

2014 Exhibition of School Planning and Architecture

Energy Positive Portable Classroom

Hawai'i Department of Education

Ewa Beach Elementary

Ewa Beach, Hawaii

Energy Positive Portable Classroom



Annotations:

- *RAMP, DECK, STAIRS TO BE FABRICATED BY COMPLETE ACCESS, OR WELCOME RAMP SYSTEM, INC. OR APPROVED ALTERNATE
- WIDTH OF AWNING ROOF MODULES AND COLUMN SPACING IS SIZED TO FIT BETWEEN STANDARD STAIR MODULES OF COMPLETE ACCESS SYSTEMS. IF ALTERNATE MANUFACTURER IS USED, VERIFY DETAILS AND DIMENSIONS WITH ARCHITECT TO COORDINATE COLUMN SYSTEM
- 150' TRAVEL PATH FROM FIRE HYDRANT
- DECK
- CONSTRUCTION JOINTS @ 5' - 0"
- EXPANSION JOINT
- PROPOSED PAVED PATH, BROOM FINISHED PERPENDICULAR TO PATH TO PROVIDE NON-SLIP SURFACE, MAX SLOPE PER ADA REGULATIONS
- FIRE ALARM
- SOLAR ARC
- CONSTRUCTION WORK STAGING AREA. LIMIT DISTURBANCE TO EXISTING LANDSCAPE TO THIS ZONE.
- PROVIDE GRAVEL FILL BELOW APPROVED SKIRTING, PER DETAIL
- 5' X 5' CONCRETE LANDING
- CATV
- HECO
- HTCO
- ENSURE THAT FOUNDATION WORK DOES NOT CHANGE TOPOGRAPHY SO AS TO CAUSE PONDING UNDER BUILDING. GROUND UNDER BUILDING TO HAVE POSITIVE OUTWARD CAMBER.
- PROVIDE SPLASH BLOCKS AT EACH DOWNSPOUT TO GUIDE WATER AWAY FROM FOUNDATION
- SAW-CUT AND PATCH FOR NEW 1-1/2" C (ELEC), +18" BELOW GRADE MIN., DIRECT BURIED. SEE ELECTRICAL SITE PLAN.
- CLASSROOM (101, 1048 SF)
- EXISTING ELECTRICAL BUILDING
- PORTABLE CLASSROOM
- HAUL ROUTE
- EXISTING FIRE ACCESS ROAD
- BUILDING D EXISTING
- BUILDING M EXISTING
- BUILDING M STAIRCASE
- BUILDING I EXISTING
- LIBRARY EXISTING
- BUILDING J EXISTING
- PREVAILING TRADEWINDS
- FH

Positive Portable

Community Environment:

The one room school and its current typological descendant, the ubiquitous portable classroom, are among the most common, mass-produced building types familiar to American children. A Re-invention of this building type will have an enormous impact on the quality of education and environmental stewardship in school districts with rapidly changing demographics, raising education standards and facilities flexibility on the one hand, and revolutionizing quality standards and construction expectations in a large sector of the prefabricated building industry.

The State of Hawaii commissioned a zero-energy, healthy and green alternative to the traditional portable school classroom so common in American public education. One in four Hawaii school children currently studies in energy intensive, poorly built and highly uncomfortable portables. The objective of this winning proposal was the creation of high technology, high-quality, relocatable classrooms that produce extensive reserve energy and other natural resources to share with permanent campus and community buildings.



Prototype for Change

Community Environment Continued:

The classroom is a prototype constructed as a test case for larger deployment across the state of Hawaii. Because Hawaii is a geologically and climatically diverse state with highly varying site conditions and microclimates, the design incorporated systems with extensive flexibility and adaptability built in. For this reason, this prototype design provides a range of optional equipment and systems that will allow the same structure to readily adapt to different sites and to a wide range of classroom functions, from an elementary school classroom in urban Ewa Beach to a science lab classroom in a wet and shaded rural Puna valley.

Due to its broad adaptability and universal message of sustainability, The Energy Positive Portable classroom can engage and empower any community around the world to generate their own energy and structure education around themes of community sustainability.

With its unique design and outlook, it has become a structure that not only adds a fresh look to the school campus, but also makes it a landmark to the campus as a meeting point / node.



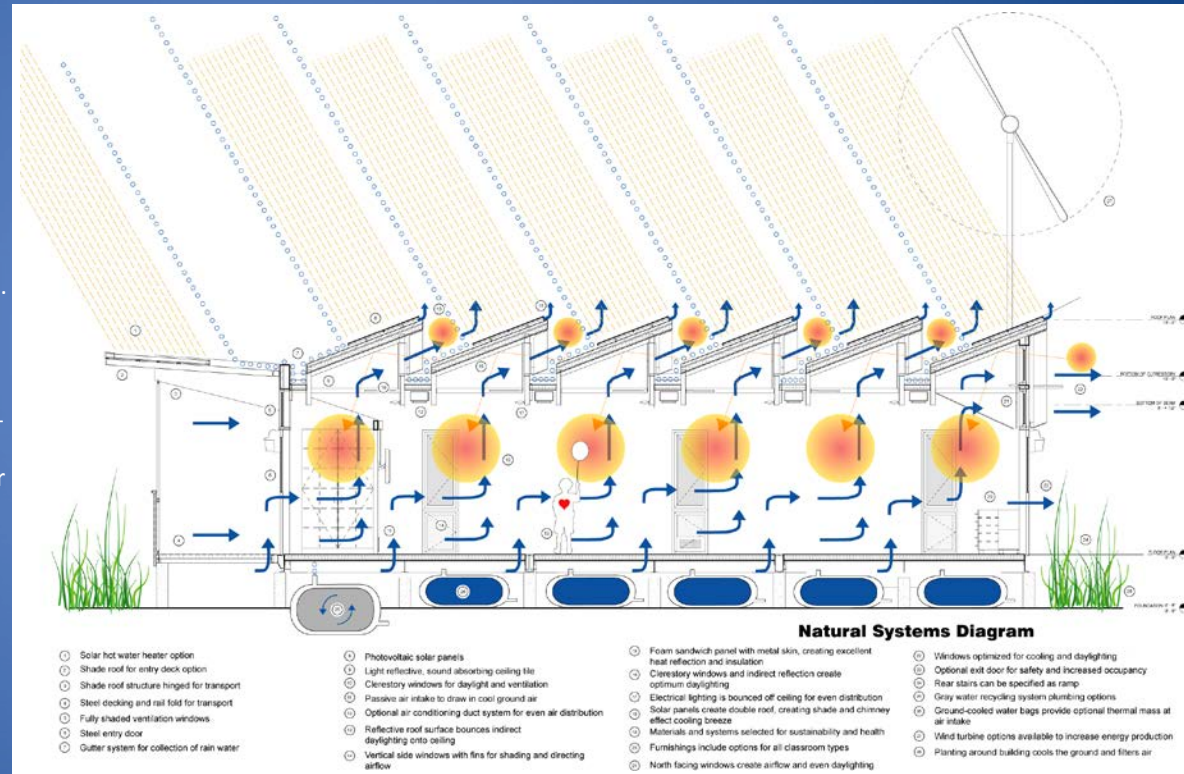
Sustainable Performance

Learning Environment:

This classroom design addresses performance issues directly impacting the learning experience of its occupants:

1. Thermal Comfort: the portable should remain passively comfortable as much as possible so as to avoid any thermal stress upon its occupants and reduce energy consumption of any optional air conditioning backup system.
2. Daylighting: adequate daylighting at task level has been shown to improve student learning ability substantially, while also reducing energy consumption.
3. Energy conservation and generation: energy conservation via passive cooling design and daylighting coupled with the energy production from renewable sources help offset any consumption of fossil fuel and make the portable an autonomous, self-supporting structure.
4. Indoor air quality via ample air change rate per hour (ACH) provided by natural ventilation assures a healthy air environment for the students.
5. Acoustical Optimization
6. Spatial Flexibility
7. Adaptability to Advancing digital technologies

The classroom includes a live, web-based sustainability information system that enables the building to be used as a learning tool, describing the green features and demonstrating how they are working using live data and interactive displays with weather and building performance data monitored in the building and visualized on the web.



Optimized Comfort Minimized Cost

Learning Environment Continued:

The Energy Positive Portable Classroom is designed to provide an optimized educational environment for students and teachers while creating a high performance classroom model that advances sustainable design principles as a curricular theme throughout the State's educational system. The design supports the Hawaii Clean Energy Initiative goals of reaching 70% renewable energy supply by 2030, contributing locally generated natural energy to existing buildings in excess of this classroom's usage. This classroom design will maximally conserve as well as collect and generate natural resources, including electrical energy, daylight, wind energy, and rainwater. As well as being strong, efficient and conserving, these qualities are highlighted and exposed throughout the structure, to serve as a learning tool as well as an efficient and healthy learning and teaching environment.

In addition to its advanced technological features, the design includes readily interchangeable and adaptable floor and wall coverings and furnishings to allow multiple types of program and teaching uses. The interior is designed to be quite, comfortable, bright and inspiring.



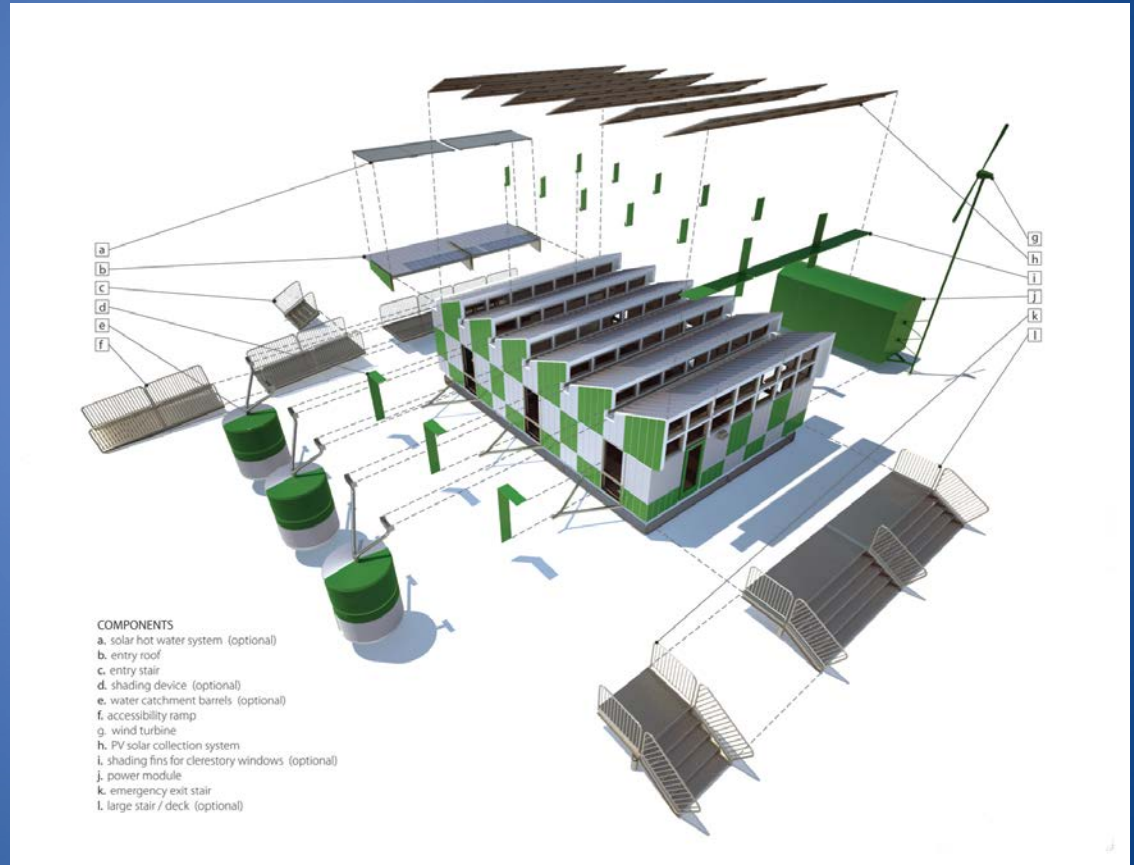
Modular Flexibility

Physical Environment:

The potential for highly varying conditions and microclimates requires extensive flexibility and adaptability built into the system of options available in the portable classroom system. This prototype includes a range of optional equipment and systems that will allow the same structure to readily adapt to different sites and to a wide range of classroom functions, from an elementary school in the desert to a science lab in a wet and shaded valley. Using Building Integrated Modeling software (BIM), accurate site data is used to drive rapid analysis, design, and manufacturing customization for any unique site.

The modular building system is optimized to provide maximum Photovoltaic roof surface orientation, optimized naturally shaded north-facing daylight glazing, and optimally modulated natural flow-through ventilation. These forces are balanced with the additional criteria of manufacturing and transport efficiency, along with functionality for classroom use, low operating costs and ease of maintenance.

The building is prefabricated in either two or three easily transportable modules, reducing initial cost and energy, and facilitating ease of transport and reuse in the future, minimizing waste. The factory-based prefabricator installs all systems, complete and test the portable classroom at its manufacturing facility before the modules are separated, packed and enclosed for land or ocean shipping. The modules are sized for cost efficiency in transport, with practical dimensions for negotiating tight urban streets and difficult rural locations. The modules are built on permanent steel frames, and will not require cranes for delivery and installation. Shipping, delivery and site installation is planned for maximum cost-efficiency.



Adaptable Systems

Physical Environment Continued:

The structure of the building is a hybrid of systems affording maximum benefits from each. Numerous foundation system options allow use in a wide range of site conditions. A steel frame and steel and rigid foam sandwich panel floor and roof system minimize material use, maximize insulation and heat reflection, and deter pests and mold in the cavity-free structure. Walls are framed and sheathed with FSC certified renewable resource wood, insulated with mineral wool for moisture resistance, and sided with 24 gauge steel over a radiation/vapor barrier. The double wall cladding and solar panel-shaded standing seam metal roof create a chimney-effect that shades and cools the building surfaces to greatly reduce heat gain. All glazing is operable and north facing and/or shaded to prevent direct sunlight, and to optimize natural ventilation and comfortable airflow.

Interior surfaces are low VOC, green products. Exposed beams are FSC certified parallams, with exposed structural steel elements displaying the primary structural components. The interior walls are naturally finished recycled rice straw panels. Ceilings are daylight reflective and sound absorbent high-recycled content acoustical tile. Flooring is natural linoleum tile. The entire classroom perimeter is paneled with a modular system of white board/recycled content tack board, allowing each room to be optimized for different classroom purposes. Interior furnishings are FSC certified, high-recycled content, wheeled modules affording maximum efficiency and adaptability with minimal maintenance.

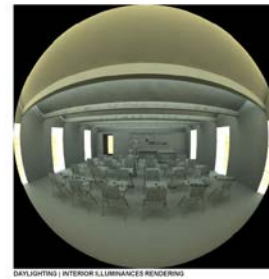


Design Simulation

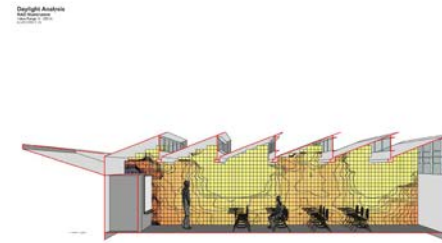
Planning Process:

Hawaii has a single statewide school district administering all K-12 education in the islands. The State Department of education invited six design-build teams to propose prototype designs with extensive performance analysis predictions and thirty-year life cycle cost analysis. The initial competitive design phase was conducted with several open planning sessions working with DOE officials and school personnel. After submittal of the six designs, DOE officials, facilities staff, teaching teams, and consultant building scientists and engineers carefully studied the proposals and analytical data and cost projections. This project was selected for construction and further testing. During the next phase of design development and construction planning, a larger team of building scientists and specialists in various education and performance disciplines worked closely with the DOE facilities personnel, and with the principal and teacher group selected as the first users of the prototype at a Honolulu elementary school. All design decisions were discussed and vetted among this group throughout the design, construction and site implementation of the first classroom prototype. Once occupied there have been extensive continuing performance analysis and post-occupancy survey studies of the project and its acceptance by students, teachers, administrators, facilities staff and the larger community. All of this ongoing research and analysis will be applied to future implementation of the project as further units are built.

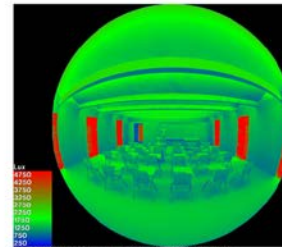
Energy simulation using accurate site data was an important design driver in order to calibrate an ideal classroom environment. The classroom was designed and modeled using Building Integrated Modeling software (BIM) that allowed rapid analysis, design and manufacturing customization for individual site conditions. With the power of this design software, the building form and systems were simulated before construction. Using BIM Modeling and simulation in combination with the advantages of modular prefabrication, the Energy Positive Portable Classroom can be optimized to suit the needs of any unique site.



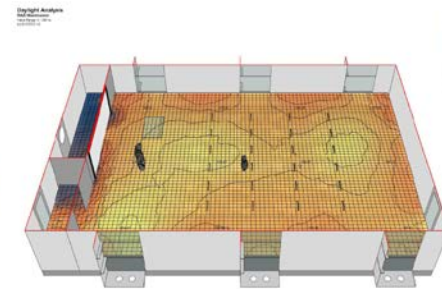
DAYLIGHTING | INTERIOR ILLUMINANCES RENDERING



DAYLIGHTING | SOUTH - NORTH CROSS SECTION ISOLINES



DAYLIGHTING | INTERIOR ILLUMINANCES FALSE COLOR RENDERING



DAYLIGHTING | WORK PLANE PLAN ISOLINES

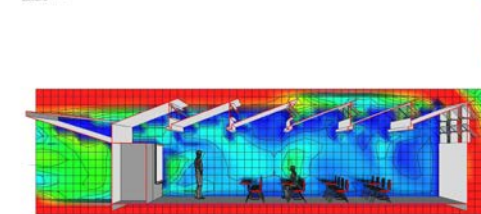
DAYLIGHTING SIMULATION

DATA	
AVERAGE ILLUMINATION @ 30" =	177 footcandles
WORK PLANE HEIGHT =	30 inches
SKY MODEL =	Clear Sky
DATE =	September 21 / Fall Equinox
TIME =	12:00 noon
GLAZING VT =	0.52
SURFACE REFLECTANCES =	80/60/40 as per IESNA
SOFTWARE	
ENGINE =	LENL Radiance 2.0
INTERFACE =	Autodesk Ecotect 2010

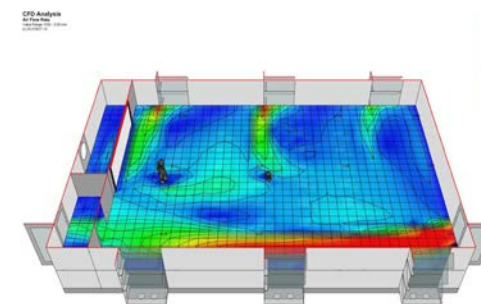
ILLUMINATION RESULTS STATISTICS

Footcandles	Min	Max	Avg	P50
0-25	86	2.18	4960	100
25-50	132	2.88	4467	97.86
50-75	84	1.84	4285	96.86
75-100	70	1.53	4291	95.13
100-125	65	2.02	4181	94.38
125-150	393	7.73	4289	96.17
150-175	492	14.38	3786	94.84
175-200	1038	33.89	3284	97.96
200-225	1046	22.89	1145	93.87
225-250	491	9.08	408	93.81

Indoor Air Quality Simulation



INDOOR AIR QUALITY | NATURAL VENTILATION AIR FLOW THROUGH CLASSROOM SOUTH - NORTH SECTION



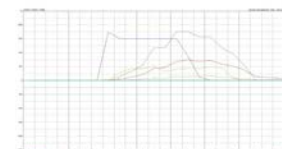
INDOOR AIR QUALITY | NATURAL VENTILATION AIR FLOW THROUGH CLASSROOM PLAN

INDOOR AIR QUALITY SIMULATION

DATA	
NATURAL VENTILATION RATE =	2.0 ACH
REFERENCE =	ASHRAE 62.1-2004
	Table 6.1 Classrooms
	10 cfm / occupant
	0.12 cfm / square foot
SOFTWARE	
ENGINE =	WSA Netværk CFD
INTERFACE =	Autodesk Ecotect 2010

AIR CHANGE RATE FOR PEAK WEATHER DAY

Natural Ventilation	
ACH	ACH
Min	Max
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0



INDOOR AIR QUALITY | VENTILATION GAINS ON PEAK WEATHER DAY

Learning + Evaluation

Planning Process Continued:

The classroom's sustainability information system enables the high-performance building to be used as a learning tool, describing the green features and demonstrating how they are working using live data and interactive displays. Weather data, energy use, energy production, resource collection, light levels, indoor air-quality and thermal comfort can all be monitored using a full array of recording data and comparative analysis published to the project web site. Current and recorded historical data are collected and available for detailed analysis and assessment.

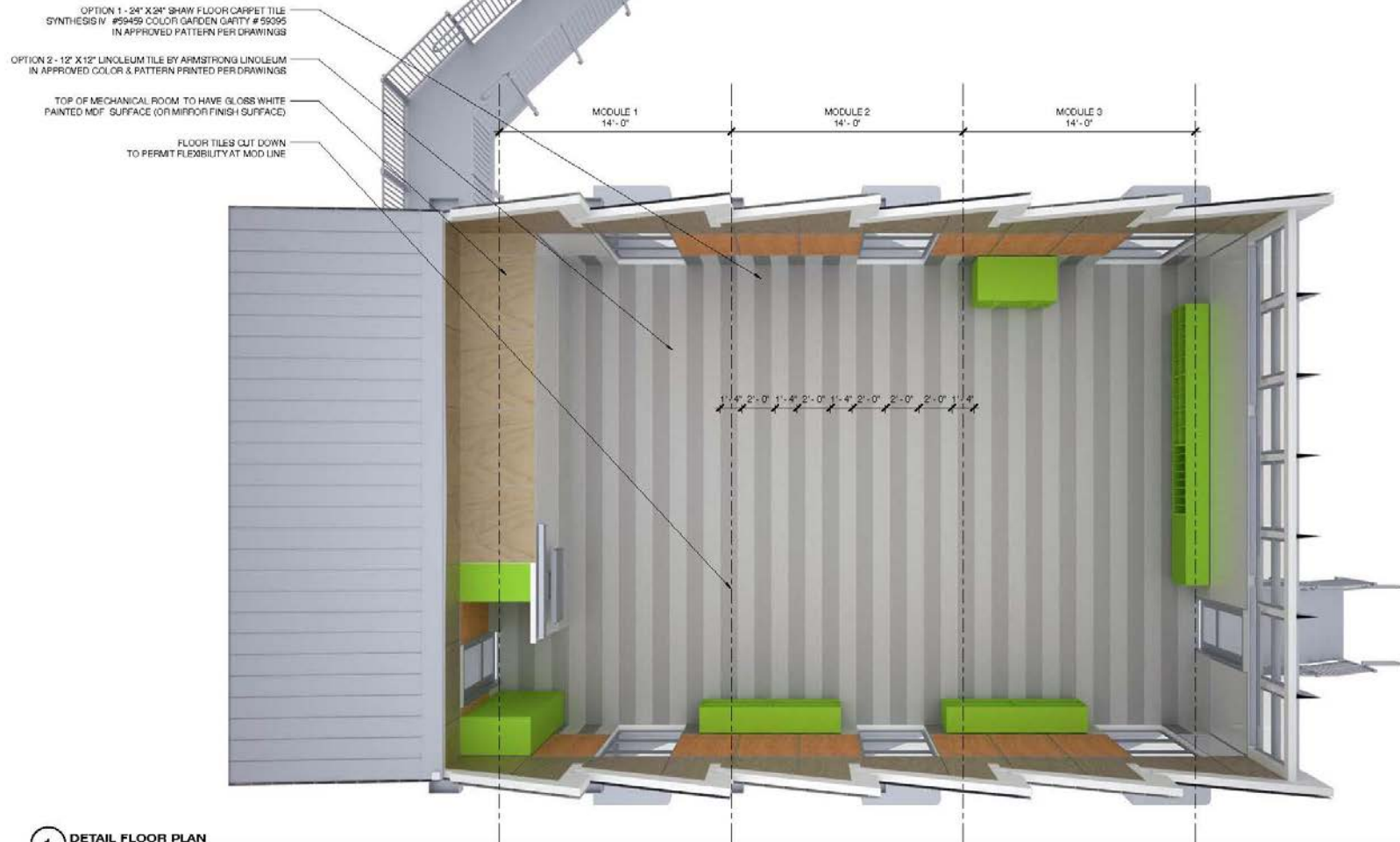
The team's intense commitment to the environment of Hawaii, its community and schools, along with its commitment to continued involvement in the prototype project and its teaching role in the school system's sustainability curriculum, is intended to assure the long-term success of future school building in the system. The projected need is that the state must build 10,000 new portable classroom units within the next ten years. This prototype has laid the groundwork for this large volume, with a strong testing and evaluation program, and a production system designed to accommodate this level of manufacturing at continuing high-quality levels. While a very small building, this humble portable classroom will have a tremendous impact on the quality of education for more than 25% of all the state's students in the coming years, while setting a high example for sustainable construction and sustainability education throughout the islands, for lasting, long-term impact.



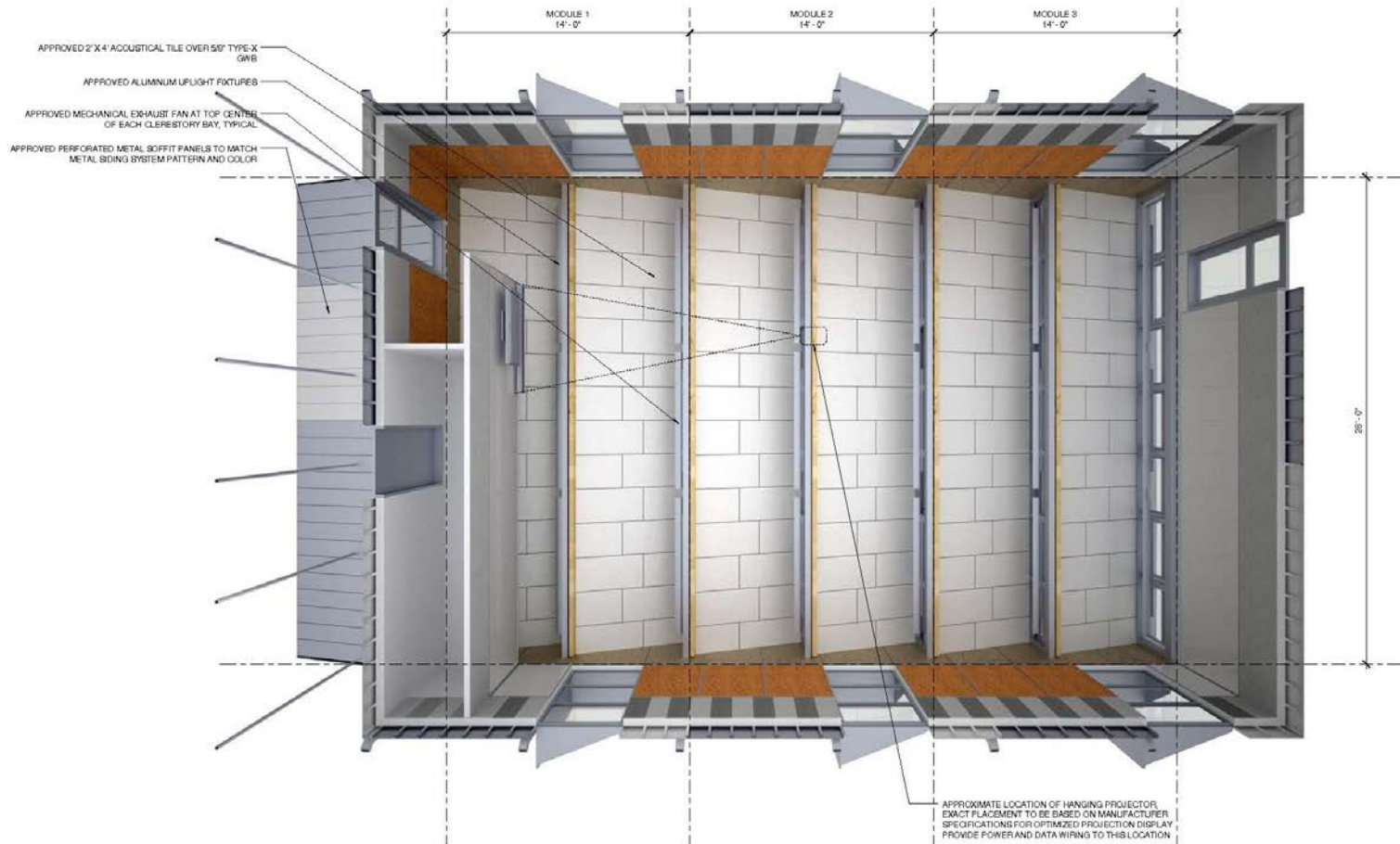
Link to Performance Monitoring Data:

<http://login.connectwithwow.net/Powersmiths.wow/KioskPage.aspx?request=GG7k4aH+ZsucpxgC7cKeFDaJwJ8YWz6jmaiuR5QvduvYkVUJAgc4oAVes0u5Vd7NnKc1c6g5C8tS/iMFwvGrS y3nwPD3bhMgdT1iDbJK9pdN2F2OYcvF2A==>

Floor Plan



Ceiling Plan



Exhibition of School Planning and Architecture

Project Data

Submitting Firm :	Anderson Anderson Architecture
Project Role	Design Architect
Project Contact	Peter Anderson
Title	Principal, FAIA
Address	90 Tehama Street
City, State or Province, Country	San Francisco, CA
Phone	415-243-9500

Joint Firm :	Anderson Anderson Hawaii
Project Role	Design Architect
Project Contact	Peter Anderson
Title	Principal, FAIA
Address	
City, State or Province, Country	Honolulu, HI
Phone	415-243-9500

Joint Partner Firm:	Blazer Industries, Inc
Project Role	Manufacturer / Engineering
Project Contact	Kendra Cox
Title	Project Coordinator
Address	945 Olney St SE
City, State or Province, Country	Aumsville, OR
Phone	503-749-1900

Joint Partner Firm:	Hawaii Modular Space
Project Role	General Contractor
Project Contact	Guy Murakami
Title	
Address	91-282 Kalaeloa Blvd.
City, State or Province, Country	Kapolei, HI
Phone	808-682-5559

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Project Data

Other Firm:	Iwamoto and Associates
Project Role	Structural Engineer
Project Contact	Ron Iwamoto
Title	President
Address	98-029 Hekaha Street, Suite 37
City, State or Province, Country	Aiea, HI 96701
Phone	808-486-5202

Other Firm:	Rocky Mountain Institute
Project Role	Bioclimatic Design Consultants
Project Contact	Victor Olgyay
Title	Principal (Buildings)
Address	1820 Folsom St
City, State or Province, Country	Boulder, CO
Phone	303-245-1003

Other Firm:	U Hawaii Sea Grant Program / School of Architecture
Project Role	Bioclimatic Design Consultants
Project Contact	Stephen Meder
Title	Director
Address	2410 Campus Road
City, State or Province, Country	Honolulu, HI
Phone	808-956-4906

Other Firm:	Symphysis
Project Role	Bioclimatic Design Consultants
Project Contact	Olivier Pennetier
Title	
Address	
City, State or Province, Country	San Francisco, CA
Phone	

Exhibition of School Planning and Architecture

Project Data

Other Firm:	Integrated Design Associates
Project Role	Electrical Engineer, Lighting, Renewable Energy
Project Contact	David Kaneda
Title	Principal
Address	1084 Foxworthy Ave
City, State or Province, Country	San Jose, CA
Phone	408-448-6300
Other Firm:	Powersmiths International
Project Role	Energy Management and Monitoring Systems
Project Contact	Philip Ling
Title	
Address	
City, State or Province, Country	Toronto, Canada
Phone	905-791-1493
Other Firm:	DL Adams and Associates
Project Role	Acoustical Engineer
Project Contact	Dana Dorsch
Title	
Address	970 N. Kalaheo Ave
City, State or Province, Country	Kailua, HI
Phone	808-254-3318

Exhibition of School Planning and Architecture

Project Details

Project Name	Energy Positive Portable Classroom
City	Ewa Beach
State	Hawaii
District Name	Leeward District
Supt/President	Kathryn Matayoshi
Occupancy Date	2013
Grades Housed	K-6 + Community
Capacity(Students)	24
Site Size (acres)	.75 Acres
Gross Area (sq. ft.)	1048 SF
Per Occupant(pupil)	43.66 SF
gross/net please indicate	Net
Design and Build?	Yes
If yes, Total Cost:	\$496,663
30 Year Lifecycle cost:	\$383,698
Includes:	Design / Testing, Construction, Shipping, Installation
If no,	
Site Development:	
Building Construction:	
Fixed Equipment:	
Other:	
Total:	\$496,663

Additional Images



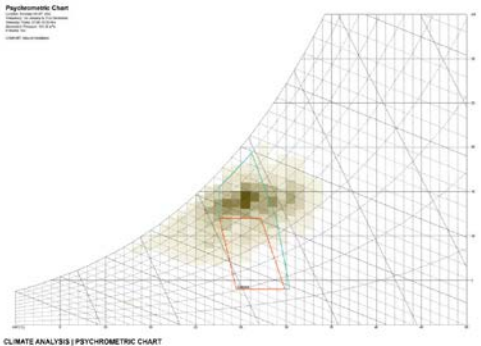
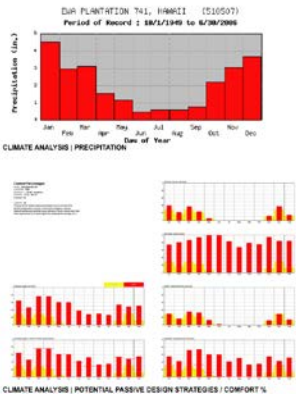
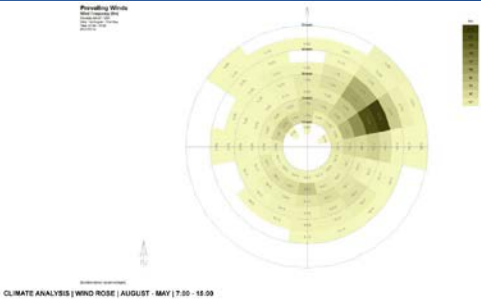
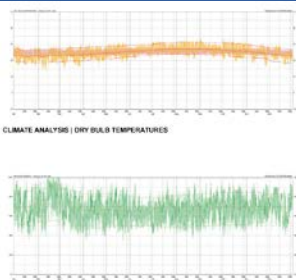
Additional Images



Climate Analysis

CLIMATE ANALYSIS

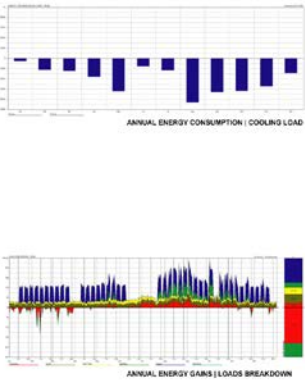
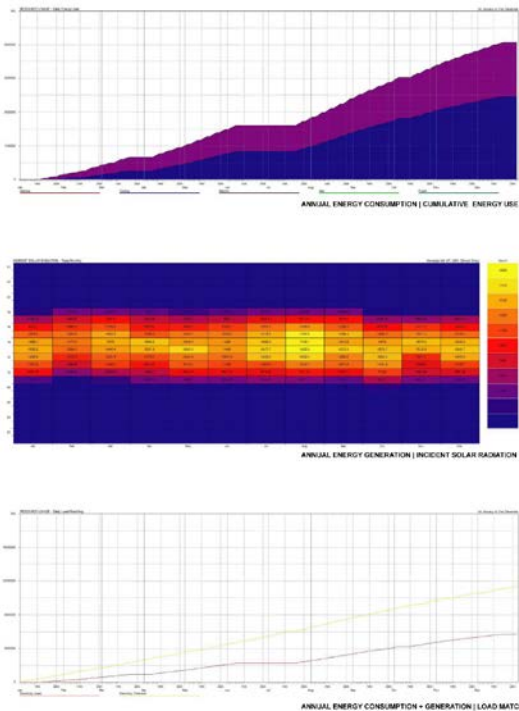
DATA	
AUG TEMPERATURE =	77.1 annual
MAX TEMPERATURE =	95
MIN TEMPERATURE =	53
RELATIVE HUMIDITY =	70.1% annual
RAIN FALL =	18.71 in/year
AUG WIND SPEED =	11.3 mph annual
DOMINANT WIND DIRECTION =	ENE
CLEAR DAYS =	90.4
PARTLY CLOUDY =	190.2
CLOUDY =	94.6
% POSSIBLE SUNSHINE =	70%
SOFTWARE	
ENGINE =	SQ01 Weather Manager 2.0
WEATHER FILE =	Houston.H1.TMY3
REFERENCE	
CLIMATIC DATA =	Western Regional Climate Center



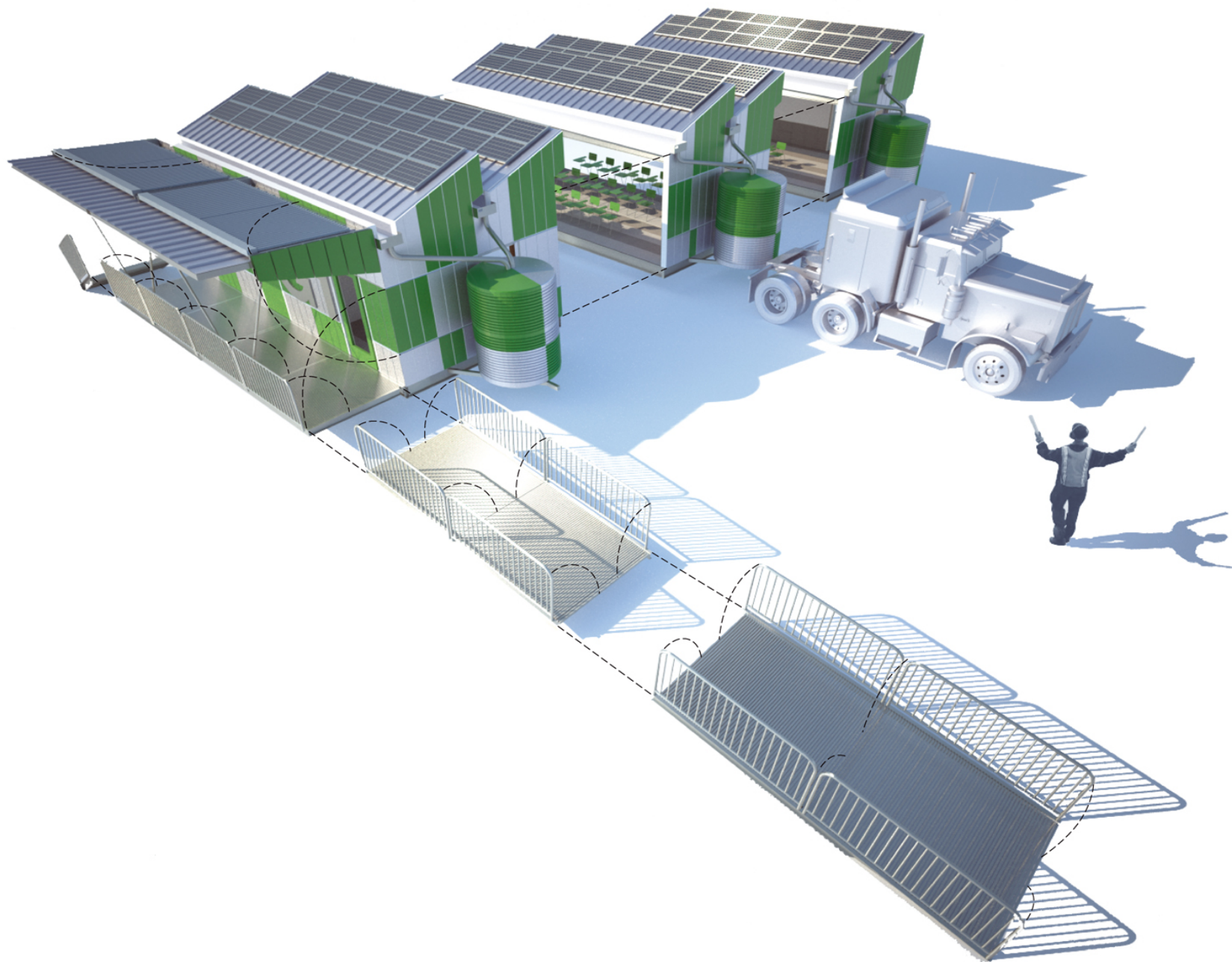
Energy Simulation

ENERGY NET GAIN SIMULATION

DATA	
ANNUAL ENERGY CONSUMPTION =	2,202 kWh/year
ANNUAL LIGHTING LOAD =	52 kWh/year
ANNUAL PLUG LOAD =	2,200 kWh/year
ANNUAL ENERGY GENERATION =	13,553 kWh/year
POTENTIAL NET GAIN =	11,351 kWh/year
ANNUAL COOLING LOAD =	3,432 kWh/year
POTENTIAL NET GAIN W/AC =	8,159 kWh/year
MODELING CONDITIONS	
GLAZING SHCO =	0.33
OCCUPANTS =	25
MET =	1.0
THERMOSTAT RANGE =	71.7°F - 83.3°F
THERMOSTAT RANGE FORMULA =	Audacema Thermal Neutrality
DAYS OF OCCUPANCY =	200
HOURS OF OCCUPANCY =	8
LIGHTING DENSITY =	12W/sqft / m2
LIGHTING OPERATION =	18 min / day
PLUG LOADS =	11 kWh / day
NOTE	
A more efficient plug load would reduce further the cooling load and overall energy consumption, reducing the plug load by 1.3 (from 11 kWh to 8.25 kWh per day) would reduce the overall energy consumption by 11% and increase the POTENTIAL NET GAIN to 8,142 kWh/year	
PHOTOVOLTAIC SYSTEM SPECIFICATIONS	
MAKE =	Kyocera
PRODUCT =	KC03SGT
TYPE =	Polycrystalline
OUTPUT =	135 Watts
EFFICIENCY =	13.5%
QUANTITY =	72
ORIENTATION =	SOUTH
TILT =	21 degrees
INVERTER TYPE =	Sunnyboy 5000US
INVERTER QUANTITY =	2
SOFTWARE	
ENGINE =	SQ01 Evolved 5.0
WEATHER FILE =	Houston.H1.TMY3



LOADS RESULTS			
	HEATING	COOLING	ELECTRIC
MONTH	(Btu)	(Btu)	(Btu)
Jan	0	35891	44763
Feb	0	18666	97207
Mar	0	36006	80562
Apr	0	63663	74902
May	0	129634	503695
Jun	0	117038	101648
Jul	0	136875	115727
Aug	0	143378	141388
Sep	0	242496	840111
Oct	0	200104	846713
Nov	0	307004	2601861
Dec	0	343117	290250
TOTAL	0	940717	2282230



Modular Installation

