Near Net Zero Building Energy Upgrade: Shell, HVAC, Lighting and Renewable Energy

Proposal Number 11 EB SI4-120

Principal Investigator: Dan Hendrickson
Libre Energy Inc.
PE Consulting GS, Inc. (dba GreenBuild Energy – SDVOSB)

ESTCP Selection Meeting

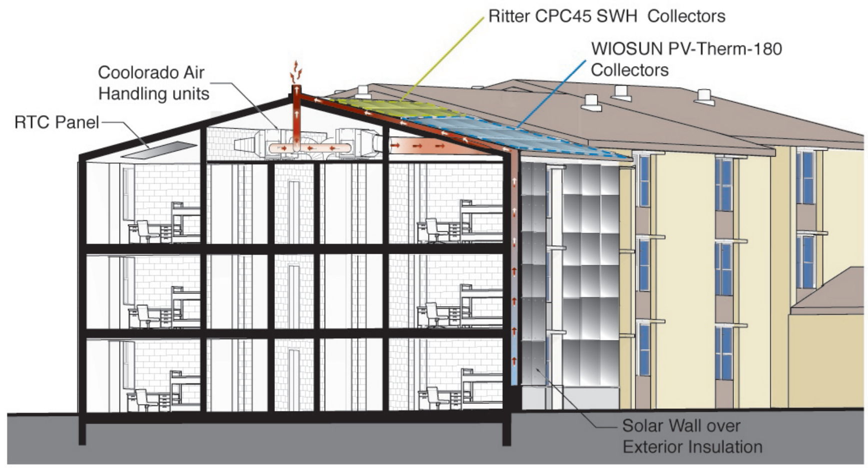
9/23/2010

Net Zero Energy Project Team

- Libre Energy & GreenBuild Energy - Dan Hendrickson (P/I and Project Manager)
- GreenBuild Energy – Chuck Brands, SDVOSB Principal (G/C and Contract Admin.)
- GreenBuild Energy - Doug Poffinbarger (Energy Engineer)
- Baucentrum Urban Studios - Phil Bona AIA (Architect)
- Design Atlantic - Finith Jernigan AIA, (Onuma & Big BIM/IPD/COBIE Process Consulting)
- Mesa Energy (SoCal) and EMCOR Group (Nationwide TBD) – MEP/HVAC Contracting
- Kelar-Pacific - Mo Mansouri (Building Information Modeling)
- Coolerado - Lee Gillan (HVAC Design Engineer)
- Cyphertech Mechanical - Milt Cyphert (HVAC Installation)
- Regisol – Mike DiPaolo (Ritter Solar CPC45 large Scale Solar System Design)
- Pelican Solar – Morgan Muir (WIOSUN PV-Therm-180/RHC)
- Adroit Solar – SWH/Solar PV Installation
- Energy-Inc – Don Pruss (CHP/ADsorption Chiller™)
- Lavelle Energy – Mike Lavelle – Smart Grid/Demand Response
- Integrated Energy Systems - Monte Lynch - TES

Barrack Environment & Energy Use

- Environmental Conditions
  - Insolation 400 to 900 watts/m2/hr
  - Temperature 10o F. to 120o F.
- Electricity use
  - 486,507 kWh ($ 35.1 K)/yr
- Peak Demand
  - 180 kW
  - $ 5,778/yr demand charges



- LPG use: 1,123 MMBTU ($ 15.7 K)/yr.
  - DHW: 667 MMBTU ($ 9.2 K)/yr
  - Space Heat: 471 MMBTU ($ 6.5 K)/yr
- Energy Cost: $ 51 K/yr. + $ 6 K demand = $ 57 K/yr
- High HVAC System Maintenance

Project Objectives

- Primary Objective: Net Zero Energy Demonstration in a 26,000 SF barrack that houses 68 personnel using a cost effective set of 'best in class' building-enhanced energy technologies and "right-time" retrofit processes comprised of:
  - Shell Passive Conservation Measures
  - HVAC and Lighting Efficiency Upgrades
  - Renewable Energy
- Secondary Objective: Demonstrate effectiveness of BIG BIM concepts for managing high-performance "smart energy" retrofits using the Onuma Virtual Real Time Information System (VRIS) platform to:
  - Enable collaborative integration of best-practice BIM, GIS, COBIE, and IPD tools and processes with
  - Building-integrated Energy Retrofits, energy performance monitoring and control
  - Deliver best-value "right-time" retrofits and integrated decision-making support for facilities, asset and energy management

Technical Approach
Overview of Project

- Barrack 261: 3 Performance levels, each in a 3 floor, 24 room section

  LEVEL DEFINITION UPGRADES

  0 - Current Configuration + Sensors. Baseline - update e-Quest energy model

  - 1 – Moderate Cost:
    - Shell: Multi-ceramic reflective coating, R-50 foam roof, 2 Skin Roof; window film
    - HVAC: Coolerado, ERV, existing fan coil (motor/control upgrade), EMS
  - 2 - High Performance:
    - Shell: Wall R-20 insulation, R-50 foam roof, 2 Skin Roof, Cool RoofReplace Windows
    - HVAC: Coolerado, ERV, RHC (radiant heating/cooling), EMS
  - 3 - Best Value - ***Upgrade Level 0 with Highest SIR systems in Level 1 & 2 demo.***.
    - 2012/13
- Barrack 261 Renewable Energy: Solar Water Heating (SWH) and Solar PV
  - SWH: 582 SF of CPV evacuated tube SWH - ___ BTU/yr DHW
  - Solar PV-SWH Hybrid: 32.4 kW PV + __BTU of SWH @ 90o F.
  - SolarHeart™ 5 kW Mid-temperature Stirling Engine to convert *Waste Heat* to Electricity

Technical Approach
Overview of Project (Cont)

- Central Plant 263
  - 80-RT ADsorption Chiller™
  - Cooling Tower and District Loop Pump Upgrade
  - TES (Thermal Energy Storage)
  - 200 kW CHP micro-turbine (LPG or *SYNGAS* from Waste-to-Energy System)

- 40 ton MSW/day – 1,600 kW Waste-to-Energy-Ft. Irwin Landfill (Option 1)
  - Lease

- Gray Water Recovery, Purification and Reuse - Cluster 263 (Option 2)

- BIM: Design/Energy Models, Cost Analysis, Project and Maintenance Management

Existing and Proposed Energy Use

Ft. Irwin Barrack 261

Electricity	eQuest Model CERL Slide #6 kWh/year		Proposed Libre Energy kWh/year			SAVINGS	
Passive Measures							
Space Cooling	139000	31.2%	240	0.2%		138760	55.1%
Ventilatioin/Fans	13400	3.0%	0	0.0%	(3)	13400	5.3%
Pumps, heating/c	66300	14.9%	34000	51.3%		29400	11.7%
Lights	73800	0.8%	36900	19.0%		36900	14.6%
Plug Loads	153500	34.4%	122800	63.3%		30700	12.2%
TOTAL	**446000**		**193940**	43.5%		**252060**	
CHP			-259285				
Solar PV			-50308				
			-115653				
Cost	**$ 44,734**		**$ (11,600)**				
Heating	**MMBTU/Year**		**MMBTU/Year**				
Space Heating	471		0	0.0%	(1)	471	
DHW	667		0	0.0%	(1)	667	
Space Cooling	0				(2)		
TOTAL	1,138		0	0.0%		**1138**	
CHP with Syngas							
Cost	$ 15,586						
Total Cost	**$ 60,319**		**$ (11,600)**				

Note: (1) Use of SWH (Solar Water Heating) for DHW and SWH + CHP heat for Space Heating will reduce the MMBTU/year requirement to ZERO

(2) Use of "waste heat" from the DHW and Space Heating SWH systems will provide sufficient 195o F. water to operate a 120 RTcentral ADsorption Chiller..

(3) An additional 60 tons of cooling/barrack provided with 12 Coolerado M50 air conditioners

Technology/Methodology
Demonstrate

- Barrack Shell Upgrade to conserve
  - 20% of heating/cooling load
- HVAC
  - 80% electric energy reduction
  - 80% demand reduction
  - 90% LPG reduction - space heating
- Energy Management System - HVAC, Lighting, Plug Loads << O&M $.
- Renewable Energy:
  - Solar Water Heating DHW - 85% LPG reduction
  - Solar PV - 30.3 kW
  - Waste-to Energy: increase SIR_{20yr} to 1.91 vs. 1.38 for a LNG fueled CHP plant
- Gray water recovery/reuse (25% water saving + pump energy reduction)
- Onuma BIM: Plan, model building + energy, Project & Maintenance Mgmt

1. Limit to one slide onl

Technology/Methodology Maturity

Barrack Shell/HVAC/Lighting/RE Systems

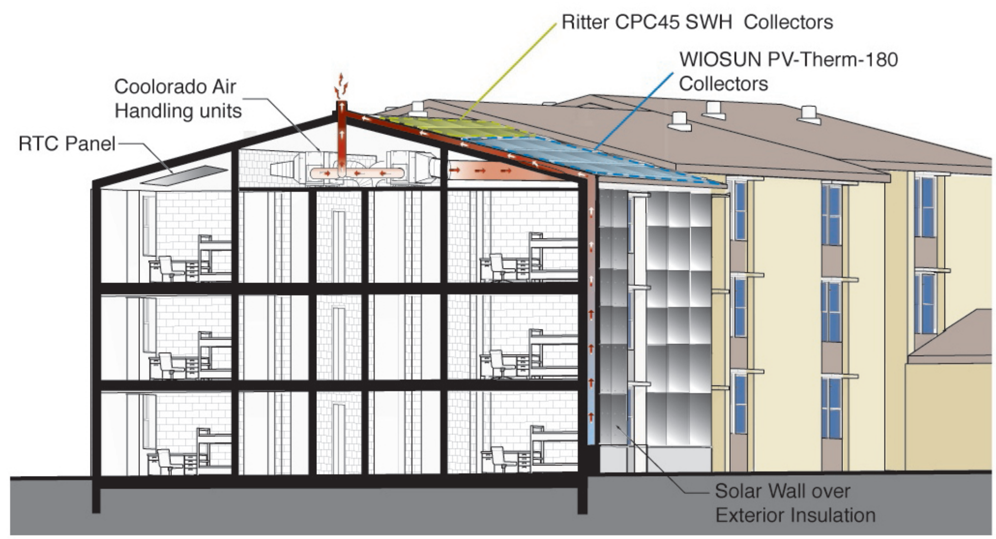
Mature Technology — **Engineering/Prototype Development**

- **Building Shell**
  - EPS Insulation, ***Multi-Ceramic Coating***, — ***Night-Sky Radiative Cooling***
  - Window Film or Replacement Windows
  - ***Double-Skin Roof cooled with exhaust air***
  - ***SolarWall (Option)***
- **HVAC**
  - ***DOAS - Coolerado Air Conditioning*** — ***64 SF Radiant Heating/Cooling Panels***
  - ***ERV – RenewAire HE2XINH***
  - ***CHP + ADsorption Chiller™*** — ***Coolerado Turbine Inlet Cooling***
- **Lighting/*Energy Management Systems*** — ***Thermal Energy Storage***
- **Renewable Energy**
  - ***Ritter Solar CPC evacuated tube collectors***
  - ***WIOSUN Solar PV-Therm-180*** — ***SolarHeart™ 5 kW Stirling Engine***
  - ***SWH Solar-Thermal Stirling Engine***
  - ***Waste-to-Energy Pyrolizer***
  - ***ElectroTherm Rankine Cycle Engine***

17 Innovative Systems - *Bolded Italic Print*

Technology/Methodology
Building Shell/Passive Heating-Cooling

- Building Shell
  - Insulation
  - Reflective Coatings
  - Fenestration
  - Vestibules with 2 doors
  - Corridors are transition zones
- Passive Heating-Cooling
  - Cool Roof ~ 90% reflectivity
  - Double-skin roof + building exhaust circulation
    - 800 w/m2/hr reduction in sun loading heat
  - Night-Sky Radiation Cooling
  - Evaporative Cooling of Roof Panels
  - Transpiring SolarWall® on South facade



Passive Heating/Cooling

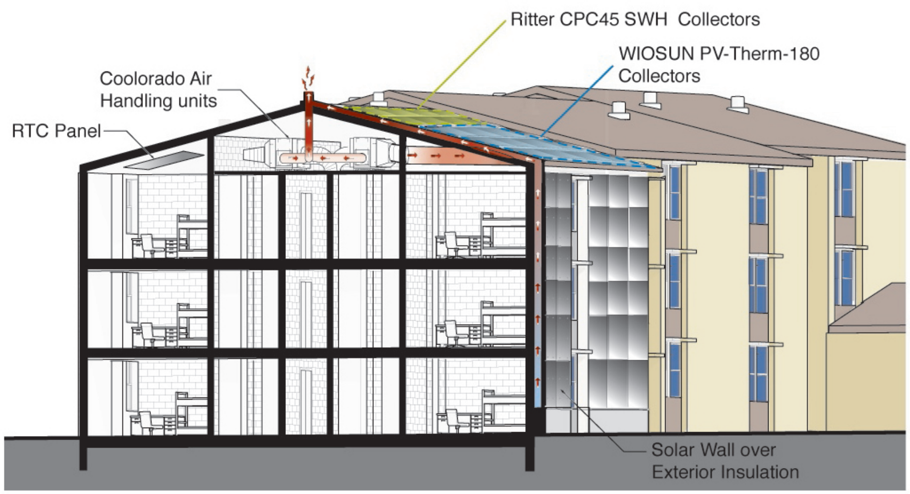
Double-Skin Roof + Circulation of Exhaust Air

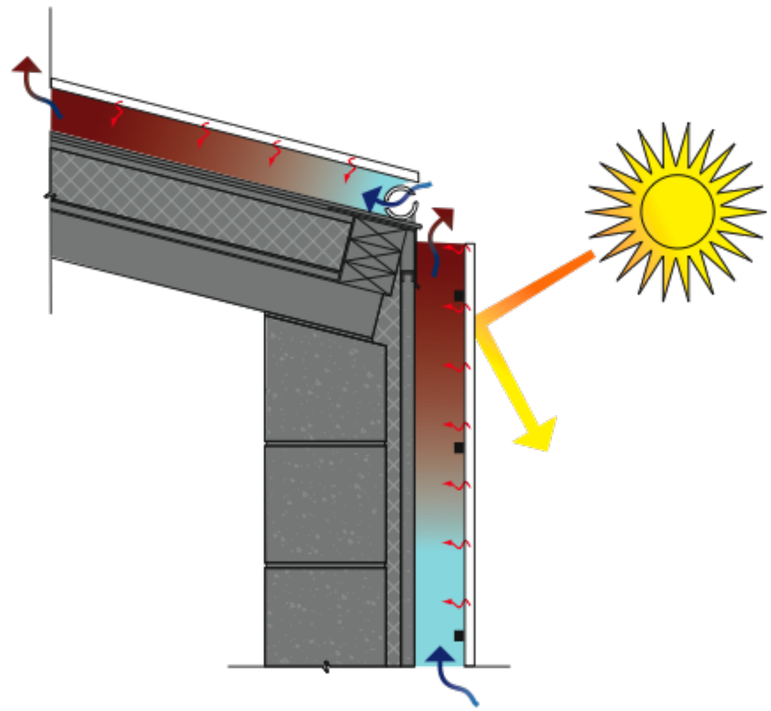
Solar Load 900 W/m2/hr x 123 m2 roof

Total Solar Load 111 kW/hr

Exhaust air 500 to 4,000 CFM

Removes > 90% of Solar Load





Section Diagram of Double Skinned Wall/Roof

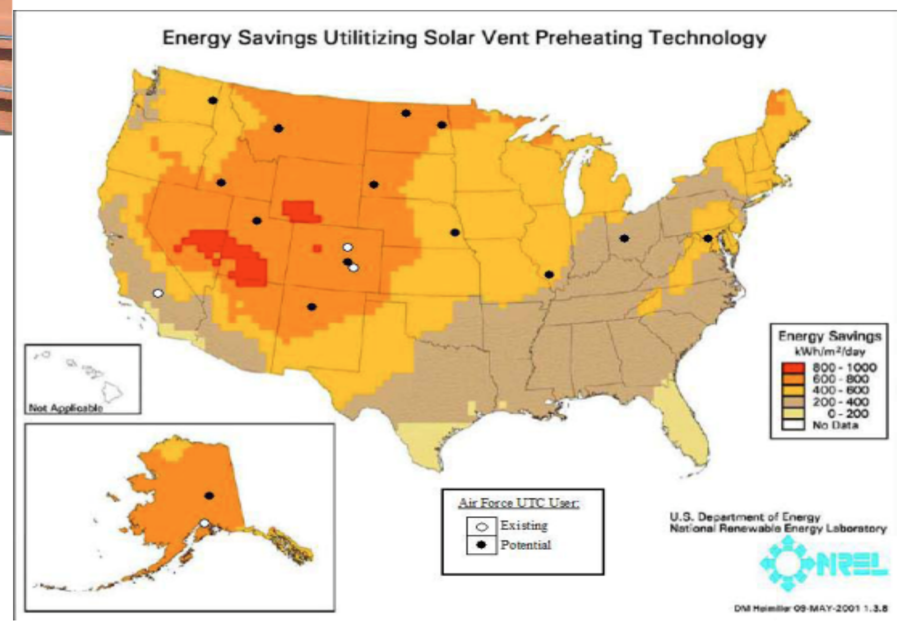
Passive Cooling

Night-Sky Radiant Cooling

- Barrack - high thermal mass
- 68 Radiant Heating/Cooling panels used as heat source
  - ~ 78o F. at room ceiling – 4,080 SF
  - Reduce CP chilled water use and recirculation at night
- 120 WIOSUN PV-Therm-180 solar panels used as radiators
  - Night-sky radiation – 1,693 SF
  - 5.8 – 10.2 W/SF - 17,269 BTU = 1.44 tons
  - 23.2 – 41.7 W/SF/night in July = 70,598 BTU = 5.88 ton-hours/night
  - ***Augment with double-skin roof + exhaust + evaporative cooling***
    - 917 BTU/lb. H2O = 7,336 BTU/gal. = 0.6 tons of cooling/gal. H2O

Passive Heating/Cooling
Transpiring SolarWall®

Barrack 261 South Façade
4518 SF x $ 27/SF
$121,986
54 BTU/SF/hr
244,000 BTU/hr
Ft Drum, NY
Ft Carson, CO
Edwards AFB, CA
Ft Huachuca, AZ



Technical Approach

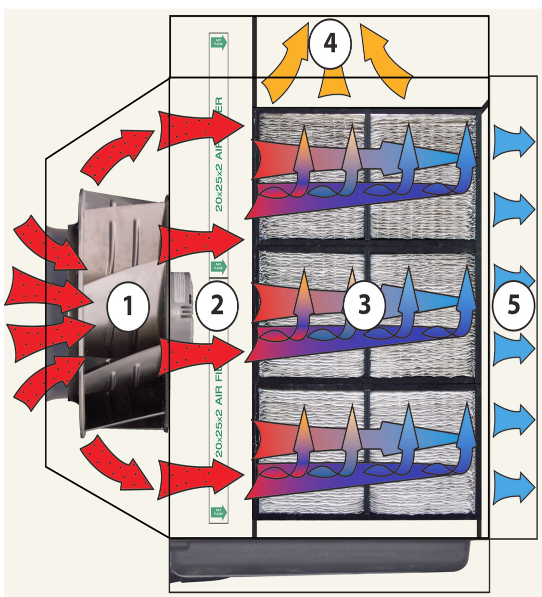
HVAC System Architecture

- Barrack 261
  - Passive Measures
  - Active Measures
    - DOAS (Dedicated Outside Air System) - Coolerado air conditioner
    - ERV conserve 75% of exhaust air energy
    - Ceiling Mounted Radiant Heating/Cooling (RHC) in barrack room
- Central Plant 263 and District Loop
  - 80 RT ADsorption Chiller™ - replaces 340 ton electric chiller
    - (TES) Thermal Energy Storage
    - Cooling Tower and Recirculation Pump Upgrade
  - 200 kW Capstone CHP micro-turbine with Turbine Inlet Cooling

Barrack 261/Central Plant 263 HVAC	Peak Tons	Percent
SolarWall	18.63	14%
Double Skin Roof	18.00	14%
Night-Sky Radiation.	1.44	1%
Coolerado Air Conditioner	52.00	39%
Radiant Heating/Cooling+CHP+ADsorption Chiller™	33.00	25%
ERV (Energy Recovery Ventilator)	8.64	7%
Total HVAC System Capacity	**131.71**	

Technical Approach
Coolerado Air Conditioner

- Elegant Simplicity
- 100 watts/ton of air conditioning
- 52 tons/barrack
- 12% of electric chiller energy
- Solar PV Powered
- $SIR_{10yr} = 1.46$ $SIR_{20yr} = 4.65$



1. Outside Air blown by ECM fan
2. Filter
3. HMX (Heat and Mass Exchanger)
4. Exhaust cools roof & Solar PV panels
5. Product air to Conditioned Space
6. ***No Humidity Added to Product Air***

Coolerado Air Conditioner Performance at Ft. Irwin

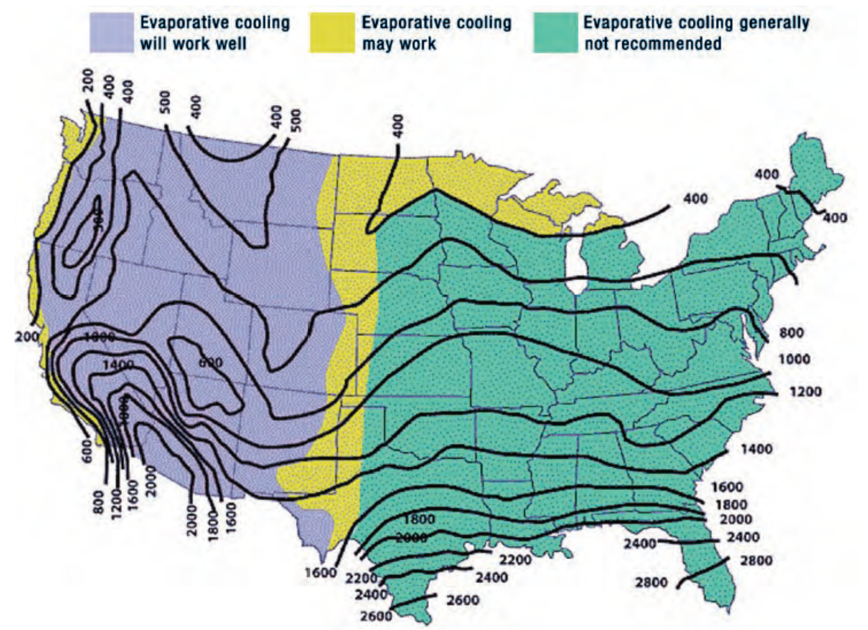
Fort Irwin summer conditions:

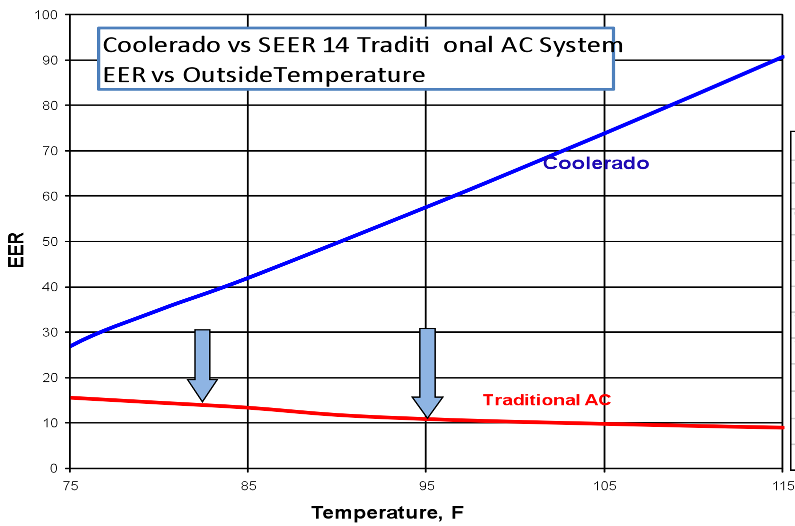
110o F., 10% Relative Humidity

= 65o F. Coolerado Product Air

SIR10yr = 1.79

SIR20yr = 1.82





Coolerado air conditioner 100 W/ton performance vs. a 600 W/ton electric chiller					
		Electric			
Air Flow 5,000 CFM	Coolerado	Chiller	Savings		
Tons	56.53	56.53		43%	
Peak kW	7.35	92.75	85.4	92%	
kWh/year	18008	155785	137778		
Energy cost/yr	$1,801	$15,579			
Water use	127				
Water Cost	$ 85				
	$ 1,886	$15,579	$13,693	88%	
Hours	$ 4,095	4313			
Hours Condensing	$ 197	790			
SCE Standard Performance Contract =	$ 20,667	$ 8,540	$ 29,207	$ 516.70	/ ton

Technology/Methodology

Zero Energy Energy HVAC - ERV

- RenewAire Energy Recovery Ventilator
  - Solar PV Powered
  - Capacity: 8.64 tons @ 4,500 CFM
    - 36 bathrooms - 1 to 8 air changes/hr. 180 – 1,460 CFM
    - 68 rooms + corridors + laundry/lounge - 1 air change/hr. ~ 3,000 CFM
    - 71% - 80% energy recovery
    - 30 % heating energy savings in winter
  - Augment ERV blowers with:
    - Bathroom ventilation fans - vary flow from 1 to 8 air changes/hr
    - Control with occupancy/humidity sensors & timers
  - ***RenewAire Solid state core vs. a rotating enthalpy/desiccant wheel***
    - ***Low maintenance***
    - ***Dehumidify Coolerado inlet air***
- $SIR_{10yr} = 1.20$ $SIR_{20yr} = 1.58$

Technology/Methodology

Low Energy HVAC - Radiant Heat/Cool

- Attach to ceiling as low energy fan coil replacement
  - ~ 60% of fan coil energy use
  - ***No fan or filter maintenance in rooms***
- Lower District Loop Losses
  - Hot water – 85o F. vs. 150o F.
  - Chilled water – 55o F. vs. 40o F
- Reduced
  - Maintenance and life cycle costs
  - Installed Cost ~ $ 2,100/RHC unit - 60 SF area
- 40% reduction in central plant chiller capacity and cost
- ***SIR_{20yr} (RHC Panels + ADsorption Chiller™ + TES + CHP)***
  - SIR_{20yr} LPG = 2.80
  - SIR_{20yr} SYNGAS = 3.56

Technical Approach

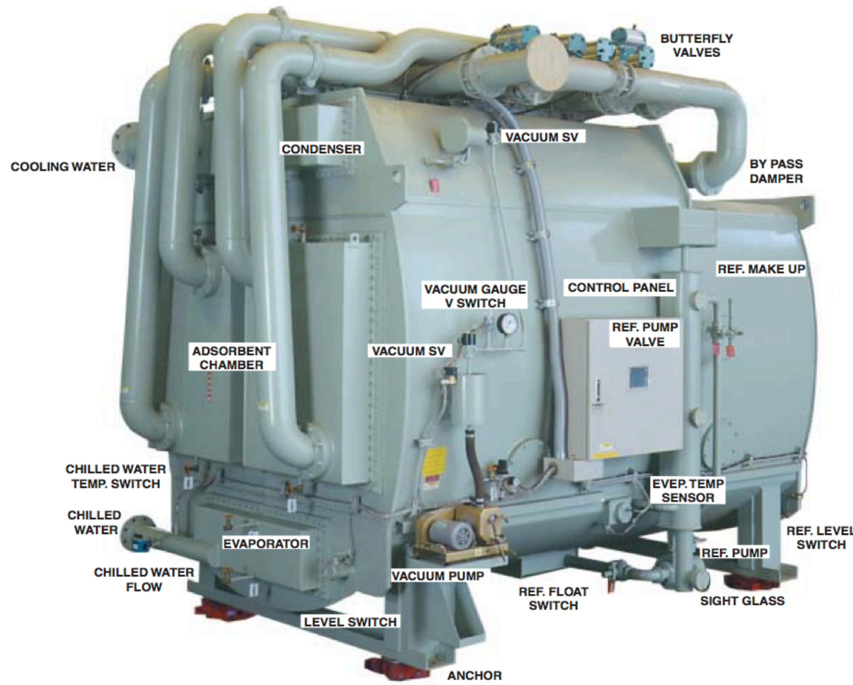
CHP+80-RT ADsorption Chiller™

- CHP waste heat OR Solar Water Heating powered.
- 200 kWe CHP with 300 kWthermal
- 80 RT Adsorption Chiller
  - ♦ 400 watts
  - ♦ 1.2 MMBTU/80 ton
  - ♦ COP = 0.7
  - ♦ 194o F. water ***waste heat*** from

CHP LNG or *SYNGAS*

OR hot water from

- 160 CPC45 solar-thermal collectors
  - ♦ DHW/space heat 1,296 MMBTU/yr
  - ♦ Space cooling 907 MMBTU/yr



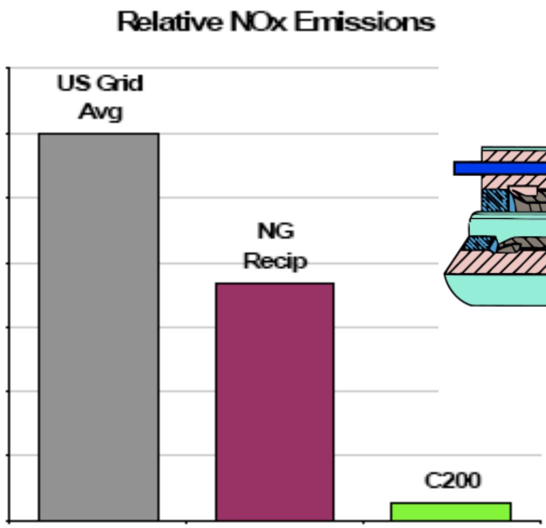
Technical Approach

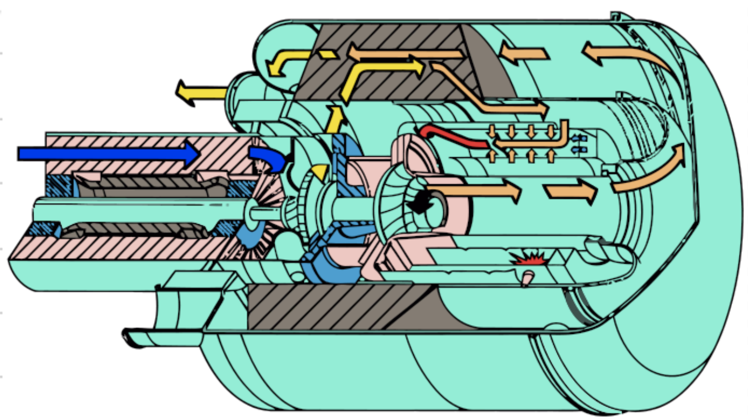
TES (Thermal Energy Storage)

- 80 RT ADsorption Chiller™ and CHP duty cycles are 24/7
  - Powered with 300 $kW_{thermal}$ C200 CHP micro-turbine ‘waste heat’
- 200% cooling capacity increase achieved by
  - 80 RT ADsorption Chiller™ augmented with 72,000 gal TES
  - 240 tons cooling during peak demand timeframe
    - Make and store 9,000 cu ft (72,000 gal.) 40o F. chilled water at night
    - Replace 340 RT electric screw chiller as part of *Cluster 263 energy upgrade*
    - Barrack 261- 36 tons + 36 tons for each non-upgraded barrack + DFAC 48 tons
  - GRP swimming pool Size
    - 60 ft. x 15 ft. x 10 ft. deep = 9,000 cu. ft. (72,000 gal. ~ 17.3 MMBTU)
  - Cost = $ 120 K vs. $ 307 K for a 160-RT chiller capacity increase
    - ***$ 187K less than an upgrade to a 240 ton chiller.***

Technical Approach
CHP (Combined Heat & Power)

- **Capstone 200 kW micro-turbine (83% efficient)**
  - 1.8 Million kWhe/yr – 205 kWe continuous - 33% electrical efficiency
  - 8,533 MMBTU/yr – 974 kBTU continuous - 50% thermal efficiency
  - $ 32,400 O&M/yr ($ 0.018/kWh) + fuel cost
- **CHP electricity and heat allocations/barrack**
  - 240,000 kWh + 1,219 MMBTU/yr
- **Barrack 261 electricity requirement**
  - 126,863 kWh/yr after upgrades + Solar PV





CARB Natural Gas Emission Standard				
	Units	2003	2007	Reduction
NOx	lb/MWh	0.5	0.07	86%
CO	lb/MWh	6.0	0.10	98%
VOC	lb/MWh	1.0	0.02	98%

Technical Approach
CHP Turbine Inlet Cooling

- Turbine is rated at ISO conditions (59o F. at sea level)
- Micro-turbine performance degrades 22% at 110o F. ambient
- Turbine inlet air temperature cooled to ~ 65o F. with two Coolerado M50 air conditioners.
  - ~ $ 36 K installed cost
  - 65o F. air @ 2,900 CFM
  - Savings of 257,400 kWh/yr.
  - SCE Standard Performance Contract could pay up to $ 38.6 K
    - More than the $ 36 K Coolerado installation cost.
  - Savings of ~ $ 18,584 yr for an estimated 6,500 hours/yr of CHP turbine operation in ambient temperatures above 65o F.
- SIR_{10yr} = SIR_{20yr} =

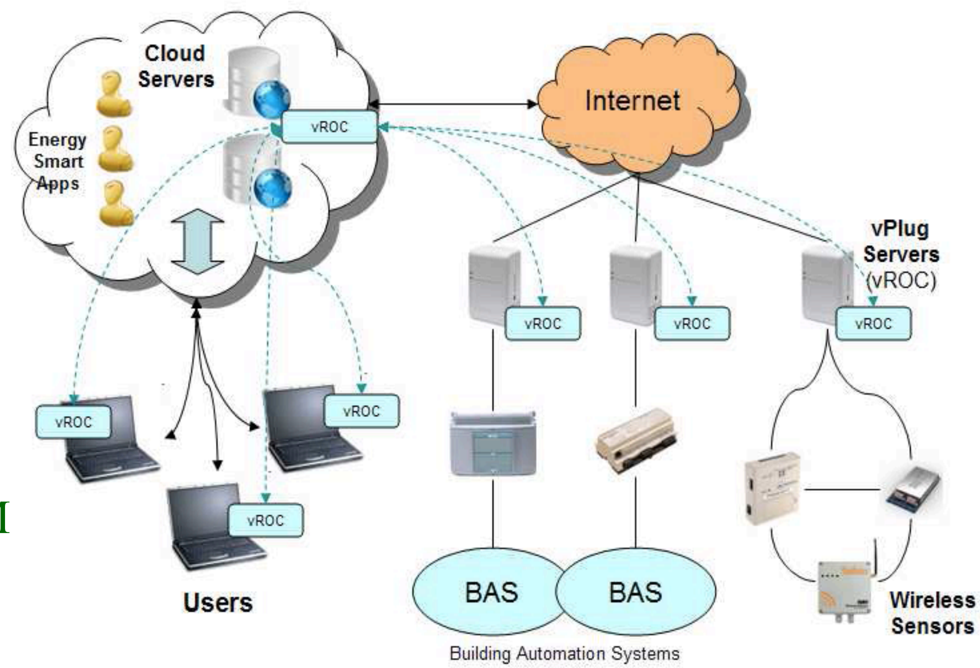
Technical Approach

Lighting & Plug Load Energy Reduction

- LED lighting
- Dimmers
- Occupancy sensors/controls
- Daylight sensors/controls

Energy Management System (EMS)

- Thermostat - Temperature, Coolerado, ERV & RHC Panel Control
- Sense and record in rooms and bathrooms (15 min intervals)
  - Temperature
  - Humidity
  - Coolerado CFM (watts)
  - ERV CFM (watts)
  - RHC Inlet/Outlet Temperature
  - RHC Pump GPM (watts)
  - Room Occupancy
  - Door Open/Closed
  - Bathroom Exhaust: ON/OFF/CFM
  - Lighting Load (watts)
  - Plug Load (watts)



- EMS/BAS Interoperable with Smart Grid

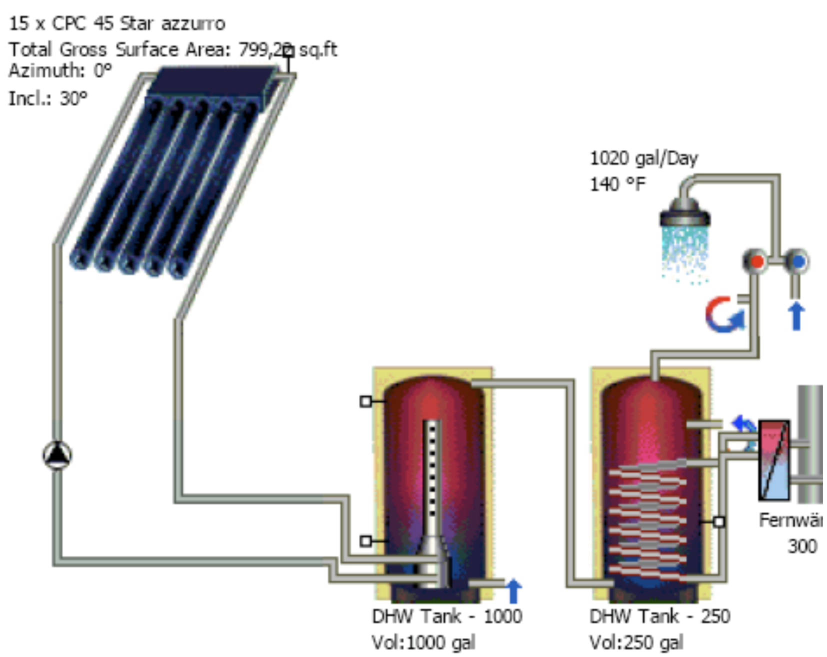
Technical Approach

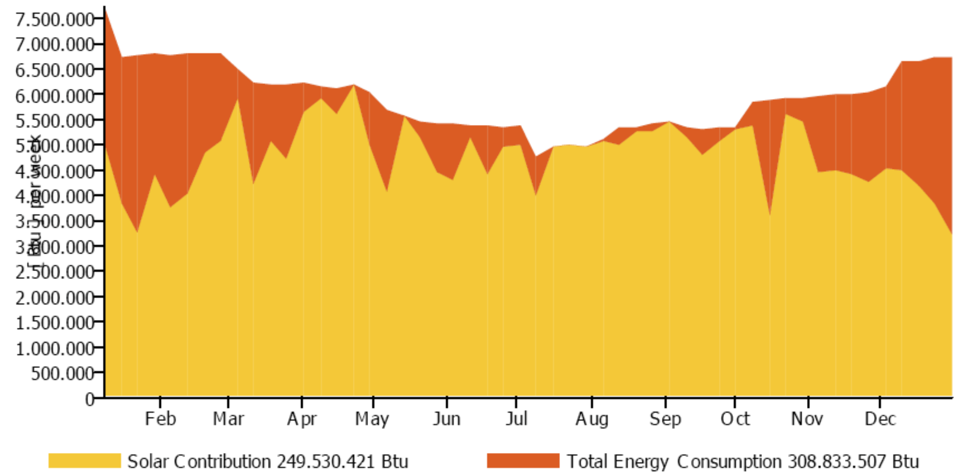
Solar PV and Water Heating

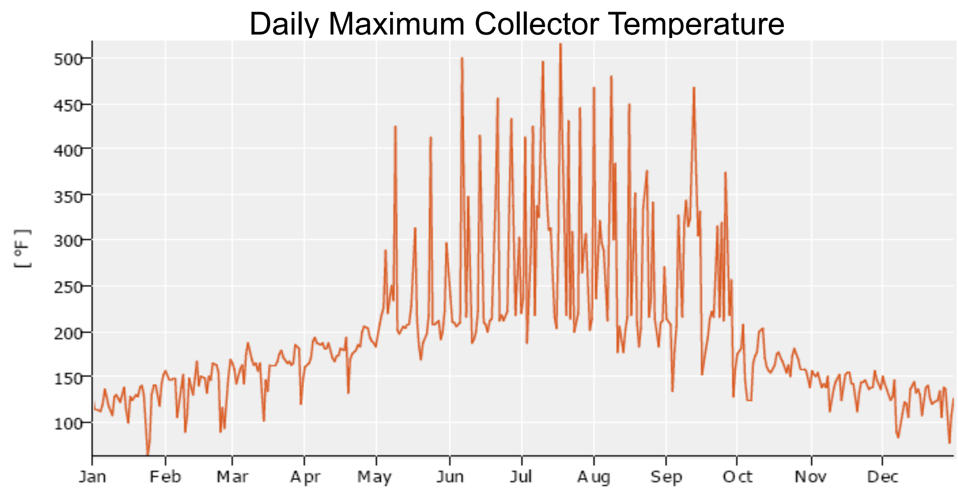
- 15 Ritter Solar CPC45 evacuated-tube SWH collectors for DHW
  - 87% of annual DHW demand of 1,020 GPD (15GPD/person)
  - DHW/space heating capacity – 750 kBTU/day
  - Low risk - 45,000 residential and 1,003 commercial installations in Europe.
  - FY 11: 15 CPC45 collectors + 1,000 gal. tank - Barrack 261.
  - Option: 160 CPC45s Central Plant 263 – Cluster 263 DHW/Space heat/cool
- 120 WIOSUN PV-Therm-180 + 60 PV collectors for PV and SWH
  - Demonstrate Collector performance in:
    - PV generation - 32.4 kW_e capacity - 71,975 kWh/yr
    - DHW/space heating capacity - 84 $kW_{thermal}$/287 kBTU
    - Night-sky radiation cooling -
  - FY 11: 60 PV-Therm-180 Collectors - 1/3 of Barrack 261 (Level 2)
  - FY 11: 60 Conventional PV Collectors - 1/3 of Barrack 261 (Level 1)
  - FY 12: 60 PV-Therm-180 Collectors - 1/3 of Barrack 261 (Level 3)

Renewable Energy
Solar Water Heating

- DHW 15 Ritter Solar CPC45 collectors
  - SWH 271 MMBTU/yr - 87%
  - DHW Load 313 MMBTU/yr
  - Saves $ 5,401/yr

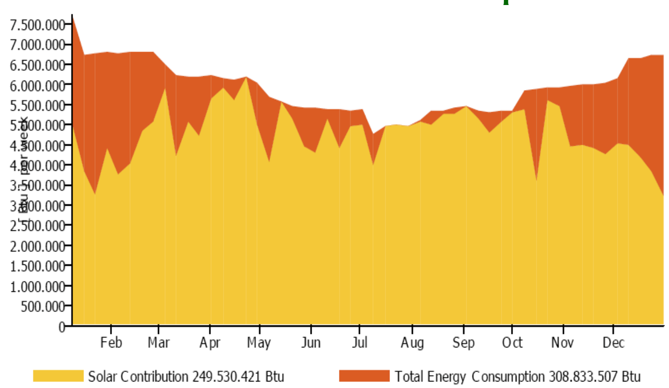






Renewable Energy
Solar PV – SWH Hybrid

- 120 WIOSUN PV-THERM-180 + 60 Solar PV Panels
  - ♦ 32.4 kWe
  - ♦ 71,975 kWh/yr
  - ♦ 84 kW thermal
  - ♦ Solar-thermal removes heat
  - ♦ 100o F. SWH output
  - ♦ PV ~ 25% more efficient than uncooled Solar PV panels



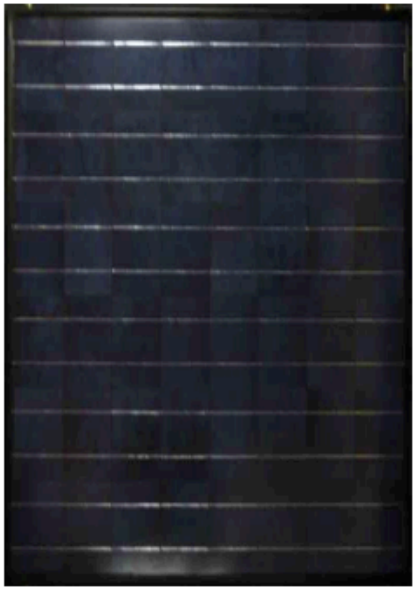
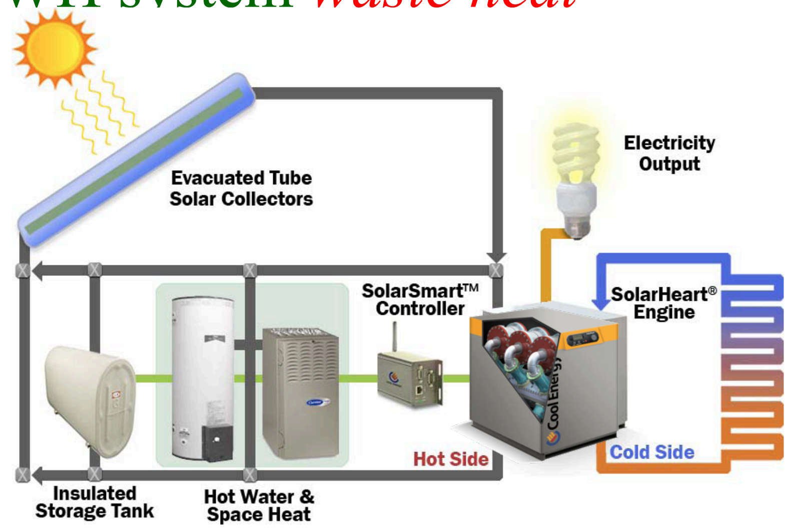


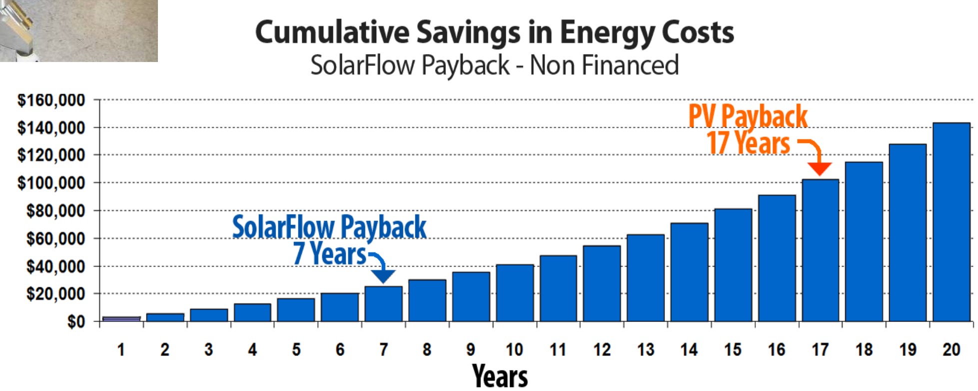
Figure 1: Collector photo of WIOSUN PVT180P Front side

Figure 2: Collector photo of WIOSUN PVT180P Back side

Renewable Energy
SolarHeart™ Stirling Cycle Engine

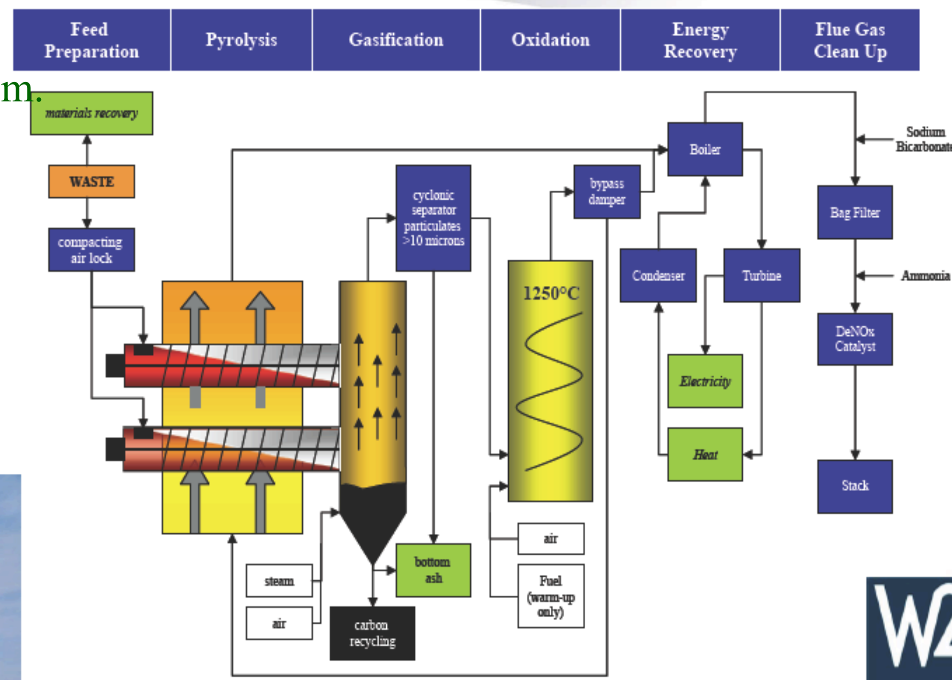
- Generate ~ 5 kW electricity with SWH system *waste heat*
  - 18 CPC 45 Star Azzuro Collectors
  - Electricity from ***waste heat*** during
    - 2 week Ft. Irwin block leave period
    - Cooling season
  - Prototype ~ $ 50 K
  - Production ~ $ 15 K
    - Cost ~ $ 6/watt
    - O&M ~ $ 0.01/kWh
  - Alternate Test Objectives
    - Electricity from
      - CHP ***waste heat***
      - Diesel Exhaust





Renewable Energy
Waste-to-Energy/CHP

- **40 ton/day MSW & sewage sludge:**
  - 40 ton/day pyrolizer at Ft. Irwin landfill.
  - Distribution through Ft. Irwin LPG system.
  - ***8 x Central Plant 263 requirement***
- **Syngas for power, heat & cooling:**
  - 1,600 kWe distributed CHP.
  - 640 tons ADsorption Chillers™
  - Heat and Cool up to 1.3 million SF



- *Syngas SIR20yr = 3.54 vs. 2.80 for LPG*
- *Net Savings = $ 3.0 Million/yr*

Technical Approach
Alternative Demonstration Sites

- USMC Base Camp Pendelton, CA
  - Net Zero Energy: 8 BEQs/2 Recreation Buildings - 1,600 personnel
    - Waste-to-Energy + 8 Capstone C65 CHP micro-turbines + 600 kW Solar PV
- USMC Base 29 Palms, CA
- USMC Logistics Center; Barstow, CA
- MCAS Miramar; San Diego, CA
- NAVSTA San Diego, CA
- NAS North Island, CA
- MCAS Kaneohe Bay, HI
- NWC China Lake, CA
- Davis Mothan AFB; Tucson, AZ
- MCAS Yuma, AZ
- Camp Billy Machen, NAVSPECWAR Training Center; Niland, CA

Technical Approach
Test Program Design

- Incremental Improvement in three 24 room ~ 8,200 SF barrack sections
- Barrack 261 FY 11/12 Upgrade Levels
  - 0 - Barrack Section AS IS with only sensors added – Baseline for SCE Incentives
  - 1 - Shell: (R28 multi-ceramic, R50 foam attic), cool roof; Dua- skin roof
    HVAC: Coolerado, ERV, retain fan coil, Energy Management System,
    Renewable Energy: solar-thermal DHW, Solar PV ~ 10 kW
  - 2 - Shell (R20 foam wall insulation, R50 foam attic), night-sky cooling, 2 skin roof
    HVAC: Coolerado, ERV, RHC, Lighting, P/L, EMS, cool roof, double skin roof
    Renewable Energy Solar-thermal DHW, Solar PV-Therm-180 & Solar PV
- Barrack 261 FY 12/13 Upgrade Levels
  - 3 - Upgrade Level 0 to Level 3 ***Best Value*** based on FY 11/12 M&V results
- Central Plant 263
  - FY 11 - Adsorption Chiller™ (use 194o F. water from boiler/SWH) + cooling tower
  - FY 11 - Capstone C200 CHP micro-turbine + Coolerado turbine inlet cooling
  - FY 12 - 9,000 cu ft TES (Thermal Energy Storage)
- 40 ton/day Waste-to-Energy - Ft. Irwin landfill

Technical Risk

- HVAC integration into barrack attic (space/access)
- Schedule:
  - ***Require contract award by 12/1/10 to test HVAC in summer 2011***
- Access to Ft. Irwin barrack rooms
  - Garrison Commander/PWD request work take place only during block leave periods: June 15-30 and Dec 15-30
  - Request two rooms + bath for HVAC & Lighting system prototyping.
- Design-to-Cost:
  - SolarHeart™ Stirling Engine and
  - RHC Panel
- Demonstrating system reliability and maintainability
  - Onuma BIM for continuous commissioning/maintenance planning
  - Sensors indicate when systems, pumps, etc. are underperforming
    - Preventative Maintenance Internet and Cellular Telephone Alerts

Expected Benefit

- Transfer technology having the highest Savings-to-Investment Ratios ASAP
  - Coolerado air conditioner for Turbine Inlet Cooling
  - Coolerado air conditioner
  - Waste-to Energy Syngas + CHP + ADsorption Chiller™ + TES + RHC
  - Ritter Solar CPC45 DHW/Space Heating/Cooling +ADsorption Chiller™ +TES + RHC
  - Multi-Ceramic & Cool Wall Reflective/Insulation Coatings
  - SWH/PV, double-skin roof + night-sky radiation cooling
- **40 ton/day W2E $ 1.5 M/year lease/O&M with Net Savings of $ 3.0 M/year**
  - Smaller savings with lower MSW burial charges / OR use of Natural Gas vs. LPG
- Environmental Impact - Barrack 261/Central Plant 263
  - GHG 151,196 tons/year reduction
- Environmental Impact - Ft. Irwin Waste-to-Energy
  - 60,800 tons/year GHG reduction
  - Zero landfill at Ft. Irwin – saves 14,600 tons of MSW in landfill/year
- Environmental Impact – Gray-water recovery/reuse
- Water use 2.19 Million gallons/year reduction.
- ***Use of BIM will facilitate transfer of technology and the assessment of environmental benefits to other users.***

ESTPC Review Comments

3. Maintenance

Systems proposed in the Zero Energy Barrack project are low maintenance:

a. Coolerado air conditioner – *Minimum maintenance, filter change at 6 months.*

b. ERV (Energy Recovery Ventilator) – *Solid state media – annual cleaning*

c. RHC Panels – *No moving parts, no filters, fans or controls other than sensors/valves*.

d. ADsorption Chiller™ - *Nil maintenance on 6 systems installed in CA in 2004 (6 years)*

e. Cooling Tower - *Dry cooling tower has less maintenance and no water cost*

f. District Loop Pumps – *Grundfos pumps, minimum maintenance*

g. CHP - *O&M costs are $ 0.018/kWh with turnkey contract (continuous commissioning)*

h. WIOSUN Solar PV-Therm-180 - *Minimum maintenance*

i. Ritter CPC45 Solar -Thermal – *Minimum maintenance*

j. SolarHeart™ - *Prototype estimate is $ 0.01/kWh turnkey contract*

k. Waste-to-Energy Pyrolizer - *Minimum maintenance, turnkey lease/O&M*

l. Gray Water Purification and Reuse - *Minimum pump, filter and solar PV maintenance*.

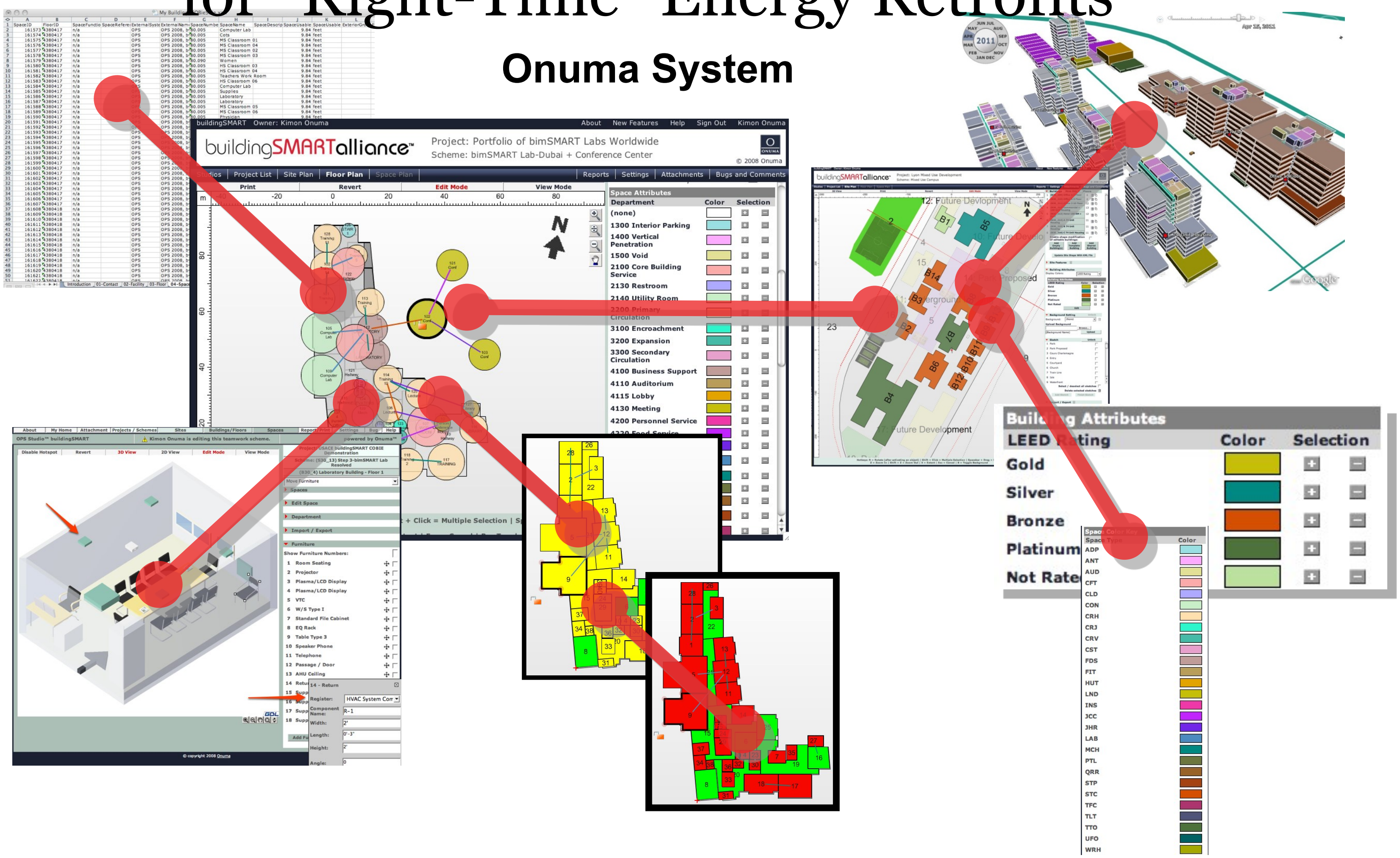
Onuma BIM

- Manage this multi-disciplinary project using Building Information Modeling (BIM) tools, such as the Onuma Planning System that enable integration with best practices to manage these building energy efficiency retrofits and their performance with Onuma Planning Systems BIM, GIS and Virtual Real-Time Information System (VRIS) software tools.

- Tasks facilitated with Onuma BIM
  - Define,
  - Design,
  - Integrated Decision Making
  - Project Management,
  - Optimize O&M support of, and
  - Training in project systems.

Onuma System VRIS:"Digital Maestro" Integrated Management and Decision Support for "Right-Time" Energy Retrofits

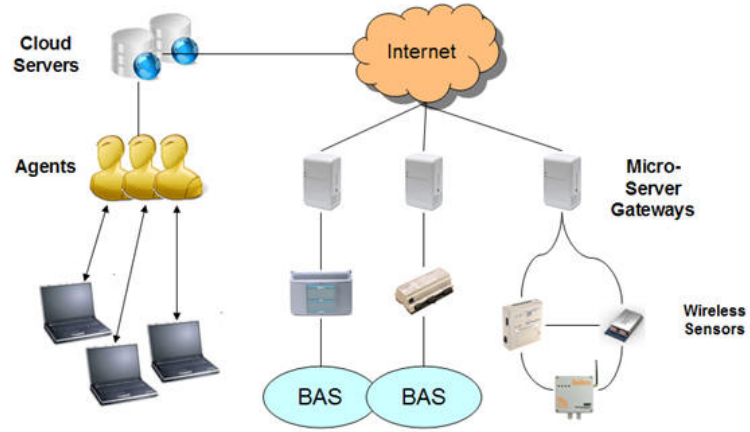
Onuma System



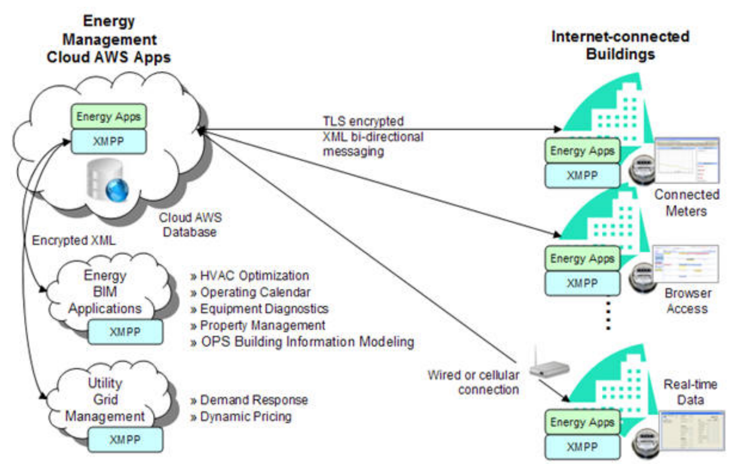
Real Time "Big BIM" MODEL SERVER

Onuma VRIS/Lavelle VROC
Big BIM + Energy "Digital Maestro" Mashup

VRIS Architecture

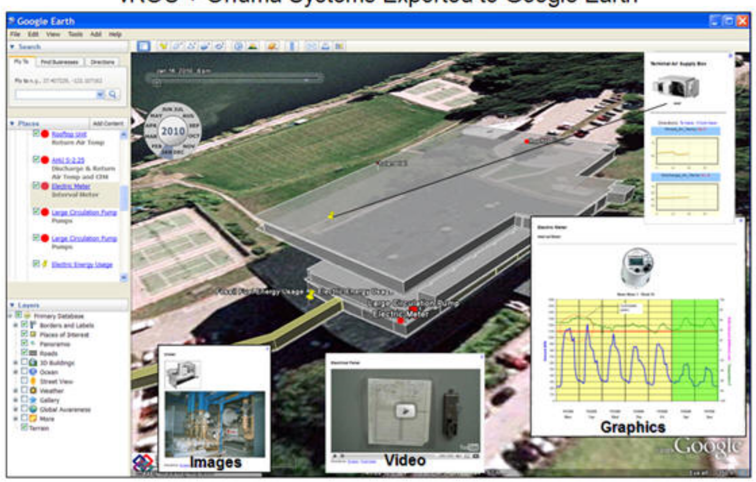


VRIS Realtime Communications



Onuma System + vROC Exported to Google Earth

vROC + Onuma Systems Exported to Google Earth



Source: http://www.automatedbuildings.com/news/may10/articles/lavelleenergy/100427104606lavelle.htm

Onuma VRIS "Digital Maestro"

- Integrated Real-Time Project and Energy Management
- Rapid Project and Energy Planning, Management, and Control
- Multi-Stakeholder Collaboration using "Big BIM" Framework
- Web-based Platform for Virtual Real-Time Rapid Project and Energy Management, Monitoring, and Control
- Interoperable, open-standards-based sensor monitoring and sub-metering for future smart-grid/micro-grid integration.
- "Real-Time" Decision Support of Smart "Right-Time" High Performance Building Energy Retrofits
- Integrate and Leverage Existing Software and Processes
- Secure, Interoperable Web-Based BIM/GIS Platform Linking Facilities Condition to Mission-Readiness
- COBie-Certified for Building Information Exchange (see note)
- Smart Grid Interactive
- Output formatted for DD1391 entries.

EMS/Smart-Grid/Demand Response

Reliability-based: “emergency” and “capacity” programs

- Most common: ***“interruptible/curtailable” rates***
- Oldest variety: also called ***“active load management”***
- Also includes ***direct load control***
- Program calls usu. ***require mandatory response ?***

Price-based: “economic” programs

- Participation usually voluntary
- ***Day-of and day-ahead options***
- Demand bidding programs
- Tariff-based**:** ***real-time, time-of-use, and “critical peak” pricing***

Added CHP to meet Demand Response

- 100% overcapacity in Waste-to-Energy + CHP micro-turbine
- 3,200 kW vs. 1,600 kW distributed micro-turbine capacity
  - 3,200 kW ***100%*** 6 hour peak demand - ***11.6% of 27,504 kW July peak***
  - 1,200 kW ***38%*** during 12 hour semi-peak
  - 800 kW ***50%*** during 6 hour off-peak
- Sufficient *SYNGAS* generated to meet demand at 1,600 kW
  - Compress and store excess SYNGAS at semi-peak & off-peak
- Syngas compression at night creates heat
  - DHW and space heating
- Syngas expansion at peak demand = energy + cooling
  - Drive air motor and/or reduce CHP Turbine compression work
  - Augment air conditioning
  - Augment turbine inlet cooling

UESC Example

- USMC Logistics Ctr. Barstow, CA
- 1.5 MW wind turbine
- $4.6 million financed by Southern California Edison
  - $6.1M total, minus $1.5M SCE rebate
- $515 K annual savings
- 15 year term
- Similar in scope to Ft Irwin
  - 1.6 MW Waste-to-Energy
  - 1.6 MW CHP microturbines
  - 640 ton ADsorption Chillers™
  - TES