ARCHITECTURE AT ZERO 2021-22

A design competition for Decarbonization, Equity and Resilience in California

URBAN VILLAGE

WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY

WROCŁAW, POLAND

Project Narrative

The design of the housing estate was based on the analysis of the area and consideration of the needs of the residents. It meets the program requirements included in the conditions of the competition as well as guidelines for zero-energy buildings. Reference to local traditions and simple architecture makes the complex fit well in the context of the place. Thanks to the arrangement of social space, the estate provides a place for neighborhood integration for people of all ages. The buildings are adapted to the climate conditions prevailing in the region of the study area through the use of a number of sustainable architecture solutions. Both natural building materials and advanced ecological systems have been used. They reduce the negative effects of harsh weather conditions while taking advantage of their positive aspects. The energy balance calculations carried out on the model building show the effectiveness of the solutions used. The project aims to promote sustainable design with respect for the environment. The basic urban planning decision was to give the buildings the form of mini-quarters. They have a semi-open forwhich makes them easy to ventilate. The design of terraces, greenhouses and the arrangement of vegetation between the buildings ensures contact with nature. The masses of individual buildings are locally lowered and replaced by terraces in order to ensure better lighting of all premises and reconstruct the original bio-active surface. In the center of the whole complex, a common space was designed to provide recreational and relaxation activities.

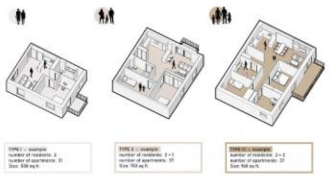
Details of Renewable Energy Systems

Climate analyzes have shown that the most beneficial source of energy is undoubtedly the use of solar energy. A predominance of sunny days throughout the year and relatively little cloudiness can bring many benefits. Therefore, an extensive system of photovoltaic panels has been located, which uses the potential of intense sunlight. Panels with standard dimensions of 5.41 ft. X 3.28 ft. Are located on the roofs of all buildings, making maximum use of their surfaces and thus the maximum possible amount of energy possible to be obtained. In addition to the photovoltaic panels, an innovative perovskite system was also used. Transparent glass cells were used that let the sun's rays into the interior and provide good lighting, while obtaining solar energy. They cover the greenhouses, the southern facade of the community house, the roofing of the terraces and blinds. They are flexible, extremely thin and also very light. This modern method has enormous potential for use and is more and more willingly used. It was used, among others, on the facade of the Aliplast factory in Lublin (Poland).

Storage Systems

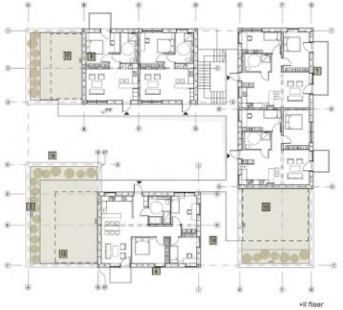
The project uses batteries for photovoltaics, allowing for the accumulation of excess energy and use it in accordance with the demand. Thanks to such batteries, they can be powered during the night or when it is overcast. The type of ESS flow batteries was used. This solar energy storage battery only loses 1% of its capacity after more than 1000 charging cycles.

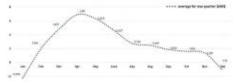
Different Apartment Types



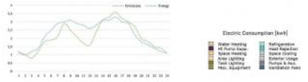
Section Detail

FLOOR PLANS
scale 1:200

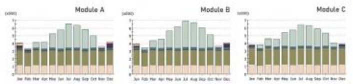




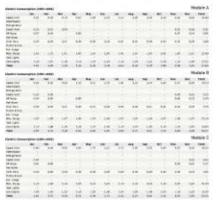
Energy Surplus/Deficit

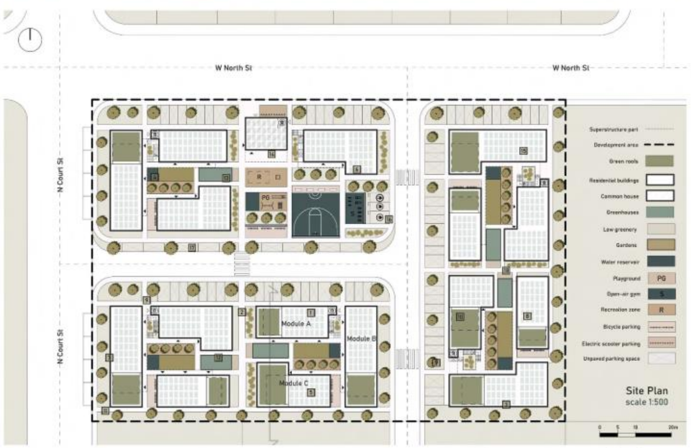


Annual Hourly Average Emissions and Energy



Monthly End Use Energy Consumption Bar Chart





Illustrated Section

CO_2 absorption

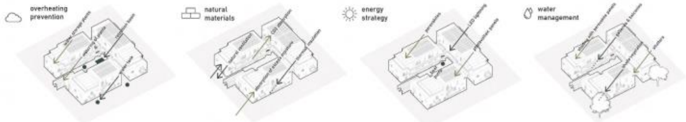
Balance of absorption and emission of CO_2 by hemp concrete	
Ingredients 1 m² of hemp concrete wall	
110 kg of hemp hurd	Absorption CO_2 – 202 kg
220 kg of lime	Emission CO_2 – 94 kg
Result	108 kg CO_2/m²

Mechanical System Summary

Heating System	1. Ground Source Heat Pump
Ventilation System	1. Natural ventilation: connection of each apartment with a natural ventilation system, ventilation shaft in each kitchen and bathroom 2. Double facade in Community Space House. 3. Ground Source Heat Pump used for both heating in winter and cooling in summer
Lightning System	1. Artificial Lighting: 100% LED 2. Natural Lightning: Regulation of natural lighting with shutters and galleries
Domestic Hot Water System	1. Ground Source Heat Pump
Renewable/Generation System	1. Photovoltaic panels on roofs 2. Perovskites transparent finishing on terraces construction, greenhouses and front facade of Community Space House 3. Flow Battery Storage System

Annual End Use Summary Table

	Module A	Module B	Module C	Glasshouse	Total
Annual energy consumption [kWh (x000)]	57,96	60,54	59,52	-	178,02
Annual energy production [kWh (x000)]	57,74	74,58	65,96	12,03	210,31
Result in one quarter	-0,22	+14,04	+6,44	+12,03	+32,29
					+90,17 [kWh]
Number of modules	5	5	6	5	
Total Result	-1,1	70,2	38,64	60,15	+167,89
					+573,96 [kWh]



UrbanVillage

ARCHITECTURE AT ZERO 2021

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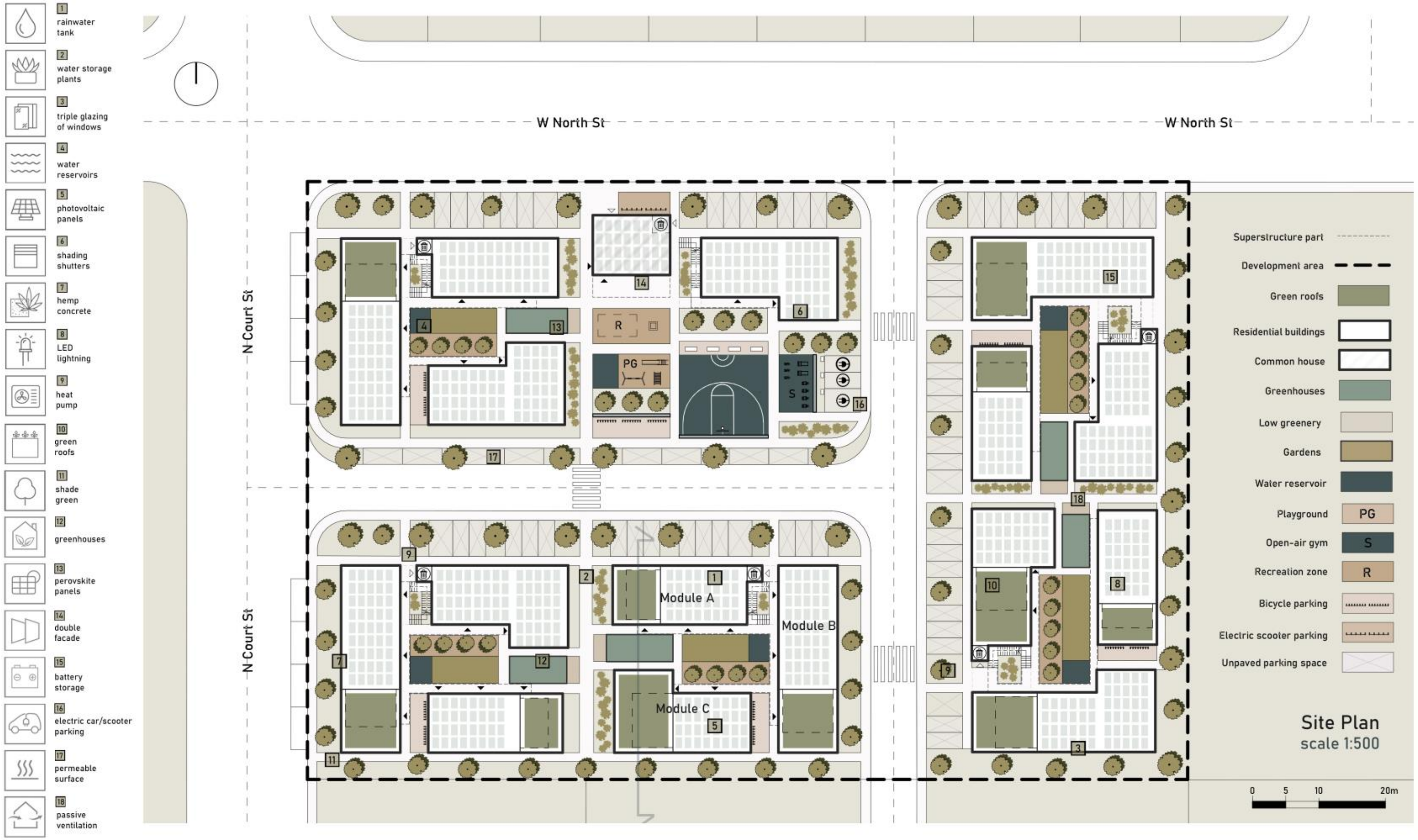
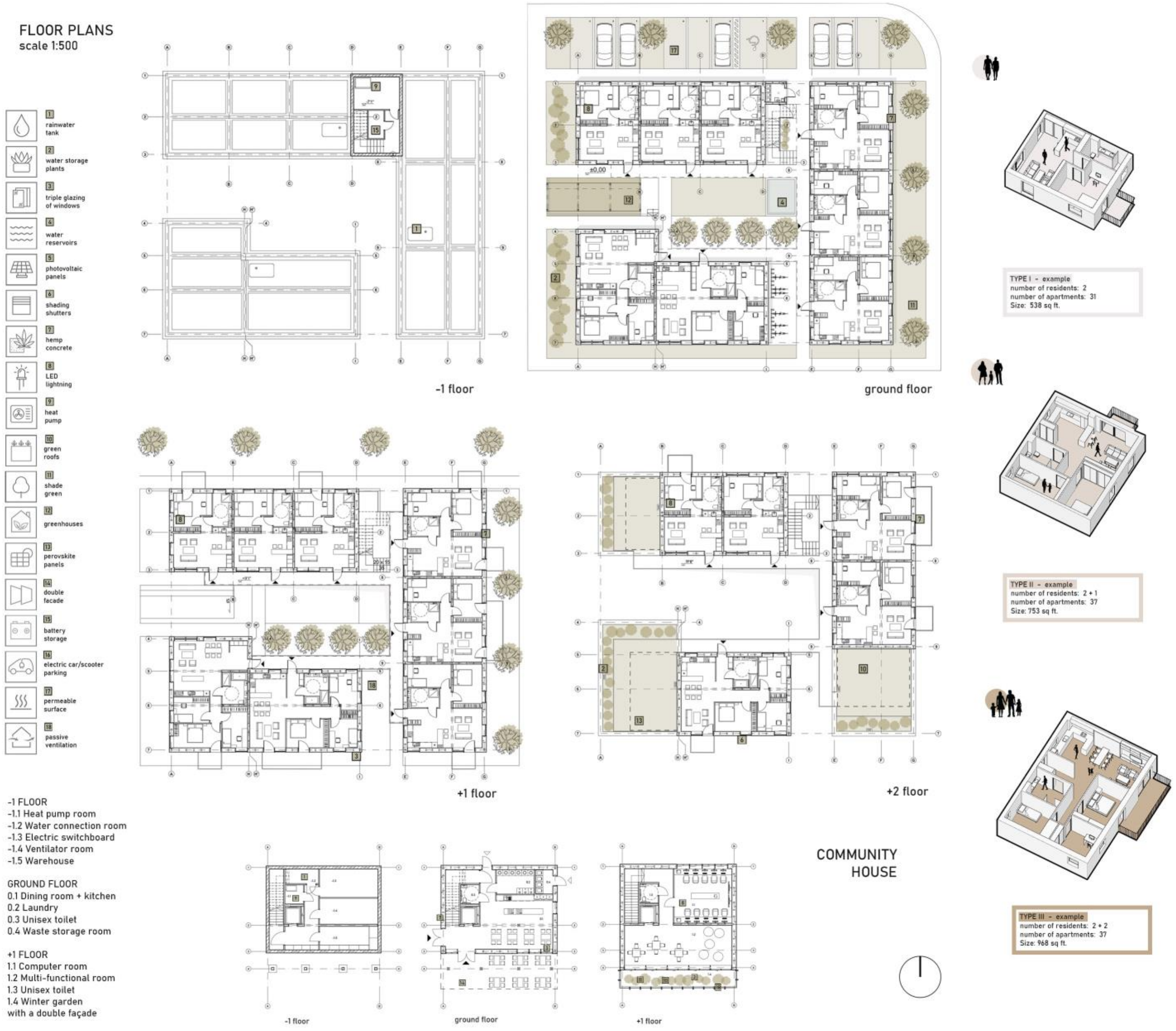
2. Site Plan



1 rainwater tank
2 water storage plants
3 triple glazing of windows
4 water reservoirs
5 photovoltaic panels
6 shading shutters
7 hemp concrete
8 LED lightning
9 heat pump
10 green roofs
11 shade green
12 greenhouses
13 perovskite panels
14 double facade
15 battery storage
16 electric car/scooter parking
17 permeable surface
18 passive ventilation
W North St
W North St
N Court St
N Court St
Module A
Module B
Module C
PG
R
S
Superstructure part
Development area
Green roofs
Residential buildings
Common house
Greenhouses
Low greenery
Gardens
Water reservoir
Playground PG
Open-air gym S
Recreation zone R
Bicycle parking
Electric scooter parking
Unpaved parking space
Site Plan
scale 1:500
0 5 10 20m

3. Floor Plans



4. Perspective Drawing

5. Illustrated Sections

1 rainwater tank
collect rainwater, which can then be used to water plants and flush toilets

2 water storage plants
accumulate water and do not require frequent watering

3 triple glazing of windows
triple glazing prevents formation of thermal bridges

4 water reservoirs
collect rainwater, cool the air and improve the microclimate

5 photovoltaic panels
capture solar energy and meet energy demand

6 shading shutters
prevents overheating and allows adjustment of lighting

7 hemp concrete
absorbs CO2 from the environment, allows natural ventilation and is non--flammable

8 LED lightning
led lighting that uses less electricity than a traditional incandescent bulb

9 heat pump
extracts heat from the ground and provides heating in apartments

10 green roofs
increase the biologically active area, provide space for recreation

11 shade green
increase the biologically active area, provide space for recreation

12 greenhouses
allow plants to grow, thus providing food for the inhabitants

13 perovskite panels
innovative cells that collect solar energy and let the sun pass through at the same time

14 shading galleries and balconies
shade windows on hot days and prevent overheating of apartments

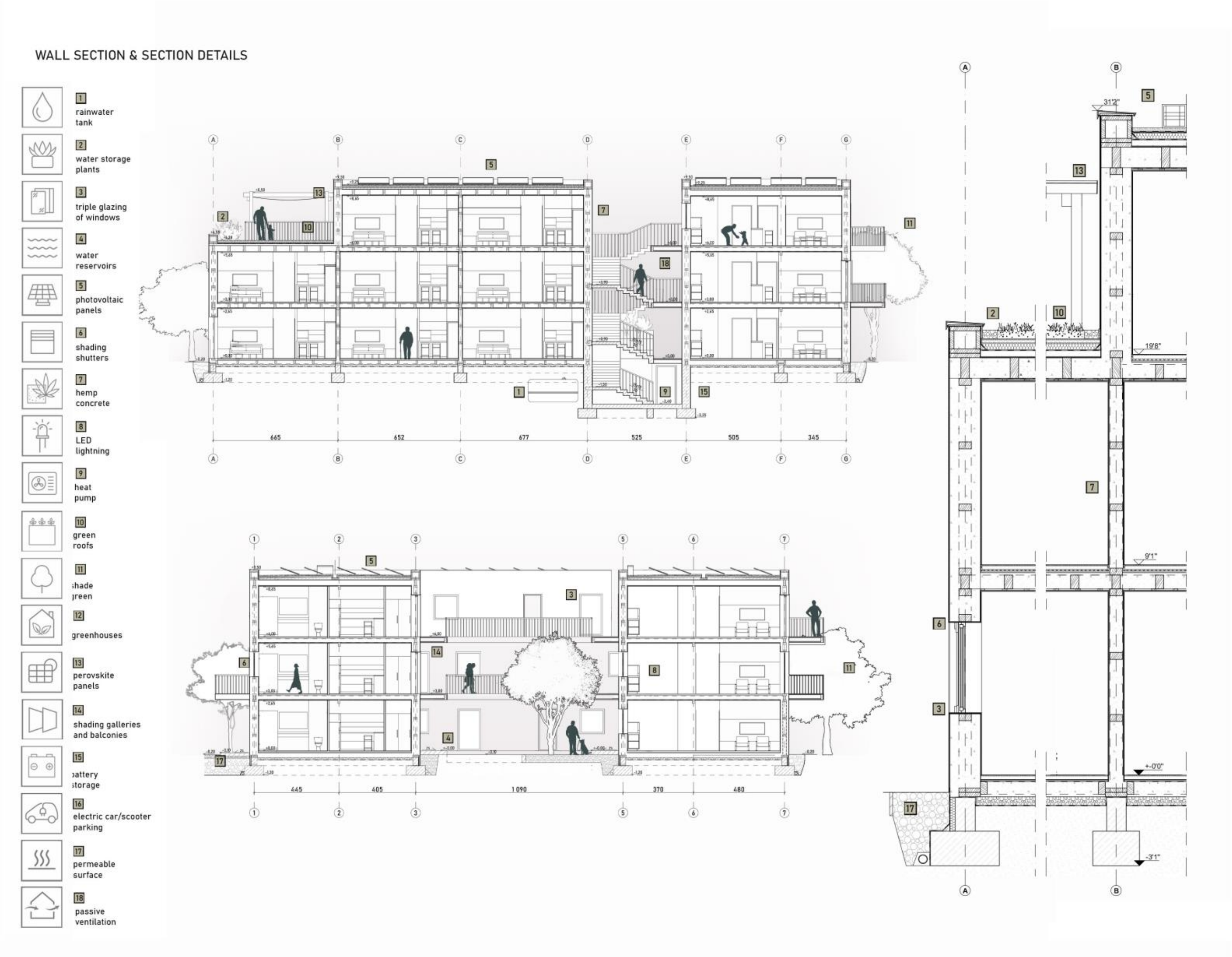
15 battery storage
take the excess energy gained and use it on cloudy days

16 electric car/scooter parking
promotion of ecological means of transport

17 permeable surface
provides natural ventilation and thermal comfort inside the building

18 passive ventilation
good ventilation thanks to openings in the structure and ventilation shafts in the apartments

5. Illustrated Sections



6. Mechanical System Summery

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7. Annual End-Use Summery Table

Electric Consumption (kWh x000) — Module A

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0,02	0,18	0,70	0,87	1,84	2,50	3,13	2,95	2,50	1,59	0,22	0,00	16,48
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0,32	0,01	0,00	-	-	-	-	-	-	-	0,01	0,18	0,51
HP Supp.	0,27	0,04	-	0,00	-	-	-	-	-	-	0,07	0,54	0,91
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	0,33	0,29	0,31	0,30	0,30	0,29	0,31	0,31	0,30	0,30	0,31	0,35	3,68
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	1,91	1,72	1,91	1,85	1,91	1,85	1,91	1,91	1,85	1,91	1,85	1,91	22,46
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	1,18	1,07	1,18	1,14	1,18	1,14	1,18	1,18	1,14	1,18	1,14	1,18	13,92
Total	4,01	3,30	4,10	4,16	5,23	5,78	6,53	6,34	5,79	4,98	3,59	4,15	57,96

Electric Consumption (kWh x000) — Module B

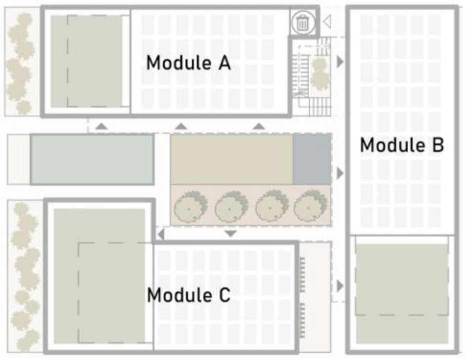
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0,02	0,26	0,92	1,16	2,15	2,79	3,41	3,23	2,64	1,68	0,27	0,00	18,53
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0,23	0,00	-	-	-	-	-	-	-	-	0,00	0,12	0,35
HP Supp.	0,20	0,02	-	0,00	-	-	-	-	-	-	0,05	0,43	0,70
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	0,33	0,29	0,31	0,30	0,31	0,30	0,33	0,32	0,31	0,31	0,31	0,35	3,75
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	1,97	1,78	1,97	1,90	1,97	1,90	1,97	1,97	1,90	1,97	1,90	1,97	23,15
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	1,19	1,08	1,19	1,16	1,19	1,16	1,19	1,19	1,16	1,19	1,16	1,19	14,05
Total	3,94	3,42	4,38	4,52	5,62	6,15	6,90	6,71	6,01	5,14	3,69	4,06	60,54

Electric Consumption (kWh x000) — Module C

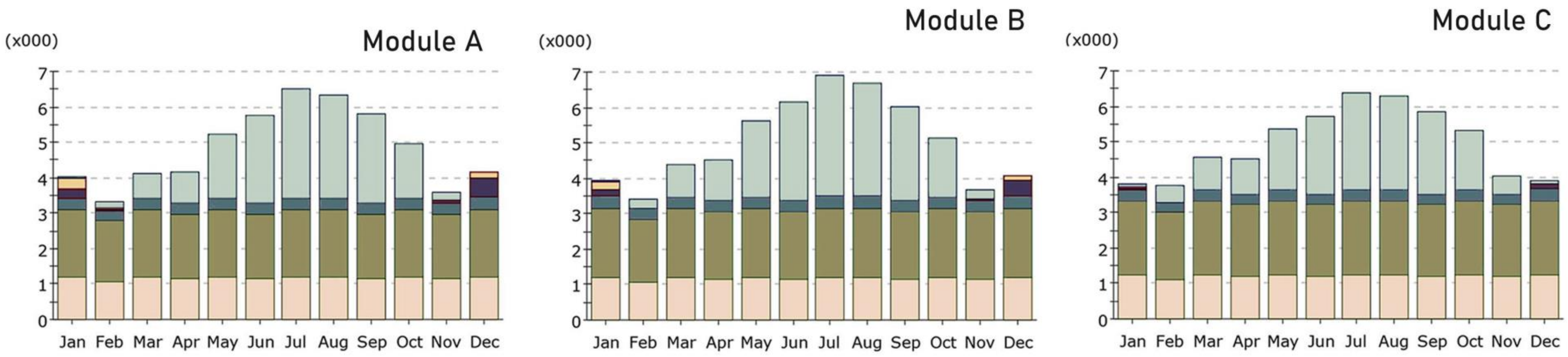
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0,08	0,46	0,95	1,00	1,75	2,22	2,73	2,65	2,35	1,69	0,53	0,09	16,52
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0,04	-	-	-	-	-	-	-	-	-	-	0,02	0,06
HP Supp.	0,04	0,00	-	-	-	-	-	-	-	-	0,00	0,13	0,17
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	0,32	0,29	0,30	0,30	0,30	0,29	0,30	0,30	0,29	0,30	0,30	0,34	3,64
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	2,10	1,90	2,10	2,03	2,10	2,03	2,10	2,10	2,03	2,10	2,03	2,10	24,76
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	1,22	1,10	1,22	1,18	1,22	1,18	1,22	1,22	1,18	1,22	1,18	1,22	14,37
Total	3,81	3,75	4,58	4,51	5,38	5,73	6,36	6,27	5,86	5,31	4,05	3,90	59,52

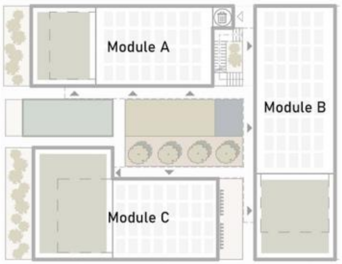
Annual End Use Summary Table

	Module A	Module B	Module C	Glasshouse	Total
Annual energy consumption [kWh (x000)]	57,96	60,54	59,52	-	178,02
Annual energy production [kWh (x000)]	57,74	74,58	65,96	12,03	210,31
Result in one quarter	-0,22	+14,04	+6,44	+12,03	+32,29
					=110,17 [kBtu]
Number of modules	5	5	6	5	
Total Result	-1,1	70,2	38,64	60,15	+167,89
					= 572,86 [kBtu]



8. Monthly End Use Energy Consumption Bar Chart

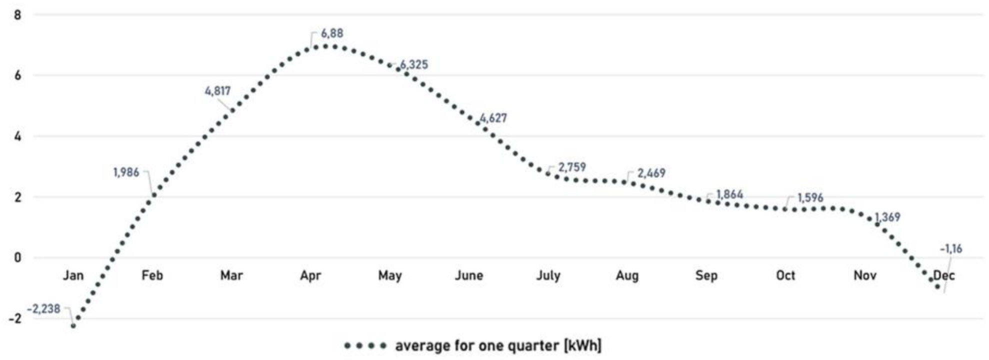




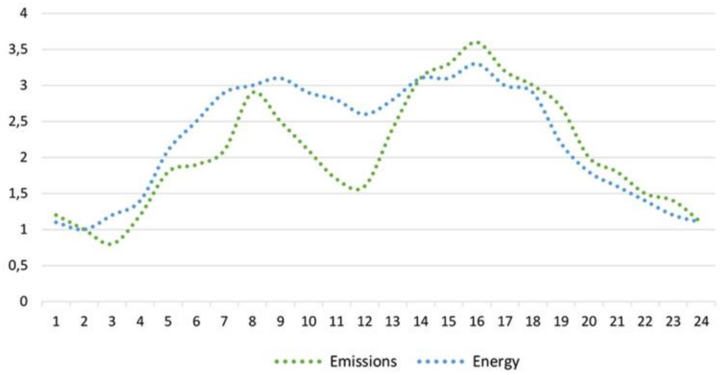
Monthly End Use Energy Consumption Bar Chart

9. Hourly load shapes for energy and emissions

Energy Surplus/Deficit



Annual Hourly Average Emissions and Energy



CO_2 absorption

Balance of absorption and emission of CO_2 by hemp concrete	
Ingredients 1 m^3 of hemp concrete wall	
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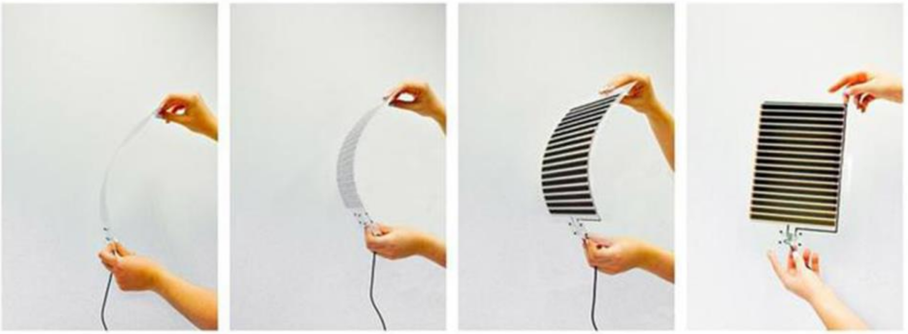

source: https://www.muratorplus.pl/technika/fasady/perowskity-pierwsza-instalacja-z-perowskitami-uruchomiona-aa-hcyN-diVZ-yBmb.html

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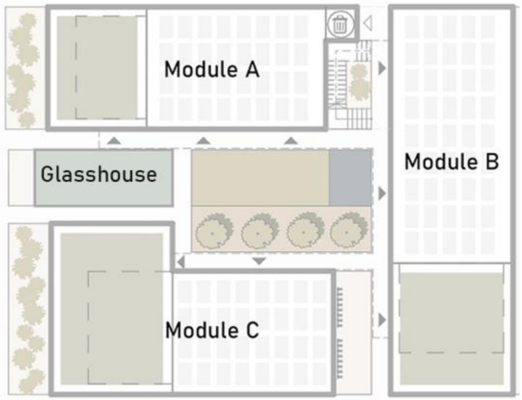

Module A — 57,739 kWh/Year*

System output may range from 54,840 to 59,021 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	3.03	2,627	420
February	4.39	3,436	549
March	5.88	4,932	788
April	6.90	5,537	885
May	7.61	6,222	994
June	8.11	6,148	982
July	7.94	6,220	994
August	7.74	6,011	961
September	7.07	5,386	861
October	5.65	4,697	751
November	4.29	3,503	560
December	3.42	3,021	483
Annual	6.00	57,740	$ 9,228

Module B — 74,579 kWh/Year*

System output may range from 70,835 to 76,235 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	3.03	3,393	542
February	4.39	4,438	709
March	5.88	6,370	1,018
April	6.90	7,151	1,143
May	7.61	8,037	1,284
June	8.11	7,941	1,269
July	7.94	8,035	1,284
August	7.74	7,764	1,241
September	7.07	6,957	1,112
October	5.65	6,067	969
November	4.29	4,525	723
December	3.42	3,902	623
Annual	6.00	74,580	$ 11,917

Module C — 64,956 kWh/Year*

System output may range from 61,695 to 66,398 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	3.03	2,955	472
February	4.39	3,866	618
March	5.88	5,548	887
April	6.90	6,229	995
May	7.61	7,000	1,119
June	8.11	6,917	1,105
July	7.94	6,998	1,118
August	7.74	6,762	1,081
September	7.07	6,059	968
October	5.65	5,284	844
November	4.29	3,941	630
December	3.42	3,398	543
Annual	6.00	64,957	$ 10,380

Glasshouse — 12,029 kWh/Year*

System output may range from 11,425 to 12,296 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	3.03	547	87
February	4.39	716	114
March	5.88	1,027	164
April	6.90	1,153	184
May	7.61	1,296	207
June	8.11	1,281	205
July	7.94	1,296	207
August	7.74	1,252	200
September	7.07	1,122	179
October	5.65	978	156
November	4.29	730	117
December	3.42	629	101
Annual	6.00	12,027	$ 1,921

C. Climate Adaptation Assessment Matrix

Climate Adaptation Assessment Matrix

PROJECT NAME: UrbanVillage

IMPACT	ADAPTIVE MEASURE	IF THE PROJECT IS EMPLOYING THIS MEASURE, BRIEFLY DESCRIBE TECHNICAL SPECIFICATIONS
HEAT	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
PRECIPITATION CHANGE ([illegible])	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
WILDFIRE	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]