Impact Photo-Voltaic Cells on the Design Process, Building Formation and its Efficiency "Review"

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Abstract:

One of the most important steps of the design building process knows the tools that the designer uses to produce the building that he designs, and with scientific and technological progress, recent discovers provide new tools that help the designer in bringing out his design in the best way. Among these tools, we find the material of photo-voltaic cells that entered the field of buildings; there was a need for the architect to study this new material and what happened to it in terms of changes and developments that lead to progress in architectural design for buildings. This study including the dimensions and thickness of these cells, how they are integrated with the building , and their compatibility with other building materials .what are the properties of these boards in terms of texture , colors, resistance, . In this paper, we focus on how this material affects the change in the way of thinking about architectural design since the first steps of the design process.

Keywords:

The design process, photo-voltaic cells, design tools, integration of photo-voltaic cells into buildings.

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1. Introduction:

In this paper, we highlight the effect of entering a new materials on building design, which is photo-voltaic solutions, and integrating with the building, and studying the impact of these materials on the design process and building formation, we find that there is an essential difference that has occurred in the way the architect thinks and the way he deals with the building. Since previous decades, the architects viewed the building as a group of spaces and areas

in which the residents practiced all life practices such as sleeping, eating, living, reading, and practicing all means of audio- visual entertainment. But since the entry of new technological materials into the field of building materials such as photo-voltaic cells, the architectural view of the building has changed, as the building has become a source of electrical energy. So that it can rely on itself to meet all its residential energy requirements through advanced photo-voltaic cells. However , this requires multiple studies, on the efficiency of the work of cells[i] , as well as the most important place in which photo-voltaic cells can be integrated, as well as studying the formation of building facades and how photo-voltaic cells are compatible with building facades.

1-2 Purpose:

Studying the changes that occur in the design process as a result of the introduction of a new material such as photo-voltaic cells in the construction building and how to make the best use of it to achieve greater efficiency in generating the energy needed by the building. This element also achieves a complete integration that is not discordant, but rather consistent with other elements of building materials and skill in the spectrum that the architect exploits these new materials so that they become an essential part of the building and achieve a technological transfer in the design and formation of the building.

1- 3 Research Problem:

Architectural design concepts change according to technological progress. the more building technology advances , more architects view of the building changes , so the building becomes not only a building element , but it becomes a basic source of the architects energy and skill, as the building is employed in order to be able to generate the largest amount of electrical energy[ii].

1-4 Research Hypotheses:

The research assumes that the development in technology sciences in the field of producing new materials, improving the properties of materials, and changing them contributes to improving the performance of buildings and reducing their energy consumption by relying on renewable energies and achieving the principles of sustainability, in terms of rationalizing energy consumption and benefiting from renewable energy sources[iii].

1-5 Research aims:

Reaching an architectural design so that the building is self - sufficient in generating the energy needed to operate all the requirements of the building. The important of the role of architectural design in the success of the buildings photo-voltaic system. Develop a vision of the building from the first steps of design and know the most important places where photo-voltaic cells are placed[iv]. Formation of the building and merging the photo-voltaic cells in harmony with the building so that the photo-voltaic cells are part of the fabric of building without disharmony or difference . Increase the awareness among architects of the importance of introducing new building materials into the system of building materials with high technologies that help raises the energy efficiency of buildings and change the external appearance of the facades. Identify new building materials with unique properties that affect the architectural formation and the aesthetic appearance of the external facades of buildings[v].

2- Research hypothesis: 2-1 First hypothesis: The use of new building materials has significant impact on changing the architectural structure and formulation of buildings, especially the external facades. It also has preference in terms of employment and economic return in the long term[vi].

2-2The Second hypothesis: First hypothesis: the use of new building materials has significant impact on changing the architectural structure and formulation of buildings, especially the external facades. It also has preference in terms of employment and economic return in the long term. The use of advanced photo-voltaic cell technology will have the greatest impact in reducing costs, extending the life span of buildings[vii], reducing maintenance, and helping to save energy and finding architectural solutions in building and construction. It also achieves distinguished designs for architects with an aesthetic appearance[viii].

3-Methodology: The study is based on two aspects, an analytical part and an application part .

3-1 Theoretical Study:

- Study and analyze how to manage the design process and the factors affecting it. know the factors that affect the design process. the effects on the design process through the introduction of new materials on Building materials, the importance of designers knowing the scientific and technology has reached, knowing the extent of the impact and employment of new building materials , such as photo-voltaic cells, on the external facades of buildings, as well as the extent of the impact of these materials on the architectural structure , Extract the foundations and determinants of the application of photo-voltaic cell technology in buildings.

3-2 application study:

Study of several projects in which the integration of photo-voltaic cells was applied[ix], an analysis of how to design the building, ideas design, and a study of building facades. The use of building evaluation points in the analytical study of buildings using photo-voltaic cell technology. Extract the most important results for the use of photo-voltaic cells in the building. The research discusses the answer to the hypothesis of using photo-voltaic cells and how it will have the greatest impact in reducing the energy costs of buildings. Conclusions and recommendations[x].

4- Methodology:

During the design process they drown what downing calls an image bank, a repository of stored images of buildings, places, events and experiences, including their own past work. Architects probe their memories for portions of their knowledge with similar features in order to recognized or identify aspects of the new solution. Apportion of their knowledge will involve images of what they believe to be true regarding the environment and other aspects of sustainability in design, these images of " what is " are derived from the " architects " experience of, and ideas about environmental issues, building, stakeholders and their objectives, the role of the architect and the nature of design- as with the three diverse images of sustainability (natural, culture and technical.) Contexts change over time and during the design process. An architect will have an image of the design project he is about to undertake. It provides a frame within which the architect can project into the future and imagine what could be. Forecasting the future usually

consists of extra poling the past and present to construct a plausible story about the future in which the architects is an active participant (Beach 1990:38)

4-1- Absence:

appears to be a straightforward concept for example, untie recently contributions to greenhouse gas emissions have generally been absent from consideration in building design problems, as the decision makers have not thought it to be relevant for take greenhouse gases into account, someone bringing to mind a " technology image" of sustainability is likely to lament knowledge someone, with a " cultural image in mind and vice versa.

4-2 Confusion:

In defining relevant objective or means arises when knowledge is defined in a way that is a distortion of haw it should be defined in order to address the particular problem., assertions of confusion depend on points of view. Knowledge with other stakeholders.

4- 3 Uncertainty and inaccuracy:

Can related to both ends and means they occur when there is a need to make assumptions about the future, and there are limitations inherent in the quantification of data. As uncertainty is a fundamental feature of nearly all sustainability about building materials, about costs and about peoples ends must be seen in this light. This is particularly when dealing with design advice. For any particular design problem, uncertainty may or may not be important consider the Collection of rainwater off the roof of a building. If the water is full drinking or firefighting and this is the only supply then a mistake would have severe consequences. In this case dealing with the uncertainty and variable of the rain would mean that a large factor of safety is designed into the solution. Compared with uncertainty inaccuracy is a fairly straight forward concept. Scientific instruments for measuring and recording physical effects. In the objective world have greatly improved the accuracy of available knowledge about the performance of buildings. Computer simulations provide sophisticated modeling tools that can predict with certain assumptions, the thermal performance of buildings. However, the accuracy with which computer or laboratory simulations and other techniques can predict quantifiable economic and environmental performance of a building proposal vary widely (Williamson terry, Rad-ford Antony and Barnett's Helen, 2003)

4-4 **DESIGN ADVICE:**

Sustainability is both a professional and public concern, and there is much information available which sets out to explain haw environmental aspects of sustainability relate to architecture and haw design should address these issues. There are two principle kinds of design advice: that which focuses on the performance of design while leaving means up to decision – makers. In their manifestation as a local national or international regulation, they are usually described as prescriptive, where particular solutions are required to be implemented or performance-based where measurable performance criteria are set out and associated levels of achievement stated that are deemed to meet certain objectives (Williamson terry, Rad-ford Antony and Barnett's Helen, 2003)

4-5 Prescriptions and prototypes:

Design advice and the critical evolution of building proposals often address the means adapted to meet objectives. The advice explains "haw to" design and builds appropriately: what procedures To follow and checks to make, what materials to use, where a building should oriented, how to Construct features that are held to have desirable characteristics. An evolution of a design checks that these means have indeed been adapted in the design." means- based "assessments are often suspend in terms of methodological transparency" Design that do not conform with the acceptable Lists may in fact be assessment is given authority solutions tend to be limited to those on the lists. Compare this kind of advice with the more general images that architects use in their work.A good example in the body of design advice available in many countries that promotes what can be called "solar-efficient model" of house design. The solar-efficient model has been advocated In temperate climates as an appropriate way of addressing environmental issues in housing. It has been promoted through design advice, such as design guides.Environmental regulations, journal article's, public awareness campaigns the education of several generations of building designers.The Rationale of structure is designed as a solar collector to reduce winter heating requirements.The solar- efficient strategy is based on using appropriate window area, orientation and shading for solar gain. solar efficient house is good for the environment is based on the idea that if the principles of the model are followed it is possible to design a house that can maintain internal comfort levels while using less purchase energy than a similar poorly designed house. Therefore, it is reasoned that a solar-efficient house can conserve resources reduce pollution. This image is so strange that the environmental friendliness of housing is likely to be judged according to whether a house exhibits component of the solar- efficient model-such as concrete slab on -ground floors, south facing windows and massive walls – rather than its actual performance in operation. (Williamson terry, Rad-ford Antony and Bennett Helen, 2003)After we reviewed the way of thinking about architectural design and the first steps to develop the architectural idea and imagine the building[xi], we will be exposes to the next step to study the design considerations of sustainable design, which takes into account the introduction of new elements, such as photo-voltaic cells[xii].

5- Ethical consideration:

The form of our buildings and cities might change radically according as new energy requirement. Buildings will be designed to meet very little energy (passive design strategies for energy efficiency) And to integrate active surfaces (as. models) for generating energy. Design has to consider not only the space we use directly but also the space required to provide for electrical and thermal energies the space required to provide for electrical and thermal energies from renewable sources. The yearly energy yield depends on both the placement that is the azimuth and tilt angles, of the modules and on the technical features of the photo-voltaic modules. Color, opaqueness and patterns of solar cells. The way architects will take up the challenge of designing ZEB(zero energy building) is crucial as architects are highly responsible of the form of the city and its symbolic meanings. we should be seen The energy as a variable able to relate itself to the form of our buildings (clusters of buildings or cities and landscapes .instead of being seen as a kind of abstract variable that design cannot deal with, in the future, design has to consider not only the space we use directly but also the space required to provide for electrical and thermal

energies from renewable sources. The surface of building is necessary for placing the energy generation devices this area can be defined as the " buildings energy footprint, because the renewable energy generation systems, in contrast to conventional energy sources, are visible for the first time in the tradition of architecture, Energy can take a "form I .e shape, colors and features of a photo-voltaic generator" and architects are responsible for designing this forms. Photo-voltaic can be used exactly where the energy is consumed (on- site energy generation) it can be easily integrated anywhere into the building envelope[xiii] , allowing for a number of functions that is on /in rooftop, and semitransparent envelope surface ,having a structure function as well as sun – shading and cladding function . Finally today photo-voltaic cells plays minor role in the composition of the most buildings envelops. Small surface- in near future , it will have a main role , as photo-voltaic cell surface in building will likely become bigger and bigger .

6- The practical method: Analysis integrated building design with early energy demand**:**

Integrated building design by high consultants. Academic research about energy – efficient design. Bridging the gap and implementation in practice[xiv]

Goal: To demonstrate why energy – simulations make design so much better to apply innovations Energy-design- Feasibility studies and master plans, Sustainability planning and certification (leed- DGNB – Bream) - Integrated design (log- process- arch) Thermal simulations building envelop(early design)-Daylight analysis- Leed-simulations- Over heating prevention-Thermal-bridge analysis-Passive house-Thermal comfort (DGNB)-CFD-(simulation)-HVAC (simulation)- Urban scales. We need inform design, support for decision- making-Quick responses, planning &energy modeling with DIM Tools- Early feedback, simple to use.

6-1-Design considerations studied the design of the building's photo-voltaic system: There are several considerations that must be studied when designing the photo-voltaic system for the building, and we must know that each building has its functional requirements, and therefore its requirements differ from others in terms of the amount of energy it needs[xv]. There are several factors that must be studied, the most important of which is:

1- Placement of photo-voltaic panels:

Building integration of photo-voltaic (PV) cells are carried out on sloped roofs, flat roofs,

facades and Solar shading systems. PV cells may be mounted above or onto the existing or traditional roofing or wall systems. However, BIPV systems replace the outer building envelope skin, thus serving simultaneously as both a climate screen and a power source generating electricity. Hence, BIPVs may provide savings in materials and lab our, in addition to reducing the electricity costs. Nevertheless, as the BIPVs act as the climate

Figure 1. Examples of BIPV tiles (left) and BIPV modules (right) (Applied Solar 2010 [4], DuPont 2011 [5]).

protection screens it is of major importance to have satisfactory or strict requirements of rain tightness and durability. Several aspects have to be considered and evaluated related to the integration of the PV cells into the outer building envelope skin. One aspect is to ensure an air gap underneath the solar cells in order to provide an air flow reducing the temperature of the solar cells, as an elevated temperature decreases the efficiency of the solar cells, especially for mono- and poly crystalline Si cells. Another aspect to be considered are the inclination of the BIPVs, both with respect to existing and new buildings, as the solar cells necessarily need to follow the roof inclination (or the wall for that matter) to be integrated solutions[xvi]. Geographical position and orientation towards the sun and area coverage are yet other aspects to be considered during integration of the BIPV systems.. Examples of solar cells integrated as BIPV tiles and BIPV modules are shown in Fig. 1. Furthermore, BIPVs as solar cell glazing products in the facade and on the roof are depicted in Fig. 2. Solar cell glazing products offer a solution for utilizing the fenestration with regard to daylight, solar heat gain, solar shading, miscellaneous architectural expressions, and finally solar energy gain by converting solar radiation into electricity[xvii]. Photovoltaic panels can be placed on the roof of the building, and the panels can be placed on the facades of the building, and photo-voltaic cells can be placed on the openings of the building, and the cells can be placed on the solar breakers of the building, as well as they can be placed on the handrails of the building's terraces. Each case must be studied separately[xviii].

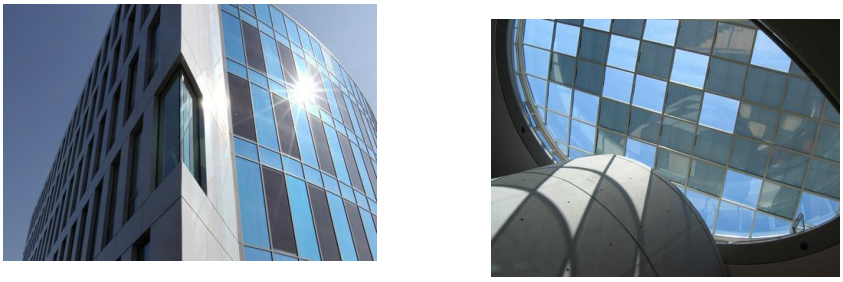


Figure 2. Examples of BIPVs as solar cell glazing products for facades (left) and roofs (right) (ASI® Glass photovoltaic modules,

Schott Solar AG [6]).

- Placing photo-voltaic panels on the roof of this building is suitable for buildings of large dimensions, as the roof can accommodate a large number of panels sufficient to provide the appropriate energy for the building, and the cells must be placed at an appropriate angle of inclination for solar radiation. Likewise, for buildings with a sloping roof, whose surface is covered with tiles, it was possible to form cells to take the shape of tiles and be a functional and formative element of the building.

6-2- Studying the position of the building in relation to the position of the sun:

Studying the angle of incidence of solar radiation on the facades of the building. Through experiments, it was found that the southern facade is the most suitable facade for placing photo-voltaic cells in it to increase the number of hours that the facade is exposed to solar radiation. As for the position of the cells, it was found that the cells should be placed at an angle of 30 degrees.[xix]

6-3 Transparency of photo-voltaic panels:

There are many types of panels, so we find there are dark panels, i.e. opaque, such as silicon cells, and there are semi-transparent types, and it has been achieved to produce completely transparent cells, which are more efficient than the previous types because they can transmit a greater amount of solar radiation, and each type has other uses the other. Dark cells are placed on the top of the roof of the building, and translucent cells can be placed on the roof openings in the building, such as the inner courtyards, and are covered with them to allow the solar radiation to pass through and at the same time generate electric current. The method, if applied to a large number of buildings, will have a huge impact on saving energy for buildings.

6-4 Shape and dimensions of photo-voltaic cells: a- BIPV categorization:

The range of BIPV products is very wide, and they may be categorized in several different ways. Within this work the categorization is mainly performed based on the product descriptions from the Manufacturers and what other material types the products are customized to be combined with. In this Work the BIPV products or systems have been categorized into the following groups: - BIPV foil products- BIPV tile products- BIPV module products- Solar cell glazing products In addition, related to the various BIPV products, the group building attached photo-voltaic (BAPV) Products should also be mentioned:

b- BIPV foil products:

BIPV foil products are lightweight and flexible, which is beneficial with respect to easy installation And prevailing weight constraints for roofs. The PV cells are often made from thin-film cells to maintain the flexibility in the foil and the efficiency regarding high temperatures for use on non-ventilated roof solutions. Unfortunately, currently there are few manufacturers on the market that provide weather tight solutions.. PV foil products have a low fill factor due to both the low efficiency and the large solar cell resistances of thin-film cells. However, it is possible to vary the degree of inclination of the product to a great extent providing flexible solutions.

Figure 3. Example of a BIPV foil product from Alwitra GmbH & Co. using amorphous silicon cells from Uni-Solar [16].

c- BIPV tile products:

BIPV tile products may cover the entire roof or selected parts of the roof. They are normally arranged in modules with the appearance and properties of standard roof tiles and substitute a certain number of Traditional roof tiles, thus also enabling easy retrofitting of roofs. The cell

type and tile shape varies. Some tile products may resemble curved ceramic tiles (see Fig. 3 in section 2.5) and will not be as area Effective due to the curved surface area, but may be more aesthetically pleasing. Some examples of BIPV tile products in Fig. 4

Figure 4. Example of BIPV tile products from SRS Energy (left) [17] and Solar Century (right) [18]

The BIPV products from solar Dickstein, Lu met and Solar Century provide the highest FFs Indicating that the efficiency are high. In fact, Solar Century reports an efficiency of 20 % per cell for Their C21e Tile. The design concept of the STEP design and the Sole Power tile is one module appearing as standard roof tiles that displaces several standard roof tiles. The module has an integrated panel of poly mono crystalline cells. I.e. parts of the module are not covered with PV cells, thus the total area Efficiency will not be as high as indicated. The STEP design solution from Solar Dickstein can be mounted on several different tile products. The C21e Tile from Solar Century has a larger active area than the previous products since mono crystalline silicon cells cover the entire module area, and is compatible with a series of named tiles and slates. Sole Power tile from SRS Energy has a design much like standard roof tiles and the amorphous silicon cell cover from Uni-Solar acts as the skin of the tiles.

e- BIPV module products:

The BIPV module products presented are somewhat similar to conventional PV modules. The Difference, however, is that the BIPV modules are made with weather skin solutions. Some of the Products may replace various types of roofing, or they fit with a specific roof solution produced by its Manufacturer. These mounting systems increase the ease of installation. There is a large amount of products on the market and some of them are promoted as BIPV products without in fact functioning as weather skins, whereas other products are not very specific on how they are actually mounted which leads to uncertainty whether they are BIPVs or BAPVs. Some of the BIPV module products are p remade modules with thermal insulation or other elements included in the body. Some examples of BIPV module products are given in Table 3, with two of them depicted in Fig. 5

Figure 5. Example of BIPV module products from Creaton AG (left) [19] and Rheinzink (right) [20].

6-4-1 Solar cell glazing products:

BIPVs as solar cell glazing products provide a great variety of options for windows, glassed or tiled Facades and roofs, Different colors and transparencies can make many different aesthetically pleasing Results possible. Some solar cell glazing product examples are given in Fig. 6. The solar cell glazing modules transmit daylight and serve as water and sun protection. The distance between the solar cells (normally 3 - 50 mm) depends on wanted transparency level and the criteria for electricity production. The space between the cells transmits diffuse daylight. Hence, both shading and natural lighting are provided while producing electricity. The solar cell glazing manufacturers usually offer customized products regarding shape, cell material, color and transparency level, i.e. the distance between the cells, whereas Table 4 presents some predefined modules. For example, the transparency level varies from 16 % to 41 % for various solar models, while it is 25 % for the Abakus Solar AG Peak In P210-60 product. The different models from Building System depicted in Fig. 6 are using either amorphous, poly-crystalline or mono crystalline cells with different cell separations.

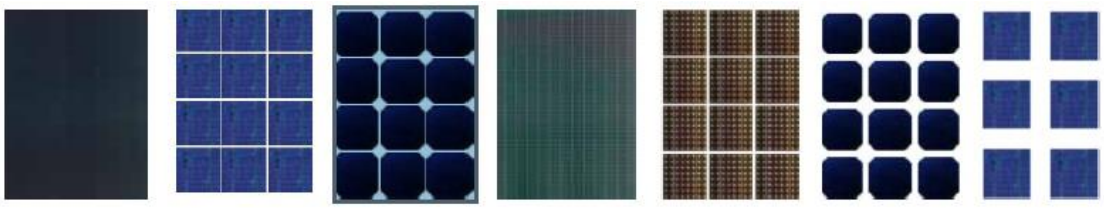


Figure 6. Example of various solar cell glazing products from Sapa Building System [21] using either amorphous, poly-crystalline or mono-crystalline cells with

different distances between the cells.

6-4-2 Building design standards at level of the shape and orientation:

-The main block shape has a fundamental role in the amount of energy consumption by making use of the largest amount of solar energy and natural ventilation. there are factors that must be taken into account while choosing the appropriate shape for the building: 1-taking into account the architectural character while choosing the shape of the block. the shape of the building is affected by the possibility of using ventilation and overall lighting. taking into account the depth of the voids in choosing the appropriate shape in order to achieve natural lighting. studying the ratio of the surface area of the building exposed to light to the total size of the building. in the buildings that are designed to exploit solar energy , the external shape of the building must be taken into account to allow the arrival of an big amount of solar radiation which is converted into electrical energy

6-4-3 Framework conditions for the use of BIPV Systems:

A BIPV system: will be integrated successfully if it is incorporated into the building fabric with good design and structure and with a sensible energy concept. Increasing facade performance expectations have led to the envelope to become a more complex and multifunctional element of a building. New technological developments allow radical changes to the design of facades and roofs while designing the building exterior we need to be aware that the use of PV as part of the

envelope is Important. But it is only one aspect out of a long list of building envelope performance expectations which need to be considered. To accomplish all these building performance expectations PV building products should not only produce electricity, but also be able to fulfill other functions pv buildings products can be truly multifunctional.

PV: **a new design element for buildings**: Today PV can be used in the building envelope to provide: Weather protection- Heat insulation- Sun protection- Noise protection-Modulation of daylight and- Security, Furthermore, PV systems can also be used as small stand-alone power units. They can be used to regulate the intake of daylight to a building by powering an automatic sun-blind, operate an engine-driven ventilation opening or even as emergency lighting. PV also acts as a public demonstration of a building gowner's green, ecological and future-oriented imag

B -Example of architectural successful BIPV Applications:

-PV modules can be added to existing walls:

to improve The aesthetic appearance of the facade. They are simply Added on to the structure. There is no need to provide A weather-tight barrier as this role is already performed By the structure underneath the modules.

Source: ThyssenKrupp, Duisburg-Beeckerwerth, Germany – Thyssen Solartec

-PV modules can also be an integral part of the building façade:

Glass PV laminates, replacing conventional cladding material, are basically the same as tinted glass. They provide long-lasting weather protection and can be tailor-made to any size, shape, pattern and colour. PV modules can be also configured as a multifunctional building element-**Semi-Transparent Facades:** providing a semi-transparent facade. The transparency Glass PV laminates can be applied to windows is normally achieved using either of the following methods:

Source: Oekotherm, Schörflingen, Austria - www.ertex-solar.

-The PV cell can be so thin or laser grooved that it is possible to see through. This will provide a filtered vision to the outside. Semitransparent thin-film modules are especially appropriate for this application. Another option is to use semi-transparent crystalline solar cells.

- Crystalline solar cells on the laminate are spaced so that partial light filters through the PV module And illuminates the room. Light effects from these panels lead to an ever changing pattern of shades in the building itself. The room remains shaded, yet not constrained. Adding layers of glass to the base unit of a semitransparent PV glass module can offer for example thermal and acoustic insulation. Other special requirements can also be designed according to the individual requirements of each application. Such PV glass modules are truly multifunctional building Components.

Source: Norwegian University Science and Technology, Trondheim, Norway - BP Solar Ray

C-Framework conditions for the use of BIPV system:

A BIPV system will be integrated successfully if it is incorporated into the building fabric with good design and structure and with a sensible energy concept. Increasing façade performance expectations have led to the envelope to become a more complex and multifunction element of a building. New technological developments allow radical changes to the design of facades and roofs. While designing the building exterior we need to be aware that the use of PV as part of the envelope is important. But it is only one aspect out of a long list of building envelope performance expectations which need to be considered. To accomplish all these building performance expectations PV building products should not only produce electricity, but also be able to fulfill other functions.

D-PV a new design element for buildings:

Today PV can be used in the building envelope to provide: weather protection, heat insulation, sun protection, noise protection, modulation of daylight and security .furthermore, PV systems can also acts as a public demonstration of a building- owners green, ecological and future-oriented image.

7- **Further integration of photo-voltaic cells** المصدر الطاقة المصدر العربية www.arabia.net

Applied research in the field of building design is directed at two levels: using smart systems to improve the efficiency of their energy consumption, and on the other hand, producing this energy from the building itself, and through developing what is known as self-sufficient energy buildings or zero-energy buildings. Energy self-sufficient buildings depend on combining energy efficiency on the one hand, and generating sufficient renewable energy for the building from environmentally friendly sources.

Applied research in the field of building design is directed towards two levels:

a-The use of smart systems: to improve the efficiency of energy consumption , and on the other hand , the production of energy from the building itself, that is, dimming the building in order to provide the necessary energy for it through modern technologies . through the development of what is known as self – sufficient energy buildings or building zero energy. To demonstrate why energy – simulations make design so much better to apply innovations Energy – design-Feasibility studies and master plans

B- Smart design : implementing energy – sufficient buildings. Begins with smart design. Designers and architects must be highly familiar with all the steps involved in the process of building zero-energy homes and familiar with the implementation of electricity networks and the smart devices connected to them there is a special code for the design that must be adhered to.

C- The smart grid : is an electronic network that includes a set of energy measuring tools such as smart meters, energy storage tools with smart technology, various sensors, and others all of which are compatible with advanced and modern sources of renewable energy , whose function is to control and monitor energy production and distribution .

d-Sustainability : given the numerous and rapid developments in the renewable energy technology sector that have become available in the markets more than ever before , the flexibility of the smart grid allows it to be easily introduced into the system .

E-Reliability : the smart grid uses technology that can detected any damage to the network and repairing it automatically without human intervention stabilizing the electricity supply and reducing damage caused by natural factors.

F- Flexibility: unlike the traditional network , as this results in problems that may be serious such as the occurrence of an excessive amount of current that creates a safety defect on the building's roof. the smart network allows it to work in two directions, so electricity can be distributed from photo-voltaic crescents on the roofs of houses or from wind turbines and others , and it works at the same time to pump the excess amount to the central network outside the building.

G-The human element the smart grid uses data from monitoring devices spread throughout the building to involve residents in the process of energy production and consumption and to educate them on solving the effects of their energy use behaviors . one of the main factors that guarantees the success of the design is that the user , especially the daily tracker of his bank account , can spend and finance during thr application monitoring on his smart phone he receives data about what you consume through sensors on the solar array in homes. The human element is important in zero energy performance .

H-The role of smart systems: innovative applications with multidisciplinary features that integrate renewable and constantly evolving energy sources and their distribution on the network , and monitoring systems by monitoring demand and responding .

K-Smart windows: there is a growing interest in exploiting building windows and making them perform new functions in addition to continuing to function as traditional windows . solar cells are currently being inserted onto the glass of traditional windows to generate energy from the

sun's rays. Window based on magnetic fluids have also been developed to shade rooms to warm them upon request in addition to windows equipped with glass smart , it allows users to control the amount of light and thus the temperature.

L-Solar cells : designed for windows for windows differ from those that we place on the roofs of buildings . we want the latter to absorb sunlight as much as possible so that they can generate the largest amount of energy . as for windows, there is a trade –off between absorbing light by converting it into energy and allowing it to pass through so that we can see through the windows . one of the criteria used in installing these cells is what known as the average optical transmittance , that is the percentage of visible light that passes through . inside , we do not want understand the solar cells to be absorbed by our ability to see , and at the same time we leave them with a sufficient amount of light to produce energy .

M-Smart glass: is currently widely used as a substitute for different types of curtains . it is a type of advanced glass whose property lies in changing its transmittance to light and controlling it through a change in its transparency when it interacts with electricity , heat , or light . there are many types of it that overlap in its manufacture in several scientific and technological fields its application saves the costs of heating , air conditioning , and lighting . it also relieves the building s residents from the constant hassle of installing and changing the position of curtains whenever the surrounding weather changes. It also protects the building from ultraviolet rays, as well as the smart glass devices from damage.

n- **Modern trend :** environmentally friendly construction trends have been reinforced by reaching window coating with materials that reduce cooling and heating costs. These films work to shade windows made of silicon photovoltaic cells that are applied to internal and external glass windows to reduce the amount of ultraviolet rays , visible rays, and infrared rays , which are currently used on a large scale . widely used to improve energy efficiency in buildings. Dr hin lap yip , professor of materials science at china south university of technology , says that these rays spread widely , and we can make these organic photovoltaic panels in the form of semi-transparent, lightweight , and colored membranes, so they become ideal for converting windows into energy generators and thermal insulators that can easily integrated into the smart grid system for zero energy building .

الالواح الشمسية البلاستيكية تقنية تغير قواعد الطاقة النظيفة : مقال بموقع الطاقة - الكا **www: attaqa.net**
تب محمد عبد السند - 10-10-2023

Solar plastic panels :

A new technology that changes the rules of clean energy . an article, from the energy web site , written by Muhammad abdel sanad , dated 10/10/2023

A group of academics has come up with a technology for plastic solar panels that relies on the technology of injecting solar cells into plastic molds .this promises tremendous applications that contribute to enhancing the productivity of electricity generated by this clean source of renewable energy , which has become the ideal solution in the race for carbon neutrality,Researcher hope that this technology , which uses thin organic plastic , will help

converting sunlight into clean sustainable electricity with high efficiency and lower cost, according to reports from the specialized energy platform. In this context , European researchers were able to prove the feasibility of integrating organic solar panels into structural plastic parts via injection molding technology. According to what was reported by pv magazine, the term injection molding refers to a technology used to produce parts by injection molten materials into a mold . this technology can help in developing solar panels inside a mold and enjoy high and stable performance , according to what researchers see. The researchers state that thanks to a design with extremely small thickness, flexible sensitive to friction , which requires strategies to protect them . they point out that integrating printed solar panels into plastic parts would help overcome the challenges related to integration while providing additional mechanical protection . and the ability to adapt to shape . .

Steps to make this discovery:

First , the researchers created solar panels printed in rolls using a light mixture known as P3HT:O-IDTBR, which was tested for its thermal and thermal stability , which is directly related to the injection molding process.

Technical mechanism :

The researchers were able to grow organic solar panels in a horizontal direction in an injection mold made of thermoplastic polyurethane based on ether copolymer . this material was tested at a low temperature during processing and gave high flexibility . the injection process was carried out using a cavity size of 120mm*120mm*2mm

The researchers indicated that they used 64 organic solar panels . 32 solar panels were injected , while 32 other solar panels were kept as refernces,this information came with permission from the specialized energy platform .



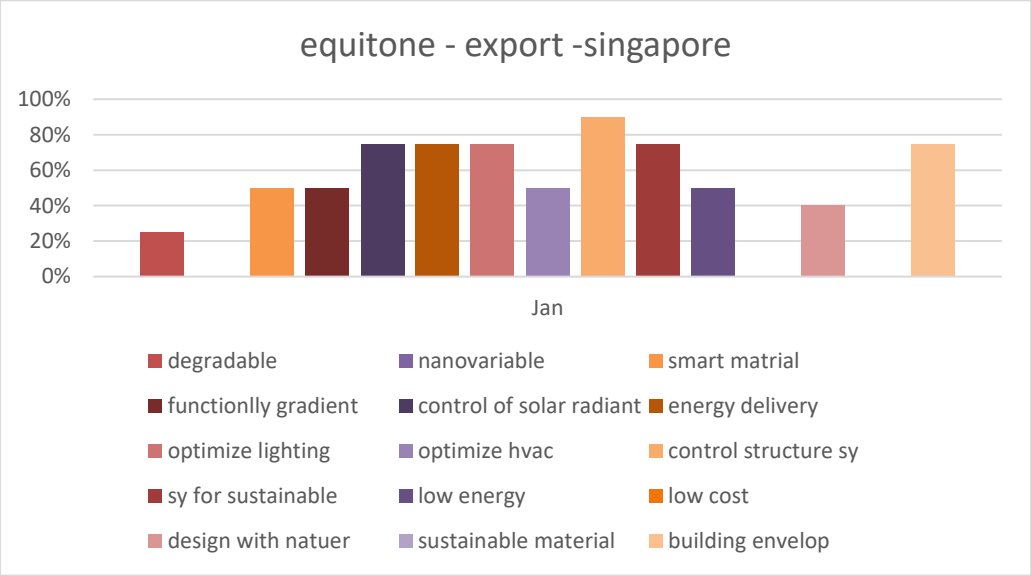
7-Case study:

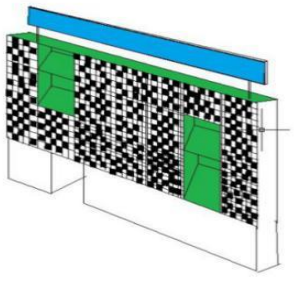
7-1: Equitone –export – Singapore

Architect: KPF, Kohn Pederson Fox Associates, # Singapore A61 Architects, **Singapore.** Ph.: Tim Griffith

In Singapore, one of the world's equitone_ export most densely built-up cities, open spaces are becoming increasingly rare. This led the city authorities to produce a program which stipulates that new high –rise buildings must be designed to include green and outdoor spaces. Known as the "landscape replacement policy for strategic areas "this guideline requires that an area of planted outdoor space at least equivalent in size to the buildings "footprint" must be made for

the users of the building or the public. The podium, a planted terrace extending through three stories, steps down in the direction of the street junction. The generous dimensions of the outdoor areas and the enormous heights are truly exceptional. not only the geometric form but also the fiber cement panels used for the facades facing the terrace make a reference to the nearby market hall " Laue pa sat " from the Victorian era. The project has achieved a green mark platinum rating, Singapore's local equivalent to # LEED, through the design of its planning, envelope and mechanical systems in this example; we find that the architect used solar panels on all facades of the building in order to achieve greater power generation. Architect placed the solar panels on fiber cement tiles, which is an innovative architectural solution that would not have been used before. Form a functional standpoint, and from formation standpoint we find that the architect put the panels are of an ideal architectural design. The panels were placed in a consecutive vertical position and left varying distances between them to create a formation on the facade.





7-2- **Case study: center for Urban Agriculture:**

In this case we can see a new model for Urban Living:

Recognizing the rapidly growing urban environmental and slow-food movements, the project winning competition entry combines all three into a visionary new model for urban life.

A-Innovative Site Response:

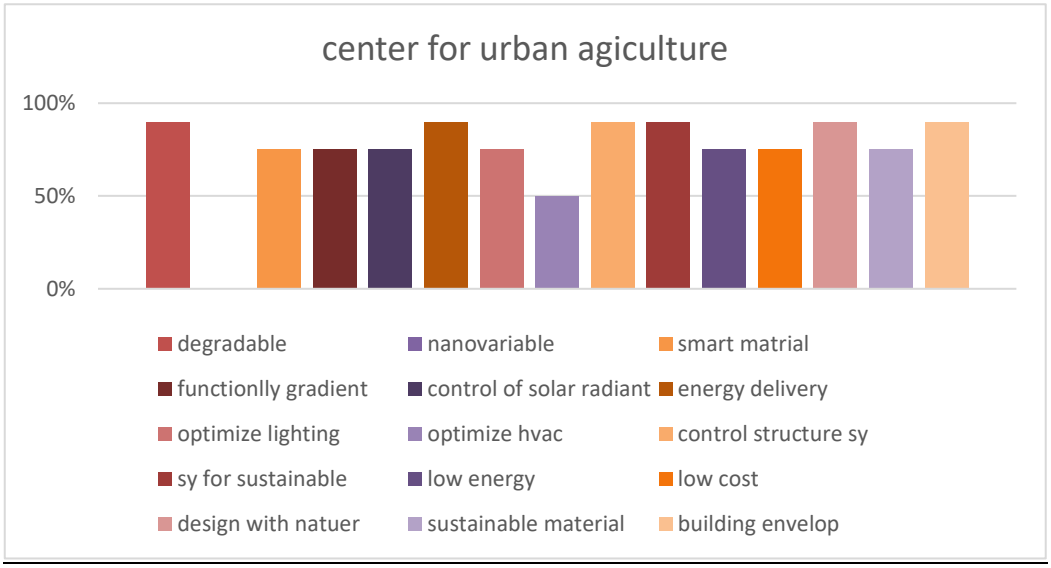
The 21-story structure presents a seek energy producing façade to the south, taking advantage of the open interstate highway landscape beyond for solar harvesting. The remaining land on this challenging, triangular site is dedicated to a vertical agricultural landscape used for education and research on urban food technologies and economics.

B-NET ZERO APPROACH:

The project generates nearly all of its own energy and food on site, with significant reductions in embodied carbon through the use of modular prefabricated building blocks. the 28.6 million gallon storage/ filtration tanks harvest rain and storm water from the site , with potential for a district scale grey water system serving the surrounding neighborhood.This project located in Seattle, Washington, " Food, water, and energy are the focus of the "Center for Urban Agriculture" (CUA) design. Agriculture features include fields for growing vegetables and grains, greenhouses, rooftop gardens, and even a chicken farm. Vertical construction allows for the CUA to incorporate more than an acre of native habitat and farmland on the buildings 72acre site." The CUA was conceived in 2007 in response to the living building challenge competition put on by the Cascadia region Green building Council and awarded the most visionary concept of the 19 entries . Self –sufficiency is the main goal of the Grey water and rain water would be collected, treated, and recycles on site to provide potable water for the entire complex. The CUA would completely independent of city water. The filtering and purifying would occur through the use of greenhouses, planters and bio membrane plants which utilize plants" ability to remove contaminates from water .34,000+surface of photovoltaic cells would collect energy , regulated over the seasons by storage as hydrogen gas in underground tanks." Along with vertical gardens, the CUA would feature 318 units, consisting of studio,1- bedroom, and 2- bedroom apartment . A cafe on the lower level would serve organic food grown on site and the CUA would also be able to sell their produce to local grocers for extra revenue. In analyses the design; architect use same elements of tools architecture as cleaver: In this design, we find that the architect began to use photovoltaic cells, to generate more electrical energy that the building may need.

1-this is form a function point of view and the same time, the aesthetics and ventilation of the façade are not taken care of in placing the cells as the building performs in a non-routine manner so that the building comes out in this wonderful form.

2- we also find that the architect has invented a new method in shaping the façade . he created cavities in the façade which are wall gardens , which is a new method in design . he also used the planting element in the northern façade in most part of the façade.



7-3

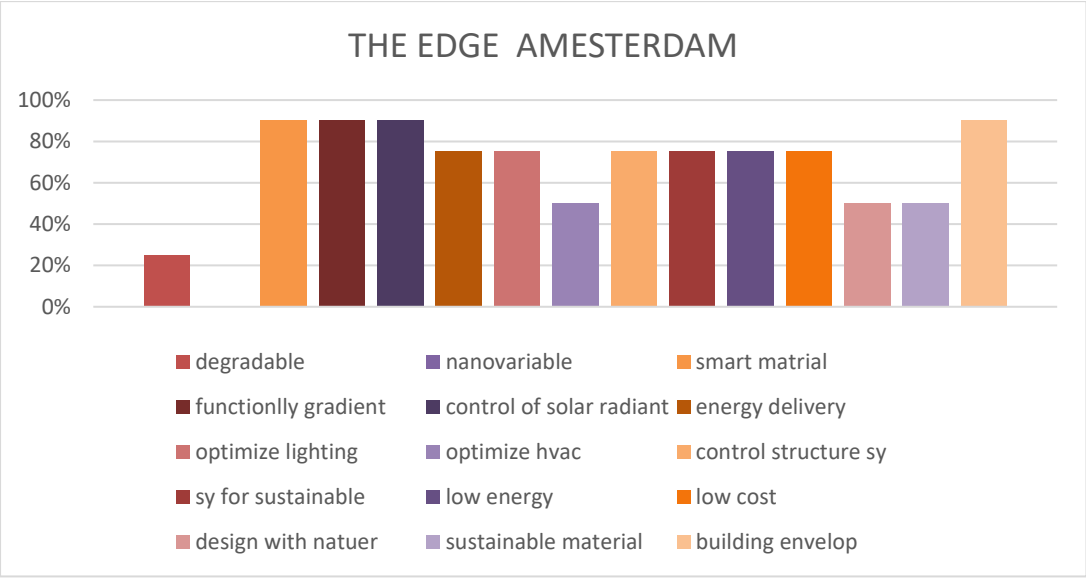
Case study: The EDGE, Amsterdam Source: plparchitecture.com

Plp Architecture was commissioned to design the edge.Deloittes new offices in Zuidas, Amsterdam's business center. The ambition of the project was two-fold: to consolidate Deloittes employees, previously spread around multiple buildings throughout the city. within a single environment , and to create a " smart building , intended as a catalyst for deloittes transition into digital age .the design for the building , which won first prize in the competition and open earlier this year , addressed these conditions directly . what is permeated by layers of technology that fundamentally alter the way that we interact with our environment , how can design augment these virtual frameworks to create places that creates a symbolic display out of the informal collaboration spaces and the multitude of different working atmospheres demanded by new patterns of working – flexible and social and virtually interconnected . The starting point was the design of a social condenser- a nucleus for the building. Taking the form of an atrium interspersed with bridges and exposed lift cores, which act as nodes of horizontal and vertical activity: this nucleus collates a series of social environment in order to galvanize a specific internal working culture. The atrium acts as a giant theatrical device: a stage that is visible from the surrounding offices which are arrayed as an amphitheater around it as well as a lens that broadcasts the multiplicity of social encounters as a civic spectacle to the city beyond.

Awards:

2016 urban land institute global awards for excellence: winner2016 BREEM Award offices – New construction,2016 Your BREEM Award2016 FGH Vast goedprijs(finalist),2016 British Expertise International Awards (outstanding international Architecture project shortlisted)

BREEAM New construction certification of "outstanding" and a score of 98.36 per cent by employing innovative smart technology. BREEM new construction certification "outstanding" and a score of 98.36 per cent by employing innovative smart technology. The scale of the space, and the atmospheres created by a subtle differentiation in materials and lighting. Make the atrium a natural gathering place. . This allows them to work anywhere in the building in varying levels of introspection or sociability : there are work- booths ,focus rooms, concentration rooms, sitting desks, standing desks , balcony desks, along with the many work-station within the sun-filled atrium itself. The building adapts to the users" preferences for lighting and heating via a mobile app, which also allows users to locate their colleagues and find free desks. the combination of app and architecture activity choose the environment, mood and atmosphere they want to work in for different tasks throughout the day .while sustainability as a purely technological narrative has been exhausted by its overuse , the edge creates a radically new working environment which is enabled by sustainable technologies . With the world's highest rating awarded to an office building by the building research establishment (BRE), the global assessor of sustainable buildings, the edge combines numerous smart technologies in tandem to create an adaptable and intelligent working environment. Here we review the way the architect thinks to arrive at the shape of building mass through an analysis of addition or deletion from the building mass with a functional aim ,with the aim of entering the greatest amount of natural lighting into all parts of the building. According to the rotation of the sunshade around the building, the architect also took advantage of the glass façade to place a huge number of solar panels to convert the largest amount of solar capacity into an electrical energy .



7-4:-the TAO ZHU YIN YUAN :also known as Agora Garden (chines :**TAO ZHU YIN YUAN**) en.m.wikipedia .org 21-10-2023 9 mp **AG**

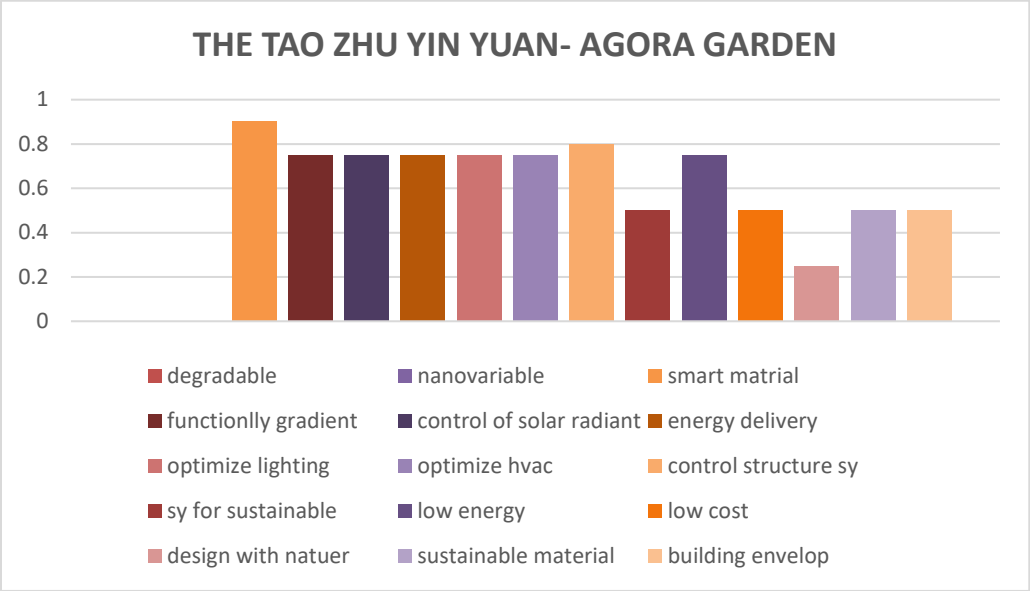
Is a residential high – rise building located in xinyi special district , Taipei , Taiwan . the building has an architectural height of 93.2m with 21 floors above ground and four basement levels , with a floor area of 42,335m2 . the tower was designed by the Belgian architect Vincent callebaut and was completed in 2018 . the building has received a leed gold energy label as well as a diamond level awarded by the low carbon building alliance .

DESIGN:

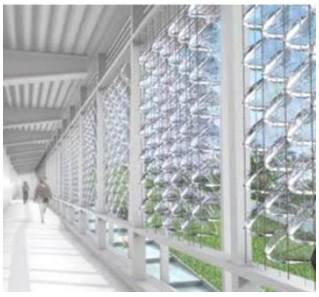
The residential building has a special appearance and is a rare twisting building, which is modeled after a DNA strand in the form of double helix rotating 90 degrees from top to bottom, with each floor rotating 4.5 degree from the previous. The building is covered in approximately 20,000 trees and shrubs , which is aimed to reduce the carbon footprint of Taipei by absorbing around 130 tonnes of carbon dioxide emissions each year.

DNA concept: the main target of " source arch daily .com"" Tao zhu yin yuan " project has been devoted to promoting carbon –absorbing architecture ,in order to decrease the temperature of the earth. Faced with the crisis of global warming and climate change , it is must be participation of all enterprise in urging the governments to draft incentive programs that world lead to carbon reduction in the sector of industry , transportation and daily life .this project also carries out fans philosophy and think of the world as one community . it makes changes that bring benefits to not only ourselves but to neighbour or even the entire world . the architectural concept is to Eco-design an energy self-sufficient building, whose energy is electric , thermal and also alimentary . the "" Tao zhu yin yuan" tower is directly inspired of

the structure in double helix of the DNA (deox yribonucleic acid) source of life , dynamism and twinning . every double helix is represented in the project by two housing units forming a full level

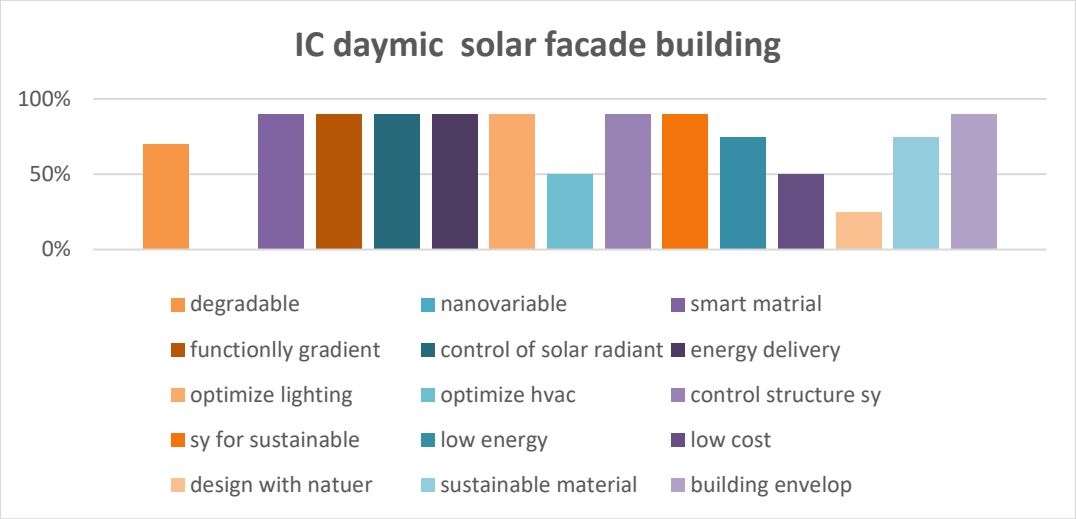


7-5 **integrated concentrating (ic) solar facade system:**



The integrated concentrating solar facade (ICSF) is a building - integrated photo-voltaic system that takes a dramatically different approach to providing interior space with electrical power , thermal energy , enhanced day-lighting, and reduced solar gain. It surpasses existing building integrated photo-voltaic (BIPV) or concentrating PV technologies in these benefits , and new construction . the system integrates architecturally into facades and atria, harvesting solar energy , while still providing outside views and diffuse daylight for the building users, ICSF accomplishes these benefits by miniaturizing and distributing the essential components of concentrating pv technology within the weather - sealed windows of building envelopes . Electricity is produced by an array of pv cells , and much of the remaining solar energy is transported out of the facade as captured , usable heat, the sum effects of ICSF are these valuable energy resources, reduced interior solar gain loads, which reduced loads on HVAC systems , and enhanced interior day-lighting quality, which reduces the need for inferior architifical lighting. The design and operation of the system permits direct partial view shades by building occupants which change and flow over the course of the day, furthering occupants engagement with their environs . the modular design compliments a range of existing building structures, or implemented in new

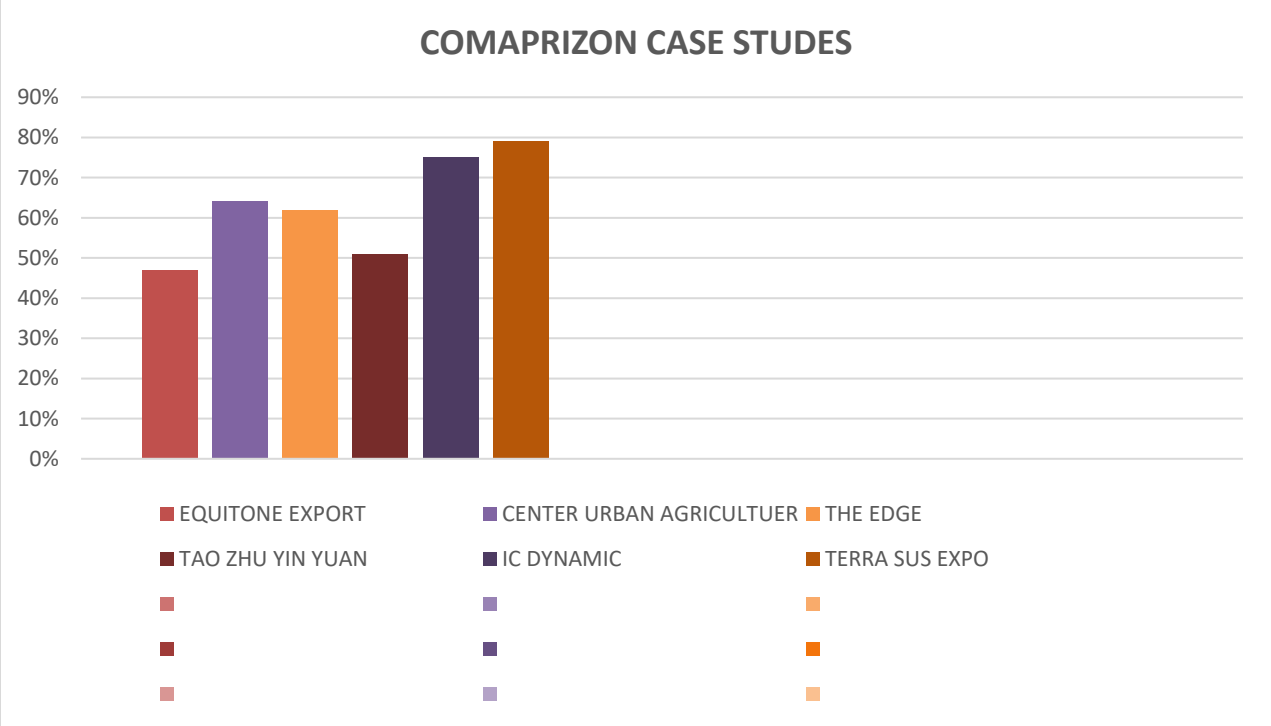
designs , offers bold design opportunities. ICSF has been developed through a series of prototypes, and is currently integrated into building envelopes.



7-6 Terra sustainability Dubai EXPO 2020 :



Sustainability Pavilion came to practical design that fully embraces environmental solution and smart innovations that combined to operate a pavilion energy in the most challenging climate regions in the world .the exhibition consists of a giant solar canopy with a shape inspired by the desert ghaf tree , which is the national symbol of the united Arab emirates. The canopy extends over the entire exhibition area and is designed to capture sunlight and water . the smart trees work to support about 4 gig watt hours of electricity , enough to meet the needs of the entire display . the canopy consists of 4912 solar panels and reaches a width of up to 130 meters , in addition to hundreds of panels spread over the 18 energy trees in the exhibition , which are made of carbon fiber composite , a material used in the aviation industry and high performance .the tree rely on a solar tracking system that controls an axis that allows them to follow the sun throughout the day to improve productivity . the energy produced is used to operate cooling systems as well , in addition to collecting and recycling water. The pavilion extends over an area of 6300 meters . the project was designed by the Grim Shaw Architects office in the united states , which met all sustainability standards the project won the LEED Platinum Award .



project	Innovative material	Building system	Using smart materials

	Biodegradable material	Smart material	Functionally gradient material	Nano materials	control of solar radiation transmiting	Control conductive heat transfer	Energy deliver y	Optimize of lighting	Optimize of hvac system	Control of structural system	System for sustainable	Low energy	Low cost	Design with nature	Sustainble material system	Building evelopand facade system	
Equitone – export – Singapore	25 %	50 %	50 %		75 %	75 %	75 %	75 %	50 %	90 %	75 %	50 %		40 %		75 %	805
center for Urban Agriculture:	90 %	75 %	75 %		75 %	75 %	90 %	75 %	50 %	90 %	90 %	75 %	50 %	25 %	75 %	90 %	1100
The EDGE, Amsterdam	25 %	90 %	90 %		90 %	75 %	75 %	75 %	50 %	75 %	75 %	75 %	75 %	50 %	50 %	90 %	1060
the TA	25	90	75		75	75	75	75	75	80	50	50		25	50	50	87

OZHUYINYUAN	%	%	%		%	%	%%	%	%	%	%	%		%	%	%	0
Ic dynamic solar facade	70%	90%	90%		90%	90%	90%	90%	50%	90%	90%	90%	50%	100%	100%	100%	1280
Terra sustainability Dubai EXPO 2020	70%	90%	90%		90%	90%	90%	90%	75%	100%	100%	100%	75%	100%	100%	90%	1350

Figure15 shows integrated photo-voltaic cell roof building design source by researcher

2.

Figure13,14 shows integrated photo-voltaic cell facade building design source by researcher

8-**Conclusion:**

We can summarize what we have achieved as follows: Architectural formation and technical development have a strong direct relationship due to the technical development that reveals the vocabulary of architectural formation . this led to a shift in the design concept of architects.as the technical developments of materials gave properties and modern techniques to materials that did not exist before, this gave the architect greater freedom to shape the building, as well as raising the efficiency of building operation to professional levels , for example being satisfied with the energy generated from the buildings construction materials . these architectural solutions and technology with the aim of arriving at architectural solutions freed from adherence to the methods of the past . the process of architectural formation was also affected by new design concepts , which include flexibility in forming architectural spaces , flexibility in designing internal and external spaces , compatibility of architecture with the environment and flexibility in the use of materials such as glass walls integrated with photo-voltaic cells that achieve multiple architectural solutions.

“we can design and formation the building by renewable resources are consumed throughout the process of design .to producing sustainable and sufficient building “

“BIPV” are reliable and environmentally responsive source of renewable energy . with the high solar availability “BIPV” applications offers a tremendous opportunity for designers to provide energy cost savings to building owners, reduce peak energy loads for utilities and minimize environmental degradation for everyone. High initial costs and design constraints have impeded

the economic program of “BIPV” applications. The economic and environmental attractiveness of building integrated photovoltaic continues to grow.

Finally “BIPV” may be seen as suitable addition to architectural programs where designers and owners want to create an aesthetically appealing building with distinctive and useful “architectural features “ economic trends indicate that price of “BIPV” will continue to decrease while the efficiency of PV generated electricity will continue to increase .

1. – Photovoltaic cell also play an increasingly important role in energy production, energy conversion, and energy storage. as catalysts in industry, nanomaterial help produce approx. 90% of all chemical products with reduced consumption of raw materials and energy. Nanomaterial have become a "sine qua non" for the production of integrated circuits, for more precise and small structures ,or the manufacturing of lithography lenses in the electronic industry. Thin layers of only a few nanometers have been used for data storage in our computers and electronic device.
2. - Solar cells are an environmentally friendly and elegant alternative or supplement to energy production from fossil fuels. For this reason, research activities regarding new material developments are of great energy-strategic importance. Energy- efficient solar cells72% Energy consumption. Reducing the production costs of photovoltaic cells and modifying their performance up to five times more productive than conventional cells with increased importance lifetime are only possible through Nano layers. Thus the future design of solar cells will be based on nanometer-thin Layer systems. The steadily growing demand for high-capacity. Powerful energy storage systems are an essential precondition for the widespread implementation of decentralized energy converters (photo-voltaic, wind-power turbines).
3. - Nanostructures in fuel cells and photovoltaic (organic, hybrid systems, thin-layer technology could contribute to a sustainable energy supply from renewable energy sources while minimizing co2 emissions. Nanostructures with high yield could also be used for light generation, for example in Organic Light Emitting Diodes (OLEDs), I.e. For efficient energy conversion, and thus enable new concepts e.g. wide area lighting. Conductive Nano-objects as well as the application of new methods of printed electronic-saving circuits (e.g. RFID)
4. - Nanomaterial in electric energy stores, such as the coming generations of lithium-ion batteries, will help store large energy amounts in a minimum space losing hardly any energy even after longer storage times. Moreover, nanostructured materials (metal hydrides, metal-organic frameworks) could be utilized for non-electric energy storage, e.g. .of hydrogen. Suitable nanostructured catalysts generally support process optimization in production processes due to their highly efficient specific surfaces.

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