

Master Planning for Resiliency and Sustainability through Net Zero Modeling – NZP Tool™

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US Army Corps of Engineers
BUILDING STRONG®

Distribution Statement A - Approved for public release; distribution is unlimited.

Definitions

- **Framing Goal** – A target goal for analysis. Not a commitment or decision.
- **Baseline** – A snapshot of the current energy use situation. The baseline is one reference point used to evaluate alternative futures.
- **Future Base Case** – The baseline extended to include already-funded renovation as well as planned construction and demolition activities. The base case is a future reference point for “business as usual.”
- **Alternative(s)** – A set of energy measures to be compared against the base case
 - ▶ Better, Best, Others
- **Site Energy** – Energy measured at the point of use.
- **Source Energy** – Energy measured at the point it is generated (takes into account conversion and transmission losses).
- **District/Cluster** - a group of buildings to be served by a microgrid/ heating/ cooling loop (or some combination of these)



The NZP Tool: Installation Sustainability and Resiliency Planner

- Web based tool that assists in energy, water, and waste (EW2) planning
- Easy to use after setup
- Projects EW2 usage, flows
- Provides ROI analysis for EW2 conservation measures
- Integrates with Master Planning Process
- Identifies a roadmap and projects
- Integrated Solid Waste and Water
- Integrated into Corps of Engineers sustainability planning process

Net Zero Planner 13.10.10-15:43

Study List Study Information Building Optimization Installation or Subsection Decision Analysis Generate Planning Forms Developmental User

Create, Edit, or View Studies

Include Archived?

[Click Here to Create a New Study](#)

Page 1 of 9

Search

- Portsmouth Naval Shipyard IE 0.14.2 (312)
Portsmouth Naval Shipyard
Testing all facility groups with existing, planned, and demolished combinations for both default and...
Details
 Archived?
- Portsmouth Naval Shipyard (340)
Portsmouth Naval Shipyard
Running the PNSY through the System for ESTCP Project (Richard L)
Details
 Archived?
- West Point USMA Original (343)
West Point Military Academy
Running USMA through for ESTCP project (Richard L)
Details
 Archived?

South Cluster Report Facilities Map

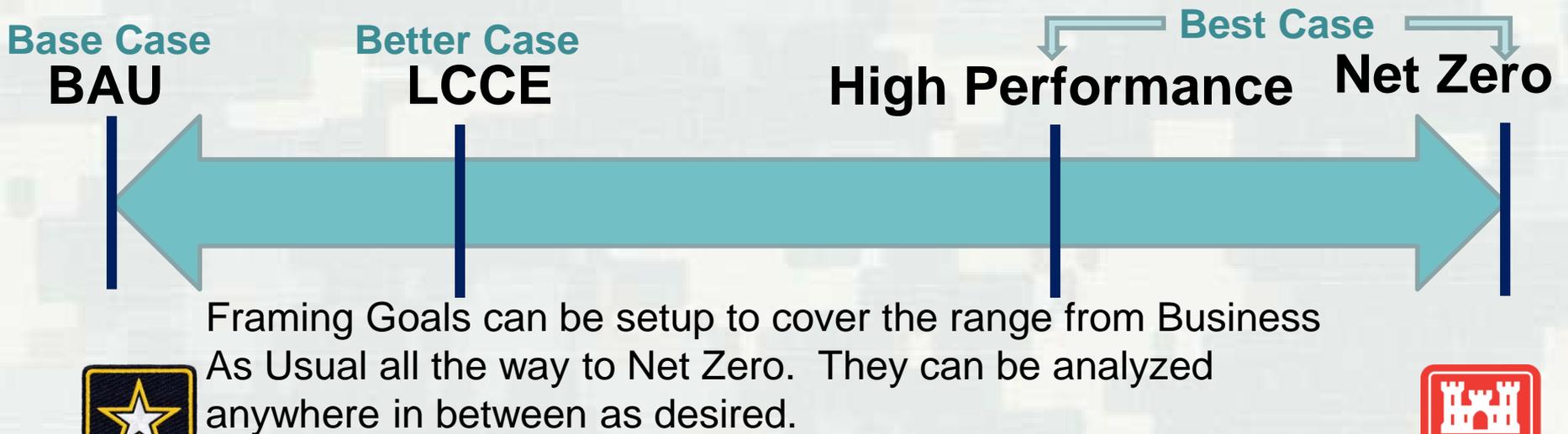
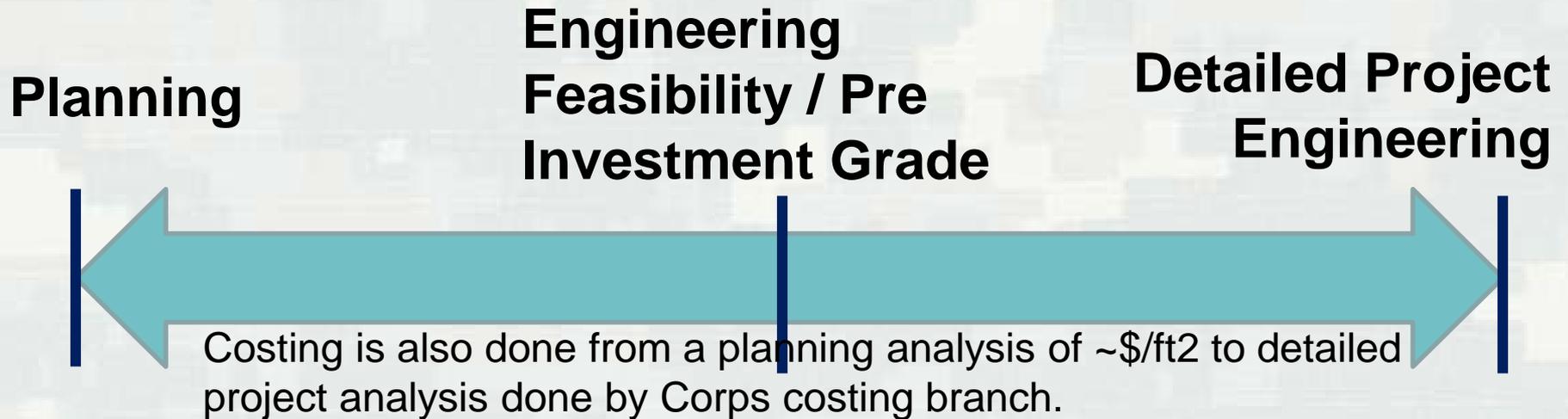
Select Buildings Navigation Legend Fullscreen Cluster Detail Street

Select Facilities Controls
New Add to Remove from Clear
Selection Selection Selection Selection

South Cluster
N/A
Number of Buildings: 23
Ground Coverage: 6,570,904 sqft
Total Electrical Load: 7,426,296 kWh/yr
Total Space Heating Load: 4,669,444 kWh/yr
Total Chw Load: 3,631,677 kWh/yr
Total Cooling Load: 4,612,399 kWh/yr
Total Heating Load Density: 1.26 kWh/yr/sqft
Total Cooling Load Density: 0.79 kWh/yr/sqft



Continuum of Analysis Costs and Goals



OSD Installation Energy Plans Memo, 31 March 2016

- OSD memo requiring all services to report in one year each agencies' plan to implementing an energy plan tied to the master plan by 2018.

Schofield Barracks, HI

Schofield Barracks, HI



OSD Installation Energy Plans Memo, 31 March 2016

- Phase 1: Identify the team, tasks, deliverables, and goals
- Phase 2: Establish baseline and future base case
- Phase 3: Analyze gaps and alternative scenarios
- Phase 4: Develop and sequence projects and activities
- Phase 5: Assemble review and finalize document
- Phase 6: Execution and maintenance of the IEP



NZP Tool Process

Phase 2:
Establish
Baseline and
Future Base
Case

Phase 1:
Establish
Planning
Goals



Phase 6:
Maintenance of IEP

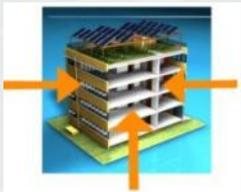
Execute, Track,
Measure

Phases 4 & 5:
Produce & Finalize Integrated
Plan Documents

- Integrated Plan
- Projects
- Sequence
- Schedule
- Costs
- Risk
- DD1391



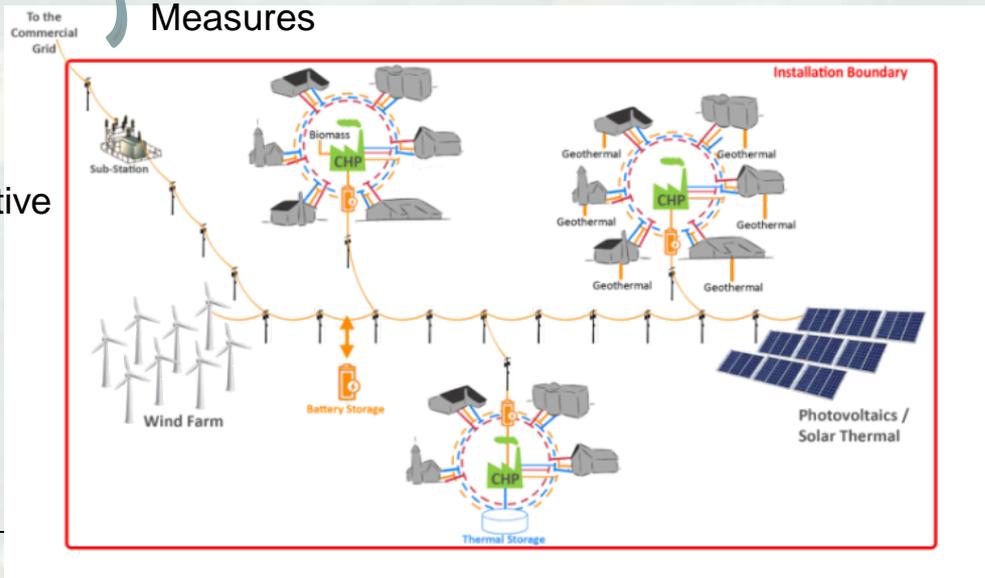
Optimize
Building
Energy
Efficiency



Iterate
over
Building
Measures

Phase 3:
Analyze alternative
scenarios

Optimize
Supply and
Distribution
System Mix



Supports



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Energy and Sustainability Goals (example)

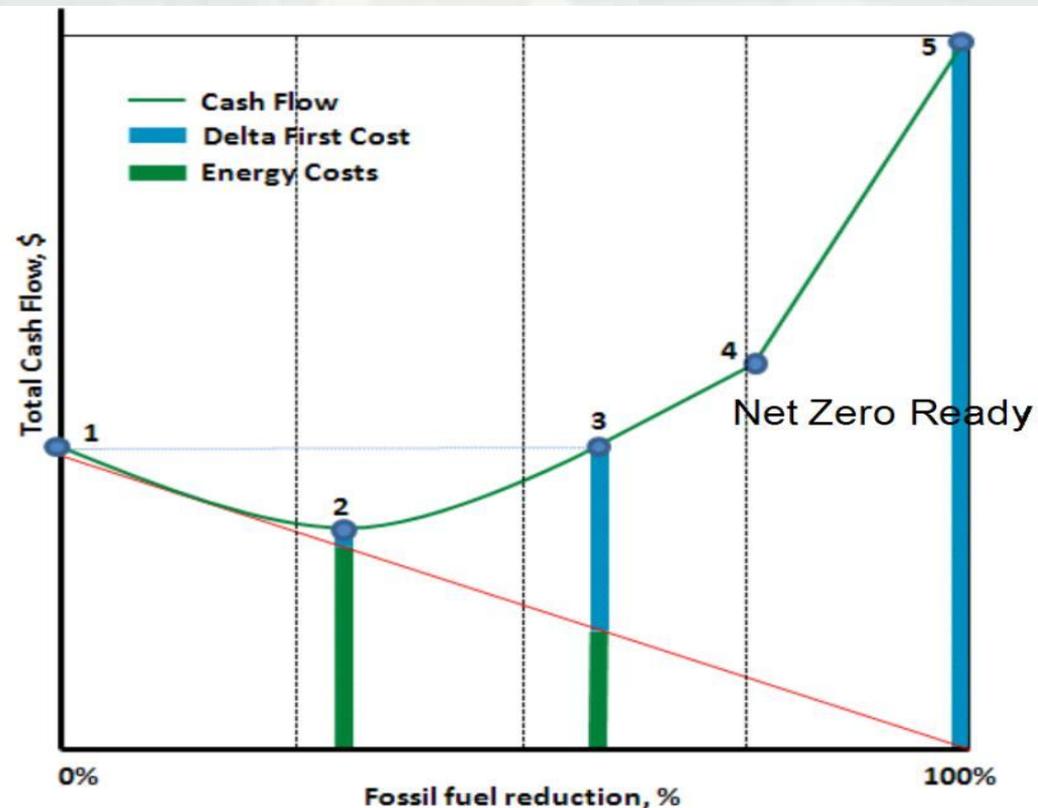
Parameter	2040 Base Case	2040 Target	Comments
Energy Efficiency %	Reference	40%	“Forty by Forty”
Source Energy Use	360,740 MWh	216,444 MWh	Based on Base Case
Site Energy Use	300,400 MWh	Derived	Depends on Scenario
GHG Reduction %	Reference	100%	Net Zero
Scope 1 & 2 Emissions	63,800 mt	Net Zero	
Energy Economics			Gov’t Analysis Life Cycle Cost Effective
Internal Rate of Return	NA	5%	Calculated over plan period
Energy Security	Acceptable	No Change	“Security and Efficiency”
Quality, reliability, resilience	NA	No change	Thermal and electric Equal or better than baseline



Cost-Optimizing Zero Energy Buildings

Integrating EEM's that are Net Zero Ready Cost Effective

- 1. business as usual or the base case
- 2. least life cycle cost option
- 3. achieved the same total annual cost as your base case building, but the building at point 3 is more energy efficient and often more comfortable.
- 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**



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Building Simulation Process

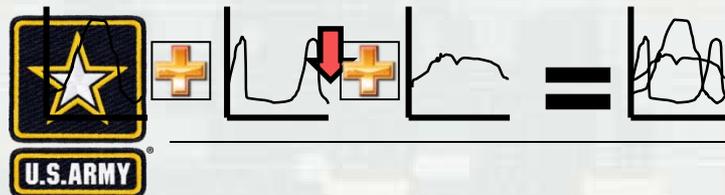
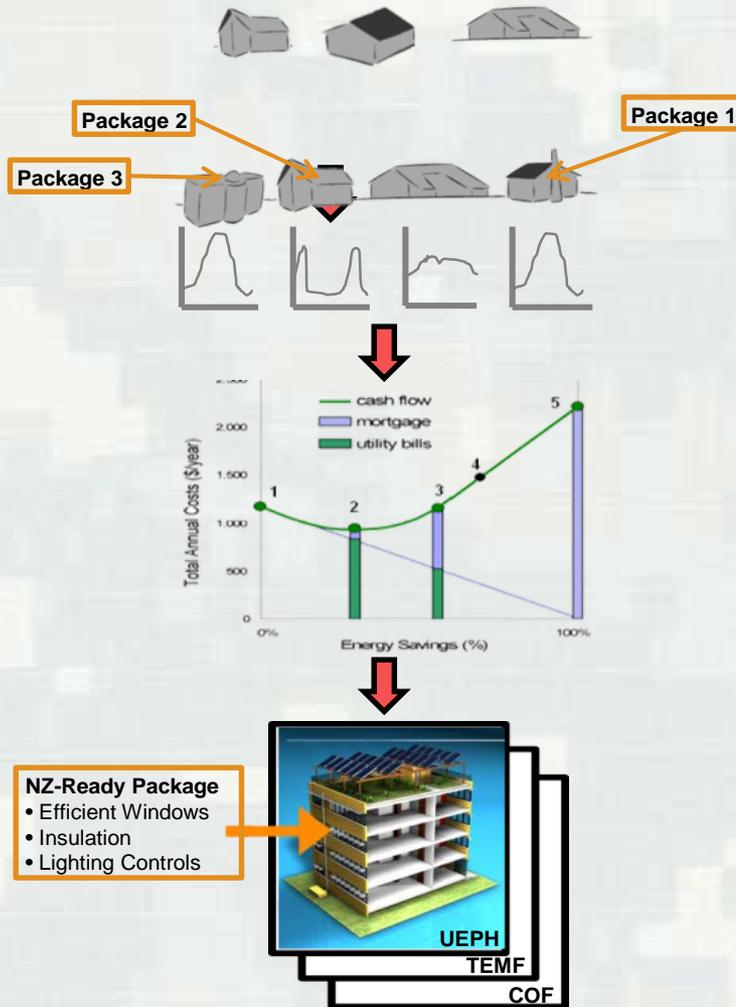
1. Gather baseline information

2. Simulate baseline and EEM packages

3. Generate Cost/Energy curve and SIR for EEM packages

4. Select optimal EEM package for each building type

5. Initial building analysis complete. Prepare load profiles to pass to next phase for cluster analysis



Description of Alternative Scenarios PNSY (Cold Weather example)

- **1. Baseline:**
 - ▶ Existing buildings and central plant equipment are simulated.
- **2. Basecase:**
 - ▶ buildings with planned construction, renovation, and demolition. Existing central plant equipment provides a “status quo” used as a comparison for the remaining scenarios.
- **3. District Steam:**
 - ▶ buildings with a modern steam system. One existing natural gas turbine is replaced with two natural gas reciprocating engines with approximately half the electrical output capacity each.
- **4. District hot water and spot steam (District Hot Water):**
 - ▶ buildings with a modern hot water system and spot steam generation to meet process loads. Central plant same as District Steam scenario.
- **5. Decentralized:**
 - ▶ buildings with decentralized boilers/furnaces and spot steam generation to meet process load. The same level of electrical backup is still required (15.4 MW for the installation, as in the existing central plant).
- **6. Net-Zero Fossil Fuel (Net-Zero FF):**
 - ▶ buildings with a modern hot water system and lowest equivalent annual cost equipment to meet net zero fossil fuel goals. Only analyzed using the NZP tool.



Description of Alternatives

JBPHH (Warm Weather Example)

- **1. Baseline:**
 - ▶ Existing buildings are simulated. No heating.
- **2. Basecase:**
 - ▶ buildings with planned construction, renovation, and demolition. No existing central plant or cooling systems
- **3. Better Case:**
 - ▶ Minor EEM improvements to buildings
- **4. Best Case:**
 - ▶ Aggressive EEM improvements to buildings.
- **5. Best Case w/ 50% renewables:**
 - ▶ Meet half of best case electrical loads with non-fossil fuel source
- **6. Best Case net zero**
 - ▶ buildings with a modern hot water system and lowest equivalent annual cost equipment to meet net zero fossil fuel goals. Only analyzed using the NZP tool.



Study Setup and Information

 **Net Zero Planner** Study: (986) Joint Base Pearl Harbor Hickam - Ford... 2.0.15.10.05 10:5

[Study List](#) [Study Information](#) [Facility Loads](#) [Installation or Subsection](#) [Decision Analysis](#) [Generate Reports](#) Case, Mike

[Details](#) [Facilities](#) [Rates](#) [Consumption](#) [Manage Users](#) [Results](#)

Study Information Details

[Study Information](#) [Alternatives](#)



Study Name: Joint Base Pearl Harbor Hickam - Ford Island Test (986)
Param Version: 0.38.0
NZI Opt Version: 0.9.0
Created By: Garton, Timothy W
Modified By: Case, Mike
Last Edited: 10/27/2015 10:44 AM
Description: N/A
Baseline Year: 2015
Study Duration: 40 Years
 Public Access



Location and Meteorological Data
[Upload PV](#)
Location: Joint Base Pearl Harbor Hickam - Ford Island
Weather File: USA_HI_Honolulu.Intl.AP.911820_TMY3.epw
Climate Zone: ASHRAE 1A
Soil Type: 
ET: 0 in. (0%)
Average Temperature: 0 °F



Study Goals:

- Fifty Percent renewable energy by 2020
- Reduce Energy Use Intensity by 50%



This Study Includes:

- Energy 
- Water 
- Waste 
- Stormwater 



Completed Study Information Progress

- Baseline

Building Optimization Progress

- EEMs

Installation or Subsection Progress

- Clusters Defined

[Edit All](#)
[View All](#)
[Edit](#)
[View](#)

[Edit](#)
[View](#)

[Edit](#)
[View](#)



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Many DoD Installations in system, with weather

Net Zero Planner Study: (986) Joint Base Pearl Harbor Hickam - Ford... 2.0.15.10.05 10:5

Study List Study Information Facility Loads Installation or Subsection Decision Analysis Generate Reports Case, Mike

Details Facilities Rates Consumption Manage Users Results

Study Location

<< Joint Base Pearl Harbor Hickam - Ford Island

Fort Wadsworth

Street Fort Wingate

Gowen Field

Helemano Military Reservation

Holston AAP

Indiana Army Ammunition Plant

Iowa Army Ammunition Plant

Jefferson Barracks

Jefferson Proving Ground

Joint Base Pearl Harbor Hickam - Ford Island



Back

Study List Study Information Facility Loads Installation or Subsection

Details Facilities Rates Consumption Ma

Study Weather and Climate

Weather File:

SA_HI_Honolulu.Intl.AP.911820_TMY3.epw

Climate Zone:

SHRAE 1A

Stomato Transpiration:

0.000 in. 0.0 %

Average Air Temperature:

0.000 °F

Adding Facilities is Easy

Net Zero Planner Study: (986) Joint Base Pearl Harbor Hickam - Ford... 2.0.15.10.05 10:57

Study List | Study Information | Facility Loads | Installation or Substitution | Decision Analysis | Generate Reports

Case, Mike

Details | **Facilities** | Rates | Cor... | Results

Study Inventory Facilities

View Map | Download

Map Viewers and building lists

Baseline, Basecase, and alternatives

Master Facility List
Master Facility List
Baseline
Base Case
Better Case
Best Case

Facility Group Summary | Facilities Summary

Drag a column header and drop it here to group by that column

Name	Facility Type	Status	Facilities (#)	Plan Area (%)	Cond. Area (ft^2)	
⊕ CDC_20151007_10:44	CDC	Planned	1	1.61	42,240	100
⊕ GIB_20151007_10:44	GIB	Planned	3	9.83	258,000	100
⊕ GIB_20151007_10:44		Existing	1	1.3	33,992	100
⊕ GIB_20151007_10:44		Existing	1	1.83	48,000	100
⊕ GIB_20151007_10:44		Existing	1	0.38	9,980	100
⊕ GIB_20151007_10:44		Existing	3	0.52	13,769	100
⊕ HotelLarge_20151007_10:44	Hotel-Large	Existing	1	2.22	58,354	100
⊕ HotelLarge_20151007_10:44	Hotel-Large	Existing	1	2.27	59,439	100
⊕ HotelLarge_20151007_10:44	Hotel-Large	Planned	1	1.62	42,600	100
⊕ InfoSys_20151007_10:44	InfoSys	Planned	3	0.23	6,000	100
⊕ InfoSys_Existing_MidCentury	InfoSys	Existing	1	2.05	53,724	100
⊕ OfficeLarge_20151007_10:44	Office-Large	Existing	2	9.81	257,435	212.5
⊕ OfficeLarge_20151007_10:44	Office-Large	Planned	1	2.86	75,047	250
⊕ OfficeMedium_20151007_10:44	Office-Medium	Existing	1	0.58	15,216	100
⊕ OfficeMedium_20151007_10:44	Office-Medium	Planned	3	5.02	131,600	100

Building types

Uses Available GIS information

Study Joint Base Pearl Harbor Hickam - Ford Island Test (986) - Master Facility List Map

Available Facilities

Add To Study

Facility Groups

Name	# Facilities	New
UEPH_Existing_Mid_Century	1	

Number	Name
55	BARRACKS EM BACHELOR ENLISTED QUARTERS E1/E4

Warehouse_Existing_Mid_Century

InfoSys_Existing_Mid_Century

RestaurantFull Service_Demolish_Mid_Century

Warehouse_Existing_Mid_Century

OfficeSmall_Existing_Mid_Century

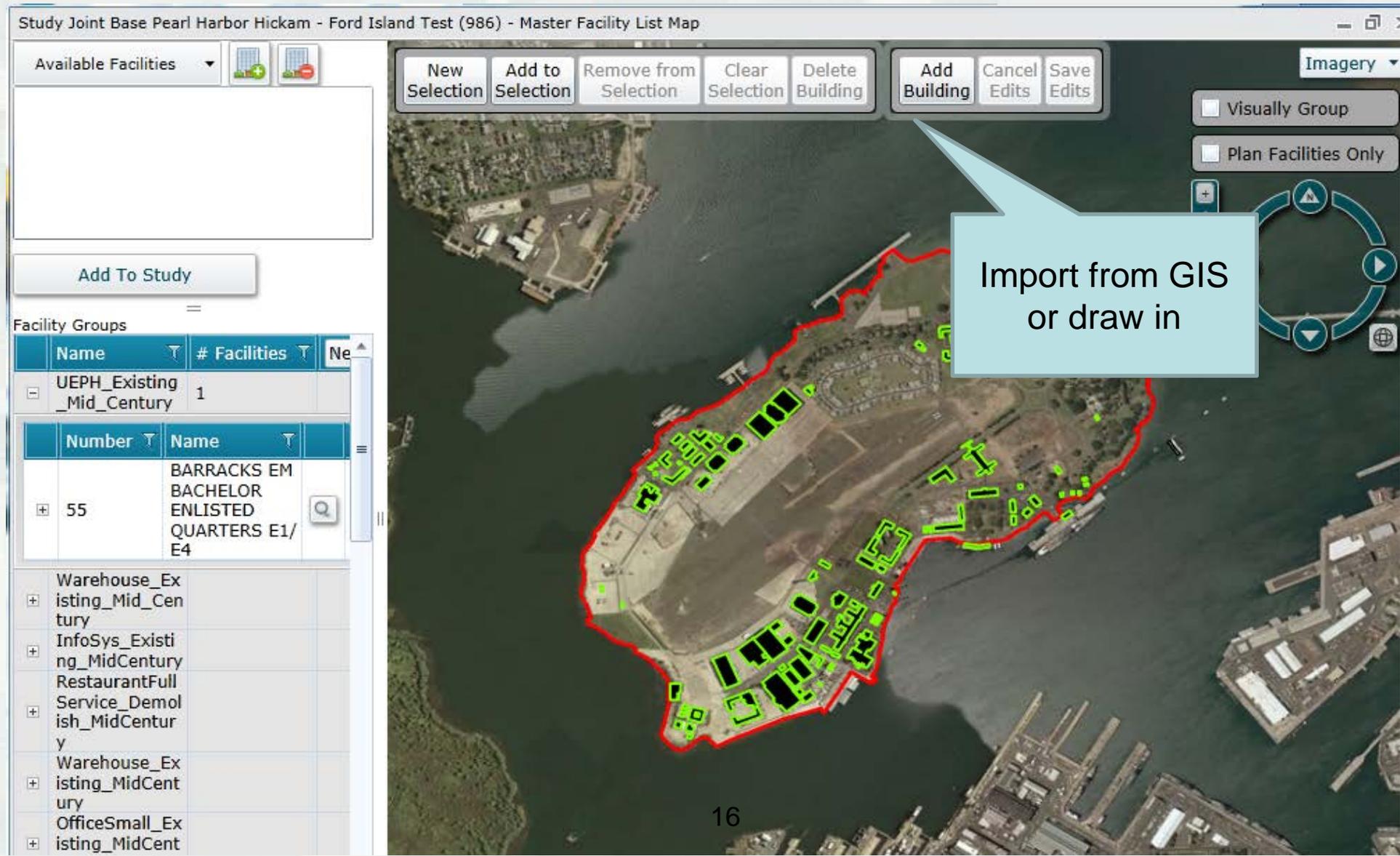
New Selection Add to Selection Remove from Selection Clear Selection Delete Building Add Building Cancel Edits Save Edits

Imagery

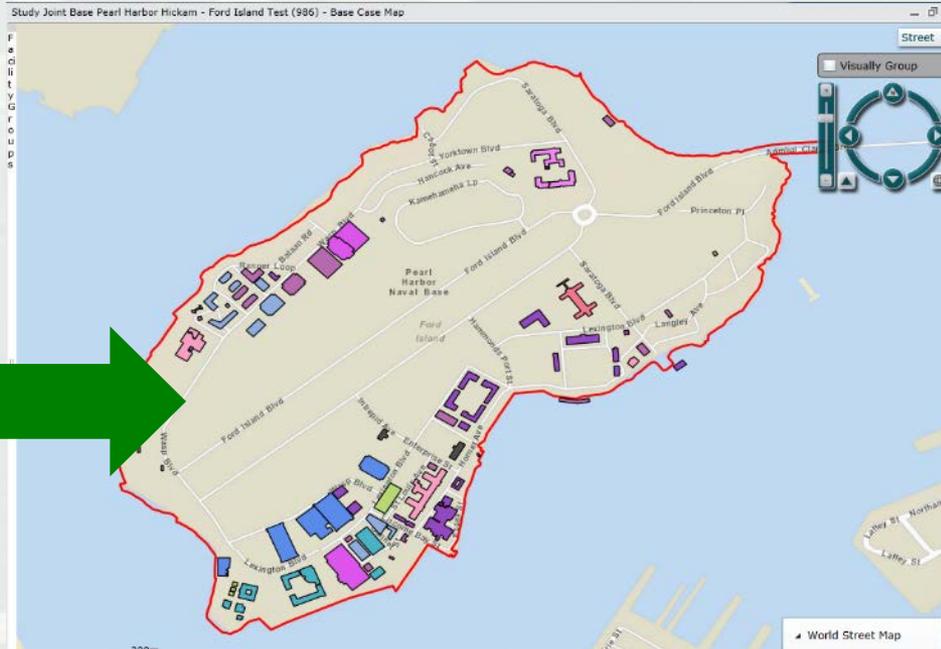
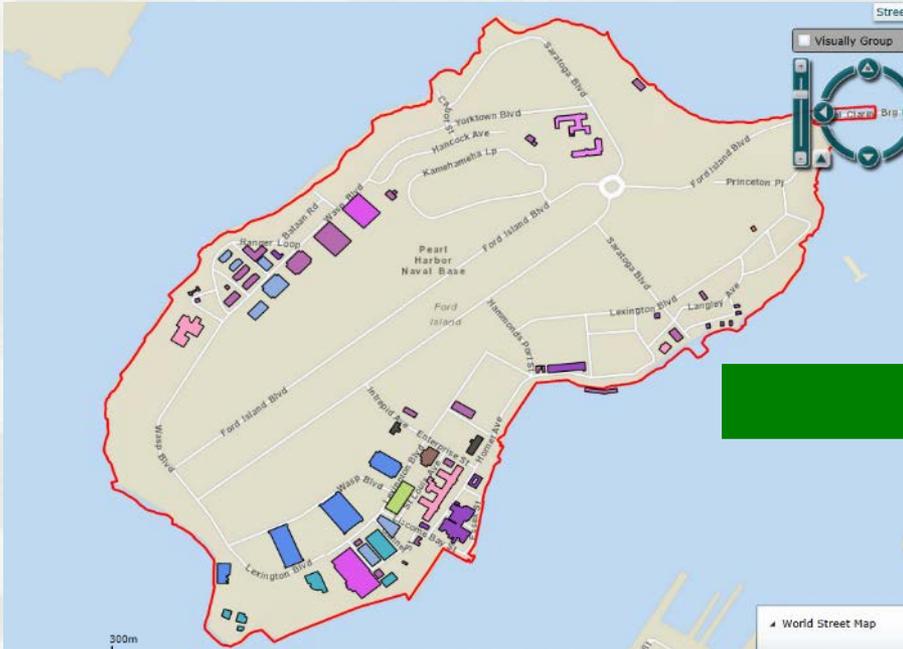
Visually Group

Plan Facilities Only

Import from GIS or draw in



Compare “as-is” to future scenarios



Present Day

Planned



Energy Efficiency Measures (EEM)

- Often called Energy Conservation Measures (ECM)
- Applied to a facility to decrease energy use
- Can be applied as *Packages* or *Bundles*
 - ▶ Cherry-picking
 - ▶ Energy Service Company (ESCOs)
- Must be analyzed as a system
- Implementation costs
 - ▶ Many measures not cost effective on their own
 - ▶ Deep retrofit
- Opportunity for benchmarking



Energy Strategies

- Reduction (EEMs)
 - ▶ Insulation & Infiltration
 - ▶ Lighting & Daylighting
 - ▶ Lighting
 - ▶ High-Efficiency Equip
 - ▶ High-Efficiency HVAC
 - ▶ Energy Recovery
 - ▶ Dedicated Outside Air Systems
 - ▶ Cool Roofs
 - ▶ Metering
 - ▶ Building Automation
- Supply & distribution
 - ▶ Renewable energy - PV
 - ▶ Cogeneration/CHP
 - ▶ Large and Small-Scale District Energy
 - ▶ Thermal Storage
 - ▶ Biomass
 - ▶ Wind



Rates and Consumption

The screenshot displays the Net Zero Planner interface for a study titled "Fort Leonard Wood Sustaina...". The main navigation bar includes "Study List", "Study Information", "Building Optimization", "Installation or Subsection", "Decision Analysis", and "Generat... Planning Fo...". The secondary navigation bar includes "Details", "Facilities", "Rates", "Consumption", "Demographics", and "Manage Us...". The "Consumption" tab is active, showing "Study Consumptions" with progress indicators for "Rates Defined", "Energy", "Water", and "Waste". An "Add Consumption" button is visible. Below, there are tabs for "Energy", "Water", and "Waste". A callout box points to these tabs with the text: "Tabs for Energy, Water and Waste input completed".

The right-hand pane shows "Study Energy Consumption Details" with the following information:

- Tags:
- Corresponding Utility: SHOME Power - checked w/ Allen 1/18/13 C
- Description: SHOME power
- Year: 2011 (FY)
- Building Area: 11,147,000 ft²
- Unit: MWh

Month	Amount	Cost (\$)
October	14534.28	1426595
November	13803.36	1291931
December	17248.41	1373902
January	16045.35	1350330
February	14614.28	1294193
March	15705.39	1359349
April	15671.39	1258454
May	17321.38	1385532
June	24916.91	1917775
July	25787.03	2165092
August	23897.02	2038930
September	18268.29	1667248

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Configuration of measures

Net Zero Planner Study: Fort Leonard Wood Sustainability Study...

Study List | Study Information | **Building Optimization** | Installation or Subsection | Decision Analysis | Generate Planning Forms

Details | **Configuration** | Simulation | Package Selection | Results

Base Case Alternative Enhancement Configuration

● Packages Defined ● Custom Spaces Defined

Instructions

Baseline | **Base Case** | Building EEMs High | Building EEMs Realistic | Building EEMs

Save Changes

Enhancements and Cost

Admin - existing - pre 1980 wood High-Efficiency Electric Lighting Retention

Enable Custom Cost ?

Custom Cost 0.00 \$/ft^2

Name	Default Value	Value	Unit	Description
lamp_type	T8	T8		Electric lighting lam
lighting_density_mechanical	0.4	0.4	W/ft^2	Electric lighting pow
lighting_density_office	0.8	0.8	W/ft^2	Electric lighting pow

Lighting Package
High-Efficiency...

Equipment Package
High-Efficiency...

Infiltration Package
Reduced Infiltration

HVAC Package
High-Efficiency Chiller
High-Efficiency Boiler
High-Efficiency...
Supply Temperature...

CoolRoof Package
Cool Roof

Daylighting Package
Daylighting Controls
AIT B/COF Planned

PARAMS model dynamically configures GUI and defines interface to simulation on JOB SERVER

Energy Efficiency Measures



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Simulations on server farm

The screenshot displays the Net Zero Planner interface for a study titled "Fort Leonard Wood Sustainability Study...". The navigation menu includes "Study List", "Study Information", "Building Optimization", "Installation or Subsection", "Decision Analysis", and "Generate Planning Forms". The "Simulation" tab is active, showing a "Simulation" sub-tab and a "Downloads" button. A legend indicates simulation statuses: Not Started (grey), Successful (green), Queued (blue), Initialized (orange), Running (yellow), Not Found (black), Error (red), Recovered (purple), and Unknown (pink). A summary shows "1310 Total Simulations" with "1310" successful. A list of simulations is visible, including "Base...", "Baselin...", "Building EEMs...", "Building EEMs Rea...", "Building EEMs Realis...", "Building EEMS Realis...", "Admin - existing - pr...", and "AIT B/COF Planned...". The "Downloads" menu is open, showing options for "Input File", "VAR File", and "XML File".

Net Zero Planner Study: Fort Leonard Wood Sustainability Study...

Study List Study Information Building Optimization Installation or Subsection Decision Analysis Generate Planning Forms

Details Configuration Simulation Package Selection Results

Enhancement Simulations

● Not Started ● Successful ● Queued ● Initialized ● Running
● Not Found ● Error ● Recovered ● Unknown

1310 Total Simulations
● 1310

Instruction

Simulations

Simulations and Status

Downloads

Input File
VAR File
XML File

Can download files for debugging

Status of all running simulations tracked

Over 1000 simulations run at a time (about 100 in parallel)



Package Selection

Net Zero Planner Study: Fort Leonard Wood Sustainability Study... 13.10.10-15:43

Study List | Study Information | **Building Optimization** | Installation or Subsection | Decision Analysis | Generate Planning Forms

Details | Configuration | Simulation | **Package Selection** | Results

Package Selection

Instructions

Save Changes

Facilities

Select All | Unselect All

- Admin - existing - pre...
- ADMIN GEN PURP
- CLASSROOM
- CLASSROOM
- OPERATION BR/WRK...
- ADMIN GEN PURP
- ADMIN GEN PURP
- ADMIN GEN PURP
- AIT B/COF Planned
- ARC Existing - Post...
- ARC Existing - Pre 1980
- BdeHQ Existing - 90.1...
- BdeHQ Existing - Post...

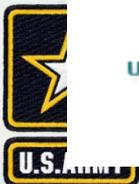
Utilities

- SHOME Power -...
- Omega Pipeline -...

Electricity: kBtu Gas: kBtu

View comparison of packages of measures and select preferred choice

Study Plan	Status	Selected		
Base Case				
Facility Group	Status	Selected		
Admin - existing - pre 1980 wood	Existing			
Selected	Package	Energy Reduction (%)	Electric Usage (kBtu)	Electric Cost
<input type="checkbox"/>	Lighting Package	3.55	1,645,077	43,395
<input type="checkbox"/>	Equipment Package	9.90	1,398,979	36,903
<input type="checkbox"/>	Infiltration Package	27.60	1,365,809	36,028
<input type="checkbox"/>	HVAC Package	44.38	1,070,685	28,243
<input type="checkbox"/>	CoolRoof Package	46.04	1,020,623	26,923
<input type="checkbox"/>	Daylighting Package	46.78	998,548	26,340
Selected	Package	Energy Reduction (%)	Electric Usage (kBtu)	Electric Cost
<input checked="" type="checkbox"/>	AIT B/COF Planned	Planned		
<input checked="" type="checkbox"/>	ARC Existing - Post 1980	Existing		
<input checked="" type="checkbox"/>	ARC Existing - Pre 1980	Existing		



Building Level Reports

Net Zero Planner Study: Fort Leonard Wood Sustainability Study...

Study List | Study Information | **Building Optimization** | Installation or Subsection | Decision Analysis | Generate Planning Forms

Details | Configuration | Simulation | Package Selection | **Results**

Study Plan Results - Site Summary

Instructions

Reports

Reports & Filters

- Cost Optimization Curve
- Debug Report
- Demand By End Use
- Demand Intensity By End Use
- Energy By End Use
- Energy Intensity By End Use
- Load Duration Curve
- Site Summary**
- Source Summary

Facilities

Select All | Unselect All

- Admin - existing - pre...
- AIT B/COF Planned
- ARC Existing - Post...
- ARC Existing - Pre 1980

Study Plan	Facilities	Total Area ft ²	Site Electricity kBtu	Site Electricity Intensity kBtu/ft ²	Site Rec
Baseline	495	7,698,669	437,832,160	56.87	0
Base Case	508	9,253,449	530,582,656	57.34	-21.1
Building EEMs High	508	9,253,449	325,483,840	35.17	25.6
Building EEMs Realistic	508	9,253,449	417,480,512	45.12	4.65
Building EEMs Realistic with AIT Barracks added	508	9,253,449	417,480,512	45.12	4.65
Building EEMs Realistic with AIT BATHW	508	9,253,449	417,480,512	45.12	4.65

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Compare baseline and all alternatives

Most commonly used reports and graphics for analysis of buildings

Installation-wide Analysis: Clusters

Baseline Base Case Building EEMs High Building EEMs Realistic Building EEMs Realistic with AIT Barracks added Building EEM



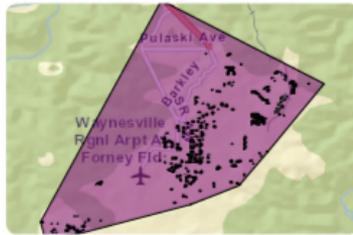
Click Here to Create a New Cluster

List View Grid View Facility Report Map View



Page 1 of 1

Search



Remaining Buildings

N/A
Number of Buildings: 403
Ground Coverage: 311,912,
Total Electrical Load: 65,161
Total Space Heating Load: 2
Total DHW Load: 24,905,86
Total Cooling Load: 41,729,
Total Heating Load Density:
Total Cooling Load Density:



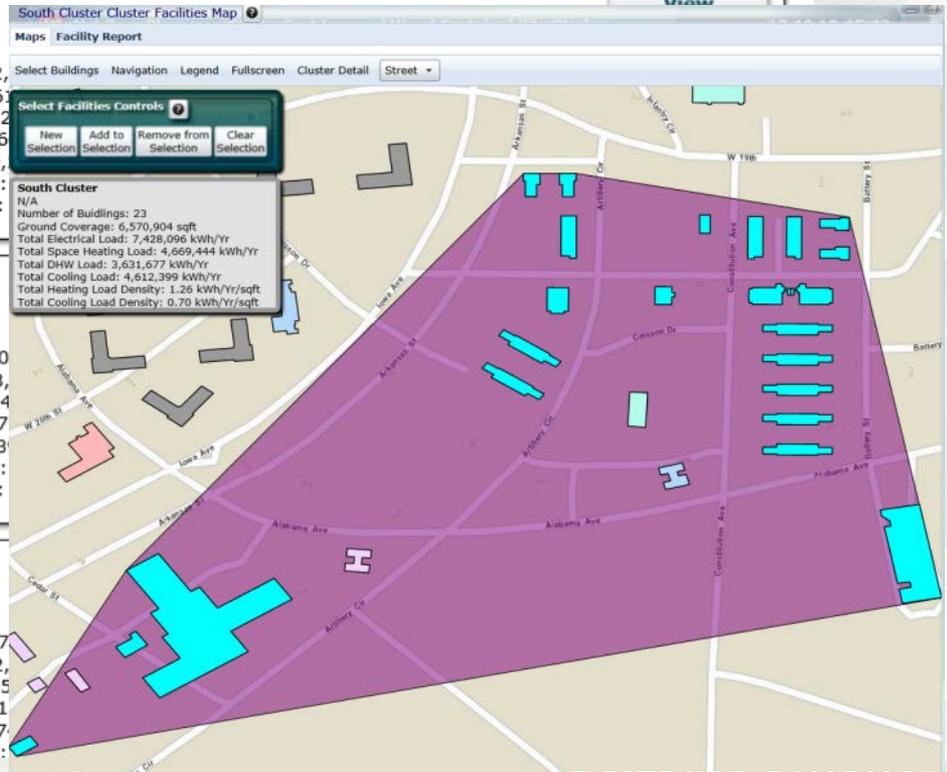
South Cluster

N/A
Number of Buildings: 23
Ground Coverage: 6,570,90
Total Electrical Load: 7,428,
Total Space Heating Load: 4
Total DHW Load: 3,631,677
Total Cooling Load: 4,612,3
Total Heating Load Density:
Total Cooling Load Density:



Specker Cluster

N/A
Number of Buildings: 46
Ground Coverage: 2,917,87
Total Electrical Load: 8,502,
Total Space Heating Load: 5
Total DHW Load: 6,083,471
Total Cooling Load: 6,002,7
Total Heating Load Density:



Choosing Equipment to Include in Optimization

Net Zero Planner Study: Fort Leonard Wood Sustainability Study... 13.10.10-15:43

Study List Study Information Building Optimization **Installation or Subsection** Decision Analysis Generate Planning Forms Developmental User

Details Cluster Networks **Equipment & Measure** Constraints Optimization Results

Building EEMs Realistic with AIT Barracks added Alternative Clusters

Equipment Defined (Input\Output Device) Equipment Defined (Storage Device)

Instructions

Baseline Base Case Building EEMs High Building EEMs Realistic **Building EEMs Realistic with AIT Barracks added** Building EEM

Save Changes

Clusters

- Remaining Buildings
- South Cluster
- Specker Cluster**
- West Cluster

Equipment	Type	Name	Max Num.	Max Power	Input
45	URC	URC_Low	10	280	2000
46	ACBus	ACBus1	5	20000	EtoBt
47	HeatE	HeatE1	10	10000	8000
48	CoolLoad	CoolingLoad1	1	9999999	Distri
49	HeatLoadHotwater	HWFedHeatingLoad1	1	9999999	Distri
50	Boilers	DistBoilersSolution	1	999999	Retai
51	Elec_Chill	DistElec_Chills	1	999999	Efron
52	PhotoVolt	PhotoVolt14kW	10	100000	Solar
53	PhotoVolt	PhotoVolt140kW	10	100000	Solar
54	PhotoVolt	PhotoVolt1400kW	10	100000	Solar

Back Continue



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Set Constraints for Optimization

Net Zero Planner Study: Fort Leonard Wood Sustainability Study... 13.10.10-15:43

Study List Study Information Building Optimization Installation or Subsection Decision Analysis Generate Planning Forms Developmental User

Details Cluster Networks Equipment & Measure **Constraints** Optimization Results

Baseline Clusters

● Constraints Defined
▼ Instructions

Baseline Base Case Building EEMs High Building EEMs Realistic Building EEMs Realistic with AIT Barracks added Building EEM

Clusters

Save Changes

Baseline Remaining Buildings Constraints and Basic Economic Values

Energy Security
Critical Electric Maximum Load: 0.00 kW

Environmental / Renewable (Annual)
Renewable Target: 0.00 %
Max. Carbon Footprint: 100,000,000.00 tCe

Basic Economic Values
Project Lifetime: 0.00 YY
Int. Rate: 5.00 %

Redundancy Factors
Additional Heating: 1.00
Additional Cooling: 1.00

Back Continue

Cluster Optimization

Net Zero Planner Study: Fort Leonard Wood Sustainability Study... 13.10.10-15:43

Study List Study Information Building Optimization **Installation or Subsection** Decision Analysis Generate Planning Forms Developmental User

Details Cluster Networks Equipment & Measure Constraints **Optimization** Results

Cluster Optimizations

● Not Started ● Successful ● Queued ● Initialized ● Running
● Not Found ● Error ● Recovered ● Unknown

24 Total Optimizations
● 24

Instructions

Optimizations

Optimizations and Status

- Base Case ●
- Remaining Building ●
- South Cluster ●
- Specker ●
- West Cluster ●
- Baseline ●
- Building EEMs High ●
- Building EEMs Realist ●
- Building EEMs Realist ●
- Building EEMS Realis ●

Downloads **Reset**

- Loads.dat
- Irradiance.dat
- devices.dat
- StorageDevices.dat
- PotableWaterConsumption.dat
- WindTurbinePower1.dat
- EGridEnRate.dat
- ElectricDemandRatesFile.dat
- Fuels.dat
- AdditionalConstraints.txt
- nzi-opt-parse.xml
- nzi-opt.mod
- nzi-opt.log
- nzi-opt-parse.log
- nzi-opt.out
- ScaledCluster8760.xls

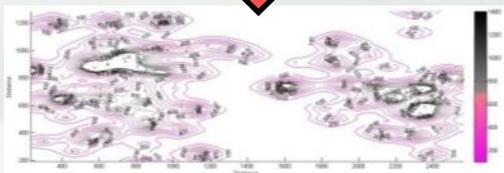
Back Continue



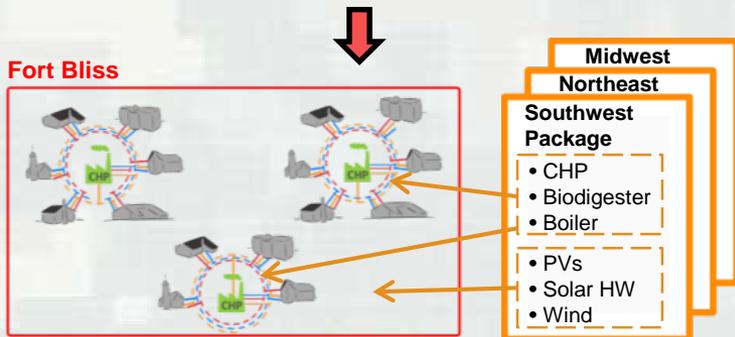
Installation Optimization Process



1. Integrate all building energy demands



2. Use energy density to identify possible clusters



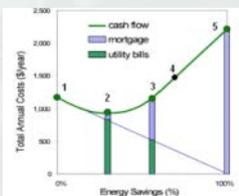
3. Determine potential cluster equipment packages for installations and region



4. Generate alternative equipment configurations, including centralized and decentralized options



5. Optimize equipment size and pipe sizes
 • Electric, thermal, hydraulic, economic simulations



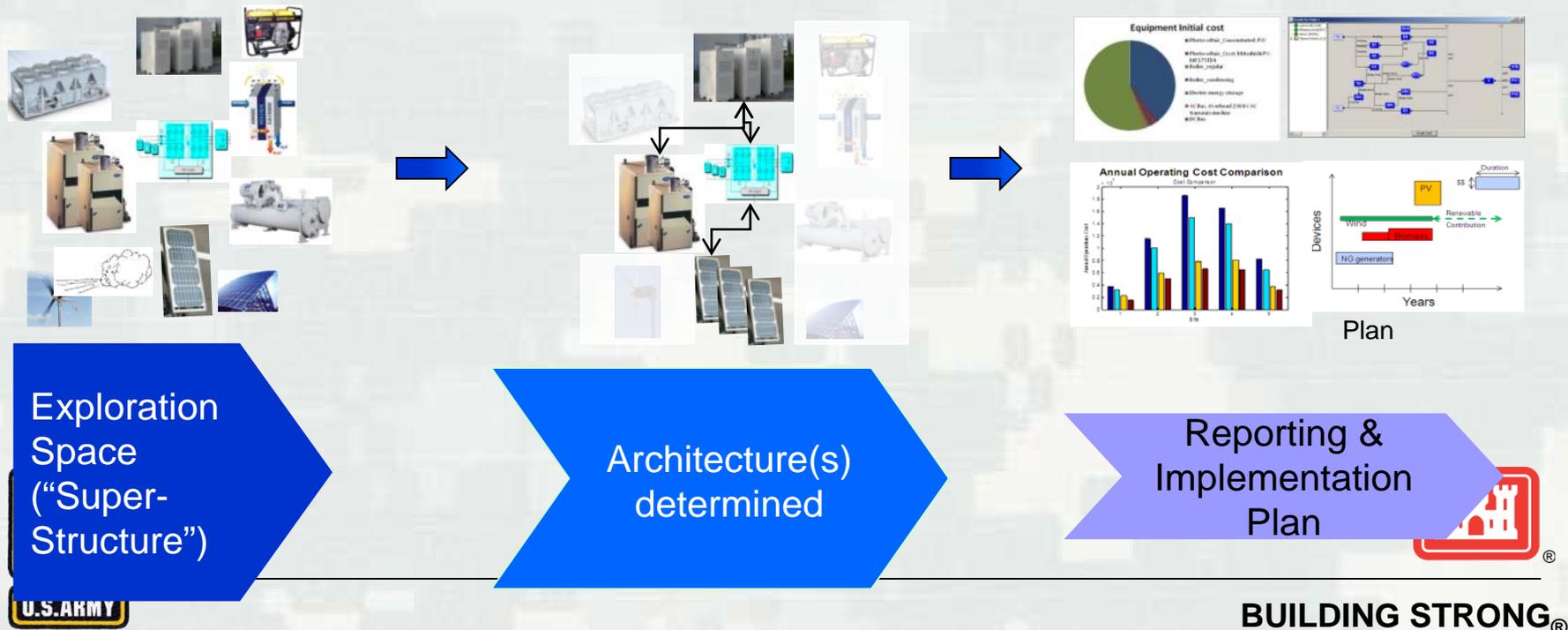
6. Calculate $SIR_{cluster}$ & EEMs



BUILDING STRONG

NZI Optimization Tool (NZI-Opt)

NZI-Opt is an optimization tool that is used to find the lowest life cycle-cost equipment suite to meet the “cluster level” demands while meeting a set of defined constraints. Cluster level demands can include heating, cooling, electric, critical electric, water, waste, etc.



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.



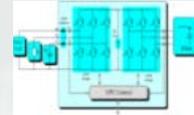
Electric Chiller



Diesel Generator



Photovoltaic



AC Bus



Absorption Chiller



Fuel Cell



Gas Boiler



Wind Turbine



Organic Rankine Cycle



Gas Turbine

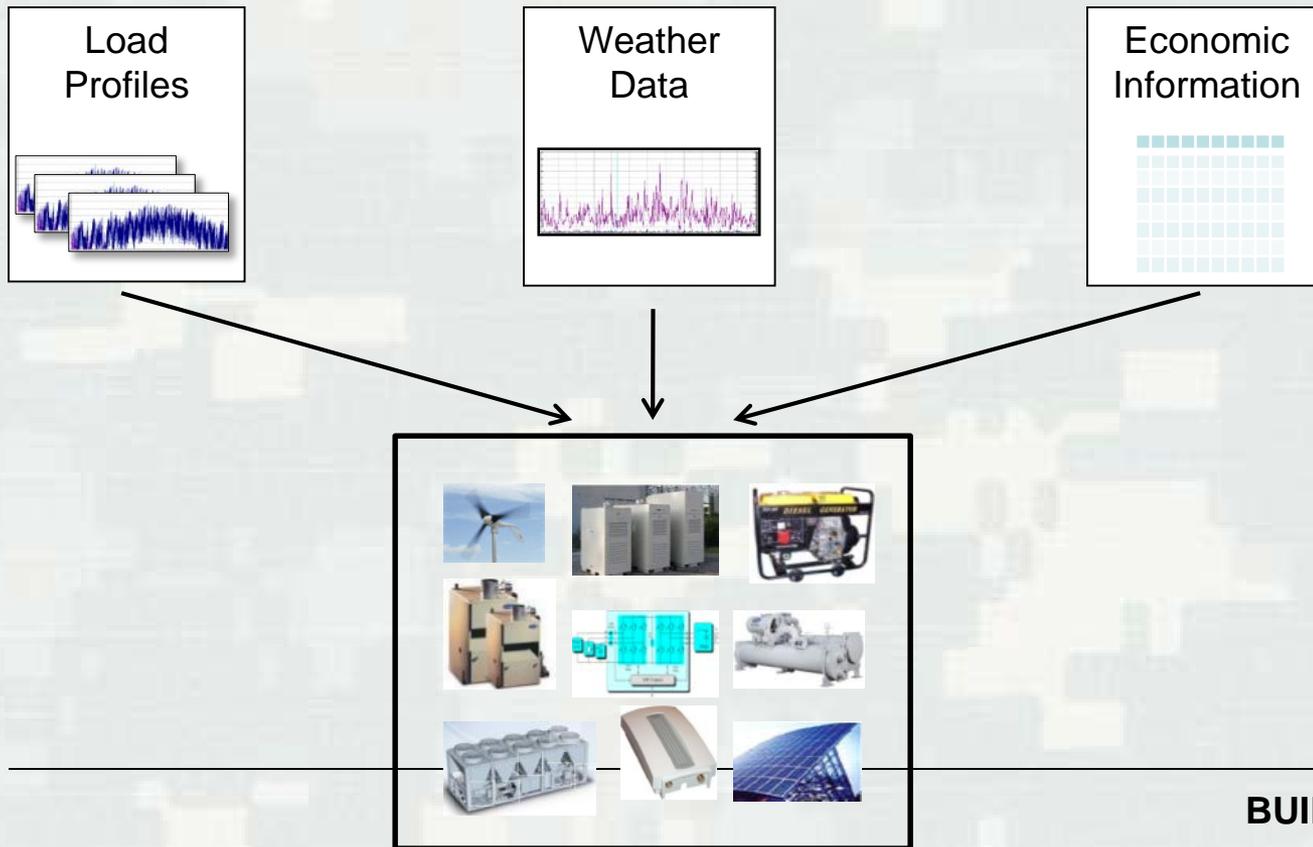


Electric Heater



Installation Specific Inputs

Load profiles are input to provide the demands that must be met by the “supply” equipment. Weather data provides the necessary information for determining the potential of renewable sources. Economic data provides regionally specific information on utility cost schedules, equipment installation and maintenance costs, and fuel prices.



BUILDING STRONG®

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.



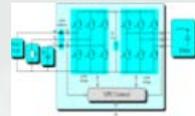
Electric Chiller



Diesel Generator



Photovoltaic



AC Bus



Absorption Chiller



Fuel Cell



Gas Boiler



Wind Turbine



Gas Turbine



Organic Rankine Cycle

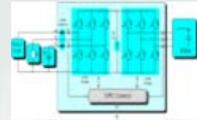


Electric Heater



Selecting a Supply Architecture

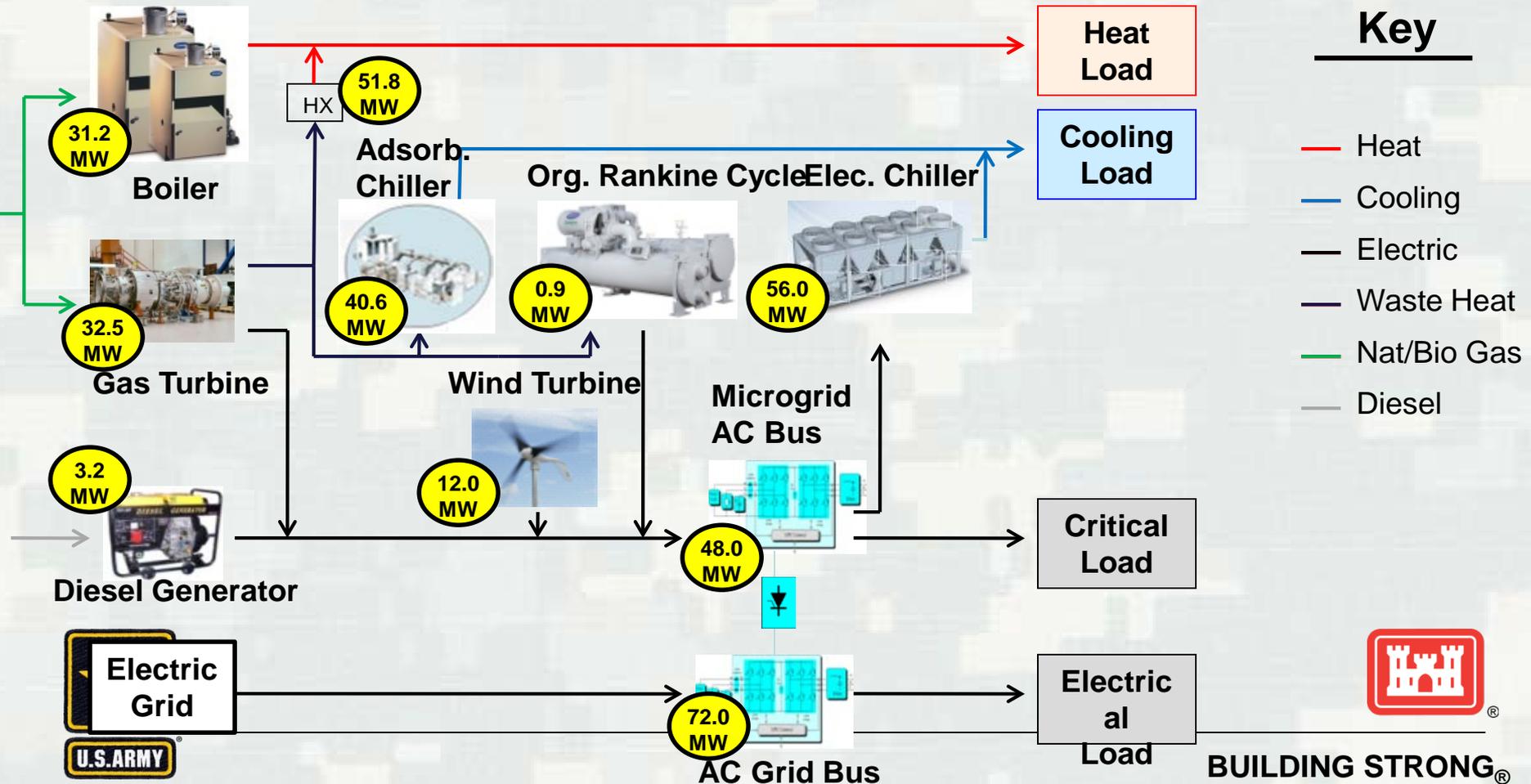
The optimization process determines the best suite of equipment by ensuring that the demands for heat, cooling, electric, etc are fulfilled at each of the 8760 hours in the year, while satisfying the additional environmental and legislative requirements.



BUILDING STRONG®

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.



Cluster Results

Net Zero Planner Study: Fort Leonard Wood Sustainability Study... 13.10.10-15:43

Study List
Study Information
Building Optimization
Installation or Subsection
Decision Analysis
Generate Planning Forms
Developmental User

Details
Cluster
Networks
Equipment & Measure
Constraints
Optimization
Results

Installation Results - Energy Comparison

Instructions

Reports
Energy: kWh Power: kW

Annual Energy Comparison

Study Plan	Natural Gas (kWh)	Peak Natural Gas (kW)	Electricity (kWh)	Pe
13.10.10-15:43	139,420		140,980,944	34
	128,586		114,134,760	29
	83,670		97,613,848	25
	119,182		113,842,288	28
	117,735		113,228,744	28
	123,478		113,307,272	27

Installation Results - Equipment Overview

Instructions

Reports

- Annual Energy Comparison
- Energy Overview
- Equipment Overview

Alternative	Devices
Base Case	20
Baseline	20
Building EEMs High	113
Building EEMs Realistic	110
Building EEMs Realistic with AIT Barracks added	116

Cluster	Devices
Remaining Buildings	64
South Cluster	17
Specker Cluster	21

Equipment	Max Power	Unit	Devices
ACBus1	20,000	kW	1
Air_Elec_Chill_2	352.00	kW	1
Air_Elec_Chill_4	1,055	kW	1
Boil0	100.00	kW	2
Boil2	2,500	kW	2
ExistingBoilers	6,956	kW	2
ExistingElChillers	3,340	kW	2



Decision Support

Net Zero Planner Study: Fort Leonard Wood Sustainability Study... 13.10.10-15:43

Study List Study Information Building Optimization Installation or Subsection Decision Analysis Generate Planning Forms Developmental User

Details Reports

Decision Analysis Results - Clustering Report

Instructions

Reports

Annual Energy Comparison

Summary Report

Alternatives

- Base Case
- Baseline
- Building EEMs High
- Building EEMs Realistic
- Building EEMs Realistic...
- Building EEMs Realistic...

Update

Scenario +

Investment +

Total Equivalent Annual Cost +

Total Source Energy

	↑	↑	↑	↑
	(Dollars/Year)		MWhs/Year	
<input type="checkbox"/> Baseline	0	22,619,526	497,248	
<input type="checkbox"/> Base Case	261,232,464	28,404,150	600,465	
<input type="checkbox"/> Building EEMs High	282,582,176	22,024,720	404,372	
<input type="checkbox"/> Building EEMs Realistic	264,259,856	25,324,252	495,929	
<input type="checkbox"/> Building EEMs Realistic with AIT Barracks added	259,427,952	24,283,958	493,831	
<input type="checkbox"/> Building EEMs Realistic with AIT Barracks MTHW	262,438,288	23,980,966	460,346	

Back
Continue

Cluster Results

Cold Climate

Study List Study Information Facility Loads **Installation or Subsection** Decision Analysis Generate Reports Case, Mike

Details Cluster & Networks Equipment & Measures Constraints Optimization **Results**

Installation Results - Equipment Overview

Instructions

Reports

- Annual Energy Comparison
- Energy Overview
- Equipment Overview**

Alternative	Devices
Baseline	21
Basecase	19
Building EEMs	19
District Steam	20
District Hot Water	32

Cluster	Devices
Current Steam Network	23

Type	Equipment	Max Power	Unit	Devices
Input\Output	ACBus1	20,000	kW	2
Input\Output	DistElec_Chills	999,999	kW	1
Input\Output	ExistingDieselGen	2,000	kW	2
Input\Output	ExistingDuctBoiler	18,200	kW	1
Input\Output	ExistingNebraskaBoiler	25,500	kW	1
Input\Output	ExistingNGT	5,700	kW	1
Input\Output	HEX300_325F80PSI	10,000	kW	6
Input\Output	HEX350_375F120PSI	10,000	kW	6
Storage	LTHotWaterNetwork	900,000	kW	1
Input\Output	NGR_Caterpillar_CHP	3,300	kW	2

Natural Gas
Recipe Engine
CHP



Cluster Results - Warm Climate

Study List | Study Information | Facility Loads | **Installation or Subsection** | Decision Analysis | Generate Reports | Case, Mike

Details | Cluster & Networks | Equipment & Measures | Constraints | Optimization | **Results**

Installation Results - Equipment Overview

Instructions

Reports

- Annual Energy Comparison
- Energy Overview
- Equipment Overview**

Alternative	Devices
Baseline	13
Basecase	13
Better Case	13
Best Case	13
Best Case w 50% Renewables	18

Cluster	Devices
De-Centralized	18

Type	Equipment	Max Power	Unit	Devices
Input\Output	ACBus1	20,000	kW	1
Input\Output	DistBoilersSolution	9,999,999	kW	1
Input\Output	DistElec_Chills	9,999,999	kW	1
Input\Output	ExistingPhotoVolt100kW	100,000	kW	7
Input\Output	ExistingPhotoVolt10kW	10,000	kW	3
Input\Output	PhotoVolt1000kW	1,000,000	kW	5

Cluster	Devices
De-Centralized	52

50% Net Zero

Net Zero

Flow Battery
(expensive electricity)



DING STRONG®

DECISION ANALYSIS FOR PORTSMOUTH NAVAL SHIPYARD (PNSY)



PNSY Aerial View



Building Representation in NZP

Select Buildings New Building Navigation Legend Fullscreen Street ▾

Select Facilities Controls ?

New Selection Add to Selection Remove from Selection Clear Selection

The screenshot shows a web-based map application interface. At the top, there is a navigation bar with the text "Select Buildings New Building Navigation Legend Fullscreen Street ▾". Below this is a "Select Facilities Controls" panel with a question mark icon and four buttons: "New Selection", "Add to Selection", "Remove from Selection", and "Clear Selection". The main map area displays a coastal region with buildings highlighted in cyan and outlined in red. The map includes street names such as "Walker St", "Main St", "Oliver Ave", "Whipple Rd", "Woodlawn Ave", "Wyman Ave", "Tilton Ave", "Newson Ave", "Government St", "Water St", "Morris Ave", "Newton St", "Garrison Ave", "Parker Ave", "Sloat Ave", "Meade Ave", "Chapel St", "Portsmouth Ave", "Oliver St", "River Rd", "Cranfield St", "Main St", "Newcastle Ave", "Shapleton Island", "Pierce Island", "Piscataqua", and "Cape Rd". Road numbers "1", "103", and "1B" are also visible. Geographical features include "Prescott Park", "Four Tree Island", "Pierce Island", and "Shapleton Island". A scale bar at the bottom left indicates "400m" and "1000ft". The U.S. Army logo is in the bottom left corner, and "BUILDING STRONG" is in the bottom right corner.

U.S. ARMY

42

BUILDING STRONG®

Description of Alternative Scenarios

- **1. Baseline:**
 - ▶ Existing buildings and central plant equipment is simulated.
- **2. Basecase:**
 - ▶ buildings with planned construction, renovation, and demolition. Existing central plant equipment provides a “status quo” used as a comparison for the remaining scenarios.
- **3. District Steam:**
 - ▶ buildings with a modern steam system. One existing natural gas turbine is replaced with two natural gas reciprocating engines with approximately half the electrical output capacity each.
- **4. District hot water and spot steam (District Hot Water):**
 - ▶ buildings with a modern hot water system and spot steam generation to meet process loads. Central plant same as District Steam scenario.
- **5. Decentralized:**
 - ▶ buildings with decentralized boilers/furnaces and spot steam generation to meet process load. The same level of electrical backup is still required (15.4 MW for the installation, as in the existing central plant).
- **6. Net-Zero Fossil Fuel (Net-Zero FF):**
 - ▶ buildings with a modern hot water system and lowest equivalent annual cost equipment to meet net zero fossil fuel goals. Only analyzed using the NZP tool.



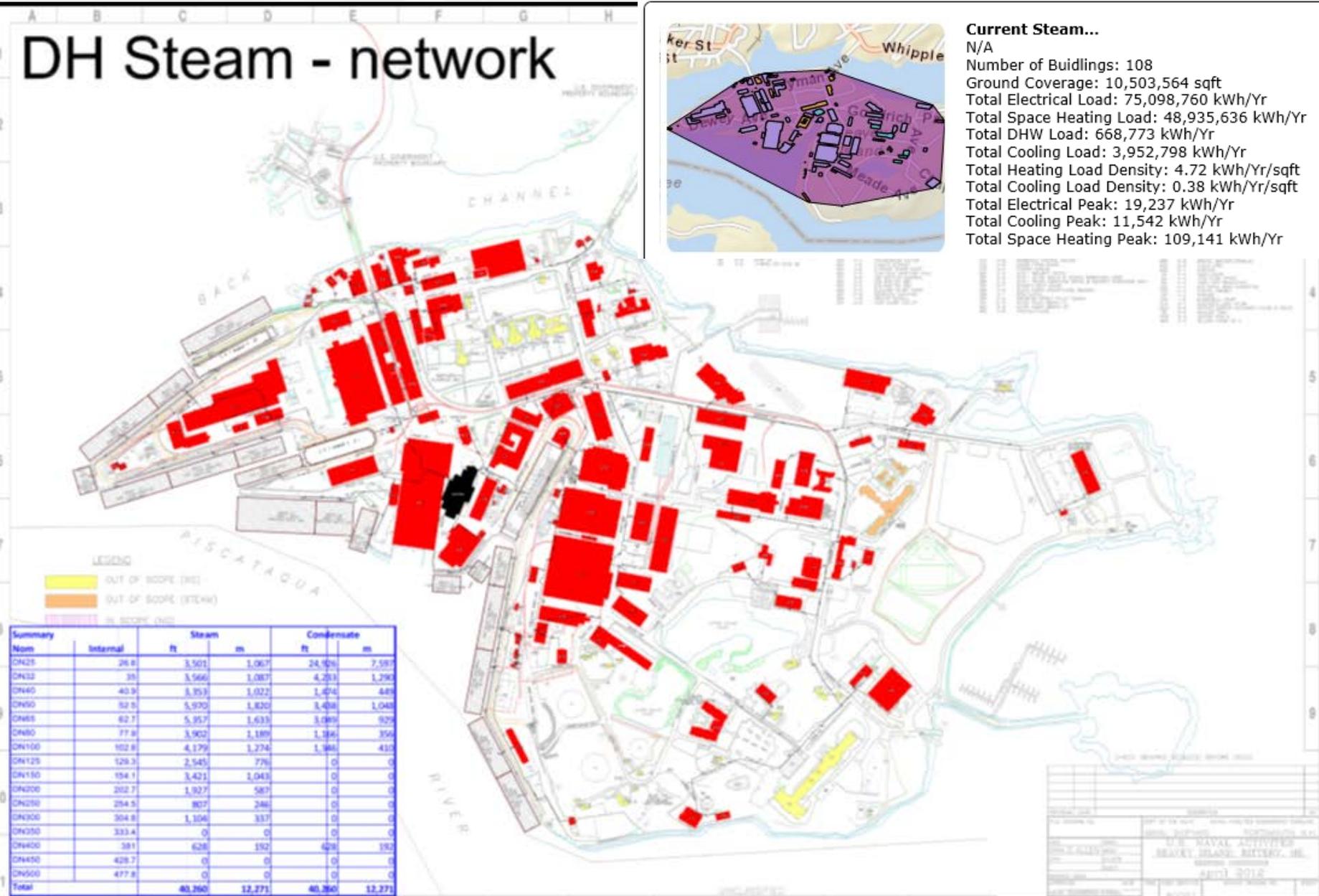
District System Network: *Sizing and Routing*

DH Steam - network



Current Steam...

N/A
 Number of Buildings: 108
 Ground Coverage: 10,503,564 sqft
 Total Electrical Load: 75,098,760 kWh/Yr
 Total Space Heating Load: 48,935,636 kWh/Yr
 Total DHW Load: 668,773 kWh/Yr
 Total Cooling Load: 3,952,798 kWh/Yr
 Total Heating Load Density: 4.72 kWh/Yr/sqft
 Total Cooling Load Density: 0.38 kWh/Yr/sqft
 Total Electrical Peak: 19,237 kWh/Yr
 Total Cooling Peak: 11,542 kWh/Yr
 Total Space Heating Peak: 109,141 kWh/Yr

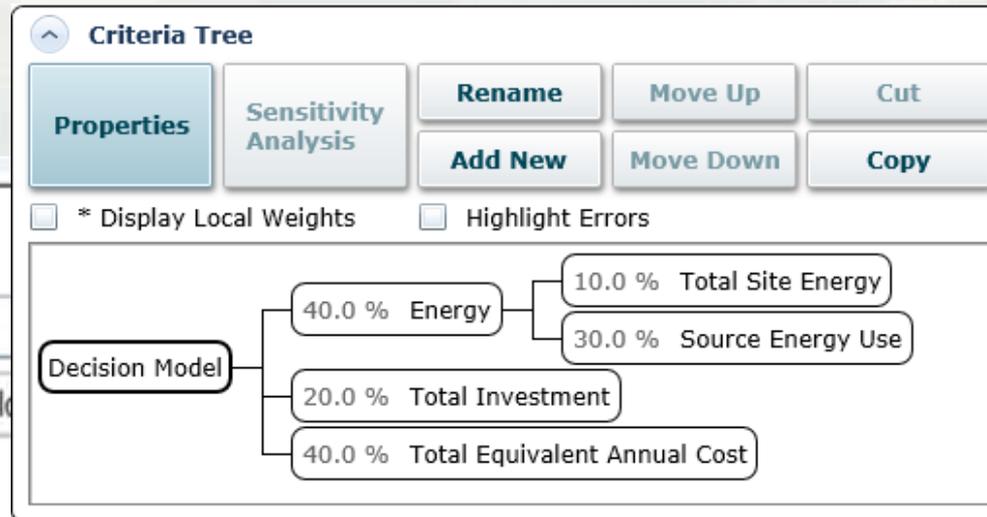


LEGEND
 [Yellow Box] OUT OF SCOPE (HE)
 [Orange Box] OUT OF SCOPE (STEAM)
 [Red Box] IN SCOPE (HE)

Summary	Steam		Condensate	
	Internal	ft	m	ft
DN21	26.0	3,501	1,067	24,926
DN32	35	3,566	1,087	4,203
DN40	40.9	3,953	1,022	1,474
DN50	52.9	5,970	1,820	3,408
DN65	62.7	5,857	1,633	3,099
DN80	77.8	3,902	1,189	1,184
DN100	102.6	4,179	1,274	1,944
DN125	129.3	2,545	776	0
DN150	154.1	3,421	1,043	0
DN200	202.7	1,927	587	0
DN250	254.5	807	246	0
DN300	304.8	1,104	337	0
DN350	333.4	0	0	0
DN400	381	628	192	0
DN450	428.7	0	0	0
DN500	477.8	0	0	0
Total		40,260	12,271	40,260

U.S. NAVAL ACTIVITIES
 BEAVER ISLAND BATTERY, ME
 APR 11 2012

Decision Model



MCDA Model: Portsmouth 2040

Name Portsmouth 2040

Centralized systems allow for higher energy security and flexibility

Access Level Edit Model Structure, Value Functions, Weights

Rank	Alternative Name	MCDA Score
1	Dist HW Reduced DD Loads	0.6854429
2	District Hot Water	0.5586616
3	District Steam	0.5157574
4	Net Zero Fossil Fuel	0.4435413
5	Decentralized	0.3951311
6	EEM Case for B...	0.1326775
7	Baseline	0.0461313
8	Baseline	

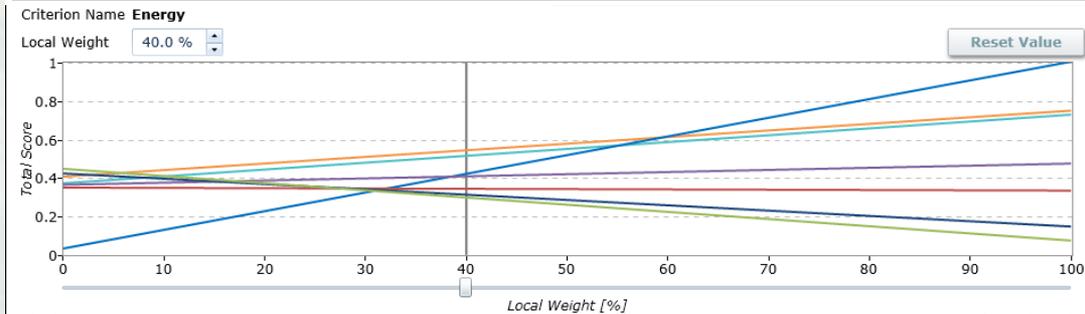
Decentralized attractive when done building by building and allows for "site energy" use reduction

Multi-Criteria Decision Analysis

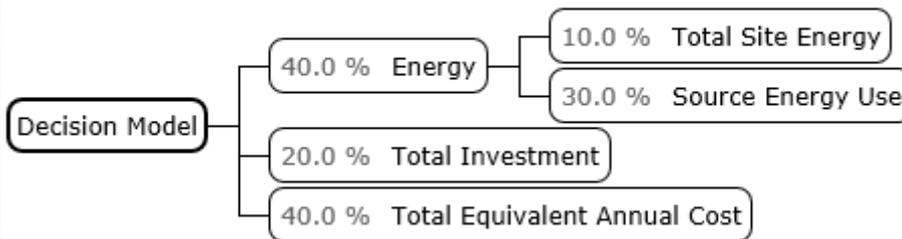
Cool Weather Example

- Uses quantitative data from NZP models
- Qualitative data can be used (e.g. stakeholder opinions)
- Sensitivity analysis can be conducted on importance of different metrics.

Rank	Alternative Name	MCD A Score
1	District Hot Water	0.541397
2	District Steam	0.5127891
3	Net Zero Fossil Fuel	0.4198398
4	Decentralized	0.4069704
5	Building EEMs	0.3420474
6	Baseline	0.3115995
7	Basecase	0.2969908



Criteria List			Alternatives List	
Criterion Name	Local Weight	Final Weight	Alternative Name	Total Score
Energy	40.0 %	40.00 %	District Hot Water	0.541397
Total Investment	20.0 %	20.00 %	District Steam	0.5127891
Total Equivalent Annual Cost	40.0 %	40.00 %	Net Zero Fossil Fuel	0.4198398
			Decentralized	0.4069704
			Building EEMs	0.3420474
			Baseline	0.3115995
			Basecase	0.2969908

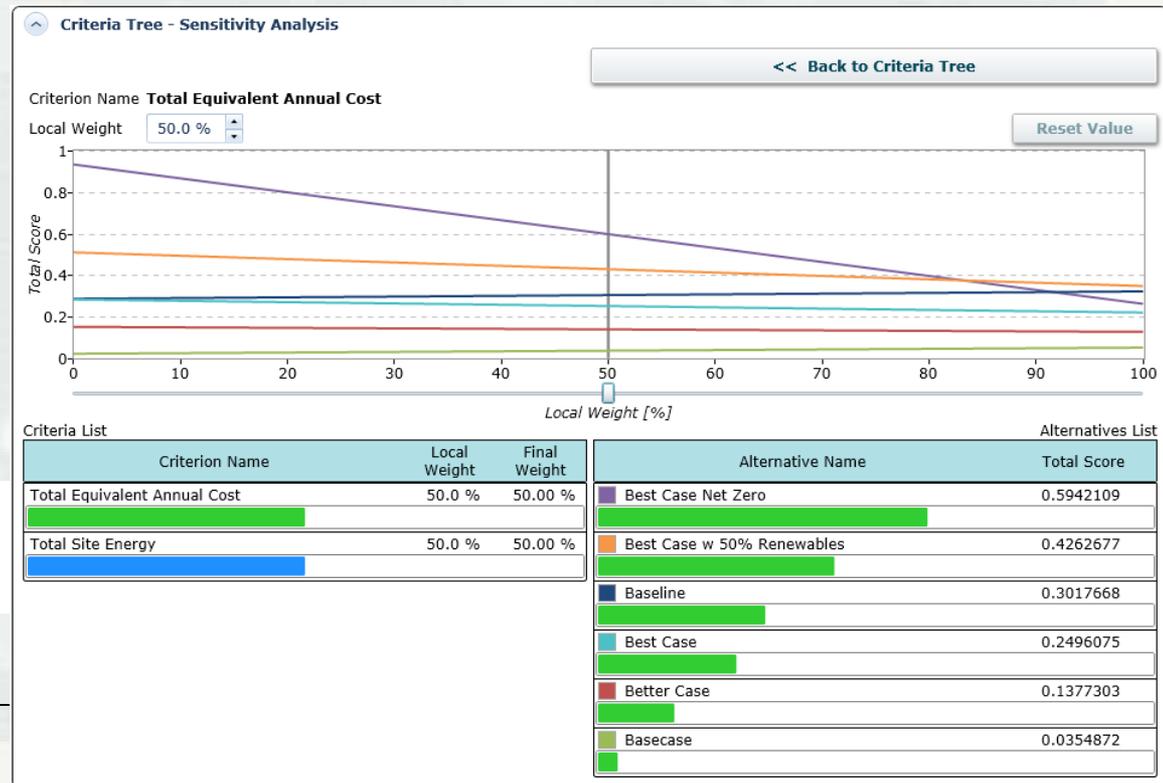


Multi-Criteria Decision Analysis

Warm Weather Example

- Net zero best choice based on equal weighting between energy and cost
- 50% new zero crosses to best at about 91% weighting on cost

Rank	Alternative Name	MCDCA Score
1	Best Case Net Zero	0.5942109
2	Best Case w 50% Renewables	0.4262677
3	Baseline	0.3017668
4	Best Case	0.2496075
5	Better Case	0.1377303
6	Basecase	0.0354872



NZP Tool Conclusions

- Do not make short term decisions without a long term plan
- Simple Interface to POWERFUL underlying tools, i.e. EnergyPlus, AMPL, CPLEX, etc.
- NZP Tool analysis currently available through U.S. Army Corps of Engineers
- NZP Tool already follows the OSD Installation Energy Plans Memo



YouTube Live Demo

<https://www.youtube.com/channel/UC2sdFPLVc5TENXyuRL4SzNw>



Conclusions

- Do not make short term decisions without a long term plan
- NZP Tool makes the data collection for energy and cost analysis faster and easier
- Simple Interface to POWERFUL underlying tools, i.e. EnergyPlus, AMPL, CPLEX, etc.

