

Sustainable Cities and Military Installations

NATO Workshop

Dr. Michael Case
Program Manager, Installations
U.S. Army Corps of Engineers
Engineer Research and Development
Center
Construction Engineering Research Lab
P.O. Box 9005, Champaign IL 61826
Phone 217-373-7259
michael.p.case@us.army.mil



US Army Corps of Engineers
BUILDING STRONG®





Net Zero Hierarchy



- **A Net Zero ENERGY Installation** is an installation that produces as much energy on site as it uses, over the course of a year.
- **A Net Zero WATER Installation** limits the consumption of freshwater resources and returns water back to the same watershed so not to deplete the groundwater and surface water resources of that region in quantity or quality.
- **A Net Zero WASTE Installation** is an installation that reduces, reuses, and recovers waste streams, converting them to resource values with zero solid waste to landfill.
- **A Net ZERO INSTALLATION** applies an integrated approach to management of energy, water, and waste to capture and commercialize the resource value and/or enhance the ecological productivity of land, water, and air.

“The primary goal is a focus toward net zero and when we talk about net zero, it's not only net zero energy, but it's net zero energy, water, and waste. When you look at the term "net zero" or a hierarchy of net zero you must start with reduction, then progress through repurposing, recycling, energy recovery, disposal being the last.”

— HON Katherine Hammack, DoD Bloggers
Roundtable, 10 October 2010



Net Zero Pilot Installations





Net Zero Energy

A Net Zero **ENERGY** Installation is an installation that produces as much energy on site as it uses, over the course of a year.

Goals:

- Contribute to the Army Campaign Plan's objective of energy security for the Army
- Address energy efficiency and conservation first
- Preference for use of renewable energy for on-site power; enables operation if grid goes down
- Must address redundant energy supply sources
 - Can the installation function for long periods of time during supply disruptions affecting the electric grid, natural gas pipeline, propane & fuel oil deliveries, etc.
- Applies to both electrical and thermal energy
- Behavioral change are necessary to change culture
- Must be fiscally responsible

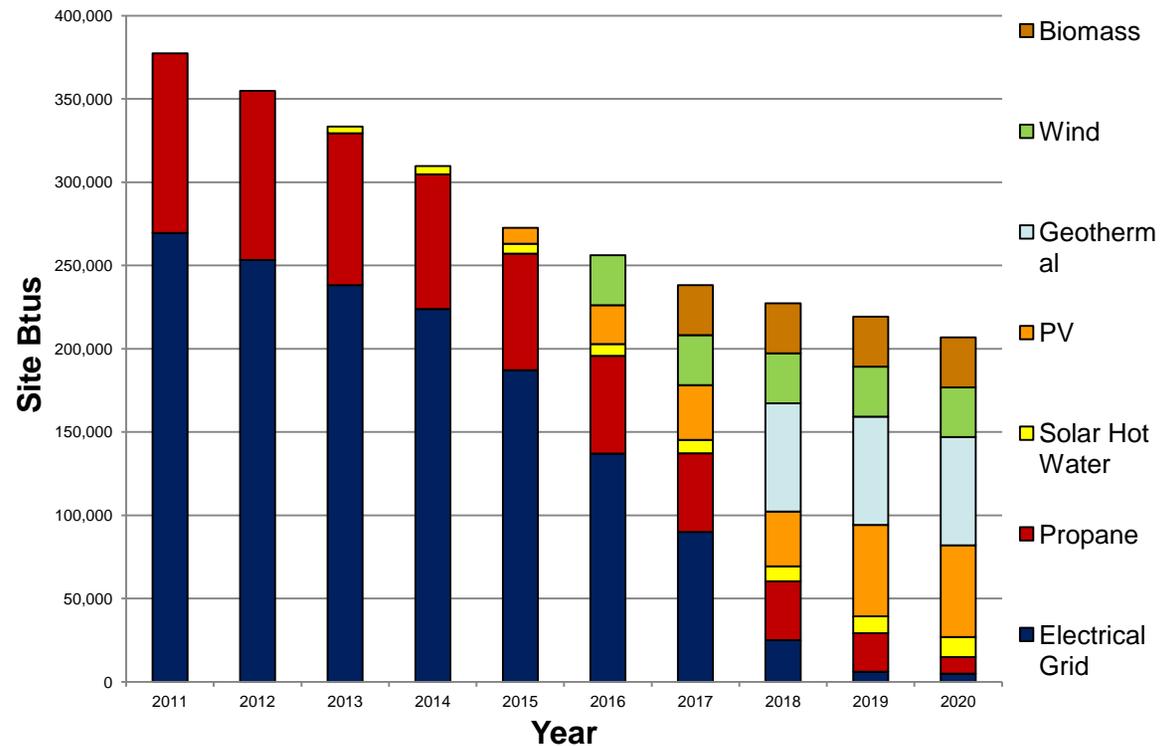


Energy Roadmaps



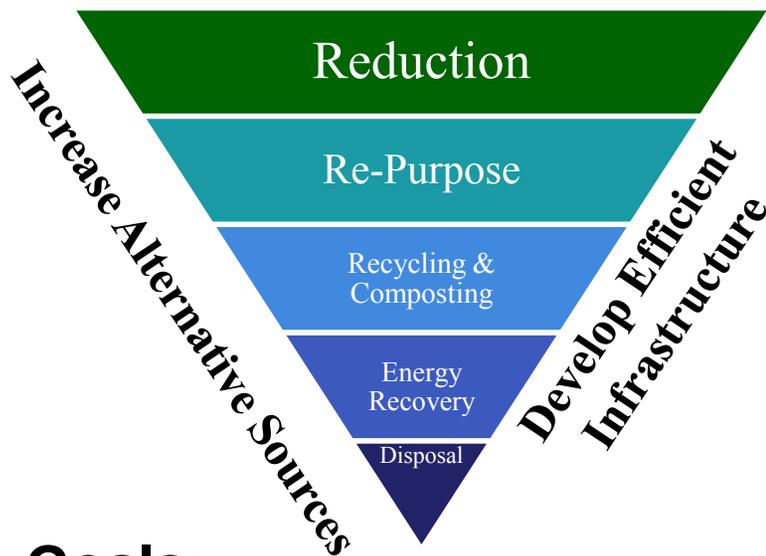
- Energy Baseline
- Energy Efficiency Assessments
- Renewable Energy Assessments
- Energy Security Assessments
- Energy Project List and Implementation Recommendations

Example Installation Energy Profile



Net Zero Water Strategy

WATER



A Net Zero **WATER** Installation limits the consumption of freshwater resources & returns water back to the same watershed so not to deplete the groundwater and surface water resources of that region in quantity and quality over the course of a year

Goals:

- Contribute to the Army Campaign Plan's water security Major Objective
- Reduce freshwater demand through water efficiency and conservation
- Access/develop alternate water sources to offset freshwater demand
- Develop water-efficient green infrastructure
- Implement low-impact development to manage storm water

Net Zero – Water Balance

Water Supply

Water Use

Water Balance = comparison of water supplied to water used

Municipal

Indoor building

On-site surface water

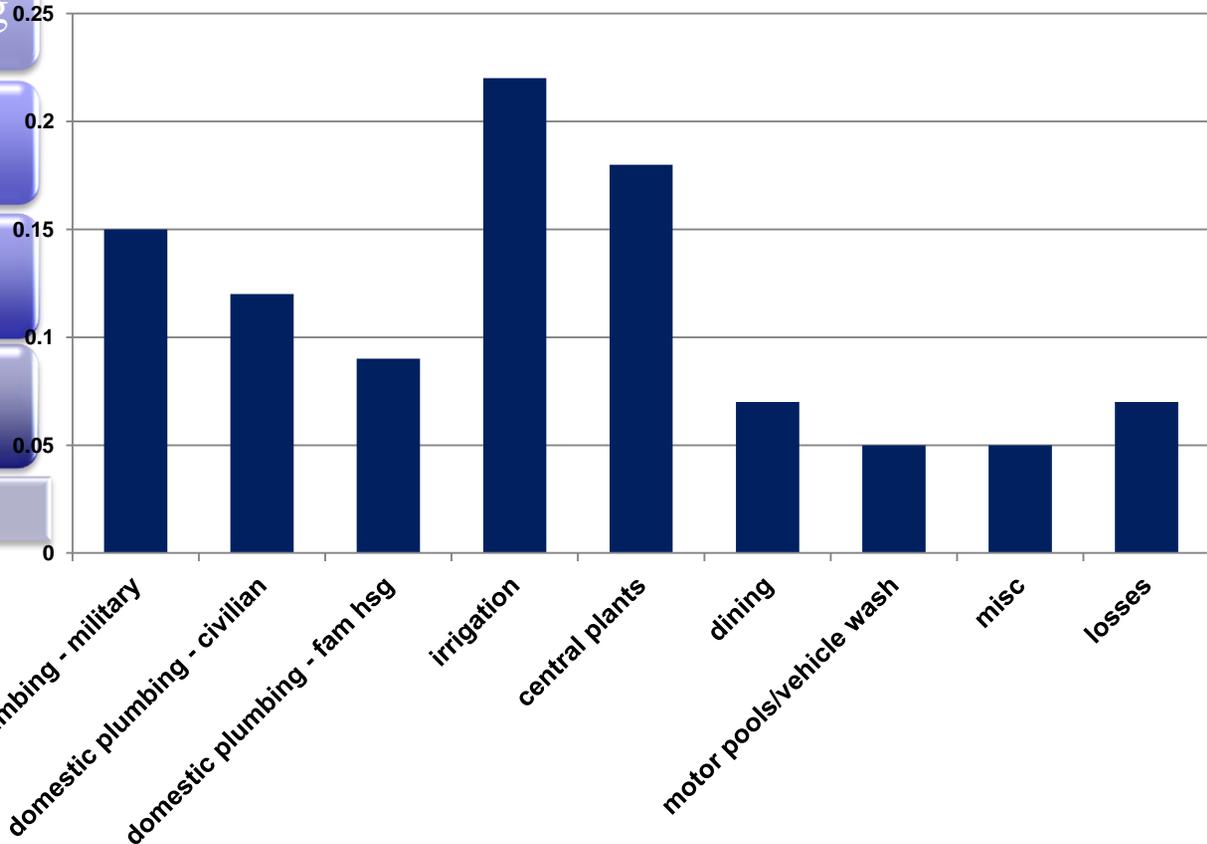
Cooling/
Process

On-site ground

Irrigation

Alternate water

Losses



Net Zero Waste Strategy

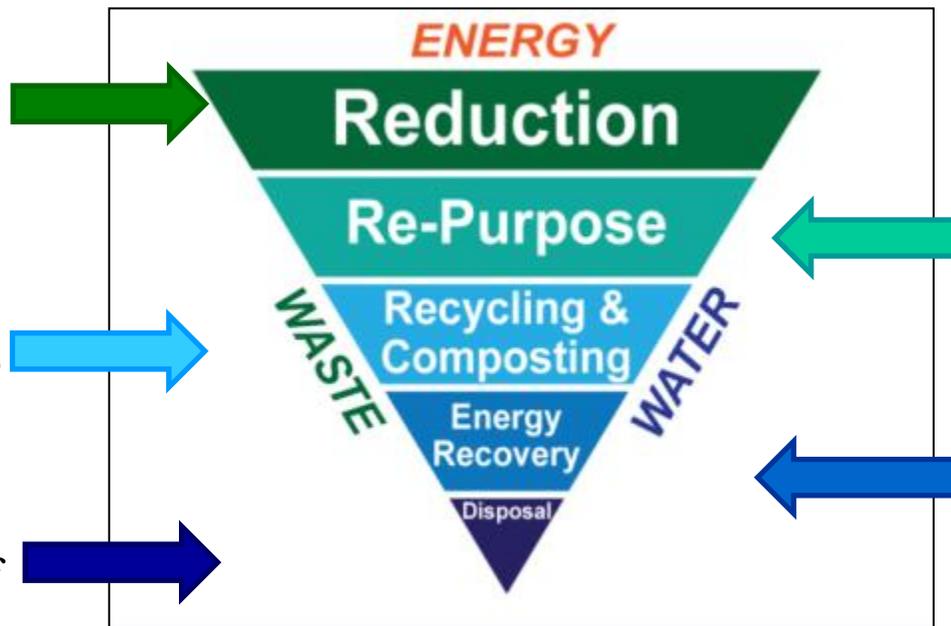


Pilot Installations should have a comprehensive program that starts at the top of the hierarchy

Waste avoidance via procurement practices & other pollution prevention (P2) efforts

All recyclable or compostable waste collected & diverted (to on- or off-post facilities)

Waste-to-Energy ash (if not further diverted) & any limited special wastes



Installation re-use centers & efforts to match waste stream 'products' with potential users (e.g., crushed drywall used for soil amendment; construction & demolition (C&D) debris reuse)

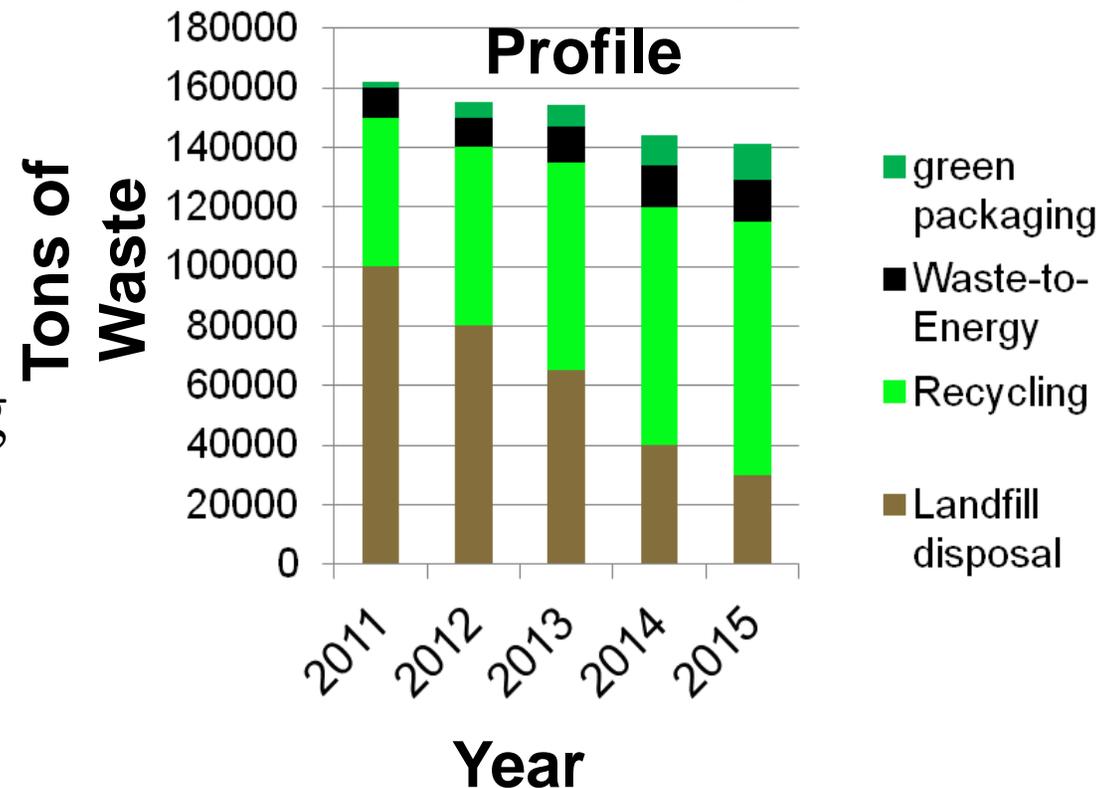
Waste that can't be re-used, recycled, or composted is sent to a WTE plant (on- or off-post)

Waste Roadmaps



- Material flow analysis
- Improved procurement practices
- Re-purpose / re-use strategy
- Recycling & composting strategy
- Potentially viable waste-to-energy technologies

**Example Installation
Waste Produced
Profile**



Leveraging Private Investments



Potential Financing Mechanisms

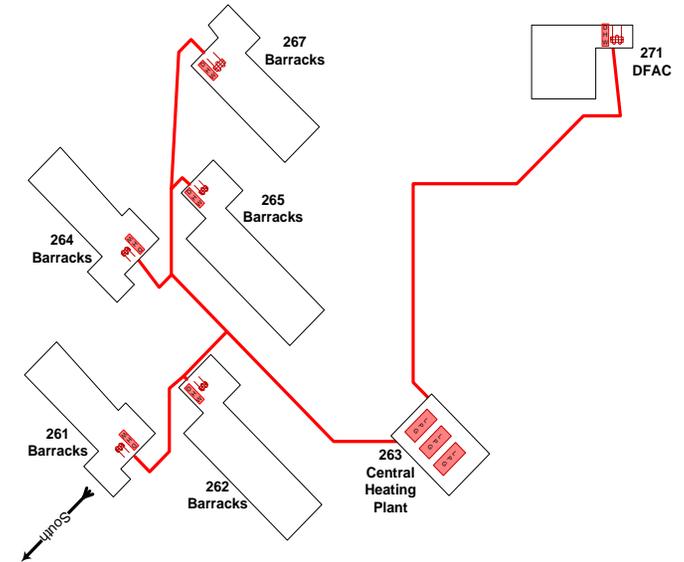
- **Energy Savings Performance Contracts (ESPC)**
 - Utilize private capital to make infrastructure improvements on military installations
 - Payment is derived from the savings generated by the improvements – Savings are verified through Measurement & Verification (M&V)
 - **Utility Energy Service Contracts (UESC)**
 - Procurement method using utility expertise & capital to meet Federal conservation mandates
 - Utility's costs repaid directly from installation's avoided costs resulting from project implementation
 - **Enhanced Use Lease (EUL)**
 - Funding method for construction on installations by allowing a private developer to lease underutilized property
 - Payment usually in the form of power back to the installation
 - **Power Purchase Agreement (PPA)**
 - Allow federal agencies to fund on-site renewable energy projects with no upfront capital costs incurred
-

NZI-E Planning Tool Objectives

- **Provide Installation Planners and contractors a capability for integrated analysis and optimization so that they achieve Net Zero Energy status.**
- **Provide support for Installation Master Plans, Energy Plans, and prioritization for energy upgrades**
- **Support public/private partnerships by identifying sound projects appropriate for private financing.**
- **Establish framework for follow-on Water, Waste, and Greenhouse Gas modeling**

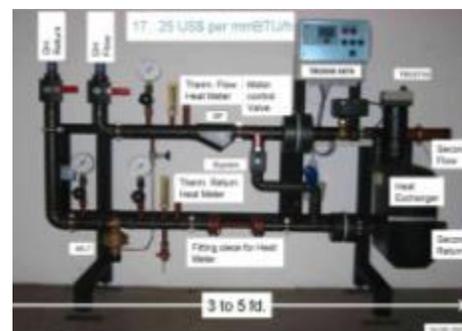
Typical Current Approach

- **Expert Team**
 - Optimize Buildings
 - Examine District Heating/Cooling/CHP options
 - Renewable Projects
- **Recent/Ongoing Projects**
 - EISA 2007 study
 - Fort Irwin
 - Fort Carson
 - Fort Bliss
 - Fort Bragg
- **Pros/Cons**
 - Pro – Draw on valuable experience
 - Pro – Access to specialized knowledge
 - Con – expensive
 - Con – takes time
 - Con – limited resources
 - Con – repetitive

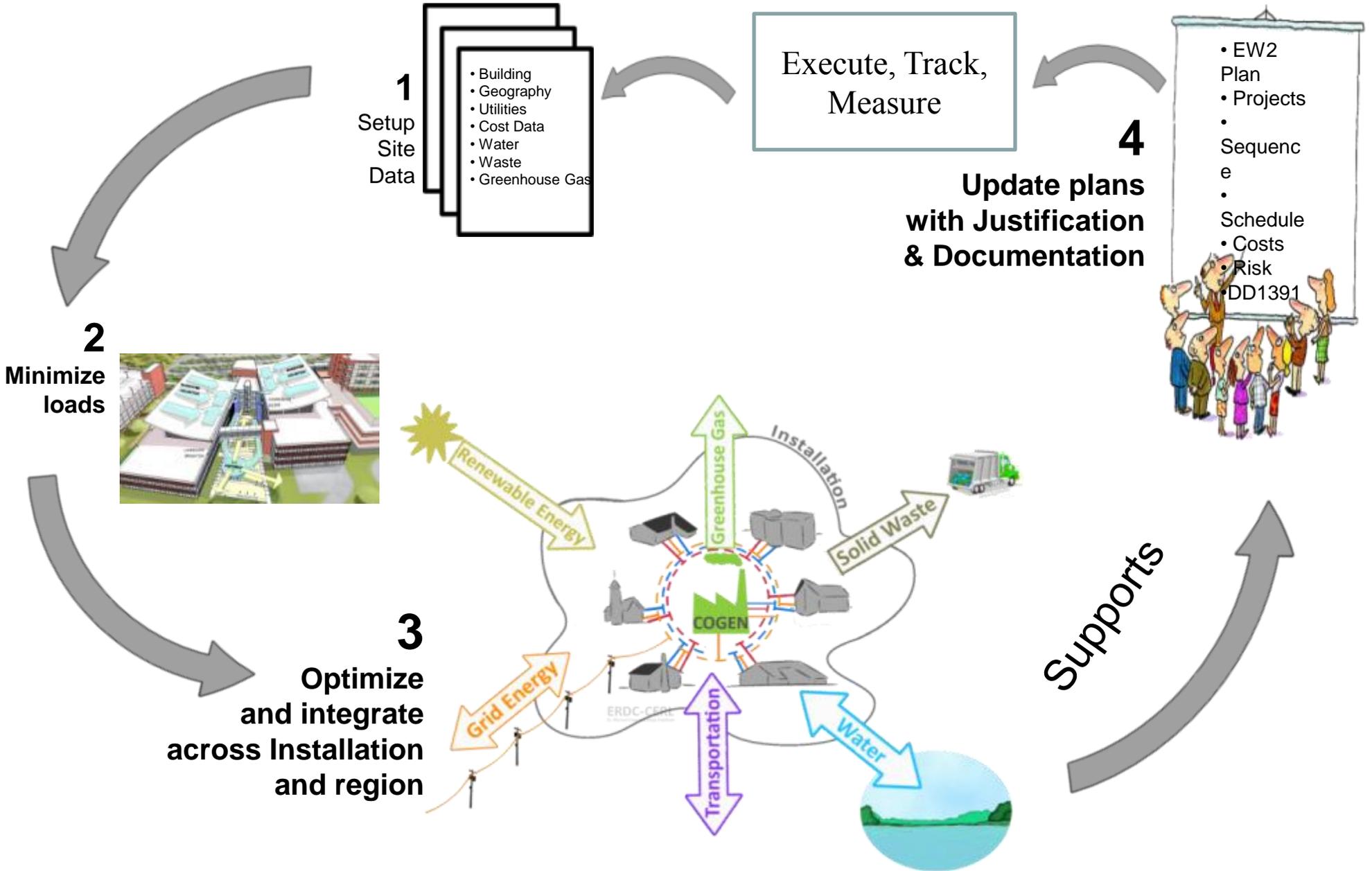


NZI Approach

- Best practices process
- Automated facility load estimation
- Library of energy models
- Region/Facility type Energy Efficiency Measure (EEM) package optimization
- District/Cluster equipment package optimization
- Recommended phasing of NZI projects



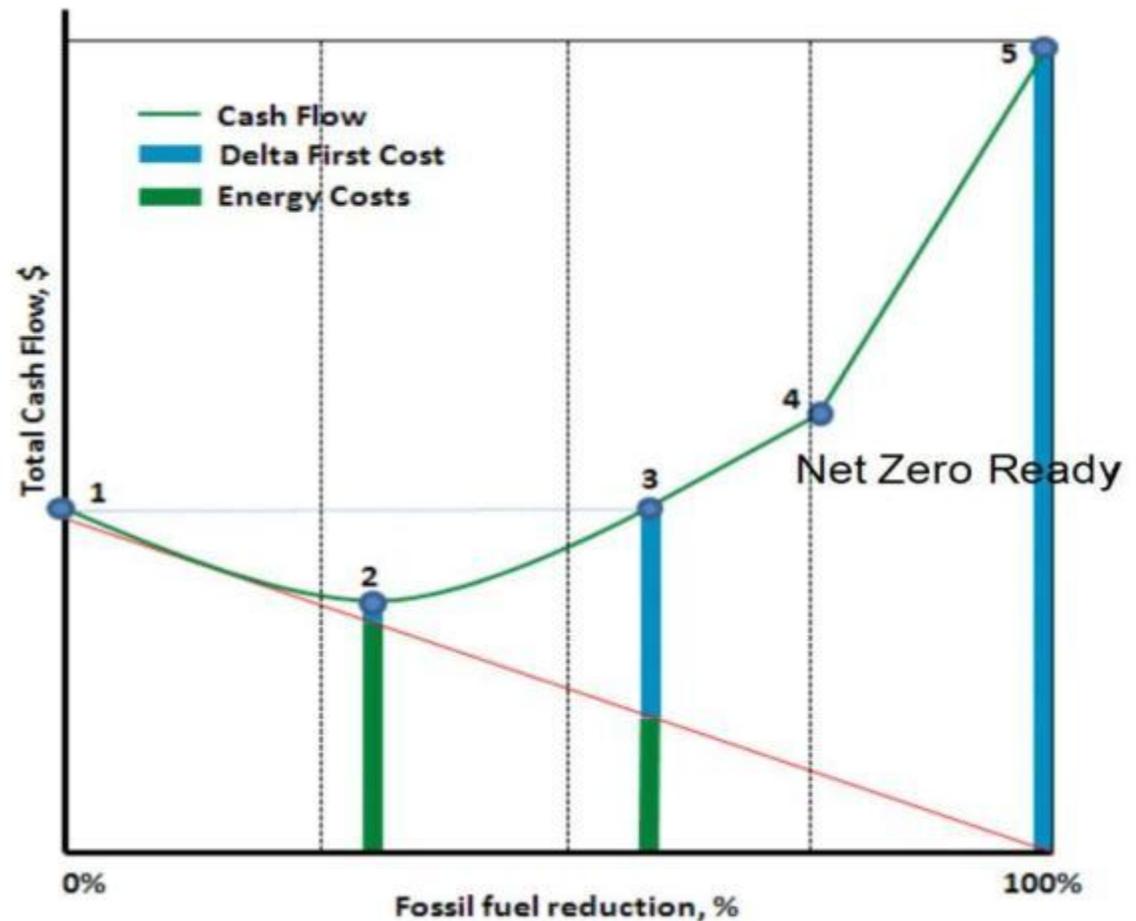
NZI Planning Cycle



Cost-Optimizing Zero Energy Systems

Integrating EEM's that are Net Zero Ready

- Debate over whether to conserve energy or generate it
- Need the lowest cost path to a building configuration which uses net-zero energy
- Point 4 is the Crossover Point: where generating renewable energy is more cost-effective than additional Energy Efficiency Measures or Net-Zero Ready. *Point 4 is normally at 60% to 80% savings depending on building and location*



Finding your baseline

- **NZI Load Estimation**
- **Metered data best!**
- **Usually need to estimate using models**
- **EnergyPlus, FEDS, DOE2/eQuest, Water Balance, SWARS, etc.**
- **Make sure model handles resolution required (e.g., 8760 hours)**

Inventory/Classify Building Types

The screenshot displays the HZIE (Hazardous Waste Inventory and Classification) software interface within a Windows Internet Explorer browser. The browser address bar shows the URL <http://134.164.53.44/HzIE/Alpha2011/>. The software window is titled "Baseline" and shows "Step 1 - View Facility Inventory".

At the top of the software interface, there are several fields for project information:

- Name: **Baseline**
- Description: **Auto-Generated Study Plan Baseline**
- Army Site: **Fort Carson**
- Weather File: **USA_CO_Colorado.Springs-Peterson.Field.724660_THY3.rpw**
- Climate Zone: **ASHRAE_SB**

The main area is a satellite map of a facility complex. Buildings are highlighted with colored outlines: cyan for most buildings, yellow for a few, and pink for others. A "Map Tools" panel is visible on the left, and a "Legend" is at the bottom left.

On the right side, there is a "List of Facilities" table. The table has columns for "# of" and "Name". The facilities listed are:

- UEPH
- BNHQ
- BdeHQ
- COF
- DFAC
- UEPH - New
- TEMP

At the bottom of the software window, there are buttons for "Close" and "Save & Continue". The browser status bar at the very bottom shows "Done" and "Internet" with a 100% zoom level.

Run baseline to determine loads/flows

The screenshot displays the NZIE software interface in a Windows Internet Explorer browser window. The address bar shows the URL <http://194.164.53.44/NZIE/Alpha2/>. The page title is "Baseline".

Step 3 - Run Simulations

Facility Groups

Name	Facility Type	
UEPH	UEPH	Collapse
Name Status Download		
Baseline	Finished	E+ Hourly E+ Resources
BNHQ	BNHQ	Expand
BdeHQ	BdeHQ	Expand
COP	COP	Expand
DFAC	DFAC	Expand
UEPH - New	UEPH	Expand
TEMP	TEMP	Expand

Baseline

Parametric Model Specifications

Name	Value
ClimateZone	ASHRAE_5B
CodeStandard	ASHRAE_90.1_2010
FacilityType	UEPH
ModelName	EnergyPlus
Version	0.8.0
WeatherFile	USA_CO_Colorado.Springs-Peterson.Field.724660_TMY3.apw

Parameters

Name	Value
ACH	0.026
ACH_Attic	0.26
ACH_Stairwell	0.31
Boiler_Eff	0.8
Boiler_Model	NONCONDENSING
Chiller_Cond_HR	NO
Chiller_COP	2.87
Cooling_Setpoint	75
DHW	2.0
EPD	1.67
EPD_CommonArea	0.46
Exfil_Ratio	0.3
Fan_Eff_Exhaust	0.65
Fan_Eff_FCU	0.6

Run Simulation

Step 3 - Run Simulations

Close Finish

Done Internet 100%

Review/Calibrate Baseline

NZIE - Windows Internet Explorer

http://134.164.53.44/NZIE/Alpha23/

Fort Carson NE Report

Reports

- Debug
- Reports
 - Summary Report
 - Monthly By End Use
 - EEM Breakout
 - Cost Optimization Curve

Facilities

- UEPH
- BNHQ
- BdeHQ
- COF
- DFAC
- UEPH - New
- TEMF

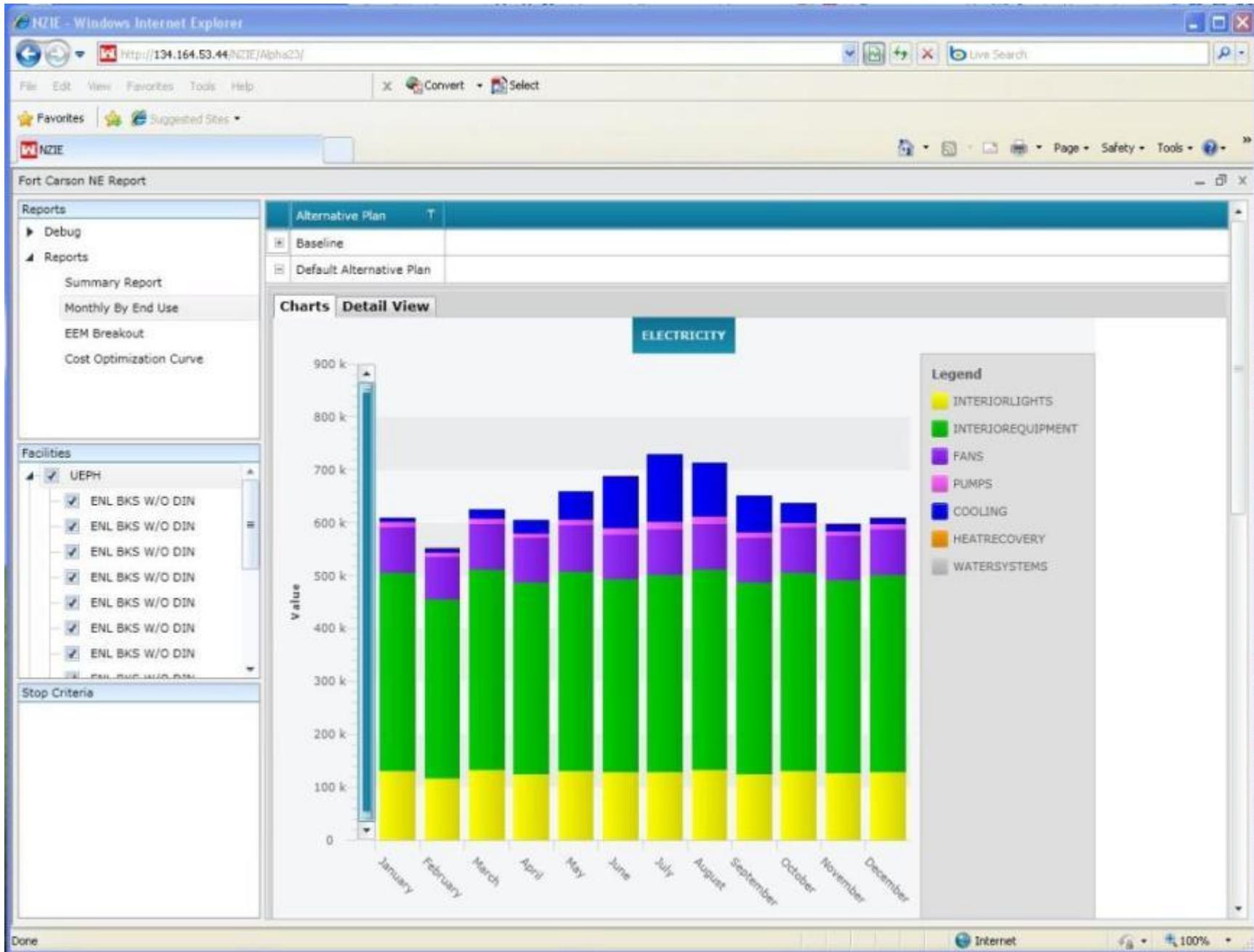
Stop Criteria

Alternative Plan	Total Facility Area	Number of Facilities	ELECTRICITY	ELECTRICITY Reduction	GAS	GAS Reduction
Baseline	882,000	32	11,334,120.00	-	335,700.70	-
Name	ELECTRICITY (kwh)	GAS (therm)	Total Energy (kwh)	Total Energy Intensity (kwh/sqft)	Facilities	Area (sqft)
UEPH	2,354,157	11 - 68,423	.3 - 4,359,430	21.91	-	10
BNHQ	1,596,853	05 - 9,746	.0 - 1,882,474	11.34	-	8
BdeHQ	156,926	17 - 508.09	.0 - 171,817	19.09	-	1
COF	798,961	04 - 45,188	.2 - 2,123,292	13.27	-	4
DFAC	3,762,011	55 - 133,804	01 - 7,683,430	112.99	-	2
UEPH - New	2,365,987	11 - 68,767	.3 - 4,381,337	21.91	-	5
TEMF	299,223	03 - 9,265	.1 - 570,754	07.13	-	2
Default Alternative Plan	882,000	32	7,685,308.00	-.32	256,283.90	-.24

Done

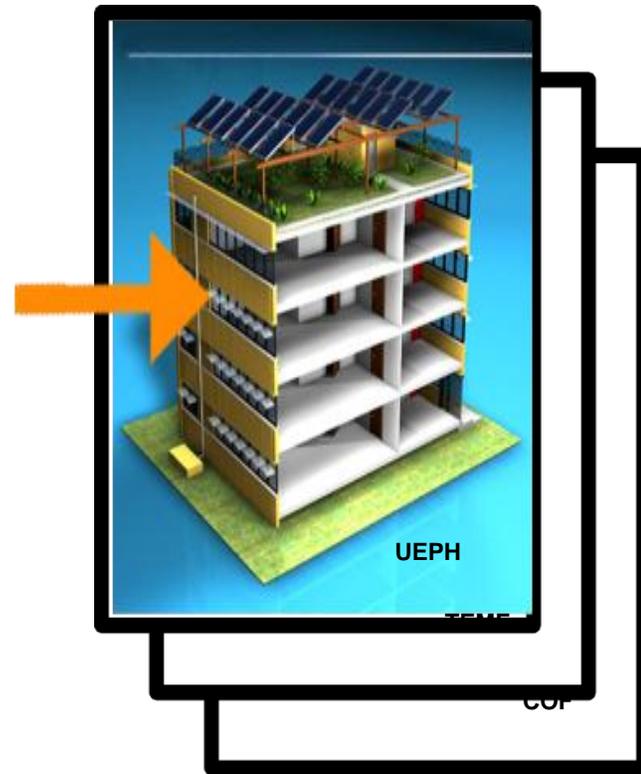
Internet 100%

Review Load Profiles



Predictive Model

- **Model Measures to be applied**
- **Energy, Water, Waste**
- **Best Practices, Technology, Behavior**



Review Measures to be Modeled

The screenshot shows a web browser window displaying a software interface for reviewing Energy Efficiency Measures (EEMs). The browser address bar shows the URL `http://134.164.53.44/NZIE/Alpha23/`. The page title is "Default Alternative Plan". The main heading is "Step 2 - Review EEMs".

The interface is divided into two main sections:

- Facilities:** A tree view on the left showing a hierarchy of facilities and their associated EEMs. The selected facility is "UEPH (UEPH)". Under it, several packages are listed, including "Lighting Package", "Equipment Package", "Envelope Package", "Infiltration Package", and "HVAC Package". The "Envelope Package" is expanded, showing "EEM: PassiveHaus Insulation" as the selected measure.
- Parameters for PassiveHaus Insulation:** A table on the right showing the parameters for the selected EEM. The table has columns for Name, Baseline Value, Default EEM Value, Value, Units, and Description.

Name	Baseline Value	Default EEM Value	Value	Units	Description
Roof Insulation	30	50	50	R	Roof insulation R-value
Slab Insulation	0	20	20	R	Slab insulation R-value
Wall Cavity Insulation	13	19	19	R	Wall cavity insulation R-value
Wall Continuous Insulation	12.5	30	30	R	Wall continuous insulation R-value
Window SHGC	0.40	0.35	0.35	SHGC	Window solar heat gain coefficient
Window U-Value	0.55	0.31	0.31	U	Window U-value

The interface also includes a navigation bar at the bottom with buttons for "Close" and "Save & Continue". The status bar at the very bottom shows "Done" and "Internet" with a 100% zoom level.

Simulation Predicts Performance & Cost

The screenshot displays the NZIE software interface within a Windows Internet Explorer browser window. The browser address bar shows the URL <http://134.164.53.44/NZIE/Alpha23/>. The main content area is titled "Step 3 - Run Simulations" and is divided into two primary sections: "Facility Groups" and "Envelope Package".

Facility Groups

Name	Facility Type	Status	Download
UEPH	UEPH		Collapse
Lighting Package		Finished	E+ Hourly E+ Resources
Equipment Package		Finished	E+ Hourly E+ Resources
Envelope Package		Finished	E+ Hourly E+ Resources
Infiltration Package		Finished	E+ Hourly E+ Resources
HVAC Package		Finished	E+ Hourly E+ Resources
DHW Package		Finished	E+ Hourly E+ Resources
Dessicant Dehumidification Package		Finished	E+ Hourly E+ Resources
Energy Recovery Package		Finished	E+ Hourly E+ Resources
Chiller Condenser Heat		Finished	E+ Hourly

Envelope Package

Parametric Model Specifications

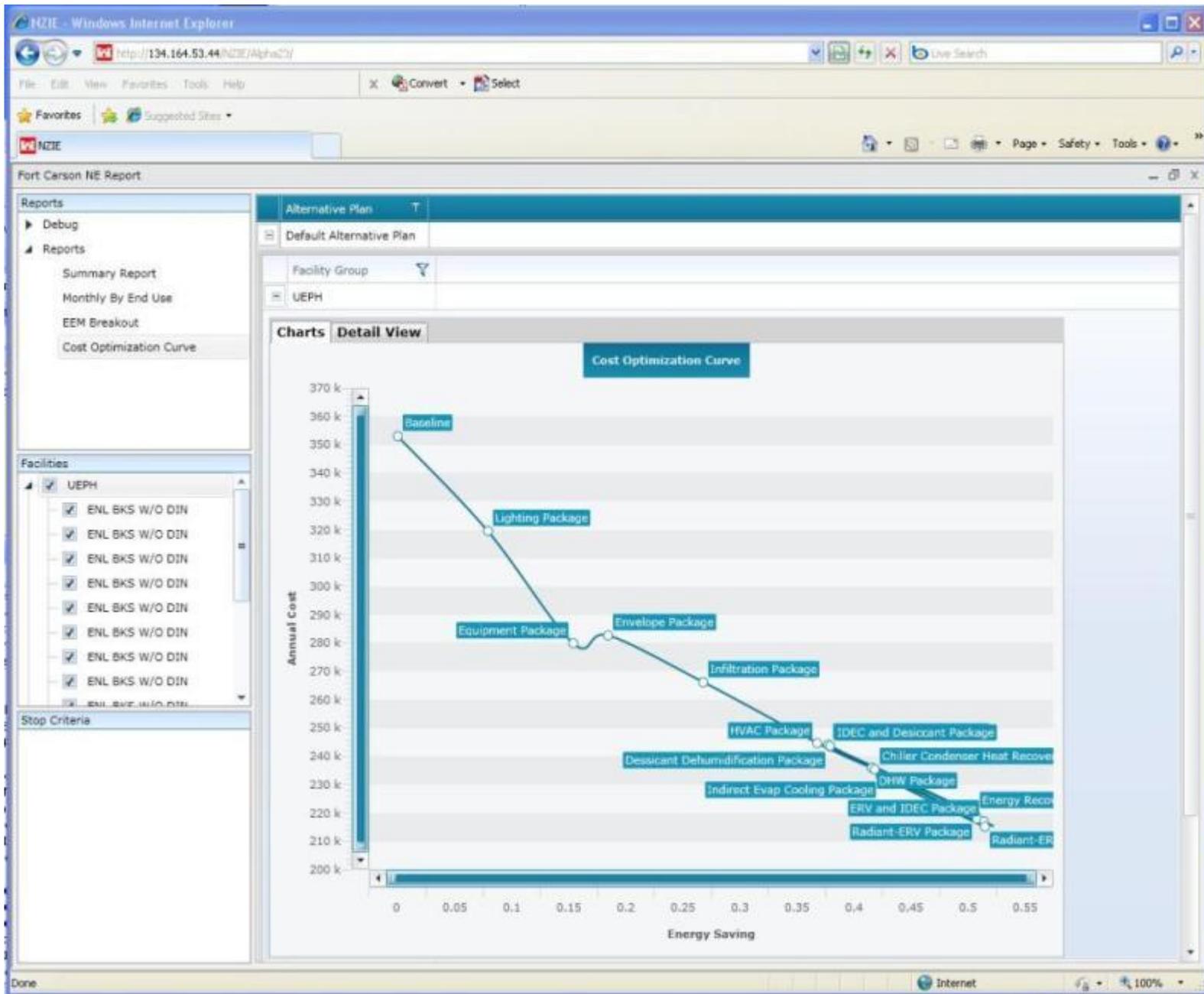
Name	Value
ClimateZone	ASHRAE_5B
CodeStandard	ASHRAE_90.1_2010
FacilityType	UEPH
ModelName	EnergyPlus
Version	0.8.0

Parameters

Name	Value
Roof_Emittance	0.9
Roof_Insulation	50
Roof_Reflectance	0.6
Slab_Insulation	20
Wall_Cavity_Insulation	19
Wall_Continuous_Insulation	30
WaterHeater_Eff	0.8
Window_Height	5.0
Window_SHGC	0.35
Window_U	0.31
Window_Width	3.0
Temp_HVAC_Housing	EMCOULATD

A large green button labeled "Run Simulation" is positioned at the bottom of the "Facility Groups" section. The browser window includes standard navigation buttons (Back, Forward, Stop, Refresh) and a status bar at the bottom showing "Done" and "Internet" connectivity.

Supporting Graphics



Supporting Data For Decision Criteria

Fort Carson NE Report

Reports

- Debug
- Reports
 - Summary Report
 - Monthly By End Use
 - EEM Breakout
 - Cost Optimization Curve

Facilities

- UEPH
 - ENL BKS W/O DIN
 - ENL BKS W/O DIN

Stop Criteria

Alternative Plan	Total Facility Area	Number of Fac	ELECTRICITY	ELECTRICITY Reduct	GAS	GAS Reduction
Baseline	882,000	32	11,334,120.00	-	335,700.70	-

Name	ELECTRICITY [kwh]	ELECTRICITY Inter	GAS [th]	GAS In	Total Energy [kw]	Total Energy Inter	Facilities	Area (sqft)	Last Package
UEPH	2,354,157	11.83	- 68,423	.34	- 4,359,430	21.91	10	199,000	Baseline
BNHQ	1,596,853	09.62	- 9,746	.06	- 1,882,474	11.34	8	166,000	Baseline
BdeHQ	156,926	17.44	- 508.09	.06	- 171,817	19.09	1	9,000	Baseline
COF	798,961	04.99	- 45,188	.28	- 2,123,292	13.27	4	160,000	Baseline
DFAC	3,762,011	55.32	- 133,804	01.97	- 7,683,430	112.99	2	68,000	Baseline
UEPH - New	2,365,967	11.83	- 68,767	.34	- 4,381,337	21.91	5	200,000	Baseline
TEMF	299,223	03.74	- 9,265	.12	- 570,754	07.13	2	80,000	Baseline

Alternative Plan	Total Facility Area	Number of Fac	ELECTRICITY	ELECTRICITY Reduct	GAS	GAS Reduction
Default Alternative Plan	882,000	32	7,685,308.00	-.32	256,283.90	-.24

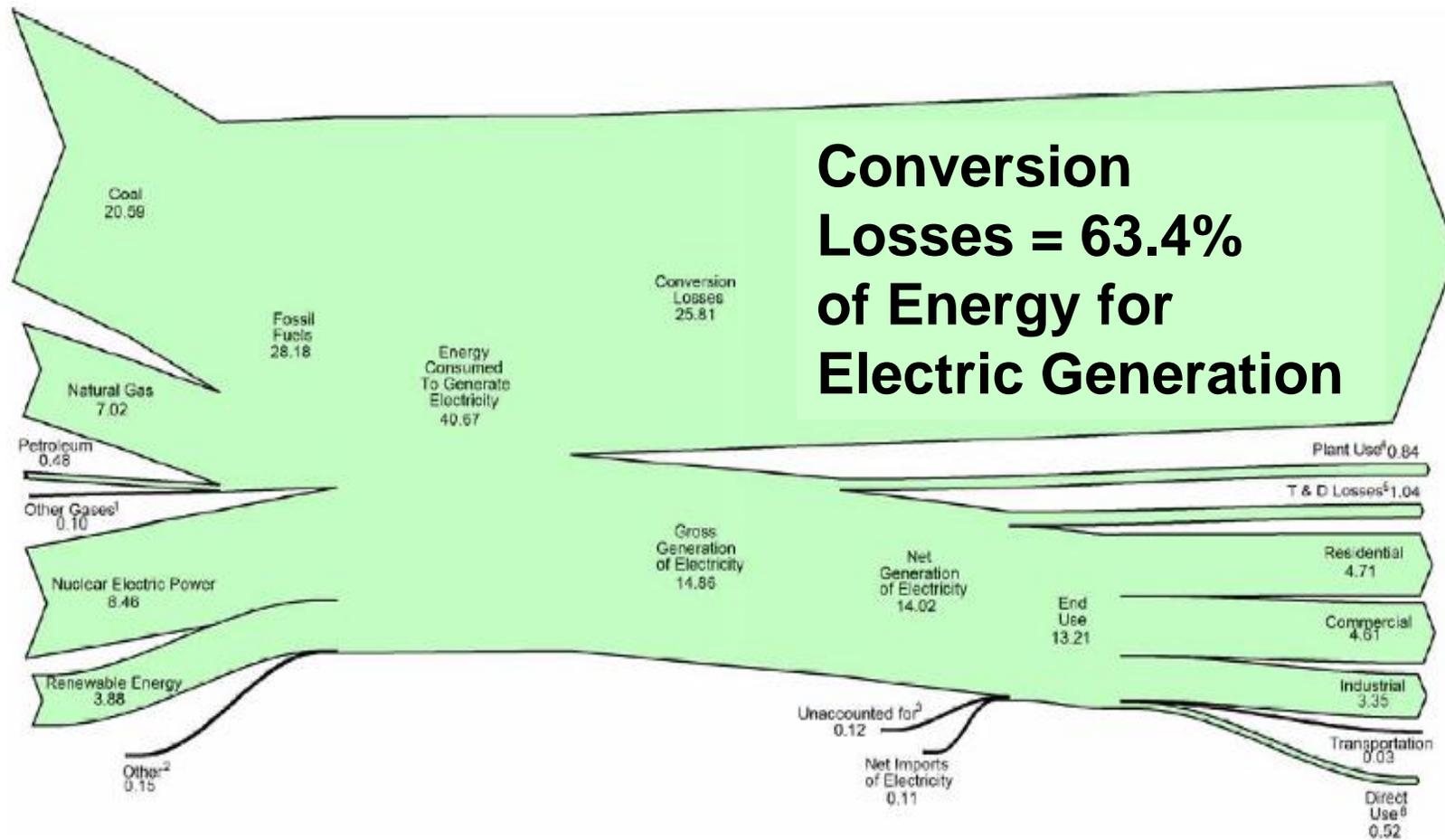
Name	ELECTRICITY [kwh]	ELECTRICITY Inte	GAS [th]	GAS Int	Total Energy [kw]	Total Energy Inte	Facilities	Area (sqft)	Last Package
UEPH	1,326,193	06.66	- 41,604	.21	- 2,545,474	12.79	10	199,000	DHW Package
BNHQ	1,011,592	06.09	- 1,072	.01	- 1,042,998	06.28	8	166,000	DOAS-Radiant-ERV Package
BdeHQ	123,720	13.75	- 167.91	.02	- 128,641	14.29	1	9,000	DOAS-Radiant-ERV Package
COF	546,742	03.42	- 34,553	.22	- 1,559,386	09.75	4	160,000	DHW Package
DFAC	3,103,366	45.64	- 129,608	01.91	- 6,901,798	101.50	2	68,000	HVAC Package
UEPH - New	1,332,858	06.66	- 41,813	.21	- 2,558,265	12.79	5	200,000	DHW Package
TEMF	240,836	03.01	- 7,467	.09	- 459,684	05.75	2	80,000	HVAC Package

Installation Level Optimization

- **Best Measures**
- **Sizes**
- **Operation Strategies**
- **Lowest Cost**
- **Models –**
 - **NZI Optimization Tool, POLIS, REO, FEDS, MODEST, MSW (Solid Waste), DSS (Water)**

Electricity Generation & Use in USA

Buildings are ~71% of total



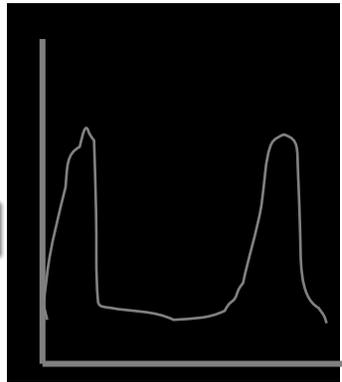
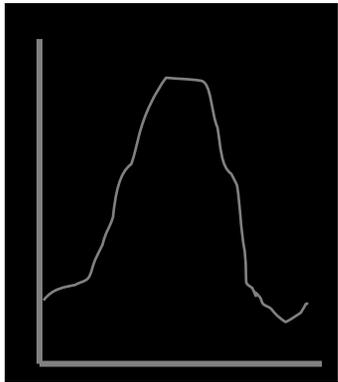
Trans & Dist Losses = 7.4% Net Gen Elec

Buildings 70.6%

US DoE EIA 2008

Largest Cause of Greenhouse Gas

Building Cluster Analysis



...
...
... = ...
...



Office Buildings
...

...



Barracks
...

...



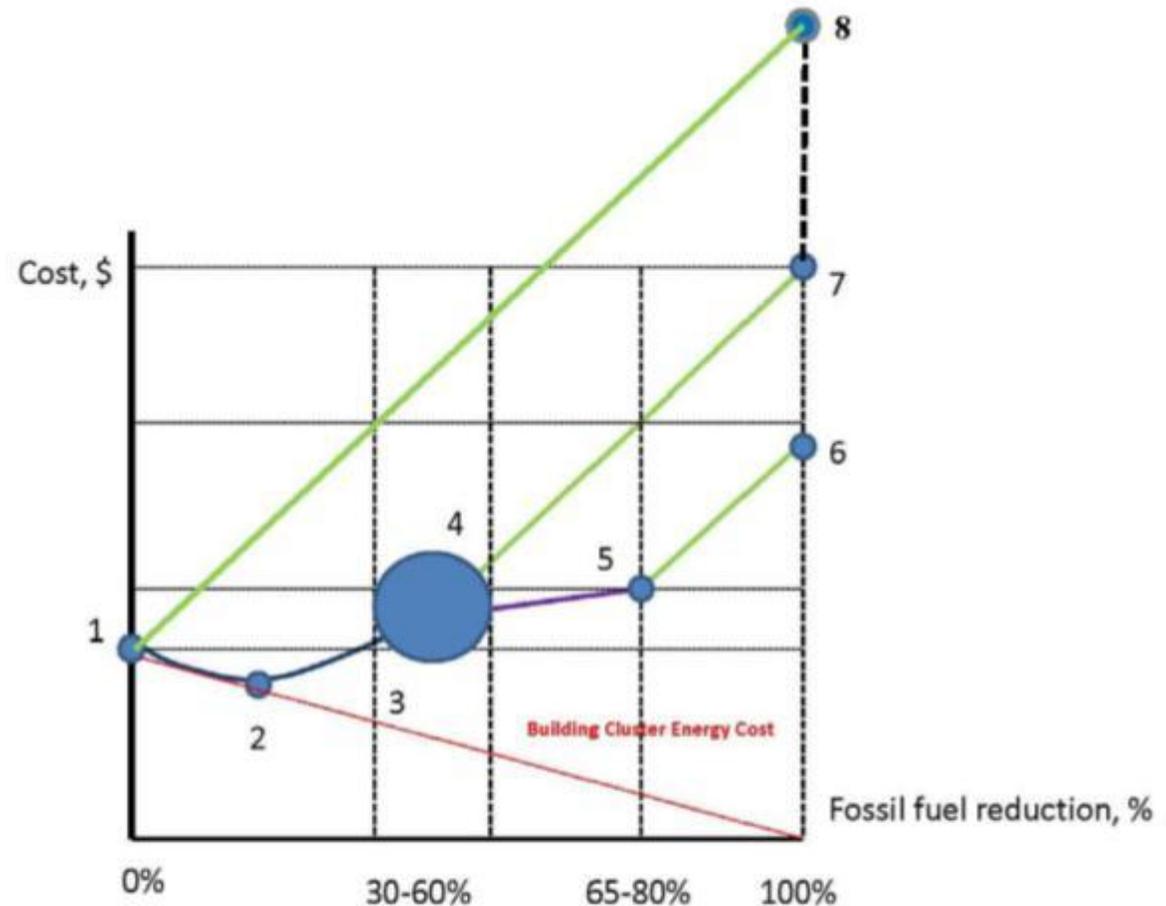
Maintenance Facility...



Other Facilities
...

...

Building Cluster Fossil Fuel Optimization Process



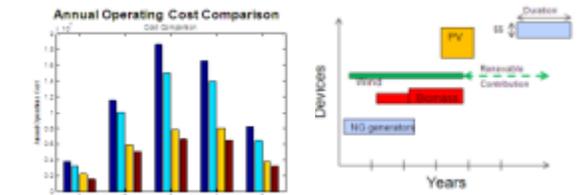
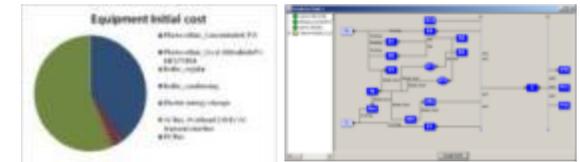
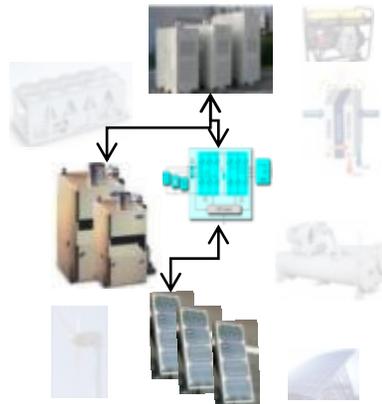
- 1 – Building prior to retrofit
- 2 - Building after retrofit with Business As Usual (BAU)
- 3 - Building after retrofit option to maintain the same annualized cost
- 4 - Building after maximum building site energy reduction retrofit
- 4-5 Building fossil fuel reduction due to Central Energy Plant (CEP) with co-generation
- 6 - NZE building connected to CEP with co-generation and a renewable energy source
- 7 - NZE building connected to a renewable energy source
- 8 - Building prior to retrofit connected to a renewable energy source

NZI Optimization Tool (NZI-Opt)

- Supply side equipment
- Lowest Life Cycle Cost
- To cluster or not to cluster
- Meet site constraints

- Heating
- Cooling
- Electric
- Critical Electric
- Water
 - Potable
 - Grey
 - Wastewater
- Solid Waste

- COGEN
- Biomass
- Solar PV
- Solar Thermal
- Wind
- Storage
- Fuel Cells, etc



Exploration Space
("Super-Structure")

Architecture(s)
determined

Reporting &
Implementation
Plan

How it works

NZI-Opt begins with definitions for all possible equipment pieces that could serve the cluster demands. These definitions include region-independent parameters such as efficiency, energy inputs, and energy outputs. Some equipment examples are shown below.



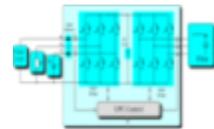
Electric Chiller



Diesel Generator



Photovoltaic



AC Bus



Absorption Chiller



Fuel Cell



Gas Boiler



Wind Turbine



Organic Rankine Cycle



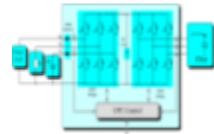
Gas Turbine



Electric Heater

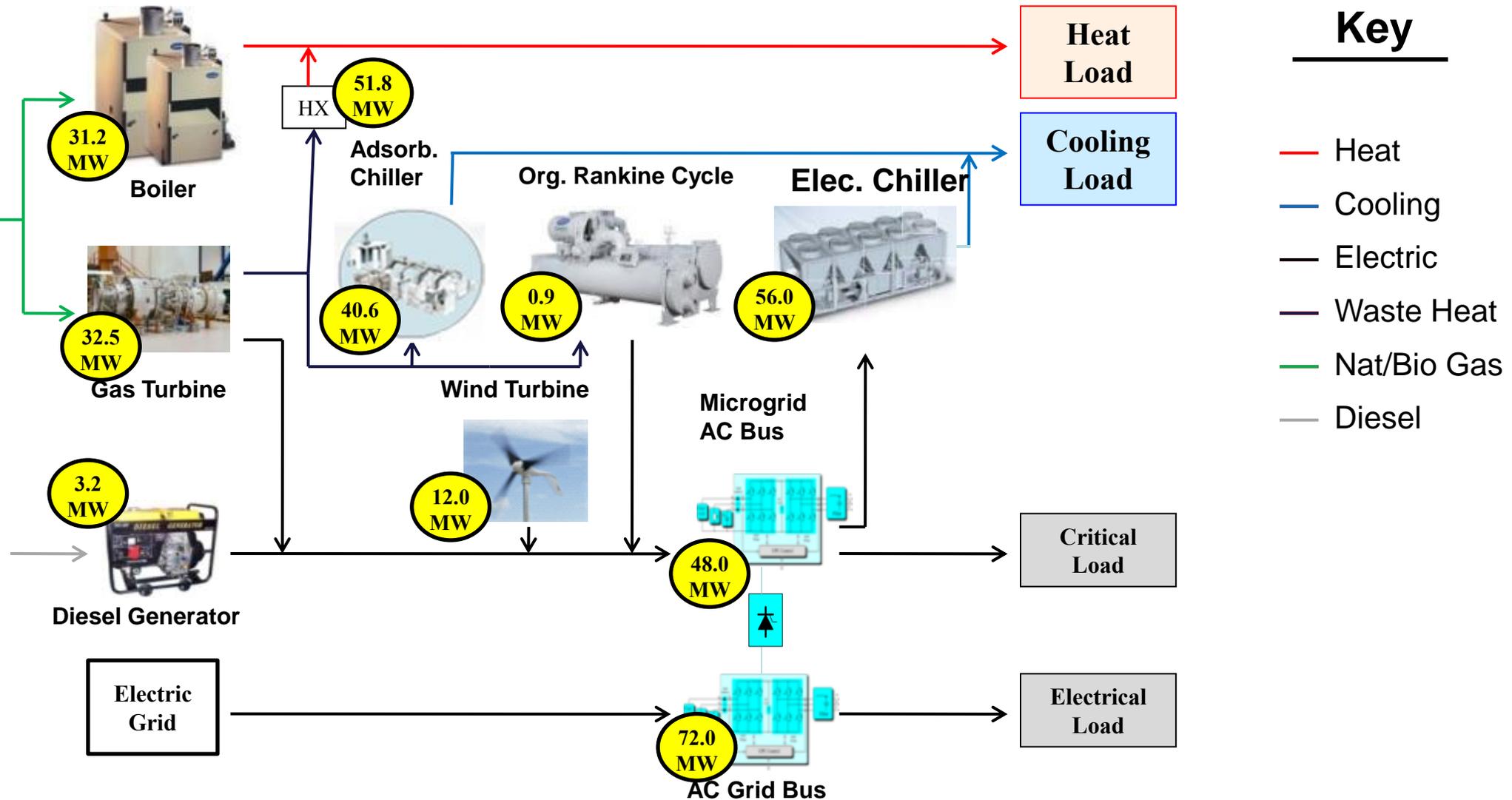
Selecting a Supply Architecture

The optimization process determines the best suite of equipment by ensuring that the demands for heat, cooling, electric, etc are fulfilled at each of the 8760 hours in the year, while satisfying the additional environmental and legislative requirements.



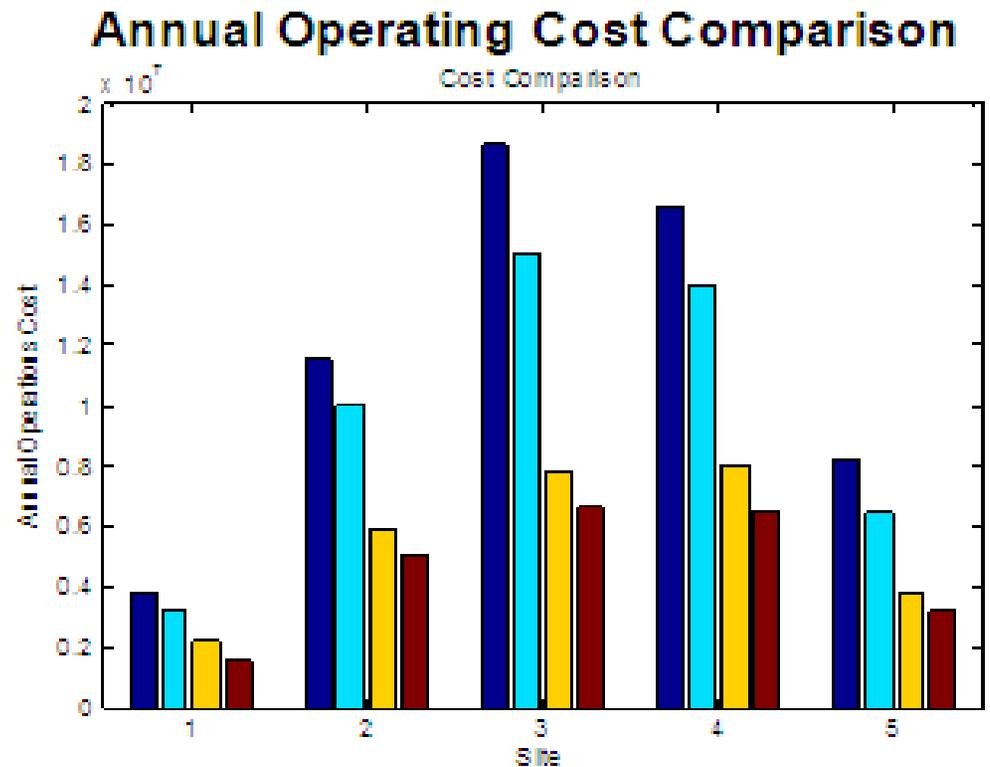
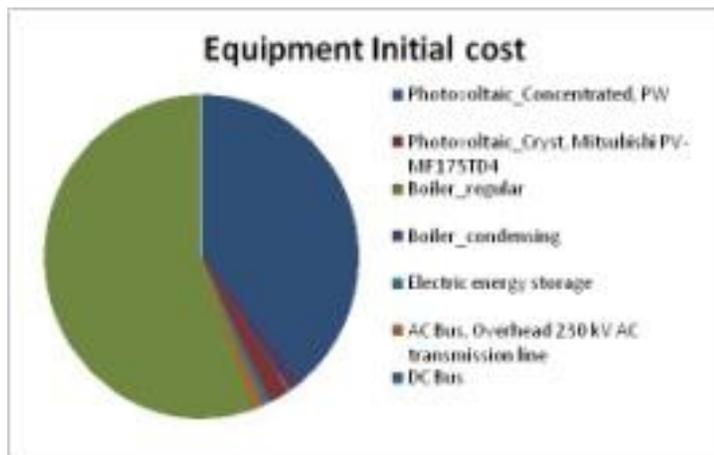
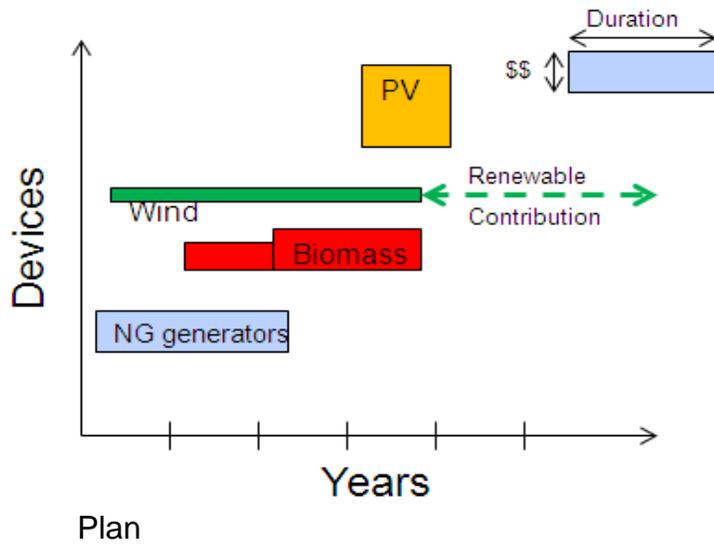
Sizing the Supply Equipment

Specific equipment pieces are sized and their interactions with each other are tracked throughout the year. The result is a complete “supply” solution that provides the sizing, initial cost, and operating cost of every piece of equipment in the lowest cost solution.

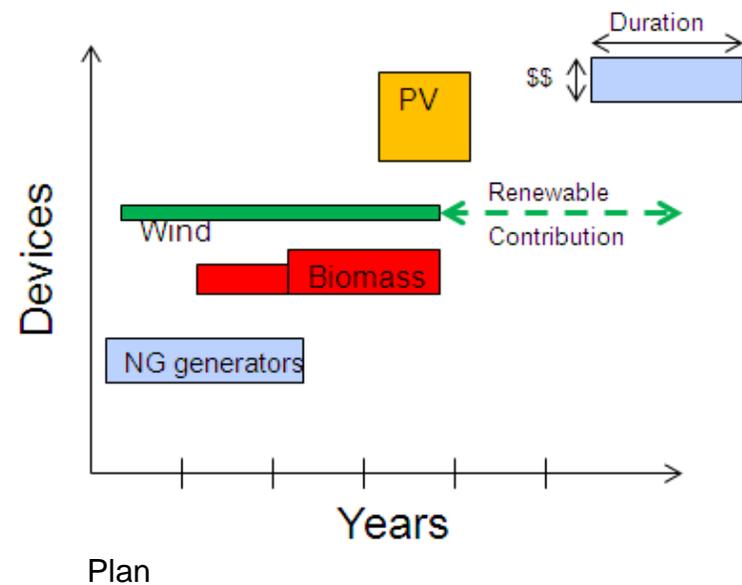
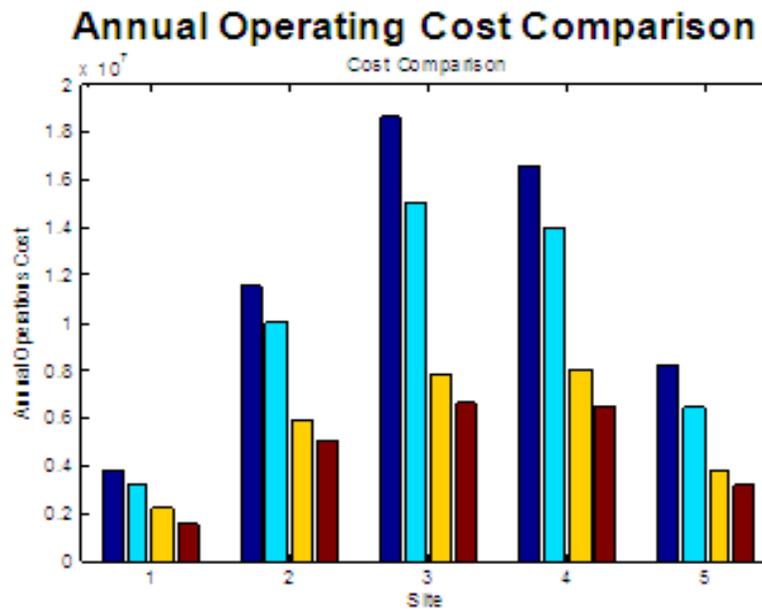
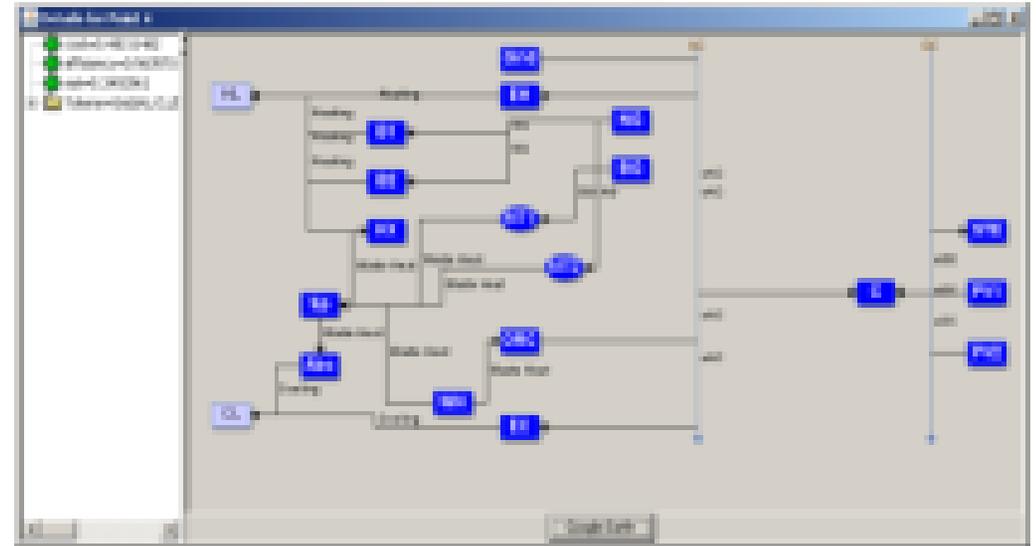
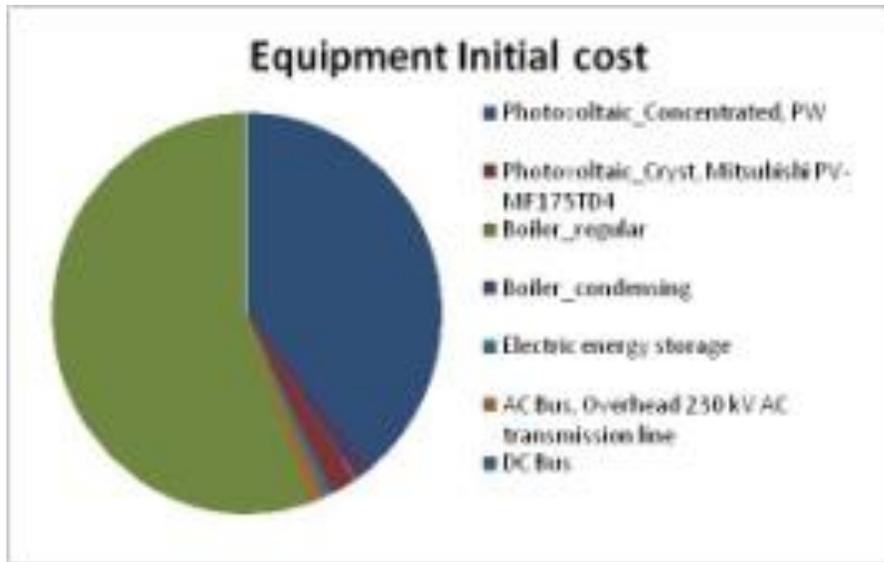


Orderly Approach

Once the equipment suite and sizing has been determined a post-process optimization can be run to determine the implementation schedule for the equipment. This process is meant to account for annual budget, progressive legislative requirements, and aging current equipment.



Reporting



USAG Fort Hunter Liggett is an Army Reserve installation in California's Central Coast region



Moffett Field
Mountain View



Parks RFTA
Dublin

Fort Hunter Liggett
Southern Monterey County



Federal Installation Energy & Sustainability Mandates

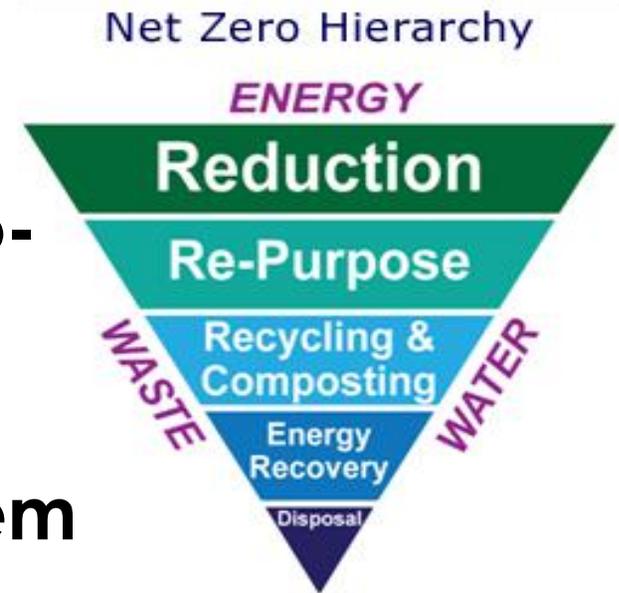
Mandate Topic	Energy & Sustainability Performance Target [Source]
Energy use in Federal buildings	<ul style="list-style-type: none"> • Reduce 3% per year to total by 30% by 2015 (2003 baseline) [EO 13423, EISA 2007]
GHG emission reduction	<ul style="list-style-type: none"> • Identify GHG emission reduction targets to be met by 2020 from 2008 baseline [EO 13514] • Army target – 34% [SA Memo to OSD]
Energy metering for improved energy management	<ul style="list-style-type: none"> • Meter electricity by Oct 2012 [EPACT 2005] • Meter natural gas and steam by Oct 2016 [EISA 2007]
Electricity use for federal government from renewable sources	<ul style="list-style-type: none"> • At least 3% of total electricity consumption (FY07-09), 5% (FY10-12), 7.5% (FY13 +) [EPACT 2005, NDAA 2007]
Total consumption from renewable sources	<ul style="list-style-type: none"> • At least 50% of required annual renewable energy consumed from “new” renewable sources [EO 13423] • 25% by 2025 -”Sense of Congress” [EISA 2007], NDAA 2007
Hot water in new / renovated federal buildings from solar power	<ul style="list-style-type: none"> • 30% by 2015 if life cycle cost-effective [EISA 2007]
Fossil fuel use in new / renovated Federal buildings	<ul style="list-style-type: none"> • Reduce 55% by 2010; 100% by 2030 [EISA 2007]
Net zero buildings	<ul style="list-style-type: none"> • All new buildings entering design in 2020 and after achieve net zero energy by 2030 [EO 13514] • New federal buildings achieve net zero by 2030 [EISA 2007]
Fleet vehicle petroleum consumption	<ul style="list-style-type: none"> • Reduce 20% by 2015 (Base 2005) [EISA 2007] • Reduce by 2% per year thru FY2020 (Base 2005) [EO 13423, EO 13514]
Fleet vehicle alternative fuel use	<ul style="list-style-type: none"> • Increase 10% by 2015 (Base 2005) [EISA 2007] • Increase by 10% annually to reach 100% (Base 2005) [EO 13423]
Water consumption	<ul style="list-style-type: none"> • Reduce consumption intensity by 2% annually FY 08-FY 15 (2007 baseline) [EO 13423] • Reduce consumption by 2% annually for 26% total by FY 2020 (2007 baseline) [EO 13514]

Key to meeting the challenge 'Master Planning for Net Zero'

- **Fort Hunter Liggett's Commander is engaged and highly supportive**
- **Constant collaboration between the energy manager, environmental manager and the master planner**
- **Partnership with your local energy provider**
- **Support from the Army**

Net Zero Energy – the approach

- **Reduce consumption to the minimum amount possible – including changing behavior, retrofitting facilities**
- **Re-purpose facilities – take under utilized facilities and repurpose them into more efficient use**
- **Produce for remaining demand, preferably utilizing renewable energy; solar, ground source heat pumps, geo-thermal, etc.**



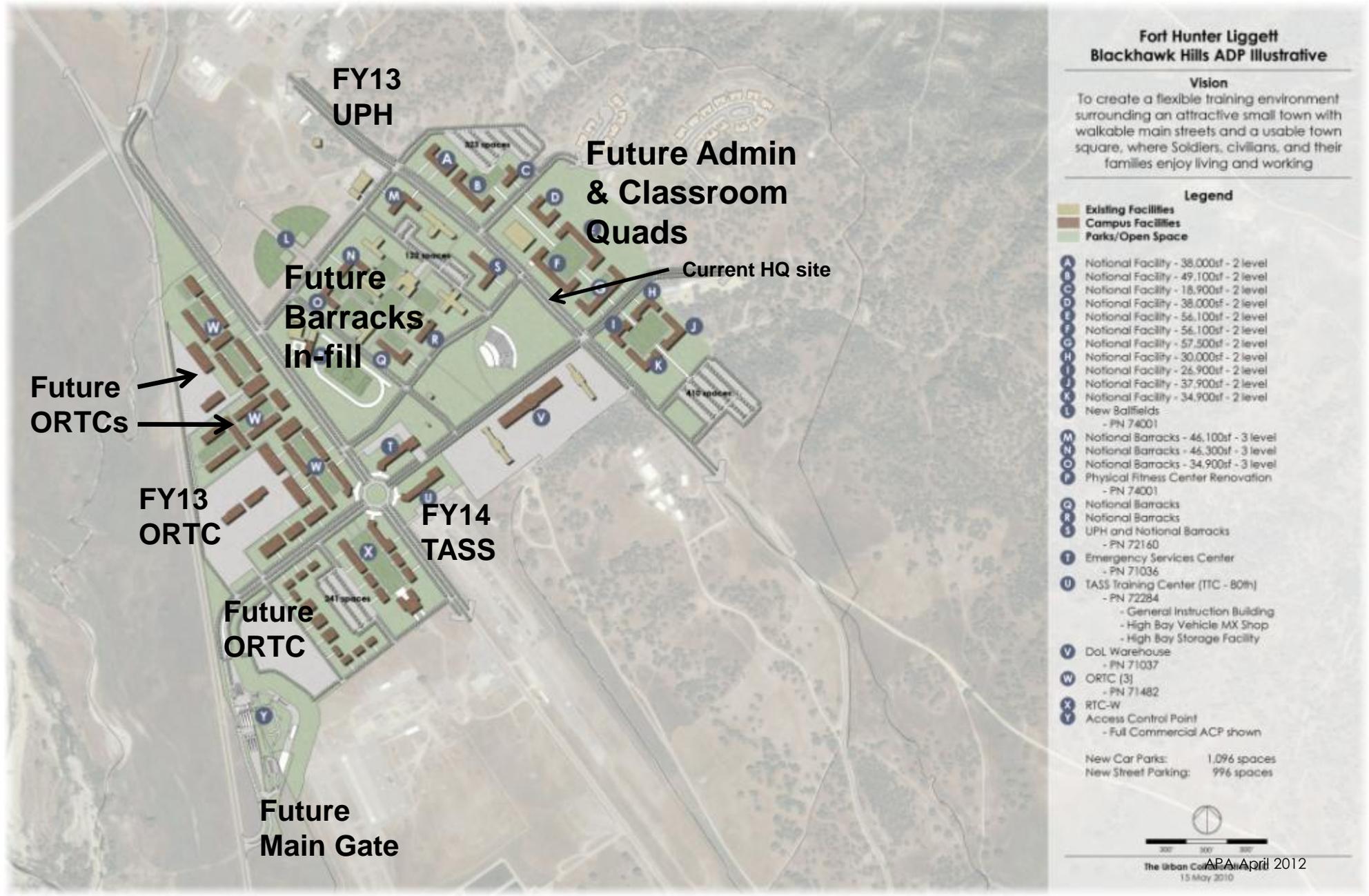
Additional factors:

- **Staffing is always a challenge**
- **Understanding the issues / metrics**
- **How to get federal mandates into a master plan**
- **“It wasn’t budgeted”**
- **Maximizing shrinking real estate**
- **It’s difficult...**

ACSIM policy: ...Create more compact urban communities that still meet security and safety factors. Planners will incorporate the following key principles of sustainable planning in their Master Plans, area development plans, and other planning products:

- **compact development**
- **infill development**
- **transit-oriented development**
- **horizontal and vertical mixed-uses**
- **connected transportation networks**
- **low impact development**
- **multi-story construction**
- **narrow buildings**

Blackhawk Hills Area Development Plan – Barracks, Classroom and Admin Quads



Blackhawk Hills Buildout Potential = 2.2M SF

Administrative:

444,000 sf minimum
888,000 sf maximum

Barracks:

180,500 sf minimum
361,000 sf maximum

Training/DES:

129,000 sf minimum
258,000 sf maximum

Maintenance:

41,250 sf minimum
82,500 sf maximum

ORTC:

209,000 sf each
627,000 sf total

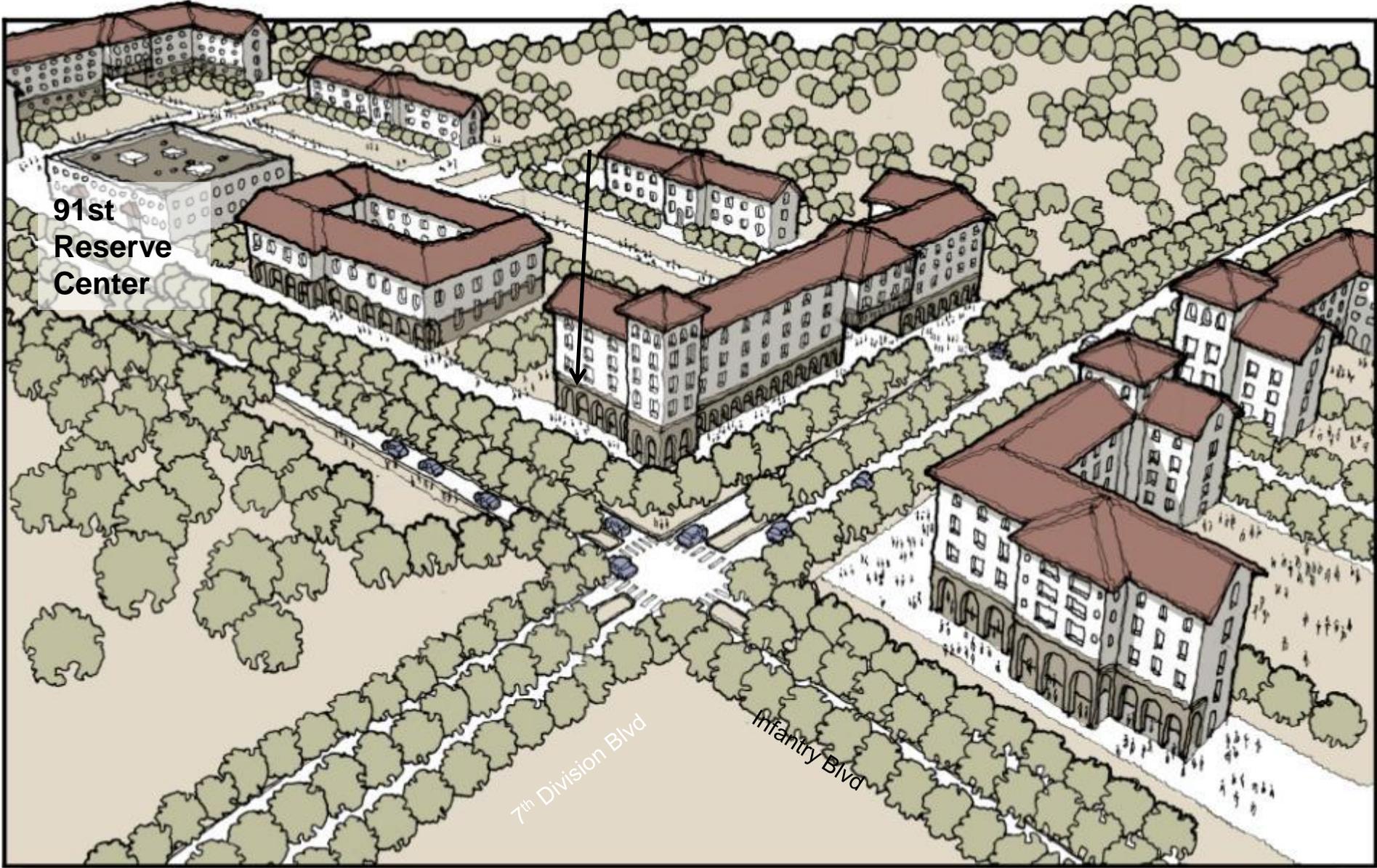
Minimum: 1,421,750 sf

Maximum: 2,216,500 sf

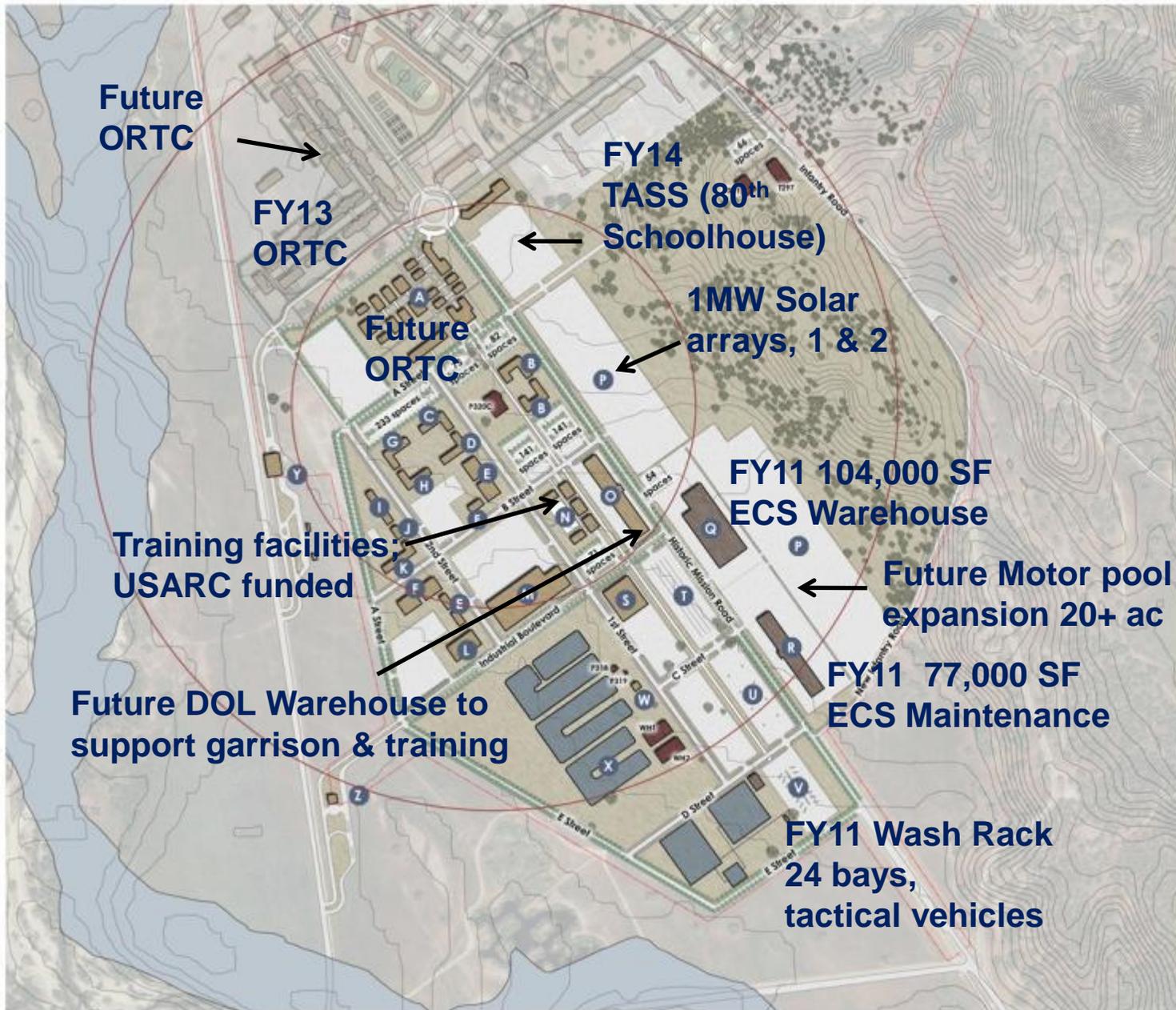
Parking Required: 1,800 spaces

Parking Provided: 1,900 spaces

Future Classroom/Admin Quad - 7th ID @ Infantry Rd



Mission Valley ADP Illustrative Plan



Fort Hunter Liggett Mission Valley ADP Illustrative

Vision

To create a flexible training environment surrounding an attractive small town with walkable main streets and a usable town square, where Soldiers, civilians, and their families enjoy living and working.

Legend

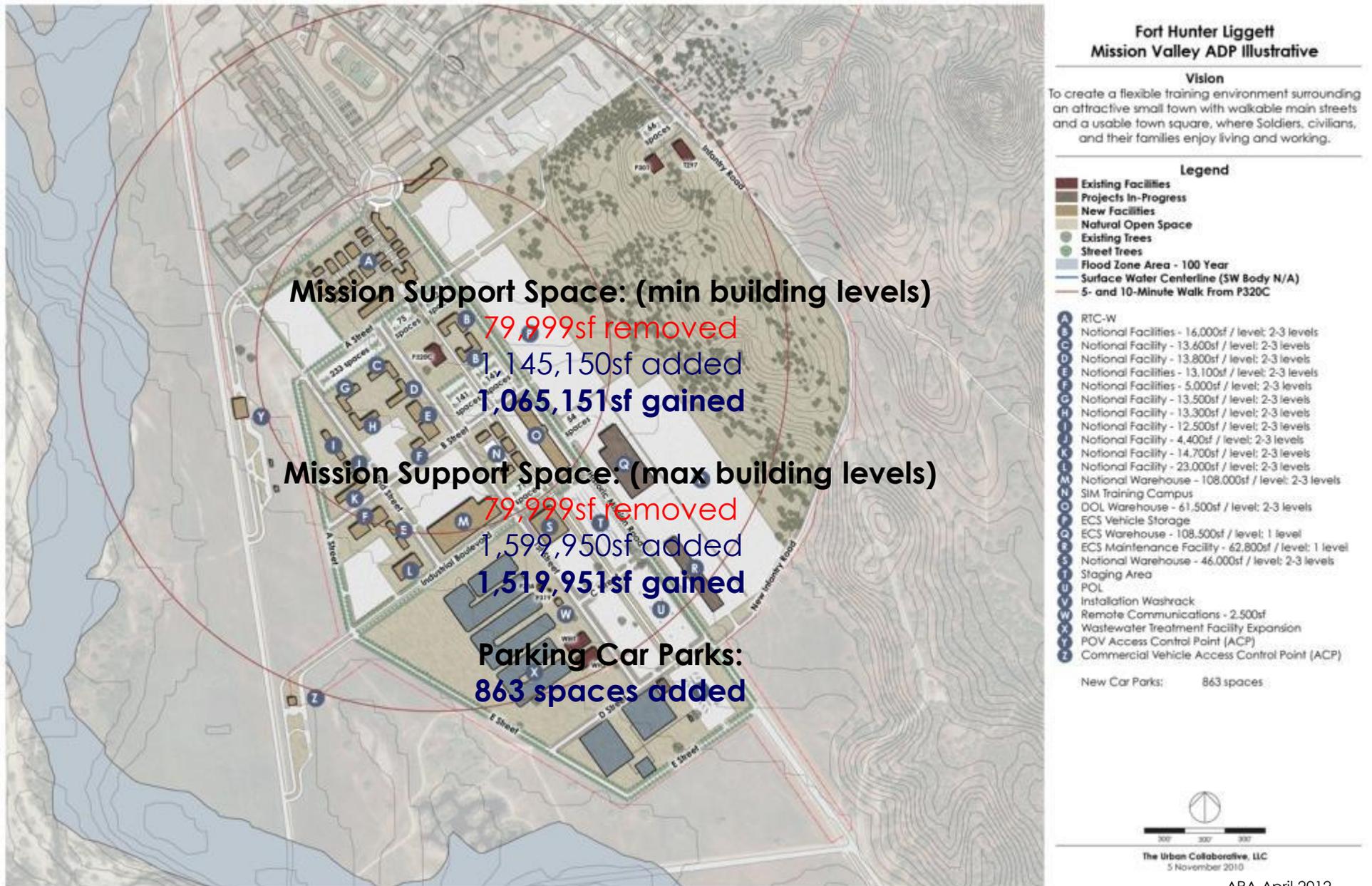
- Existing Facilities
 - Projects In-Progress
 - New Facilities
 - Natural Open Space
 - Existing Trees
 - Street Trees
 - Flood Zone Area - 100 Year
 - Surface Water Centerline (SW Body N/A)
 - 5- and 10-Minute Walk From P320C
-
- A** RTC-W
 - B** National Facilities - 16,000sf / level; 2-3 levels
 - C** National Facility - 13,600sf / level; 2-3 levels
 - D** National Facility - 13,800sf / level; 2-3 levels
 - E** National Facilities - 13,100sf / level; 2-3 levels
 - F** National Facilities - 5,000sf / level; 2-3 levels
 - G** National Facility - 13,500sf / level; 2-3 levels
 - H** National Facility - 13,300sf / level; 2-3 levels
 - I** National Facility - 12,500sf / level; 2-3 levels
 - J** National Facility - 4,400sf / level; 2-3 levels
 - K** National Facility - 14,700sf / level; 2-3 levels
 - L** National Facility - 23,000sf / level; 2-3 levels
 - M** National Warehouse - 108,000sf / level; 2-3 levels
 - N** SIM Training Campus
 - O** DOL Warehouse - 61,500sf / level; 2-3 levels
 - P** ECS Vehicle Storage
 - Q** ECS Warehouse - 108,500sf / level; 1 level
 - R** ECS Maintenance Facility - 62,800sf / level; 1 level
 - S** National Warehouse - 46,000sf / level; 2-3 levels
 - T** Staging Area
 - U** POL
 - V** Installation Washrack
 - W** Remote Communications - 2,500sf
 - X** Wastewater Treatment Facility Expansion
 - Y** POV Access Control Point (ACP)
 - Z** Commercial Vehicle Access Control Point (ACP)
- New Car Parks: 863 spaces



The Urban Collaborative, LLC
5 November 2010

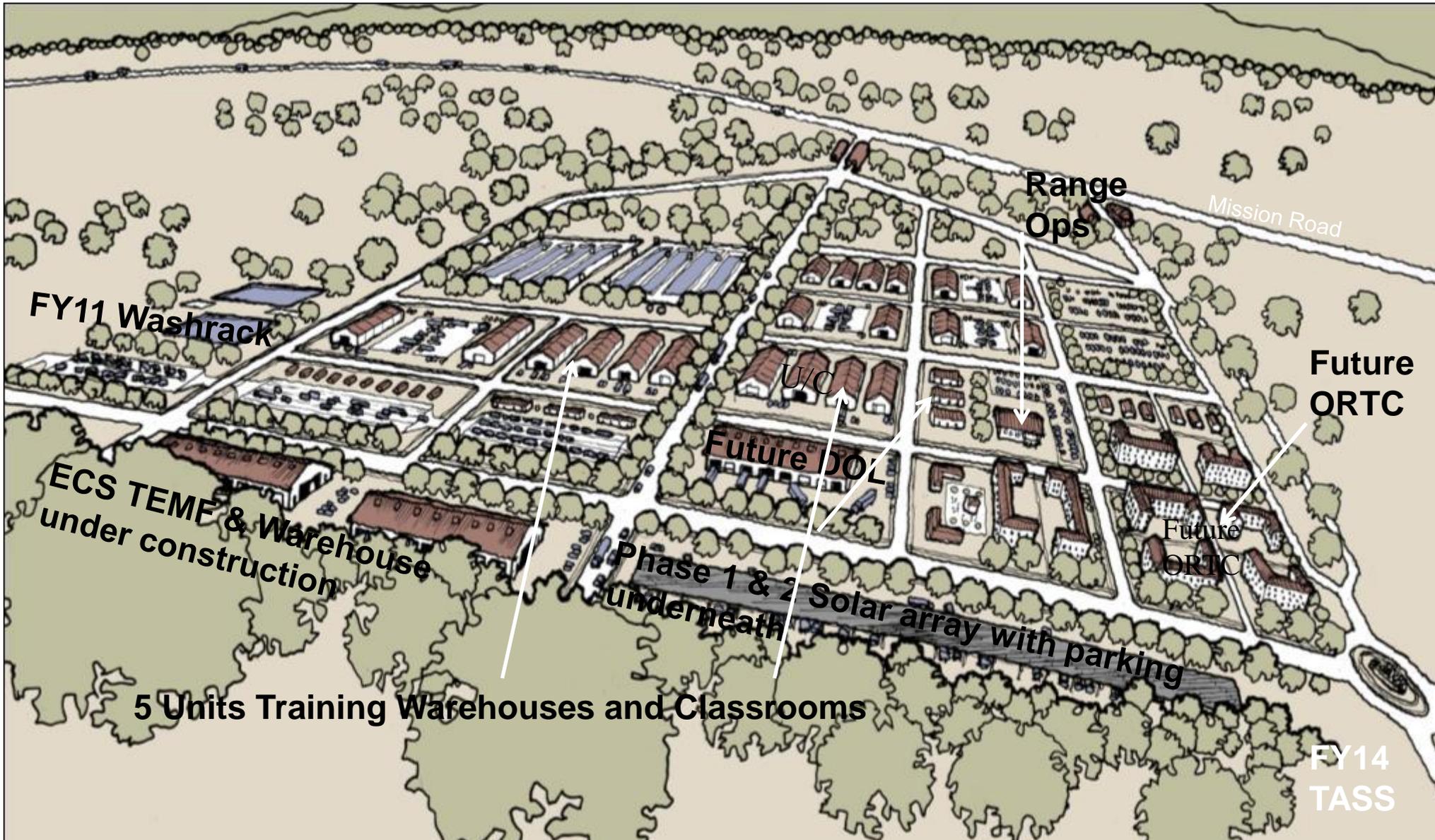
APA April 2012

Mission Valley Buildout Potential = 1.5M SF

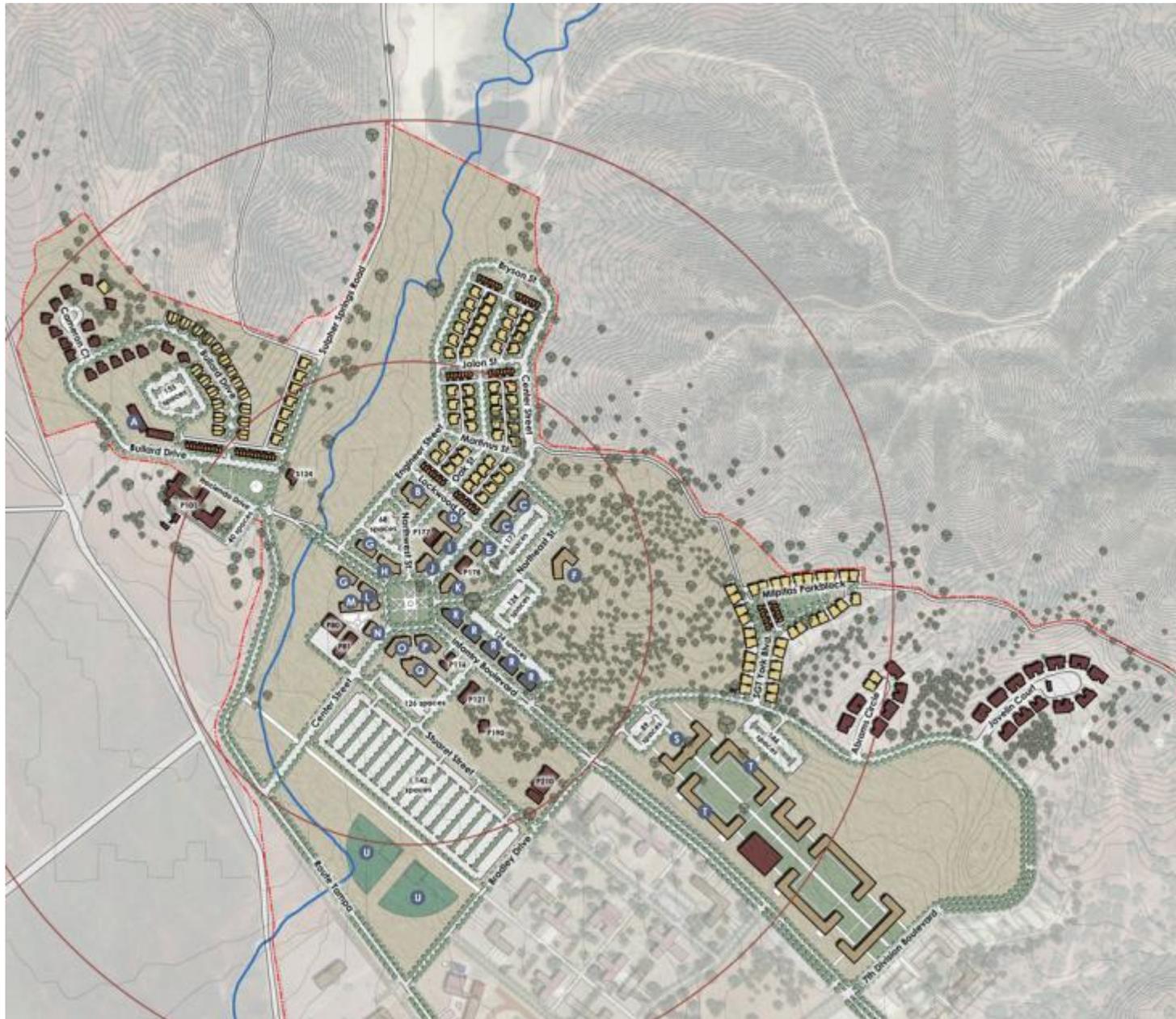


APA April 2012

Mission Valley Training Support Area



Hacienda Heights ADP Illustrative Plan



Fort Hunter Liggett Hacienda Heights ADP Illustrative Plan

Vision

To create a flexible training environment surrounding an attractive small town with walkable main streets and a usable town square, where Soldiers, civilians, and their families enjoy living and working.

Legend

- Existing Facilities
- New Facilities
- Barracks
- Townhouses
- Single-Family Homes / Duplexes
- Natural Open Space
- Parks / Quads
- Existing Trees
- Street Trees
- Flood Zone Area - 100 Year
- Surface Water Centerline (SW Body N/A)
- 5- and 10-Minute Walk From Town Square

- A** P-128 Renovation
- B** MWR Community Support; 11,00sf / level, 2-3 levels
- C** National Facility; 5,800sf / level, 2-4 levels
- D** National Facility; 6,500sf / level, 2-4 levels
- E** National Facility; 3,700sf / level, 2-4 levels
- F** Chapel; 11,500sf / level, 1-3 levels
- G** National Facility; 5,500sf / level, 2-4 levels
- H** National Facility; 6,500sf / level, 2-4 levels
- I** National Facility; 6,100sf / level, 2-4 levels
- J** National Facility; 5,100sf / level, 2-4 levels
- K** National Facility; 5,400sf / level, 2-4 levels
- L** National Facility; 8,600sf / level, 2-4 levels
- M** National Facility; 6,100sf / level, 2-4 levels
- N** National Facility; 3,200sf / level, 2-4 levels
- O** National Facility; 7,900sf / level, 2-4 levels
- P** National Facility; 7,300sf / level, 2-4 levels
- Q** DECA Commissary; 17,050sf / level, 1-3 levels
- R** UEPH Barracks; 5,000sf / level, 2-3 levels
- S** Headquarters; 22,100sf / level, 2-4 levels
- T** National Admin; 28,000sf / level, 2-4 levels
- U** Ballfields; PN 74001

New Car Parks: 2,189 spaces
 New On-Street Parking: 801 spaces
Total Parking: 2,990 spaces

New Townhouses: 78 units
 New Single-Family Homes / Duplexes: 128 units
Total Housing: 206 units



The Urban Collaborative, LLC

APA April 2012

Fort Hunter Liggett UPH



Fort Hunter Liggett

Baseline Data

• Current Electrical Load	12M Kwh
• Future Electric Load (MILCON)	6M Kwh
• Thermal Load (propane/diesel)	<u>11M Kwh</u>
Total	29M Kwh

“NZEI Roadmap”

• Energy Conservation Projects (28%)	8M Kwh
• Human Factor” Conservation (10%)	3M Kwh
• UNICOR renewable projects (24%)	7M Kwh
• ECIP Renewable Projects (38%)	<u>11M Kwh</u>
Total	29M Kwh

Army NZEI Goal is 2020!

Renewable Energy Projects

Project Title	Energy Production	% towards NZEI
Energy Management Control System	Reduces energy use by 15%	15%
PH 3 1MW Solar PV Array w/initial EMCS	1.8M Kwh produced	6.2%
Ph 4 1MW Solar PV Array w/initial "smart grid"	1.8M Kwh produced	6.2%
Solar Hot Water (Barracks/DFAC)	1M Kwh conserved	3.4%
Grid Energy Storage (Battery)	1.5M Kwh stored	5.2%
Ground Source Heat Pumps	3M Kwh conserved	10.3%

46.3% towards NZEI Goal





Incorporating NZI into Planning for Net Zero on Installations

Matthew Hiett

Graduate Research Assistant

University of Illinois, Urbana-Champaign

U.S. Corps of Engineers, ERDC-CERL

matthew.d.hiett@usace.army.mil



US Army Corps of Engineers
BUILDING STRONG®

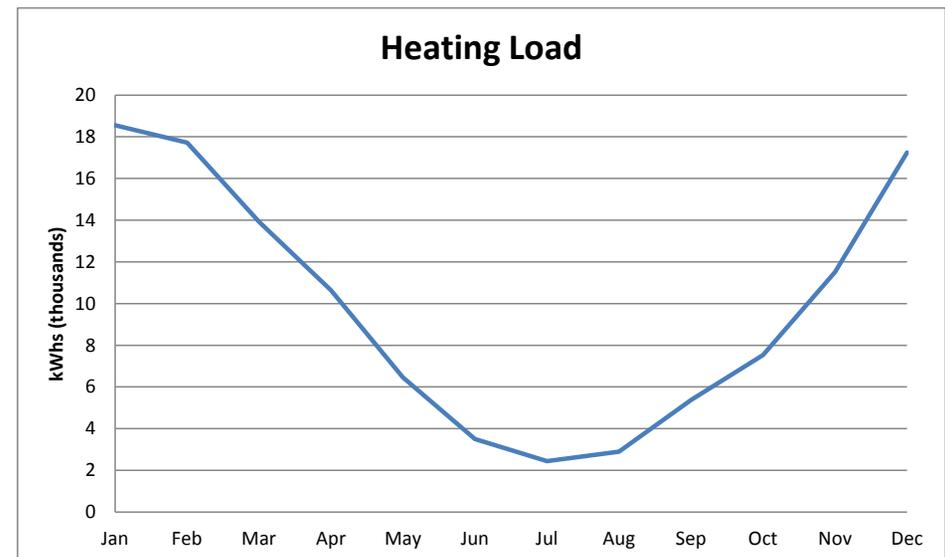
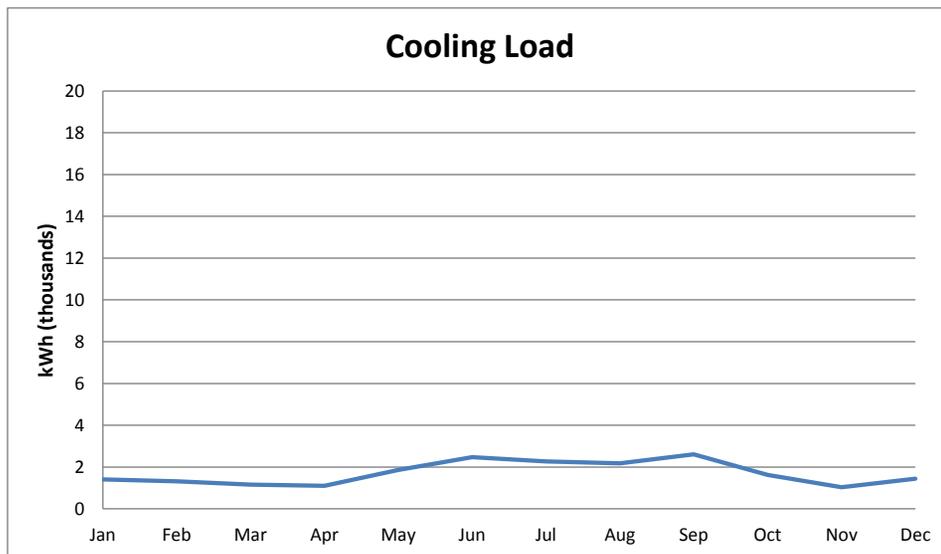


Planning in the Design Space

- If the process applied to a different installation, what would change?
 - Weather
 - Viability of renewable options (solar, wind, biomass)
 - Waste-energy conversion (available waste stream)
 - Installation electricity load (heating and cooling)
 - Electricity rates
 - Source fuel mixture (coal, nat. gas, nuclear, etc.)
 - Current infrastructure / physical compactness

Baseline model

- Baseline represents “typical” installation in the NE United States.



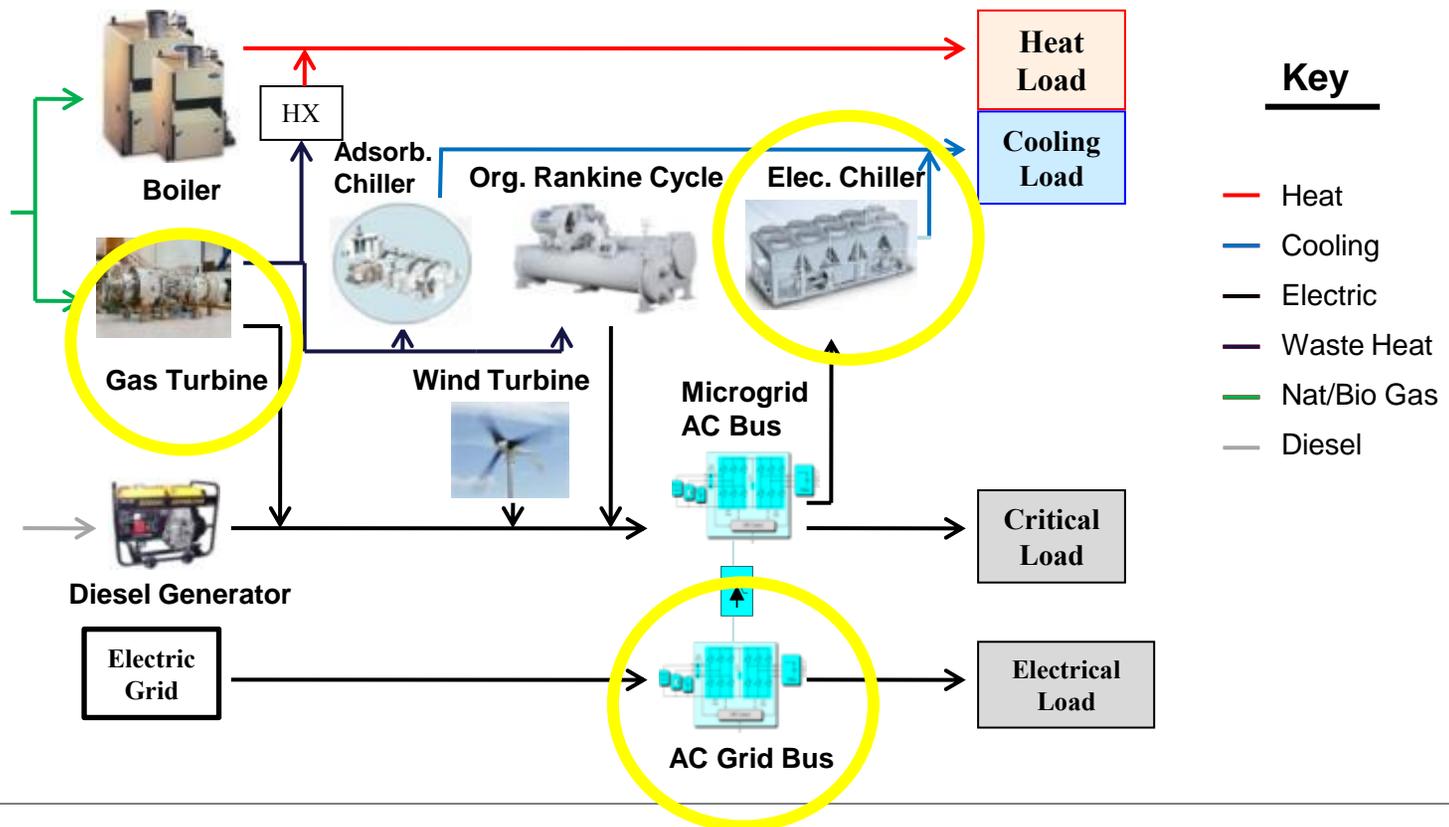
- Wind and solar resources are both marginal

Baseline model

- Model returns optimal mix of technologies and cost

1	Boil1	0
2	Boil2	0
3	Boil3	0
4	HeatE1	0
5	ACBus1	3
6	EChilr1	11
7	AChilr1	0
8	WPump1	2
9	EBatt1	0
10	GTurb1	0
11	GTurb2	0
12	GTurb3	0
13	IndGasTurb1	0
14	IndGasTurb2	2
15	IndGasTurb3	1
16	IndGasTurb3	0
17	IndGasTurb3	0
18	PhotoVolt1	0
19	DCtoAC1	0
20	WindTurb1	0
21	EfromGrid	0
22	EtoGrid	0
23	ACtoAC1	0
24	BackPressure	0
25	ExhaustBoiler	0
26	ExhaustBoiler	0
27	ExhaustBoiler	0
28	HeatExchanger	4

		Installed Cost	\$ 13,058,500
		Operating Cost	\$ 193,724,000
Total 30 Year Cost	\$ 206,782,952	Maintenance	\$ 3,917,550
Annual Cost	\$ 6,892,765	Electricity	\$ 30,960,500
		Natural Gas	\$ 162,095,000
		Biogas	\$ -

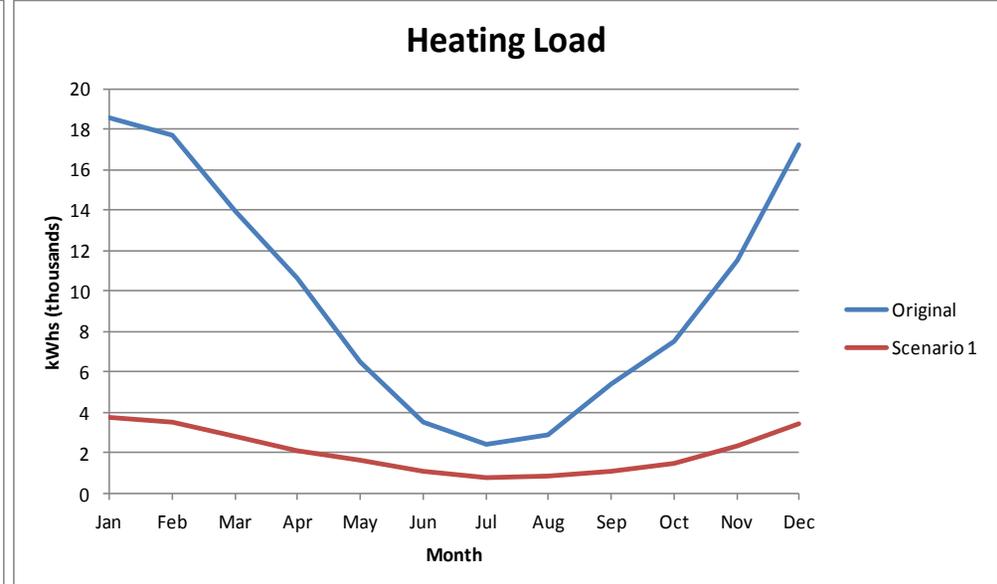
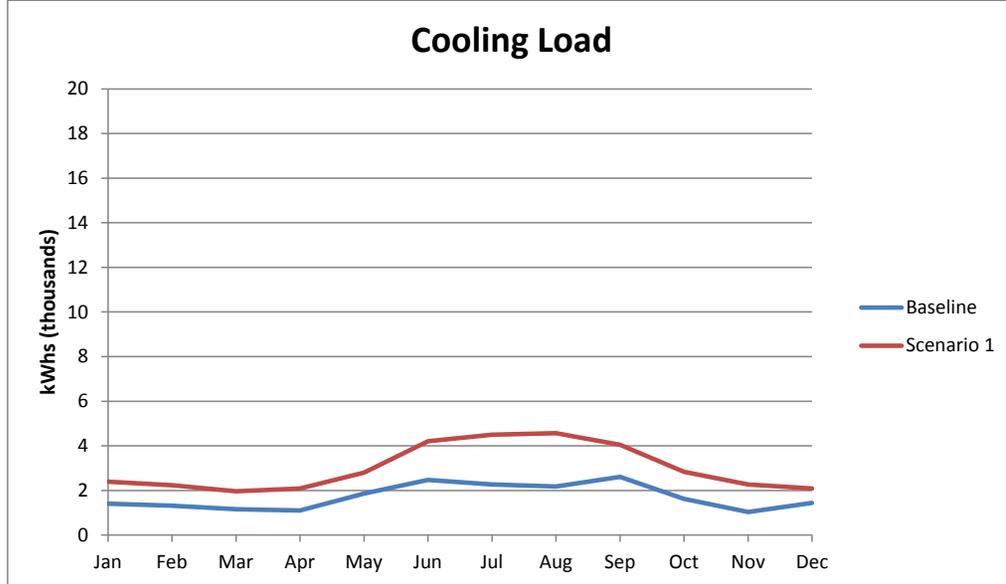


Group Input

- Imagine an installation in the SE, SW or NW United States.
- How does energy, water, and waste planning fit into your Master Planning process?
- How might heating/cooling/electric loads, weather, wind/solar, biomass resources or electricity rates impact the feedback?
- What are the most significant challenges one might experience planning for Net Zero?
 - Alternative financing methods?
 - Changes in policy?
- What additional analysis do you need to perform

Scenario 1- Change Loads

- What considerations would change if the process was applied to an installation in the SW?

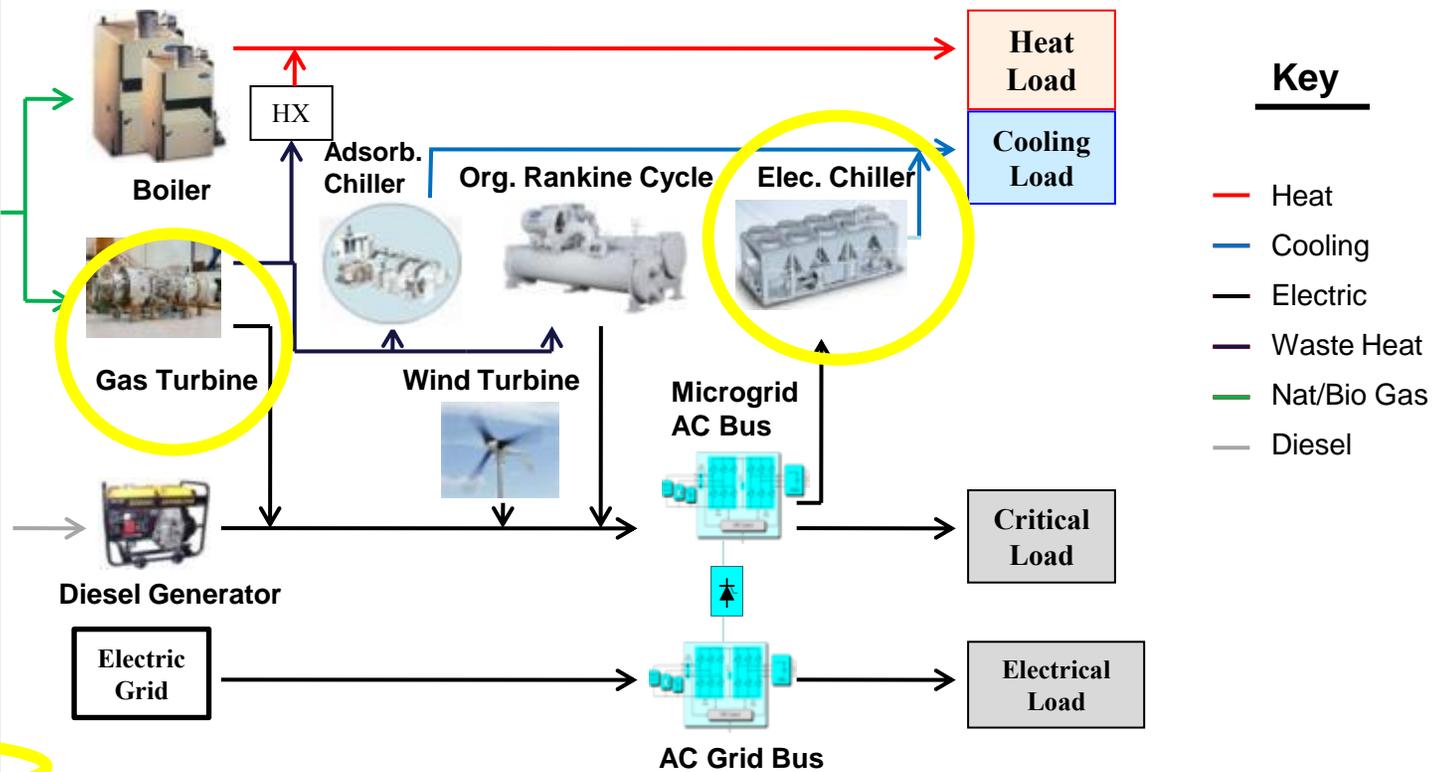


Scenario 1- Change Loads

- Significant increase in electric chillers
- Substantial heating load decrease = less cogeneration

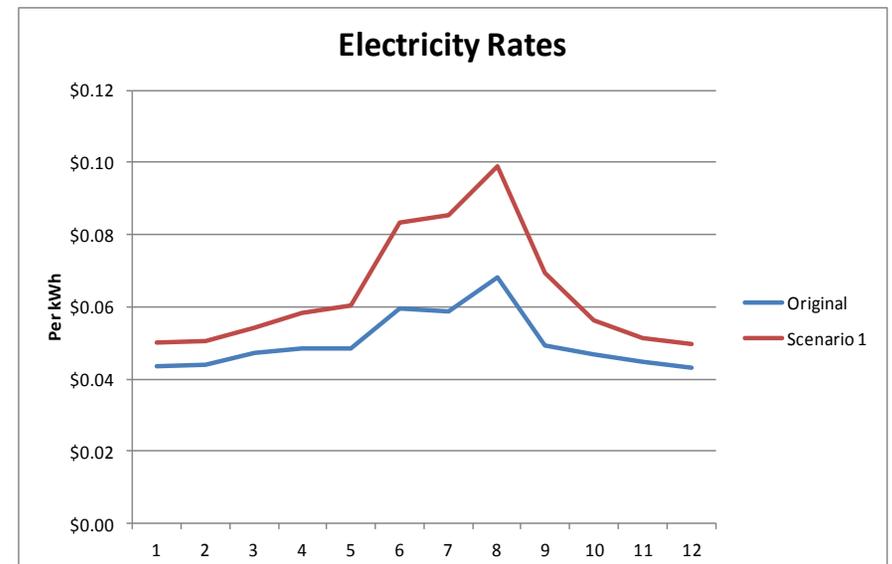
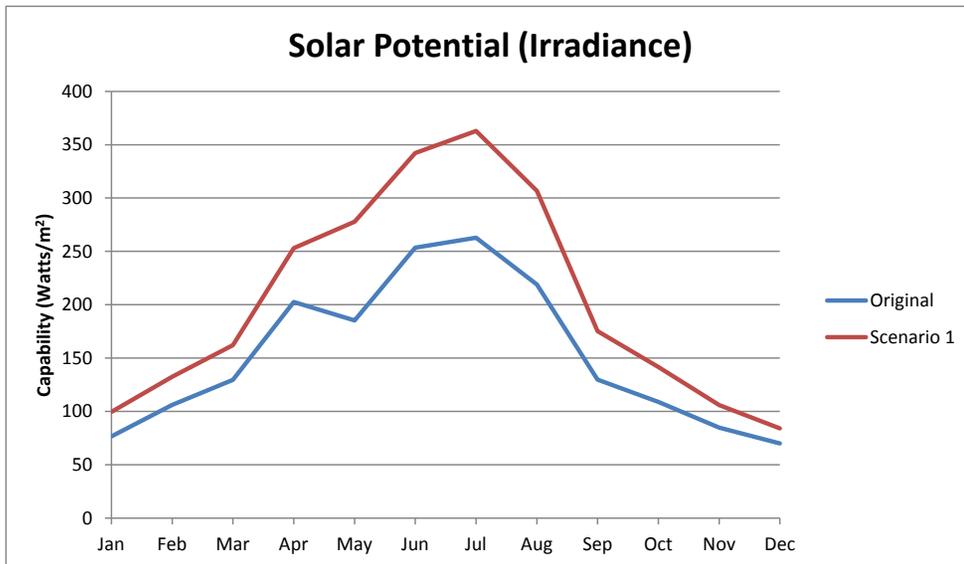
1	Boil1	0
2	Boil2	0
3	Boil3	0
4	HeatE1	0
5	ACBus1	3
6	EChilr1	22
7	AChilr1	0
8	WPump1	2
9	EBatt1	0
10	GTurb1	0
11	GTurb2	0
12	GTurb3	0
13	IndGasTurb1	0
14	IndGasTurb2	1
15	IndGasTurb3	0
16	IndGasTurb3	0
17	IndGasTurb3	0
18	PhotoVolt1	0
19	DctoAC1	0
20	WindTurb1	0
21	EfromGrid	0
22	EtoGrid	0
23	ACtoAC1	0
24	BackPressure	0
25	ExhaustBoiler	0
26	ExhaustBoiler	0
27	ExhaustBoiler	0
28	HeatExchanger	2

		Installed Cost	\$ 6,985,000
		Operating Cost	\$ 150,552,000
Total 30 Year Cost	\$ 157,536,706	Maintenance	\$ 2,095,500
Annual Cost	\$ 5,251,224	Electricity	\$ 111,923,000
		Natural Gas	\$ 37,110,500
		Biogas	\$ -



Scenario 2 – Renewables

- What happens if, in addition to increased loads, solar and wind potential increased?
- What if electricity rates also increased?

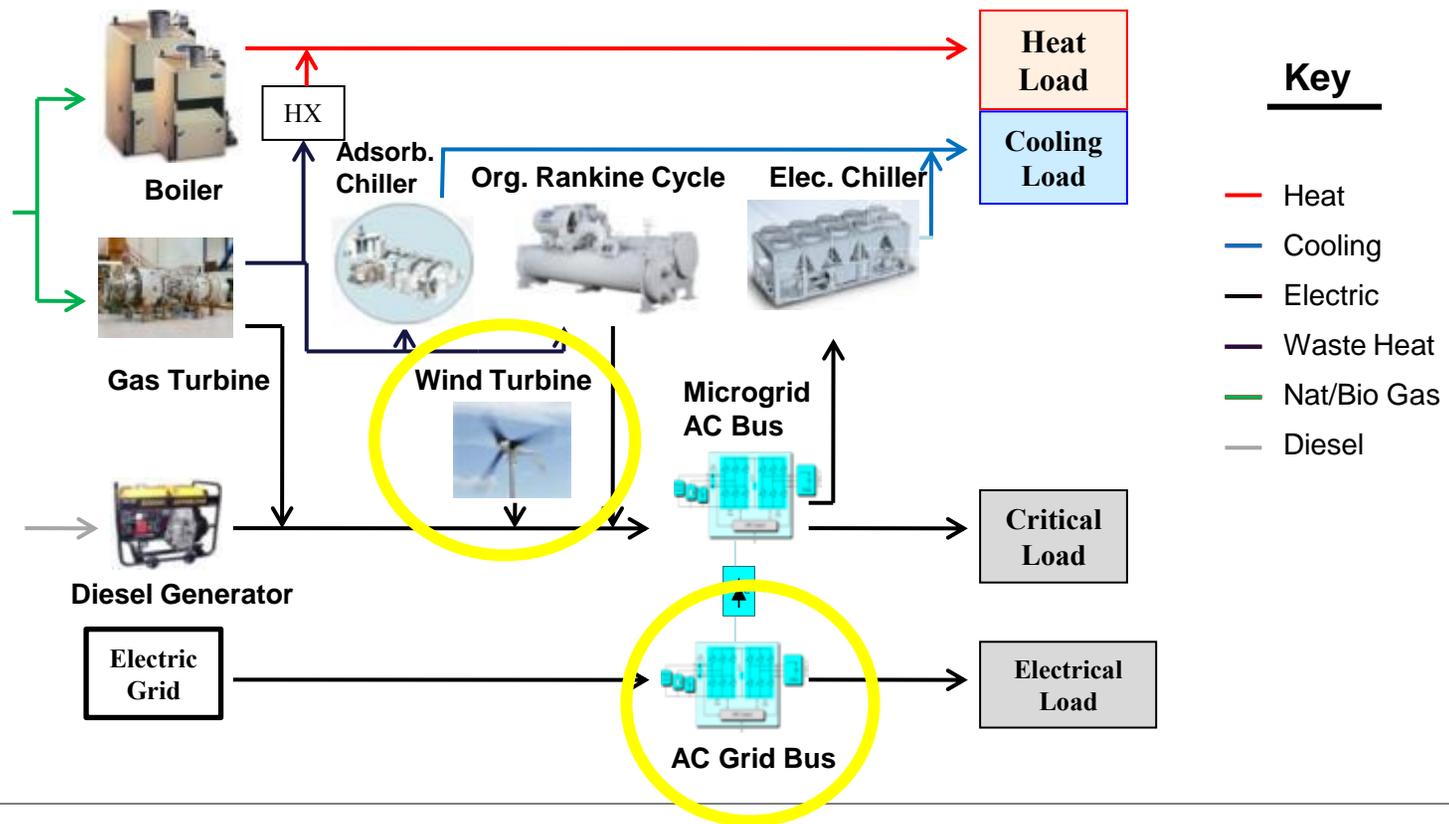


Scenario 2 – Renewables

- High price of solar = recommendation of wind turbines
- 30 year horizon necessary for payoff

1	Boil1	0
2	Boil2	0
3	Boil3	0
4	HeatE1	0
5	ACBus1	5
6	EChilr1	22
7	AChilr1	0
8	WPump1	2
9	EBatt1	0
10	GTurb1	0
11	GTurb2	0
12	GTurb3	0
13	IndGasTurb1	0
14	IndGasTurb2	1
15	IndGasTurb3	0
16	IndGasTurb3	0
17	IndGasTurb3	0
18	PhotoVolt1	0
19	DctoAC1	0
20	WindTurb1	18
21	EfromGrid	0
22	EtoGrid	0
23	ACtoAC1	3
24	BackPressure	0
25	ExhaustBoiler	0
26	ExhaustBoiler	0
27	ExhaustBoiler	0
28	HeatExchanger	2

		Installed Cost	\$ 97,741,000
		Operating Cost	\$ 68,460,700
Total 30 Year Cost	\$ 166,201,663	Maintenance	\$ 29,322,300
Annual Cost	\$ 5,540,055	Electricity	\$ 1,569,300
		Natural Gas	\$ 37,875,900
		Biogas	\$ -

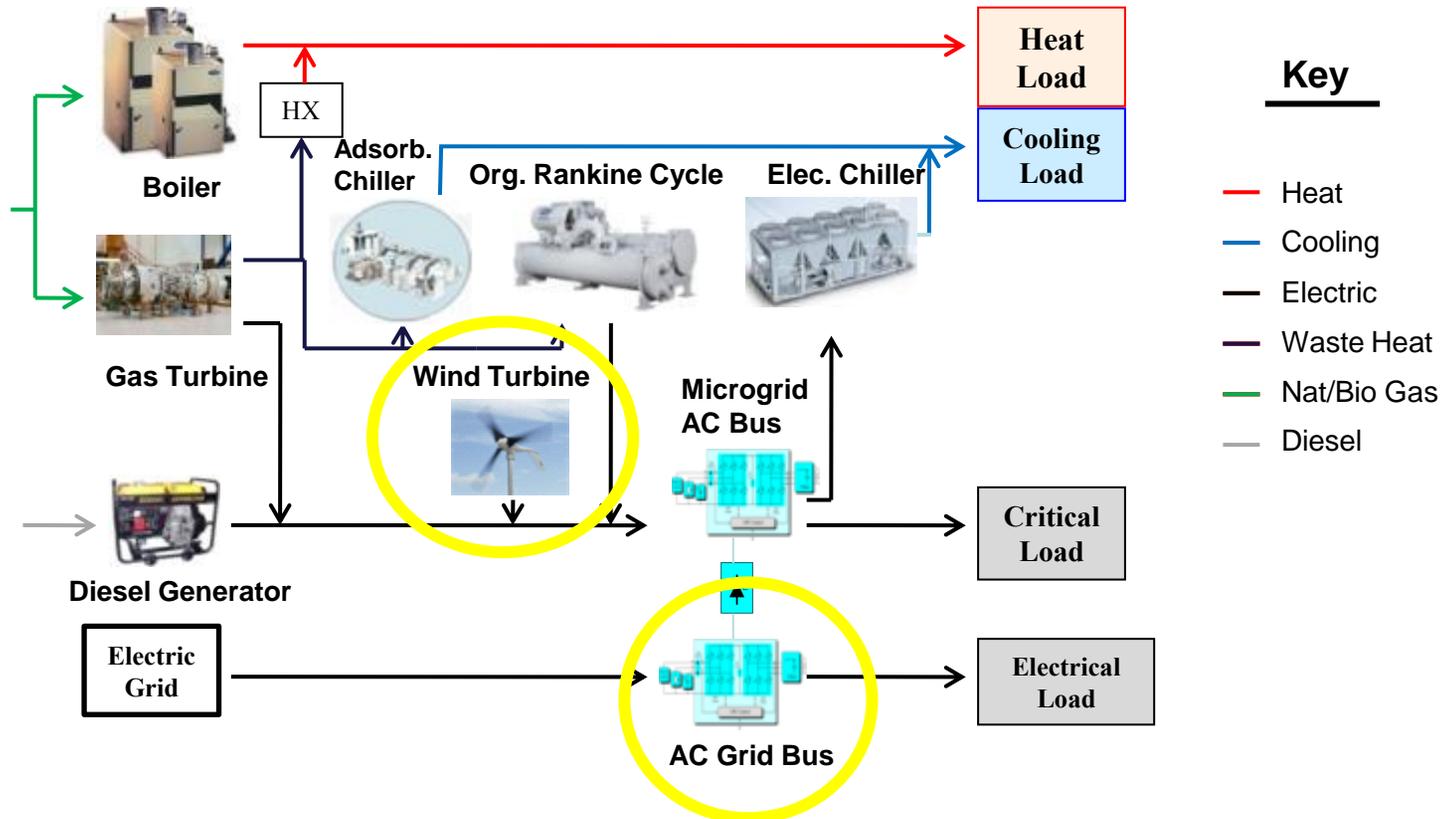


Scenario 3 – Required Renewables

- Requirement for Net Zero included – 100% energy to come from renewable sources

1	Boil1	0
2	Boil2	1
3	Boil3	0
4	HeatE1	1
5	ACBus1	7
6	EChilr1	22
7	AChilr1	0
8	WPump1	2
9	EBatt1	0
10	GTurb1	1
11	GTurb2	0
12	GTurb3	1
13	IndGasTurb1	0
14	IndGasTurb2	0
15	IndGasTurb3	0
16	IndGasTurb3	0
17	IndGasTurb3	2
18	PhotoVolt1	0
19	DCtoAC1	0
20	WindTurb1	23
21	EfromGrid	0
22	EtoGrid	0
23	ACtoAC1	4
24	BackPressure	0
25	ExhaustBoiler	0
26	ExhaustBoiler	0
27	ExhaustBoiler	0
28	HeatExchanger	1

		Installed Cost	\$ 122,399,000
		Operating Cost	\$ 100,586,000
Total 30 Year Cost	\$ 222,984,607	Maintenance	\$ 36,719,500
Annual Cost	\$ 7,432,820	Electricity	\$ 2,785,530
		Natural Gas	\$ -
		Biogas	\$ 60,011,400



Additional/Future Considerations

- Viability of other renewables (biofuels, solar-thermal, etc.)
- Storage of excess production “in the system”
 - Electric vehicle fleet
 - Hydrogen production
 - Hot water / steam production
- Others?

THANK YOU!

QUESTIONS?
