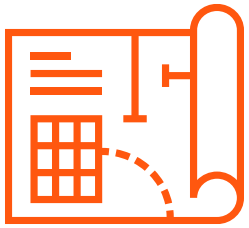
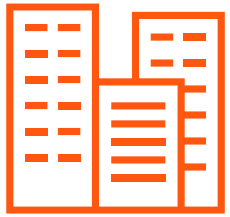
Planning for a Better Tomorrow: Utilizing Accurate Models to Shape the Future

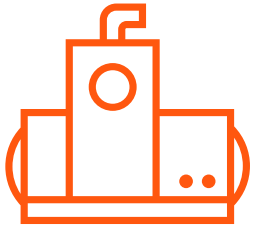
We Love a Good Puzzle



PRECONSTRUCTION / SOLUTION DEVELOPMENT



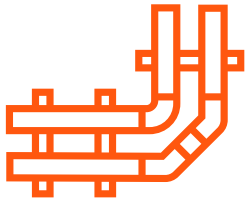
BUILD



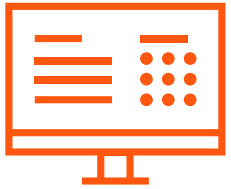
FACILITY SERVICES

BUILDING ANALYSIS + MODELING

ENERGY + ENVIRONMENT



MANUFACTURING



BUILDING AUTOMATION

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Diversity, Equity & Inclusion (DEI)

MISSION + VISION

UMC's DEI mission is to foster a culture that welcomes a diverse group of skills, perspectives, and experiences–and empowers individuals to succeed and grow.

We are committed to creating a workplace where everyone feels **safe**, **seen**, **valued**, and **heard**.

THIS INCLUDES

Dedicating resources to ensure UMC is a safe place for all.

Supporting diverse trade partners and vendors so they can thrive.

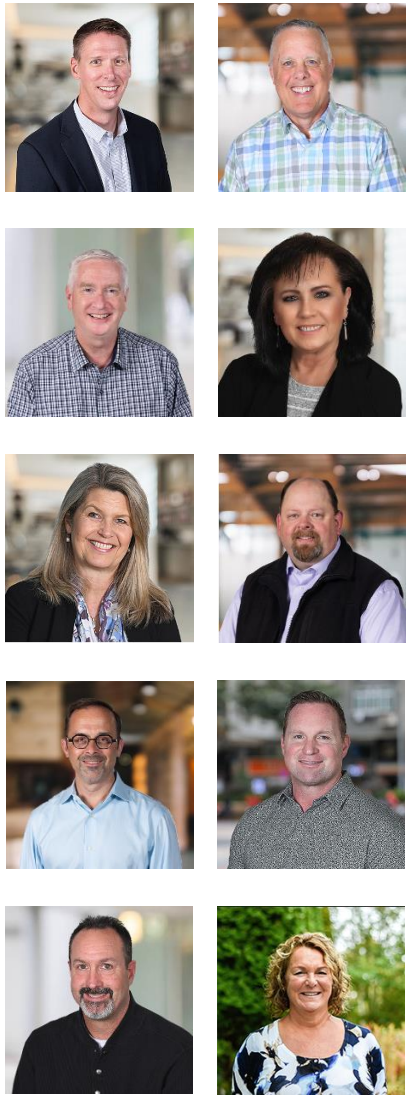
Providing education opportunities around unconscious bias.

Establishing core actions and policies to retain talent.

Evaluating pay equity and promotion velocity data within UMC.

Continuous monitoring of the health of our DEI culture.

UMC DEI COMMITTEE



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BAM!

David Park, Ph.D, PE, CEM, BEMP

BUILDING ANALYSIS & MODELING MANAGER

Every. Single. Energy savings. Matters! David couples analysis with energy audits to identify energy efficiency measures (EEMs) that are cost effective for owners' business goals. Driven to make a significant impact towards carbon reduction and sustainability, David enjoys studying and analyzing how building energy reduces utility and operational costs, making it a great investment for the future.

Hailee Hammerquist, LEED Green Associate

BUILDING ANALYSIS & MODELING ENGINEER

Hailee is detail oriented, organized, and passionate about sustainable design. She loves tackling the complexity of our projects to ensure all the pieces fit efficiently together inside high-performing exteriors. Coming from West Virginia, Hailee is excited to experience all the outdoor adventures that the Seattle area has to offer. She spends her time off the clock outside hiking in the summer and hitting the slopes in the winter.

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Objectives

KNOWLEDGE

Why is our building so important?

FORESIGHT

What is going on with new energy code and legislature?

TIMELINESS

What is a “Model”?

COLLABORATIVE

How can we understand our building better?

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Why are Buildings so Important?

90%

of time is spent indoors

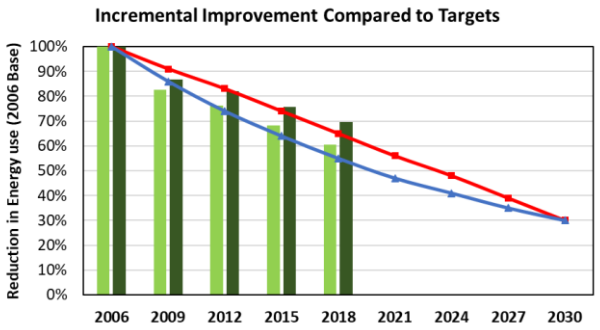
40% of energy consumption…

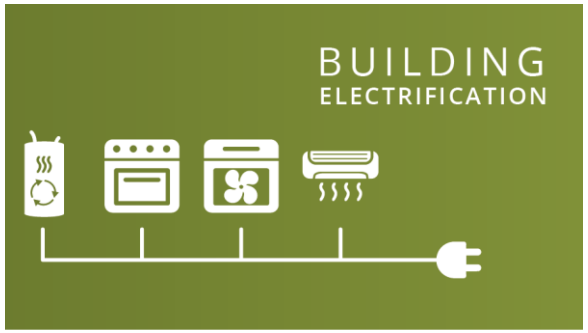
14,600 million ton of CO_2 emission

Carbon sequestered by 241,412 million tree seedlings grown for 10 years

Possible Complications

Stricter Targets Energy Code

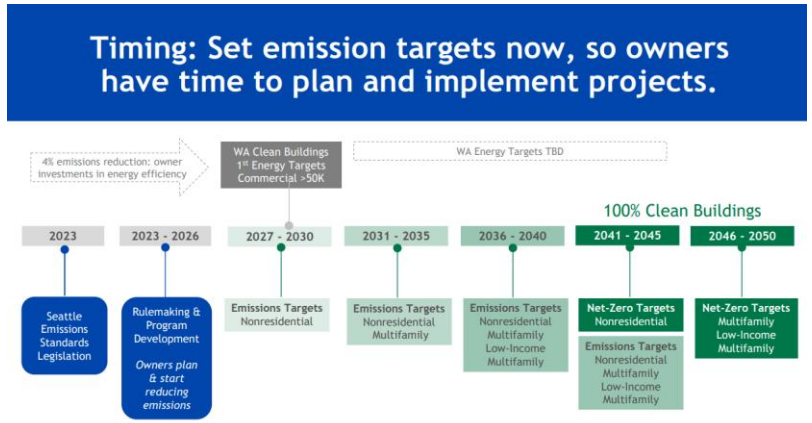




Clean Buildings Standard

*Buildings 20,000 SF – 50,000 SF must now submit their EUI per Energy Star Portfolio Manager along with their Energy Management Plan, Operation & Maintenance Program, and Capital Management Plan by July 1, 2027

Seattle Building Emissions Performance Standard



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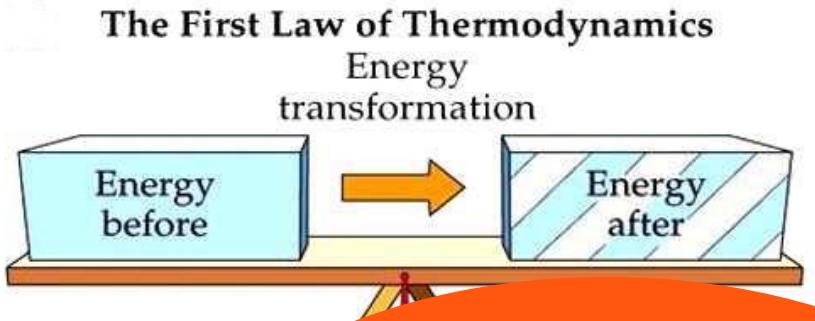
1ST LAW of Thermodynamics



Checking point
Are we minimizing energy loss?
Are we minimizing waste?

ENERGY INPUT: Total Energy Consumption

WASTE

ENERGY LOSS: Inefficiency

ENERGY NEED: Building

Do we *know* our buildings?

PUGET SOUND ENERGY

Important Information pse.com

Issued: July 15, 2018
Account Number: 200012345678
DUE DATE August 4, 2018
TOTAL DUE $165.64

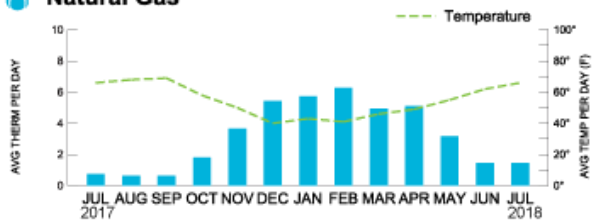
JENNY PUGET
Serving: 12345 POWER AVE S, Bellevue

Your Usage Information

Electric

	Last Year	This Year
Average daily kilowatts	19.67	**32.81**
Average daily cost	$2.07	**$3.25**
Days in billing cycle	30	**32**
Average temperature	66°F	**66°F**

Natural Gas



	Last Year	This Year
Average daily therms	0.73	**1.46**
Average daily cost	$1.21	**$1.93**
Days in billing cycle	30	**32**
Average temperature	66°F	**66°F**

Your Account Summary

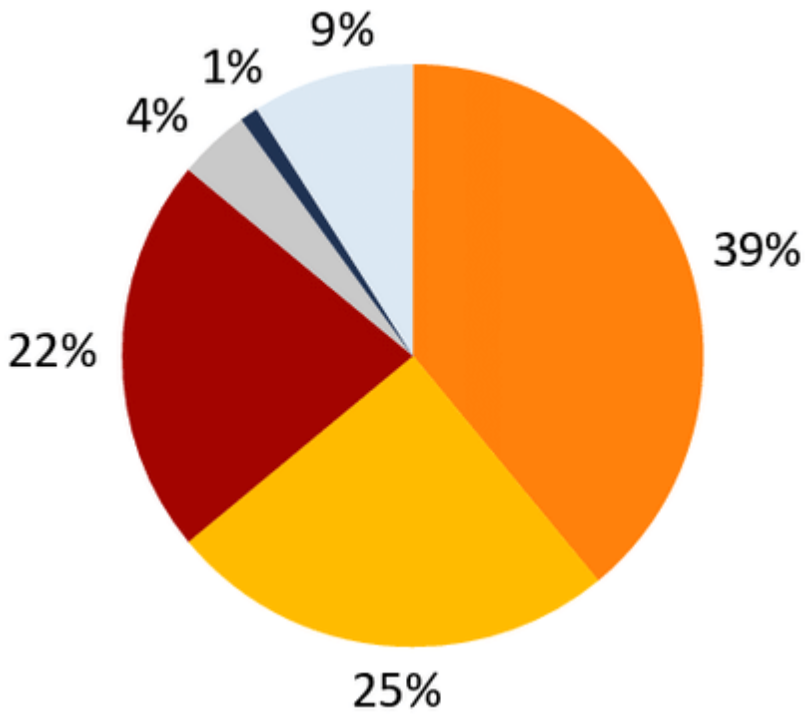
Previous Charges:		
Amount of Your Last Bill (dated 6/13/2018)	$	137.78
Payment received 7/3/2018 – Thank you!		−137.78
Past Due Amount	**$**	**0.00**
Current Charges:		
Electric Charges	$	103.95
Natural Gas Charges		61.69
Total Current Charges	**$**	**165.64**
Total includes current and past due charges	**Total $**	**165.64**

Late Payments | A late payment fee of 1% per month will apply to past due charges, if any, and amounts unpaid more than 10 business days after the statement due date. Amounts will be considered delinquent if payment is not received on or before the due date.

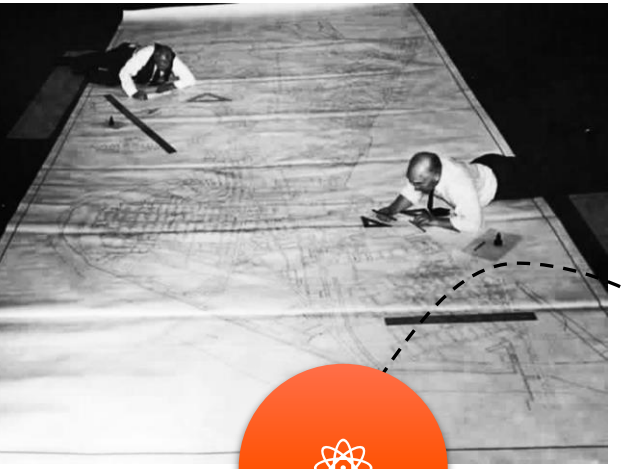
Monthly Energy Tip
Save money and stay cool this summer. Add insulation to make your home more energy efficient throughout the year.

How to reach us

Email: customercare@pse.com
Customer Service: 1-888-225-5773 | TTY: 1-800-962-9498
Hours: 7:30 a.m. – 6:30 p.m. M – F | TRS: 1-866-831-5161
Puget Sound Energy: P.O. Box 91269, Bellevue, WA 98009
24 Hour Emergency and Outage line: 1-888-225-5773



Technological Evolution

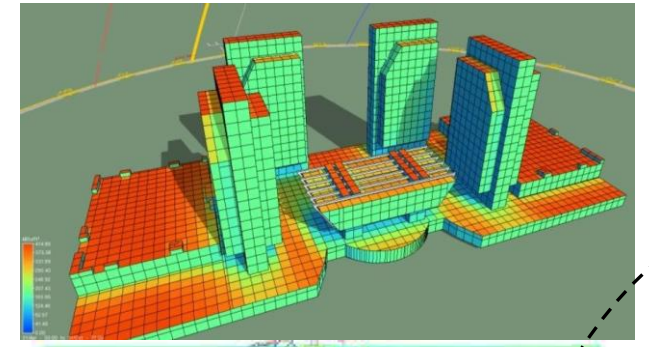


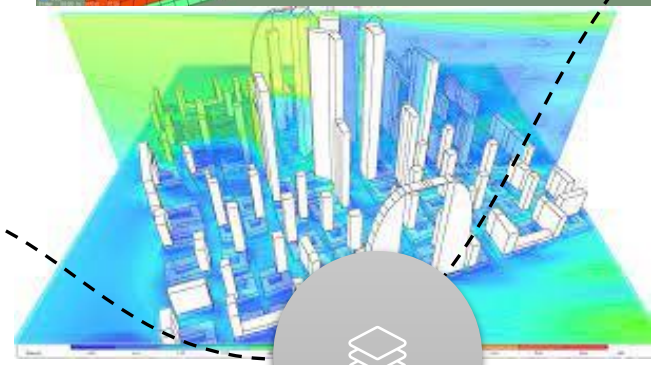
ENERGY CONSUMPTION CALCULATOR

Location	My House		Maximum consumption per day	11.33	kWh
Cost/kWh	0.75	$	Average consumption per day	9.78	kWh
Total Rating/Hour	3,949.00	Watt	Total Consumption per month	293.47	kWh
			Total Monthly Cost	220.10	$

© 2016 - Exceltemplate.net

No	Appliances	Rating (W)	Hourly Usage per Day	# of Units	Consumption per Day	Day Frequency Usage per Week	Consumption per Week	Day Frequency Usage per Month	Consumption per Month	Monthly Cost
1	Television - Samsung	150.00	5.0	1	0.75	7.0	5.25	30.0	22.50	16.88
2	Air Conditioner - Panasonic	480.00	6.0	1	2.88	7.0	20.16	30.0	86.40	64.80
3	Air Conditioner - Panasonic 2	400.00	1.0		0.40		2.80		12.00	9.00
4	WiFi Modem	10.00	24.0		0.24		1.68		7.20	5.40
5	Cable TV Setup Box	25.00	24.0		0.60		4.20		18.00	13.50
6	Internet Modem	10.00	24.0	1	0.24		1.68		7.20	5.40
7	Mobile Phone Charger - Samsung	3.00	3.0	1	0.01	7.0	0.06		0.27	0.20
8	Microwave	600.00	0.5	1	0.30	5.0	1.50		9.00	6.75
9	Refrigerator	105.00	24.0	1	2.52	7.0	17.64		75.60	56.70
10	Coffee Maker	600.00	1.0	1	0.60	5.0	3.00	20.0	12.00	9.00
11	Toaster	600.00	0.5	1	0.30	5.0	1.50	20.0	6.00	4.50
12	Laptop	50.00	3.0	1	0.15	7.0	1.05		4.50	3.38
13	Electric Iron	400.00	3.0	1	1.20	2.0	2.40	8.0	9.60	7.20
14	Washing Machine	500.00	1.0	1	0.50	2.0	1.00	8.0	4.00	3.00
15	LED Light Bulb - 7	7.00	10.0	4	0.28	7.0	1.96		8.40	6.30
16	LED Light Bulb - 9	9.00	10.0	4	0.36	7.0	2.52		10.80	8.10
17										
18										
19										
20										





Pre 1970

1990–2000ish

Now

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What is Building Energy Model and CFD?

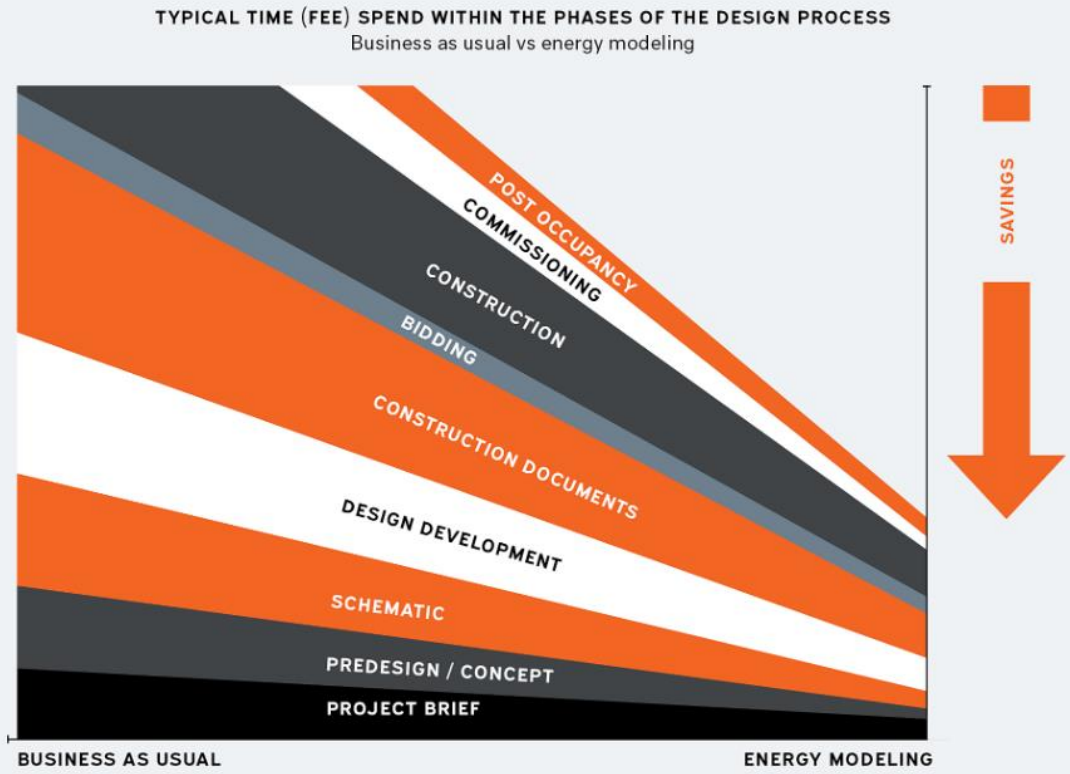
BUILDING ENERGY MODELING

The practice of using computer-based simulation software to perform a detailed analysis of energy use and energy-using systems

COMPUTATIONAL FLUID DYANMICS (CFD)

Mathematically predicting physical fluid flow by solving the governing equations using simulations

List of Capabilities with model



- CAMPUS + DISTRICT ENERGY PLANNING
- CARBON + ENERGY PLANNING
- CODE COMPLIANCE
- CLEAN BUILDINGS STANDARD COMPLIANCE
- COMPUTATIONAL FLUID DYNAMICS (CFD)
- DEEP ENERGY + CARBON RETROFITS
- ENERGY ANALYSIS
- GREEN BUILDING RATING SYSTEM CERTIFICATION

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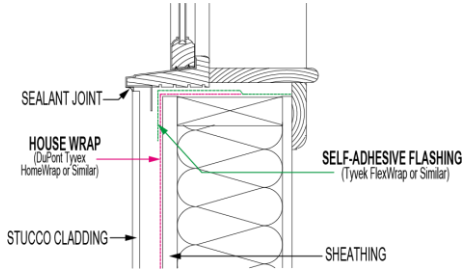
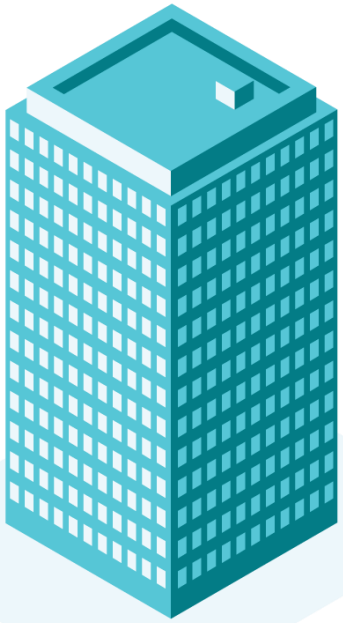
Why You Should Consider Modeling

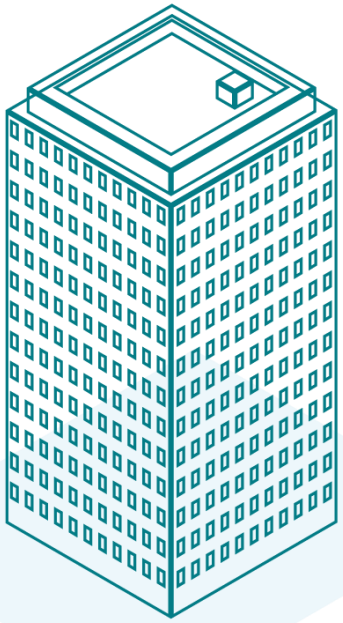
Energy Modeling Enables a Cycle of Benefits Throughout the Design Process

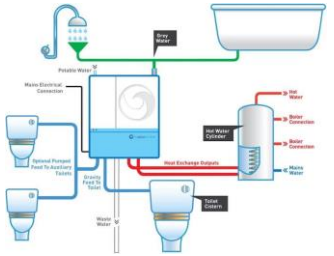
- Aggressive targets and code
- Smart and efficient decisions
- Reduced Operating and Cost
- Deeper knowledge of building design
- Sustainable Design and Solution
- Working together

Definition of a Model









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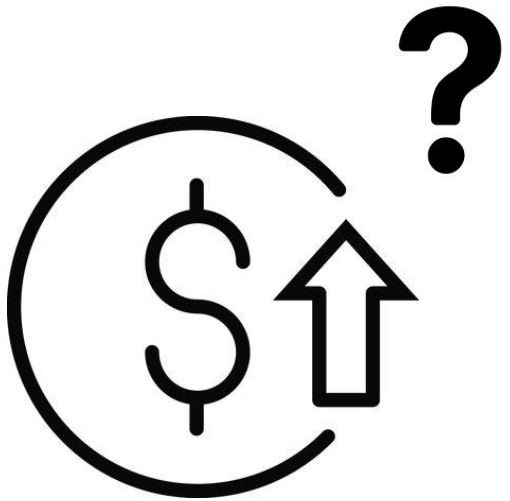
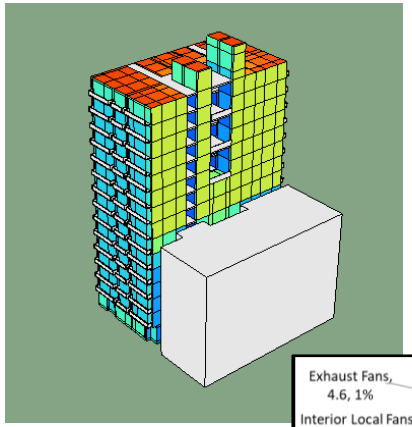
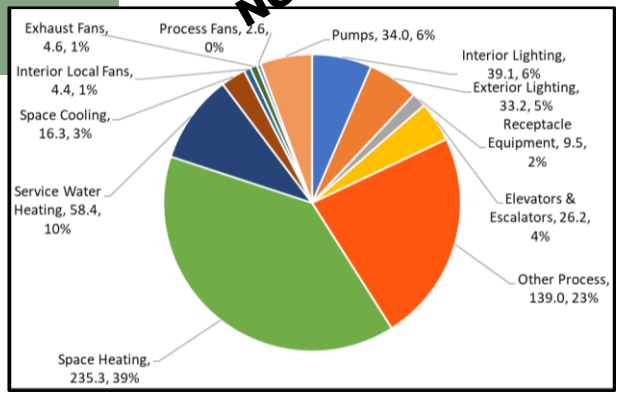
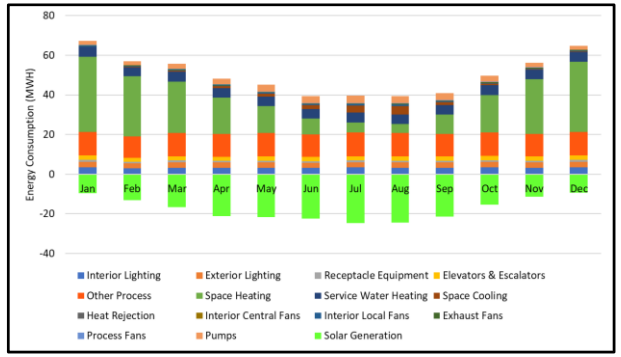
Limitation and Challenges









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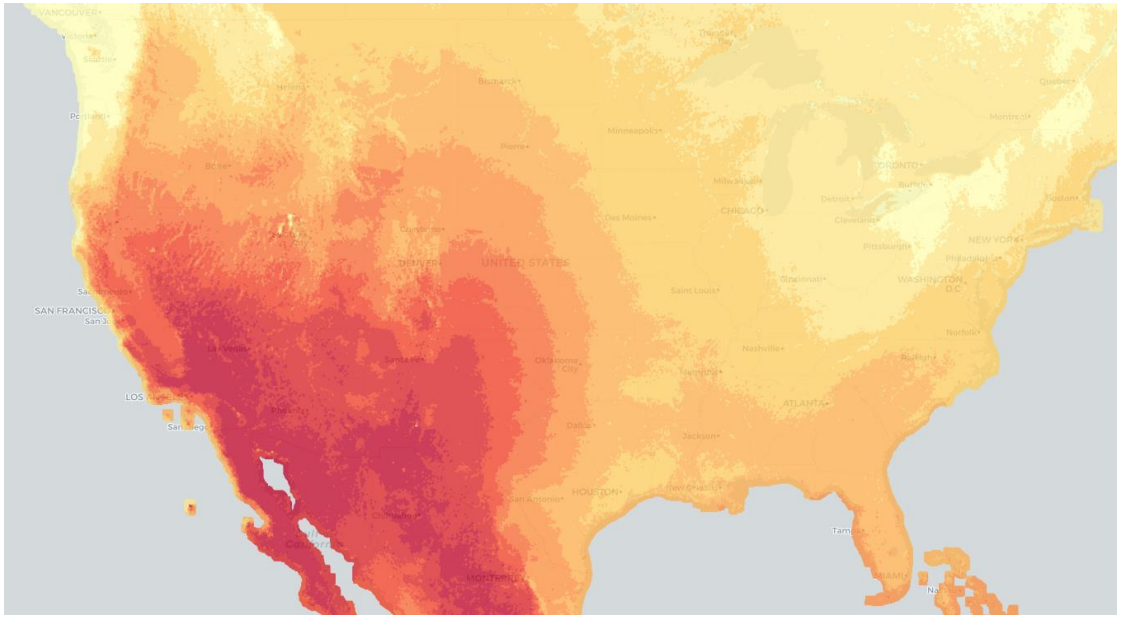
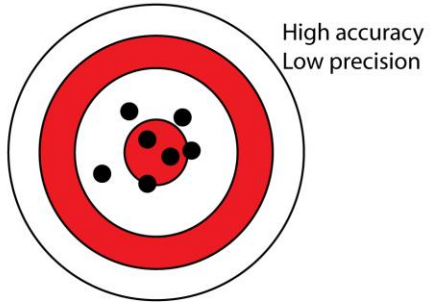
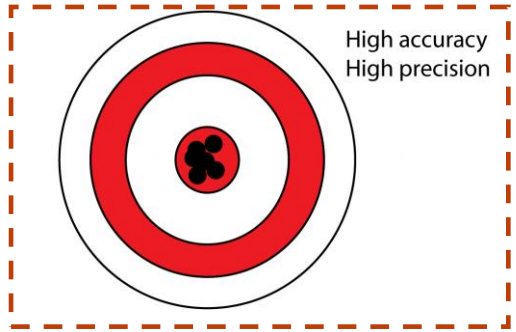
Complex in Nature

- Site, Climate, Shading
- Building Schedule
- Occupancy type
- Loads
- Design
- AND MORE!







Accuracy

Energy Models

eQuest Open Studio

Energyplus

IES-VE

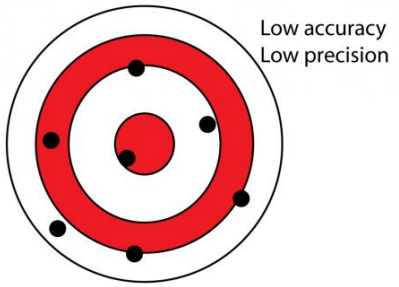
Energy Management Software

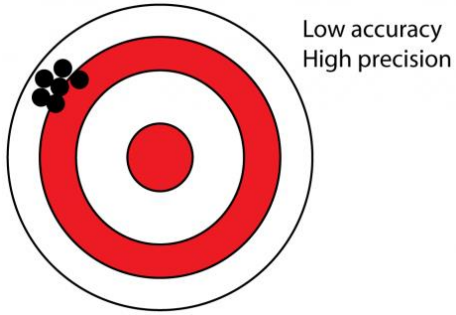
Building Automation Systems

Retrofit Analysis Software

Spreadsheet

Precision

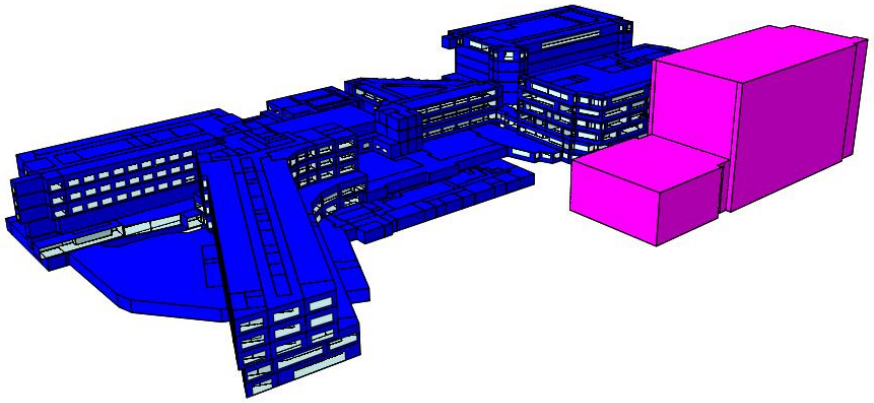




Overlake Medical Center

- Objective: Develop energy management plan to meet clean building standards and decarbonization goals

- Challenge
  - Finite amount of budget
  - Complicated system



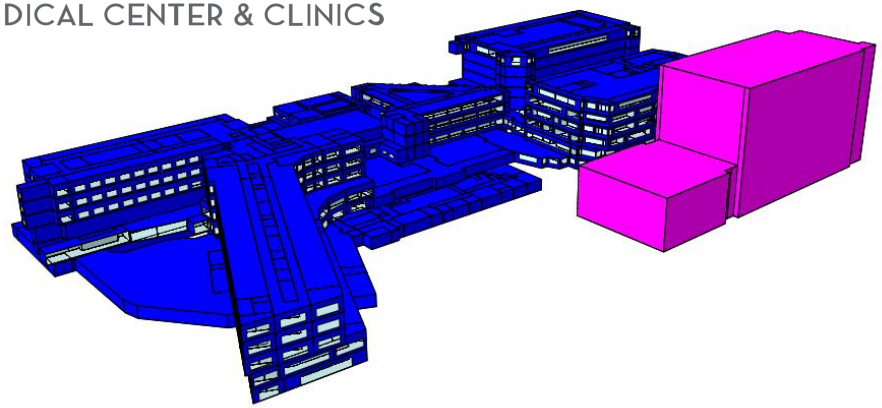
OVERLAKE
MEDICAL CENTER & CLINICS

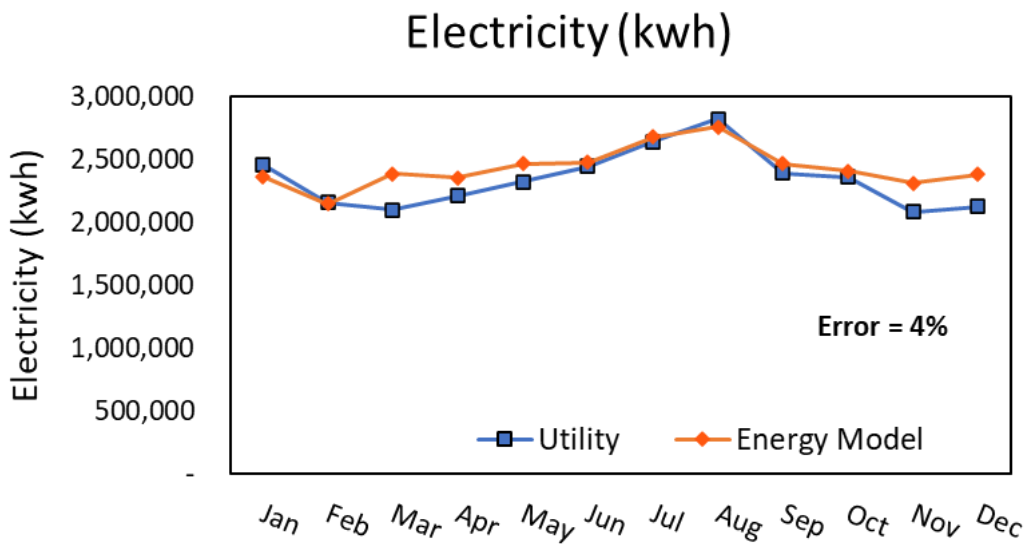
High accuracy and precision

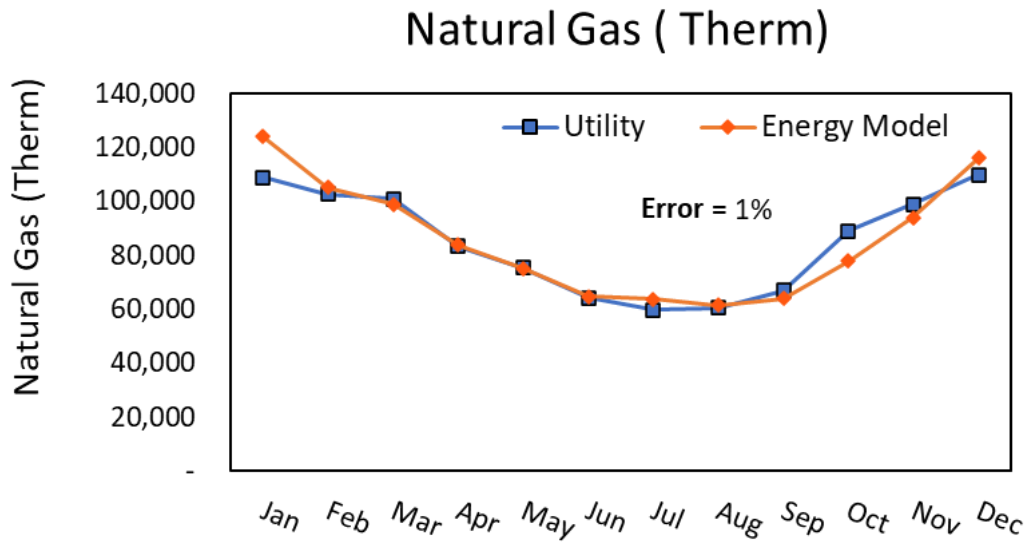
CASE STUDY

Overlake Hospital Medical Center

OVERLAKE
MEDICAL CENTER & CLINICS







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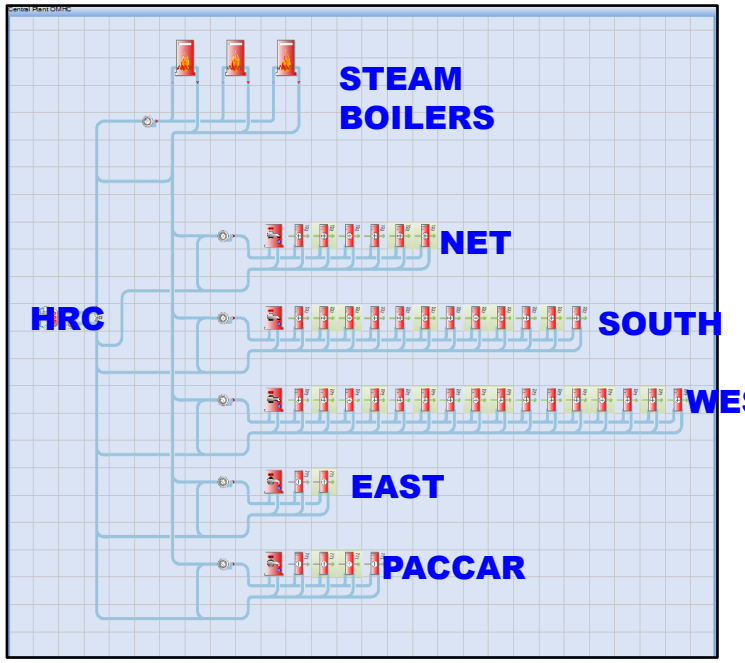
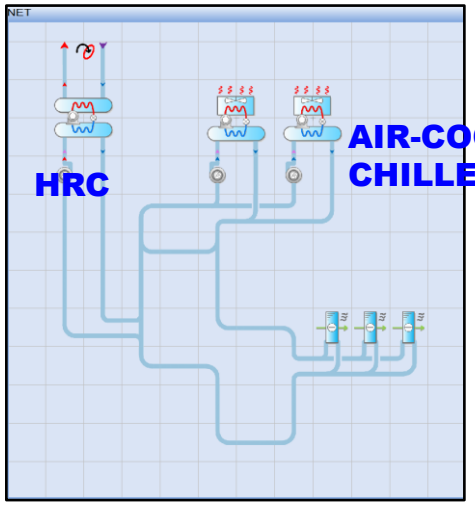
ENRERGY MODEL – SYSTEM DIAGRAM

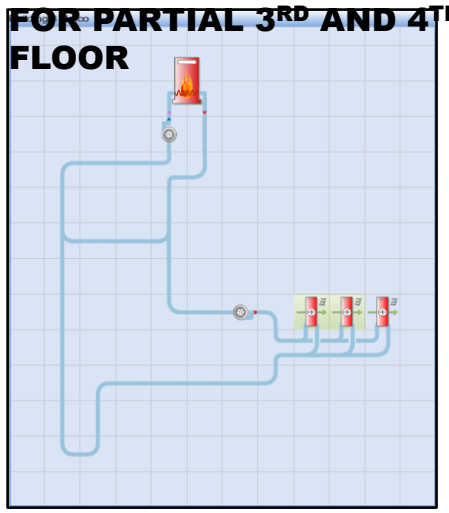
MAIN STEAM PLANT



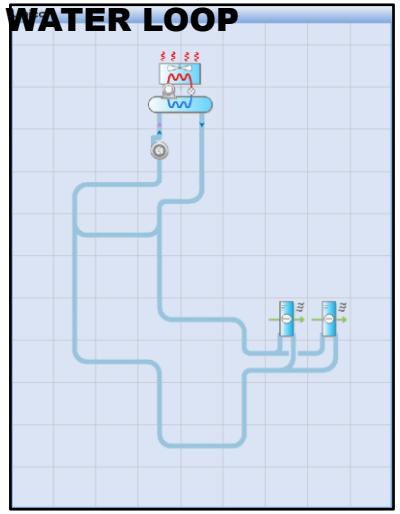
NET CHILLED WATER LOOP



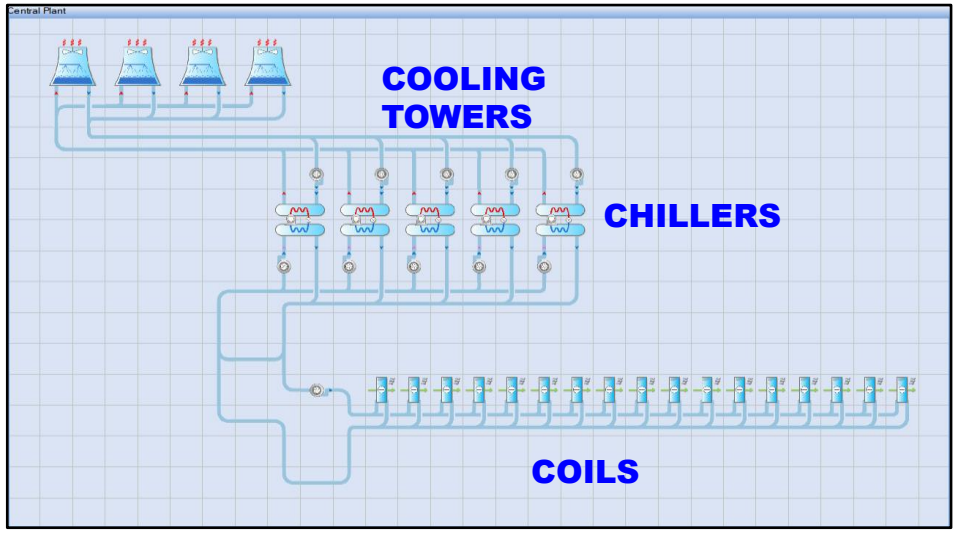
UNICO HOT WATER LOOP FOR PARTIAL 3RD AND 4TH FLOOR



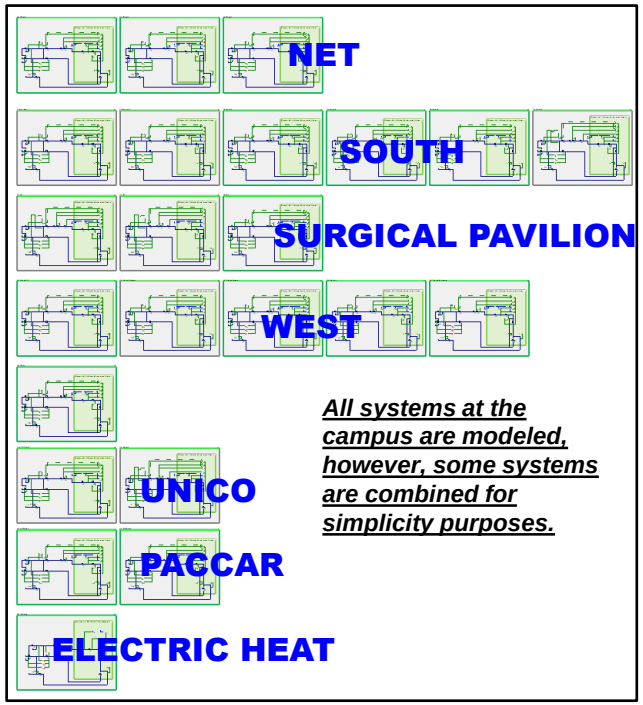
UNICO CHILLED WATER LOOP



MAIN CHILLED WATER PLANT

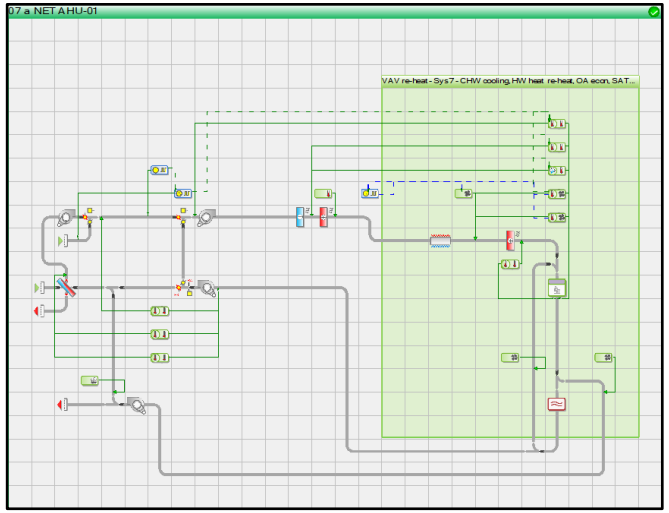


AIR HANDLING UNITS



All systems at the campus are modeled, however, some systems are combined for simplicity purposes.

SAMPLE AHU – NET AHU-01



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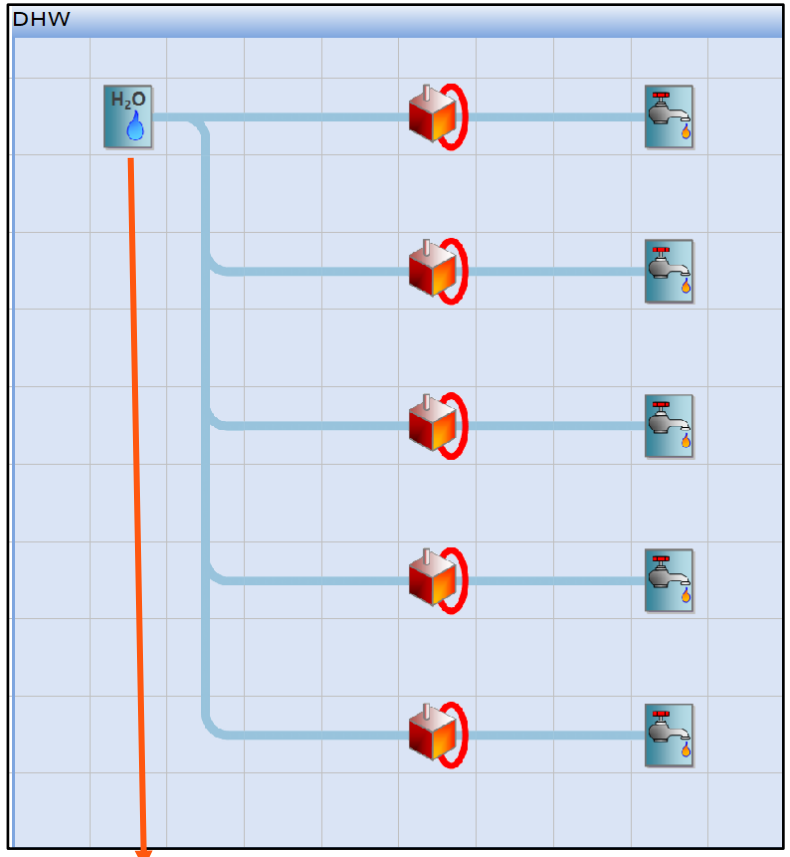
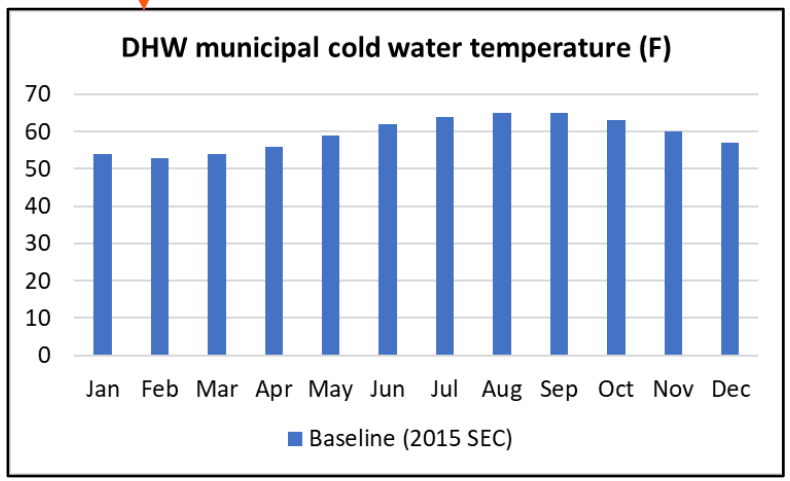
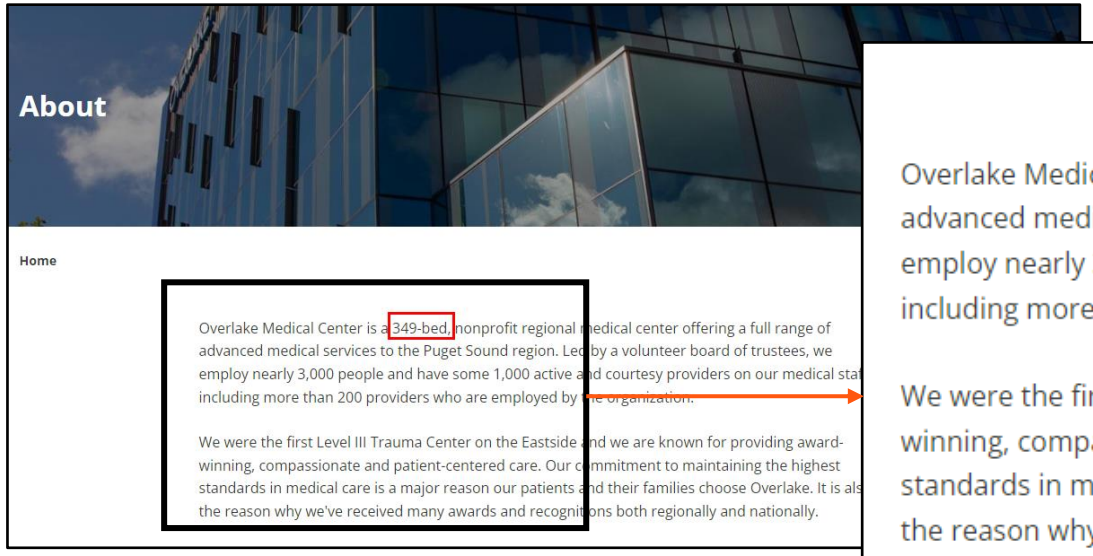
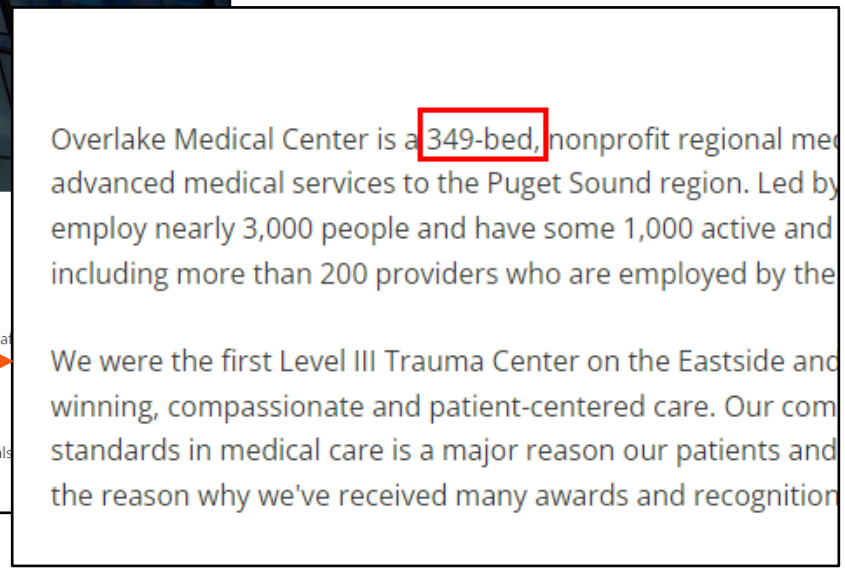
ENRERGY MODEL – DHW





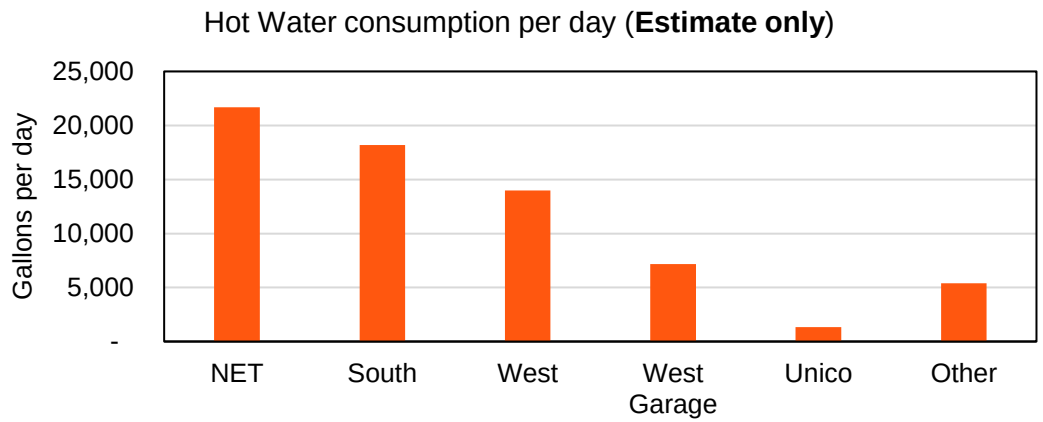




DHW USAGE CALCULATION

- *Typical Hospital 150-250 gallons of water per day per bed (70% assumed to be hot water)*
- *20 visitors per day on average per staff*
- *Overlake*
  - *349 Beds (250 x 349 x 70% = 61,075 gallon of hot water*
  - *3,000 Staff (20 x 3,000 = 60,000 Visitors)*

Water consumption data can be re-calibrated once total water consumption data is available.

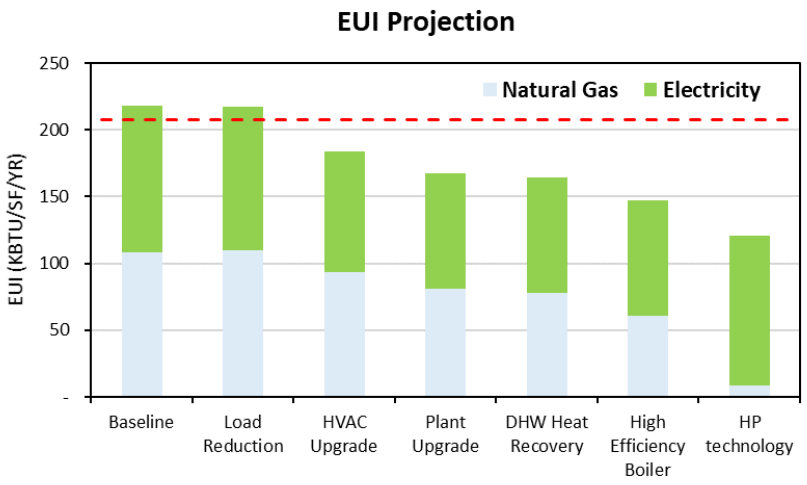


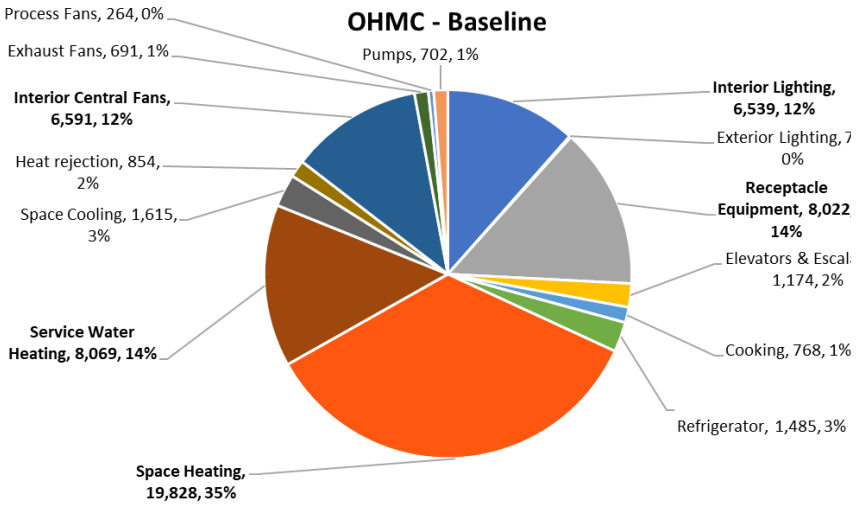
Overlake Medical Proposed Design Summary

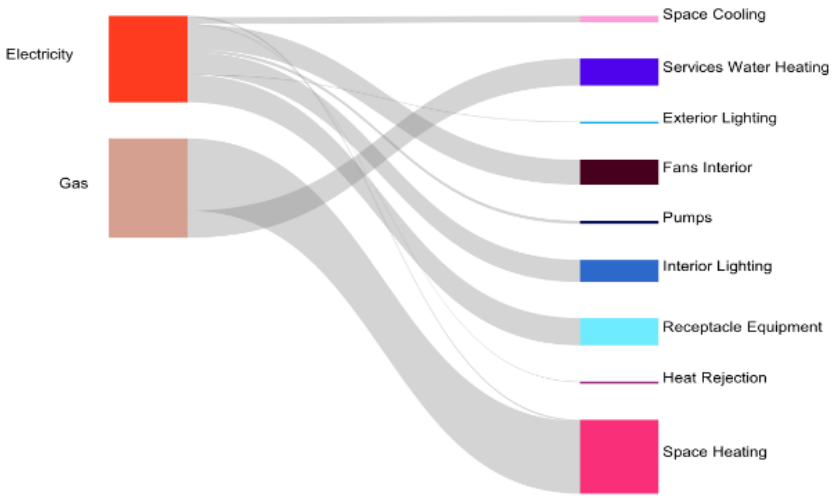
~~223.1~~ 120.6 kBtu/sf/yr

Energy Use Intensity Proposed model

Annual Cost Saving
$ 468,151 per year







Energy Efficiency Measures (EEM) Summary

Following list summarizes only key EEMs for each category. Breakout EEM analysis will be provided in the future.

Load Reduction (1-5 EUI reduction)

- Lighting improvement (Occupancy sensors, LED installation, and etc) – currently only focused on patient room and amenity – **Potentially more savings available with full lighting audit**
- Mechanical load optimization (Lab/med vacuum)

HVAC Upgrades (20-35 EUI reduction)

- AHU return air installation (South Tower AHU-3,4,5, SP SF-1,2,3)
- Fan wall replacement
- Setpoint optimization (Zone temperature set point, occupancy sensor setbacks, etc.)
- Static pressure resets for AHUs (coil cleaning, reset control, removing inlet vanes, and etc.)
- Surgery Volume scanning & Minimum ACH optimization

Plant Upgrades (5-15 EUI reduction)

- General Heat recovery for the plant
- Boiler economizer
- Steam leakage/heat loss reduction (DA tank pressure reduction, pipe insulation, etc)
- Cooling Tower Relocation and optimization
- Chiller plant sequence optimization
- Pump VFD installation

DHW heat recovery (3-10 EUI reduction)

- DHW preheat / heat recovery

Major Equipment Upgrades (15-40 EUI reduction)

- High efficiency condensing boiler
- HP technology
- Heat recovery Chiller

FROM THIS | Just numbers → TO THIS | Informed decisions

brk	PROJECT TOTAL	TOTAL
	AHU Damper Functional Testing & Adjust	$1,081,834
EEM-11	HVAC. AHU Damper Functional Testing & Adjust. AHU-2R dampers are mostly shut and not positioning correctly. AHU-2 in NET return dampers not functioning properly. AHU-44 dampers not positioning properly, WT Heart & Vascular AHU outside air dampers not functioning properly, AHU-8 lower damper section not open. These and other issues indicate need to functional testing of all AHU dampers with those that modulate given priority.	$1,100,000
	AHU Supply Air Temperature Reset	$660,495
EEM-20	HVAC. AHU Supply Air Temperature Reset. Reset AHU supply air temperature based on zone level input from all terminal units that the unit serves. Investigate and correct any rogue zones which artificially reset the AHU. Add timers to provide system stability.	$660,000
	Internal Envelope Inspections and Optimization in High ACH or Volume Rooms	$451,800
EEM-71	Envelope. Internal Envelope Inspection and Optimization in High ACH or Volume Rooms. Perform a detailed inspection of room internal envelopes and appropriately seal the room. Surgery Rooms, Decontamination, All Rooms, Sterile Processing, and Labs are examples including any rooms where airflow offsets are greater than room requirements to meet pressure requirements.	$450,000
	AHU Airflow Stations for Calculating Minimum Outside Air Damper Position	$134,592
EEM-75	HVAC. AHU Airflow Stations for Calculating Minimum Outside Air Damper Position. All AHU's without airflow stations should have these stations added for outside air and supply air then calculate minimum outside air position (technically flow not position).	$135,000
	AHU-1, 2 for OMT DX Sequence Optimization	$39,255
EEM-83	HVAC. AHU-1, 2 for OMT DX Sequence Optimization. The direct expansion cooling sequence of operations for the OMT AHU's appears to not be as energy efficient as it can be. Adding a new optimized sequence can help the unit perform better.	$40,000
	AHU Remove Fan Inlet Dampers, add Current Transducers (or alternative), and Alarm	$101,212
EEM-84	HVAC. AHU Remove Fan Inlet Dampers, add Current Transducers (or alternative), and Alarm. Numerous AHU's have inlet fan barometric dampers which produce significant pressure drops and friction for the system, reduces capacity, and affects energy efficiency. Removal and adding safeties such as alarms to catch any fan failures can produce the same intended results as the damper.	$100,000
	AHU Return Air Addition to all 100% Outside Air Fans and Remove Heat Wheels & Heat Pipes	$1,636,363
EEM-86	HVAC. AHU Return Air Addition to all 100% Outside Air Fans and Remove Heat Wheels & Heat Pipes. Surgery Pavilion, South Tower 2nd Floor Mechanical Rooms, and any other 100% outside air AHU's can be converted to return air units, their heat recovery devices removed, airflow sensors added to control system to meet ventilation needs. This reduces heating and cooling loads significantly.	$1,640,000
	DOAS install for OMT Pharmacy Space & Remove from Central AHU	$0
EEM-91	HVAC. DOAS Install for OMT Pharmacy Space (and other 24/7 ventilation loads) & Remove from Central AHU. Possible DOAS installation on 2nd floor roof on NW corner of building or 3rd floor ASC mechanical room above existing unit. Approximate airflow to pharmacy space is 3,000 to 4,000 CFM.	$2,500,000
	Fan Terminal Unit Filter Upsizing to 2"	$554,869
EEM-92	HVAC. Fan Terminal Unit Filter Upsizing to 2". Install sheet metal sliding racks or front-loading racks to approximately 208 Fan Terminal Units in the building.	$550,000
	Fan Terminal Unit Rebalance to Neutral in OMT	$235,754
EEM-93	HVAC. Fan Terminal Unit Rebalance to Neutral in OMT. Rebalance of approximately 208 FTU's. Adjustment of setpoints to balance unit to neutral. This does not include	$235,000
	NET Heating Water Bypass Valve for Series Operation	$79,490
EEM-94	HVAC. NET Heating Water Bypass Valve for Series Operation. Add a heating water bypass valve in the NET mechanical room to place the HRC in series with the steam heat exchangers.	$80,000
	Optimum Start/Stop Sequence Addition for OMT	$31,886
EEM-95	HVAC. Optimum Start/Stop Sequence Addition for OMT. Add optimum start/stop sequence to the existing Siemens DDC system.	$30,000

Recommend FY2023 (+6 EUI Benefit)

$200,000 be assigned to Low Capital Projects

				EUI Delta	$/EUI	Cumulative EUI	Cumulative $
EEM-55	Plant	DA Tank Pressure Reduction to 5.5 psi	$ 456.00	3.45	$ 132	3.45	$ 456
EEM-45	Plant	Chiller Condensing Water Inlet Temperature Optimization	$ 19,220.00	1.81	$ 10,648	5.26	$ 19,676
EEM-25	HVAC	AHU on West Tower Roof (Haakon) Outside Air Damper/Airflow Fix	$ 956.00	0.05	$ 20,340	5.30	$ 20,632
EEM-54	Plant	Cooling Tower Sequence Optimization	$ 3,220.00	0.08	$ 42,933	5.38	$ 23,852
EEM-16	HVAC	AHU Humidification & Dehumidification Optimization	$ 18,442.00	0.21	$ 89,092	5.59	$ 42,294
EEM-14	HVAC	AHU & EF Filter Upgrade from 2" to 4"	$ 12,446.00	0.04	$ 311,150	5.63	$ 54,740
EEM-17	HVAC	AHU Removal of Inlet Vanes on P1, P2, P3 AHU's	$ 6,200.00				$ 60,940
EEM-18	HVAC	AHU Sensor Calibration/Verification	$ 5,400.00				$ 66,340
			$ 3,200.00				$ 69,540
EEM-19	HVAC	AHU Sensors Relocated & Reference Lines Installed Correctly					
EEM-26	HVAC	Critical/Control Function Sensors Calibrated/Verified	$ 88,000.00				$ 157,540
EEM-29	HVAC	Equipment & Zone Scheduling	$ 12,448.00				$ 169,988

*Some of these tasks could potentially be performed in-house

EEM-17-29 will have an EUI benefit – unable to model those impacts currently

EUI Delta	$/EUI	Cumulative EUI	Cumulative $
3.45	$ 132	3.45	$ 456
1.81	$ 10,648	5.26	$ 19,676
0.05	$ 20,340	5.30	$ 20,632
0.08	$ 42,933	5.38	$ 23,852
0.21	$ 89,092	5.59	$ 42,294
0.04	$ 311,150	5.63	$ 54,740
			$ 60,940
			$ 66,340
			$ 69,540
			$ 157,540
			$ 169,988

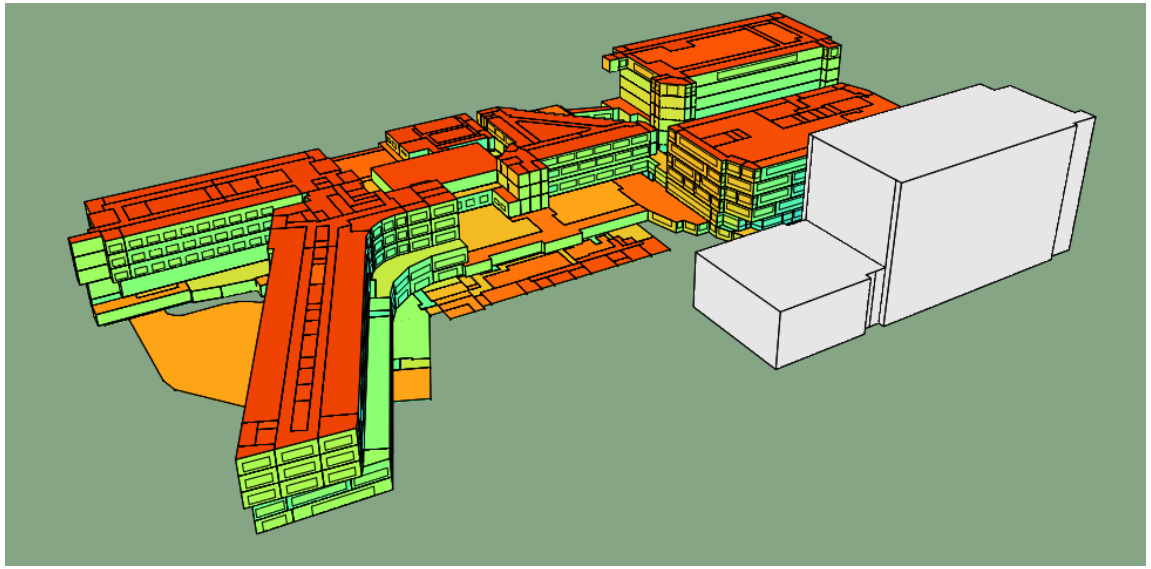
Method 1 | ENERGY MODEL

Contract
Client = ~$ 25,000

Hours spent
157 hours

Scope

- Develop Energy Management Plan for CBS compliance / Decarbonization
- Prioritize investment to meet EUI goals
- Built energy model for any future studies / upgrades



Method 2 | SPREADSHEET (EST)

ROM hours to estimate energy savings
24 hours

Estimated hours for 40 measures
960 hours → **Approximately 6x more than energy modeling**

Cost underestimate
ROM hours of 24 hours to develop spreadsheet for each measure is probably underestimated.

Single-use
Because projects vary, spreadsheet must adapt, and the time spent developing them can increase.

Unreliable
Accuracy is not guaranteed.

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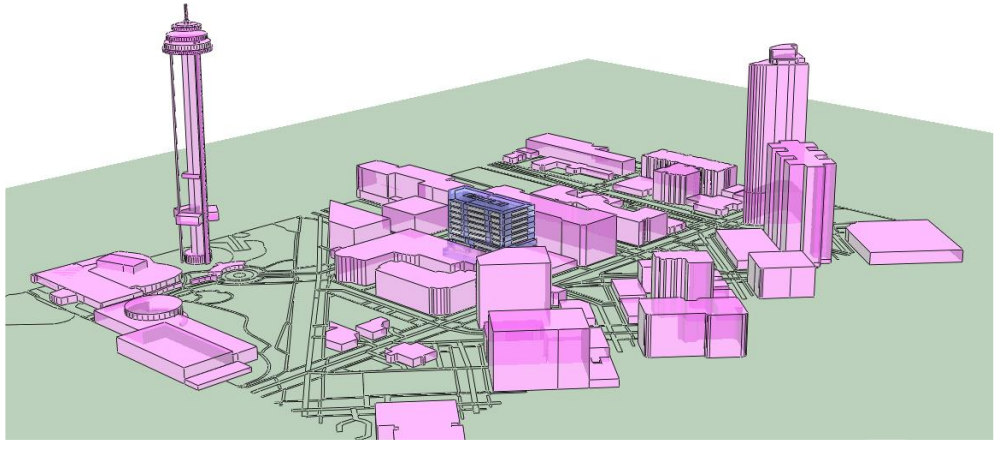
Achieving Success through Accuracy



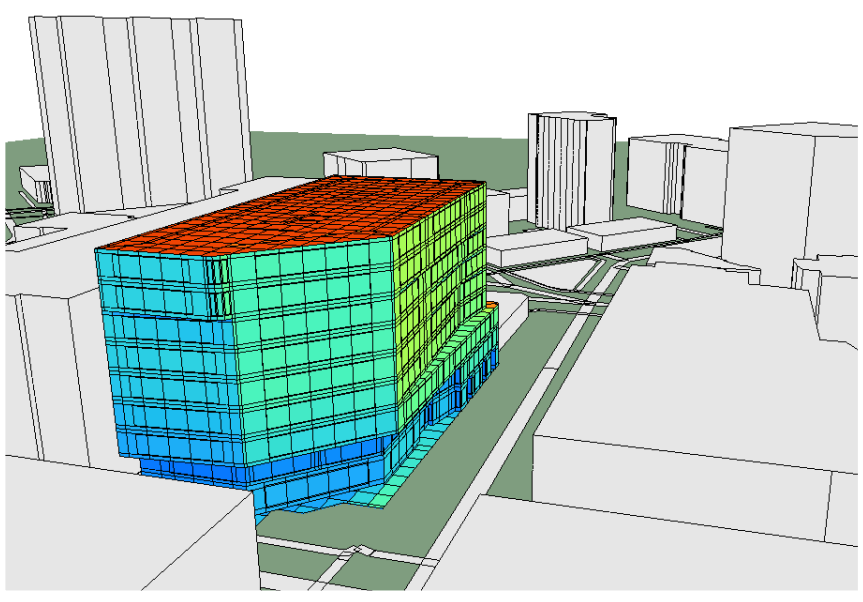
Initial Load Calculation of ~500 ton cooling

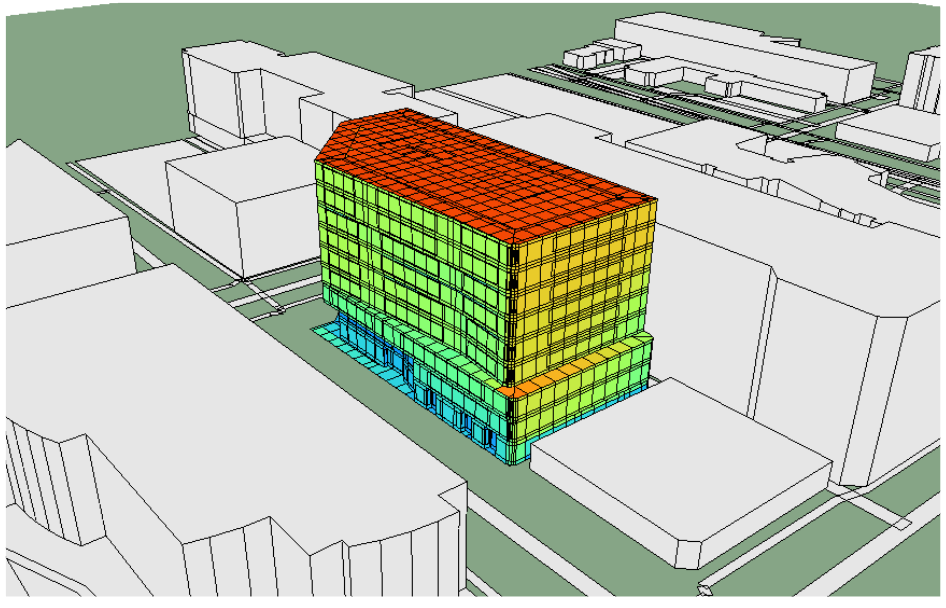
PROBLEM

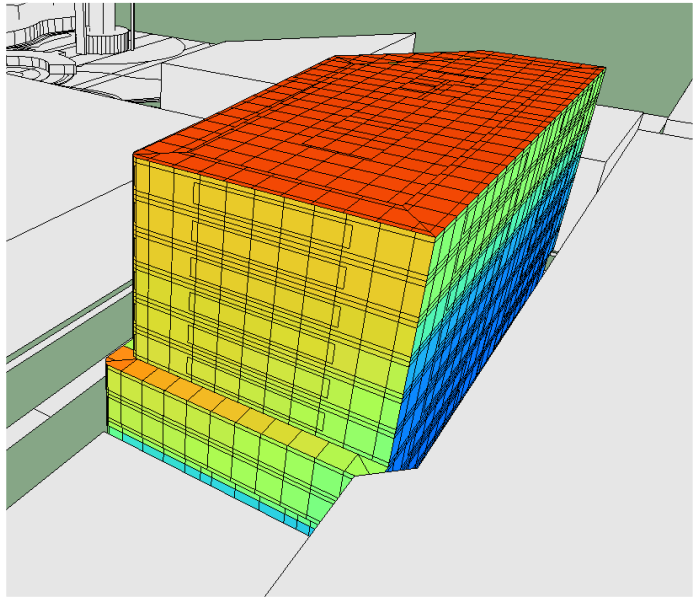
- The project does not have enough roof space for bigger chillers
- Traditional load calculation tool is not able to consider shading effect accurately
- Initial load is peak of peaks, not building peaks

BAM IMPLEMENTED SHADING ANALYSIS

- Peak of peak: 490 ton
- Building Peak: 450 ton

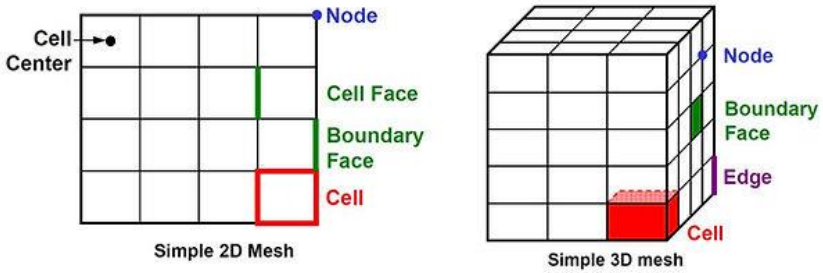


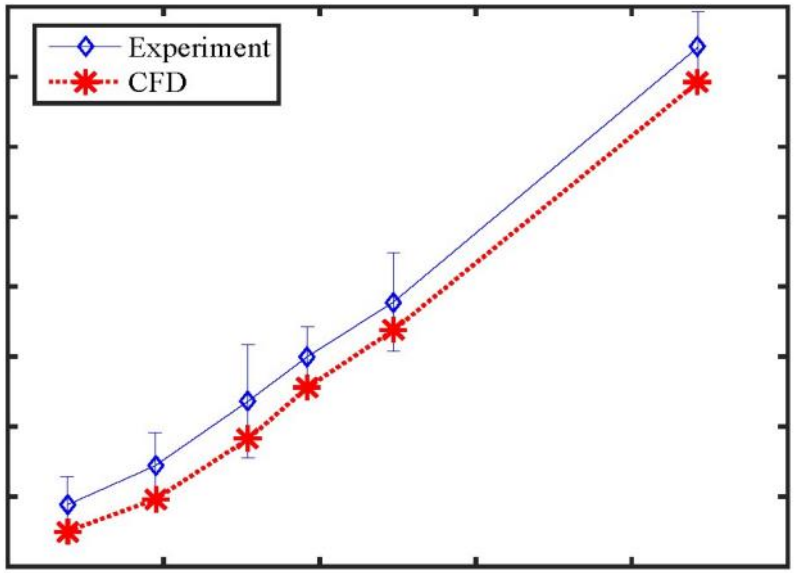


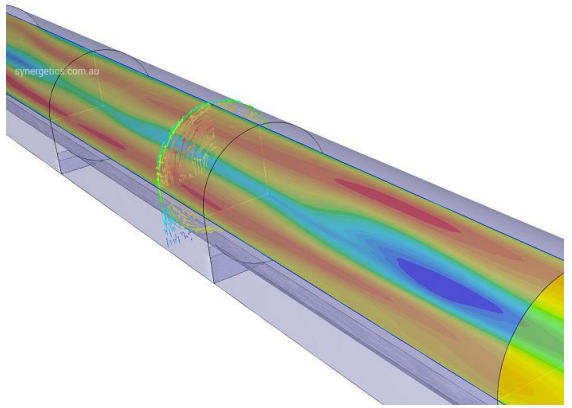


Computational Fluid Dynamics (CFD)

Simulates fluid flows and analyze the flow characteristics using numerical methods

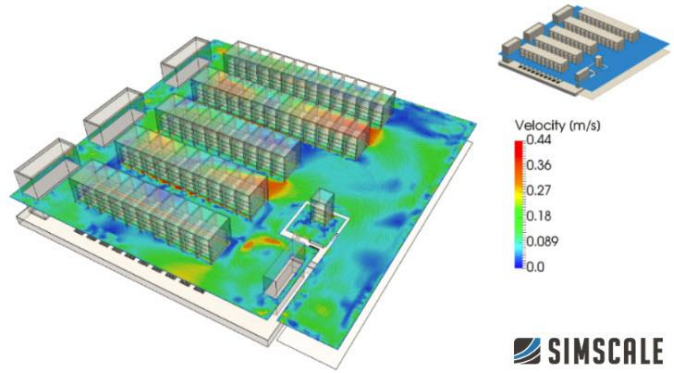




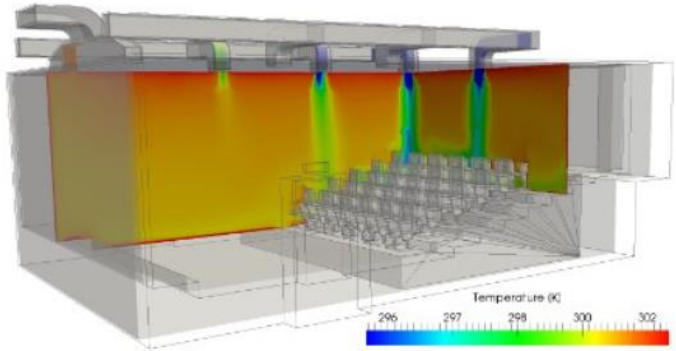


Tunnel Ventilation

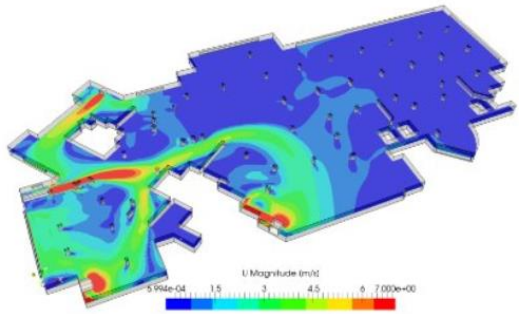
Data Center Cooling



Data Center Cooling



Thermal Comfort



Contaminant Control

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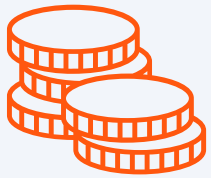
Top Three 2022 BAM Jobs

SAVINGS! SAVINGS! SAVINGS!

School *Shelton SD*

Hospital *Overlake Medical Center*

Multifamily *303 Battery*



$435,263
cost reduction

175.5 EUI
reduction

Over **4 Million** LB
CO2 Emission
(4,391,869 LB)

Equal to **32,940** tree
seedlings grown for
10 years

1-2 Months
payback

OVER 85 ENERGY EFFICIENCY MEASURES

Questions? Let's Connect

David Park, Ph.D, PE, CEM, BEMP

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Every. Single. Energy savings. Matters! David couples analysis with energy audits to identify energy efficiency measures (EEMs) that are cost effective for owners' business goals. Driven to make a significant impact towards carbon reduction and sustainability, David enjoys studying and analyzing how building energy reduces utility and operational costs, making it a great investment for the future.

Hailee Hammerquist, LEED Green Associate

hhammerquist@umci.com | hailee-hammerquist

Hailee is detail oriented, organized, and passionate about sustainable design. She loves tackling the complexity of our projects to ensure all the pieces fit efficiently together inside high-performing exteriors. Coming from West Virginia, Hailee is excited to experience all the outdoor adventures that the Seattle area has to offer. She spends her time off the clock outside hiking in the summer and hitting the slopes in the winter.

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