

Appendix A – Visitors' Statistics

YEARLY	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
VISITORS	294,517	288,875	334,520	293,888	417,540	488,616	526,082	611,907	718,816	632,902	649,861	771,862	910,980
Percentage	-	-1.92%	15.80%	-12.15%	42.07%	17.02%	7.67%	16.30%	17.50%	-12.00%	5.00%		

أحصائية الزوار المتحف دبي

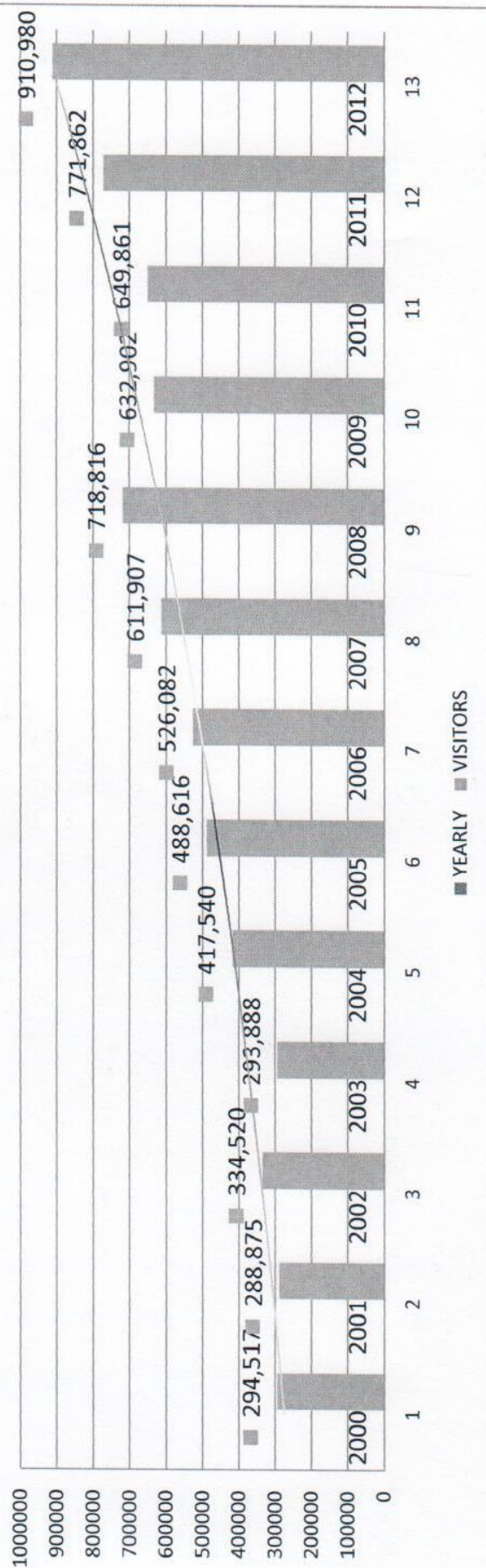


Figure A.1 Visitors' statistics (Dubai Museum)

Appendix B – Dubai Weather Data

Table B.1 Dubai Weather Data (IES-VE APLocate)

	Temperature		Humidity	Solar radiation
	Min. T db (°C)	Max. T db (°C)	T wb at Max. T db (°C)	W/m ²
Jan	19.50	28.20	17.50	1202
Feb	22.30	31.10	17.80	1187
Mar	26.60	35.90	18.50	1164
Apr	28.50	39.20	19.80	1130
May	30.40	42.10	21.10	1106
Jun	32.10	43.20	22.40	1092
Jul	34.40	44.20	23.80	1093
Aug	34.50	44.20	23.90	1107
Sep	31.00	41.20	23.20	1136
Oct	27.80	38.20	21.30	1166
Nov	24.00	33.90	19.40	1190
Dec	20.90	30.00	18.70	1204

Appendix C – Thermal Conditions parameters for Base Model

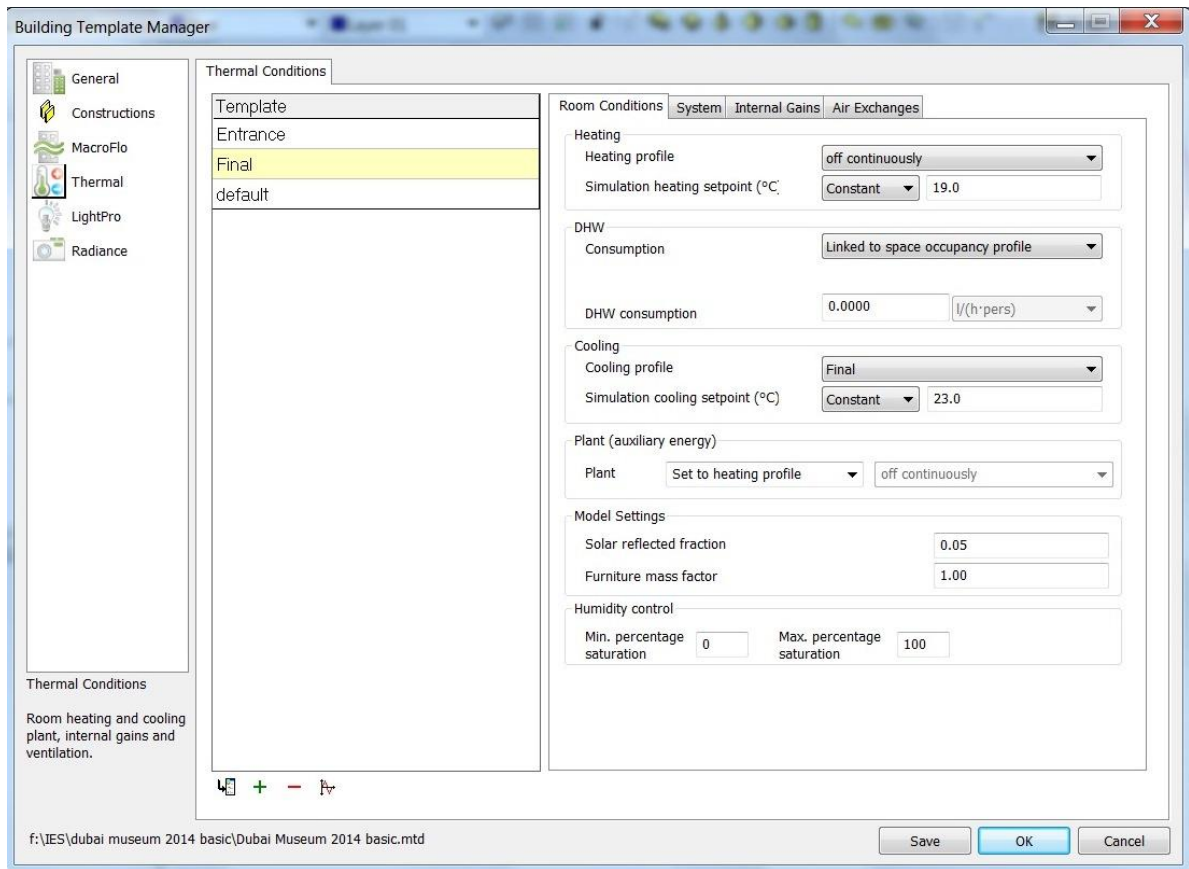


Figure C.1 Room condition parameters (IES-VE)

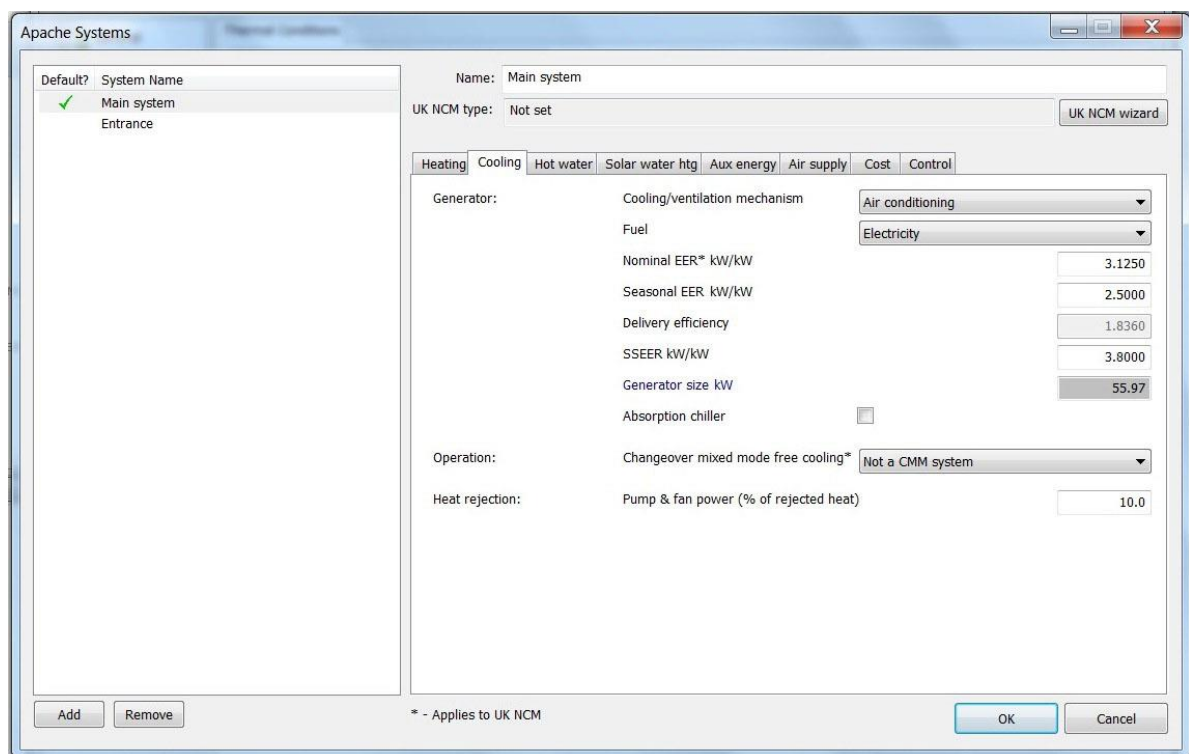


Figure C.2 System parameters (cooling) (IES-VE)

Internal Gains

Type	Gain Reference	Maximum Sensible C	Maximum Latent Gai	Occupancy	Max Power Co	Radiant Fraction	Fuel	Variation f	Dimming f	Add To Tem
People	People	90.000 W/person	60.000 W/person	8.000 m ² /perso	-	-	-	Final	-	T
Fluorescent Lighting	Fluorescent Lighting	2.700 W/m ²	-	-	2.700 W/m ²	0.45	Electricity	Final	Final	T
Tungsten Lighting	Tungsten Lighting	4.070 W/m ²	-	-	4.070 W/m ²	0.85	Electricity	Final	Final	T
Miscellaneous	Miscellaneous	3.500 W/m ²	0.000 W/m ²	-	3.500 W/m ²	0.22	Electricity	Final	-	T

+ Add Internal Gain - Remove Internal Gain Select All Deselect All

Type: People Reference: People
 Occupancy units: m²/person
 Variation Profile: Final

Maximum Sensible Gain (W/P): 90.000
 Maximum Latent Gain (W/P): 60.000
 Occupancy Density (m²/person): 8.000
 Diversity factor: 1

OK Cancel

Figure C.3 Internal gain (people) (IES-VE)

Internal Gains

Type	Gain Reference	Maximum Sensible C	Maximum Latent Gai	Occupancy	Max Power Co	Radiant Fraction	Fuel	Variation f	Dimming f	Add To Tem
People	People	90.000 W/person	60.000 W/person	8.000 m ² /perso	-	-	-	Final	-	T
Fluorescent Lighting	Fluorescent Lighting	2.700 W/m ²	-	-	2.700 W/m ²	0.45	Electricity	Final	Final	T
Tungsten Lighting	Tungsten Lighting	4.070 W/m ²	-	-	4.070 W/m ²	0.85	Electricity	Final	Final	T
Miscellaneous	Miscellaneous	3.500 W/m ²	0.000 W/m ²	-	3.500 W/m ²	0.22	Electricity	Final	-	T

+ Add Internal Gain - Remove Internal Gain Select All Deselect All

Type: Fluorescent Lighting Reference: Fluorescent Lighting
 Units: W/m²
 Radiant Fraction: 0.45
 Fuel: Electricity
 Variation Profile: Final
 Dimming Profile: Final

Maximum Illuminance (lux): 300.00
 Installed Power Density (W/m²(100 lux)): 3.75
 Maximum Sensible Gain (W/m²): 2.700
 Maximum Power Consumption (W/m²): 2.700
 Diversity factor: 1

OK Cancel

Figure C.4 Internal gain (fluorescent) (IES-VE)

Figure C.5 Internal gain (tungsten) (IES-VE)

Internal Gains

Type	Gain Reference	Maximum Sensible C	Maximum Latent Gain	Occupancy	Max Power Co	Radiant Fraction	Fuel	Variation f	Dimming f	Add To Temp
People	People	90.000 W/person	60.000 W/person	8.000 m²/perso	-	-	-	Final	-	T
Fluorescent Lighting	Fluorescent Lighting	2.700 W/m²	-	-	2.700 W/m²	0.45	Electricity	Final	Final	T
Tungsten Lighting	Tungsten Lighting	4.070 W/m²	-	-	4.070 W/m²	0.85	Electricity	Final	Final	T
Miscellaneous	Miscellaneous	3.500 W/m²	0.000 W/m²	-	3.500 W/m²	0.22	Electricity	Final	-	T

Type: Tungsten Lighting
 Units: W/m²
 Maximum Illuminance (lux): 0.00
 Installed Power Density (W/m²/(100 lux)): 3.75
 Maximum Sensible Gain (W/m²): 4.070
 Maximum Power Consumption (W/m²): 4.070
 Diversity factor: 1

Reference: Tungsten Lighting
 Radiant Fraction: 0.85
 Fuel: Electricity
 Variation Profile: Final
 Dimming Profile: Final

Internal Gains

Type	Gain Reference	Maximum Sensible C	Maximum Latent Gain	Occupancy	Max Power Co	Radiant Fraction	Fuel	Variation f	Dimming f	Add To Temp
People	People	90.000 W/person	60.000 W/person	8.000 m²/perso	-	-	-	Final	-	T
Fluorescent Lighting	Fluorescent Lighting	2.700 W/m²	-	-	2.700 W/m²	0.45	Electricity	Final	Final	T
Tungsten Lighting	Tungsten Lighting	4.070 W/m²	-	-	4.070 W/m²	0.85	Electricity	Final	Final	T
Miscellaneous	Miscellaneous	3.500 W/m²	0.000 W/m²	-	3.500 W/m²	0.22	Electricity	Final	-	T

Type: Miscellaneous
 Units: W/m²
 Maximum Sensible Gain (W/m²): 3.500
 Maximum Latent Gain (W/m²): 0.000
 Maximum Power Consumption (W/m²): 3.500
 Diversity factor: 1

Reference: Miscellaneous
 Radiant Fraction: 0.22
 Fuel: Electricity
 Variation Profile: Final

Figure C.6 Internal gain (miscellaneous) (IES-VE)

Air Exchanges

Type	Exchange Reference	Max Flow	Unit	Variation Profile	Adjacent Condition	Temperature Profile	Temperature Offset (°C)	Add To Template
Infiltration	Infiltration	0.250	ach	on continuously	External Air	-	-	

Type: Infiltration
 Reference: Infiltration
 Max Flow: 0.25 ach
 Variation Profile: on continuously
 Adjacent Condition: External Air

Figure C.7 Air Exchanges (IES-VE)

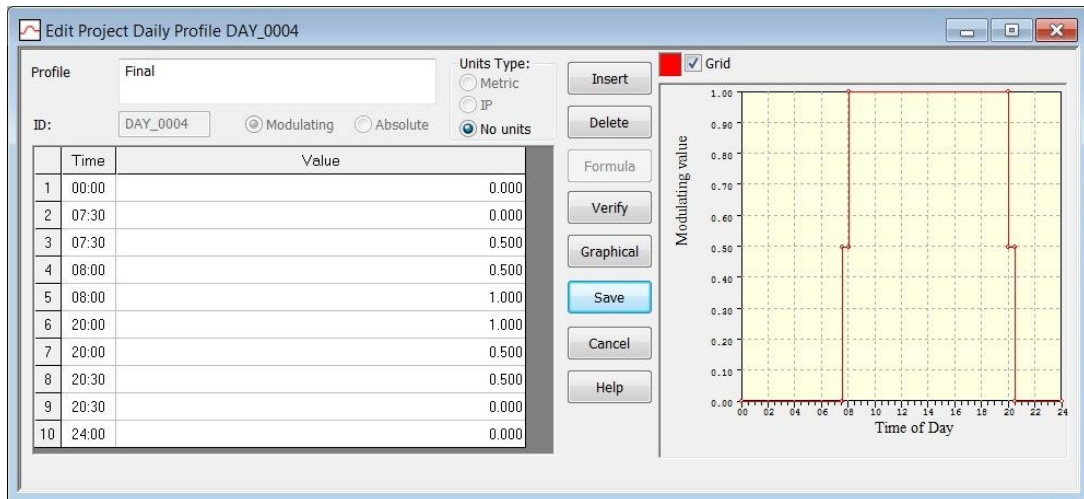


Figure C.8 Daily profile (IES-VE)

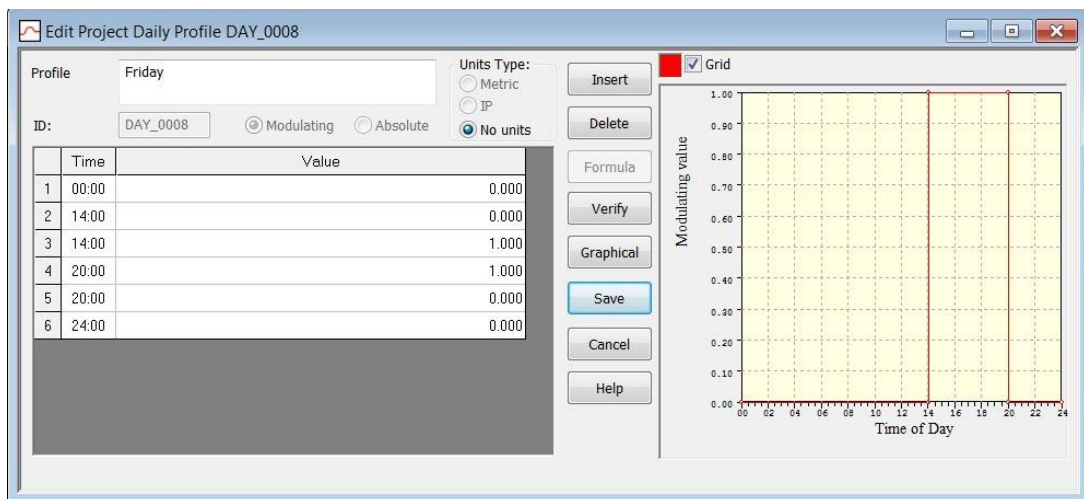


Figure C.9 Friday profile (IES-VE)

Project construction (opaque)

Description: limestone;plaster 800 ID: STD_WAL1

Performance

U-value: 1.0746 W/m²·K EN-ISO Thickness: 850.000 mm Thermal mass: 125.2800 kJ/(m²·K)

Total: 0.2273 m²K/W Mass: 1780.0000 kg/m² Lightweight

+ Surfaces

+ Functional settings

+ Regulations

Construction layers

Material (outside to inside)	Thickness mm	Conductivity W/(m·K)	Density kg/m ³	Specific Heat Capacity J/(kg·K)	Resistance m ² K/W	Vapour Resistivity GN·s/(kg·m)	Category
[LIM] LIMESTONE	800.000	1.5000	2180.0	720.0	-	-	Sands, Stones
[USPM0002] PERLITE PLASTER - (ASHRAE)	50.000	0.2200	720.0	1300.0	-	0.000	Plaster

Copy Paste Cavity Insert Add Delete Flip

System materials Project materials

Condensation analysis Derived parameters

OK Cancel

Figure C.10 Construction template for external wall – 800mm thick. (IES-VE)

Project construction (opaque)

Description: ID:

Performance

U-value: W/m²·K Thickness: mm Thermal mass: kJ/(m²·K)

Total: m²K/W Mass: kg/m² Lightweight

Surfaces
 Functional settings
 Regulations

Construction layers

Material (outside to inside)	Thickness mm	Conductivity W/(m·K)	Density kg/m ³	Specific Heat Capacity J/(kg·K)	Resistance m ² K/W	Vapour Resistivity GN·s/(kg·m)	Category
[LIM] LIMESTONE	900.000	1.5000	2180.0	720.0	-	-	Sands, Stones
[USPM0002] PERLITE PLASTER - (ASHRAE)	50.000	0.2200	720.0	1300.0	-	0.000	Plaster

Figure C.11 Construction template for external wall – 950mm thick. (IES-VE)

Project construction (opaque)

Description: limestone;plaster 1100 ID: STD_WAL:

Performance

U-value: 0.8845 W/m²·K EN-ISO Thickness: 1150.000 mm Thermal mass: 125.2800 kJ/(m²·K)

Total: 0.2273 m²K/W Mass: 2434.0000 kg/m² Lightweight

+ Surfaces

+ Functional settings

+ Regulations

Construction layers

Material (outside to inside)	Thickness mm	Conductivity W/(m·K)	Density kg/m ³	Specific Heat Capacity J/(kg·K)	Resistance m ² K/W	Vapour Resistivity GN·s/(kg·m)	Category
[LIM] LIMESTONE	1100.000	1.5000	2180.0	720.0	-	-	Sands, Stones
[USPM0002] PERLITE PLASTER - (ASHRAE)	50.000	0.2200	720.0	1300.0	-	0.000	Plaster

Copy Paste Cavity Insert Add Delete Flip

System materials Project materials

Condensation analysis Derived parameters

OK Cancel

Figure C.12 Construction template for external wall – 1100mm thick. (IES-VE)

Project construction (opaque)

Description: ID:

Performance

U-value: W/m²·K Thickness: mm Thermal mass: kJ/(m²·K)

Total: m²K/W Mass: kg/m² Mediumweight

+ Surfaces

+ Regulations

Construction layers

Material (outside to inside)	Thickness mm	Conductivity W/(m·K)	Density kg/m ³	Specific Heat Capacity J/(kg·K)	Resistance m ² K/W	Vapour Resistivity GN·s/(kg·m)	Category
[CYT] CLAY TILE	50.000	0.8400	1900.0	800.0	-	-	Tiles
[BASESC11] SCREED	50.000	0.4100	1200.0	840.0	-	-	Screeds &
[F/B] FELT/BITUMEN LAYERS	5.000	0.5000	1700.0	1000.0	-	-	Asphalts & Other
[WWSL] WOOD-WOOL SLAB	25.000	0.1000	500.0	1000.0	-	-	Timber
[WDSF] Wood subfloor (ASHRAE)	12.000	0.1151	650.0	1199.9	-	0.000	Timber
[O] OAK (RADIAL)	250.000	0.1900	700.0	2390.0	-	-	Timber

Copy Paste Cavity Insert Add Delete Flip

System materials Project materials

Condensation analysis Derived parameters

OK Cancel

Figure C.13 Construction template for roof (IES-VE)

Project construction (opaque)

Description: ID:

Performance

U-value: W/m²·K Thickness: mm Thermal mass: kJ/(m²·K)

Total: m²K/W Mass: kg/m² Very heavyweight

+ Surfaces

+ Functional settings

+ Regulations

Construction layers

Material (outside to inside)	Thickness mm	Conductivity W/(m·K)	Density kg/m ³	Specific Heat Capacity J/(kg·K)	Resistance m ² K/W	Vapour Resistivity GN·s/(kg·m)	Category
[SLSD1] SAND	75.000	0.3500	2080.0	840.0	-	-	Sands, Stones
[GBS] GRAVEL-BASED SOIL	250.000	0.5200	2050.0	184.0	-	-	Sands, Stones
[CPTW] CULTIVATED PEAT SOIL 366%D.W.	500.000	0.5000	1100.0	3650.0	-	-	Sands, Stones

Copy Paste Cavity Insert Add Delete Flip

System materials Project materials

Condensation analysis Derived parameters

OK Cancel

Figure C.14 Construction template for ground floor (IES-VE)

Appendix D – PV Panels Performance Parameters

Renewables

PVS generator Wind generator CHP generator

PV array type Other thin films

☐ Derive performance parameters from PV array type?

PV module nominal efficiency 0.1050 Nominal cell temperature (NOCT) (°C) 25.0

Reference irradiance for NOCT 800 Temperature coefficient for module efficiency (1/K) 0.0043

Degradation factor 0.9900 Shading factor 1.0000 Electrical conversion 0.8500

	Area (m²)	Azimuth (° clockwise from north)	Inclination (° from horizontal)
Panel 1	122.000	180.0	5.0

Add panel Remove panel

OK Cancel

Figure D.1 PV performance parameters – Scenario 1 (IES-VE)

Renewables

PVS generator Wind generator CHP generator

PV array type Other thin films

☐ Derive performance parameters from PV array type?

PV module nominal efficiency 0.1050 Nominal cell temperature (NOCT) (°C) 25.0

Reference irradiance for NOCT 800 Temperature coefficient for module efficiency (1/K) 0.0043

Degradation factor 0.9900 Shading factor 1.0000 Electrical conversion 0.8500

	Area (m²)	Azimuth (° clockwise from north)	Inclination (° from horizontal)
Panel 1	51.000	180.0	25.0

Add panel Remove panel

OK Cancel

Figure D.2 PV performance parameters – Scenario 2 (IES-VE)

Renewables

PVS generator Wind generator CHP generator

PV array type Other thin films

☐ Derive performance parameters from PV array type?

PV module nominal efficiency 0.1050 Nominal cell temperature (NOCT) (°C) 25.0

Reference irradiance for NOCT 800 Temperature coefficient for module efficiency (1/K) 0.0043

Degradation factor 0.9900 Shading factor 1.0000 Electrical conversion 0.8500

	Area (m²)	Azimuth (° clockwise from north)	Inclination (° from horizontal)
Panel 1	22.000	180.0	0.0

Add panel Remove panel

OK Cancel

Figure D.3 PV performance parameters – Scenario 3 (IES-VE)

Renewables

PVS generator Wind generator CHP generator

PV array type Monocrystalline silicon

☐ Derive performance parameters from PV array type?

PV module nominal efficiency 0.2010 Nominal cell temperature (NOCT) (°C) 45.0

Reference irradiance for NOCT 800 Temperature coefficient for module efficiency (1/K) 0.0038

Degradation factor 0.9900 Shading factor 1.0000 Electrical conversion 0.8500

	Area (m²)	Azimuth (° clockwise from north)	Inclination (° from horizontal)
Panel 1	51.000	180.0	25.0

Add panel Remove panel

OK Cancel

Figure D.4 PV performance parameters – Scenario 4 (IES-VE)

Renewables

PVS generator Wind generator CHP generator

PV array type Other thin films

☐ Derive performance parameters from PV array type?

PV module nominal efficiency 0.1050 Nominal cell temperature (NOCT) (°C) 25.0

Reference irradiance for NOCT 800 Temperature coefficient for module efficiency (1/K) 0.0043

Degradation factor 0.9900 Shading factor 1.0000 Electrical conversion 0.8500

	Area (m²)	Azimuth (° clockwise from north)	Inclination (° from horizontal)
Panel 1	11.000	180.0	25.0

Add panel Remove panel

OK Cancel

Figure D.5 PV performance parameters – Scenario 5 (IES-VE)

Renewables

PVS generator Wind generator CHP generator

PV array type Other thin films

☐ Derive performance parameters from PV array type?

PV module nominal efficiency 0.1050 Nominal cell temperature (NOCT) (°C) 25.0

Reference irradiance for NOCT 800 Temperature coefficient for module efficiency (1/K) 0.0043

Degradation factor 0.9900 Shading factor 1.0000 Electrical conversion 0.8500

	Area (m²)	Azimuth (° clockwise from north)	Inclination (° from horizontal)
Panel 1	7.000	180.0	25.0

Add panel Remove panel

OK Cancel

Figure D.6 PV performance parameters – Scenario 6 (IES-VE)

Renewables

PVS generator Wind generator CHP generator

PV array type Monocrystalline silicon

☐ Derive performance parameters from PV array type?

PV module nominal efficiency 0.1900 Nominal cell temperature (NOCT) (°C) 25.0

Reference irradiance for NOCT 800 Temperature coefficient for module efficiency (1/K) 0.0043

Degradation factor 0.9900 Shading factor 1.0000 Electrical conversion 0.8500

	Area (m²)	Azimuth (° clockwise from north)	Inclination (° from horizontal)
Panel 1	13.500	180.0	90.0

Add panel Remove panel

OK Cancel

Figure D.7 PV performance parameters – Scenario 7 (IES-VE)

Appendix E – Energy Consumption and PV Power Generation Charts

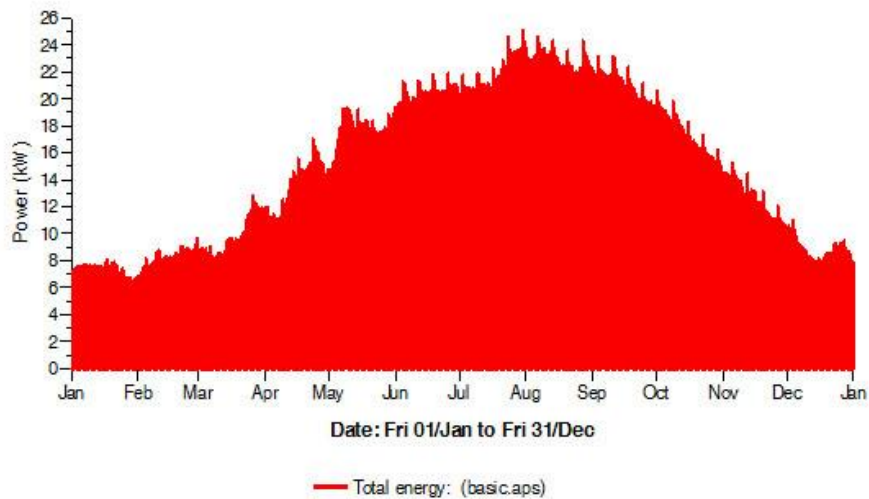


Figure E.1 Energy consumption – Base model (IES-VE)

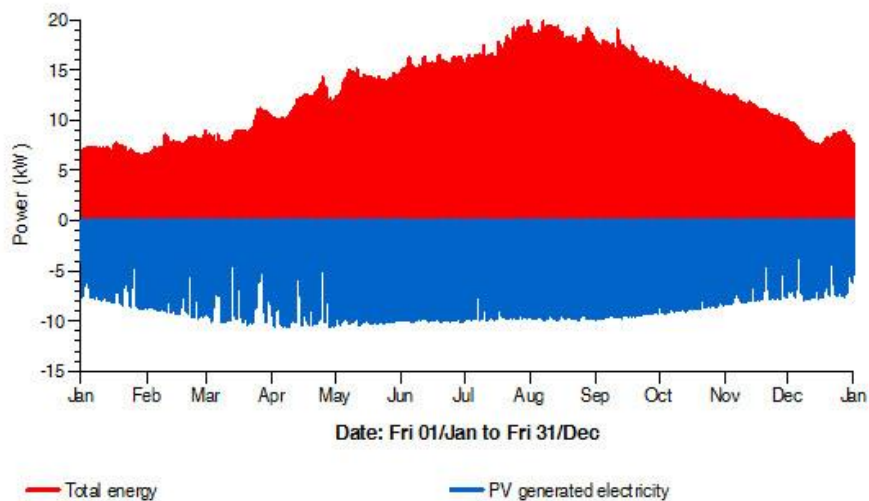


Figure E.2 Energy consumption & PV power production – Scenario 1 (IES-VE)

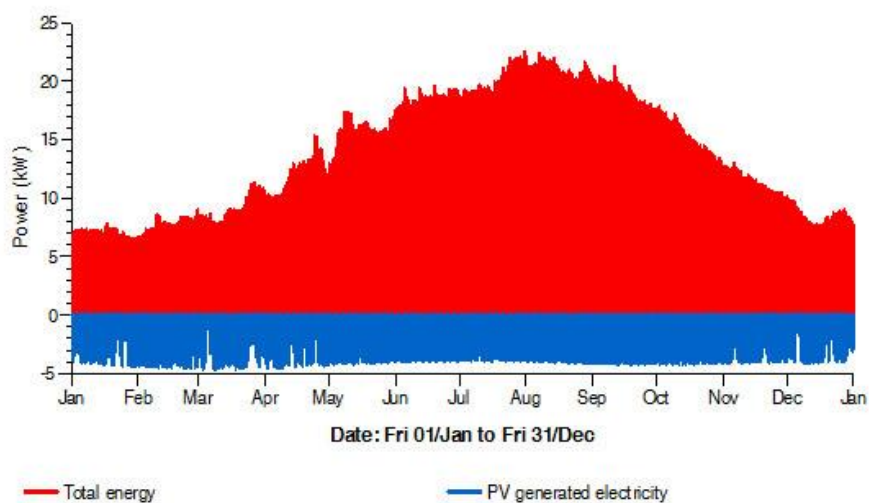


Figure E.3 Energy consumption & PV power production – Scenario 2 (IES-VE)

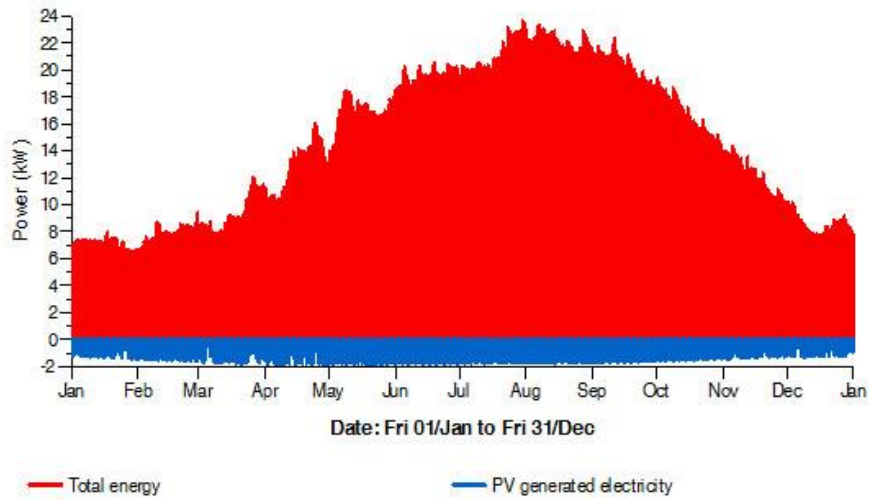


Figure E.4 Energy consumption & PV power production – Scenario 3 (IES-VE)

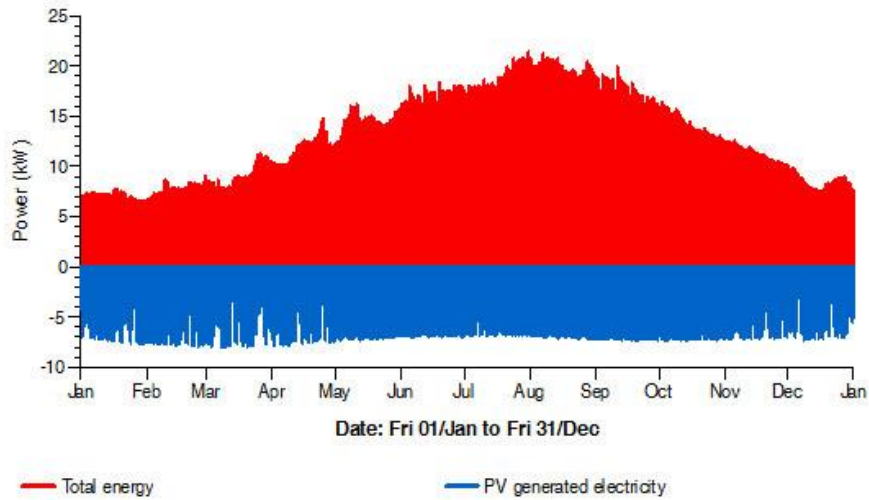


Figure E.5 Energy consumption & PV power production – Scenario 4 (IES-VE)

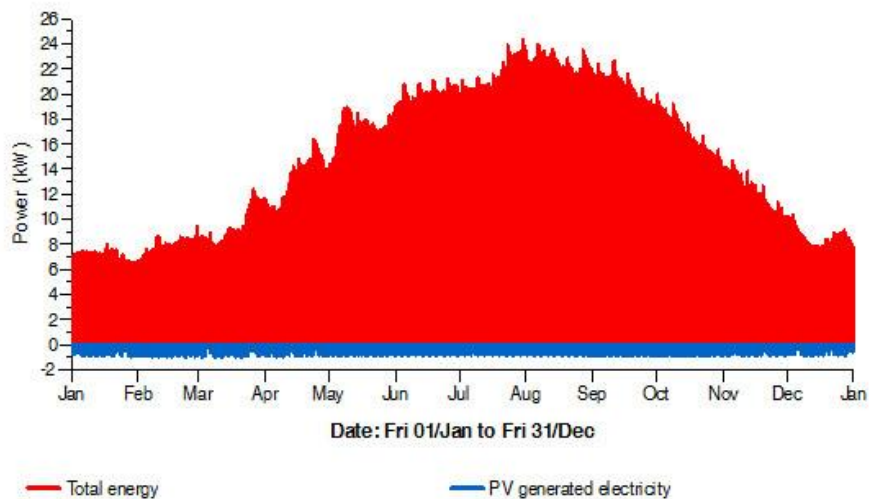


Figure E.6 Energy consumption & PV power production – Scenario 5 (IES-VE)

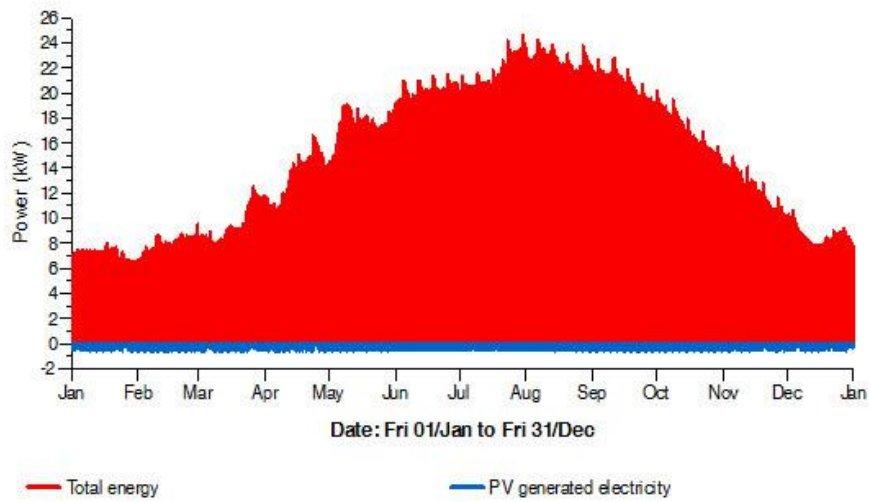


Figure E.7 Energy consumption & PV power production – Scenario 6 (IES-VE)

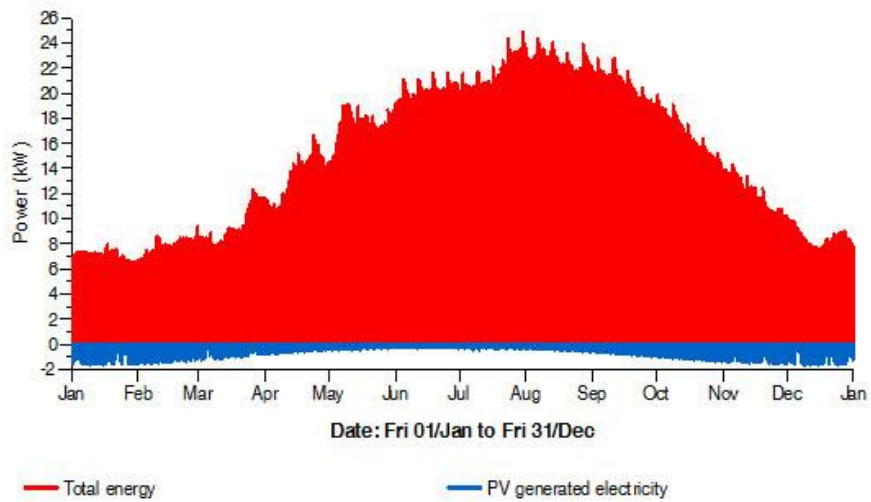


Figure E.8 Energy consumption & PV power production – Scenario 6 (IES-VE)

Appendix F – Questionnaire Sheet

The Potential of Integrating Photovoltaic System in the Heritage Building (Dubai Museum)

Solar energy is one of the renewable energy sources widely utilized to generate clean, almost cheap and secured power. Nowadays, Integrating PV panels into the building's façade become common but for heritage buildings it is a big challenge for the architects and engineers due to the sensitive architectural scene of such buildings and the notable contrast between the modern prospect of the PV panels and the old-fashion scene of the heritage building.

This survey aims to explore the public acceptance about integrating the PV systems at Dubai Museum (Al Fahidi Fort). Different approaches / scenarios are proposed and studied to investigate the visual impact of the PV system on the aesthetical value of the heritage building, the proper application technique and the energy production of the proposed PV systems which contributes in reduce the CO2 emission.

General Information:

Gender:	Male	Female	Asian	African	Euro.	N.America	S. America
Nationality:	CCC	Arab	Bachelor	MSC	Doctorate		
Education:	High school	Architect	Engineer	Academic	Other (specify)		
Occupation:	Student						

The Questionnaire

	Strongly Negative	Negative	Slightly Negative	No Effect	Slightly Positive	Positive	Strongly Positive			
1- Visually, score the harmony of the proposed scenarios with the fort's architecture										
Scenario 1	1	2	3	4	5	6	7	8	9	10
Scenario 2	1	2	3	4	5	6	7	8	9	10
Scenario 3	1	2	3	4	5	6	7	8	9	10
2- From 1 to 10 score the idea of integrating PVs in the heritage building based on:										
Energy Saving	1	2	3	4	5	6	7	8	9	10
Aesthetic value	1	2	3	4	5	6	7	8	9	10
New Concept	1	2	3	4	5	6	7	8	9	10
3- Would this affect you visiting the site?										
4- Applying the proposals will encourage visitors stay for long time.										
5- Applying the proposals will enhance the visitors' convenience during the tour.										
6- Utilize the renewable energy sources (solar energy) in the heritage buildings emulates the adoption of these building (in the past) with the environment.										
7- as the public be aware about the environmental impact of the PV's, they accept the idea of integrating these devices in the heritage building.										
8- The visual impact of integrating PVs in the heritage building is more significant than the power production										
9- Despite the smoothness of integrating the PVs, it degrades the aesthetical value of the heritage building.										
10- In general, integrating PV panel in heritage building is applicable										

إمكانية دمج الانظمة الكهروضوئية في المباني التراثية

الطاقة الشمسية هي واحدة من مصادر الطاقة المتجددة المستخدمة على نطاق واسع لتوليد طاقة نظيفة، وإحاطة الكلفة وأمنة في الوقت الراهن اصبح من الشائع دمج الانظمة الكهروضوئية في واجهات المباني، ولكن بالنسبة للمباني التراثية ما زالت تشكل تحديا للمعماريين والمهندسين نظرا للفرق الواضح بين المنظر المعاصر لهذه الانظمة والمباني القديمة للمباني التراثية. هذا الاستبيان يهدف الى استيضاح مدى تقبل الجمهور لدمج الانظمة الكهروضوئية في متحف دبي (قلعة الفهيد) حيث تم وضع ودراسة عدة مقترحات للتحقق من التأثير البصري لهذه الانظمة على القيمة الجمالية للمباني التراثية وافضل تقنيات التطبيق بالاضافة الى حجم الطاقة المنتجة من الانظمة المقترحة والتي تساهم في تقليل انبعاث غاز ثاني اوكسيد الكاربون.

معلومات عامة

الجنس:	ذكر	أنثى
الجنسية:	مواطن	عربي
التحصيل الدراسي:	تأثري	بكالوريوس
الوظيفة:	طالب	معماري

الاستملاء

1- بصريا قيم تناغم المقترحات مع الشكل المعماري للمبنى

المقترح 1	1	2	3	4	5	6	7	8	9	10
المقترح 2	1	2	3	4	5	6	7	8	9	10
المقترح 3	1	2	3	4	5	6	7	8	9	10

2- من 1 الى 10، قيم فكرة دمج الاواح الكهروضوئية في المباني التراثية من حيث:

توفير الطاقة	1	2	3	4	5	6	7	8	9	10
القيمة الجمالية	1	2	3	4	5	6	7	8	9	10
فكرة جديدة	1	2	3	4	5	6	7	8	9	10

3- هل ستؤثر هذه الفكرة على زيارتك للمتحف؟

سلبيا جدا	سلبيا قليلا	لا تأثير	ايجابيا قليلا	ايجابيا جدا
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4- تطبيق هذه المقترحات سيترجم الزاين البقاء في المتحف لفترة اطول.

وافقي بشدة	وافقي	غير متأكد	لا وافقي	لا وافقي بشدة
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5- تطبيق هذه المقترحات سيعزز من شعور الزاين بالراحة أثناء جولتهم.

وافقي بشدة	وافقي	غير متأكد	لا وافقي	لا وافقي بشدة
------------	-------	-----------	----------	---------------

6- الاستفادة من مصادر الطاقة المتجددة (الطاقة الشمسية) في المباني التراثية يحاكي تكيف هذه المباني (في الماضي) مع البيئة المحيطة بها.

وافقي بشدة	وافقي	غير متأكد	لا وافقي	لا وافقي بشدة
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7- حيث ان الجمهور يدرك الاثر البيئي لاستخدام الانظمة الكهروضوئية بزيادة تقبلهم لدمج هذه الانظمة في المباني التراثية.

وافقي بشدة	وافقي	غير متأكد	لا وافقي	لا وافقي بشدة
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8- التأثير البصري لدمج الانظمة الكهروضوئية في المباني التراثية له اهمية اكبر من الطاقة التي تنتجها هذه الانظمة.

وافقي بشدة	وافقي	غير متأكد	لا وافقي	لا وافقي بشدة
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9- دمج الانظمة الكهروضوئية في المباني التراثية سيقلل من القيمة الجمالية لهذه المباني حتى وان تناغم دمج هذه الانظمة مع تلك المباني.

وافقي بشدة	وافقي	غير متأكد	لا وافقي	لا وافقي بشدة
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10- بشكل عام، يمكن دمج (استخدام) الانظمة الكهروضوئية في المباني التراثية.

وافقي بشدة	وافقي	غير متأكد	لا وافقي	لا وافقي بشدة
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Appendix G – Questionnaire 3D Visual Board

The Potential of integrating PV in Heritage Buildings

Solar energy is one of the renewable energy sources widely utilized to generate clean, almost cheap and secured power. Nowadays, integrating PV panels into the building's facade becomes common for heritage buildings to reduce the carbon footprint and improve the building's energy efficiency. However, the integration of PV panels into the facade of heritage buildings is a sensitive architectural issue due to the sensitive architectural scene of each building and the notable contrast between the building's facade and the PV panels. This survey aims to explore the public acceptance about integrating the PV systems at Dahab Museum (Al Fahad Fort). Different approaches / scenarios are proposed and studied to investigate the visual impact of the PV systems on the aesthetic value of the heritage building, the proper application technique and the energy production of the proposed PV systems which contributes to reduce the CO2 emission.



إمكانية دمج الأنظمة الكهروضوئية في المباني التراثية

الطاقة الشمسية هي واحدة من مصادر الطاقة المتجددة المستخدمة على نطاق واسع لإنتاج طاقة نظيفة وموثوقة. نظراً لكونها من المصادر المتجددة، فإنها توفر طاقة نظيفة وآمنة. في الوقت الحاضر، أصبح دمج الألواح الكهروضوئية في واجهات المباني التراثية شائعاً لتقليل البصمة الكربونية وتحسين كفاءة الطاقة. ومع ذلك، فإن دمج الألواح الكهروضوئية في واجهات المباني التراثية يمثل تحدياً معمارياً، حيث يجب مراعاة التوافق بين المظهر المعماري للمبنى وبين المظهر الجمالي للأنظمة الكهروضوئية. تهدف هذه الدراسة إلى استكشاف تقبل المجتمع لدمج الأنظمة الكهروضوئية في واجهات المباني التراثية، ودراسة بعض الأساليب المقترحة لدمج الأنظمة الكهروضوئية في واجهات المباني التراثية، ودراسة بعض الأساليب المقترحة لدمج الأنظمة الكهروضوئية في واجهات المباني التراثية.

المشهد 01

SCENARIO 01

الحالي

EXISTING

المقترح

PROPOSED

المشهد 02

SCENARIO 02

الحالي

EXISTING

المقترح

PROPOSED

المشهد 03

SCENARIO 03

الحالي

EXISTING

المقترح

PROPOSED

Appendix H – On-Site Photos

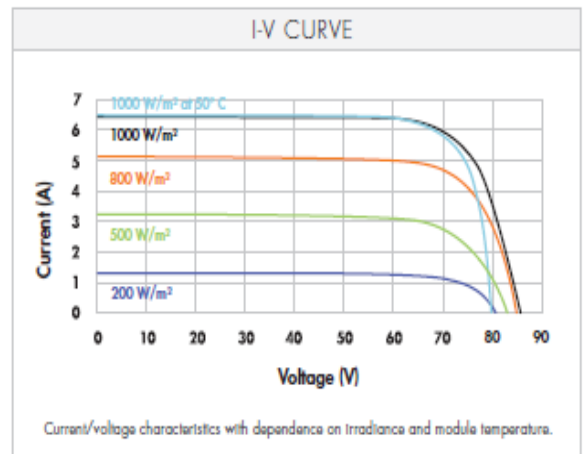


Figure H.1 On-Site survey photos (Author)

Appendix I – PV Panel Data Sheets

ELECTRICAL DATA		
Measured at Standard Test Conditions (STC): irradiance of 1000 W/m ² , AM 1.5, and cell temperature 25° C		
Peak Power (+/- 5%)	P _{max}	435 W
Cell Efficiency	η	22.5 %
Panel Efficiency	η	20.1 %
Rated Voltage	V _{mpp}	72.9 V
Rated Current	I _{mpp}	5.97 A
Open-Circuit Voltage	V _{oc}	85.6 V
Short-Circuit Current	I _{sc}	6.43 A
Maximum System Voltage	UL	600 V
Temperature Coefficients	Power (P)	- 0.38%/K
	Voltage (V _{oc})	- 235.5 mV/K
	Current (I _{sc})	3.5 mA/K
NOCT		45° C +/- 2° C
Series Fuse Rating		20 A
Grounding		Positive grounding not required

MECHANICAL DATA	
Solar Cells	128 SunPower Maxeon™ cells
Front Glass	High-transmission tempered glass with anti-reflective (AR) coating
Junction Box	IP-65 rated with 3 bypass diodes Dimensions: 32 x 155 x 128 mm
Output Cables	700 mm cables / Multi-Contact (MC4) connectors
Frame	Anodized aluminum alloy type 6063 (silver); stacking pins
Weight	56.0 lbs. (25.4 kg)



TESTED OPERATING CONDITIONS	
Temperature	- 40° F to +185° F (- 40° C to + 85° C)
Max load	113 psf 550 kg/m ² (5400 Pa), front (e.g. snow) w/specified mounting configurations 50 psf 245 kg/m ² (2400 Pa) front and back (e.g. wind)
Impact Resistance	Hail: (25 mm) at 51 mph (23 m/s)

WARRANTIES AND CERTIFICATIONS	
Warranties	25-year limited power warranty 10-year limited product warranty
Certifications	Tested to UL 1703. Class C Fire Rating

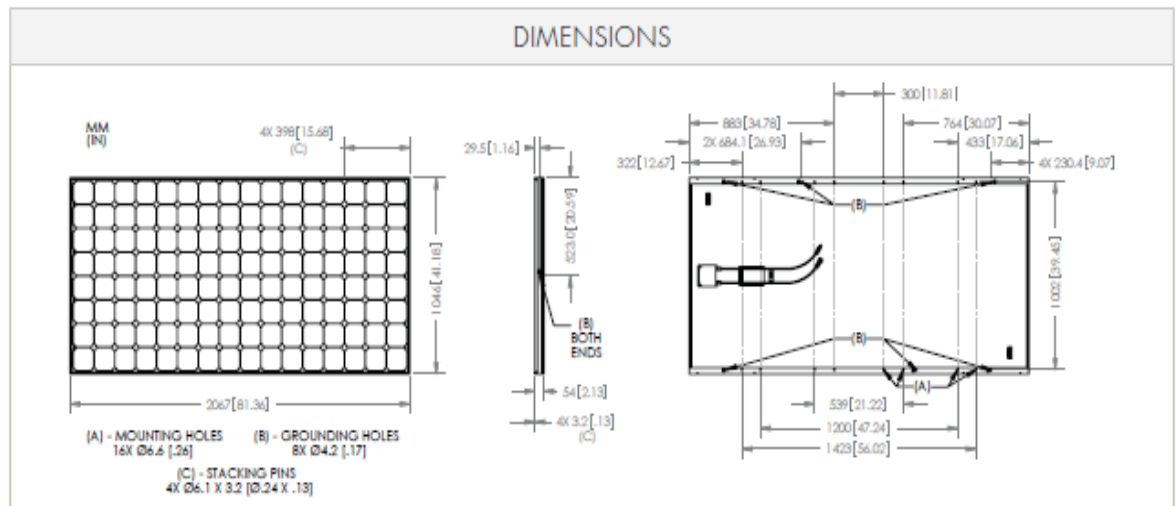


Figure I.1 Monocrystalline panel data sheet (Author)

Electrical Specifications* Figure 1.2 CIGS flexible PV panel data sheet (Author)

Capacity rating	P _{max}	300 W	275 W	250 W
Tolerance of P _{max}	%	± 7%	± 7%	± 7%
Module aperture area efficiency	%	12.6%	11.5%	10.5%
Rated voltage	V _{mpp}	53.9 V	50.3 V	46.5 V
Rated current	I _{mpp}	5.6 A	5.5 A	5.4 A
Open circuit voltage	V _{oc}	71.2 V	68.4 V	65.7 V
Short circuit current	I _{sc}	6.4 A	6.3 A	6.2 A

*Measured at (STC) Standard Test Conditions: 25°C, 1 kW/m² insolation, AM 1.5

Temperature Coefficients

Maximum power	-0.43%/°C
Voltage at Maximum Power	-0.38%/°C
Open circuit voltage	-0.33%/°C
Short circuit current	-0.03%/°C

Mechanical Specifications

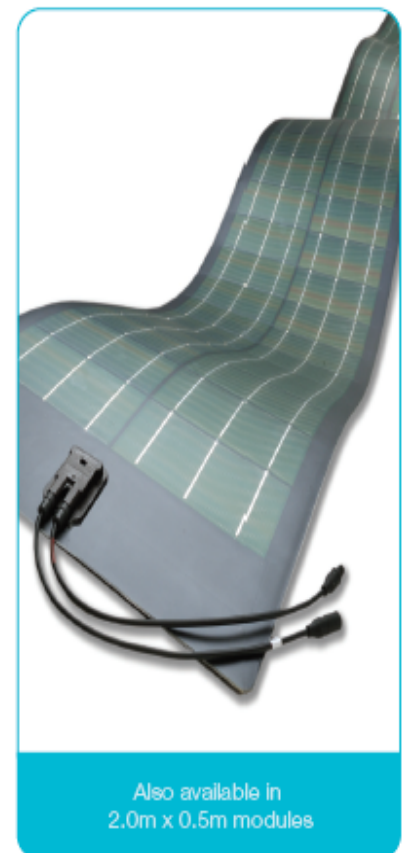
Dimensions	5745 x 495 x 3 mm (226 x 19.3 x 0.12 in)
Weight	9.9 kg (nominal weight with adhesive) 3.5 kg/m ² (0.7 lb/ft ²) with adhesive
Junction Box	Junction box with bypass diode
Cables	Typo Solarlok
Front Sheet	Non-stick ETFE
Solar Cells	108 CIGS cells (210 x 100 mm)
Frame	None

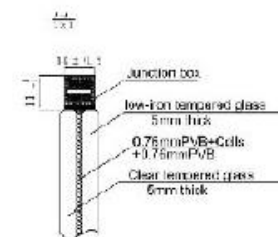
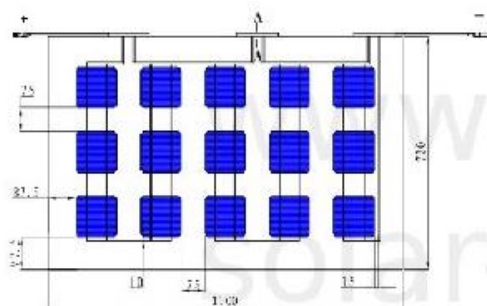
Operating Conditions

Temperature Range	-40°C to + 85°C
Maximum System Voltage	1000 V

Certifications and Warranty*

UL 1703, IEC 61646 / 61730
Materials and workmanship - 5 years
Power output - 25 years (90% @ 10 yrs; 80% @ 25 yrs)





Electrical Parameter (Data at STC)

(1000W/m², 25°C, AM1.5)

Nominal Peak Power (P _{mp})	41W	Light transmittance (%)	80
Peak Power Voltage (V _{mp})	8.01V	Light reflectance (%)	8
Peak Power Current (I _{mp})	5.04A	Shading coefficient	0.62
Open Circuit Voltage (V _{oc})	0.60V	U-value	5.0
Short Circuit Current (I _{sc})	5.39A	Weight (kg)	22

Power tolerance: ±5%

Notes:

1. Module construction:
5mm low iron tempered glass
+0.76mm PVB+Cells+0.76mm PVB
+5mm Clear tempered glass.
2. Cell type: Mono-Crystalline 125×125mm.
Efficiency=10%.
3. Cell number: 348 PCS.
4. Glass Edge Type: Hot ground edge.
5. The installed tolerance: ±2.

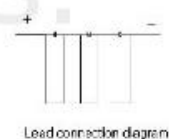


Figure I.3 Semi-transparent Monocrystalline PV panel data sheet (Author)