje tasarımlarını zorlaştıran ve maliyeti arttıran unsurlardır. Bu sebeple, her BIPV sistem uygulanmış yapı farklı görsel/estetiksel, uygulama tekniği ve elektrik üretimi/ enerji verimine sahiptir. (P.A 21) • BIPV sistemler, ekonomik ve teknolojik yeterlilik, yapı özellikleri, kullanıcı ve uygulayıcının bilinç ve bilgi düzeyi doğrultusunda yapılarda farkı şekillerde değerlendirilebilir. (P.A 23) • Çatıda uygulanması elektrik üretimi için daha uygun olabilir. Ama estetik açıdan cephede uygulanması daha iyi. (P.A 24) • A cephesinde verimin daha fazla olacağını düşünüyorum. Fakat uygulama aşamasında daha fazla hassasiyet gerektirmektedir. B	fotovoltaik modüller daha fazla kullanılmış gibi, o nedenle ısı geçirgenlik oranı farklı olabilir (ısı kayıpları vb.) ve daha fazla elektrik ürettiyor olabilir. (P.E 11) • Mühendis olarak B binası daha farklı bir mimariye sahip olduğu için onda çalışmak/yaşamak isterim. Ama işveren olarak A binasını tercih ederim. Çünkü daha çok enerji verimliliği sağlıyor olabilir. (P.E 12) • BIPV kullanmak, bir yapı oluşturmaktan ve daha sonra fotovoltaik diziler eklemekten çok daha uygun maliyetlidir. Çünkü BIPV başlangıçtaki inşaat harcamalarının bir parçasıdır ve pahalı yapı malzemeleri üzerine kurulmak yerine geleneksel malzemeleri değiştirirler. Bina içine entegre edilen sistemlerin kullanılması estetik açıdan daha cazip hale gelebilir, çünkü sistemler binaya uyum sağlayacak şekilde tasarlanabilir ve ağırlı bir başparmak gibi dışarıda durmak yerine mimari olarak eklenebilir. Doğası gereği çevre dostu ve uygun maliyetli olmanın yanı sıra, binaya entegre fotovoltaikler de çift amaçlı olarak kullanılabilir. Örneğin, güneş
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cephesi görsel açıdan daha estetikdir ve uygulanması daha kolaydır. (P.A 25)	pili olan camlar güneş enerjisini toplar ve dönüştürür, ancak aynı zamanda odaları serinletir ve özel bir soğutma sistemini kullanma ihtiyacını azaltır. (P.E 13) • En azından asgari seviyede elektrik üretsın yeter. Çünkü geleneksel binaların hiçbirı kendi elektriğini kendisi üretecek sisteme sahip değiller. (P.E 14) • Daha ekonomik olanı tercih ederim. (P.E 15) • Estetiksel olarak, boyut ve biçiminin yapının genel bütünlüğü ile uyumunun sağlanması, renksel ve dokusal özelliklerinin yapının diğer öğeleri ile uyumu sebebiyle B yapısını tercih ederim. Elektrik üretimi ve uygulama tekniğı hakkında bir bilgim yok. (P.E 16) • BIPV sistemlerin ne kadar verim sağladığını bilmek için, coğrafi etkenler, geometrik özellikler (yön, eğim) , gölgeleme etkenleri (yapı yoğunluğu, topografya), bitki örtüsü gibi güneş ışıınıını niceliğini ve rüzgar yükü , yağış oranı / kar yükü, dış hava sıcaklığı gibi iklimsel özellikleri bilmemiz gerekiyor. (P.E 18)
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	• Elektrik üretimi, görsel veya estetik konular, fiziksel olarak uygulama tekniğı, yatırımcıya ve konsepte bağlı olarak değişiklik gösterir. (P.E 19) • Fotovoltaik sistemler, tüm enerji kaynakları içerisinde ulaşılması en kolay, en bol ve en temiz olan güneşten elektrik ürettiğı için tercih ederim. (P.E 23) • Elektrik üretimi ve uygulama tekniğı açısından bilgim yok. Ama estetiksel olarak B binasını tercih ederim. (P.E 24) • Enerji üretimi olarak, daha verimli, daha güvenilir, daha sürekli, daha yeterli olan binayı tercih ederim. (P.E 25)
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Table 4.7. Comparative responses of participants for Question 28 b.

28.b. Enerji verimliliği verimliliklerinin çatı üstü fotovoltaik uygulamalardan daha iyi veya daha kötü olduğunu düşünüyor musunuz? Nedenini açıklayabilir misin?	
MİMARLAR	MÜHENDİSLER
- Çatıların enerji erişimlerinin cephelere oranla daha fazla olduğunu düşünüyorum. Bu yüzden cephe fotovoltaiklerinin özellikle sıkışık kent dokusu içinde yeterli enerji üretim verimliliği sağlayacağını düşünmüyorum. (P.A 1) - Kullanım, bakım, güneşlenme, yüzey alanı gibi sebeplerden ötürü duruma göre değişebileceğini düşünüyorum. (P.A 2) - Yüzey alanı daha fazla olduğundan, bina konumu da uygun ise cepheler daha verimli olabilir. (P.A 4) - Çatılardaki uygulamanın daha kötü olduğunu tahmin ediyorum, çünkü cephedekiler gibi en verimli açıda duramıyorlar. (P.A 5) - Bu soruya daha sağlıklı bir cevap verebilmek için, binanın güneşe göre yönelmesini, yapının bulunduğu koordinatları ve yapının etrafındaki diğer yapıları bilmemiz gerekir. Çatıdaki panellerin sabit ya da hareketli olmasına göre de değişir.	- Verimlilik, güneş alma zamanına göre farklılık gösterecektir. Çatı panelleri tüm gün boyunca güneş alabilir. Cephe panelleri bina yönüne bağlı olarak tüm gün güneş alamayabilir. (P.E 1) - Cepheler daha iyidir. (P.E 2) - Çatılar daha iyidir. Daha fazla güneş alması nedeniyle elektrik üretimi daha iyi olacaktır. (P.E 5) - Çatılar daha iyidir. Daha fazla güneş alması nedeniyle elektrik üretimi daha iyi olacaktır. (P.E 7) - Çatılarda uygulaması, güneş açısından dolayı daha iyidir. (P.E 8) - Cephede uygulaması daha iyidir. Çünkü cepheler şeffaf (cam) olduğu için güneşi alma kapasitesi olarak daha yüksektir. (P.E 9) - Bu açı ile ilgili bir durumdur. Binanın coğrafi konumu ve güneş alma açısı ile ilgilidir. Genel olarak, çatı uygulamalarında daha esnek

Bunu binanın bulunduğu yerde en fazla verim cepheden mi alınabilir yoksa çatıdan mı alınabilir hesaplamak gerekiyor. Eğer aynı verim alınacaksa, o zaman daha fazla m2 ye sahip olanı tercih ederim ki daha fazla enerji üretme kapasitem olsun. (P.A 6) - Çatılarda daha kötüdür, çünkü çatıya güneş daha dik gelir. (P.A 7) - Güneşi aldığı açığa ve güneş alma miktarına göre değişebileceğini düşünüyorum. Bu yüzden net bir biçimde yanıt veremem. (P.A 8) - Verimlilik yüzey alanı, güneş alma açısı, gölgelenme süresine göre değişiklik gösterir. (P.A 9) - Çatıdaki fotovoltaik uygulamalar cephelerdeki uygulamalara göre daha fazla kullanılıyor. Bu henüz BIPV cephe sistemlerinin Türkiye'de bilinmemesinden kaynaklanıyor olabilir. Enerji üretim verimliliği bakımından buna yorum yapmam doğru olmaz. Çünkü bu binanın büyüklüğü ve yüksekliğine göre değişir. Eğer cephe yüzeyi çatı yüzeyinden fazla ise elbette ki enerji üretimi ve verimi daha fazla olur. (P.A 11)	davranılabildiği için çatı verimliliği daha iyi olabilir. (P.E 10) - Çatılar her zaman daha iyidir. (P.E 11) - Güneş ışığını alma ile alakalı olduğu için görselsiz yorum yapamam. (P.E 12) - Çatılar daha iyidir. (P.E 14) - Çatıdaki kadar olmasa da cephelerde de uygulamak verim ve estetik açıdan iyidir. (P.E 15) - Çatılarda daha iyidir, çünkü güneş ışınlarını daha dik alma potansiyeli daha fazladır. (P.E 16) - Çatı panellerinin güneş ışığı alışı açıları ve süreleri daha fazla olduğu için daha verimli uygulamalardır. (P.E 17) - Gölge olmadıkça çatı daha iyidir. (P.E 18) - Çatılardaki daha iyidir. Çünkü gölgelemeye maruz kalmaz. (P.E 19) - Güneş ışınları çatılardaki uygulamalardaki gibi sürekli
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• Çatılar, gün ışığını cephelere göre daha uzun süre almaktadır, bu yüzden daha verimlidir. (P.A 12) • Güneş alma açısı sebebi ile çatılardaki uygulama daha kötü olabilir. (P.A 13) • Çatılarda uygulanması daha kötüdür. (P.A 15) • Çatı daha uzun süre güneş alabildiği için daha kötü olabilir. (P.A 16) • Çatılar daha iyi, çünkü yenilenebilir bir kaynaktan enerji üretmiş sağlıyor. (P.A 17) • Bence çatılar daha iyi. Çatıda kullanıldığına kesintisiz olarak kullanılabilir ve daha geniş yüzeylerde kullanılabilir. (P.A 18) • Çatılardaki uygulaması daha iyi olabilir. Çünkü uygulama alanı daha fazla. (P.A 20) • Yine lokasyonlarını bilmekte fayda var. Bilmiyorum. (P.A 21) • Bence çatılarda daha iyidir. (P.A 23) • Bence çatılarda daha kötüdür. Çünkü çatılarda güneşin geliş açısına göre	gelmeyeceği için cephelerdeki verim daha düşüktür. (P.E 25)
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doğru açıyı verip verimi yükseltebiliyoruz, ancak bu sistemlerde açı 90 derece oluyor genelde. Binanın mimarisi yüksek üretim verimine göre tasarlanabilir, ancak estetik olmayabilir. (P.A 24) • Cepheye PV entegre etmek güneşin geliş açısı düşünüldüğünde, kışın iyi verimlilik gösterse de, yazın azalacaktır. Bu sebeple çatıya monte edilen uygulamalara göre verimi daha düşük olacaktır. (P.A 25)	
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Table 4.8. Comparative responses of participants for Question 28 c.

28.c. Maliyet etkinliği hakkında ne düşünüyorsunuz?	
MİMARLAR	MÜHENDİSLER
• Hangi yöntem kullanılırsa kullanılsın, maliyeti ülkemizde yüksek olduğu için uygulanabilirliğini düşük görüyorum. (P.A 1) • Look 50. (I think it may change depending on the situation due to reasons such as usage, maintenance, sunbathing, surface area.) (P.A 2) • Maliyeti yüksektir. (P.A 4) • Şu an için bence çok maliyetli. (P.A 5) • Piyasada çok pahalı cephe malzemeleri olduğundan, bu özellikteki malzemeler normalden daha pahalıya mal olmayabilir. (P.A 6) • Yapının sahip olduğu özelliklere göre değişir. Örneğin, verilen iki görselde B'deki yapının birleşme detaylarının daha incelikli olduğunu tahmin ediyorum. Dolayısıyla, bu malzemelerin imalatı sanırım daha pahalı olacaktır. (P.E 8)	• Cephelerde ya da çatılarda, uygulama aşamasındaki ve uygulamadan sonraki, malzeme, doğrama detayları, kullanım, güneşlenme-gölgelenme, bakım/temizleme vb. özelliklere bakmak gerekir. Bu özelliklere sahip BIPV sistemler ile geleneksel sistemler karşılaştırılarak, hangi sistemin daha maliyetli olabileceği belirlenebilir. (P.E 1) • Zamana yönelik maliyet hakkında bir fizibilite çalışması yapılmalıdır. (P.E 2) • Uygulama açısından maliyetleri yüksek olsa da kısa sürede kendini amorti edebilir. (P.E 5) • İlk yatırım maliyetlerinin yüksek olabileceğini, ancak yapı kullanımı sırasında elektrik enerjisi maliyetlerinin düşük olabileceğini düşünüyorum. (P.E 6) • Aylık enerji tüketimi düşünülürse, yapım aşamasında biraz daha maliyetli olsa da zamanla maliyetinin uygun olacağını düşünüyorum. (P.E 7)

• Geleneksel yapılardan daha maliyetli olacağını düşünüyorum. (P.A 9) • Binanın ihtiyacına göre yapılarak maliyeti minimumda tutmak mümkün. Teknoloji her geçen gün ilerlemesiyle maliyetler de azalmakta. Ama uzun vade de düşünülmesi gereken bir konu ve uzun vadede zaten verimli bir uygulama. (P.A 12) • Uzun vadedeki verime göre değişir. (P.A 12) • Bence, uygulanabilir sistemler. (P.A 15) • Yapıda kullanılan teknolojiye göre değişir. Örneğin, A yapısındaki parça sistemini daha uygulanabilir buluyorum. (P.A 16) • Üretim aşamasında maliyet fazla olabilir. Fakat sonrasında sağlayacağı enerji tasarrufları ile uzun vadede üretim maliyetini karşılayabilir. (P.A 17) • Geri dönüşüm hızlandıkça insanlar kullanmak isteyecektir. (P.A 18) • Pahalı sistemlerdir. (P.A 23)	• İleriye dönük getireceği kar payını incelemek lazım. (P.E 8) • Çatı daha az detayla çözülebileceği için, daha az maliyetli olabilir. (P.E 10) • Binayı inşa eden kişinin bütçesine göre değişir. (P.E 11) • Çatıdaki güneş panellerinin montajı ve bakımı maliyeti daha uygun olacağı için, çatının uygulama alanı daha sık olur. (P.E 12) • Uygulanabilir. (P.E 13) • Zamanla kendini kara geçirir. (P.E 14) • 5-7 yıl gibi yatırım geri dönüş süresi vardır. (P.E 16) • Çatıların cephelere göre daha kısa amorti olur diye düşünüyorum. (P.E 18) • Pahalı sistemler. (P.E 19) • Maliyet açısından uygulanabilirlikleri zor. (P.E 25)
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• Her türlü bir tasarruf sağlayacağı için maliyeti önemsemiyorum. (P.A 24) • Yapının detaylarına göre farklılık gösterir. Özellikle A cephesinde PV, doğramanın yerini aldığı için Yapı + PV maliyetine göre daha ekonomik de olabilir. (P.A 25)	
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Table 4.9. Comparative responses of participants for Question 28 d.

28.d. Hangisi bize daha fazla fayda sağlıyor? Neden?	
MİMARLAR	MÜHENDİSLER
- Fotovoltaiklerde, en fazla güneş erişimine ulaşmak en yüksek verimlilik demektir. Bu nedenle çatılarda çok daha kesintisiz ve yüksek verimlilikle enerji üretimi söz konusu olabilir. Ancak yüzey bakımından ele alındığında, cephe yüzeylerinin çatıya göre daha fazla olduğu durumlarda cephe kaplamaları daha verimli olabilir. (P.A 1) (Bkz 50.) Kullanım, bakım, güneşlenme, yüzey alanı gibi sebeplerden ötürü duruma göre değişebileceğini düşünüyorum. (P.A 2) - B yapısı, çünkü PV'ye sahip daha büyük bir yüzey alanı var gibi. (P.A 4) - Çatıdaki uygulamalar, çünkü daha çok elektrik ürettiğini düşünüyorum ve cephede panellerin yarattığı görsel etkiden hoşlanmıyorum. (P.A 5) - B binasındaki fotovoltaik panellerin daha fazla yer kapladığından ötürü daha çok enerji üretebileceğini düşünüyorum. Tasarım kurgusu ve enerji etkinliği açısından daha fazla fayda sağlayacaktır. (P.A 8)	- Ekonomik olarak daha çok verimliliğe sahip olan bina, bize daha fazla fayda sağlar. (P.E 1) - Fizibilite sonuçları yapılarak değerlendirilmelidir. (P.E 2) - B binası bize daha fazla yarar sağlıyor. Çünkü tasarımda maliyet çok önemlidir. (Bkz. 49.) B binası, estetiksel ve uygulama maliyeti açısından daha iyidir. Uygulama tekniği olarak da B binası, kaplama sistemi olduğu için uygulaması, giydirme cephe olan A binasına göre daha kolaydır. (P.E 5) - İkisi de elektrik üretebilen sistemler olarak fayda sağlamaktadır. (P.E 6) - B binası daha fazla güneş pilleri içerdiği için, daha çok fayda sağlıyor olabilir. (P.E 7) - B binası içerdiği modül sayılarına göre daha çok elektrik üretiyor olabilir. (P.E 11)

- Kullanılan BIPV sistemde enerji üretiminden sağlanan verim hangi binada daha fazla ise, bu bina bize daha çok fayda sağlar. (P.A 11) - Hangi bina daha sürdürülebilir bir tasarım ise, o bina daha çok fayda sağlar. (P.A 12) - İkisi de faydalıdır. (P.A 13) - B, daha etkin bir enerji üretimi sağlıyor. (P.A 17) - Tasarım öncesi ve sonrası maliyet açısından daha ekonomik olan bina, bize daha fazla yarar sağlar. (P.A 18) - B binası, doğal yollardan enerji sağlanmış oluyoruz. (P.A 23) - Her iki bina da kullanım amacına göre daha fazla fayda sağlayabilir. (P.A 24) - B binası, tasarım kaygısından ödün vermeden PV sistemi kullanmayı amaçladığından daha fazla fayda sağlıyor. (P.A 25)	- Yine güneş ışığını alma ve yüzey alanı ile alakalı olduğu için yorum yapamam. (P.E 12) - İkisi de. (P.E 13) - İkisi de elektrik ürettiği için bize fayda sağlar. (P.E 14) - Daha ekonomik olan bina bize fayda sağlarlar. Bir yapıda en önemli faktörlerden biri maliyettir. (P.E 15) - Çatı uygulaması. (P.E 16) - Çatı uygulamaları, daha fazla elektrik üretimi sağlar. (P.E 18) - İnşaat maliyeti düşük olan ve verimi yüksek olan bina bize fayda sağlar. (P.E 25)
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Table 4.10. Comparative responses of participants for Question 28 d.

28. e. Hangi binada yaşamak / çalışmak istersiniz?	
MİMARLAR	MÜHENDİSLER
- Her iki binada da yaşamayı tercih etmem. Fakat B binasını çalışmak için tercih ederim, ofis ortamı için huzurlu gözüküyor. (P.A 1) - B yapısı. Bkz 45. (B örneğinde artistik ekspresyonun teknolojik bir rasyonellik ve yalınlıktan kaynaklandığı ve herhangi bir görsel stilizasyon kaygısından kaynaklanmadığı anlaşılıyor.) (P.A 2) - B binası (P.A 3) - İkisinde de istemem. (P.A 4) - A binasına göre daha modern görüldüğü için B binasını tercih ederim. (P.A 5) - B’de yaşamak isterdim, A ise çalışılacak bir bina gibi görünüyor. Ama A’nın görünüşünde çekici bir çalışma binası olduğuna dair ipucu yok. (P.A 6) - Sanırım A binasında çatıya çıkılabilir. O yüzden onu tercih ederim. (P.A 7) - B binasını tercih ederim. Çünkü (Bkz. 52). B binasındaki fotovoltaik	- Çalışmak için A binasını, yaşamak için B binasını tercih ederdim. (P.E 1) - Binaların iç mimarisini, lokasyonunu ve ofis yerleşim planlarını görmeden bu soruyu yanıtlamanın benim için doğru olmayacağını kanısladım. (P.E 2) - İç mekan aydınlatma kalitesinin daha iyi olmasından ötürü, A binasını tercih ederdim. (P.E 3) - Estetiksel ve uygulama maliyeti açısından daha iyi olduğu için, B binasını tercih ederdim. (P.E 5) - B yapısında. Modüler tasarımı hoş gözüküyor. (P.E 6) - B binasından yaşamak/çalışmak isterim. Alt kat doğal aydınlatma olarak çalışma alanı, üst kat ise renkli fotovoltaik cam tasarımı ile gölgeleme sağlayarak dinlenme/uyuma alanı için uygundur. (P.E 7) - Verim ve estetik yönünden B binasını tercih ederim. (P.E 8)

panellerin daha fazla yer kapladığından ötürü daha çok enerji üretebileceğini düşünüyorum. Tasarım kurgusu ve enerji etkinliği açısından daha fazla fayda sağlayacaktır. (P.A 8) - Bkz. 45. Bütüncül uygulama sebebiyle ve opaklık / geçirgenlik dengesi açısından B binasını daha çok beğendim. (P.A 9) - B binasında. Çünkü daha önce de açıkladığım gibi B binası cephede kullanılan soğuk renklerin yoğunluğuna rağmen daha daha samimi, sıcak ve zevkli geliyor. (P.A 11) - B yapısı daha modern ve teknolojik gözüküyor. (P.A 12) - İkisi de. (P.A 13) - B binası bina, çünkü daha modern ve anlamlı görünüyor. (P.A 14) - B binası, çünkü geleneksel binalardan farklı duruyor. (P.A 15) - Hiçbiri. Yaşamak ya da çalışmak isteyeceğim tarzda binalar değil. (P.A 16)	- Güneşi alma kapasitesinin ve saydam yapılarının fazla olması nedeni ile A binasında yaşamak ya da çalışmak isterdim. (P.E 9) - İki binada da yaşamak ya da çalışmak isterdim. A binası çalışmak için, B binası yaşamak için uygun. (P.E 10) - B binasını tercih ederim. Çünkü (Bkz. 47) A yapısı soğuk, B yapısı ise sıcak/samimi bir görünüme sahip. (P.E 11) - B binasında yaşamak ya da çalışmak isterim. Çünkü (Bkz. 47) A yapısı, klasik/ basmakalıp binalar, Türkiye’deki devlet daireleri gibi gözüküyor ve daha ucuz malzeme kullanılmış gibi. Fakat, B binası ise daha modern gözüküyor. (P.E 12) - B yapısı, çünkü estetiksel olarak daha başarılı. (P.E 13) - İkisinde de. (P.E 14) - Daha modern ve teknolojik tasarıma sahip olduğu için, B binasını seçerim. (P.E 15) - Pasif enerji etkin çözümlerinin yapıldığı ve böylece binanın düşük enerji ihtiyacının da yenilenebilir
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• A binası çalışmak için, B binası yaşamak için uygun gözüküyor. (P.A 17) • Daha yenilikçi ve ilerici bir yapı oluşundan dolayı B yapısını seçerdim. (P.A 18) • Tasarımsal sebeplerden ötürü B yapısını tercih ederim. (P.A 19) • A yapısı, çünkü iç mekanları daha aydınlık olabilir. (P.A 20) • Hiçbir fikrim yok. İç mekanı görmeden söylemek zor. (P.A 21) • A yapısı çalışma ortamı için, B binası hem çalışma hem de yaşama ortamı için uygun. (P.A 22) • Hiçbirini tercih etmem. İkisi de benim tarzım yapılar değiller. (P.A 23) • B yapısının kübik tasarımı hoşuma gitti. (P.A 24) • B yapısı. Çünkü B yapısı hem çalışmak, hem de yaşamak için uygun. (P.A 25)	kaynaklardan sağlanabildiği yapıyı tercih ederdim. (P.E 16) • Başarılı mimari tasarımından ötürü, B binasını tercih ederim. (P.E 18) • Enerji etkinliği daha fazla olan binada çalışmak/yaşamak isterdim. (P.E 19) • Estetik açıdan daha iyi olduğu için, B binasını seçerim. (P.E 23) • Uzun vadede hangisi daha verimli ise onu tercih ederdim. (P.E 24) • B binası, çünkü daha modern gözüküyor. (P.E 25)
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Table 4.11. Comparative responses of participants for Question 30.

30. BIPV'nin bu binalardaki görsel entegrasyonunu nasıl buluyorsunuz?	
	
(A)	(B)
MİMARLAR	MÜHENDİSLER
- A binasında çatıdan gelen ışığın kontrol edilmesi ve mekana kontrollü verilmesi nedeniyle görsel entegrasyonu olumlu buluyorum. B binasında herhangi bir görsel entegrasyon algılamadım. (P.A 1) - Başarılı (P.A 2, P.A 14, P.A 15, P.A 18, P.A 25) - Uygundur (P.A 3) - İyi (P.A 4, (P.A 19, 20) - Fena değil. (P.A 5) - Göreceli bir kavram olsa da, bence iki bina da başarılı entegrasyonlar. (P.A 6) - A binasının görsel entegrasyonu daha başarılı görünüyor. (P.A 7)	- Her iki binada da BIPV modüller, geleneksel yapı elemanları olan cephe ve çatı yerine kullanılarak, yapı kabuğuna doğal bir şekilde entegre olmuşlar. (P.E 1) - Renk/ malzeme kombinasyonları ve BIPV modüllerinin ölçüleri/ cephe kombinasyonu ve uyumu gayet başarılıdır. (P.E 2) - Güzel (P.E 3, P.E 9, P.E 13) - A binası, B binasından daha başarılı bir biçimde entegre olmuş. (P.E 5) - B binasındaki görsel entegrasyon A binasına göre daha iyi. (P.E 6)

- A seçeneğindeki binanın görsel entegrasyonunu daha başarılı buluyorum, ışığı alma oranında çatıdaki yarı saydam modüller kontrolü sağlarken, cephede kullanıcının dışarı ile ilişkisini daha aydınlık bir ortam sunarak zenginleştiriyor. B’de ise, anladığım kadarıyla film kullanılmaktadır. Bu yüzden içerdeki ışığı ve kullanıcının dışarı ile ilişkisini olumsuz etkileyebilir diye düşünüyorum. (P.A 8) - Estetik ve fonksiyoneller. (P.A 9) - Işık alımı bakımından gayet başarılılar. Fakat B binası için yılın belli aylarına, ayın belli günlerine ve günün belli saatlerine göre bir gölgeleme sistemi gerekebilir. (P.A 11) - A binası görsel açıdan yarı saydam çatısı ile başarılı bir uygulama, B binası, ince filmler ile belli belirsiz bir uygulama olmuş. (P.A 12) - BIPV’nin görsel entegrasyonları binanın bütünü ile uyumlu görünüyorlar. (P.A 13) - PV yapı bileşenleri, binanın diğer bileşenleri ile uyum içerisindedir. (P.A 16)	- A yapısındaki malzeme bütünlüğü, B binasına göre daha estetik görünüyor. (P.E 7) - Her ikisi de başarılı. (P.E 8, P.E 15, P.E 18) - A binası, B binasına göre daha iyi görsel entegrasyona sahip. (P.E 11) - A binası, binanın geneli ile bütünleşmemiş. B binası ise binanın bir parçası haline gelmiş. (P.E 12) - İyi (P.E 14, P.E 19) - Binaların bulunduğu iklim bölgesi de göz önüne alınarak yorum yapılmalıdır. (P.E 16) - Konstrüksiyona ve işleve uyumlular. (P.E 25)
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• Çok başarılılar. Yapıya sonradan eklenmiş gibi durmuyorlar. (P.A 17) • Konum ve yön seçimi, iklim veri analizi, gölgelenme analizi gibi saha analizleri yapıldıktan sonra, uygulanan tasarımın görsel entegrasyonun başarısına yorum yapılmalıdır. (P.A 21) • Gayet güzel (P.A 24)	
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Table 4.12. Comparative responses of participants for Question 30.a.

30. a. Her iki yapıyı da aydınlatma kalitesi ve iç mekanın görsel konforu açısından değerlendirebilir misiniz?	
MİMARLAR	MÜHENDİSLER
- A binası çok daha doğal bir aydınlatma sahip. B binası ise daha az gün ışığına erişiyor gibi görünüyor. (P.A 1) - Bkz. 56. (Görsel iç mekan kalitesine etkisi bakımından B örneğinin daha başarılı olduğunu söyleyebilirim.) (P.A 2) - A binasında ışık miktarı oldukça sağlıklı duruyor. B binasındaki cam rengi nedeniyle iç mekan karartılmış görünüyor. Rahatsız edici olabilir. (P.A 4) - İkisi de iyiler. (P.A 5) - Bunları değerlendirmek için mekan fonksiyonlarını bilmem gerekir. Fakat, B binasını, A binasına göre daha başarılı buluyorum. (P.E 6) - İki bina da kontrollü ve başarılı bir şekilde çatıdan ve cepheden ışık alıyor. (P.A 7) (Bkz. 56.) A seçeneğindeki binanın görsel entegrasyonunu daha başarılı	- Fark yok. (P.E 1) - A binası daha başarılı aydınlatma kalitesi ve görsel konfora sahip. (P.E 2) - A binası daha aydınlık bir iç mekana sahip. (P.E 3) - A binası, B binasından daha başarılı. (P.E 5) - B binasının aydınlatma kalitesi daha başarılı, mekan daha ferahlatıcı görünüyor. (P.E 6) - A binasında oval çatı yapısı sebebiyle iç aydınlatmanın ve güneş ışığının daha çok etki edeceğini düşünüyorum. (P.E 7) - Bence ikisi de aynı. (P.E 8) - Görsel konfor açısından B daha başarılıdır. (P.E 9) - A binası daha iyi aydınlatma kalitesi ve görsel konfora sahip. (P.E 11)

buluyorum, ışığı alma oranında çatıdaki yarı saydam modüller kontrolü sağlarken, cephede kullanıcının dışarı ile ilişkisini daha aydınlık bir ortam sunarak zenginleştiriyor. B’de ise, anladığım kadarıyla film kullanılmaktadır. Bu yüzden içerdeki ışığı ve kullanıcının dışarı ile ilişkisini olumsuz etkileyebilir diye düşünüyorum. (P.A 8) - A binasını tercih ederim. B binasında renkli filmlerin iç mekan konforunu rahatsız edeceğini düşünüyorum. (P.A 9) - A binası gerek aydınlatma kalitesi, gerek görsel konfor açısından çatı üzerinde kullanılan modüllerle beraber gölgeleme sistemi içererek daha avantajlıdır. Fakat B binası için aydınlatma kalitesi iyi olsa da, görsel konfor açısından belli zaman dilimlerine göre göre bir gölgeleme sistemi gerekebilir. (P.A 11) - A binasının iklim şartlarını bilmiyorum ama ışık geçirgenliği açısından yarı gölge ve gölge olan kullanışlı alanlar yaratmış. B binasının cidar bölümü iyi ışık	- A binası daha aydınlık ve daha iyi görsel konfora sahip. (P.E 12) - İkisi de harika. (P.E 13) - Güzel (P.E 14) - Çatıda uygulanan gölgeleme sistemi yetersiz kalırsa, A binası çok fazla gün ışığına maruz kalabilir. B binasında cam filmleri kullanılarak güneş ışığının rahatsız edici etkisi önlenmiş. Bu sebeple B binasını tercih ederim. (P.E 15) - İklimsel olarak yılın önemli bir kısmında açık bir gökyüzü varsa, iç mekanlarda konforsuz dönemler fazla olabilir. (P.E 16) - İkisi de aydınlık ve güzel. . (P.E 17) - A binası çok başarılı, B binası yeterince aydınlık değil. (P.E 18) - Fotoğraflar aynı saatte çekilmiş gibi durmuyor; ama eğer öyle ise A binası daha iyi. (P.E 24) - A binası gün ışığını içeriye daha net almaktadır. (P.E 25).
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almakta; ama iç mekanlar yeterli gün ışığı almıyor gibi. (P.A 12) • İkisi de konforlu görünüyor. (P.A 13) • B binası daha başarılı. . (P.A 14) • Kullanım amacına göre değerlendirmek gerekir. (P.A 15) • A binası daha aydınlık ve ferah. B binası daha karanlık. (P.A 16) • A binasının iç mekanı ferah/huzurlu bir ambiyansa sahip. Fakat, güneş ışınlarının direk iç mekana yayılması iç mekan konforunda problemler yaratabilir. B binasında filmlerde kullanılan farklı renkler iç mekan atmosferinde ılımlı ve sıcak bir ambiyans yaratmış. (P.A 17) • İç/dış mekan ilişkileri kuvvetli. Fakat, yüzeyler çok fazla saydam, fazla saydamlık dışında başarılı bir tasarım kurguları var. (P.A 18) • Aydınlatma kalitesi açısından A binası daha iyi. Fakat görsel konfor açısından B binası daha iyi. (P.A 19) • Bence gayet iyiler. (P.A 20)	
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• B binasının iç mekan aydınlatma kalitesi ve görsel konforundan düşülerek enerji kazanımı elde edilmeye çalışırken, A binasında tam tersi mantık uygulanmış. (P.A 21) • Tabi ki A binası (P.A 23) • A binası daha iyi tabi ki de, B’ de pembe loş bir ışık kalıyor içerde. (P.A 24) • A binasında, güneş ışığı iyi süzülmemekte ve daha iyi görsel konfor sunmaktadır. (P.A 25)	
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Table B.4. Comparative responses of participants for Question 30.b.

30. b. Hangi iç mekanda yaşamak / çalışmak istersiniz?	
MİMARLAR	MÜHENDİSLER
- A binası; çünkü son derece ferah ve doğal bir aydınlık seviyesine sahip. (P.A 1) - B binasında yaşamak/çalışmak isterim. Bkz. 56. (Görsel iç mekan kalitesine etkisi bakımından B örneğinin daha başarılı olduğunu söyleyebilirim.) (P.A 2) - Açıklık hissi daha ön planda olduğu için A binasını seçerim. (P.A 4) - Bina formundan ötürü A binasını tercih ederim. (P.A 5) - Sanırım iki mekan da yaşanılan veya çalışılan mekanlar değil, geçiş alanları gibi algılıyorum. Bu sebeple, iki mekanda da yaşamak ya da çalışmak istemezdim. (P.A 6) - Karar vermek çok zor. Sanırım, A binasını tercih ederim. (P.A 7) - Daha aydınlık ve ferah olduğu için, A binasında yaşamak ya da çalışmak isterim. (P.A 8) - A binası çalışma/ofis, B binası yaşama ortamı için uygun. (P.A 9)	- Daha yüksek, daha ferah ve daha aydınlık olduğu için, A binasını tercih ederim. - A binasında çalışabilirim ama dediğim gibi, diğer faktörleri (tasarımın amacı, gereklilikler, fonksiyonellik ve iç mimarisi, lokasyonunu ve ofis yerleşim planları) de dikkate almak gerekli. (P.E 2) - Daha aydınlık olduğu için, A binasını tercih ederim. (P.E 3) - Görselliği ve aydınlatması daha güzel olduğu için A binasını seçerdim. (P.E 5) - B, çünkü iç mekan ferah görünüyor. (P.E 6) - A (P.E 7, P.E 10, P.E 11) - İkisini de tercih ederim. (P.E 8) - B, çünkü estetik olarak daha güzel. (P.E 9) - Açıklık hissi daha ön planda olduğu için A binasını seçerim. (P.E 12)

- Aydınlatma kalitesi, görsel konfor ve gölgeleme sistemi olarak kuvvetli olması bakımından A binasını tercih ederim. (P.A 11) - İç ve dış ilişkisi ve geçişleri daha iyi olduğu için A binasını tercih ederim. (P.A 12) - İkisi de (P.A 13, P.A 15) - A binasında, çünkü daha iyi ışık kalitesine sahip. (P.A 14) - Hiçbiri. Tasarım anlayışıma uygun binalar değil. (P.A 16) - İki binada da çalışmak ya da yaşamak isterim. (P.A 18) - A (P.A 20, P.A 23) - B binası, enerji kazanımı açısından belki daha iyi performans gösterebilir fakat içeriye gelen ışığın aydınlatması hem düşük hem de farklı renkte olacağı için düşük verimli bir çalışma ortamı olurdu. A binasının lokasyonunu söylemeden cevap vermek güç. Lokasyona göre parıltı ve ısı radyasyonu dayanılmaz	- B (P.E 13, P.E 14) - B, (Bakınız 5.) Çatıya uygulanan gölgeleme sistemi yetersizse, A binası çok fazla gün ışığına maruz kalabilir. B binasında cam filmi kullanılarak güneş ışığının engelleyici edici etkisi engellendi Bu nedenle B binasını tercih ediyorum (P.E 15) - A binasını seçiyorum, B binasının gün ışığı alması zayıf görünüyor. (P.E 16) - Daha parlak ve daha ferah olduğu için A binasında yaşamak veya çalışmak istiyorum. (P.E 17) - Estetik açıdan daha başarılı olduğu için B inşa etmeyi tercih ederim. (P.E 23) - A binasında, çünkü daha iyi ışık kalitesine sahip. (P.E 24) - Daha ferah iç mekan A yapısını seçerim. (P.E 25)
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seviyeye gelebilir. Cevabım kuşkulu bir A. • Daha ferah iç mekan ve daha iyi ışık kalitesi sebebiyle A yapısını seçerim. (P.A 24) • Daha iyi mimari tasarımı olduğu için ve başarılı bir BIPV uygulaması yapıldığı için, A binasında yaşamak/çalışmak isterdim. (P.A 25)	
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Table B.5. Comparative responses of participants for Question 32.

32. BIPV'nin bu binadaki görsel entegrasyonunu nasıl buluyorsunuz?	
	
MİMARLAR	MÜHENDİSLER
- Mekanın kullanım amacını bilmesem de iç aydınlatmanın başarılı bir şekilde tasarlandığını görüyorum. (P.A 1) - Tesadüfen ve üzerinde düşünülerek belli bir görsel stilizasyona ulaşılmadığını öne süren bu tasarım, BIPV'nin iç teknolojik prosedürleri ile görsel dil açısından ulaştığı art-deco etkisine ne ölçüde ulaştı? Bu konuda gözlemlenebilir yapısal bir süreç olmadığı kanısındayım. Rastgele ya da en azından sınırlı görsel dille sınırlı olduğunu düşündüğünüz bu estetik ifadenin başka şartlar ve koşullarda ne kadar	- Çok güzel. (P.E 1) - Biraz karmaşık. (P.E 2) - Başarılı (P.E 5) - Biraz soluk (P.E 6) - Binanın görsel bütünleşmesi estetikdir. Ancak bina güneş ışığına fazla maruz kalmıyor. (P.E 7) - Çok iyi (P.E 8) - Güzel, başarılı (P.E 9, P.E 12) - Biraz karmaşık. (P.E 10) - Yenilikçi ve ilerici bir tasarım. (P.E 11)

çeşitleneceğini tahmin edemem. (P.A 2) - Görsel karışıklığa neden oldu. (P.A 4) - Biraz karanlık. Ancak içerideki loş belirli bir amaç için tasarlanmışsa, bu farklı bir durumdur. (P.A 5) - İçimde sevdiğim atmosfer bilinçli olarak yaratılmışsa çok başarılı. (P.A 6) - Çok zarif tasarım (P.A 7, P.A 24) - Ben başarısız buluyorum. Işık alma şekli iç mekanda önemli ölçüde canlılık sağlasa da uzun süre çalışmak ya da yaşamak için net desenleri vurgulayacak şekilde ışık almanın konforu olumsuz etkileyeceğini düşünüyorum. (P.A 8) - Dengeli (P.A 9) - Bu binadaki görsel entegrasyon çok başarılı. İnsanlara huzur, güven ve huzur vermenin yanı sıra enerjiyi de yüksek tutar. (P.A 11) - Görsellik ön plana çıkar ve gün ışığını çok fazla engeller. (P.A 12) - Başarılı (P.A 13, P.A 14, P.A 17, P.A 18)	- Hoş (P.E 13) - Mekanın kullanım amacına bağlıdır. Ancak güneş ışığını fazla istemeyen bir hedefi varsa başarılıdır. Çünkü güneş ışığını neredeyse yok ediyordu. (P.E 14) - Güzel (P.E 15, P.E 23) - Çok başarılı (P.E 16) - Başarılı (P.E 18) - İyi tasarlanmış (P.E 19) - Konstrüksiyonla uyumlu (P.E 25)
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• Parlak, güzel (P.A 16) • Yerin amacına göre iyi tasarlanmış. (P.A 19) • Bina cephesinden süzülen ışıklar ve renk tonu dinginlik verir. (P.A 23) • Yenilikçi ve moderndir. (P.A 25)	
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Table 4.13. Comparative responses of participants for Question 32.a.

32. a. Her iki yapıyı da aydınlatma kalitesi ve iç mekanın görsel konforu açısından değerlendirebilir misiniz?	
	
MİMARLAR	MÜHENDİSLER
- Kullanım amacının bilmeden yorum yapmak doğru değil. (P.A 1) (Bkz 60.) Belirli bir görsel stilizasyona tesadüfen ulaşmadığı ve üzerin düşünülmüş olduğunu düşündüren bu tasarım, görsel dil bakımından ulaştığı art-deco etkiye ne ölçüde BIPV'nin iç teknolojik yordamlarıyla ulaşmıştır? Bu konuda gözlenebilir bir yapısal süreç olmadığı kanısındayım. Tesadüfiliğin ya da en azından kısıtlı bir görsel dilin içine hapsoldüğünü düşündüğün bu estetik ifade, başka durum ve koşullar altında ne derece çeşitlenebilecektir, pek kestiremiyorum. (P.A 2)	- Çok iyi görünüyor. (P.E 1) - Bu sorunun cevabı, mekanın kullanım amacına ve kullanıcının talebine göre değişir. (P.E 2) - Karanlık, yapay aydınlatmalara ihtiyaç duyulmuş. Fakat belki mekanın kullanım amacına göre doğal ışıktan faydalanmak istenmeyip, renkli fovoltaitik cam teknolojisi ile gölgeleme etkisine başvurulmuştur. (P.E 3) - BIPV konusunda çok bilgim bulunmamaktadır. Fakat mekanın kullanıcısı olarak yorum yaparsam,

- Görsel konfor eğer bir çalışma alanı ise düşük. Homojen bir dağılım söz konusu değil. (P.A 4) - Biraz karanlık (P.A 5) - Değerlendirmek için, mekanın fonksiyonunu bilmem gerekir. (P.A 6) - Çok şık (P.A 7) (Bkz. 60) Başarısız buluyorum. Işık alma biçimi iç hacimde önemli ölçüde hareketlilik sağlasa dahi, uzun süre çalışmak ya da yaşamak için bu biçimde net desenleri vurgulayacak biçimde ışık alınmasının konforu olumsuz etkileyeceğini düşünüyorum. (P.A 8) - Gölge ve ışık dengesi tatmin edici. (P.A 9) - Aydınlatma kalitesi ve görsel konfor açısından gayet başarılı. (P.A 11) - İç mekanın dışarı ile ilişkisini koparmış ve gün ışığını engellemiş durumda. (P.A 12) - Başarılı (P.A 13)	bu mekan rahatsız etmeyen ve huzur veren bir atmosfere sahip. (P.E 4) - Estetiksel olarak ve aydınlatma açısından kaliteli. (P.E 5) - Göz yorucu, yeterli aydınlatma yokmuş gibi. (P.E 6) - İç mekanda güneş ışığını kesen malzeme dolayısıyla aydınlatma kalitesi düşük, ama estetik kalitesi yüksek. (P.E 7) - Çok iyi (P.E 8) - Görsel konforu güzel, aydınlatması da başarılı. (P.E 9) - Yorucu (P.E 10) - İyi (P.E 11) - Zayıf (P.E 12) - Enfes (P.E 13) - Biraz karanlık (P.E 15) - Mekanın kullanım şekline bağlı, dinlenme mekanı olarak iyi olabilir ama çalışma mekanı olarak değil. . (P.E 16)
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• Bence başarılı ve konforlu görünüyor. (P.A 14) • Başarılı. Işık gayet kontrollü bir biçimde alınmış, ayrıca malzeme de iyi kullanılmış. (P.A 18) • Görsel konfor gayet iyi, aydınlatmayı kısmen engellemiş olması bence bilinçli bir şekilde yapılmıştır. Mekanda güneşten korunmak adına, güneş kırıcı rolü görüyor. (P.A 19) • Başarılı (P.A 16,17, 20, 23, 24) • İç mekan güneş ışığına çok fazla maruz kalmakta. Bu yüzden gölgeleme sistemi kullanılmış. (P.A 25)	• Aydınlatma düşük, ama loş hava mevcut. Belki de bu amaçlanmış olabilir. (P.E 18) • Başarılı (P.E 23) • Binadaki aydınlatma yetersiz. (P.E 24) • Aydınlatma düşük gözüküyor. (P.E 25)
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Table 4.14. Comparative responses of participants for Question 33.

33. Kullanılardan farklı renkte üretilmiş bir cam modül kullanılırsa, iç mekanın aydınlatma / ışık kalitesinde değişiklik olur mu? Cevabınız evet ise ne tür bir değişiklik oluyor?	
MİMARLAR	MÜHENDİSLER
- Kullanılan rengin, hem içeri giren ışık üzerinde, hem de içeriden dışarıya gözlem üzerinde olumlu ya da olumsuz bir etkisi olacaktır. (P.A 1) - Renk ve opaklık kavramlarının farklı şeyler olduğunu biliyorum. Beyaz ve tamamen opak olan bir yüzeyin iç mekanda siyah etkisi verebileceği gibi, öte yandan daha siyaha yakın renklerin parlaklık üzerine olumsuz bir etkisi olabilir. (P.A 2) - Değişim olmaz. (P.A 4) - İç mekandaki ışık kalitesinin değişiminin, renk ile değil, saydamlıkla ilgisi vardır. Tamamen saydam olursa, ışık kalitesinde değişim olabilir. (P.A 5) - Simülasyon araçları kullanılarak değerlendirilmelidir. (P.A 6) - Değişim olur tabiki de. (P.A 7) - Tahmin ettiğim biçimde renk kullanımının siyah dışında bir renk olması, bu mekana ışığın daha homojen ve kontrast yaratmayacak	- Işığın rengi tamamen frekansına bağlıdır. Dalga boyunun değişmesi ışığın rengini değiştirmez. Sadece frekansın değişmesi rengi değiştirir. Bu sebeple farklı bir frekansa sahip renk kullanılırsa iç mekanın aydınlatmasında ya da ışık kalitesinde bir değişim olur. (P.E 1) - Kesinlikle değişim olacaktır. Sıcak veya soğuk tonlarda kullanılan renklere göre, farklı bir ortam atmosferi ve ışık kalitesi olur. (P.E 2) - Kullanılan renge ve renk tonuna göre daha aydınlık ya da daha karanlık bir ortam olur. (P.E 3) - Evet değişim olur. Fakat, bence bu örnek, renk gözü yormayan ve iyi kaliteli bir ortam sağlayan bir renktir. (P.E 5) - Evet, renksiz bir cam kullanılırsa, güneş ışığı iç mekana daha çok yayılır. (P.E 6)

biçimde alınmasını sağlayabilirdi. Böylece ışığın mekana daha çok dengeli dağılmasını sağlayabilirdi. (P.A 8) - Kullanılan cam renginin ışığı geçirgenliğine göre ortamın ışık/aydınlatma kalitesi değişir. (P.A 9) - Mavi renkte üretilmiş bir cam modül huzur, güven, dinginlik ve enerji vermesi bakımından gayet iyi. Örneğin kırmızı renkte sıcak tonlu bir bir cam modül içerinin atmosferini ve ışık kalitesini tam tersi yönde etkileyebilirdi. (P.A 11) - Renk, ışık kalitesini değiştirir. İç mekanın fonksiyonu önemli; ama gün ışığına yakın renkler konforu artırır. (P.A 12) - Evet, değişim olur. (P.A 13, 22) - Evet, açık ve koyu renk tonlarına göre ışığın kalitesi değişir. (P.A 14) - Evet. Renklerin psikolojiye etkisini bu değişime örnek verebiliriz. (P.A 16)	- Aydınlatma kalitesinde bir değişim olmayacağını düşünmüyorum; fakat ışık kalitesinde ilerleme olacağını düşünüyorum. (P.E 7) - Bu örnekteki renk, en iyisi gibi görünüyor. (P.E 8) - Evet değişir. Kullanılan rengin frekansına göre, ışığın rengi ve ışığın kalitesi değişir. (P.E 9) - Evet, şeffafa yakın olsa ya da mavi daha iyi bir ışık kalitesi olur. (P.E 11) - Hayır, bence olmaz. (P.E 12) - Evet, değişim olur, fakat bu renkler uygun. (P.E 13) - Hayır, kullanılan renkler ışığın kalitesini etkilemez. (P.E 14) - Evet, değişim olabilir. (P.E 15) - Değişim olacağını sanmıyorum. (P.E 16) - Daha açık renkler ve renk tonları kullanılırsa, daha aydınlık ortam oluşur. (P.E 18)
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• Evet olabilir. Işığın oluşturduğu gölgeler iç mekanda farklı bir his yaratabilir. (P.A 17) • Bence olmaz. (P.A 18, 25) • Güneş ışığını geçirme ya da yutma bakımından farklılık yaratabilir. (P.A 19) • Evet olur, ışık kalitesi renge göre değişir. Renk koyulaştıkça, aydınlatma ve termal radyasyonda düşüş olur ve böylece görsel konfor düşer. (P.A 21) • Tabi ki olur. Her rengin kırılma indisi ayrı diye biliyorum. (P.A 23) • Renge göre ışık kalitesinde değişim olur. Fakat bu değişim, mekanın kullanım amacına ve kullanıcının zevkine göre değişir. Eğer konut ise daha loş bir ortam yaratılmak istenebilir, eğer iş yeri/ofis ise daha aydınlık bir ortama ihtiyaç duyulabilir. (P.A 24)	• Evet olur. Beyaz olursa daha aydınlık olur. (P.E 23) • Tabi ki olur. Daha açık bir cam ile iç ışık daha aydınlık olabilir. (P.E 24) • Evet, güneşin dalga boyları her renkte farklı iletkenlik göstereceği için, farklı renk cam kullanıldığında, içeriye gelen ışık kalitesi değişir. (P.E 25)
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Table 4.15. Comparative responses of participants for Question 34.

34. Renk değişiminin fotovoltaik modülün enerji verimliliği üzerinde bir etkisi olduğunu düşünüyor musunuz? Cevabınız evet ise nasıl etkilenir?	
MİMARLAR	MÜHENDİSLER
- Bildiğim örneklerdeki fotovoltaiklerin genellikle siyah renkli olduğunu gördüm. Siyah rengin en fazla ışığı emme potansiyeli olduğu için diğer renklere göre verimliliğinin fazla olduğunu düşünüyorum. (P.A 1) - Yalnızca koyu renklerin daha çok ışık soğurduğunu biliyorum. (P.A 2) - Hayır, değişim olmaz. (P.A 4) - Koyu renklerin daha verimli çalıştığını zannediyorum. (P.A 5) - Koyu renklerin daha iyi bir enerji verimliliğine sahip olduğunu düşünüyorum. (P.A 6) - Basit bir bilgi olan siyah ışığı daha çok çeker bilgisine dayanarak etkisinin olabileceğini düşünüyorum. Işığı ve ısıyı içinde tutma oranı artabilir. Fakat son teknolojik gelişmeler hakkında yeterli bilğim yok. (P.A 8)	- Renklerin dalga boyları güneş ışığının geçirimine etki ediyorsa verim değişebilir. (P.E 1) - Evet olabilir. Renk ve renk tonuna göre azalır veya artar. (P.E 3) - Evet. Güneş ışığı koyu renklere daha fazla etki gösterir. Buna bağlı olarak enerji verimliliği de değişiklik gösterecektir. (P.E 5) - Evet. Modül renklendikçe güneş ışığının iç mekana etkisi azalır diye düşünüyorum. (P.E 6) - Elbette, azalabilir. (P.E 8) - Etkilediğini düşünüyorum. Modül renginin renk tonuna verimlilik azalır ya da artar. (P.E 10) - Olur mutlaka. Işığın kırılma, prizma etkisi, dalga boyu değişecektir. (P.E 11) - Evet düşünüyorum. Yapraklardaki fotosentez ile aynı prensiplerde. (P.E 12)

- Evet, ışığı daha çok soğuran ve yansıtan renkler vardır. (P.A 9) - Renk değişiminin fotovoltaik modülün enerji verimliliğine etkisi olup olmadığı hakkında detaylı bir bilğim yok. Fakat mutlaka ışığın kırılma indisi ve değerlerine göre bence enerji verimliliği değişiyordur. - Hayır, bence olmaz. - Evet. Renklerin psikolojiye etkisi. (P.A 16) - Değişim olmayabilir (P.A 17) - Bence herhangi bir etkisi yoktur; ama benim bilmediğim şekilde olabilir. (P.A 18) - Renklerin güneşi yansıtması ya da yutması bakımından farklılık gösterebilir belki. (P.A 19) - Renk koyulaştıkça performansı artar diye tahmin ediyorum. (P.A 21) - Tabi ki olur. Yukarda da dediğim gibi, her rengin kırılma indisi ayrı diye biliyorum. (P.A 23)	- Hayır, sanmıyorum. (P.E 14) - Evet, renk etkiler. (P.E 15) - Güneş ışınının spektrumuna bağlı olarak küçük farklar olabilir. (P.E 16) - Evet. Absorbe edilen dalga boyu ile enerji verimi doğrudan ilişkili olmalıdır. (P.E 17) - Önemli olan hücre özelliğidir; ama güneş ışınlarını soğurmadan dolayı koyu renkler daha etkilidir. (P.E 18) - Kesinlikle düşünüyorum. Işığın soğurması düşücektir renk açıldıkça. (P.E 24) - Evet, tabiki de değişim olur. (P.E 25)
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• Evet etkisi deęiřir. Panellerin kristallerindeki mavi lacivert renk muhtemelen en verimli renktir diye dūřunuyorum. (P.A 24) • Iřıęı absorbe etme oranına gōre verimlilik deęiřebilir. (P.A 25)	
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Table 4.16. Comparative responses of participants for Question 35.

35. BIPV sistemlerinin avantajları ve dezavantajları neler olabilir? Değerlendirir misin?	
MİMARLAR	MÜHENDİSLER
- Avantajlar; sürdürülebilir enerji, altyapı bağımsızlığı, kullanımda düşük maliyet. Dezavantajlar; kurulumda ve bakımda yüksek maliyet, üretim için gerekli hammadde yetersizliği, dışa bağımlı sanayidir. - Bir dezavantajı olacağını düşünmüyorum. Enerji verimliliği ise en büyük avantajıdır. (P.A 2) - Sistemin en büyük avantajının, sürdürülebilir bir enerji kaynağına sahip olması diye düşünüyorum. Cephe ve çatı uygulamaları gün boyu ışık alan bu yüzeylerin birer enerji üretim elemanı olarak çalışmasını sağlıyor. Aynı zamanda binaya bir kabuk oluşturuyor. Dezavantajının ise, yapım maliyetine getirdiği artış olduğunu düşünüyorum. (P.A 4) - Avantajları: elektrik üretimi, dezavantajları: bu konuda uygulama uzmanı sayısı azlığı ve maliyetidir. (P.A 5)	- Avantajları; PV sistemlerinin kullanım ömrü, maliyetini ödeyecek kadar uzundur. Bakımı kolaydır ve bakım maliyetleri çok düşüktür. Güneş enerjisini yakıt olarak kullandığından yakıt alım ve nakliye maliyeti yoktur. Çevreye zararlı atık bırakmazlar ve sessiz çalışırlar. Dezavantajları; ilk yatırım maliyeti yüksektir. Yüksek güç gerektiren motorlar ve ısıtma sistemleri için ekonomik değildir. Güneş enerjisini elektriğe dönüştürme oranı düşüktür, bu nedenle geniş alanlara ihtiyaç duyar. Sistemin üretim potansiyeli mevsimsel ve günlük hava değişimlerinden etkilenir. (P.E 1) - Dezavantaj olarak, bazı sistem zorunlulukları nedeniyle mimari çerçevede yeterli esnekliği sağlayamamak olabilir sanırım. Avantaj olarak ise, en önemlisi olan enerji üretimine ve verimliliğine olan katkıları söylenebilir. (P.E 2)

• Enerji üretimi avantajıdır, ilk maliyet dezavantajıdır. (P.A 7) • Kullanılan malzemenin ve tekniğin tasarımı ve kullanıcının konforunu olumsuz etkilemediği sürece BIPV sistemlerin dezavantajının olacağını düşünmüyorum. Maliyeti fazla olsa dahi zaman içinde enerji tüketimini düşürerek, bu harcama kara dönüşebilir. Çevre için de büyük ölçüde olumlu katkısı olacaktır. (P.A 8) • Avantajı enerji verimliliği, dezavantajı maliyetidir. . (P.A 9) • Avantajları, enerji verimliliği sağlamak, çevre dostu olması, farklı estetik ve işlevsel alanlarda kullanılması. Dezavantajları ise ülkemizde bilinmeyen ve eğitimi verilmeyen bir sistem olması, uygulaması için usta azlığı olabilir. (P.A 11) • Enerji verimliliği için büyük bir avantaj. Yapı elemanı olarak uygulama, maliyet ve tasarımda zorluklarının olması ise dezavantajları olabilir. (P.A 12)	• Avantajları tasarım esnekliği ve enerji verimliliğidir. Herhangi bir dezavantajı olduğunu düşünmüyorum. (P.E 3) • Avantajlar: Güneş dünyanın sonuna kadar sınırsız bir güneş ışığı kaynağımız olacak. Güneş enerjisi yenilenebilir ve sürdürülebilir enerji olarak hayatımızda her zaman yerini alacaktır. Bu temiz enerji, kırsal bölgelerde yaşayan insanlar için elektrik enerjisini elde etme adına büyük kolaylıktır. Güneş teknolojisi ekipmanları yerine yerleştirildikten sonra, güneş enerjisinin çalışması için hiçbir şekilde yakıt gerektirmez. Ayrıca temiz enerji kaynağı olarak çevreye sera gazı veya toksik maddeler yaymaz. Güneş enerjisinin kullanılması çevre üzerindeki etkimizi büyük ölçüde azaltabilir. Üretilen fazla elektrik depolanarak tekrar elektrik şebekesinde kullanılarak aylık elektrik faturalarında indirim sağlanabilir. Güneş enerjisi sessizdir ve kirlilik oluşturmaz. Bu, dünyadaki birçok insan tarafından tercih edilmesinin en
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• Cepheye sonradan müdahale edilmiş gibi durmaması en büyük avantajı bence. Dezavantajları hakkında bir bilgim yok. (P.A 13) • Avantajı, binanın entegre bir parçası olması ve ek maliyet olarak düşünülmemesidir. Dezavantajı ise, geleneksel kabuk malzemelerine göre daha pahalı olabilir. (P.A 14) • Fiyat ve performans, avantajları arasında olabilir. (P.A 16) • Etkin enerji kullanımına ve sürdürülebilir yaşam alanlarına katkı sağlayabilir. (P.A 17) • Benim için herhangi bir dezavantajı olacağını düşünmüyorum, tasarımla sorunlar çözülebilir. (P.A 18) • Temiz enerji bakımından avantaj sağlayabilir; ancak maliyet bakımından yük getirebilir. (P.A 19) • Enerji üretimine katkısı avantajı, fiyat performansı dezavantajıdır. (P.A 20)	büyük nedenlerinden biridir. Güneş enerji santralleri diğer enerji tesisleriyle karşılaştırdığımızda bakım ve işletme maliyetleri düşüktür. Yılda sadece birkaç kez bakım gerektirebilir. Güneş enerjisi kullanılan bir sistemin herhangi bir dezavantajının olacağını düşünmüyorum. (P.E 5) • Enerji verimliliği avantajıdır. İlk yatırımının yüksek olması dezavantajıdır. Fakat bu sistemler, uzun vadede tercih edildiği zaman, verimlilik sağlayarak, bu ilk yatırım maliyetini önemsiz hale getirmektedirler. (P.E 8) • Avantajları, yapıya estetik kalite katması, daha yüksek enerji almamızı sağlamasıdır. Dezavantajı olduğunu düşünmüyorum. (P.E 9) • Maliyeti, sürekli olmaması ve bu nedenle depo (akü,vs.) gerekmesi dezavantajlarıdır. Yenilenebilir enerji kaynağı olan güneş enerjisi kaynaklı olduğu için sürdürülebilir bir yaklaşıma sahip olması ise en büyük avantajıdır. (P.E 10)
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• Genelde, cephede sistemin performansı ile konfor ters orantılı oluyor diye düşünüyorum. Performans arttıkça konfor azalıyor. Bu sebeple performans/Konfor dengesini ayarlamak da tasarımcılara düşüyor. Bu zorluk sistemin dezavantajı olabilir. Sistemin en büyük avantajı ise, yenilenebilir, temiz ve sonsuz bir enerji kaynağı olan güneş enerjisini kullanmasıdır. (P.A 21) • Maliyetini bilmediğim için yorum yapamıyorum. (P.A 23) • Avantajları; enerji elde etmek ve tasarruf etmektir. Dezavantajları; yapım tekniklerinin zor olabilme ihtimalidir. Bu sebeple, mimarisi ve estetiği çok iyi tasarlanmalıdır. (P.A 24) • Yüksek maliyet ve kaliteli işçilik gerektirir. Diğer yandan bina planlama ve tasarım aşamasında her bir kısım çözülmelidir. (P.A 25)	• Değişkenler arasında uzlaşırsa kazanç olur. (P.E 11) • Güneş pillerinin verimliliği arttırıldığı zaman bence çok daha kullanışlı bir sistem olacak. (P.E 12) • Tasarruf avantajı, ilk kurulum maliyeti dezavantajıdır. (P.E 13) • Tasarım olarak yenilikçi ve modern bir anlayışı var. Dezavantajlarının olacağını düşünmüyorum. (P.E 15) • Binanın yapısal bir unsuru olarak bütünsellik oluşturması tasarımsal avantajlar sunuyor ve enerji üretimine katkı sağlıyor. Yönlenmeler ve iklimsel özellikler göz önüne alınmalı. Dezavantajları hakkında bilgim yok. (P.E 16) • Tek dezavantajının maliyet olduğunu düşünüyorum. Avantajları ise elektrik üretmek, binalardaki ısıtma-soğutma sistemini sağlamaktır. (P.E 17) • Yenilikçi bir sektör olması ve mevcut bina entegrasyonu sağlaması avantajları, yüksek maliyetli olması ve yönetimsel
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	zorlukları ise dezavantajlarıdır. (P.E 18) • Çok bilgim yok; ancak dezavantaj olarak; bina mukavemeti düşebilir. Herhangi bir doğal afette daha dayanıksız olabilir. Isıtma daha zor olabilir, geçirgenliği daha fazla olduğu için. (Bilgim yok, sadece tahminlerim). Avantaj olarak; enerji üretimi, estetik görünüm sağlarlar. (P.E 24) • Avantajı; yenilenebilir enerji olduğu için tasarruf sağlar. Dezavantajları; bu tip sistemler hala yüksek maliyetlerde üretildiği için talepleri konusunda sorun yaşanabilir. (P.E 25)
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