MAIA-TAQA - Mobilizing new Areas of Investments And Together Aiming to increase Quality of life for All

Report on the Amman pilot project definition

WP3 Development of sustainable services in the MED area (pilot cases)

Output 3.1 Detailed design of the pilot project

WP leader: QUIPO

Responsible partner: Jordan Chamber of Commerce

Contributing partner: Centre for Renewable Energy Sources and Saving - CRES

Date Version Comment

9/9/2021	1st	-

Contents

Abbreviations

ASCAME Association of the Mediterranean Chambers of Commerce and Industry

CRES Centre for Renewable Energy Sources and Saving

JOCC Jordan Chamber of Commerce

Abstract/summary

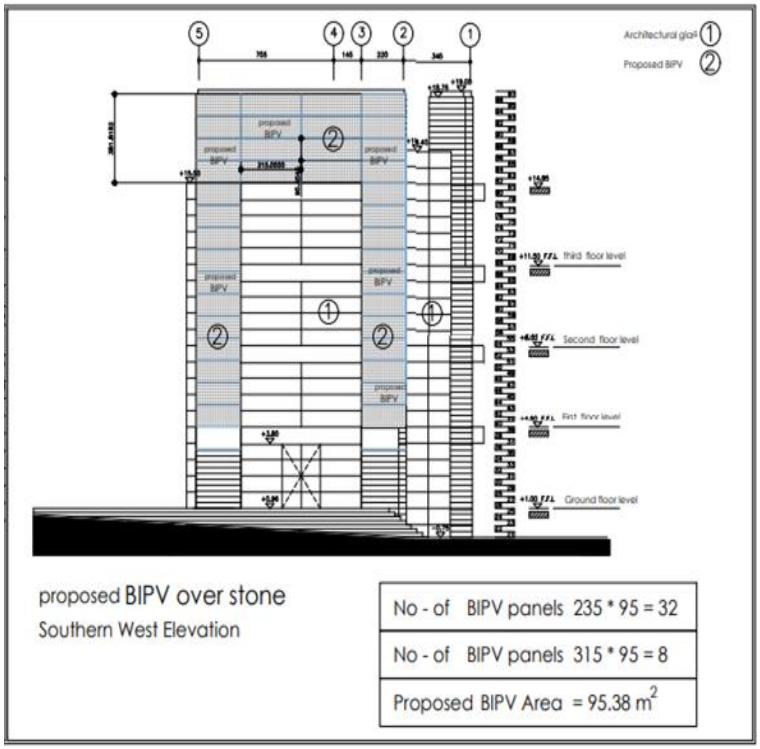
This report was elaborated in the framework of Output 3.1 “Detailed design of the pilot project” of the MAIA-TAQA project. The objective of this output was to identify the resource efficiency service to be piloted in Jordan and to specify the technical details of the pilot project in terms of beneficiary, location, technology and sizing. The effort was led by the Centre for Renewable Energy Sources and Saving, which cooperated with the Jordan Chamber of Commerce,

MAIA -TAQA partner in Jordan, towards the definition of the pilot project. The partners followed a carefully designed methodology that included a desktop research, a series of roundtable discussions with important stakeholders, an onsite technical visit, and the employment of dedicated software for the elaboration of a feasible solution from a technical and economic point of view, taking into account end user requirements and project budget restrictions. The proposed solution to install Grid Connected Solar BIPV (Building Integrated Photovoltaic solar system) in the façade of Jordan Chamber of Commerce building at the south east and south west elevations but in stages depending on the availability of the funds, capacity of 14 KWp BIPV system that will cover 20% of the building electricity demand.

Amman pilot project definition MAIA-TAQA Solar BIPV Plant **(Building Integrated Photovoltaic solar system)** at JoCC building - Amman

Description of the Building / Site / Owner Owner Jordan Chamber of Commerce Location: Amman, Jordan Type of building: Office building Electricity area: ground floor and five floors of around 1000 m^2 General Description of the system The 2nd pilot project in Jordan aims at improving and upgrading the provision of power at JOCC's main building in Amman by installing a Building Integrated Photovoltaic System (BIPV). This project is implemented in the framework of the European project: Mobilizing new Areas of Investments and Together Aiming to increase Quality of life for All - MAIA-TAQA, which is funded by the EU under the ENI CBC Med Program. By this project JOCC will install Grid Connected Solar BIPV (Building Integrated Photovoltaic solar system) in the façade of the building at the south east and south west elevations, but in stages depending on the availability of the funds.	Technical Characteristics 5 floors including the ground floor, with a total height of 20.5 m up to the highest point of the structure **pls. refer to page 6 (project description)** **Solar BIPV** Solar type: tempered Glass **pls. refer to page (7 – 10) Proposed installation method , option 1 and option 2** **PV glass configuration** - Total thickness : 13.80 mm **pls. refer to page 10 and 14** **Nominal power capacity**: 14 kW **Configuration**. pls. refer to page 10 -14 **Existing system: JEPCO** Grid connected system is a system supplying the excessive power generated during sunny days to the main national grid and import it again if the generated power in other day or night time is not enough (the invoice will be for the net power (imported power from grid KWh – exported power to the grid KWh) * cost for KWh . if the export power is higher than the imported, the cost will be approximate zero . If vise versa , the cost will be for the difference only. In other words, main national grid is used as storage

Building Integrated Photovoltaic solar system



Methodology of the Amman pilot project :

JOCC PILOT PROJECT definition:

With the aim of devoting a culture of energy conservation in society, and within the framework of the national strategy to spread community energy awareness, and to achieve the Chamber's goals in the field of studies, research, and pilot projects within Renewable Energy & Efficiency Jordan Chamber of Commerce has signed a contract for preparing consultancy services to implement a Building-Integrated Photovoltaics (BIPV) system at JOCC with Creative Engineering & Environment Company on 10/2/2021 at JoCC premesis.

Objective:

Jordan Chamber of Commerce JOCC intends to use BIPV system in its existing building located in AMMAN / JORDAN and Creative Engineering & Environment (CEE) is a consultancy firm with relative experience that will perform the consultant services to reach the goal.

This report was done to confirm the structure of the building can stand all new installations , aims to perform a technical feasibility study for the implementation of the BIPV system at JOCC building in Amman to generate power via environmentally safe systems to reduce the value of power invoice and to decrease the quantities of CO2 released to the environment during the expected life time of the system which is expected to be 35 years and to estimate approximate cost, benefits and payback period of the investment to implement the BIPV system.

The system will be connected to JORDAN ELECTRIC POWER COMPANY network via a net metering system. The methodology followed for the definition of the pilot project in Amman included the following stages:

1. A technical feasibility study for the implementation of the most suitable BIPV system at JOCC building in Amman.
2. The study should be accompanied by a structural evaluation of the building Façade to

support the new proposed photovoltaic system;

3. Preparation of tender documents for the implementation of the above BIPV system;
4. Technical assistance offers evaluation and final project acceptance.

Pre-evaluation of the RE service and building and local market

During the pre-evaluation phase, the RE technologies with high perspectives in the area were examined through a desk analysis. For the MAIA-TAQA pilot project in Jordan, the BIPV technologies with innovative features which could be applied in the pilot project were examined.

The result of the desk analysis and the primary selection of BIPV system, as RE service in Jordan pilot project, was firstly discussed during the MAIA-TAQA Kick-off meeting – Round table discussion among CRES, JOCC, Arab Renewable Energy Commission - AREC, EBHE, ASCAME in 2nd of October 2019 in Pikermi, Greece.

Picture 1: Round-table discussion on the pilot project in Jordan during the kick-off meeting of the project on the 2nd of September 2019.

On-site technical visit

After the pre-evaluation of the pilot project, an on-site visit at the selected building of “Amman chamber of commerce” in Jordan was organized. The objective of the visit was to examine the compatibility of the building for the installation of BIPV system and to collect further necessary input for the pre-design of the system.

Project Description

JOCC building located in AMMAN / JORDAN consists of 5 floors including the ground floor, with a total height of 20.5 m up to the highest point of the structure.

Façade of the building is composed of two main components,

1- Double glaze glass with 16 mm spacer.

2- Natural white stone.

The building is almost square shape and it is oriented with four elevations facing as following: - South east North east

North west South west

The two elevations (north east and north west) are subjected for shadow most of the day time, so they are not suitable to be used for BIPV system and will be excluded from the study,

The other two elevations are facing the sun most of the time and could be great help for BIPV system.

Photos of existing building

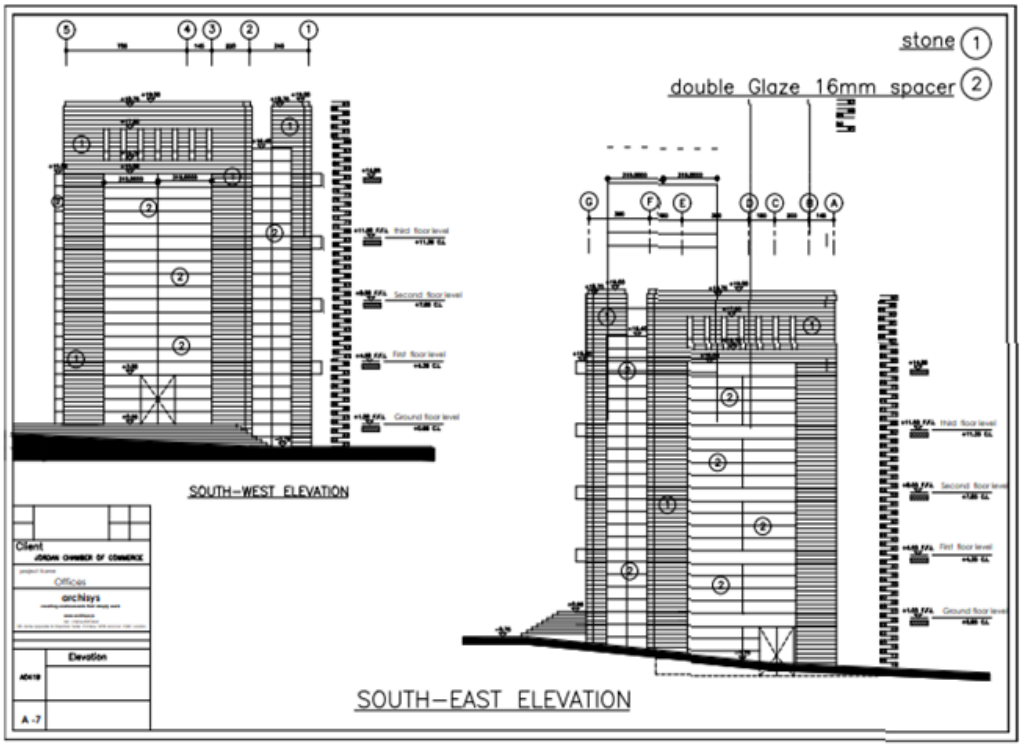
South- East Elevation

South- East Elevation

South- West Elevation

Proposed installations methods

CEE will examine in the forthcoming pages, the feasibility of a photovoltaic integration in the Jordan Chamber of Commerce, located in Amman, Jordan. We have included 2 options, both options include glass facing SE and SW orientations.



OPTION 1: Install photovoltaic glass above stone area

SPANDREL glass (GL.01 and GL.02): mono crystalline technology in the spandrel area of the façade. Glass sizes: 3150x950mm. (GL.01) and 2350x950mm. (GL.02). Glass configuration: 6+6mm. with ceramic back frit (RAL to be determined). The glass configuration is the same for GL.01 and GL.02

These dimensions and configurations offered can be changed according to the requirements of the architects. All figures showed in this presentation are prepared as a hypothesis that should be studied in depth in the future, in case the project moves forward.

As per previous CEE report, CEE select the monocrystalline technology for two types of installation because of high power produced, more CO2 savings, economic reason and short time of payback period.

OPTION 2: Replace existing glass with photovoltaic glass

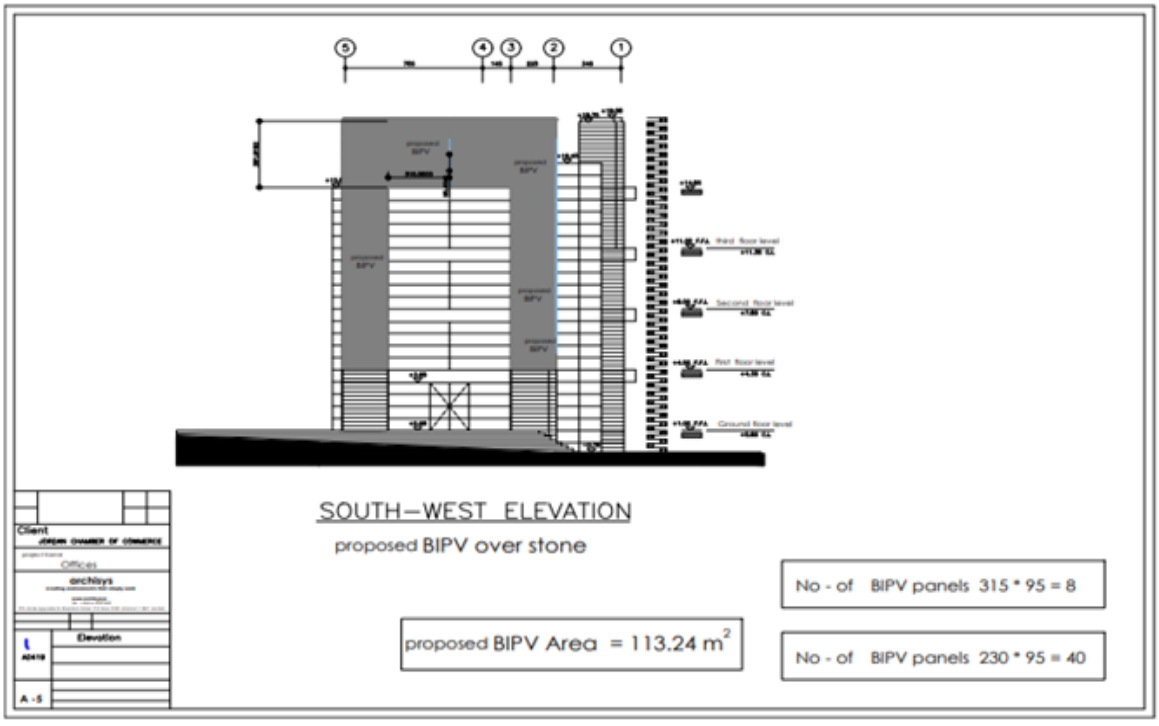
CURTAIN WALL glass (GL.03 and GL.04): mono crystalline technology in the curtain wall area of the façade. Glass sizes: 3120x950mm. (GL.03) and 1180x950mm. (GL.04). Glass configuration: 6+6mm. with a 12mm Argon chamber and a rear tempered glass of 6mm. With Low-E coating. The glass configuration is the same for GL.03 and GL.04. power connected is 43.06 KW p.

OPTION 3: To merge the above two options

Merging the above two option will give more power which is equal to summation of both environmental and economic benefits and it is required to cover the complete power bill.

1- Install photovoltaic glass above stone area

This will increase the total amount of electricity produced when covering the stone facades, the dark glass will be provided for this area. **As shown in the below drawing:**

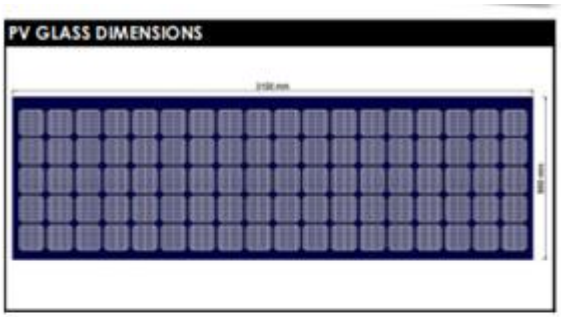


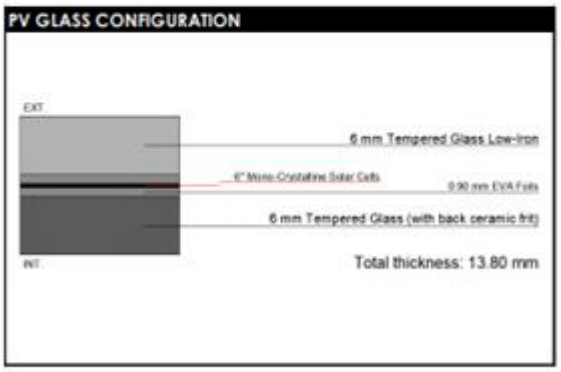
A- CAPACITY KW p

B- Transparency of glass (no transparency) as shown below

C- LEED CREDITS

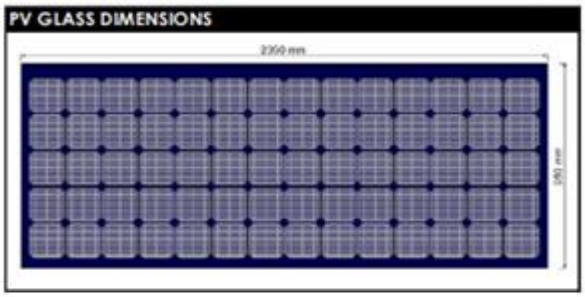
GL 01

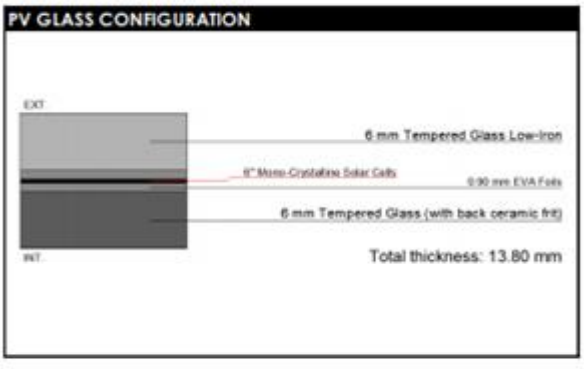




GLASS PROPERTIES	Onyx Equivalent Glass
Light Transmission	0% (opaque)
U-value [W/sqm.K]	N/A
Peak Power [Wp/sqm]	138,3

GL 02





GLASS PROPERTIES	Onyx Equivalent Glass
Light Transmission	0% (opaque)
U-value [W/sqm.K]	N/A
Peak Power [Wp/sqm]	144,2

D- SUMMARY TABLE

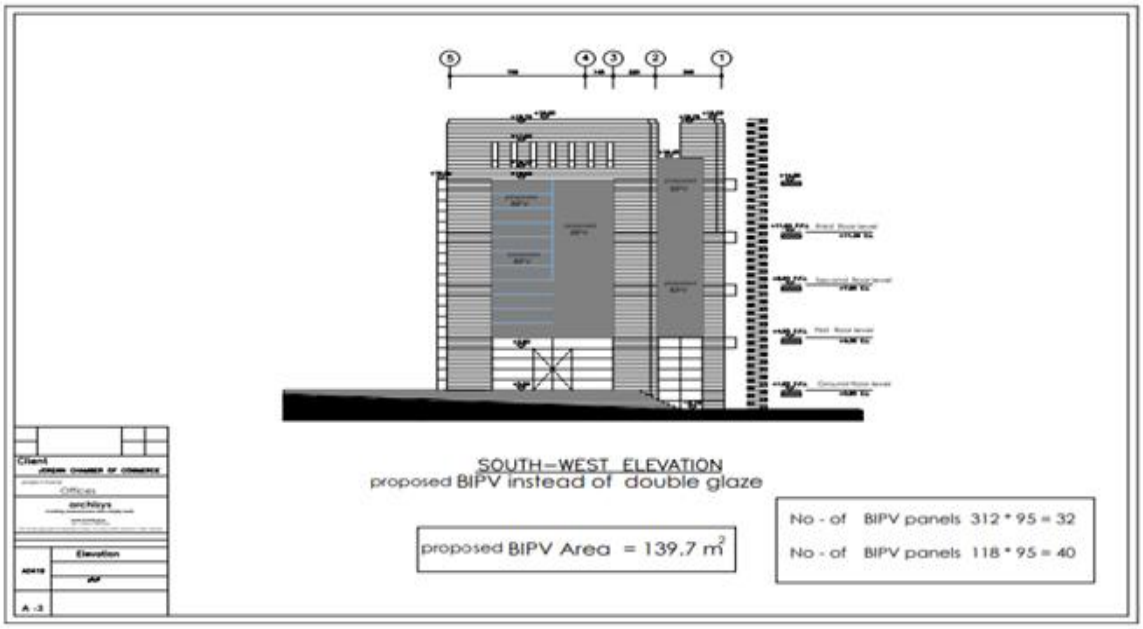
Install photovoltaic glass above stone area

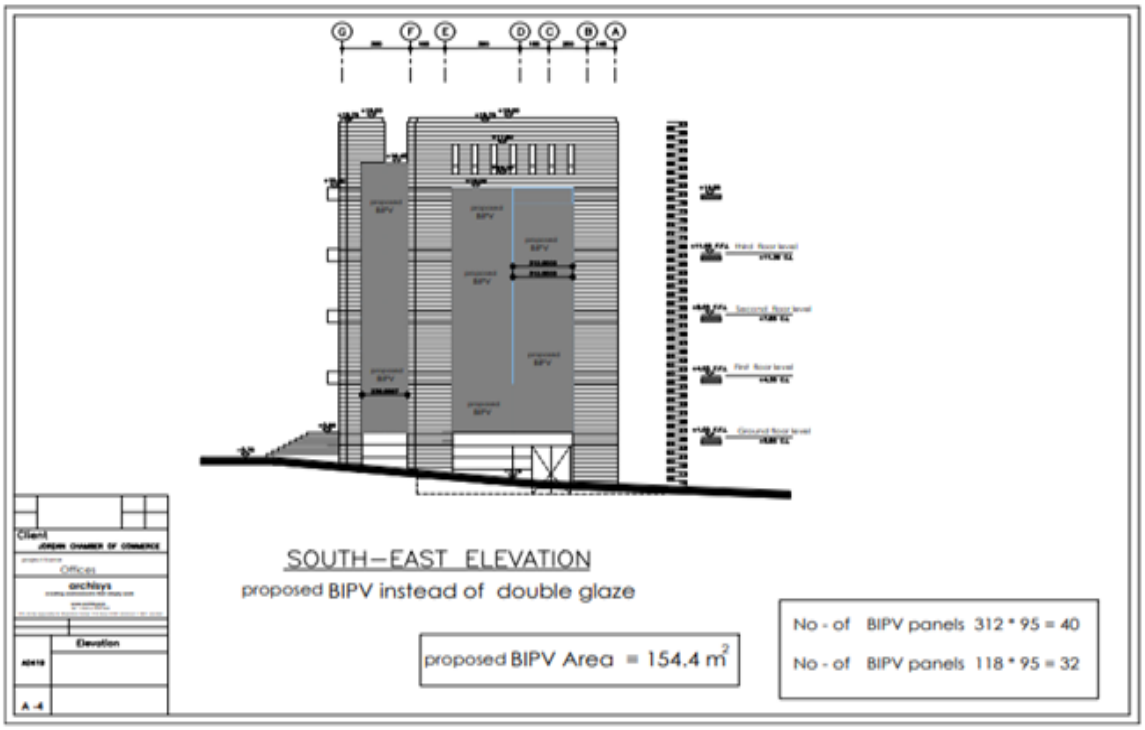
ENVIRONMENTAL BENEFITS	
Benefits Surface	226.48 Sqm
Power installed	32.38 KWP
Electricity generated	1,147,185 KWh
Light points	2,254
Cars off the road	22 cars
Tons of CO2	731
Barrels of oil	675Barrels of oil107325 LITRES OF OIL
Trees planted	226

ECONOMIC BENEFITS	
Value of the electricity generated /35 years including inflation	286,652 JOD
Net investment= price of BIPV glass including maintenance – price of traditional glass	42,868 JOD
Total investment	70,000 JOD approx..
Profit obtained	243,784 JOD
Times that the investment is recovered	7.5 Years
Medium annual rent ability (IRR)	16.5%
Payback time	6.8 years
Saving time	28.2 years

2- Replace existing glass with photovoltaic glass

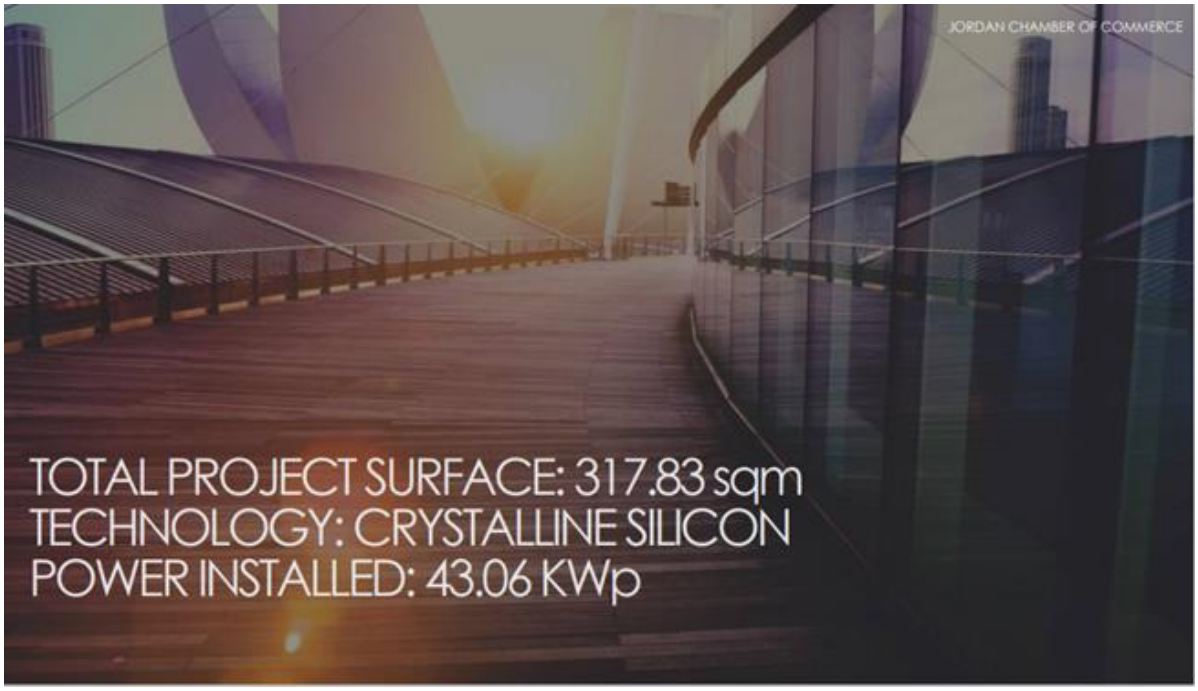
The existing double glazed on the facade is 6 x16 x 6 mm (16mm spacer) and will be replaced by the same double glazed photovoltaic with spacing 16mm between the external internal glass. The internal 6mm is clear ordinary glass while the outside glass is with 37 % transparency with built in photovoltaic layer that when sun rises it produces DC current that will be converted to AC current (using special invertors).



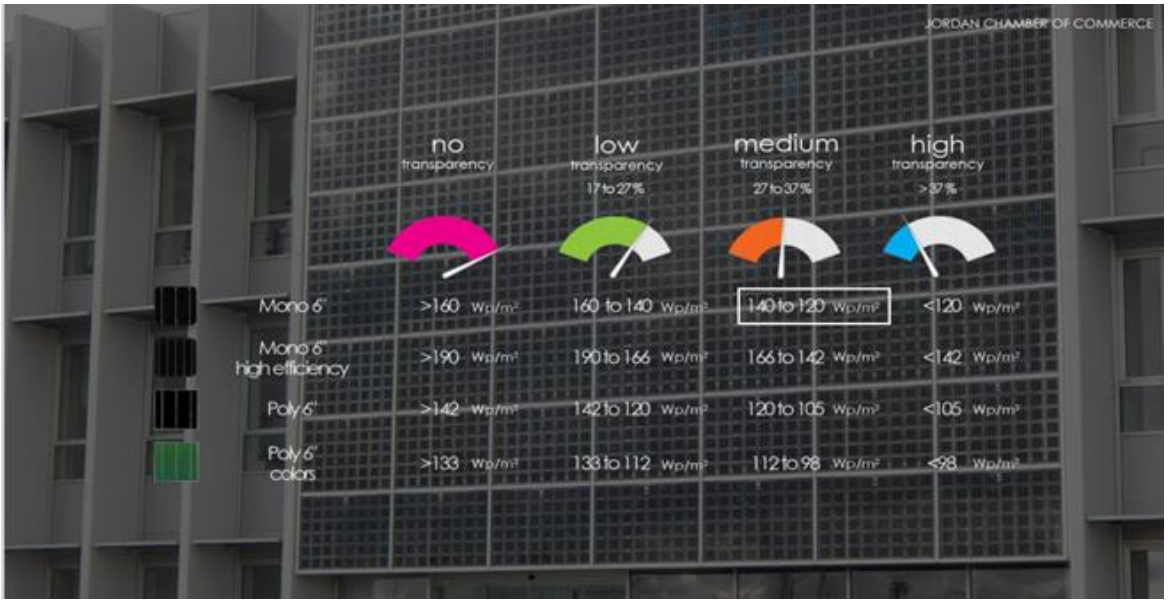


shown in the below drawing:

A- CAPACITY KW p

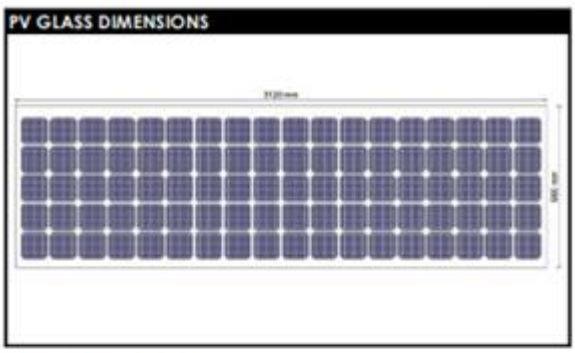


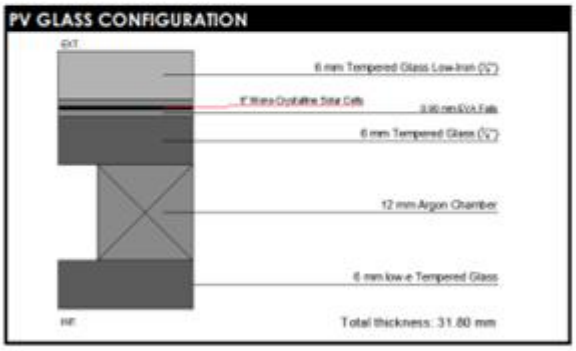
B- Transparency of glass (medium transparency 27% -37%) as shown below:-



C- LEED CREDITS

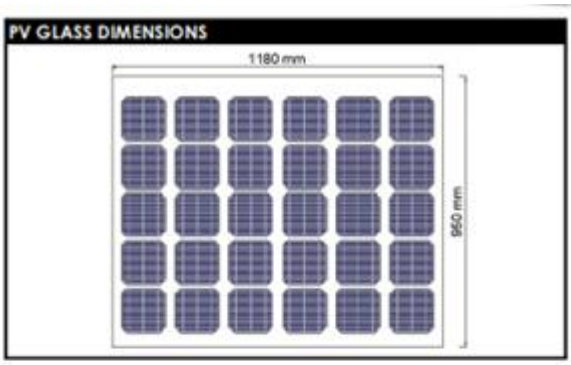
GL 03

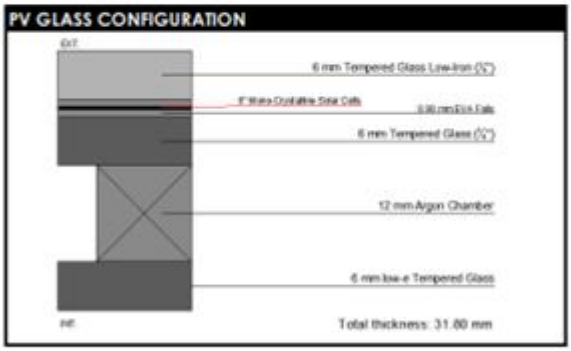




GLASS PROPERTIES	Onyx Equivalent Glass
Light Transmission	30%
U-value [W/sqm.K]	1.2
Peak Power [Wp/sqm]	139.7

GL 04





GLASS PROPERTIES	Onyx Equivalent Glass
Light Transmission	38%
U-value [W/sqm.K]	1.2
Peak Power [Wp/sqm]	123.1

D- SUMMARY TABLE

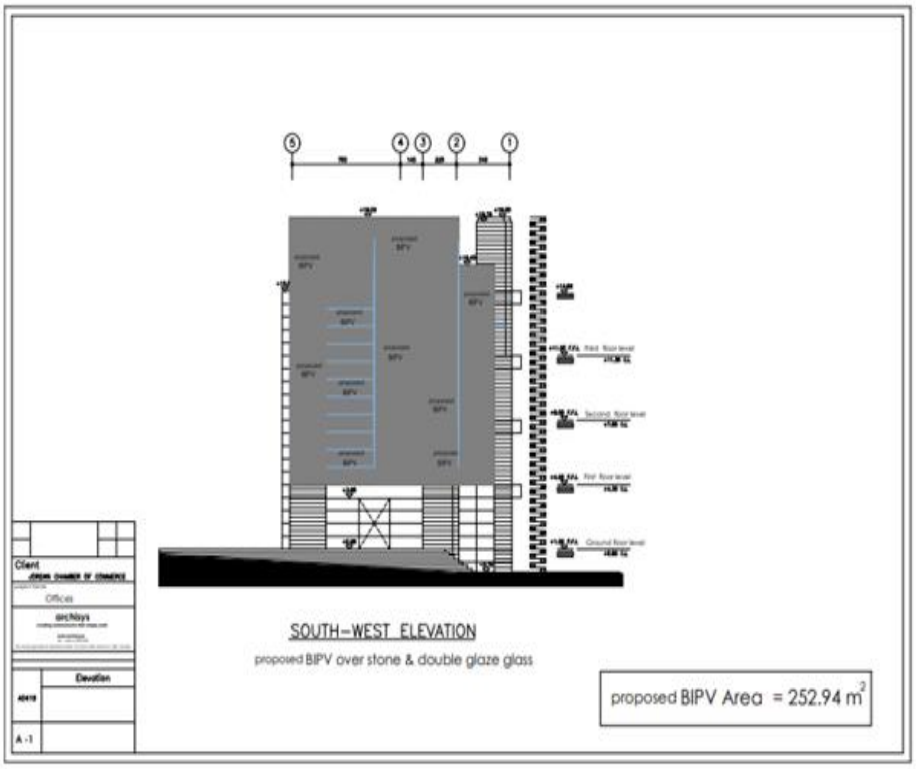
Replace existing glass with photovoltaic glass

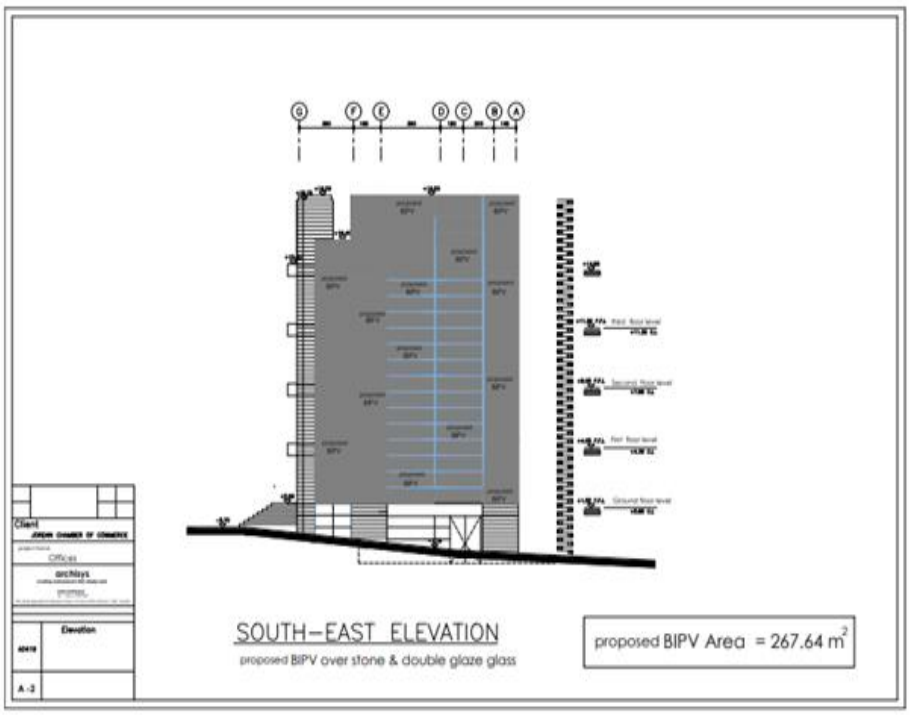
ENVIROMENTAL BENEFITS	
Surface	317.83 Sqm
Power installed	43.06 KWP
Electricity generated	1,526,200 KWh
Light points	3,000
Cars off the road	30 cars
Tons of CO2	972
Barrels of oil	898Barrels of oil142,794 LITRES OF OIL
Trees planted	318

ECONOMIC BENEFITS	
Value of the electricity generated /35 years including inflation	381,358 JOD
Net investment= price of BIPV glass including maintenance – price of traditional glass	46,085 JOD
Total investment	85000 JOD approx.
Profit obtained	335,273 JOD
Times that the investment is recovered	8.3
Medium annual rent ability (IRR)	18.9%
Payback time	5.6 years
Saving time	29.4 years
Building's value increase	78,810 JOD depending on the value increase rate

3- Combination of the two methods of installation

For more power both methods of installation should be used as per below drawings: -





SUMMARY TABLE

Replace existing glass with photovoltaic glass& Install photovoltaic glass above stone area

ENVIROMENTAL BENEFITS	
Benefits Surface	544.28 sqm
Power installed	75.44 KW p
Electricity generated	2673385 KW h
Light points	5,254
Cars off the road	52 cars
Tons of CO2	1703
Barrels of oil	1573Barrels of oil250107 LITRES OF OIL
Trees planted	544

ECONOMIC BENEFITS	
Value of the electricity generated /35 years including inflation	668010 JOD
Net investment= price of BIPV glass including maintenance – price of traditional glass	88953 JOD
Total investment	155,000 JOD approx..
Profit obtained	579057 JOD
Times that the investment is recovered	6.7 Years
Medium annual rent ability (IRR)	15.5 %
Payback time	6.3 years
Saving time	28.7 years

Building's value increase	138050 JOD depending on the value increase rate

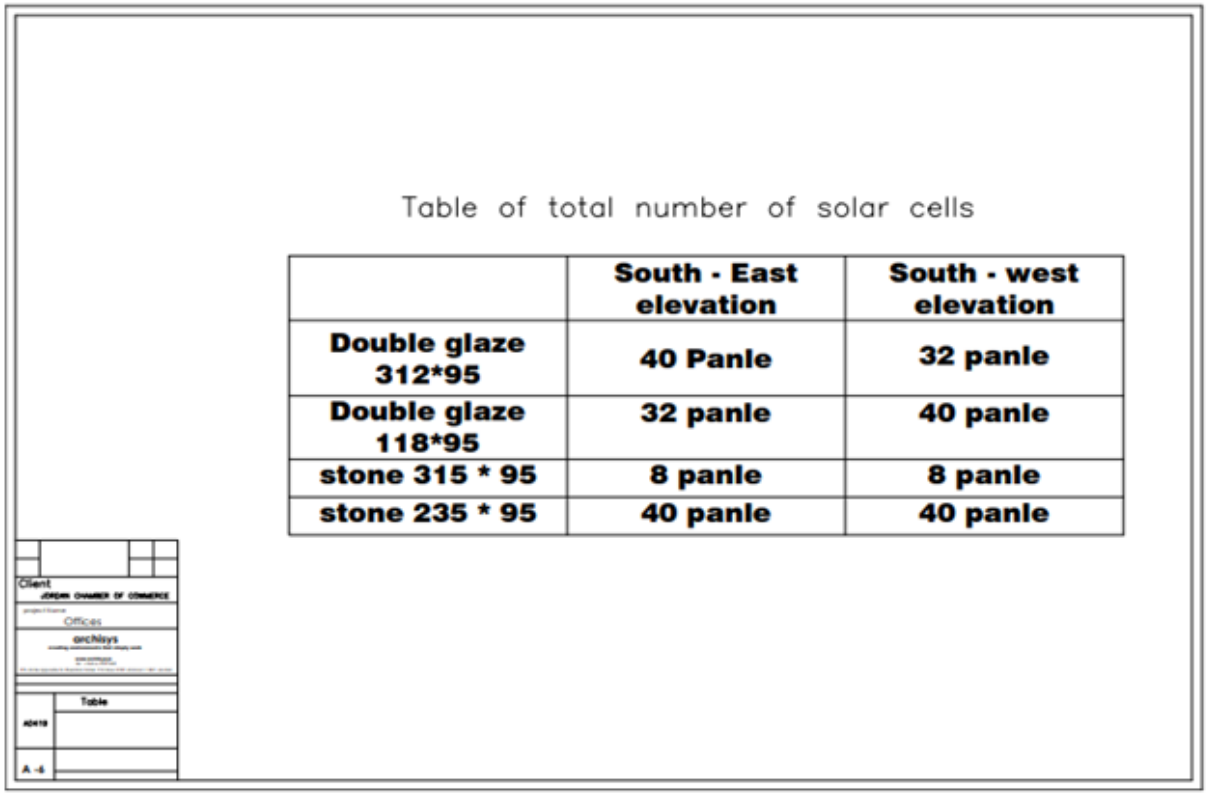


Table of total number of solar cells

	South - East elevation	South - west elevation
Double glaze 312*95	40 Panle	32 panle
Double glaze 118*95	32 panle	40 panle
stone 315 * 95	8 panle	8 panle
stone 235 * 95	40 panle	40 panle

Analysis of study

Option #	Total Estimated investment cost JOD	Estimated investment cost JOD= Total investment – price of conventional glass	Value of Power generated / 35 years JOD	CO2 Saved Ton	Pay Back period years	Profit Obtained JOD
1	70,000	42,868	286,652	731	6.8	243,784
2	85000	46,085	381,358	972	5.6	335,273
3	155000	88953	668010	1703	6.3	579057

Technical Specifications

Site Information

The BIPV plant is to be located on the JOCC building located in AMMAN as indicated in Section 8. The 0.4 kV interconnection point is at the GL of the building.

General Specifications

The system design and equipment for the BIPV plant shall be of proven technology, in accordance with best industry practice and with a strong track record in similar environments experience at the site. Equipment should have a design life of 35 years.

The system is to be designed and installed in accordance with the most recent version (including amendments) of the following standards and codes:

- JEPCO GRID CODE FOR POWER SYSTEM.
- AS/NZS 1768:2007/ IEC 62305 : 2006. - Lightning Protection.
- AS/NZS 1170.0:2002 Structural Design Actions - General Principle.
- AS/NZS 1170.1:2002 Structural Design Actions - Permanent, Imposed and other actions.
- AS/NZS 1170.4:2007 Earthquake Actions.
- IEEE 998 :2012

1.electrical Installation

For Electrical installation works, it is assumed to comply with latest Technical Specification and Standards.

For DC System, the following IEC standards, but not limited to shall be adhered:-

- IEC 61727:2004Photovoltaic (PV) Systems - Characteristics of the Utility Interface
- IEC TS 61836 Solar photovoltaic energy systems
- IEC 60364-7-712 - Low voltage electrical installations – Part 7-712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems
- IEC 62116:2014 - Utility-interconnected photovoltaic inverters – Test procedure of islanding prevention measures
- BS EN 60068-2-14:2009 - Environmental testing
- IEC 61215 - Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1-1: Special requirements for testing of crystalline silicon photovoltaic (PV) modules
- IEC 61646 – Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval
- IEC 61730 – Photovoltaic (PV) module safety qualification
- IEC 61701 – Salt Mist Corrosion Testing of Photovoltaic (PV) Modules
- IEC 61853-1 – Photovoltaic (PV) module performance testing and energy rating – Part 1: Irradiance and temperature performance measurements and power rating
- IEC 62109-1,2 – SAFETY OF POWER CONVERTERS FOR USE IN PHOTOVOLTAIC POWER SYSTEMS - PART 2: PARTICULAR REQUIREMENTS FOR INVERTERS
- IEC 61683 – Photovoltaic Systems - Power Conditioners - Procedure for Measuring Efficiency

2. Civil Works

1. Any civil work during installation such as drilling, coring, or repairing any defects appears because of BIPV installation should be amended urgently

3. PV Modules

2. Installed BIPV Array DC Capacity to be 14 kW at least.

3.All modules provided are to be of identical make and model and must be from a recognized BIPV module manufacturer.

4. Modules must be warranted to produce at least 90% of their nominal output (at STC) after 10 years, 80% of their nominal output after 25 years, and have a defects warranty period of at least 10 years. A warranty statement for the make and model of the module proposed must be provided. The statement must define when the warranty period starts,

5.Modules must be certified to the international standard IEC 61215 (or IEC 61646 as applicable) and IEC 61730, and have been tested at a qualified testing institution (e.g. ESTI, TUV Rhineland, or equivalent). Testing certificates must be provided.

6.Modules to be special for BIPV system as shown in drawing section 8

7.Bypass diodes are required on each module.

8.Standard locking connectors (e.g. MC-4 or equivalent) certified to EN 50521 are to be included with the modules. Non-locking connectors (e.g. MC-3 or equivalent) are not to be used.

9.Each module must be fitted with a manufacturer's sticker on the underside, providing the following information:

1. Manufacturer's name;
2. Module model number;
3. Module serial number;
4.Rated power at STC;
5. VOC, ISC, VMP, IMP;
6.Date of manufacture;
7.Country of manufacture.

4.PV Mounting Structure

1. The array mounting structure must be made of stainless steel (grade 316 or 304), aluminium, or hot- dipped galvanised steel.

2. Fasteners are to be made of stainless steel (grade 316 or 304) or galvanized steel. Bare carbon steel fasteners are not acceptable.
3. Calculation verification and shop drawings should be submitted prior to delivery and installation

4. The design of the array mounting structure should be such that parts are pre-cut at the factory and do not need to be cut in the field. This is so that any corrosion-resistant coatings (e.g. anodization or galvanic layer) on the mounting structure's members are not compromised by being cut.

5. All sharp edges are to be removed at the factory, to prevent injury during construction, and to prevent damage to cabling. Protruding members (e.g. module rails) are to be capped to prevent injury to passing maintenance personnel.

6. PV module installation manuals are to be provided, showing that the mounting system used complies with the module manufacturer's requirements (e.g. location and spacing of mounting

clamps on module frames)**.**

5. Inverters

1.The number and rated capacity of the inverters must be such that Total PV Array DC capacity < 1.2 x Total Inverter AC output capacity. The sizing of the inverter shall consider the operable requirement on Power Factor as per JEPCO Grid Code.

2.Where available, the inverters are to include a display that allows operators to see how much power is being generated, grid voltage, and output current. The string level monitoring facility shall be made available.

3. Inverters must be able to be monitored and controlled locally

4.The inverter is to have a 10-year warranty from the manufacturer (in addition to any contractor warranties). Standard warranties are often 5 years, so evidence of the extended warranty having been purchased will need to be provided when the inverter is ordered.

5. Inverters must be certified as per JEPCO requirement

6. The installation of the inverter is to be in accordance with manual of installation provided by the manufacturer

6. Balance of System Components

1. No cabling is to be exposed to direct sunlight, even if sheathing is marked as being UV-stabilized. All cabling that may be exposed must be routed through UV-stabilized conduit.

2. All cables under modules shall be protected from inadvertent contact with passing maintenance personnel. This may be achieved by routing the cabling on the underside of the mounting rails, or through cable tray, trunking or conduit. Care must be taken to minimize direct exposure to sunlight when cables pass between modules.

3.Plastic cable ties, where used, must be protected from both direct and reflected UV radiation. Any cable ties used in UV exposed locations must be stainless steel.

4. All cable terminations are to be crimped or use a solar connector (e.g. string inverter DC input).

5. Details of how cable will be run (i.e. description and drawings) are to be provided.

6. Where flexible conduit is used, care must be taken to prevent tracking of water down cabling into the conduit. The preferred method is to have conduit entries facing downwards, as water will not be able to track upwards into the conduit. Plugging the conduit entry with silicone is not an acceptable long-term solution.

7. The communication and power cables will need to run in individual conduits that are physically separated by 300 mm for the entire cable run.

8. PV cabling at the array must be installed such that inductive loops are minimized in order to minimize voltage spikes caused by inter-cloud lightning strikes.

9. Lightning arrestors should be installed on the DC circuits, as inter-cloud lightning may cause

voltage spikes on the array circuits. Lightning arrestors are to have a method of visually checking that they are still operational. The DC lightning arrestors for the string inverter may be integrated in the string inverters, per the manufacturer's specifications. Instructions for replacing the surge arrestors are to be provided.

10.Confirm whether additional lighting protection (e.g. lightning rods) is required at the array. The assessment is to be done in accordance with AS 1768.

11. The inverter is to have a separate three-phase AC isolator at its output, rated for at least the maximum current output of the inverter.

12. Outdoor isolator enclosures and junction boxes are to be rated IP65 and resistant to UV damage and UV transmission to the components inside. Isolator enclosures must also be sheltered from direct sun and rain by the array or an awning. Isolator enclosures must be of a robust material resistant to bending under pressure and designed for operation in hot environments.

13. Enclosure covers are to be capable of being easily installed and removed multiple times from the enclosure body without damage (e.g. damage caused by stripping mounting holes in the enclosure body with over tightening of the enclosure cover screws).

14. Isolator enclosures are to be fitted with a clear window, so operators can easily verify the on/off state of the isolators inside.

15. Enclosures are to be easily opened for switch access without the use of a key or other tool, as keys or tools may not be readily available in emergencies. Site access will be restricted to relevant staff.

16. All outdoor enclosure cable entries are to be done from the bottom, to prevent water ingress. Care is to be taken in preventing water entry into conduits,

17. Quality of switchgear, isolator enclosures and other balance of systems components will be considered in the design review, as poor-quality BOS components can jeopardize the long-term viability of a project.

18-Permanent labelling is required to identify all major components including circuit breakers, isolators, fuses, lightning arrestors, and inverters meeting requirements of AS 3000, AS 4777 and AS 5033.

7- Metering

1.a power export meter panel shall be installed at the 0.4 kV interconnection point. The energy meter shall be procured from JEPCO Metering Department inclusive of configuration and installation services. The energy meter shall store data on board. It must be capable of logging data on a per hour basis. It will record at a minimum; voltage, frequency, current, real and active power and power factor of the plant generated electricity.

8- Operations and Maintenance Manuals

A comprehensive plant O&M manual will be provided to the Owners Engineer prior to Practical Completion and training with two hard copies and one soft copy. It shall include at a minimum;

- Project information: Names, addresses, email, phone of responsible people within JOCC, Contractor, and subcontractors (where applicable)
- Safety Instructions
- Equipment information: Contact information of manufacturers and suppliers of Main Equipment including datasheets of the equipment

- Equipment description: This part shall describe the location of the equipment, the performance figures and equipment specific information such as manufacture date and flash lists for PV modules
- All Software, Manuals and Project Documentation required to operate, maintain, service, repair and restore the inverters, protection systems, switchgear, monitoring, control systems and other systems that form part of the Plant
- Operation Procedures: Appropriate manufacturer's technical literature.

- Maintenance Procedures: Appropriate manufacturers technical literature including detailed recommendations for preventative maintenance, frequency and procedures
- Detailed and thorough self-troubleshooting providing logical step-by-step procedures where possible, including dis-assembly, repair and re-assembly, cleaning and alignment
- Applicable Certificates

All test documentation and As-Built Drawings shall

9- Performance Monitoring and Acceptance Testing

Independent acceptance testing will be undertaken on the system within 7 days of Practical Completion.

Costs for Independent Acceptance Testing and Performance Monitoring shall be borne by the Employer, except where the tests are unable to be conducted due to incomplete works or Contractor unavailability. In this case, the Contractor will be liable for any additional costs (ie. travel costs and fees) borne by the Principal.

Independent Acceptance Testing shall include, but not be limited to:

o A review of all required documentation submitted;

o A visual inspection of all components to confirm:

§ General quality of electrical and civil works;

§ Compliance with relevant standards, the specification, and approved design drawings.

o I-V tracing of all PV strings;

o Earth continuity testing of all PV module frames;

o DC isolator operation under full load;

o Insulation resistance testing of all cables;

o Loss-of-communications control test;

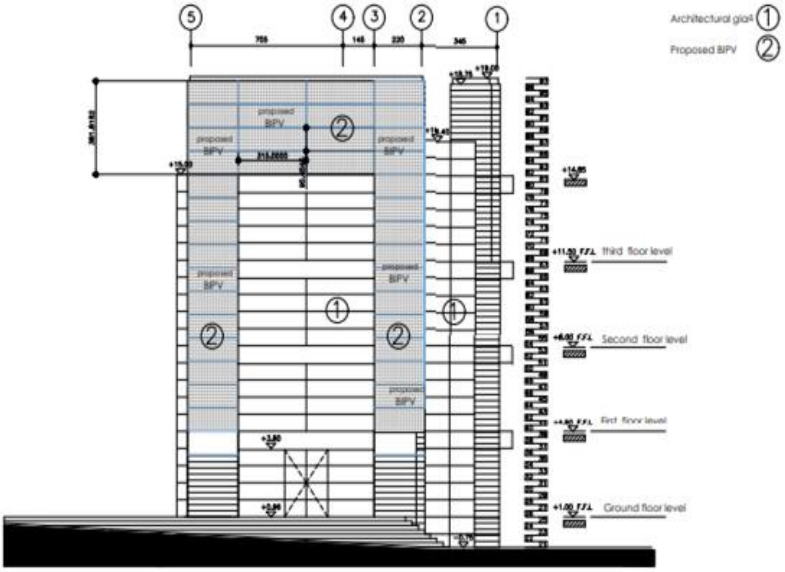
o Infra-red imaging of relevant electrical components.

System performance is to be monitored by the Contractor and the Owners Engineer (either remotely or on-site) for 3 days ; the Performance Monitoring Period.

The Final Acceptance Performance Test (FAC Test) shall be conducted after 1 month of operation and shall be carried out in accordance with this Schedule.

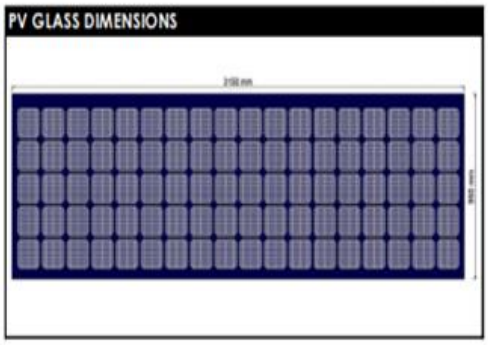
All Tests shall be performed in accordance with the Test Procedures approved by the Employer and in compliance to JEPCO Grid Code.

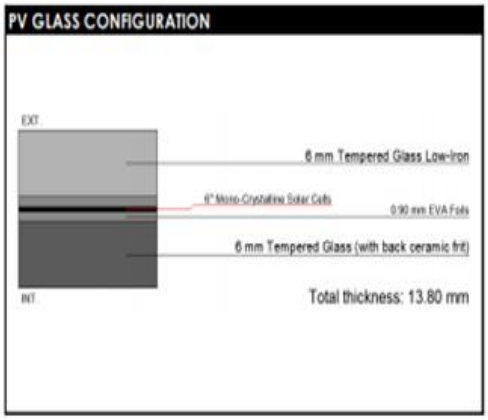
BIPV GLASS DETAILS



proposed BIPV over stone
Southern West Elevation

No - of BIPV panels 235 * 95 = 32
No - of BIPV panels 315 * 95 = 8
Proposed BIPV Area = 95.38 m^2





GLASS PROPERTIES	Onyx Equivalent Glass
Light Transmission	0% (opaque)
U-value [W/sqm.K]	N/A
Peak Power [Wp/sqm]	138.3

Summary and Conclusion

All of the above three options are worthily and profitable and could be applied to the building

1- The first option needs to install Aluminum supports and easy to be installed, and will cover 40% of the energy bill.

2- The second option needs to replace the construction glass with photovoltaic glass and will cover 60% of the energy bill.

3- The third option is to use both methods of installation in order to cover the complete bill off power.

Recommendation

- A plan should be there to apply option No:3.
- Depending on the budget available, JOCC can go for any option one or two and then to install the other option. Both options together are option three.
- Option 2 is costing more than option 1 but it generates more power and more profits by 25%.