

System Master PLanner / Net Zero Planner (SMPL/NZP) Tool Technical Capabilities

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Laboratory - U.S. Army Construction Engineering
Research Laboratory



US Army Corps of Engineers
BUILDING STRONG®



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distribution is unlimited.**

SMPL/NZP Supports Resilience Planning

- Critical electrical load (resilience)
- Redundant capacity planning for equipment
- Supports 14 day mission critical resource planning
- Maximum Investment cost
- Project life cycle costing

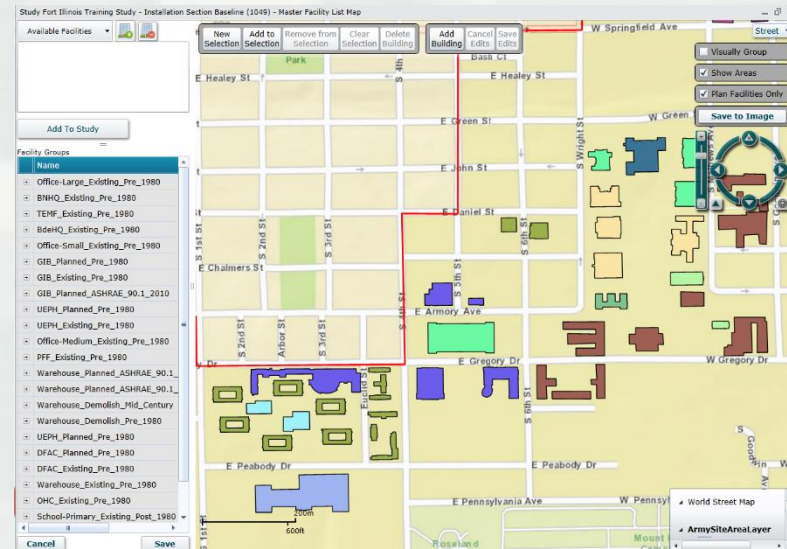
Today – will touch on load estimation, but spend more time on the supply side to support resilience.



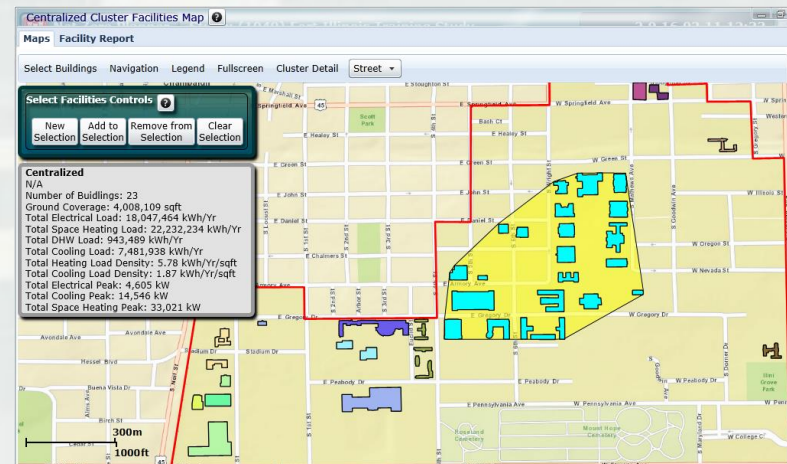
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SMPL/NZP Tool

- Web based tool that assists in installation-wide energy, water, and waste planning
- Estimates current and future energy **loads and profiles**
- Optimizes **supply side** to meet loads
 - ▶ Electrical integrated with thermal
 - ▶ Resilience
- Estimates costs and returns for ROI analysis



Master Facility Map



Energy Cluster View²

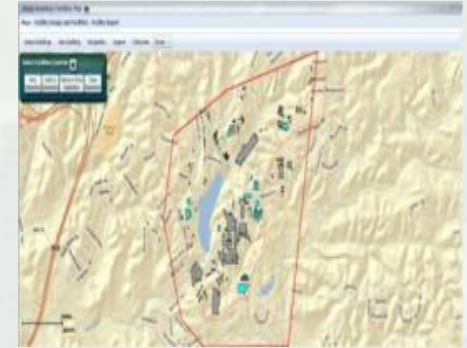
The SMPL/NZP Tool is used extensively by the U.S. Army Corps of Engineers



Fort Leonard Wood



West Point USMA



Waterways Experiment Station




Fort Hunter Liggett



Portsmouth Naval Shipyard

- Schofield Barracks
- Fort Hood
- Presidio at Monterey
- NASA Johnson Space Center
- Parks RFTA
- Lakenheath AFB, UK
- MCAS Iwakuni, Japan
- Over 60 studies 2015-2017

Setting up a Study

 **Net Zero Planner**

Study: (1055) Fort Illinois Example

2.0.16.03.11 12:33

Study List

Study Information

Facility Loads

Installation or Subsection

Decision Analysis

Generate Reports


Case, Mike

Menu


Details Facilities Rates Consumption Manage Users Results


Study Information Details


Study Information Alternatives



Study Name: Fort Illinois Example (1055)
Created By: Case, Mike
Modified By: Case, Mike
Energy Param Version: 0.39.0
Energy NZI Opt Version: 0.10.0
Water Param Version: 0.24.0
Water Opt Version: 0.0.0
Waste Param Version: 0.16.0
Waste Opt Version: 0.0.0
StormWater Param Version: 0.9.1
StormWater Opt Version: 0.0.0
Created: 4/18/2016 9:35 AM
Last Edited: 4/18/2016 9:41 AM
Description: This study provides an example for present
Baseline Year: 2016
Study Duration: 40 Years
☐ Public Access




Location and Meteorological Data
Upload PV
Location: Fort Illinois
Weather File: USA_IL_University.of.Illinois-Willard.AP.7
Climate Zone: ASHRAE 5A
Soil Type: 
ET: 0 in. (0%)
Average Temperature: 50 °F







Study Goals:

- Reduce building energy consumption
- Improve resiliency
- Reduce source energy usage



This Study Includes:

- ☒ Energy 
- ☐ Water 
- ☐ Waste 
- ☐ Stormwater 

Edit All

View All

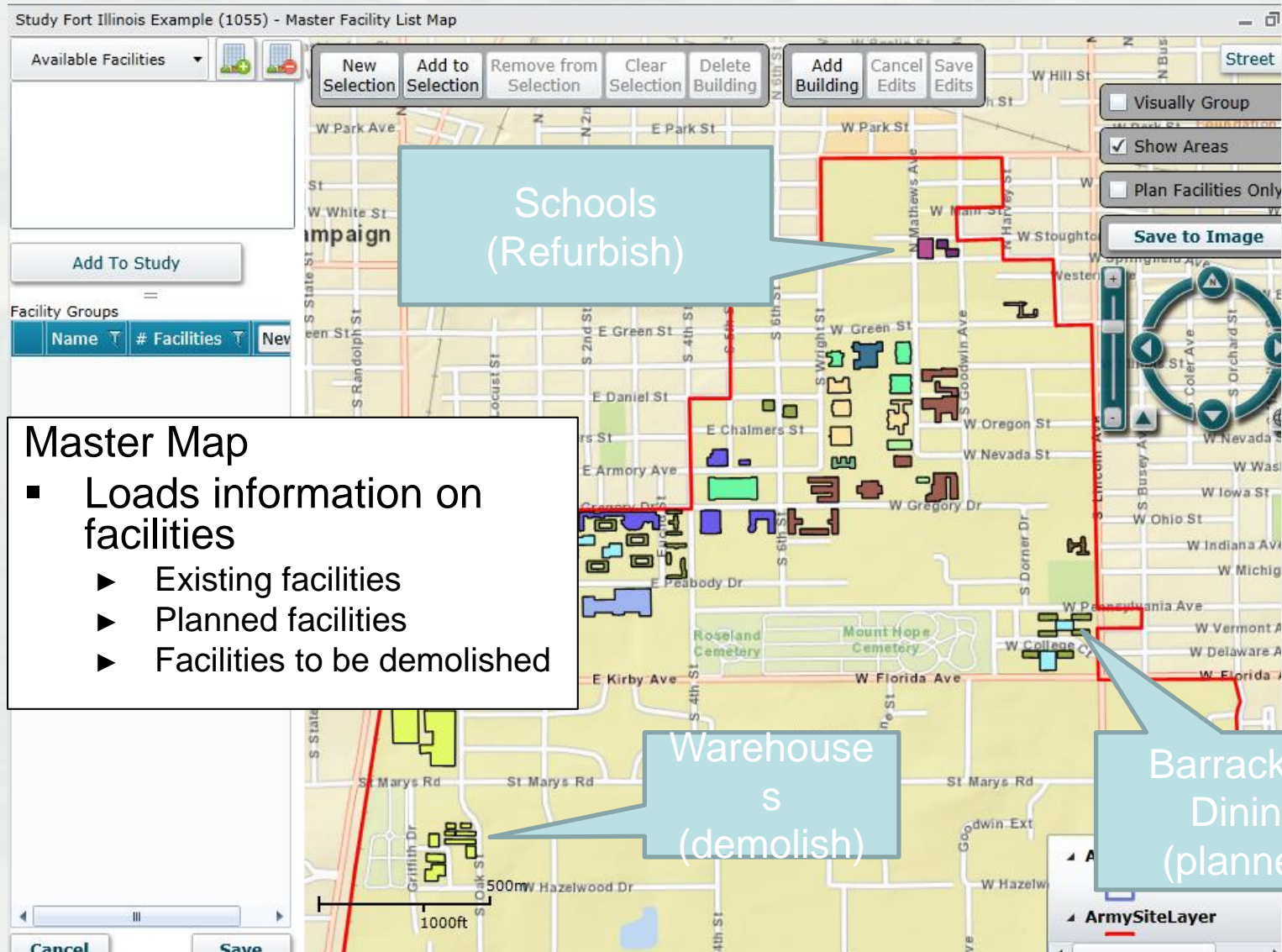
Edit

View

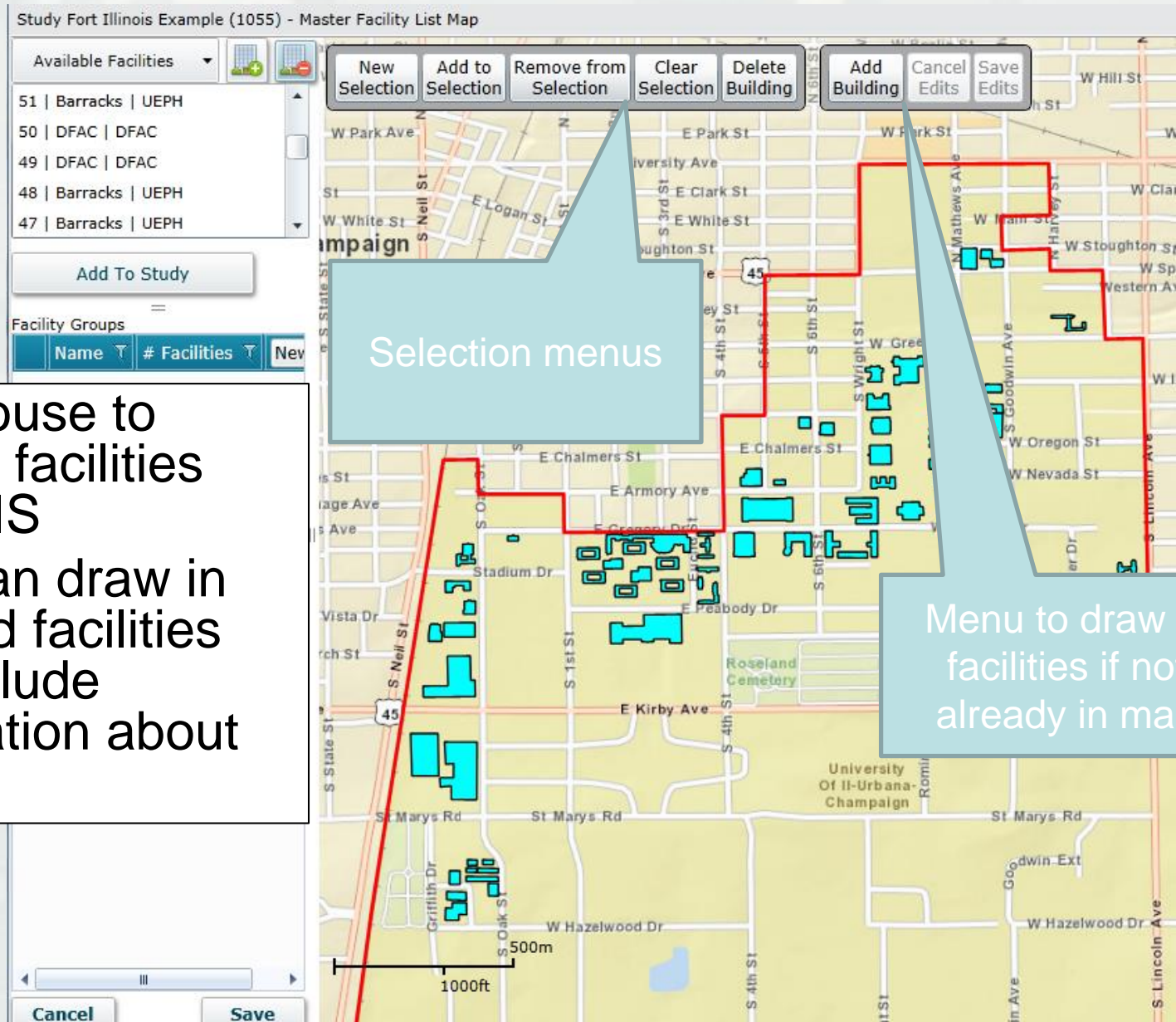
- To set up a study
 - Name of project
 - Choose location (automatically loads weather file)
 - Establish goals
 - Select what to include in study
 - Energy
 - Water
 - Waste
 - Stormwater

Begin with Geospatial Information System (GIS)

Map of Installation



Select Facilities to Include in Study



- Use mouse to choose facilities from GIS
- User can draw in planned facilities and include information about them

Group Facilities for Modeling

- Group by:
 - ▶ Type
 - ▶ Era of Construction
 - ▶ Physical Characteristics
- Designate
 - ▶ Existing
 - ▶ Planned
 - ▶ Demolish

The screenshot displays a software interface for modeling facilities. On the left, a list of facilities is shown, grouped by name. The list includes:

- GIB_Existing_Pre_1980** (5 items):

Number	Name	Include In Alternative	Construction Date	Conditioned Area (ft^2)
73	Classrooms	<input checked="" type="checkbox"/>	2020	12887
69	Classrooms	<input checked="" type="checkbox"/>	2026	130316
55	Classrooms	<input checked="" type="checkbox"/>	2026	
54	Classrooms	<input checked="" type="checkbox"/>	2026	60210
53	Classrooms	<input checked="" type="checkbox"/>	2026	79188
- Warehouse_Planned_ASHRAE_90.1_2010** (1 item):

Number	Name	Include In Alternative	Construction Date	Conditioned Area (ft^2)
67	Warehouse-Planned	<input checked="" type="checkbox"/>	2020	130901
- Warehouse_Demolish_Mid_Century** (3 items):

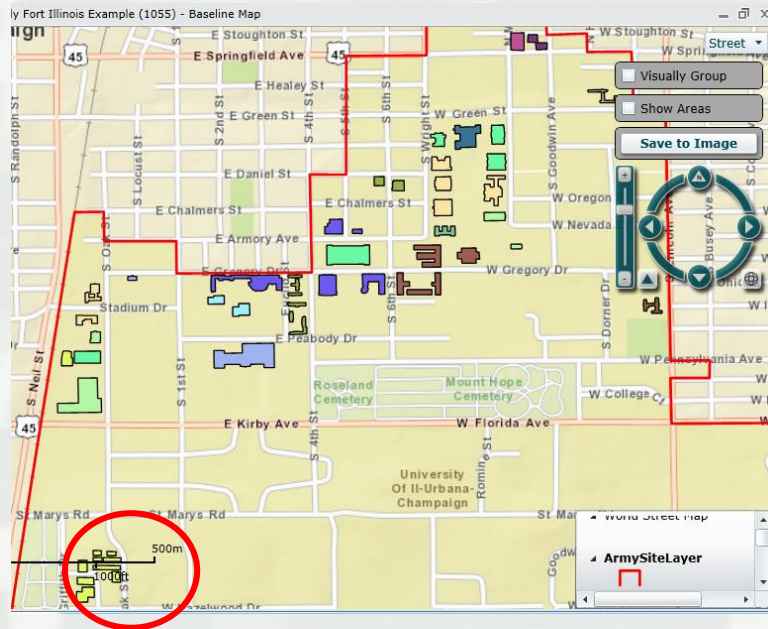
Number	Name	Include In Alternative	Construction Date	Conditioned Area (ft^2)
66	Warehouse-Demolish	<input checked="" type="checkbox"/>	2025	13027
65	Warehouse-Demolish	<input checked="" type="checkbox"/>	2025	13011
64	Warehouse-Demolish	<input checked="" type="checkbox"/>	2025	13033
- Warehouse_Demolish_Pre_1980** (6 items)
- School-Primary_Existing_Post_1980**
- School-Secondary_Existing_Pre_1980**
- UEPH Planned Pre 1980**

On the right, a map area is shown with various colored polygons representing different facility types. Callouts point to specific areas on the map:

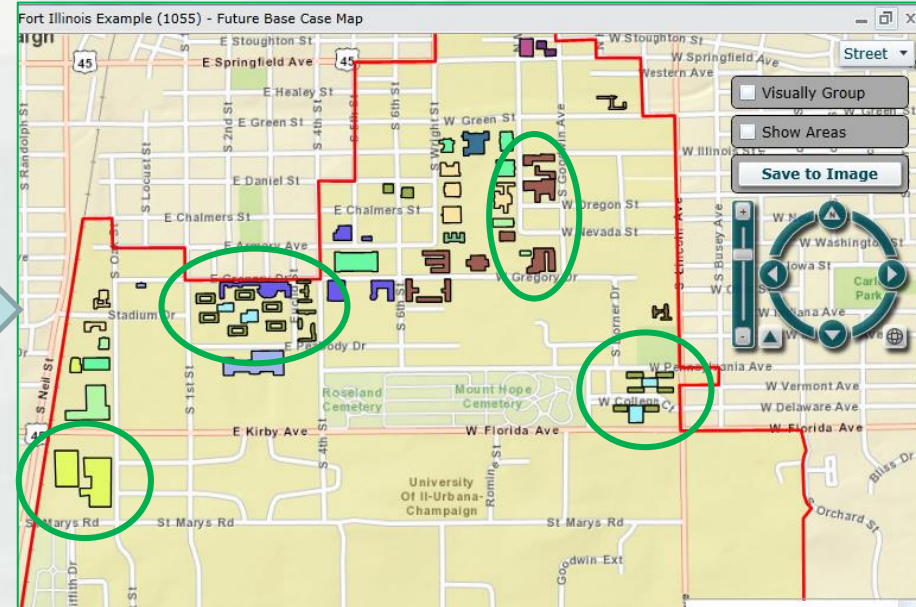
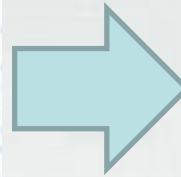
- Existing, Pre-1980**: Points to a yellow area.
- Planned ASHRAE 90.1-2010**: Points to a green area.
- Demolish Mid 20th Century**: Points to a blue area.
- Map Area**: Points to the map area.
- Conditioned area & Construction/Retrofit Date**: Points to the 'Conditioned Area' column in the table.

The interface includes a 'Facilities' tab, a 'New' button, and a 'Save' button. The map area is powered by Esri.

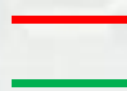
Compare Baseline and Future Alternatives



Today



Future



Demolish
Planned



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FACILITY LOAD ANALYSIS



Adjust Baseline Parameters

- NZP has a library of facility models by type and era.
- User can adjust parameters to reflect facility condition from assessments

Net Zero Planner Study: (1055) Fort Illinois Example 2.0.16.03.11 12:33

Generate Reports Case, Mike

Focus: Energy Alternative: Baseline

re_1980 Baseline Cost

re_1980 Baseline Parameters

Name	Default Value	Value	Unit	Description
Leakage Fraction	0.1	0.1		supply ducts upstream of the terminal unit
VAV Terminal Type	STANDARD	STANDARD		VAV zone terminal unit type
Mechanical Room Ventilation Rate - Air Changes per Hour	10.0	10.0		Mechanical room ventilation rate - Air Changes per Hour
Vestibule Implementation	false	false		Accounts for reduced infiltration due to vestibule entrances
Wall Base Cavity Insulation	0	0	R	Wall base cavity insulation R-value
Wall Base Continuous Insulation	5.560	5.560	R	Wall base continuous insulation R-value
Wall Base Type	Concrete MW Solid Grouted	Concrete MW Solid Grouted		Wall base type
Wall Exterior Type	Stucco	Stucco		Wall exterior type
Wall Interior Type	Gypsum 5/8in	Gypsum 5/8in		Wall interior type
Domestic Hot Water Heater Efficiency	0.8	0.8		Domestic hot water heater nominal efficiency

Simulate Facility Energy Use

The screenshot shows the Net Zero Planner software interface. The top bar includes the logo, the text "Net Zero Planner", the study name "Study: (1055) Fort Illinois Example", and the date/time "2.0.16.03.11 12:33". Below this is a navigation menu with tabs: "Study List", "Study Information", "Facility Loads" (selected), "Installation or Subsection", "Decision Analysis", and "Generate Reports". The "Facility Loads" tab is active, showing a sub-menu with "Details", "Input", "Simulation" (selected), "Package Selection", and "Results". The "Simulation" sub-menu is active, displaying a status bar with icons for "Not Started", "Successful", "Queued", "Initialized", "Running", "Not Found", "Error", "Recovered", "Unknown", and "Polling". Below the status bar, it says "0:00:21 Since Last Study Plan Status Update." The main area shows a tree view of energy simulations under the "Energy" category. The tree is expanded to show a list of simulations, each with a status icon and a gear icon for configuration. The simulations listed are:

- Baseline
- GIB_Existing_Pre_1980
- Warehouse_Demolish_Mid_Century
- Warehouse_Demolish_Pre_1980
- School-Primary_Existing_Post_1980
- School-Secondary_Existing_Pre_1980
- DFAC_Existing_Pre_1980
- BdeHQ_Existing_Pre_1980
- UEPH_Existing_Pre_1980
- TEMF_Existing_Pre_1980
- Office-Small_Existing_Pre_1980
- Warehouse_Existing_Pre_1980
- BNHQ_Existing_Pre_1980
- Office-Large_Existing_Pre_1980
- PFF_Existing_Pre_1980
- Office-Medium_Existing_Pre_1980
- OHC_Existing_Pre_1980
- Hotel-Large_Existing_Post_1980

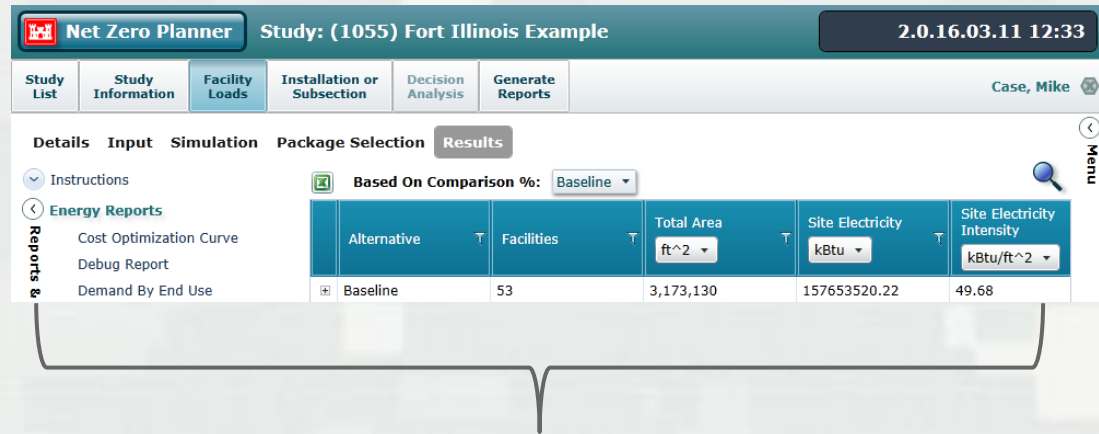
On the right side of the screenshot, there is a text box containing the following bullet points:

- Energy Plus simulations run on server farm
- 1000's of simulations can be queued
- ~ 100 run simultaneously
- Results are kept in database for reuse

The bottom right corner of the slide features the "BUILDING STRONG" logo, which consists of a red castle icon and the text "BUILDING STRONG" with a registered trademark symbol.

Calibrate Facility Simulation Models

- Use utility bills, meter data, assessments
- Use available data to get the best match between models and data.
- May or may not have individual facility meter data or sub-meter data



Alternative	Facilities	Total Area ft ²	Site Electricity kBtu	Site Electricity Intensity kBtu/ft ²	Site Gas kBtu	Site Gas Intensity kBtu/ft ²	Energy Cost \$/year	Site Total Energy kBtu/ft ²	Site Total Energy kBtu
Baseline	53	3,173,130	157,653,520	49.68	239651548.5	75.53	6,382,882	125.21	397,305,069
Facility Group		Facilities	Total Area	Electricity Intensity	Gas	Gas Intensity	Energy Cost	Total Energy Intensity	
BdeHQ_Existing_Pre_1980	4	360,480	20,852,448	57.85	1846917	21.77	668,871	79.61	
BNHQ_Existing_Pre_1980	6	398,928	16,249,537	40.73	11646591	29.19	561,901	69.93	
DFAC_Existing_Pre_1980	2	52,840	6,432,737	121.74	15130832	286.35	299,796	408.09	
GIB_Existing_Pre_1980	5	461,651	17,227,486	37.32	1341794	52.73	683,911	90.04	
Hotel-Large_Existing_Post_1980	1	57,543	2,788,298	48.46	529216	89.14	119,438	137.59	
Office-Large_Existing_Pre_1980	1	71,515	4,157,125	58.13	253794	34.31	139,885	92.44	
Office-Medium_Existing_Pre_1980	5	346,102	22,881,788	66.11	21027850	60.76	825,269	126.87	
Office-Small_Existing_Pre_1980	1	24,947	1,275,662	51.13	1320554	52.93	47,098	104.07	
OHC_Existing_Pre_1980	1	43,195	1,611,323	37.30	769854	17.82	52,887	55.13	
PFF_Existing_Pre_1980	2	181,807	18,549,704	102.03	41861984	230.26	851,490	332.28	
School-Primary_Existing_Post_1980	1	47,610	2,157,551	45.32	4096707	86.05	93,359	131.36	
School-Secondary_Existing_Pre_1980	1	110,247	5,757,781	52.23	956974	89.41	241,235	141.63	
TEMF_Existing_Pre_1980	5	691,205	24,413,830	35.32	67032496	96.98	1,208,441	132.30	
UEPH_Existing_Pre_1980	8	172,912	10,670,726	61.71	14821994	85.72	421,738	147.43	
Warehouse_Demolish_Mid_Century	3	63,602	1,142,644	17.97	6890930	108.34	84,158	126.31	
Warehouse_Demolish_Pre_1980	6	64,974	1,089,581	16.77	3979372	61.25	61,195	78.02	
Warehouse_Existing_Pre_1980	1	23,572	395,290	16.77	1443881	61.25	22,201	78.02	

Calibrate baselines against Energy Use Intensities (EUI) by Facility Group

Facility Load Analysis

Build the Base Case Using Simulation

- The future doing business as usual
- Planned facilities are added using the **default** standard
 - ▶ ASHRAE 90.1-2010
 - ▶ Adjust parameters to reflect other standards
- Demolished buildings are removed

default

The screenshot displays the 'Future Base Case' simulation setup in the Facility Load Analysis software. The interface includes a top header with 'Example' and a timestamp '2.0.16.03.11 12:33'. A user profile 'Case, Mike' is visible in the top right. The 'Focus' is set to 'Energy' and the 'Alternative' is 'Future Base Case'. The main title is 'Future Base Case GIB_Planned_ASHRAE_90.1_2010 Default Cost'. Below this, the 'Install Cost' is set to '0.00 \$/sqft'. The 'Future Base Case GIB_Planned_ASHRAE_90.1_2010 Default Parameters' table is shown, listing various parameters and their values. On the left, the 'Enhancements & Cost' sidebar is visible, with a 'Save Changes' button and a list of enhancements. The 'Default' enhancement is selected, and an arrow points to it with the word 'default'.

Future Base Case GIB_Planned_ASHRAE_90.1_2010 Default Parameters

Name	Default Value	Value	Unit	Description
Air Leakage Rate	1.3	1.3	cfm/ft ²	Air leakage rate when pressurized at 0.3 inch H2O (75 Pa)
Annual Landscaping Irrigation Factor	5.28	5.28		Location and irrigation system specific factor in units of gal/ft ² /year used to calculate annual irrigation water use
Boiler Efficiency	0.8	0.8		Boiler nominal efficiency rated at full load at 180F outlet water and 150F inlet water temperature at HHV
Boiler Type	NONCONDENSING	NONCONDENSING		Boiler type
Cooling Coil Condensate Collection	false	false		Creates tank to capture cooling coil condensate to be recycled elsewhere in the building
DX COP	3.52	3.52		DX cooling coil nominal COP
DX SEER	9.7	9.7		DX cooling coil nominal SEER
				Cooling coil type for air

Base Case vs. Baseline

- Facility area increases
- Energy use increases
- EUI decreases (a little)
- Energy cost increases

Illinois Example 2.0.16.03.11 12:33

Generate Reports Case, Mike

Comparison %: Baseline

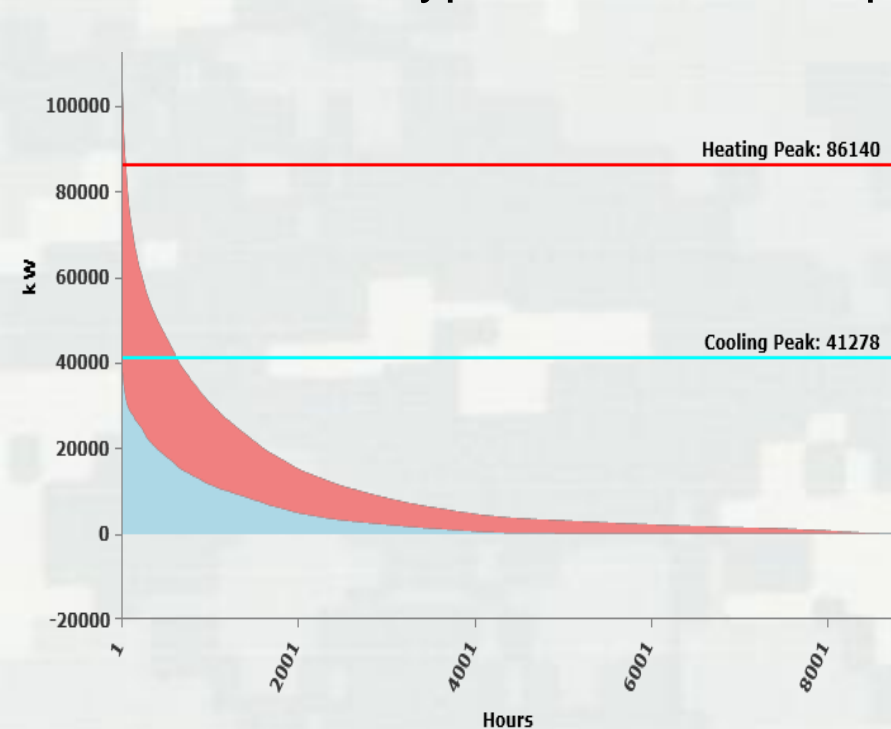
Alternative	Facilities	Total Area ft ²	Site Electricity kBtu	Site Electricity Intensity kBtu/ft ²
Baseline	53	3,173,130	157,653,520.22	49.68
Future Base Case	65	4,570,489	219,476,983.22	48.02

Alternative	Facilities	Total Area ft ²	Site Electricity kBtu	Site Electricity Intensity kBtu/ft ²	Site Electricity Reduction %	Site Gas kBtu	Site Gas Intensity kBtu/ft ²	Site Gas Reduction %	Energy Cost \$/year	Site Total Energy Intensity kBtu/ft ²	Site Total Energy kBtu
Baseline	53	3,173,130	157,653,520	49.68	0	239,651,549	75.53	0	6,382,882	125	397,305,069
Future Base Case	65	4,570,489	219,476,983	48.02	-39	320,381,506	70.10	-34	8,788,496	118	539,858,489



Base Case Load Duration Curves

- Use for resilience planning
- Used to determine base loading & peaking requirements
- Shows combined loads of all facilities in the study
- Different types of facilities experience peak load at different times



Heating and Cooling
Loads



Electrical Power
Loads

Create Alternative Scenario(s)

- For planned buildings, can simulate measures more efficient than the standard
- For existing buildings due for a major retrofit, can simulate deep energy retrofit measures
- For the rest, look at typical minor improvements, ESCOs, etc.
- As many alternatives as you want to consider
- Different funding levels and energy prices – tool gives an opportunity to ask – “What if?”



SMPL/NZP Automatically Simulates “Packages” of Efficiency Measures

- Measures vary by facility type and climate zone
- Costs per package based on delta from standard
- User can change parameters and costs to reflect higher or lower efficiencies
- Costs and efficiency effects are cumulative as packages are combined

Net Zero Planner Study: (1055) Fort Illinois Example 2.0.16.03.11 12:33

Case, Mike

Details Input Simulation Package Selection Results

Packages Defined Custom Spaces Defined Focus: Energy Alternative: High Efficiency Build

High Efficiency Buildings GIB_Planned_ASHRA 99.1-2018 HVAC Package Cost

Install Cost 10.00 \$/sqft

Cost for this package

Name	Default Value	Value	Unit	Description
Boiler Efficiency	0.9	0.9		Boiler nominal efficiency rated at full load at 180F outlet water and 150F inlet water temperature at HHV
Boiler Type	CONDENSING	CONDENSING		Boiler type
Domestic Hot Water Heater Efficiency	0.95	0.95		Domestic hot water heater nominal efficiency

Default values can be changed by the user

Packages of bundled measures

Results - High Efficiency Facilities Alternative

Despite facility area increase of 44%:

- EUI and total energy use decreased by 43%
- Requires additional investment of ~\$72M
- Annualized cost decreased by 20%

Net Zero Planner Study: (1055) Fort Illinois Example 2.0.16.03.11 12:33

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

Details Input Simulation Package Selection **Results**

Instructions Based On Comparison %: Baseline

Energy Reports

Cost Optimization Curve
Debug Report
Demand By End Use
Demand Intensity By End Use
Energy By End Use
Energy Intensity By End Use

Alternative	Facilities	Total Area ft ²	Site Electricity kBtu	Site Electricity Intensity kBtu/ft ²
Baseline	53	3,173,130	157653520.22	49.68
Future Base Case	65	4,570,489	219476983.22	48.02
High Efficiency Buildings	65	4,570,489	145176239.89	31.76

Alternative	Facilities	Total Area ft ²	Site Electricity kBtu	Site Electricity Intensity kBtu/ft ²	Site Electricity Reduction %	Site Gas kBtu	Site Gas Intensity kBtu/ft ²	Site Gas Reduction %	Energy Cost \$/year	Site Total Energy Intensity kBtu/ft ²	Total Bldg Investment Cost \$	Annualized Cost (Energy + Bldg Invest)/(\$/yr)	Site Total Energy kBtu
Baseline	53	3,173,130	157,653,520	49.7	0.0	239,651,549	75.5	0	6,382,882	125.2	0	6,382,882	397,305,069
Future Base Case	65	4,570,489	219,476,983	48.0	-39.2	320,381,506	70.1	-33.7	8,788,496	118.1	0	8,788,496	539,858,489
High Efficiency Buildings	65	4,570,489	145,176,240	31.8	7.9	160,893,689	35.2	32.9	5,438,078	67.0	71,861,472	6,999,506	306,069,929

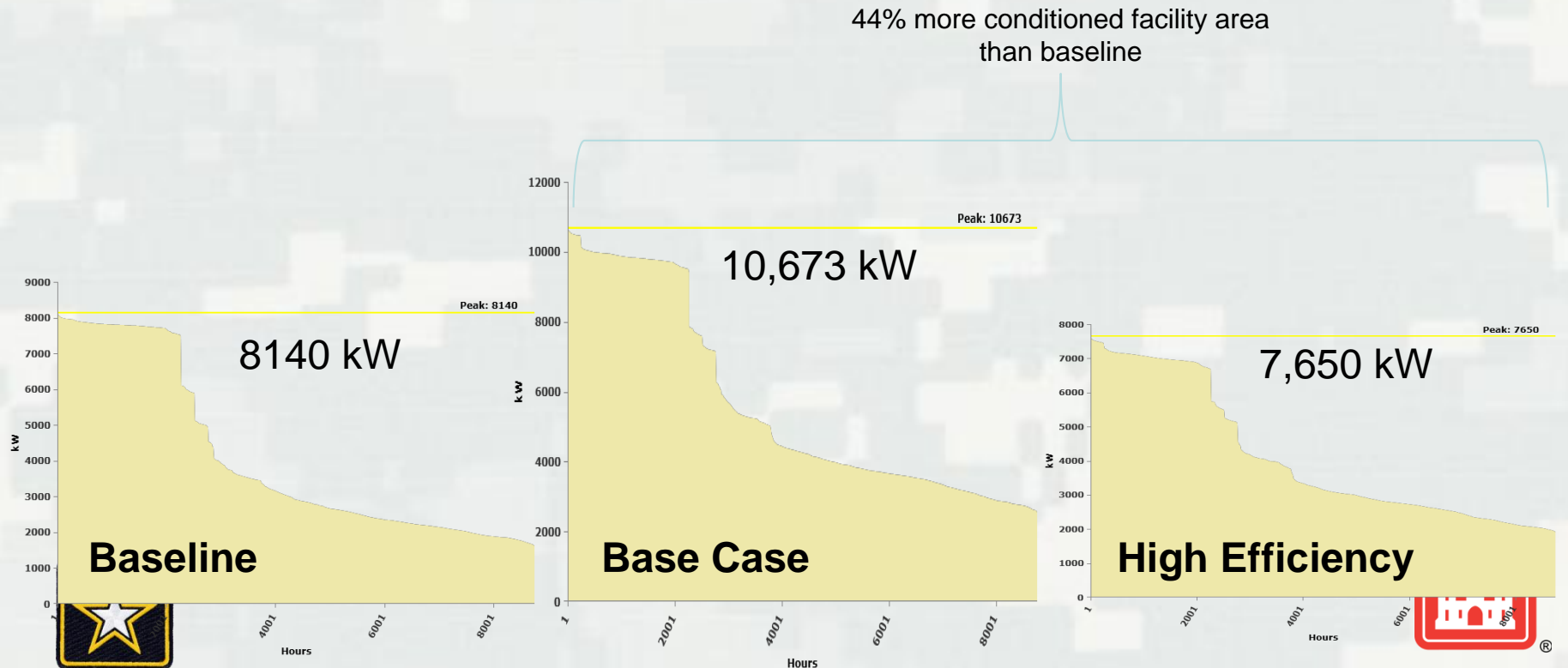
investment

life cycle cost decreases

energy use decreases

Compare Electrical Load Duration Curves

- Many Installations are constrained by their connection to the commercial grid
- Resilience is improved by lowering electrical power peak loads



Curves y-axes scaled to be approximately equivalent



INSTALLATION ENERGY CONVERSION AND DISTRIBUTION: CLUSTER ANALYSIS

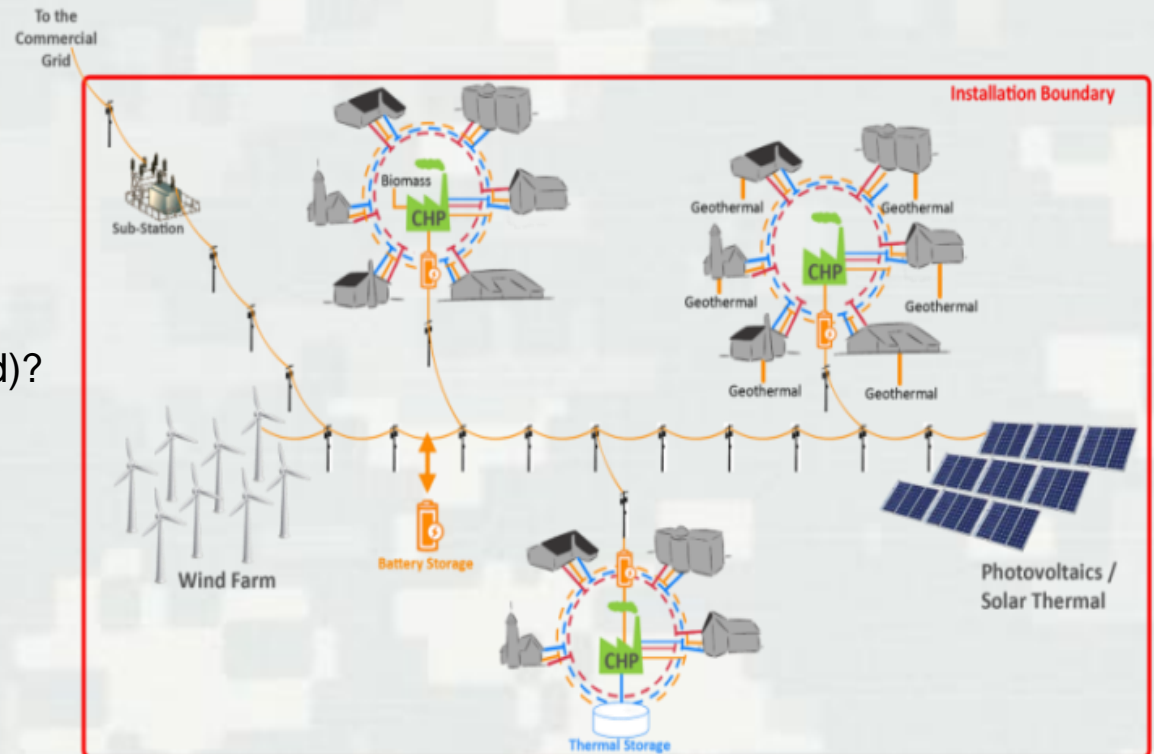


Optimizing Supply and Distribution

Loads were determined in the previous section

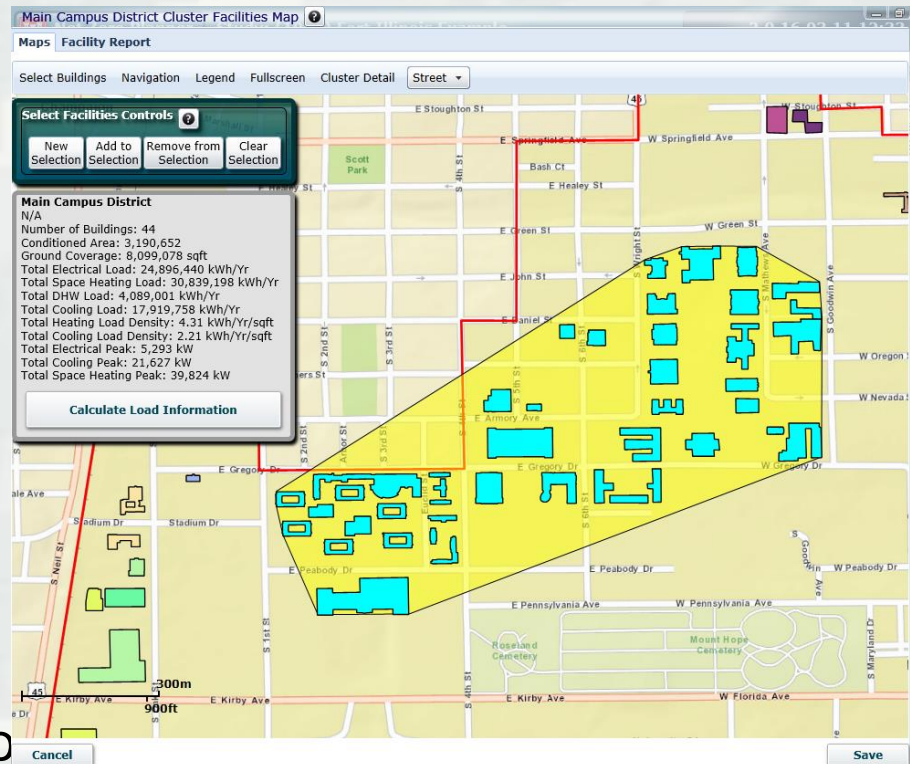
What is the most cost effective way to meet those loads?

- How long can the community run using on-site generation?
- Distribution
 - ▶ Electrical Power Grid?
 - ▶ Decentralized Heating/Cooling (Natural Gas Grid)?
 - ▶ District Heating/Cooling?
- Storage
 - ▶ Thermal
 - ▶ Electrical
- Supply
 - ▶ Renewables?
 - Solar
 - Wind
 - Biomass
 - Etc.
 - ▶ Fossil Fuels?



The SMPL/NZP Tool Optimizes “Clusters” for Supply Options

- A cluster is a group of facilities and systems selected by the user for supply options
- **No Technology bias, use data and costs for optimization**
- SMPL-NZP Tool calculates loads and uses a database of distribution, supply, and storage options
- Optimization uses Mixed-Integer Linear Programming (MILP using AMPL-CPLEX) to meet the loads at the lowest cost.



Technologies Considered

- Boilers (central & distributed)
- Chillers (central & distributed)
- Engines (Natural Gas, Diesel)
- Gas Turbines (incl. Cogen)
- Steam Turbines
- Combined Cycle Turbines
- Solar Photovoltaic
- Wind Turbines
- Biomass (incl. Cogen)
- Organic Rankine Cycle
- Waste to energy
- Various sizes of above
- High temperature hot water district
- Low temperature hot water district
- Steam district
- Hot Water Storage
- Chilled Water Storage
- Electrical Storage

86 combinations of above technologies in various sizes are in the tool.

The User can add technologies as desired:

- Capacity (size)
- Conversion efficiency
- Installation cost
- Maintenance costs
- Losses (for storage and networks).

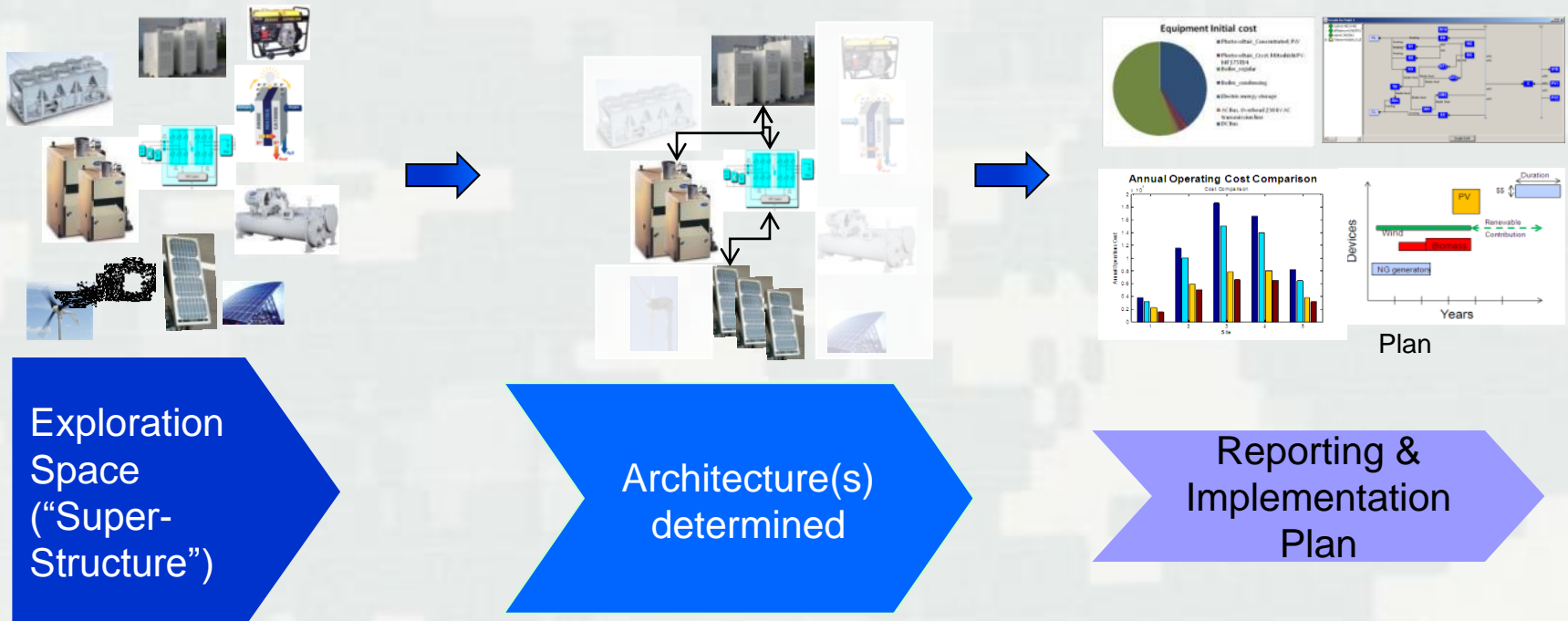
Set Constraints

Constraints include:

- Critical electrical load => resilience
- Maximum Carbon Footprint
- Excess generated electrical power can be exported (Net Metering) - (yes/no)
- Redundancy (e.g., $n + 1$)
- Maximum Investment cost
- Maximum available combustibles (for waste to energy)
- Project lifetime

NZI Optimization Tool (NZI-Opt)

NZI-Opt is a module of SMPL/NZP 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.



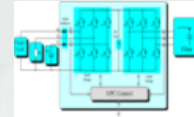
Electric Chiller



Diesel Generator



Photovoltaic



AC Bus



Absorption Chiller



Fuel Cell



Gas Boiler



Wind Turbine



Gas Turbine



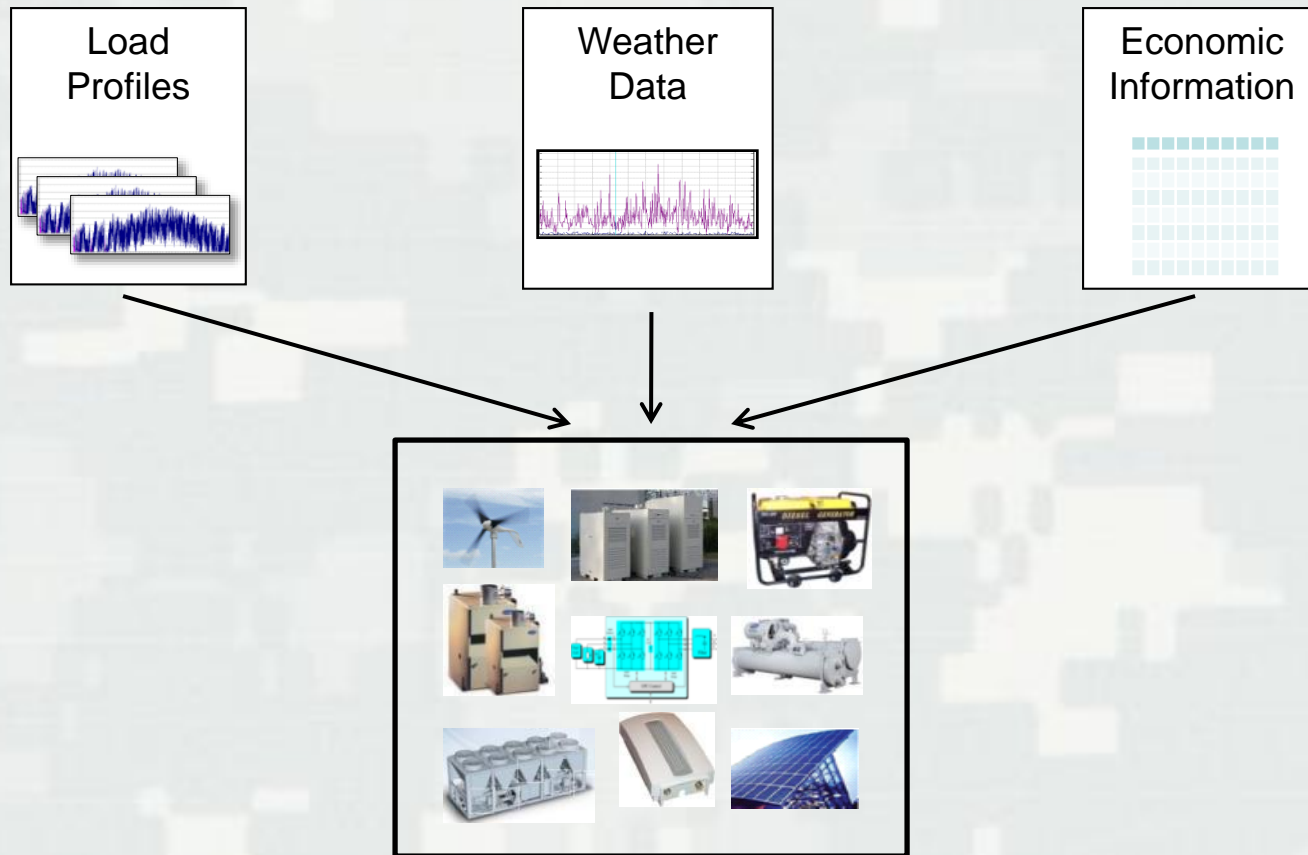
Organic Rankine Cycle



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.



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.



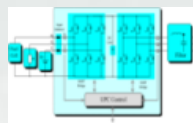
Electric Chiller



Diesel Generator



Photovoltaic



AC Bus



Absorption Chiller



Fuel Cell



Gas Boiler



Wind Turbine



Organic Rankine Cycle



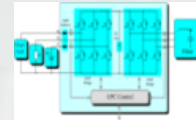
Gas Turbine



Electric Heater

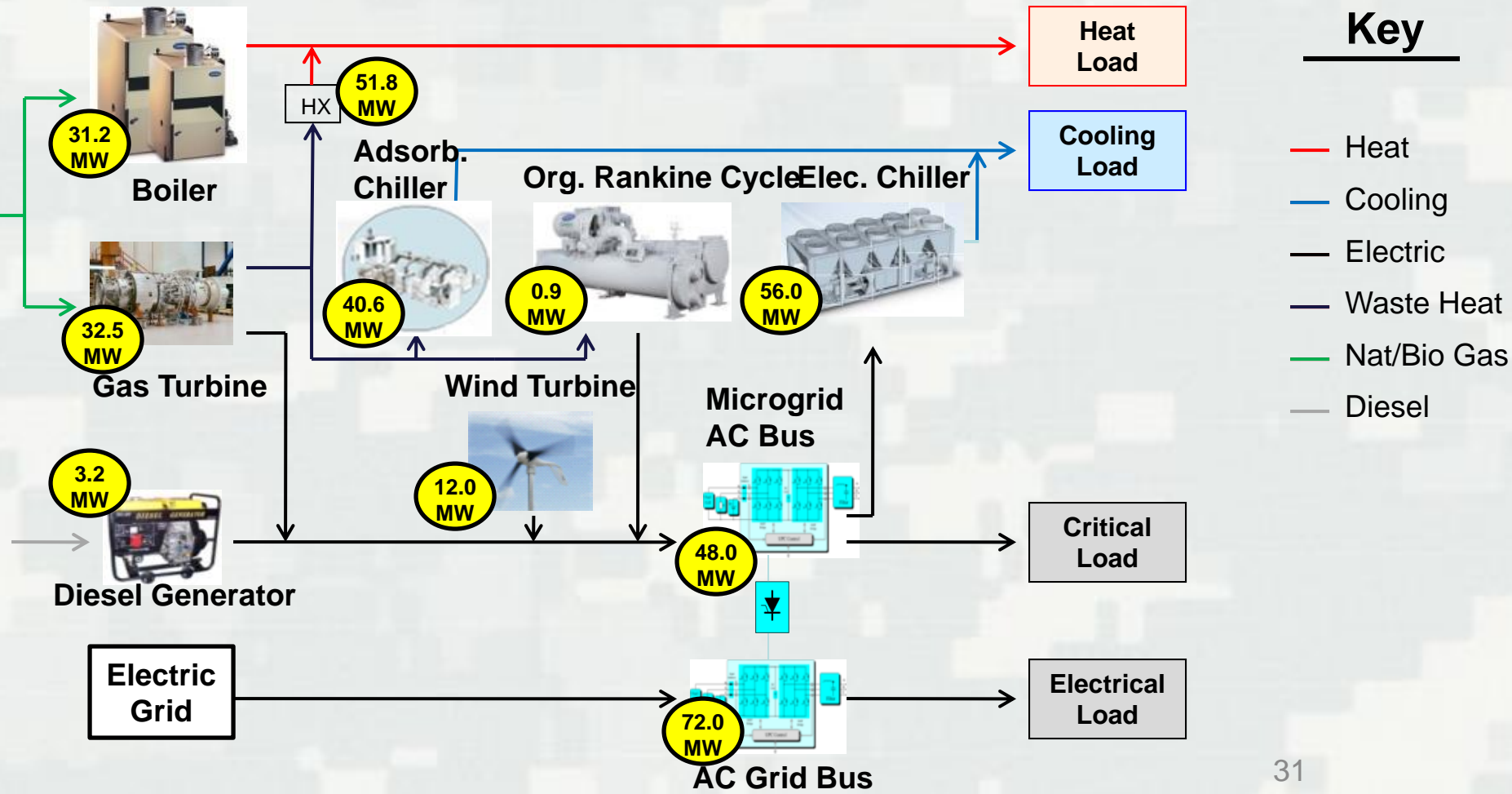
Selecting a Supply Architecture

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.



Cluster Results

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

SMP/NZP displays a list of equipment to meet facility loads

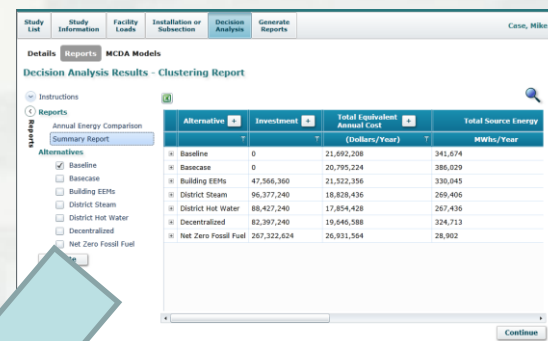
Natural Gas Reciprocating Engine CHP

DECISION SUPPORT



Decision Support Example

- SMPL/NZP produces an “analysis of alternatives” decision matrix
- Includes energy consumption, investment, and data for LCC and Simple payback
- In this example, converting district steam to hot water is the most LCC effective alternative.



Alternative	Investment	Total Equivalent Annual Cost (Dollars/Year)	Total Source Energy MWh/Year
Baseline	0	21,692,208	341,674
Basecase	0	20,795,224	386,029
Building EERs	47,566,360	21,532,356	230,045
District Steam	96,377,240	18,828,436	269,406
District Hot Water	88,427,240	17,854,428	267,436
Decentralized	82,397,240	19,646,588	324,713
Net Zero Fossil Fuel	267,322,624	26,931,564	28,902

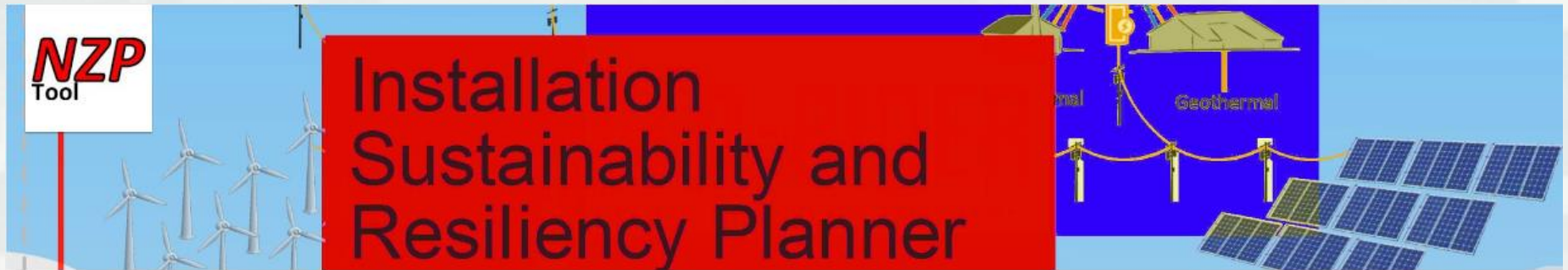
SI Units NZP Energy (MWh/yr)								
Scenarios	Total Fossil Fuel + Biomass Fuel	Total Electricity	Total Site Energy	Total Source Energy	% Source Energy Reduction from Baseline	Investment \$	Life Cycle Cost (Disc Rate = 3%)	Simple Payback Yrs
Baseline	258,810	23,228	282,038	348,550	0%			
Basecase	259,424	31,020	290,444	375,219	-8%		\$477,361,000	
District Steam	196,254	14,488	210,742	253,866	27%	\$155,220,000	\$460,051,000	25
District Hot Water	188,011	16,189	204,200	250,916	28%	\$144,570,000	\$435,313,000	21
Decentralized	45,564	78,232	123,796	308,998	11%	\$141,240,000	\$467,827,000	27
Net Zero Fossil Fuel	2,828 / 303,132	2,297	307,957	40,628	88%	\$193,155,480	\$562,650,000	* See Note

More on Decision Support Tomorrow!

SMPL-NZP Tool Training Videos available on YouTube

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

Search for “NZP Tool” in YouTube



SMPL-NZP Tool Training and Tech Manual

Master Planning Training Courses Developed (DOD Master Planning Institute/PROSPECT)

Course 258: Master Planning Energy and Sustainability addressing the SCP/ process

Next offering: 13-16 March 2018, New Orleans, LA

Course 163: Master Planning Sustainability and Resilience addressing how to use SMPL/NZP Modeling Tool to assess different Energy, water, and waste

Next offering: 24-26 April 2018, Champaign, IL

There is a Pre-Final version SCP/ Technical Manual

Conclusions

- The SMPL/NZP tool provide a simple Interface to POWERFUL underlying tools, i.e. EnergyPlus, AMPL, CPLEX, etc.
- SMPL/NZP Tool analysis and training currently available through U.S. Army Corps of Engineers
- ERDC-CERL also has a Cooperative Research and Development Agreement with Big Ladder Software.
<https://bigladdersoftware.com>



Questions?

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Backup Slides



U.S. Office of Secretary of Defense Installation Energy Plan Guidance, March 31, 2016

SMPL/NZP Tool directly supports Phases 1-3 and 6. It provides supporting data for phases 4 and 5.

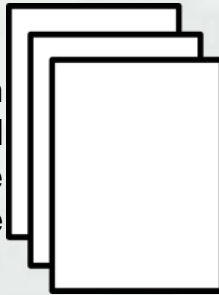
- ✓ Phase 1: Identify the team, tasks, deliverables, and goals
- ✓ Phase 2: Establish baseline and future base case
- ✓ Phase 3: Establish alternative scenarios and analyze gaps
- Phase 4: Develop and sequence projects and activities
- Phase 5: Assemble review and finalize document
- ✓ Phase 6: Execution and maintenance of the Installation Energy Plan (allows iteration on the plan due to unforeseen circumstances)



SMPL-NZP Tool Process in a web based tool

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

Iterate
over
Building
Measures

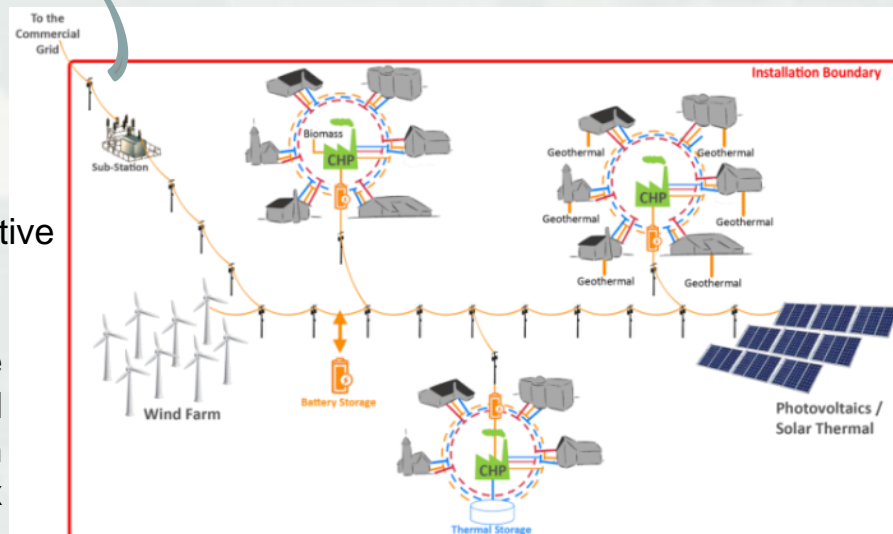
Optimize
Building
Energy
Efficiency



Phase 3:

Analyze alternative
scenarios

Optimize
Supply and
Distribution
System Mix



Supports



BUILDING STRONG®

Useful Definitions

- **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.
- **Base Case** – This scenario extends the baseline into the future and includes 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 selected set of scenarios that include different energy measures related to buildings, distribution systems, and generation systems. These scenarios are compared to the baseline for energy use change and to the Base Case for investment and operational costs.
- **District/Cluster** - a group of buildings and systems to be considered in the analysis.



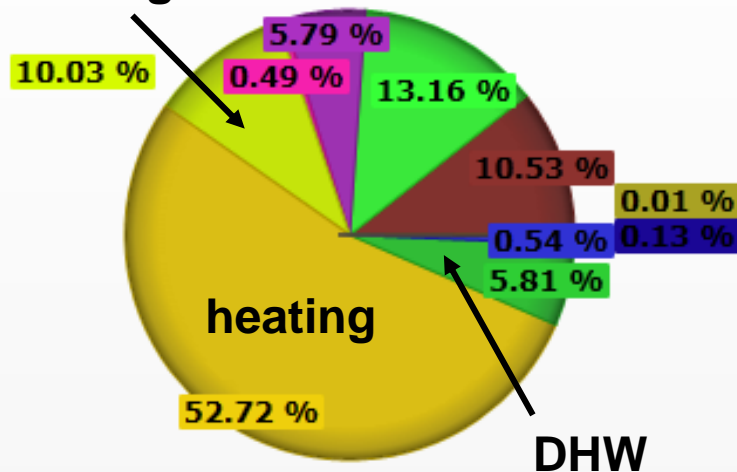
Future Base Case

End Use by Energy Use Intensity

- Examine where energy being used
- For this climate, heating loads dominate

Total Resource Breakdown

cooling



Legend

INTERIORLIGHTS	EXTERIORLIGHTS
INTERIOREQUIPMENT	EXTERIOREQUIPMENT
FANS	HEATREJECTION
PUMPS	
COOLING	
HEATING	
WATERSYSTEMS	

After Simulation, User Selects Packages

- Energy savings and costs displayed
- User chooses best package for each facility type

Net Zero Planner Study: (1055) Fort Illinois Example 2.0.16.03.11 12:33

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

Details Input Simulation **Package Selection** Results

Energy

Instructions

Save Changes Auto Select Select Baseline

Study Plans > Facility Groups > Packages

▲ GIB_Planned_ASHRAE...
☐ Default
☐ Envelope Package
☐ Infiltration Package
☐ Lighting Package
☐ HVAC Package
☒ VRF Package
☐ Daylighting Package
☐ Equipment Package
☐ On-Site Water Harvesting Package

► GIB_Planned_Pre_1980
► Hotel---

Packages Criteria Report Viewer

High Efficiency Buildings > GIB_Planned_ASHRAE_90.1_2010

Electricity: kBtu Gas: kBtu

Package	Energy Reduction (%)	Electric Usage (kBtu)	Electric Cost (\$)	Gas U
Default	0.00 %	12,199,144	357,550.24	13,23
Envelope Package	4.42 %	12,032,683	352,671.33	12,28
Infiltration Package	12.79 %	11,655,961	341,629.83	10,52
Lighting Package	19.76 %	9,359,427	274,319.69	11,04
HVAC Package	29.63 %	8,631,030	252,970.75	9,268
VRF Package	54.73 %	9,447,898	276,912.71	2,066
Daylighting Package	34.01 %	7,108,614	208,349.58	9,675
Equipment Package	37.23 %	6,043,230	177,123.77	9,922
On-Site Water Harvesting Package	37.23 %	6,043,230	177,123.77	9,922

Compare energy
reduction of packages

