UNIVERSITY *of* WASHINGTON
Integrated Design Lab

COLLEGE OF BUILT ENVIRONMENTS

U.S. DEPARTMENT OF ENERGY

neea

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ENERGY IMPACT

TARGETING 100!

OVERVIEW | EXPLORE | LOCALIZE | PRECEDENTS | LIBRARY

W INTEGRATED DESIGN LAB

OVERVIEW

- + hospital energy use
- + hospital energy cost
- + goals
- + integrated design
- + opportunities
- + T-100 approach
- + study design
- + energy outcomes
- + cost outcomes
- + conclusions
- + early adopters
- + partners
- + team
- + about this site

5%

+ The operation and construction of hospitals uses 5% of all energy consumed in the United States; including buildings, transport, and industry.

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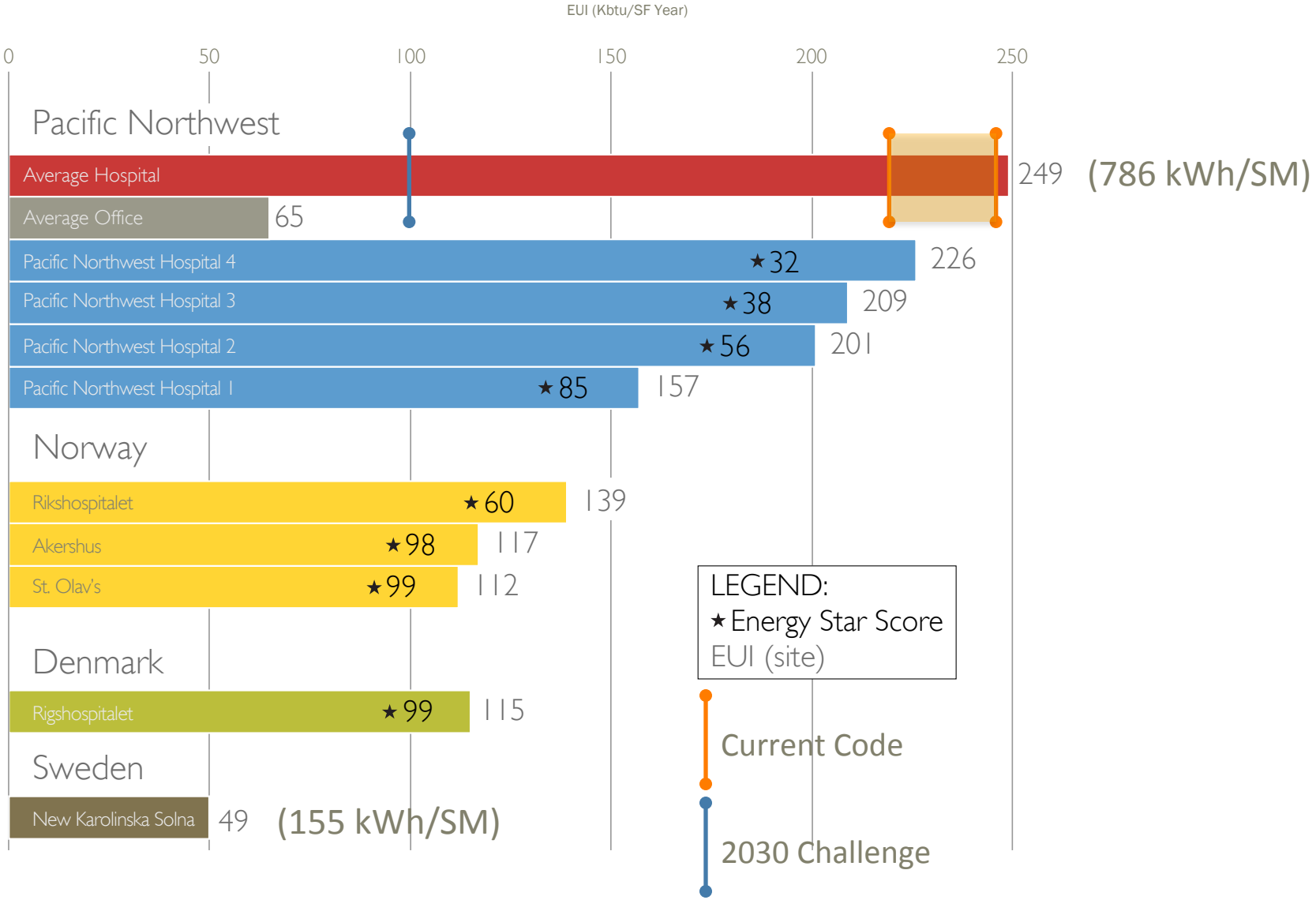
ENERGY USE IN CONTEXT

SELECTED ENERGY USE IN HOSPITALS BY COUNTRY



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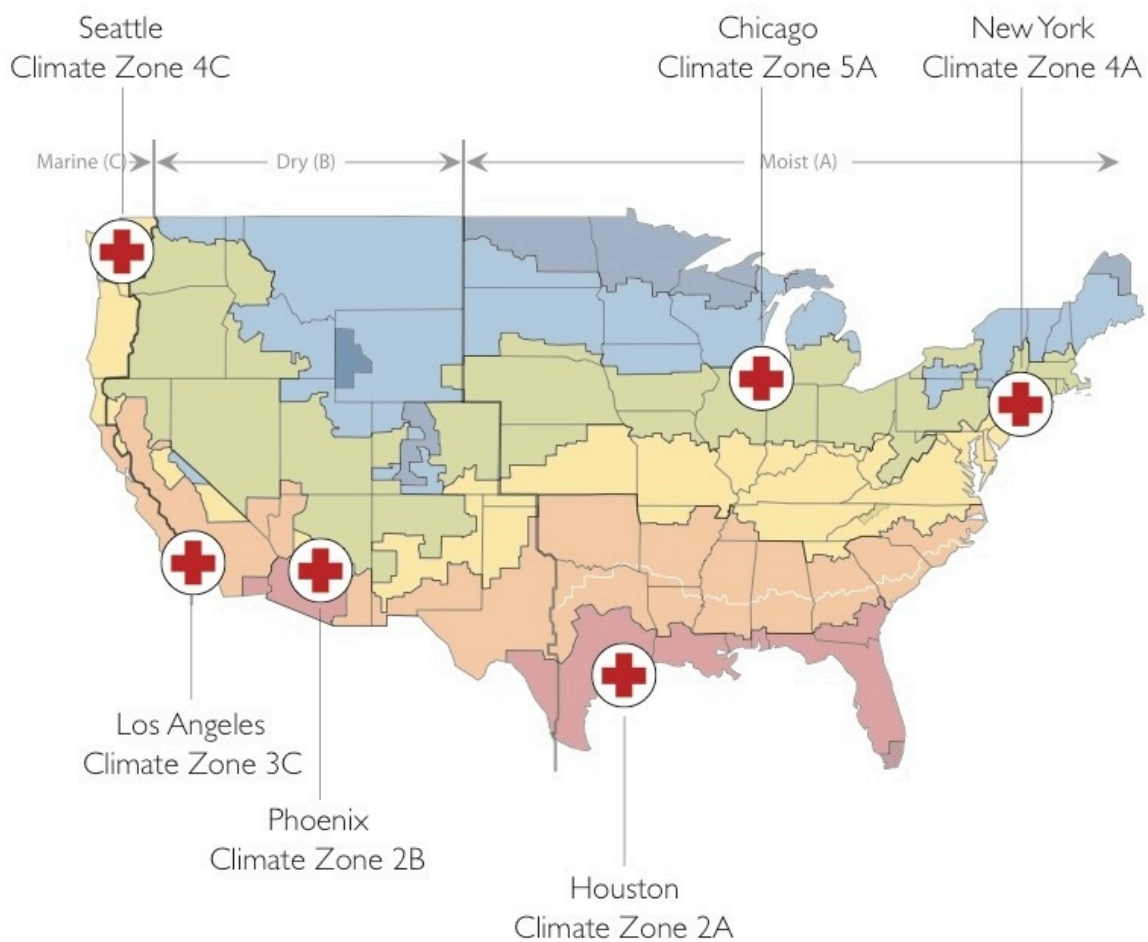
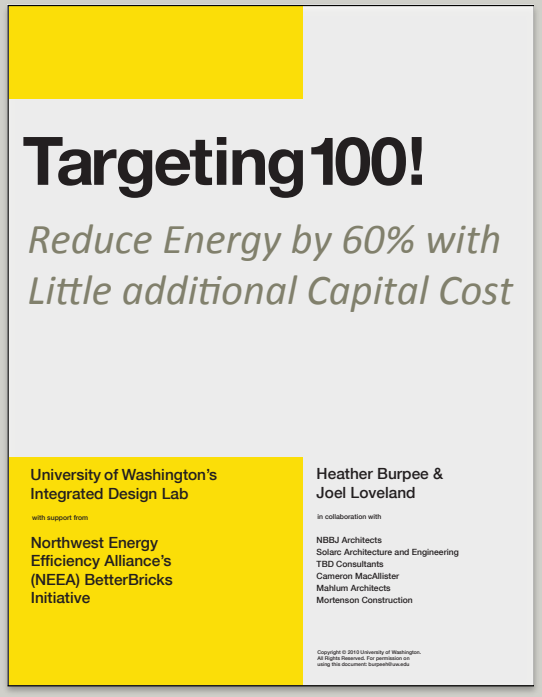
TARGETING 100! NATIONAL STUDY





Goals

- *Meet the 2030 Challenge (60% energy reduction)*
- *Determine the first cost investment required*
- *Disseminate Results*

with

SOLARC ARCHITECTURE AND ENGINEERING INC

tbd consultants Project & Construction Cost Management

nbbj

U.S. DEPARTMENT OF ENERGY

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HOSPITAL ENERGY USE

Energy Use Index = EUI

Typical **OPERATIONAL** acute-care hospitals

225-350 KBtu/SF Year

Typical **NEW** Hospitals that follow ASHRAE 90.1 2004

200-250 KBtu/SF Year

Typical **OFFICE BUILDING**

70 KBtu/Sf Year

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BENCHMARKING

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INTEGRATED DESIGN LAB

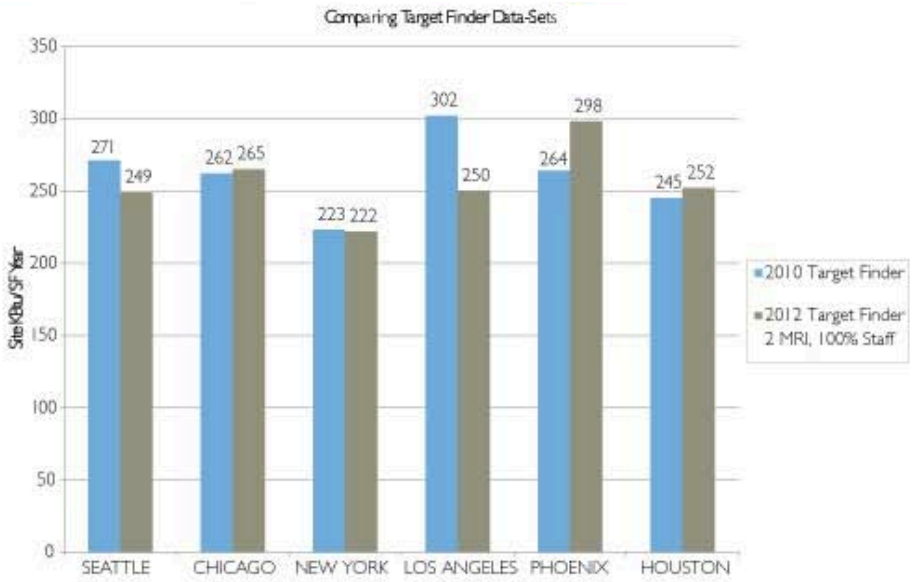
Process | Climate | Design Strategies | Loads | Energy | Cost

PROCESS

- introduction
- climate
- design strategies
- loads
- energy
- cost

OTHER RESOURCES

- T-100 process
- high performance healthcare
- benchmarking
- energy modeling
- peer review
- subtext
- next steps



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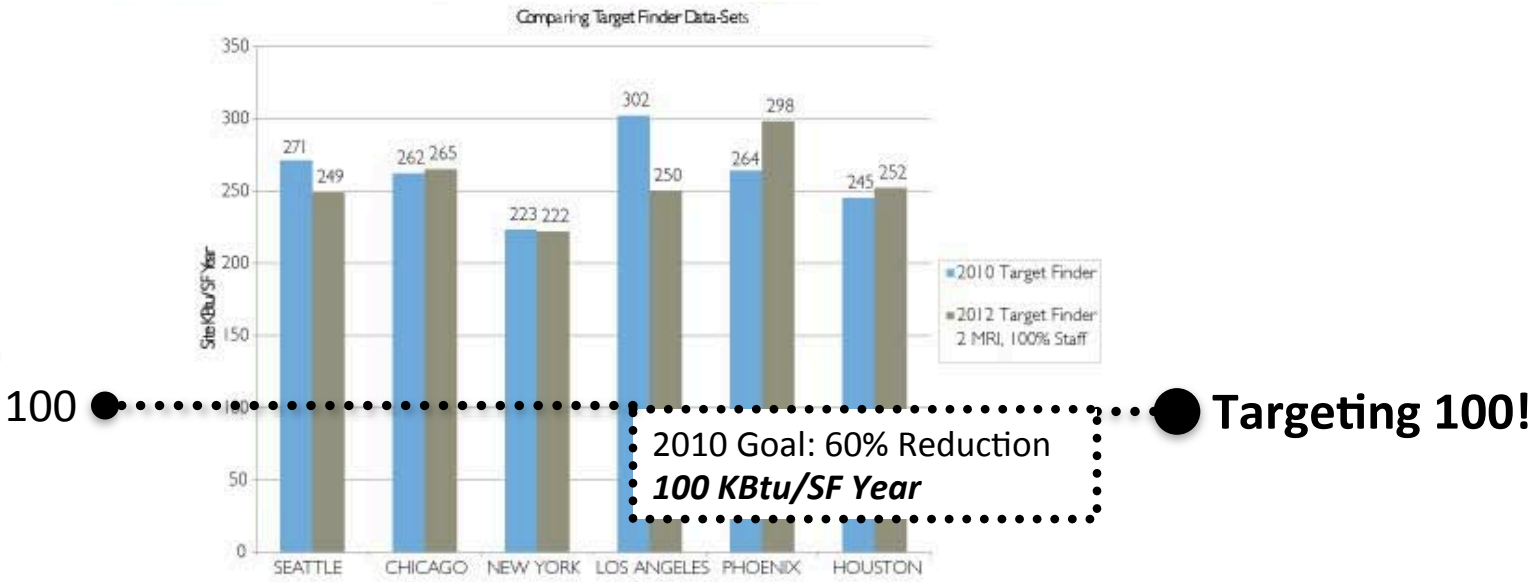

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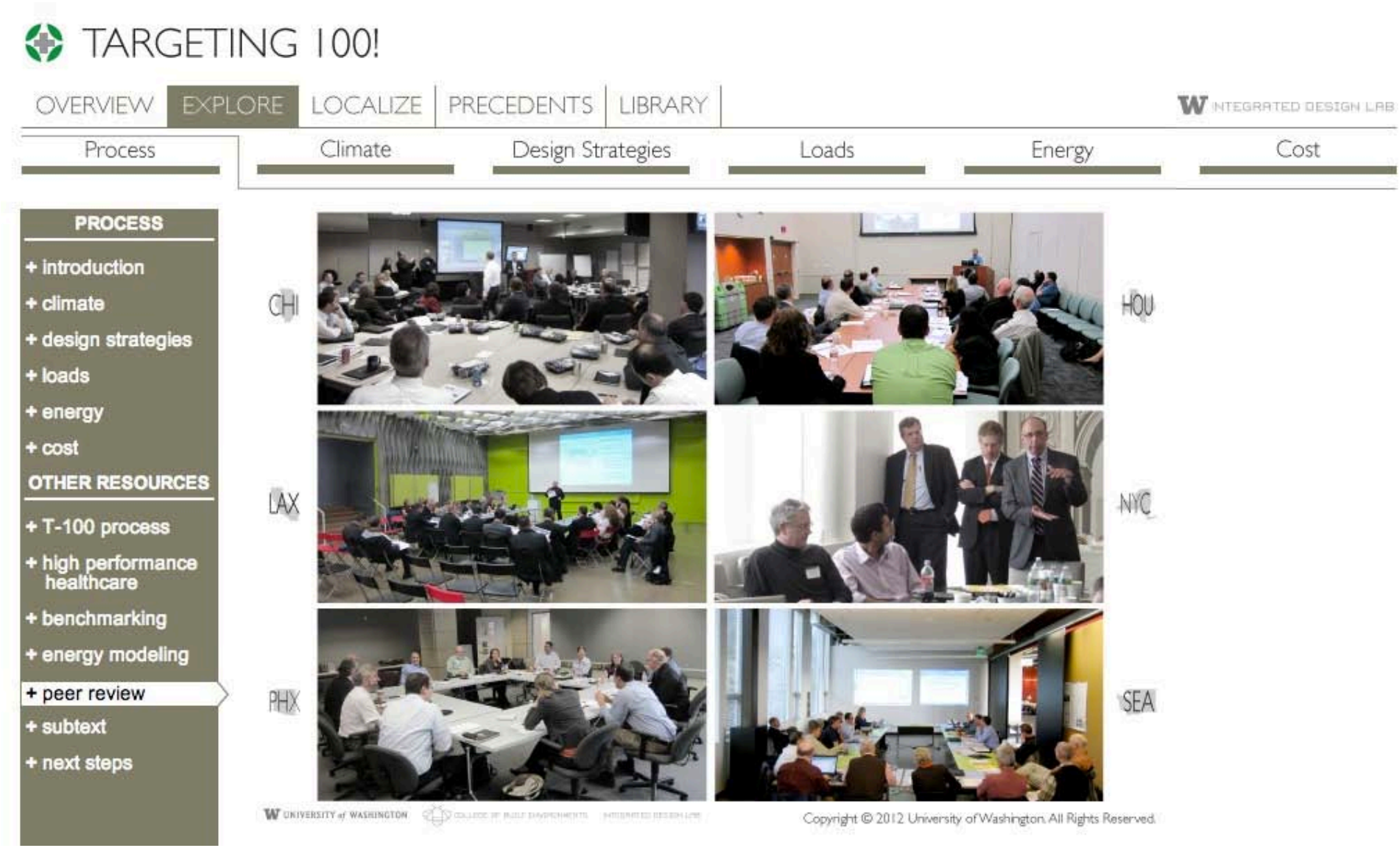
PEER REVIEW AND STAKEHOLDERS



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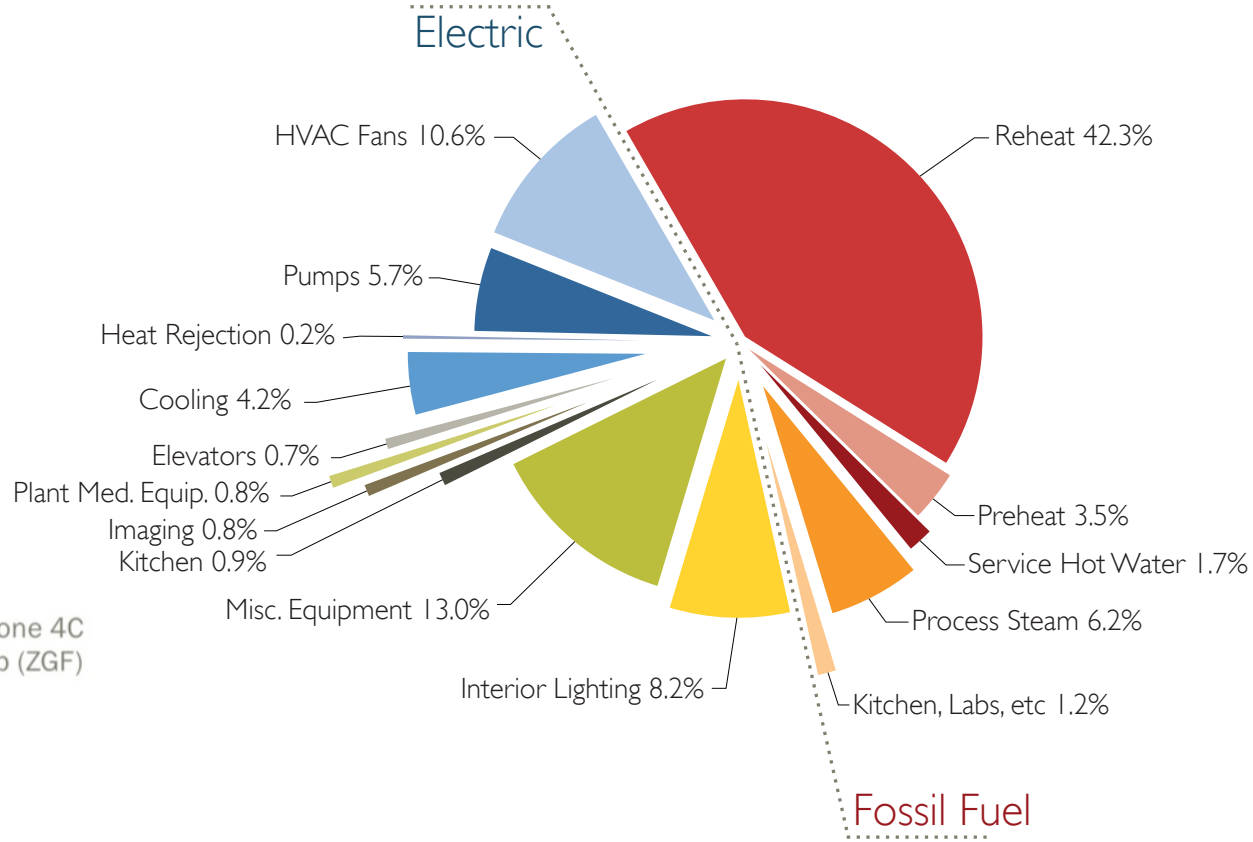
ENERGY EVALUATION STUDY
LEGACY SALMON CREEK MEDICAL CENTER

FACILITY PROFILE

LOCATION	Vancouver, Washington/Climate Zone 4C
ARCHITECT	Zimmer Gunsul Frasca Partnership (ZGF)
ENGINEER	AEI Affiliated Engineers
CLIENT	Legacy Health, Portland, Oregon
COMPLETED	2005
BEDS	220
SIZE	456,000 sf
EUI	215 KBtu/SF Year

ENERGY MONITORING RESULTS



THE TOOL

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- + early adopters
- + partners
- + team
- + about this site

+ When navigating the website...

OVERVIEW | EXPLORE | LOCALIZE | PRECEDENTS | LIBRARY

1. Use the OVERVIEW tab to understand more about the concepts of Targeting 100!
2. Use the EXPLORE tab to view Targeting 100! details and results.
3. Use the LOCALIZE tab as a filter to find data on a specific hospital type.
4. Use the PRECEDENTS tab to see examples of high performance hospitals.
5. Use the LIBRARY tab to download parts of Targeting 100! and other detailed information.
6. When you see a "+" symbol, click for more information.

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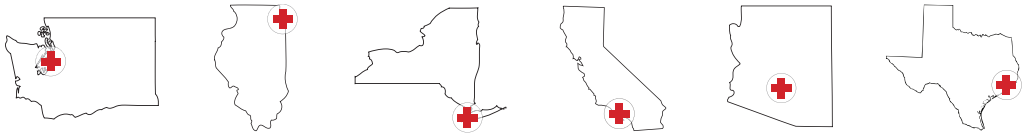
THE GOALS OF T-100



SEATTLE 4C | CHICAGO 5A | NEW YORK 4A | LOS ANGELES 3C | PHOENIX 2B | HOUSTON 2A

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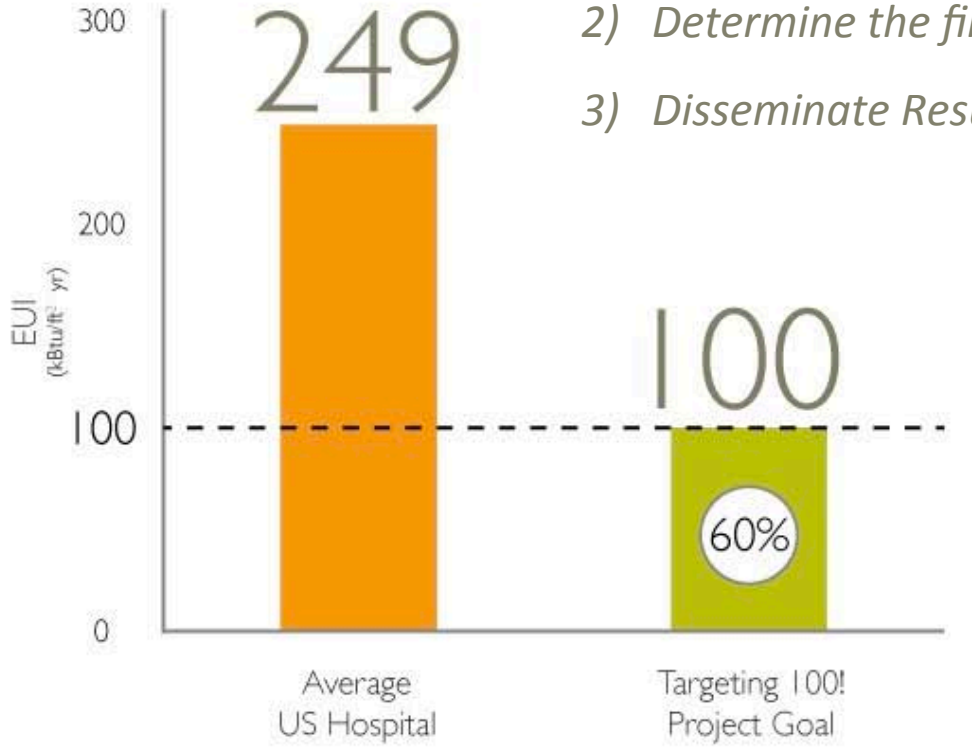
1) *Meet the 2030 Challenge for 2010.*
2) *Determine the first cost investment.*
3) *Disseminate Results.*



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CONCEPTUAL FRAMEWORK

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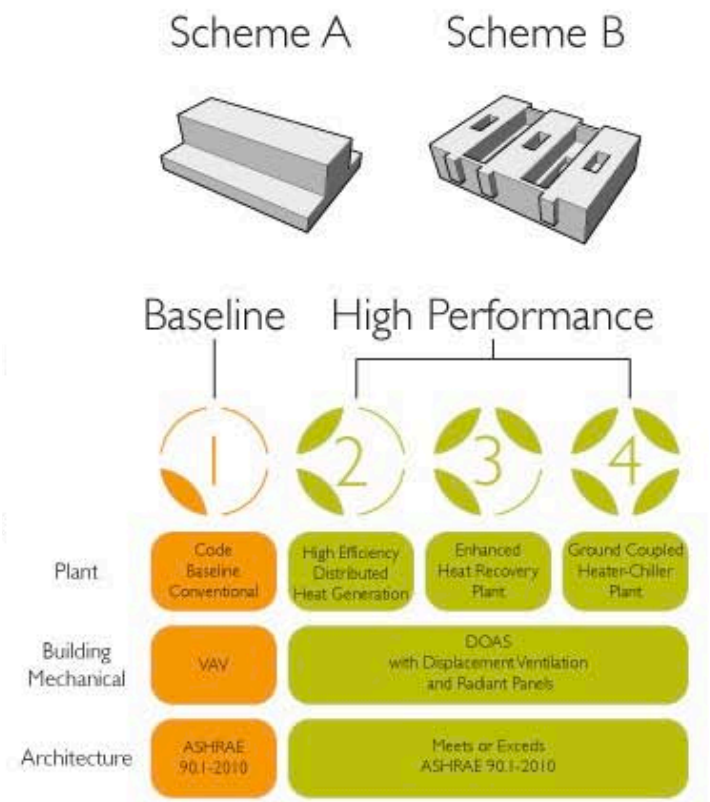

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Holding Constant Between Schemes:

- Program – 225 beds, 477,000 SF
- Window to wall ratios – 30%
- Approximate footprint
- Energy related strategy bundles

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INTEGRATED DESIGN

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INTEGRATED STRATEGIES FOR ENERGY AND COST SAVINGS

+ Integrated design teams working together from the beginning of a project allows the appropriate energy efficient systems to work together effectively.

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FIRST – LOAD REDUCTION

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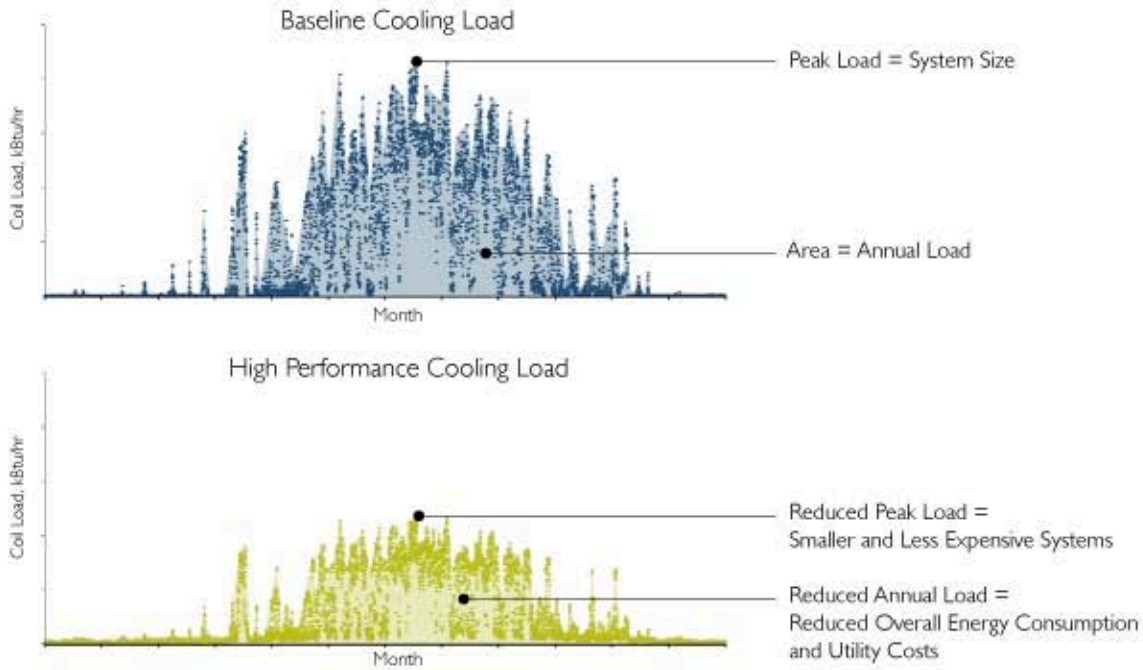

+ The Targeting 100! approach is to first reduce loads, then to apply smaller, efficient systems.

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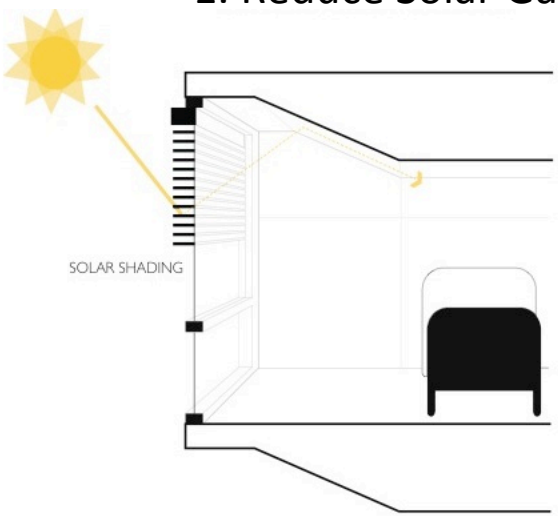
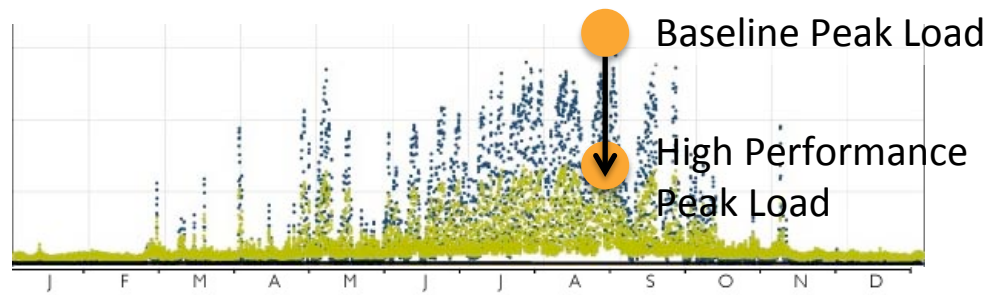
INTEGRATED STRATEGIES - EX

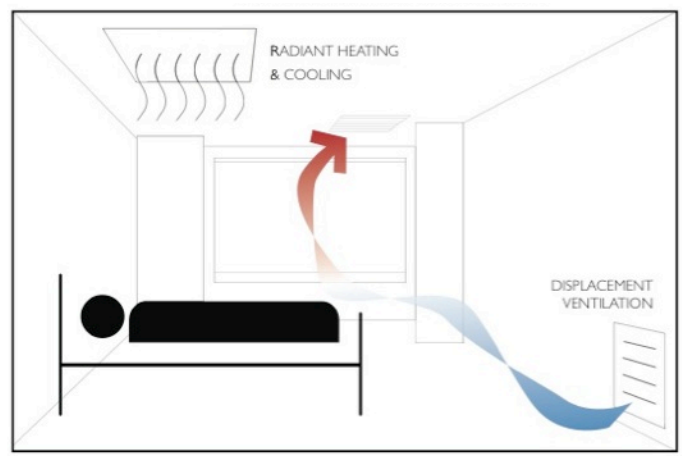
1. Reduce Solar Gain



2. Reduce Peak Loads



3. Reduce Building Loads, De-couple Heating, Cooling, Ventilation



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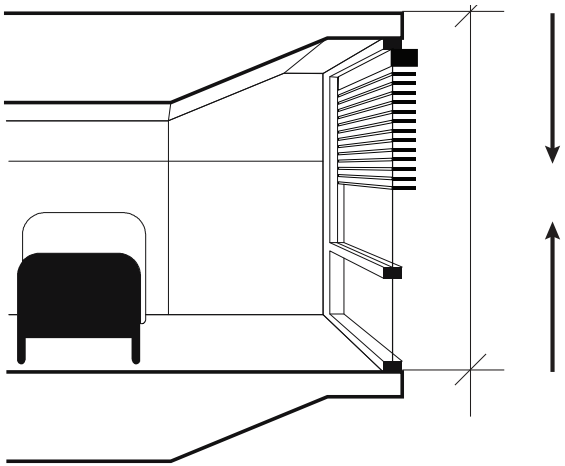
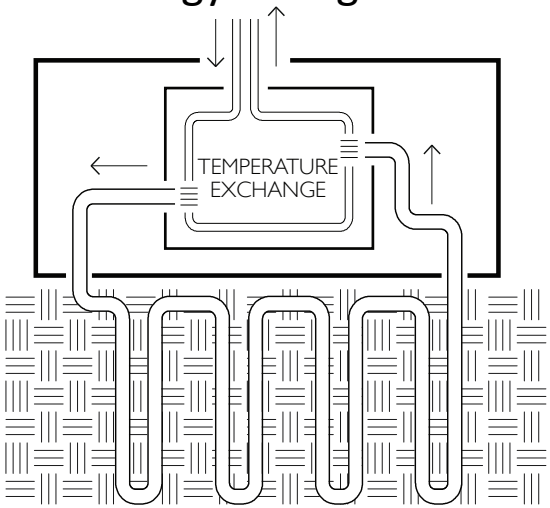
INTEGRATED STRATEGIES - EX

4. Reduced loads allow for lower floor-floor
= cost savings



5. Balanced loads allows for more efficient, and smaller plant systems
= cost & energy savings



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ARCHITECTURAL SYSTEMS

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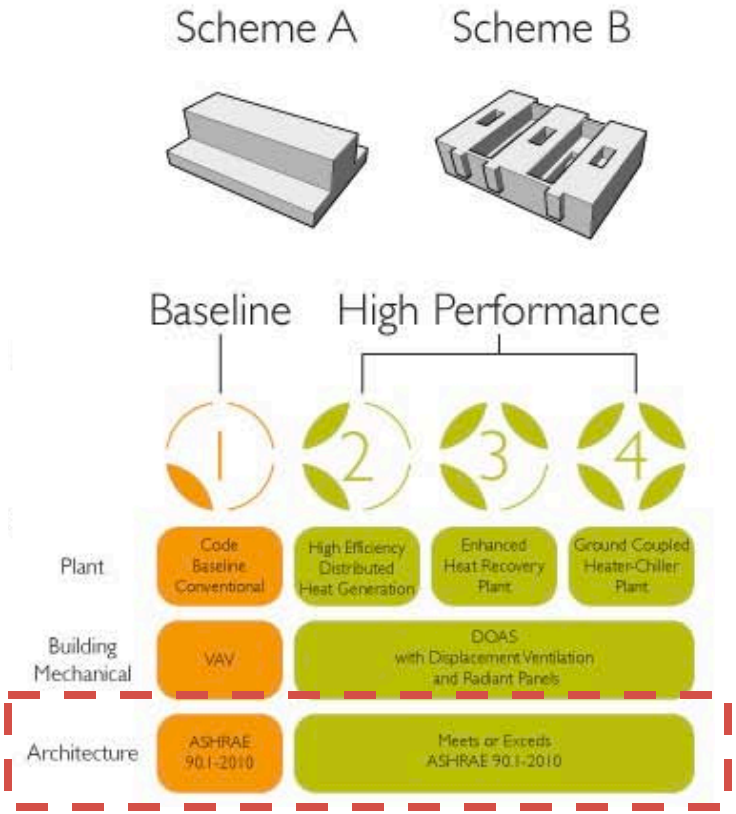

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Holding Constant Between Schemes:

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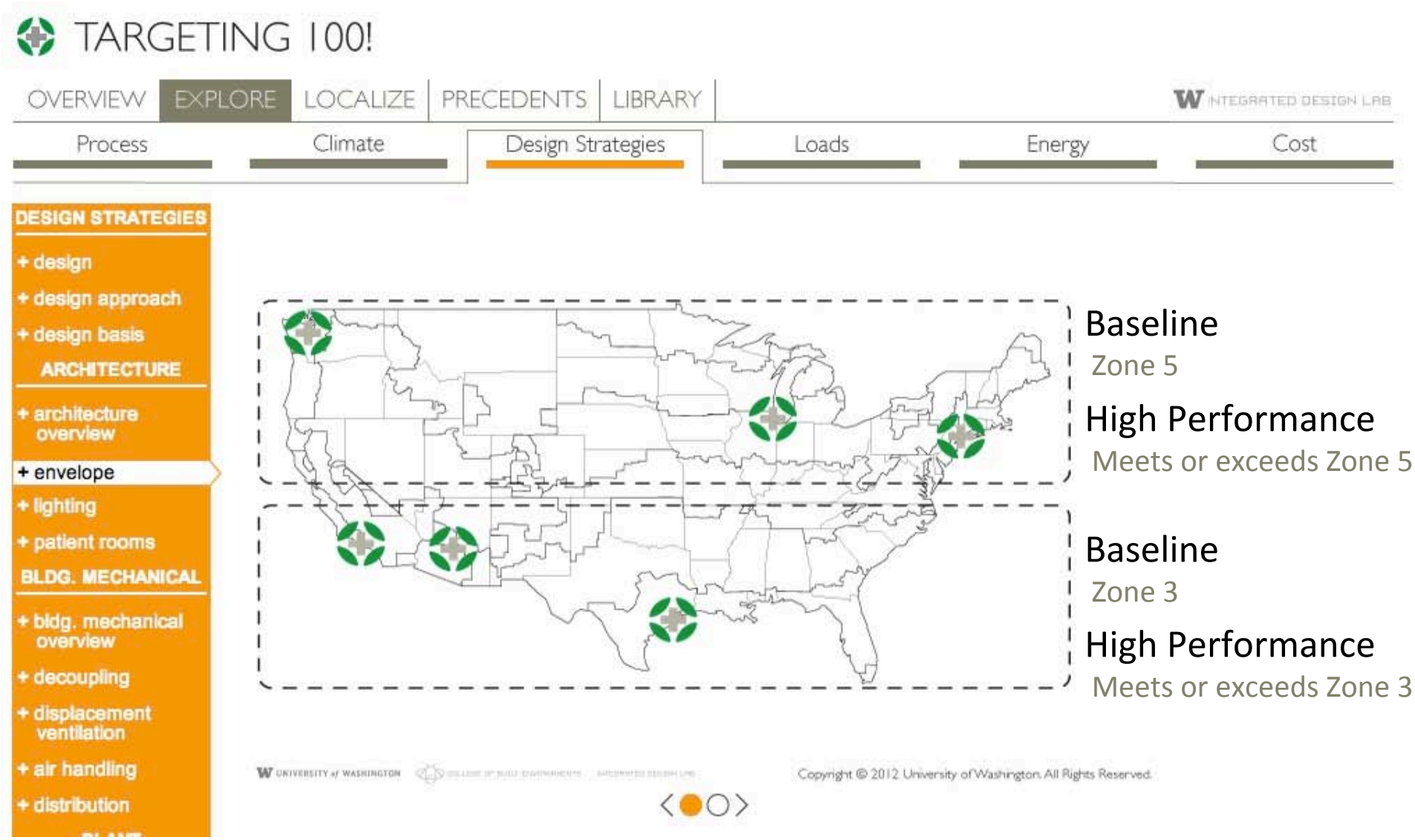
GROUPING CLIMATES - ENVELOPE



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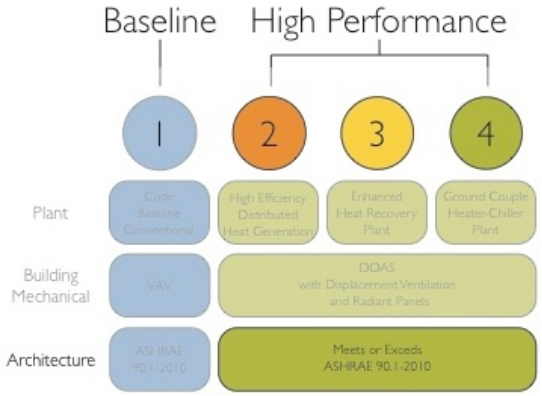
ARCHITECTURAL SYSTEMS

Architectural Systems:

- *High Performance Envelope*
  - *Balance heat loss and radiant comfort with thermal performance*
- *Solar Control*
  - *Minimize peak loads for cooling performance and increased thermal comfort*
- *Daylighting*
  - *Increase interior environmental quality and decrease electric lighting*



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BUILDING MECHANICAL SYSTEMS

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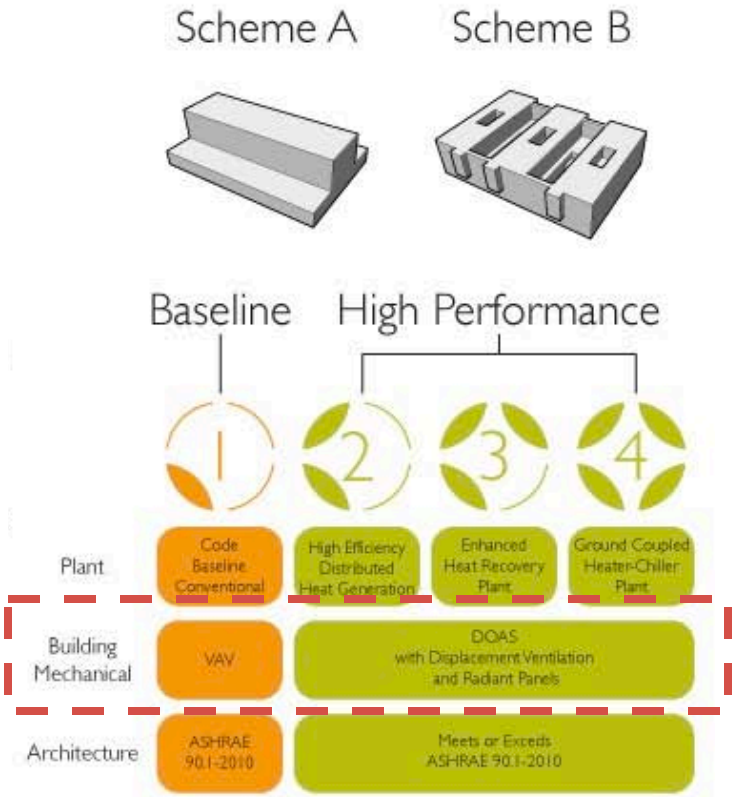

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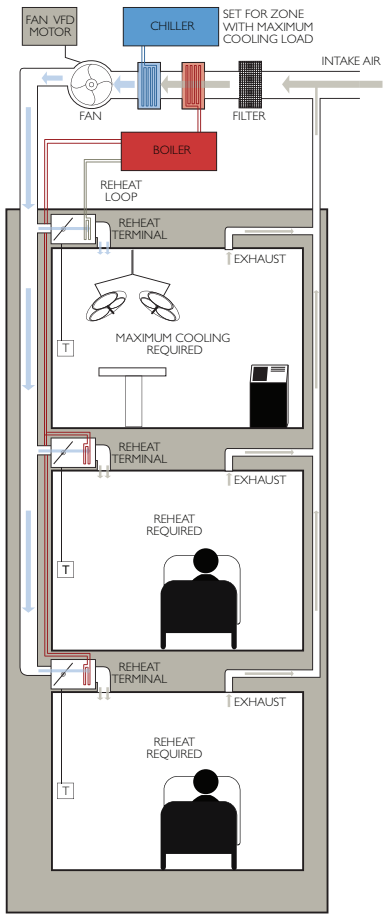
BUILDING MECHANICAL SYSTEMS

Baseline

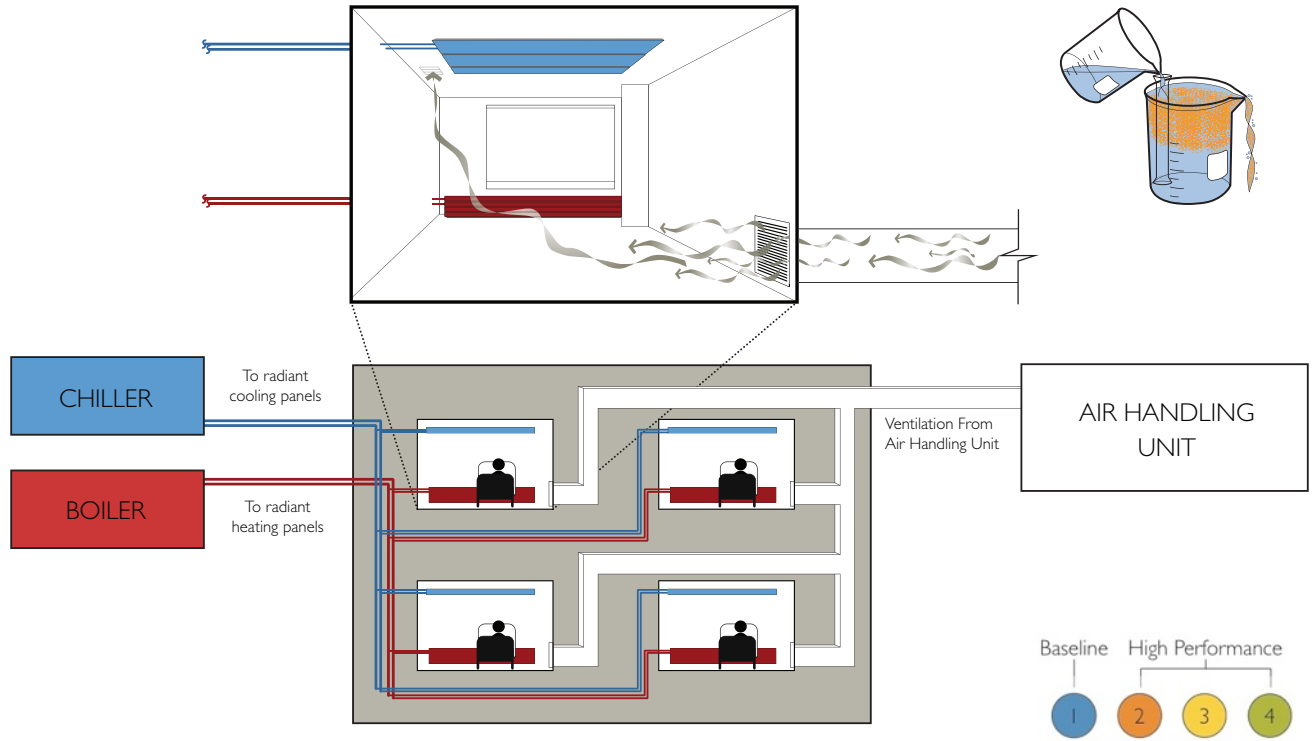
VAV



High Performance

De-Coupled Ventilation and Zonal Heating and Cooling via Radiant Sources

DOAS
with Displacement Ventilation
and Radiant Panels



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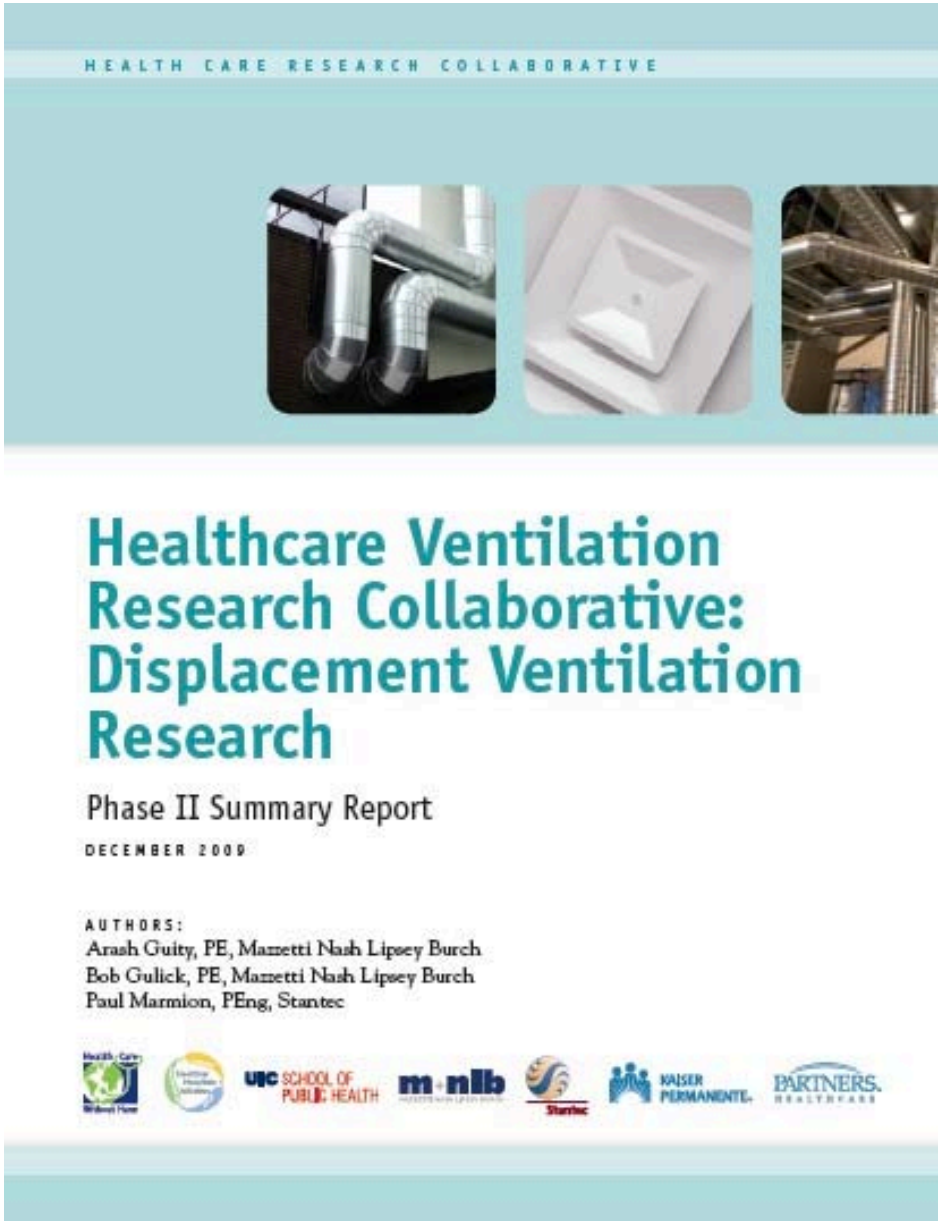
DISPLACEMENT VENTILATION


HEALTH CARE RESEARCH COLLABORATIVE

Healthcare Ventilation Research Collaborative: Displacement Ventilation Research

Phase II Summary Report

DECEMBER 2009

AUTHORS:
Arash Guity, PE, Mazzetti Nash Lipsey Burch
Bob Gulick, PE, Mazzetti Nash Lipsey Burch
Paul Marmion, PEng, Stantec

with:
Wieren Xu
HVRC
Kaiser and Partners Health Funding

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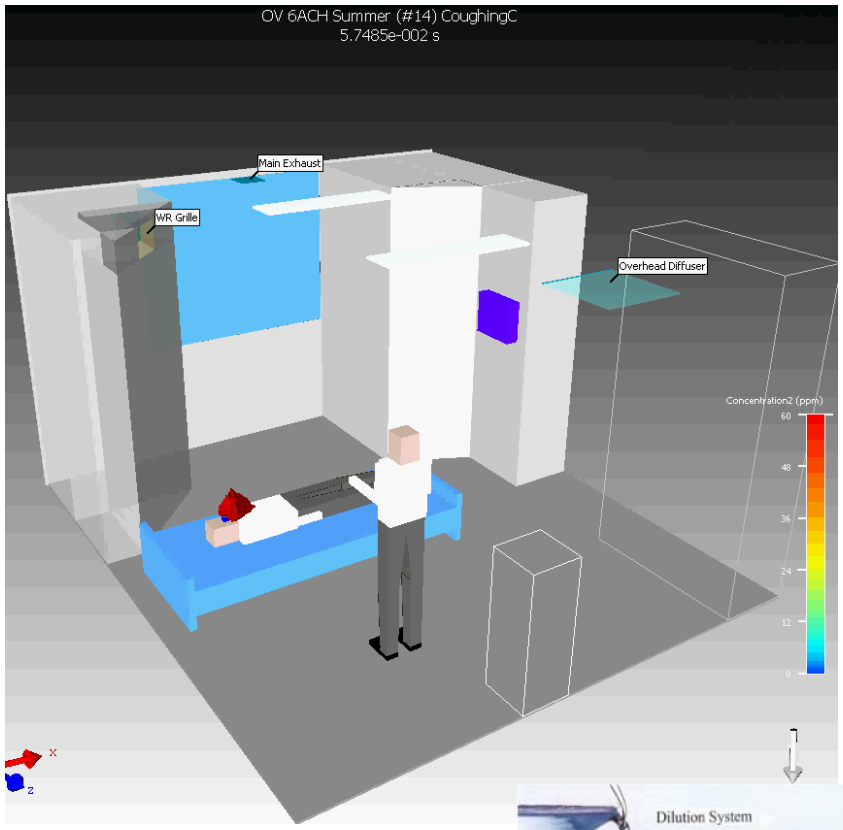
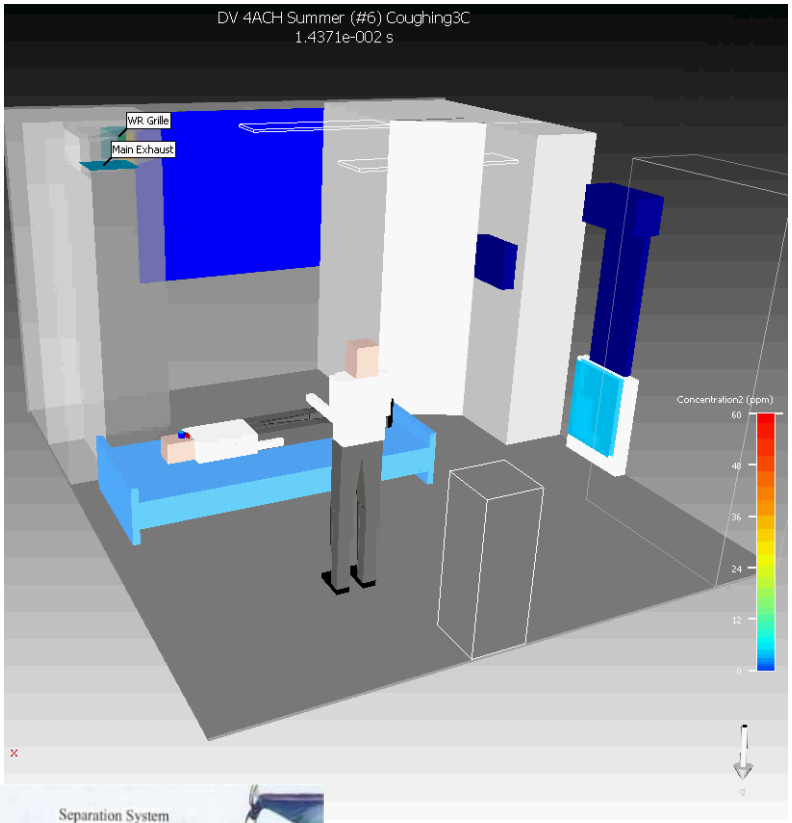
DISPLACEMENT VENTILATION

Design Considerations – Coughing





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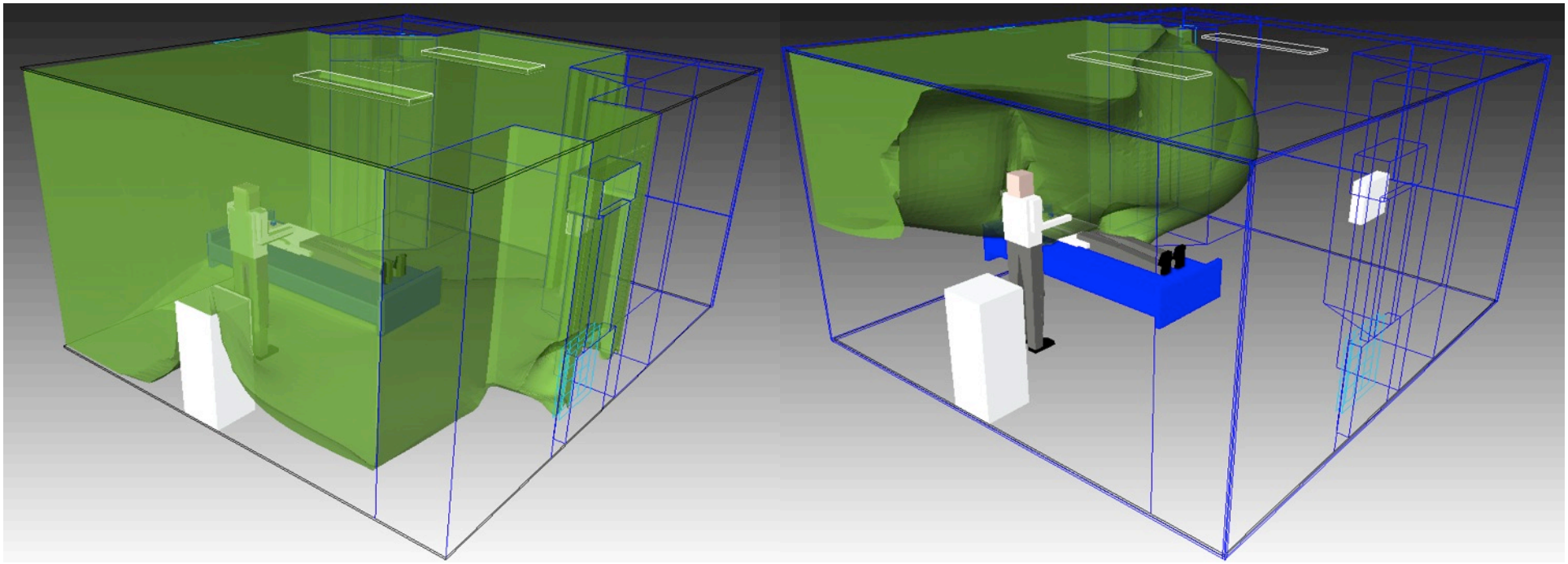
DISPLACEMENT VENTILATION

Design Considerations – Solar Gain

3 ppm Iso-Surface Concentration



Solar Gain: Full

Solar Gain: Mitigated

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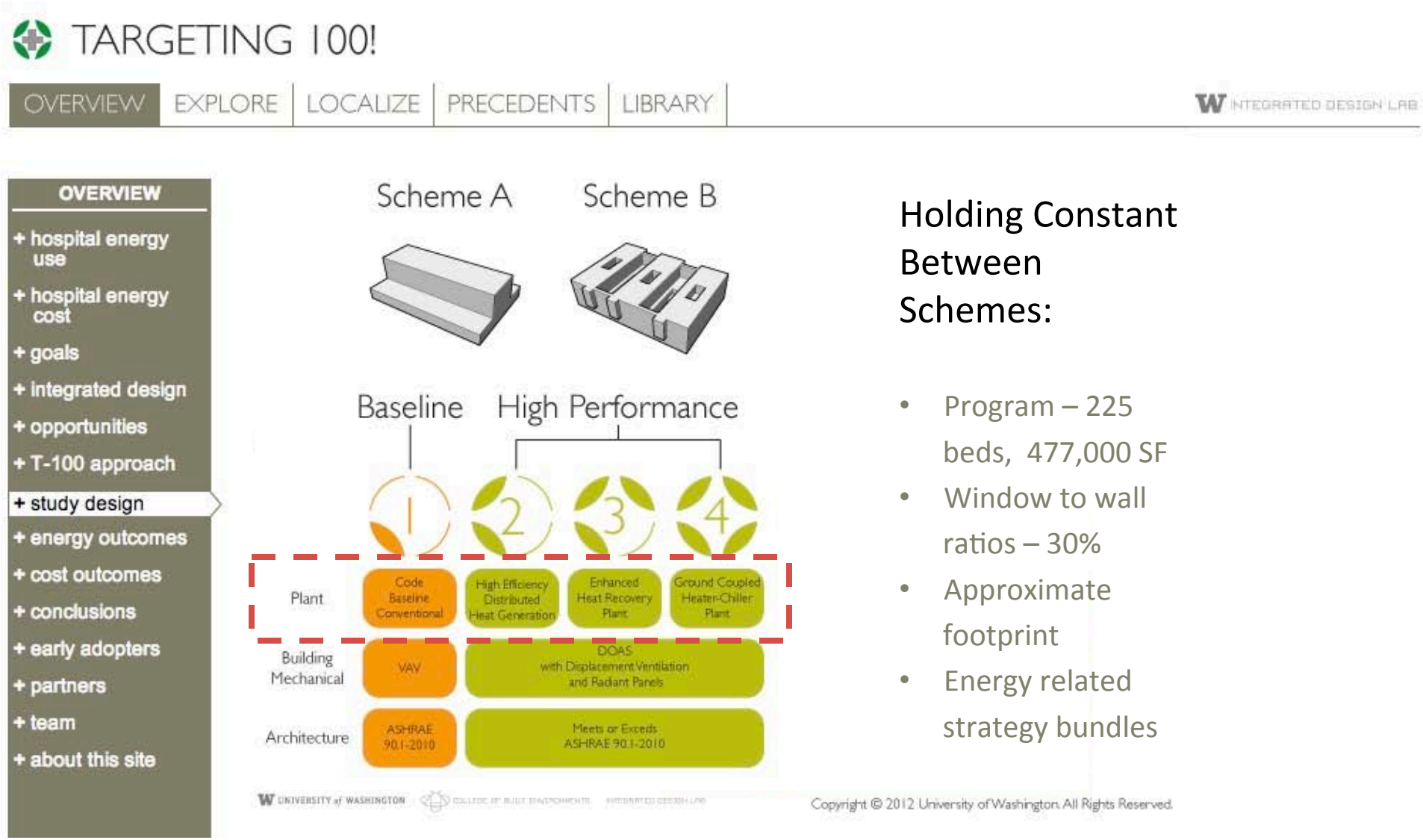
PLANT SYSTEMS



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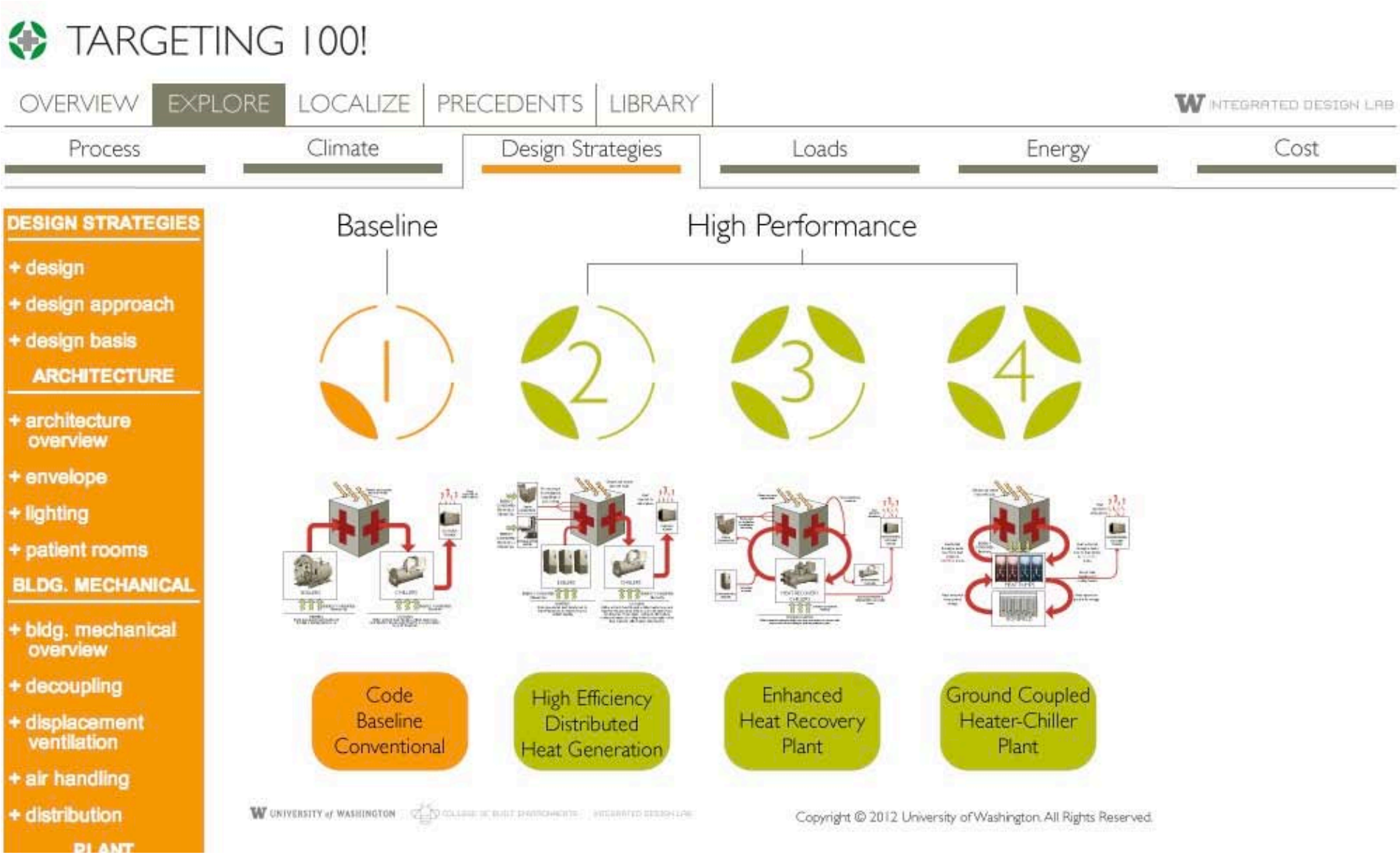
PANT SYSTEMS



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BASELINE – PLANT 1

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Process | Climate | Design Strategies | Loads | Energy | Cost

DESIGN STRATEGIES

+ design
+ design approach
+ design basis

ARCHITECTURE

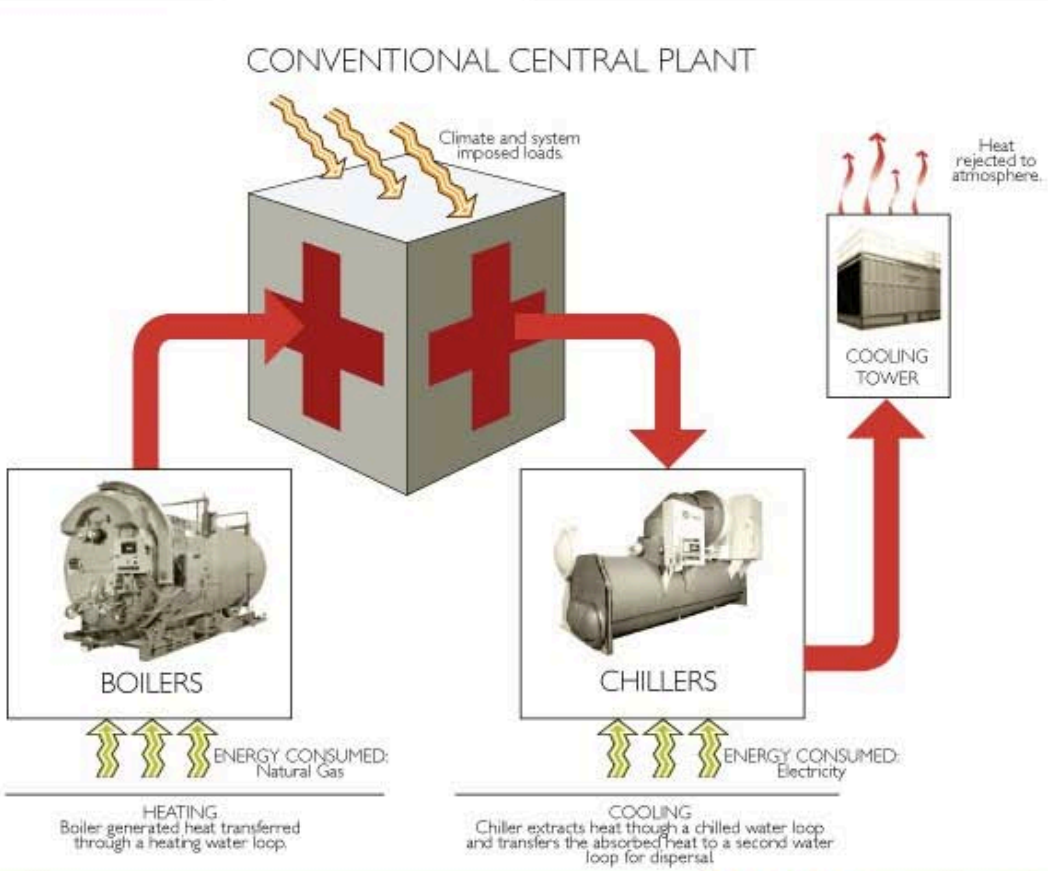
+ architecture overview
+ envelope
+ lighting
+ patient rooms

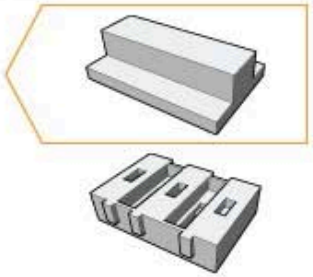
BLDG. MECHANICAL

+ bldg. mechanical overview
+ decoupling
+ displacement ventilation
+ air handling
+ distribution

PLANT

+ plant overview
+ plant 1





Plant 1

Baseline

DIAGRAMS **SCHEMATICS**

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HIGH PERFORMANCE – PLANT 2

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Process | Climate | Design Strategies | Loads | Energy | Cost

DESIGN STRATEGIES

- + design
- + design approach
- + design basis

ARCHITECTURE

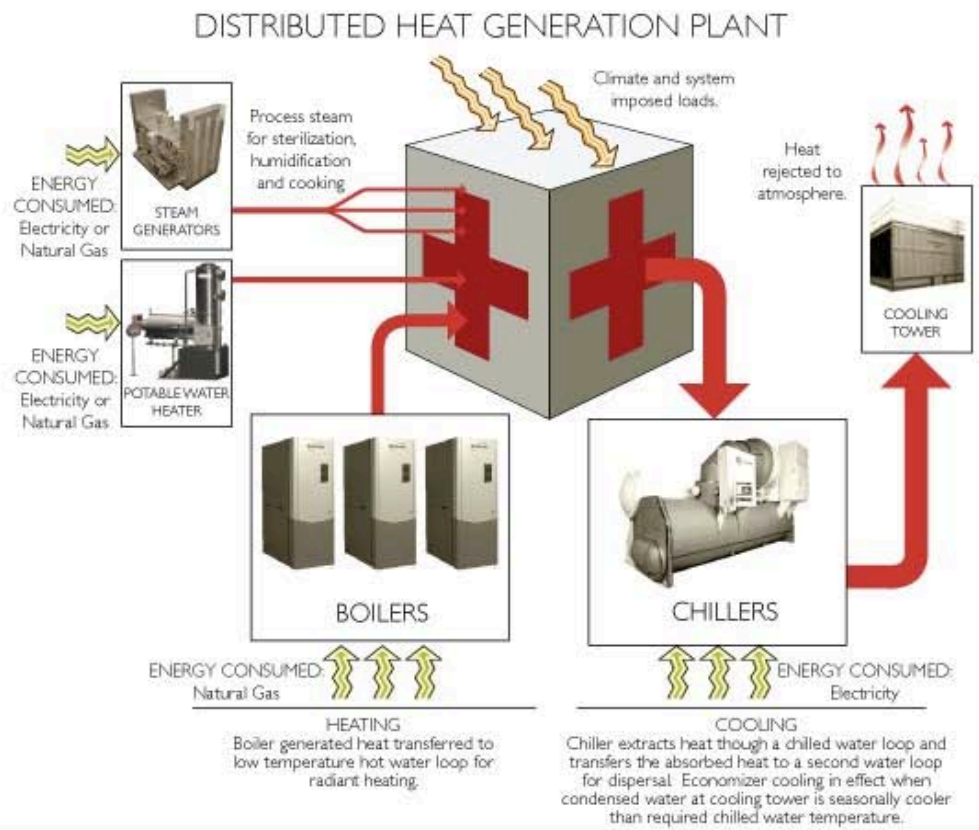
- + architecture overview
- + envelope
- + lighting
- + patient rooms

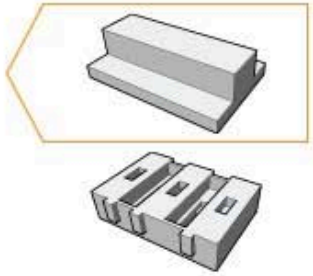
BLDG. MECHANICAL

- + bldg. mechanical overview
- + decoupling
- + displacement ventilation
- + air handling
- + distribution

PLANT

- + plant overview
- + plant 1





Plant 2 DIAGRAMS SCHEMATICS

Dedicated Distributed Heat Generation Plant

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HIGH PERFORMANCE – PLANT 3

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Process | Climate | Design Strategies | Loads | Energy | Cost

DESIGN STRATEGIES

+ design
+ design approach
+ design basis

ARCHITECTURE

+ architecture overview
+ envelope
+ lighting
+ patient rooms

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+ bldg. mechanical overview
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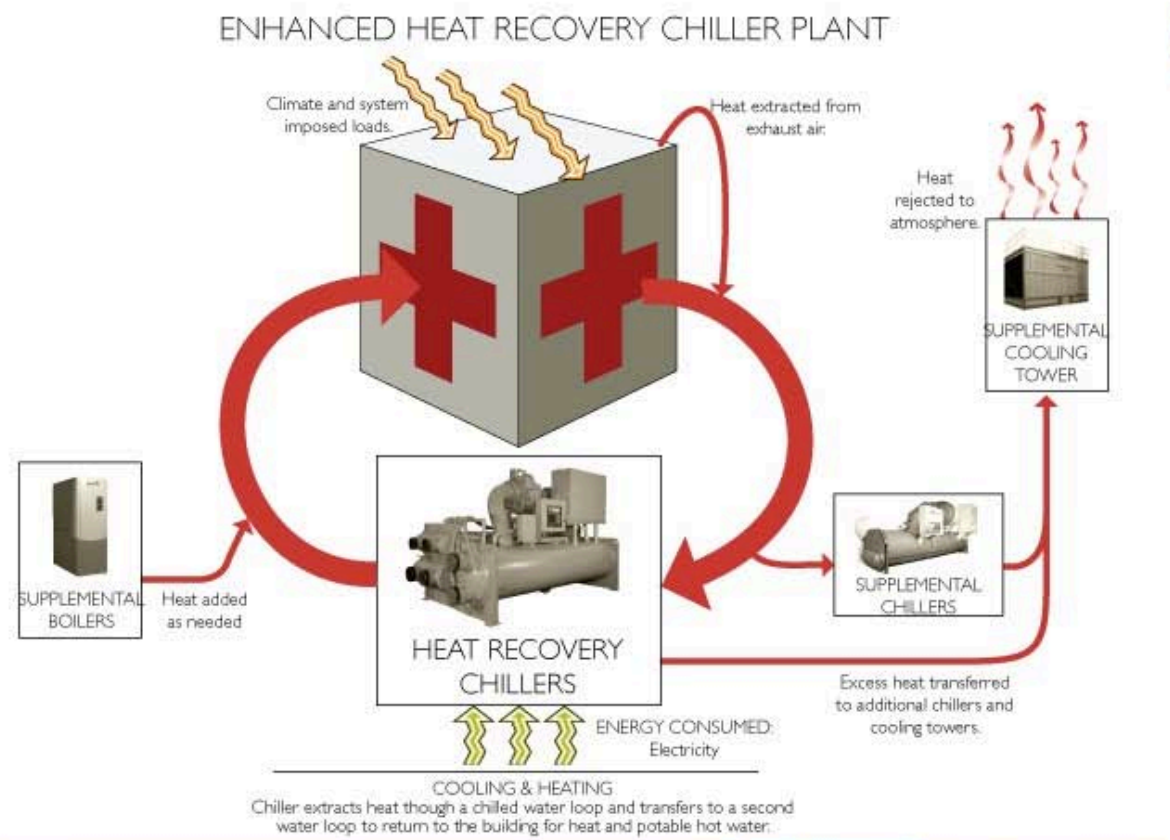
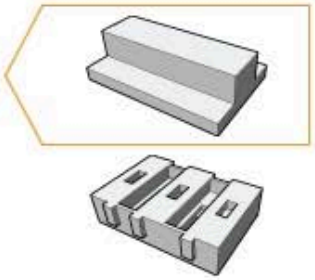
+ air handling
+ distribution

PLANT

+ plant overview
+ plant 1





Plant 3

Enhanced Heat Recovery Chiller Plant

DIAGRAMS **SCHEMATICS**

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HIGH PERFORMANCE – PLANT 4

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W INTEGRATED DESIGN LAB

Process | Climate | Design Strategies | Loads | Energy | Cost

DESIGN STRATEGIES

- + design
- + design approach
- + design basis

ARCHITECTURE

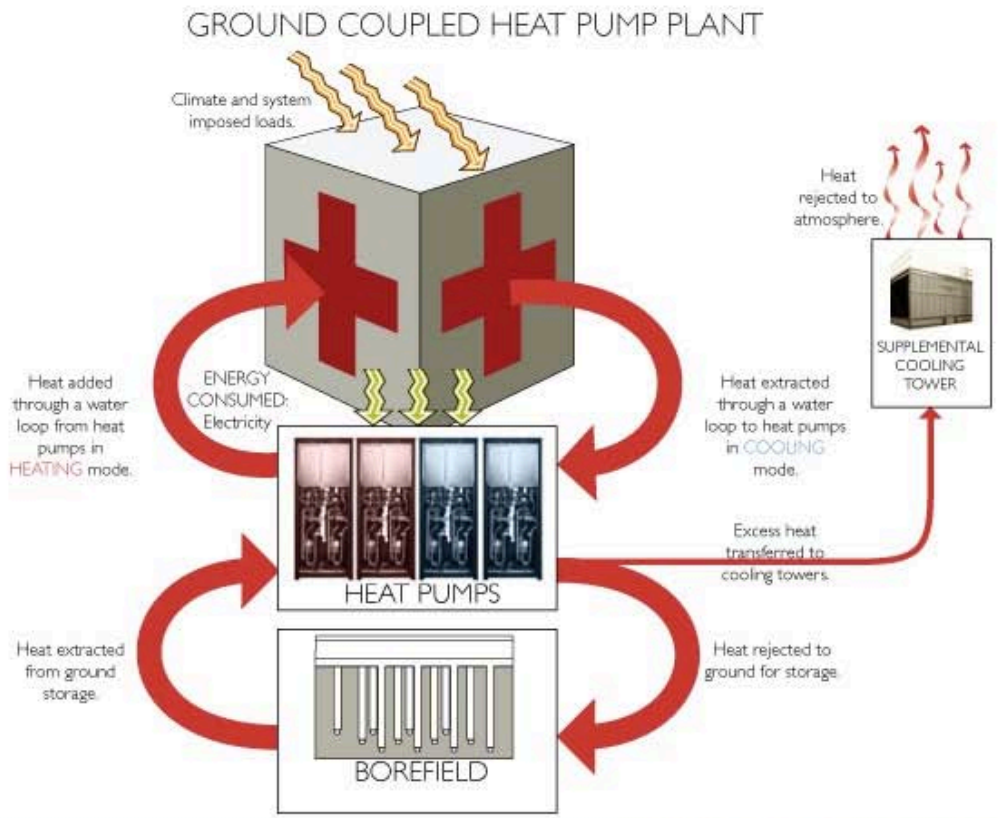
- + architecture overview
- + envelope
- + lighting
- + patient rooms

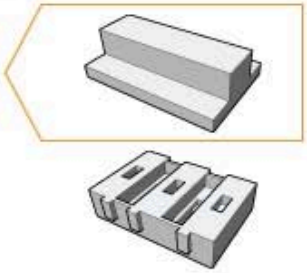
BLDG. MECHANICAL

- + bldg. mechanical overview
- + decoupling
- + displacement ventilation
- + air handling
- + distribution

PLANT

- + plant overview
- + plant 1
- + plant 2





DIAGRAMS SCHEMATICS

Plant 4

Ground-Coupled Heat Pump Plant

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ANNUAL LOAD PROFILES -- BASELINE

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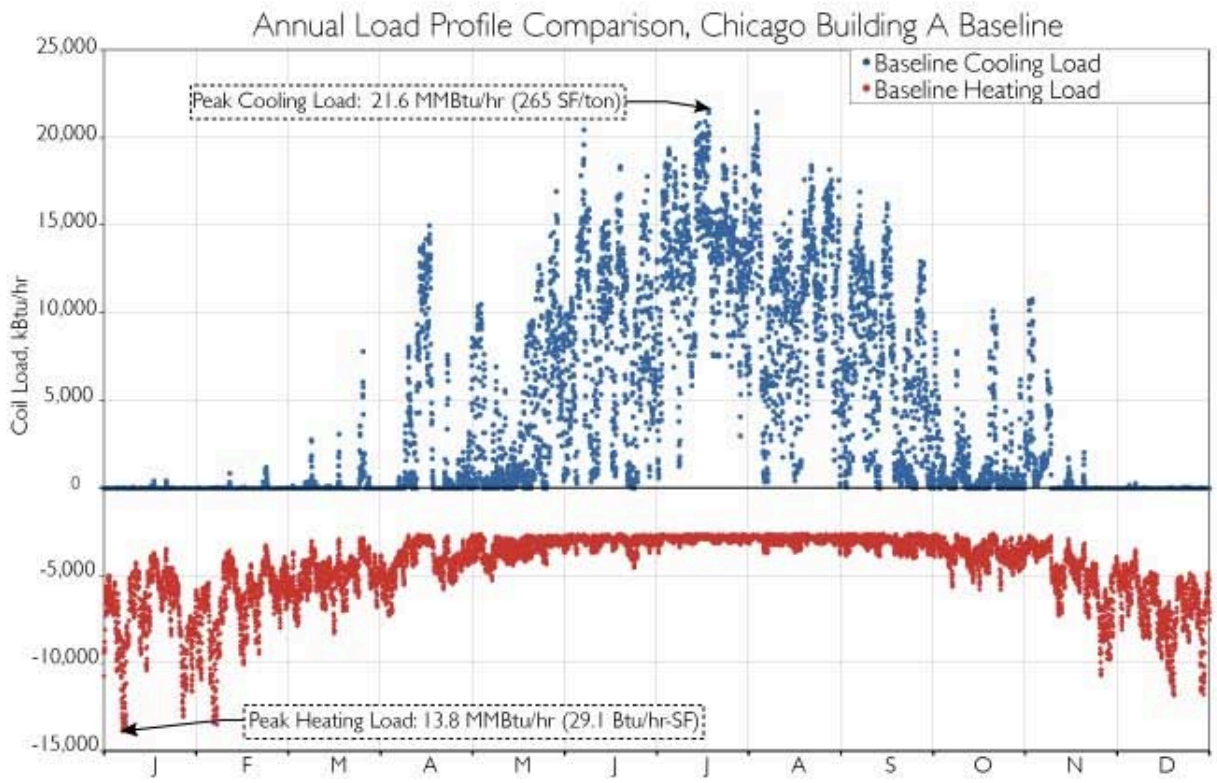
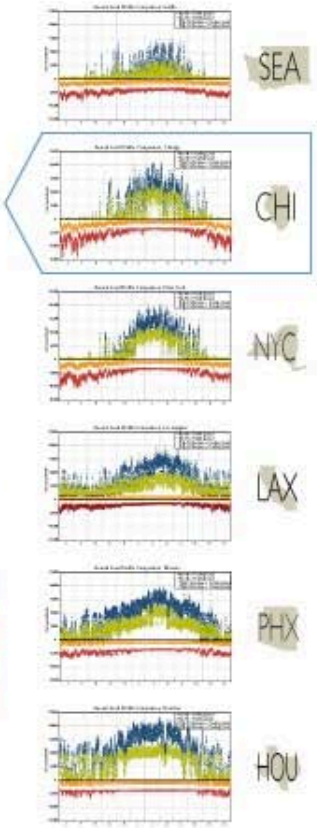
INTEGRATED DESIGN LAB

Process | Climate | Design Strategies | Loads | Energy | Cost

LOADS

- + loads
- + loads approach
- + plant loads overview
- + plant heating
- + plant cooling
- + patient rooms zone loads
- + patient room solar loads
- + patient room peak solar loads
- + shading





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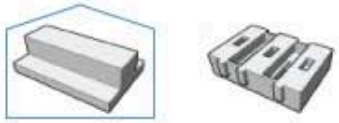
- Baseline Cooling Load
- Baseline Heating Load
- High Performance Cooling Load
- High Performance Heating Load

All
Baseline
High Performance



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ANNUAL LOAD PROFILES -- HP

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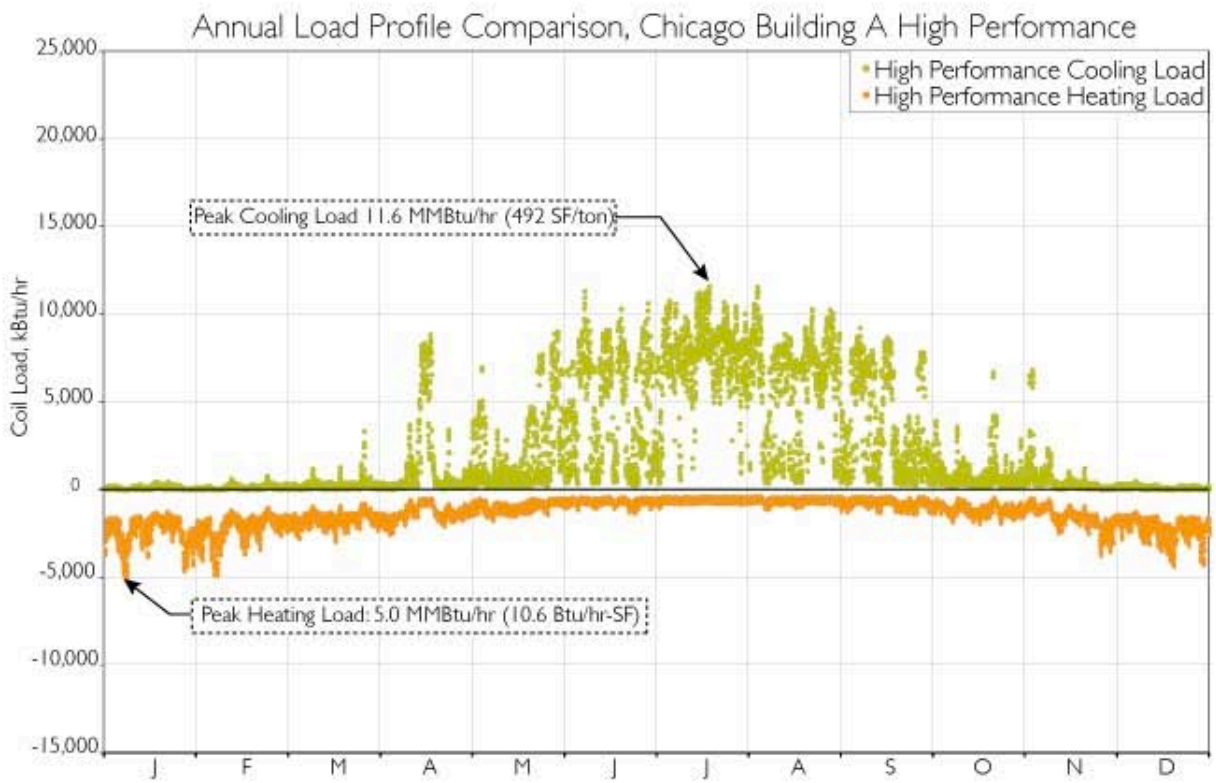
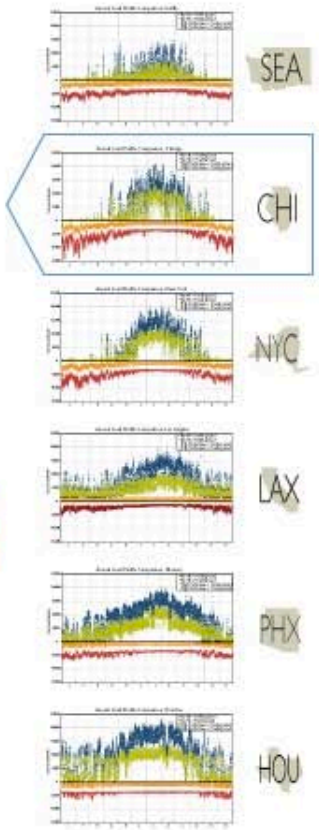
Process | Climate | Design Strategies | Loads | Energy | Cost

LOADS

- + loads
- + loads approach
- + plant loads overview
- + plant heating
- + plant cooling
- + patient rooms zone loads
- + patient room solar loads
- + patient room peak solar loads
- + shading





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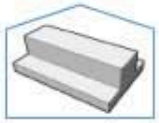
- Baseline Cooling Load
- Baseline Heating Load
- High Performance Cooling Load
- High Performance Heating Load

All
Baseline
High Performance



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ANNUAL LOAD PROFILES -- ALL

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Process | Climate | Design Strategies | Loads | Energy | Cost

LOADS

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- + plant loads overview
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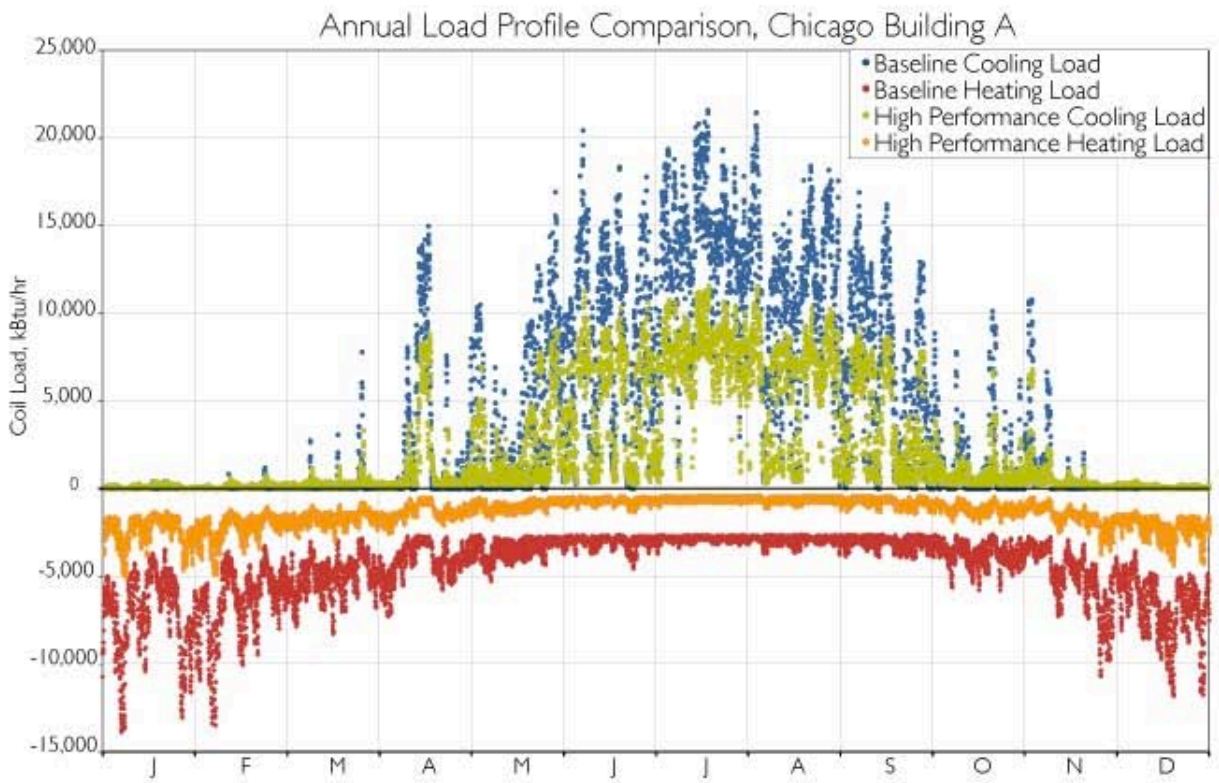
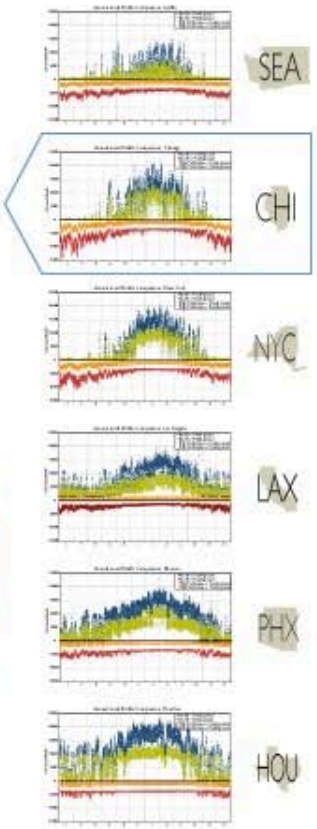
- + plant cooling
- + patient rooms zone loads
- + patient room solar loads
- + patient room peak solar loads
- + shading





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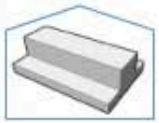
- Baseline Cooling Load
- Baseline Heating Load
- High Performance Cooling Load
- High Performance Heating Load

All
Baseline
High Performance



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INDIVIDUAL ZONE LOADS

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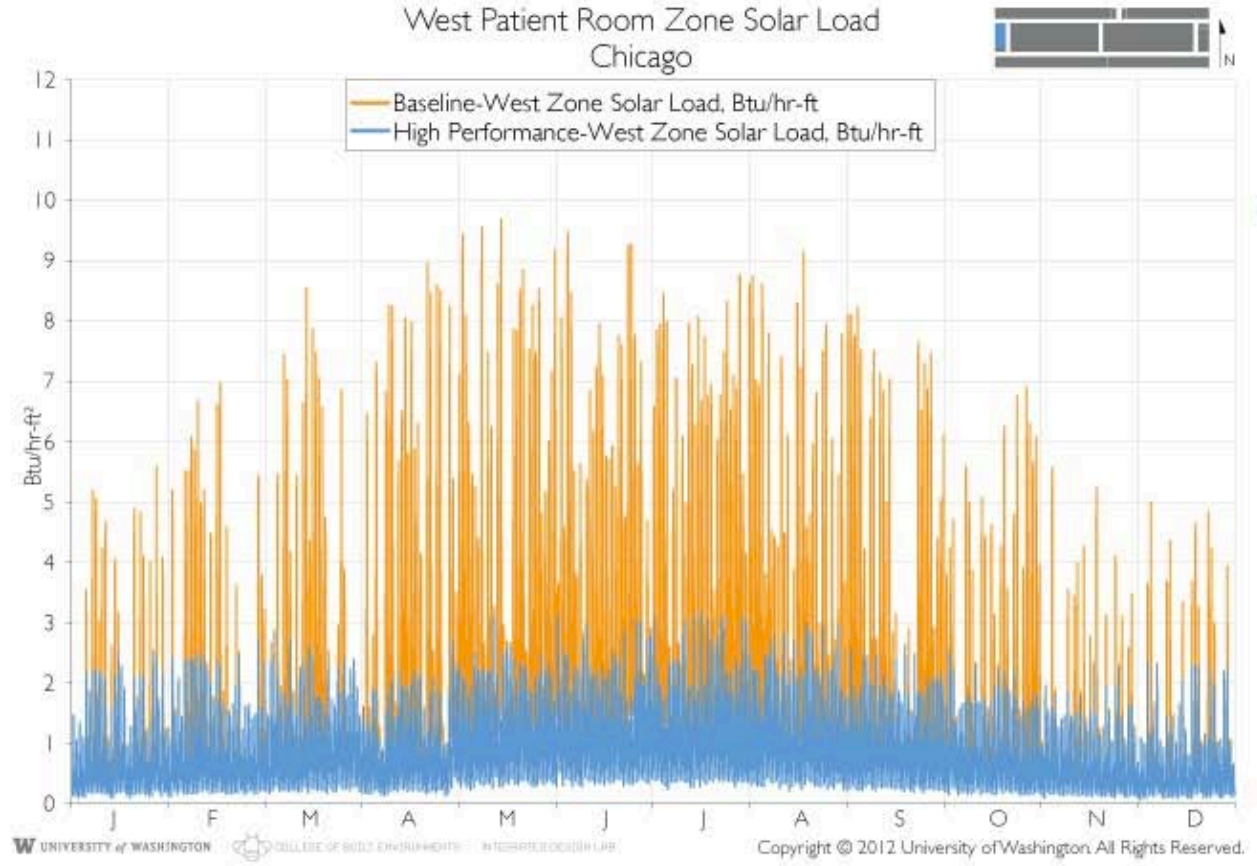
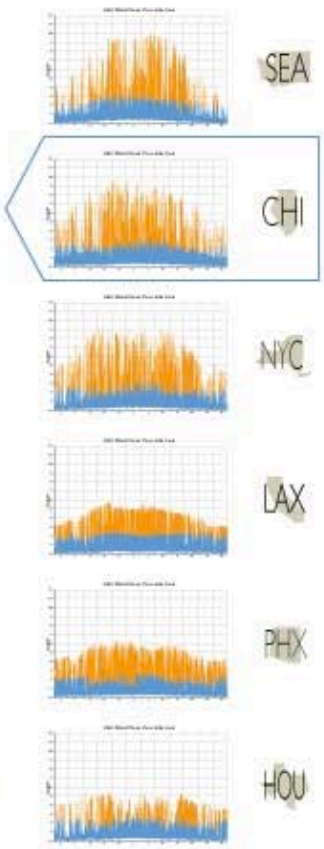
Process | Climate | Design Strategies | Loads | Energy | Cost

LOADS

- + loads
- + loads approach
- + plant loads overview
- + plant heating
- + plant cooling
- + patient rooms zone loads
- + patient room solar loads
- + patient room peak solar loads
- + shading





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NORTH | EAST | SOUTH | WEST

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SOUTH ZONE SOLAR LOADS

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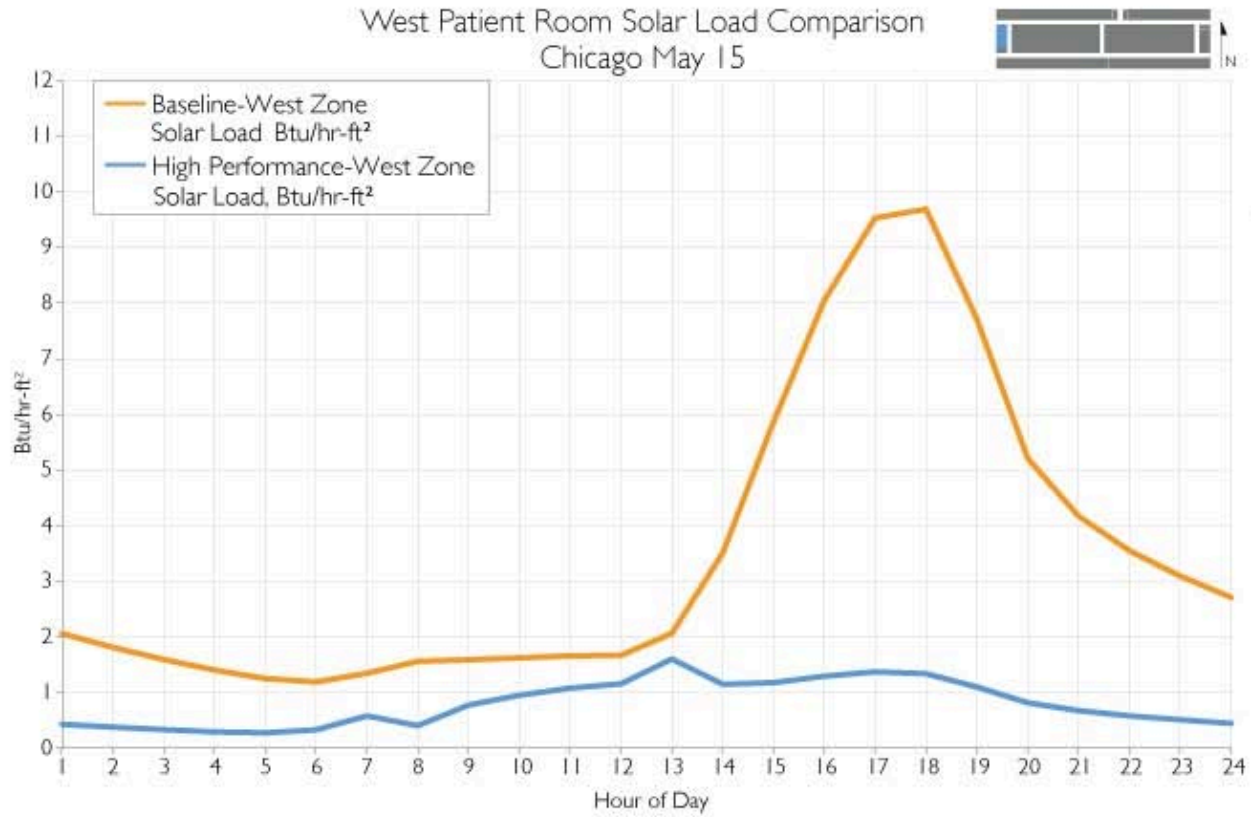
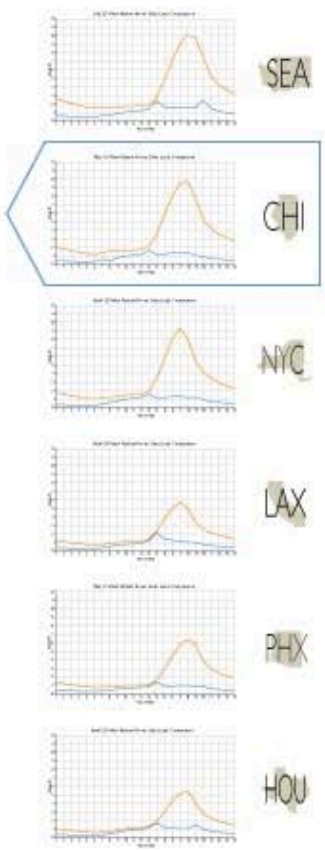
INTEGRATED DESIGN LAB

Process | Climate | Design Strategies | Loads | Energy | Cost

LOADS

- + loads
- + loads approach
- + plant loads overview
- + plant heating
- + plant cooling
- + patient rooms zone loads
- + patient room solar loads
- + patient room peak solar loads
- + shading





NORTH | EAST | SOUTH | WEST

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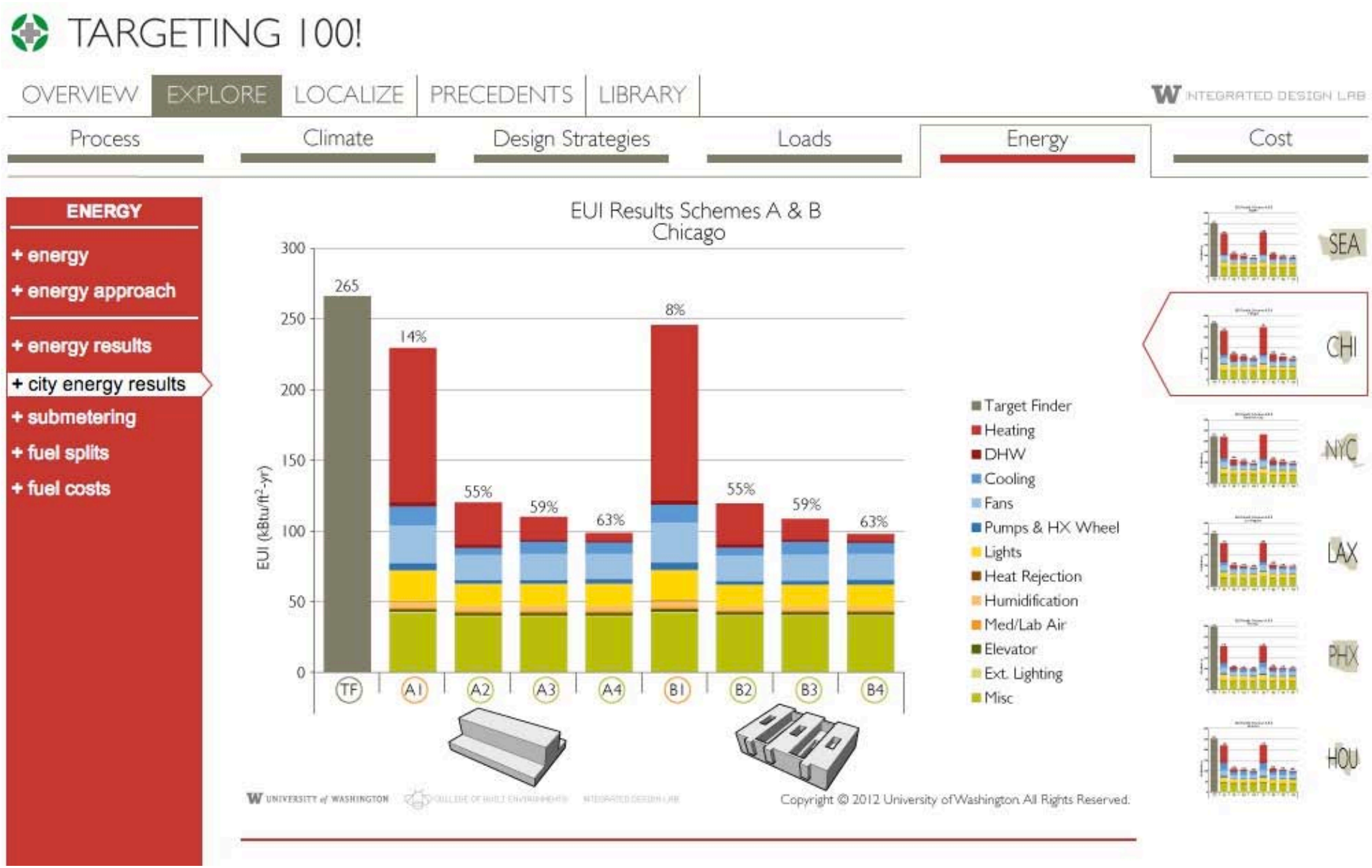
ANNUAL ENERGY USE



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MEETS THE 2030 CHALLENGE

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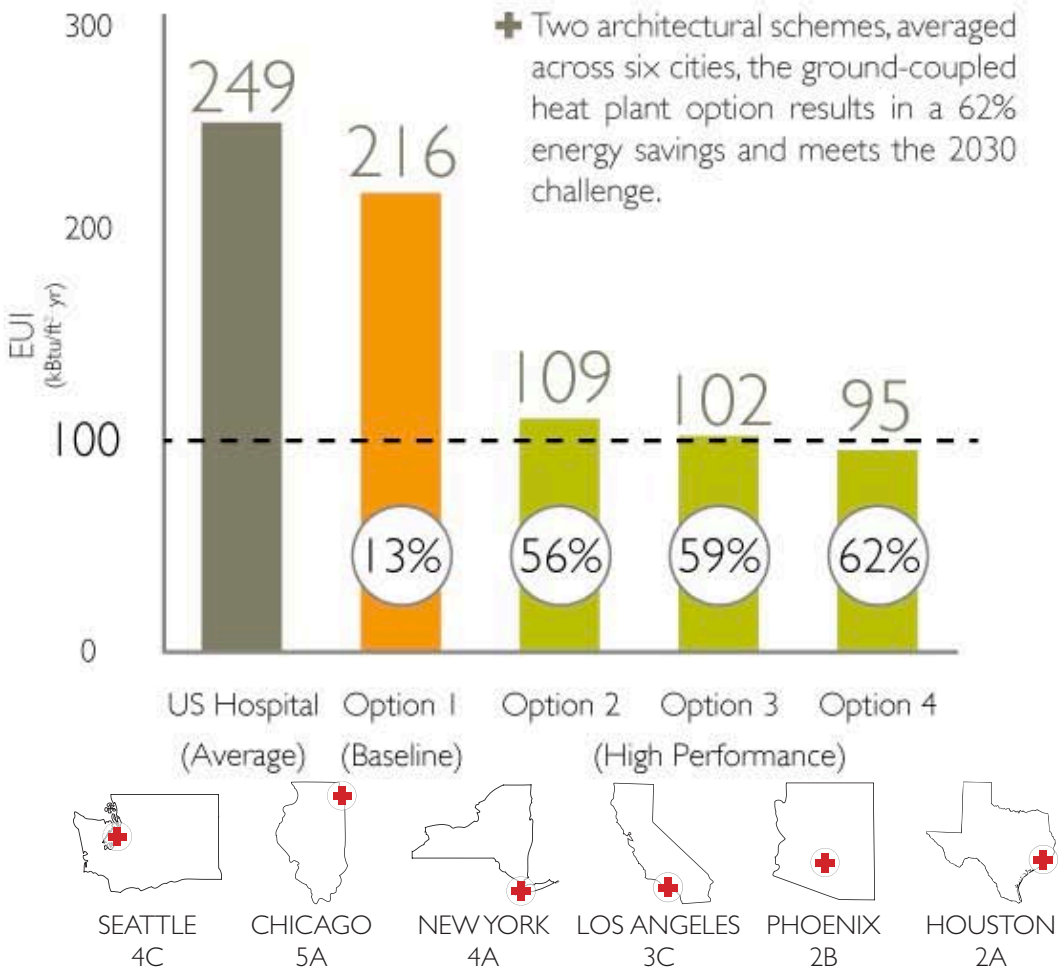
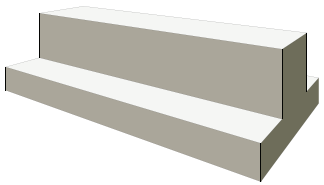
OVERVIEW

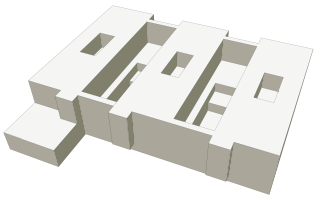
- + hospital energy use
- + hospital energy cost
- + goals
- + integrated design
- + opportunities
- + T-100 approach
- + study design
- + energy outcomes
- + cost outcomes
- + conclusions
- + early adopters
- + partners
- + team



Scheme A



Scheme B



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WITH LITTLE ADDITIONAL CAPITAL

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OVERVIEW

- + hospital energy use
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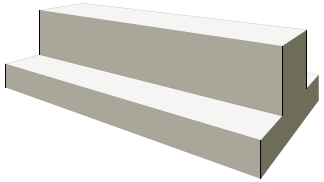
- + goals
- + integrated design
- + opportunities
- + T-100 approach
- + study design
- + energy outcomes
- + cost outcomes
- + conclusions
- + early adopters
- + partners
- + team
- + about this site

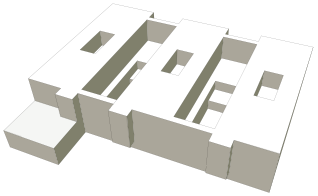
+ The most efficient plant option is a 3% cost increase over the baseline option.

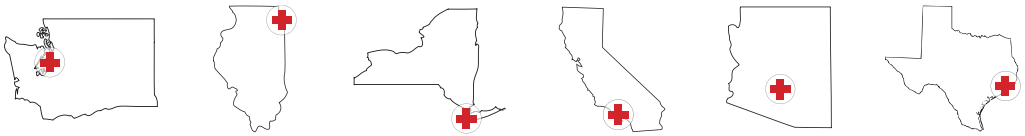
*High performance prices include a $4/ft² utility incentive

Scheme A



Scheme B





SEATTLE 4C | CHICAGO 5A | NEW YORK 4A | LOS ANGELES 3C | PHOENIX 2B | HOUSTON 2A

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COST BREAKDOWN

TARGETING 100!

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Process | Climate | Design Strategies | Loads | Energy | Cost

COST
- + cost
- + cost approach
- + cost results
- + city cost results
- + cost breakdown
- + cost detail
- + roi

CHICAGO, ILLINOIS					BUILDING SQFT	476,094
% CHANGE FROM BASELINE					UTILITY INCENTIVE ($4/SF)	$ 1,904,376
		SCHEME A1	SCHEME A2	SCHEME A3	SCHEME A4	
A	SUBSTRUCTURE					
A10	FOUNDATIONS	0%	0%	0%	0%	
A20	BASEMENT CONSTRUCTION	0%	0%	0%	0%	
B	SHELL					
B10	SUPERSTRUCTURE	0%	-2%	-2%	-2%	
B20	EXTERIOR CLOSURE	0%	5%	5%	5%	
B30	ROOFING	0%	2%	2%	2%	
C	INTERIORS					
C10	INTERIOR CONSTRUCTION	0%	-1%	-1%	-1%	
C20	STAIRCASES	0%	-3%	-3%	-3%	
C30	INTERIOR FINISHES	0%	0%	0%	0%	
D	SERVICES					
D10	CONVEYING SYSTEMS	0%	0%	0%	0%	
D15	MECHANICAL	0%	9%	9%	14%	
D50	ELECTRICAL	0%	-1%	-1%	-1%	
E	EQUIPMENT & FURNISHING					
E10	EQUIPMENT	0%	11%	11%	11%	
E20	FURNISHINGS	0%	0%	0%	0%	
BUILDING COST		210,397,410	215,000,515	215,012,161	217,591,541	
COST DIFFERENCE W/ INCENTIVE		$ -	$ 2,698,729	$ 2,710,375	$ 5,289,755	
PERCENTAGE DIFFERENCE		0.0%	1.3%	1.3%	2.5%	

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SCHEME A | SCHEME B

SEA
CHI
NYC
LAX
PHX
HOU

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COST DETAIL

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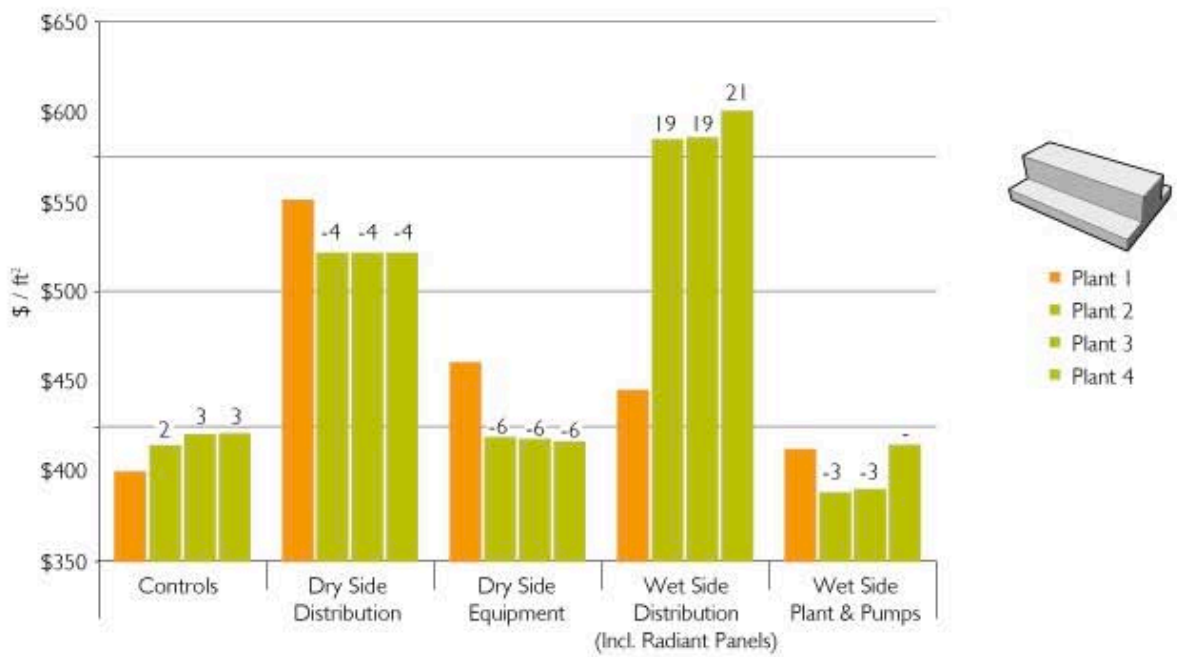
INTEGRATED DESIGN LAB

Process | Climate | Design Strategies | Loads | Energy | Cost

COST

+ cost
+ cost approach
+ cost results
+ city cost results
+ cost breakdown
+ cost detail
+ roi

Mechanical Systems Cost Per Square Foot Details
National (Scheme A)



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BOTTOM LINE

TARGETING 100!

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OVERVIEW

- + hospital energy use
- + hospital energy cost
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- + integrated design
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- + T-100 approach
- + study design
- + energy outcomes
- + cost outcomes
- + conclusions
- + early adopters
- + partners
- + team
- + about this site

62%

+ Energy Reduction possible using Targeting 100! performance goals.

3%

+ Increase in cost over typical design using Targeting 100! goals.

*Includes a $4/ft^2 utility incentive

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TOOL DEVELOPMENT

www.idlseattle.com/t100

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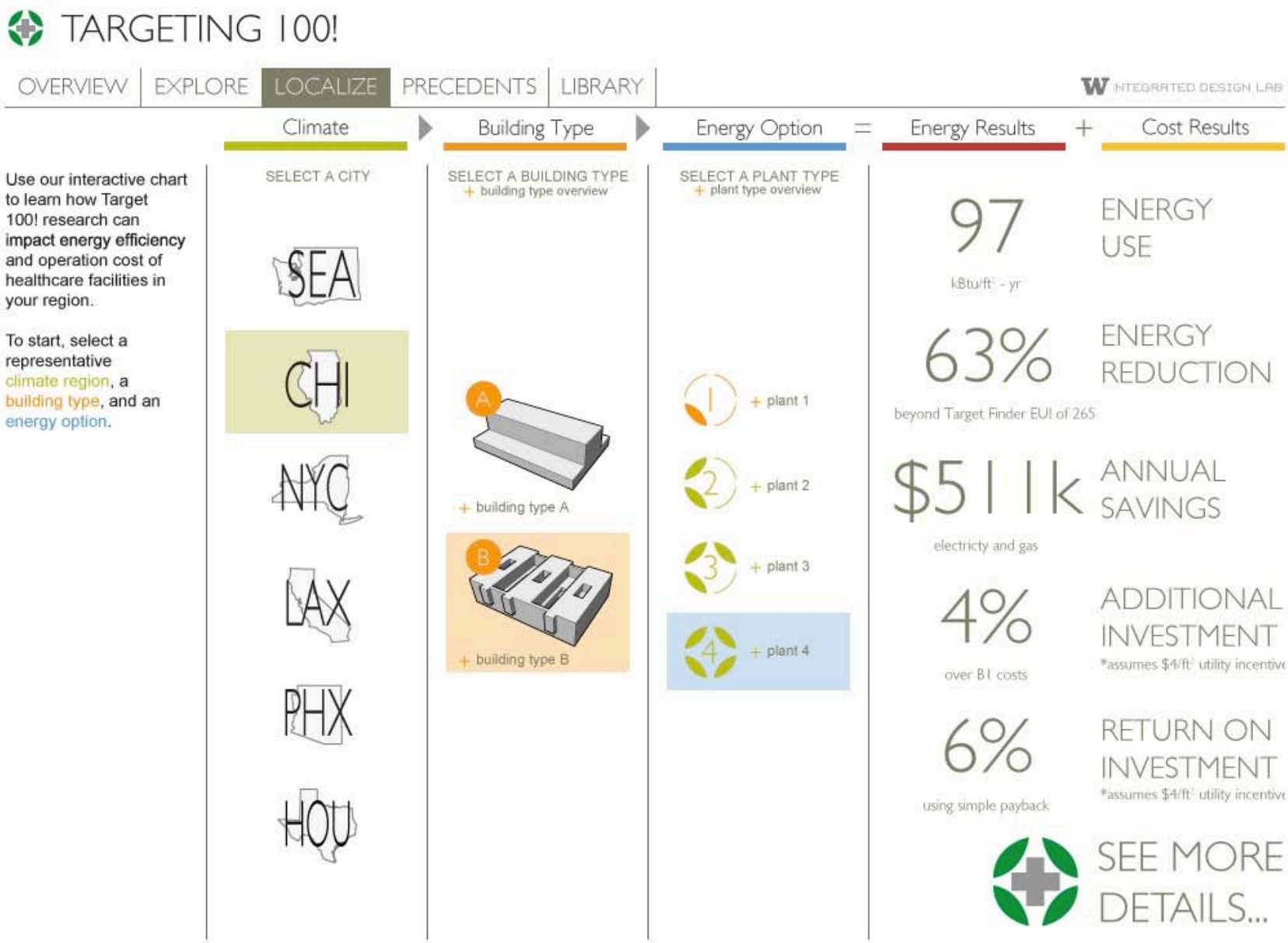
LOCALIZE



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LIBRARY

TARGETING 100!

OVERVIEW | EXPLORE | LOCALIZE | PRECEDENTS | LIBRARY

W INTEGRATED DESIGN LAB

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Project Summary

Targeting 100! Exexutive Summary (PDF)

Research Reports

Targeting 100! 2010 Pacific Northwest Executive Summary (PDF)

Targeting 100! 2010 Pacific Northwest Full Report (PDF)

CleanMed 2011 Poster (PDF)

CleanMed 2012 Poster (PDF)

NIH Sustainable Labs Poster (PDF)

ASHE Conference 2009 High Performance Hospitals White Paper (PDF)

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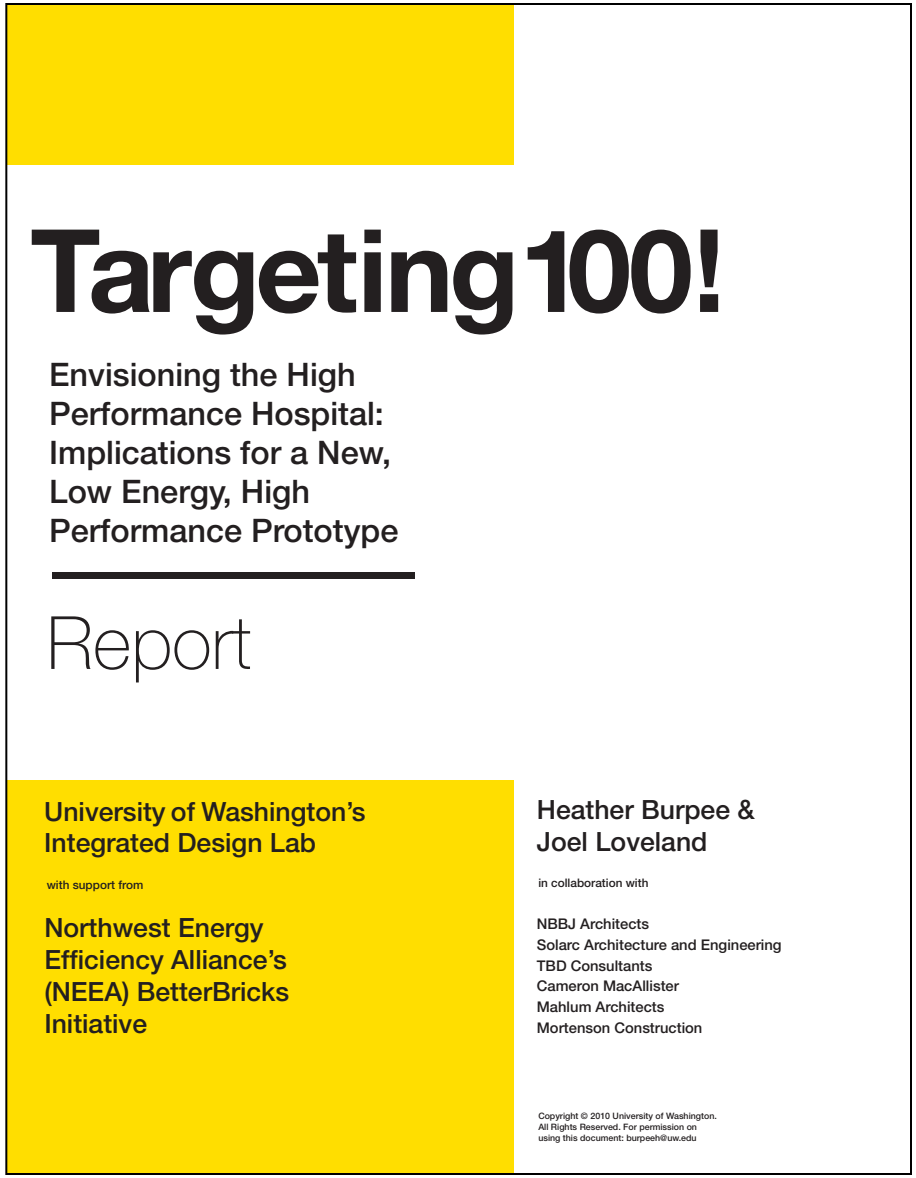
OTHER ROADMAPS



Targeting 100!

Envisioning the High Performance Hospital: Implications for a New, Low Energy, High Performance Prototype

Report

University of Washington's Integrated Design Lab

with support from

Northwest Energy Efficiency Alliance's (NEEA) BetterBricks Initiative

Heather Burpee & Joel Loveland

in collaboration with

NBBJ Architects
Solarc Architecture and Engineering
TBD Consultants
Cameron MacAllister
Mahlum Architects
Mortenson Construction

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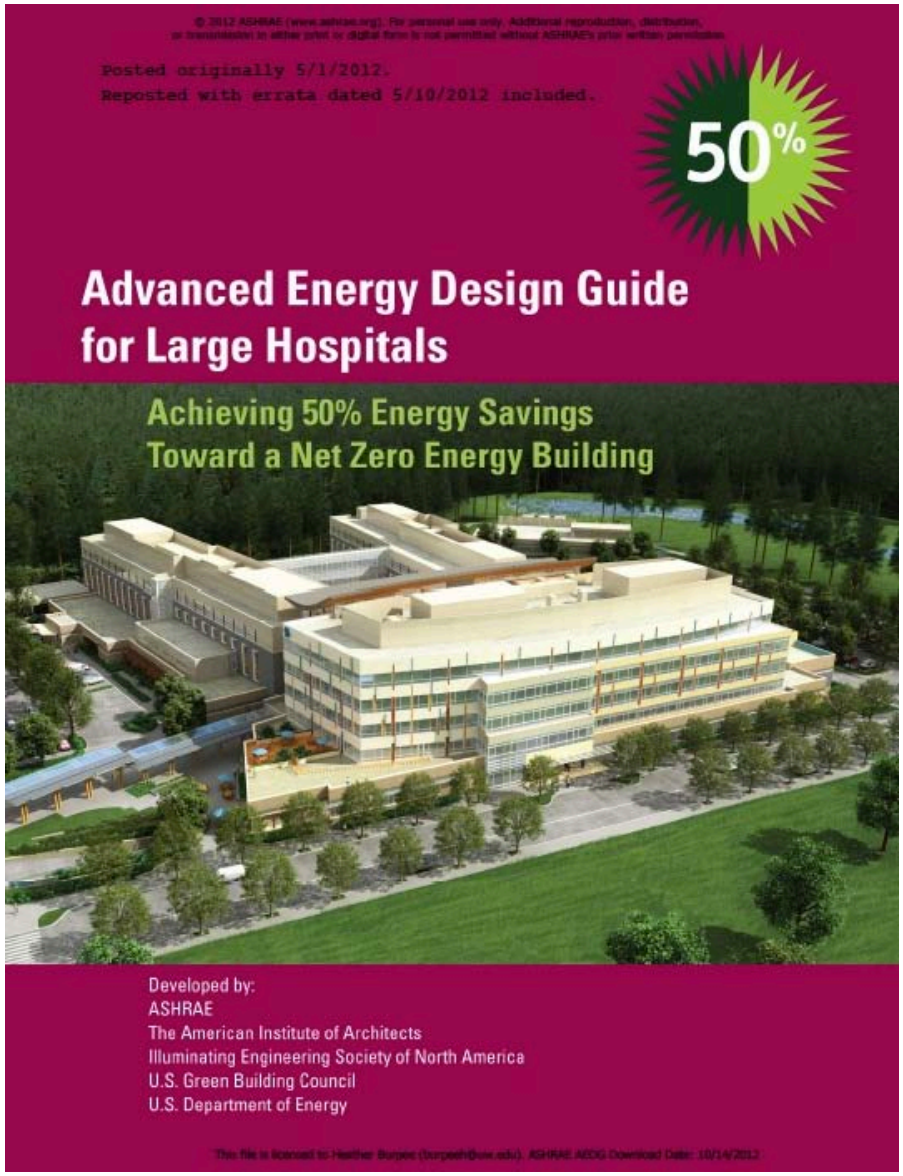

Posted originally 5/1/2012.
Reposted with errata dated 5/10/2012 included.

50%

Advanced Energy Design Guide for Large Hospitals

Achieving 50% Energy Savings Toward a Net Zero Energy Building

Developed by:
ASHRAE
The American Institute of Architects
Illuminating Engineering Society of North America
U.S. Green Building Council
U.S. Department of Energy

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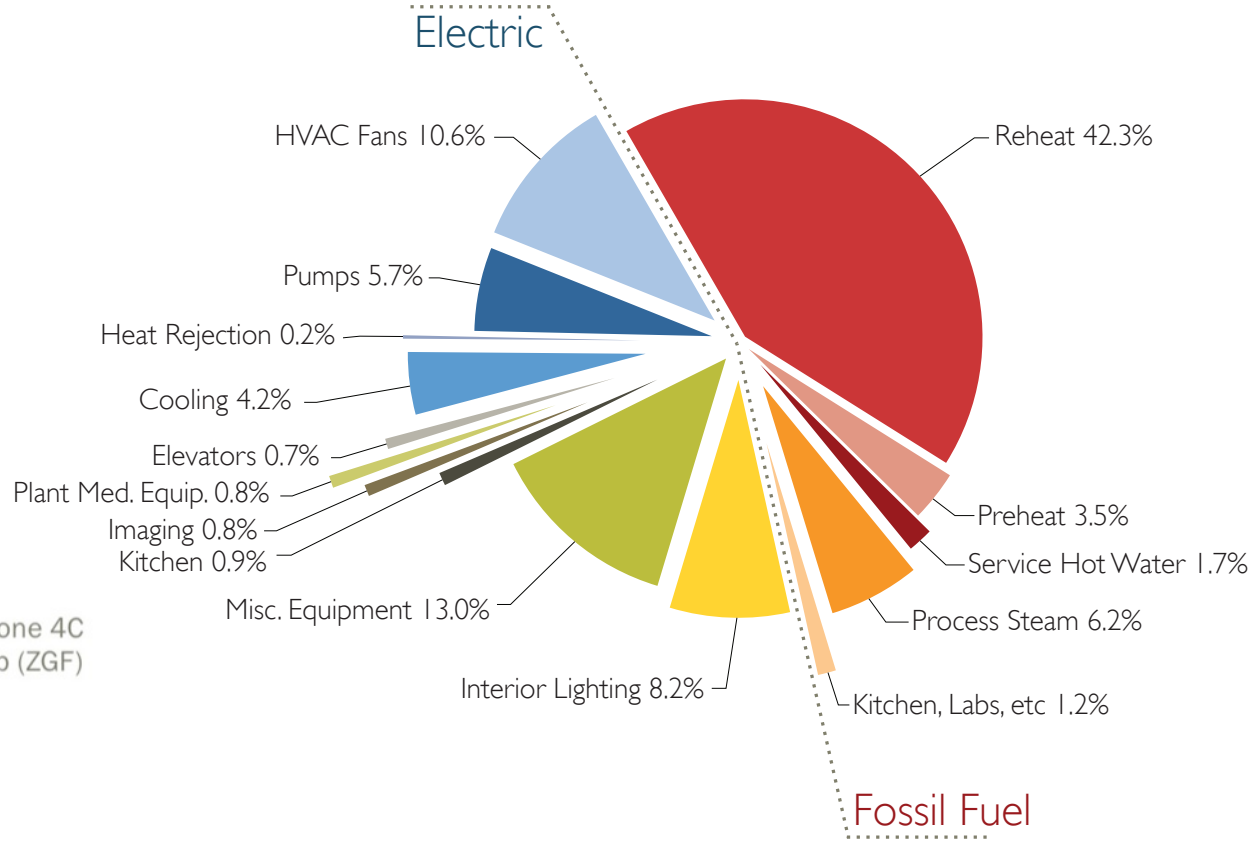
ENERGY EVALUATION STUDY
LEGACY SALMON CREEK MEDICAL CENTER

FACILITY PROFILE

LOCATION	Vancouver, Washington/Climate Zone 4C
ARCHITECT	Zimmer Gunsul Frasca Partnership (ZGF)
ENGINEER	AEI Affiliated Engineers
CLIENT	Legacy Health, Portland, Oregon
COMPLETED	2005
BEDS	220
SIZE	456,000 sf
EUI	215 KBtu/SF Year

ENERGY MONITORING RESULTS



PACIFIC NW HOSPITAL PROJECTS

Swedish Issaquah 125 KBtu/SF Year

Strategies

Integrated Design
Energy Goal Setting
Energy Benchmarking
Energy Modeling
Occupancy Sensors
VAV
Supply Temp Reset
Heat Recovery
Heat Recovery Chiller
Largest PSE Incentive
$4.2 M

IDL's Roles with Swedish Issaquah

Master Plan with Mahlum '08
Contractor on Scandinavian Study Tour '09
Technical Assistance with Mahlum '08-'09
Technical Assistance with Collins Woerman '08-'10
Energy Modeling Review with CDi '10
Multiple Presentations with the entire project team '07-'12

Average Pacific Northwest Hospital

270 KBtu/SF Year

- '05 Nome Hospital. Mahlum
- **'06 Providence Everett. ZGF**
  200 KBtu/SF Year
- '06 Peace Health St. Joseph. Mahlum
- **'06 Seattle Children's Hospital Master Plan & Tower. ZGF**
  175 KBtu/SF Year
- '07 Mercy Medical Center. Mahlum
- '07 Providence Newberg Post Occupancy Assessment. Mahlum
- '07 Virginia Mason Tower. NBBJ
- **'07 UW Medical Center Montlake Tower. NBBJ**
  145 KBtu/SF Year
- **'07-'10 Swedish Issaquah Hospital. Mahlum, Collins Woerman**
  125 KBtu/SF Year
- '08 Providence Alaska Medical Center. ZGF
- **'08 Seattle Children's Bellevue Clinic. NBBJ**
  97 KBtu/SF Year
- '09 Spokane Sacred Heart. Mahlum
- '09 Swedish Medical Office Building, Mill Creek. Mahlum
- '10 Valley Medical Center MOB, Covington. NBBJ
- '10 Women and Children's Pavilion, Madigan Hospital. ACE
- **'10 Peace Island Medical Center. Mahlum**
  115 KBtu/SF Year
- '10 Ketchikan Medical Center. NAC Architecture.

***Energy use estimated by energy models**

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NEXT STEPS

Healthcare 21

- Some aspects of high performance hospitals were not able to be included in the scope of Targeting 100!, but may be considered in further research.

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What will nature help us do here?
There's no such thing as waste
Think Local

THANK YOU FOR PARTICIPATING !

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HEATHER BURPEE
UW Integrated Design Lab
burpeeh@uw.edu

www.idlseattle.com

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