O'Brien360

EXEMPLARY BUILDING PRE-CONSTRUCTION ENERGY STUDY

For Hobson Place South

10/26/21

Project Description & Scope

Project Description

- Permanent supportive housing (PSH) building project
- 7 stories (3 clinic, 4 residential)
- 92 small efficient dwelling units on L4 ~ L7
- PSH residential service at L1
- Medical clinic on L1 ~ L3
- Parking garage on P1

Areas within Model Scope

Space Type	Building Area (ft^2)	Modeled Area (ft^2)
Residential Apartment (Level 4-7)	32,045	32,045
Residential Corridors (Level 4-7)	7,490	7,490
Residential Stairwell (Level 1-7)	3,427	3,427
Residential Laundries (Level 4-7)	760	760
Residential Storage (Level 4-7)	597	597
Other Residential Area (Level 1-7)	3,711	-
Supportive Housing Area (Level 1)	5,360	-
Health Clinic (Level 1-3)	26,375	-
Parking Garage (Level P1)	13,105	-
Total	92,870	44,319

Energy Conservation Measures

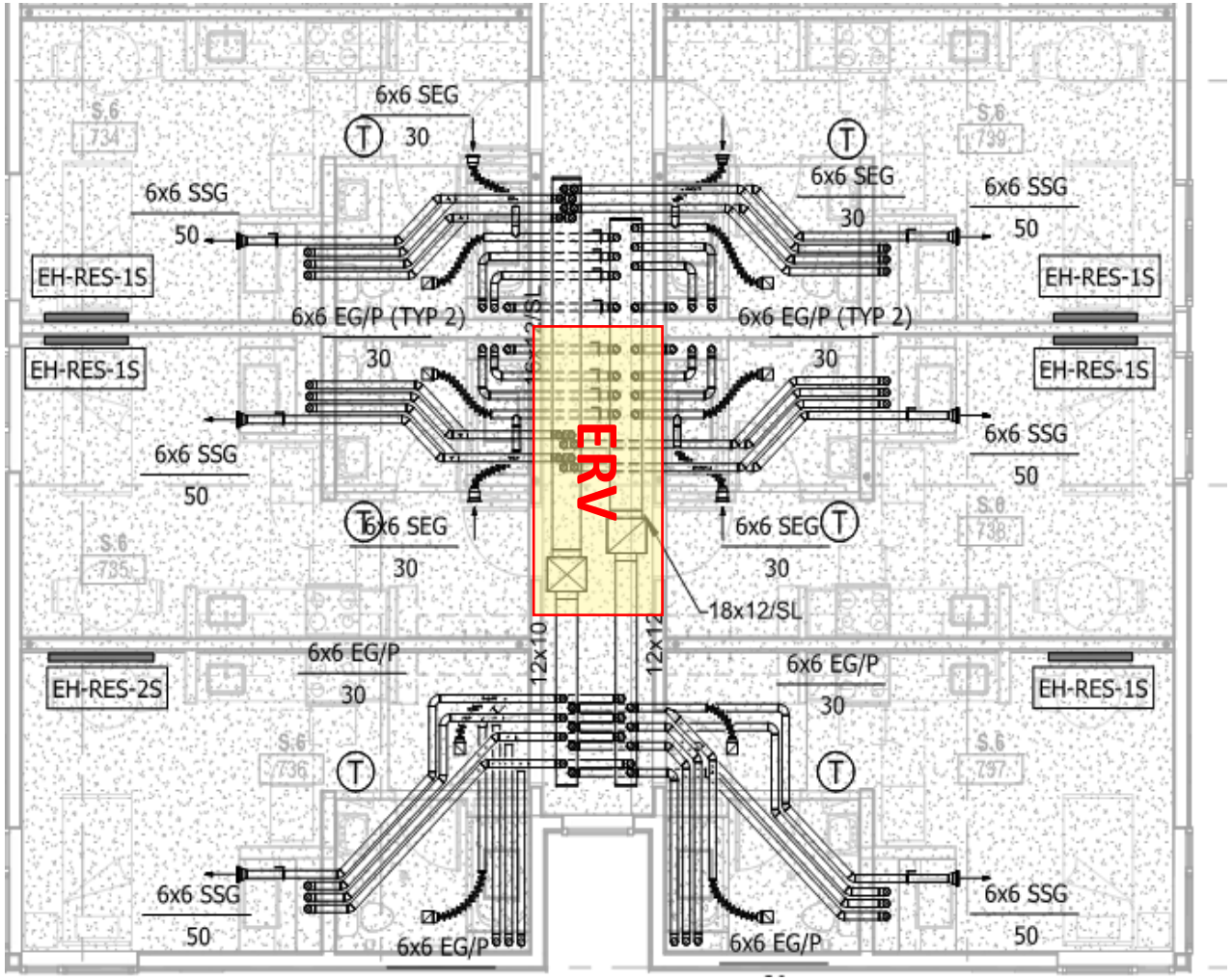
Energy Conservation Measures

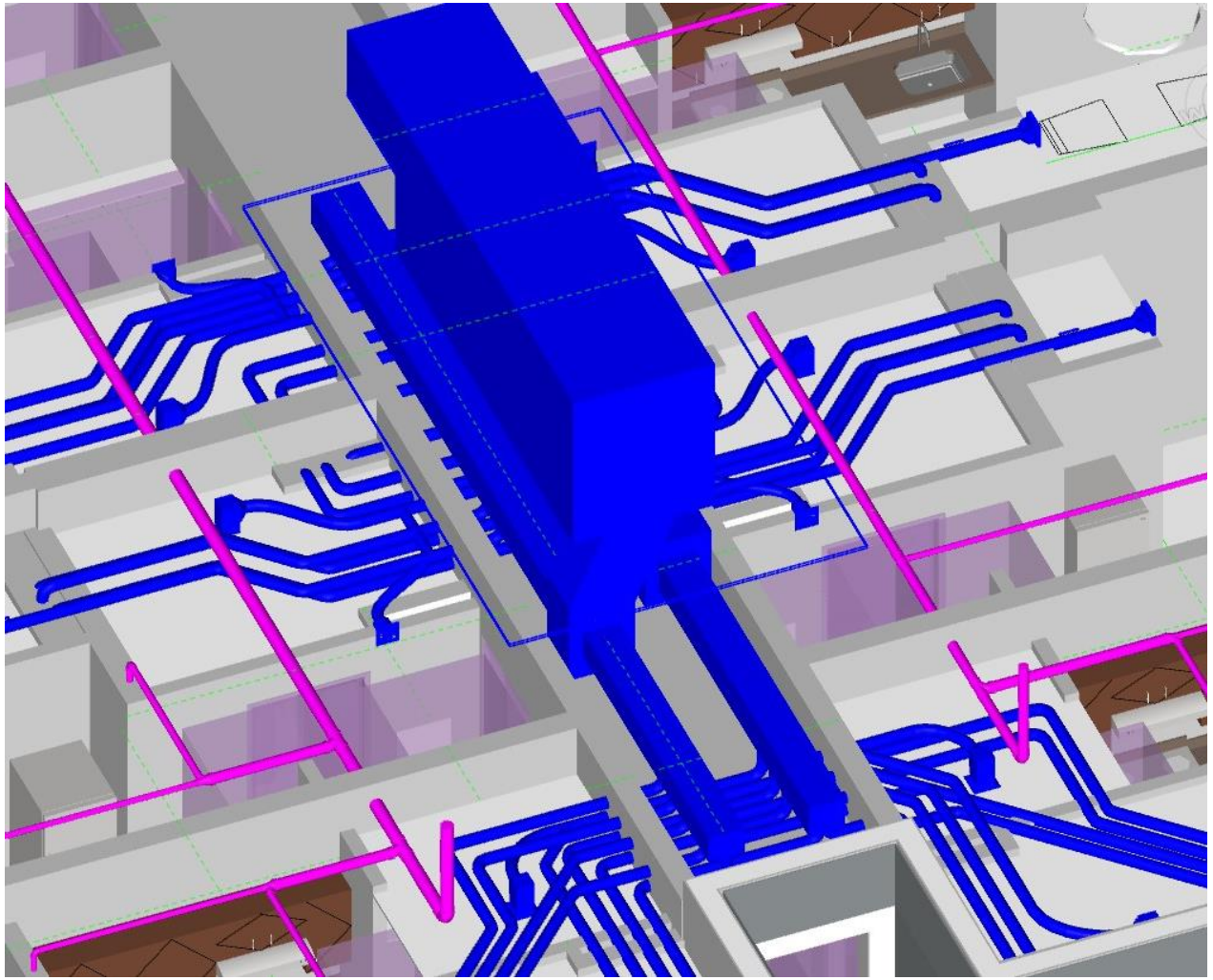
ID	ECM	Baseline *
A1.0	Triple-pane vinyl windows (U-0.18)	Double-pane vinyl windows (U-0.26)
A2.0	Air leakage 0.08 cfm/ft2 @ 0.3 in H2O	Air leakage 0.25 cfm/ft2 @ 0.3 in H2O
E1.0	Reduced lighting power (37% less than baseline)	Standard lighting power
E2.0	Energy Star refrigerators	Non-Energy Star refrigerators
E3.0	Energy Star common clothes washers/dryers	Non-Energy Star common clothes washers/dryers
M1.0	Energy recovery ventilation (ERV) system	Whole house exhaust fan in each apartment
M2.0	Thermostat with window switch	Standard thermostat
P1.0	Low flow rate plumbing fixtures	Plumbing fixtures with code-maximum flow rates
P2.0	Improved plumbing distribution	Typical plumbing distribution
P3.0	Heat pump water heaters	Electric resistance water heaters

* Baseline was 2015 SEC with Enhanced Envelope (C406.8) and Reduce Air Leakage (C406.9) options included

M1.0 – Centralized ERV System

- 3 rooftop ERVs (Swegon Gold RX) serving:
  - Dwelling units
  - Corridors
  - Trash rooms
- All duct works are in conditioned spaces
- 85% sensible efficiency, 0.78 W/cfm system power using MERV 13 filters
- Baseline was whole house exhaust fans with electric heat






GOLD
GOLD

P3.0 – Heat Pump Water Heater

- (10) Sanden CO2 heat pump located in the parking garage.
- (2) 504 gal storage tanks w/ R-16 insulation and a 27 kW electric resistance back-up heater located in P1 mechanical room.
- 8 kW “swing tank” heater and TMV in a mechanical room on L4. Pump run continuously
- Assume HPs shut off when EWT = 90F.
- Modeled annual COP: 3.8
- Baseline is central electric resistance water heating

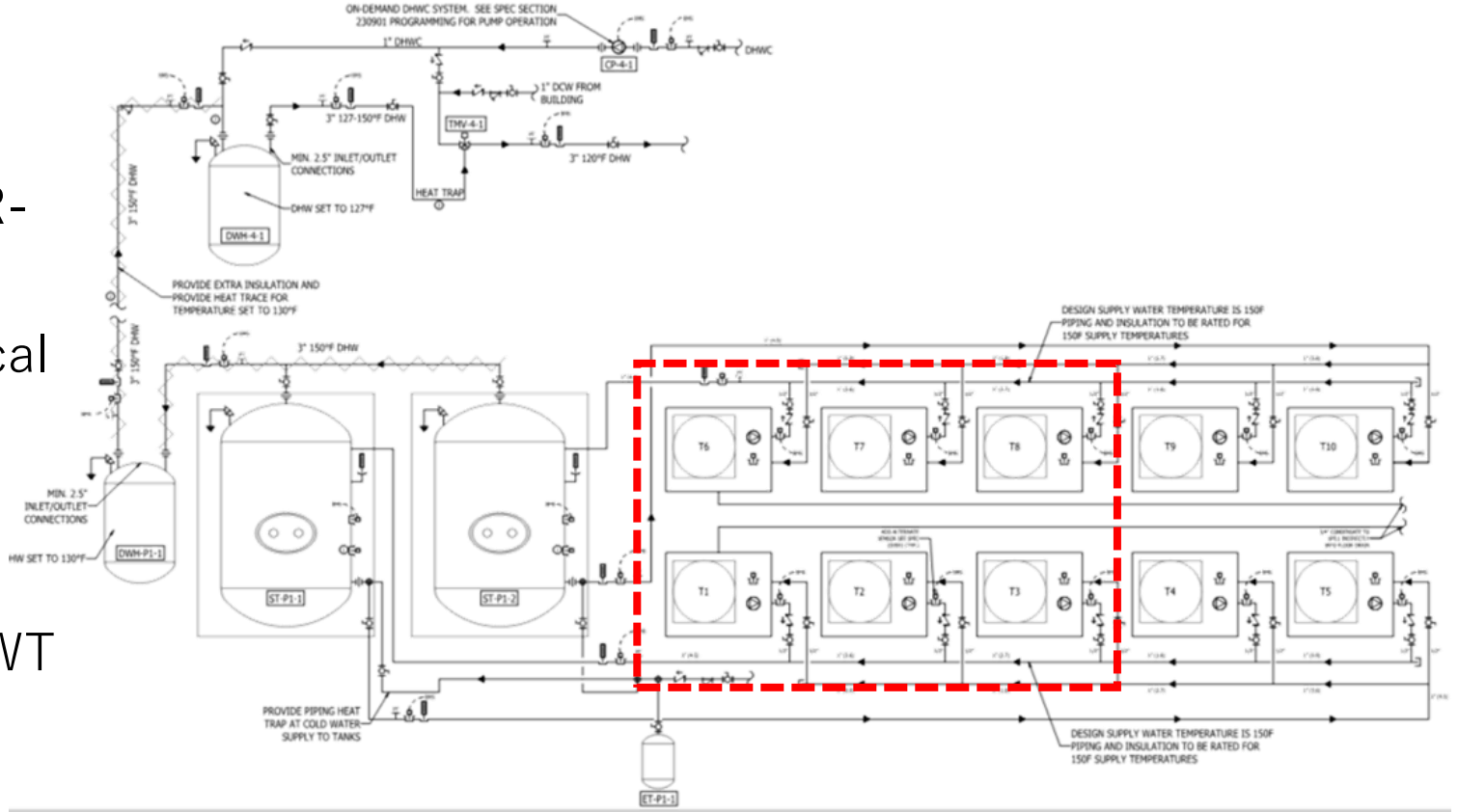
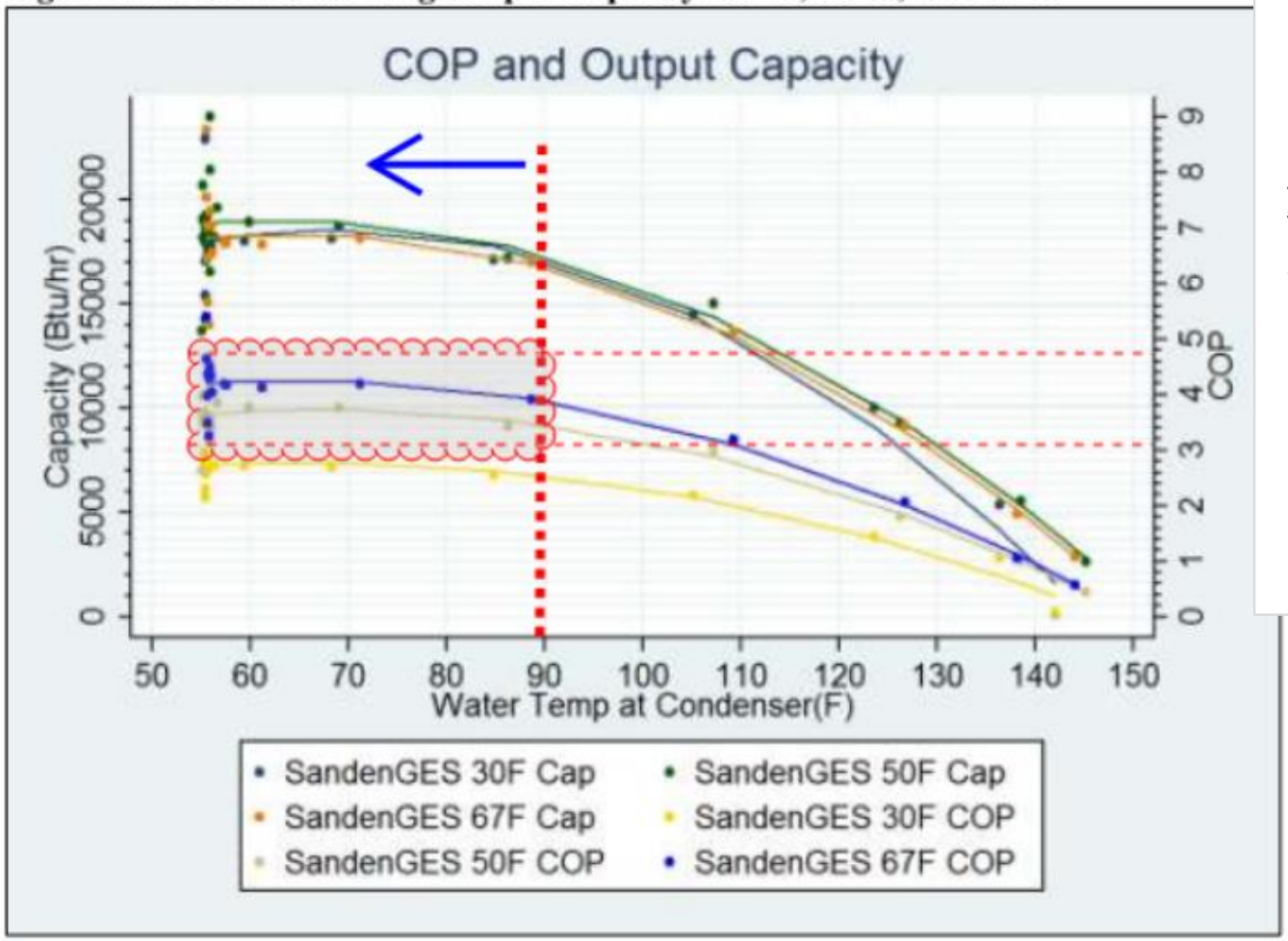
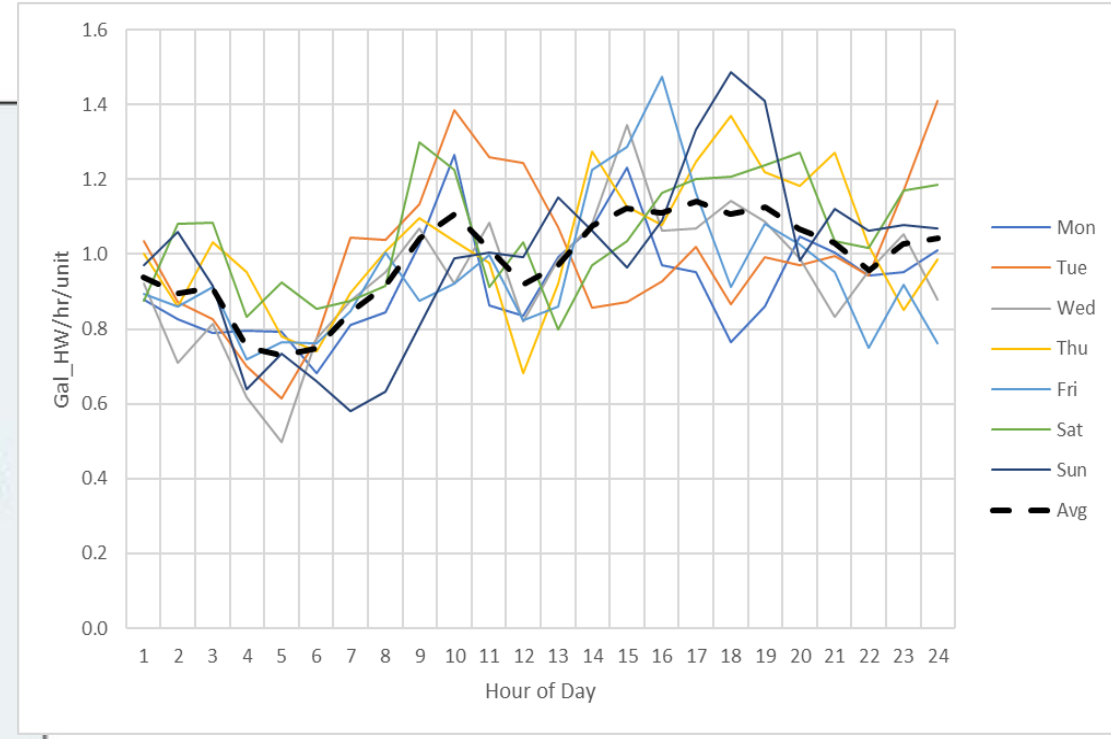


Figure 16. COP and Heating Output Capacity: 30° F, 50° F, and 67° F



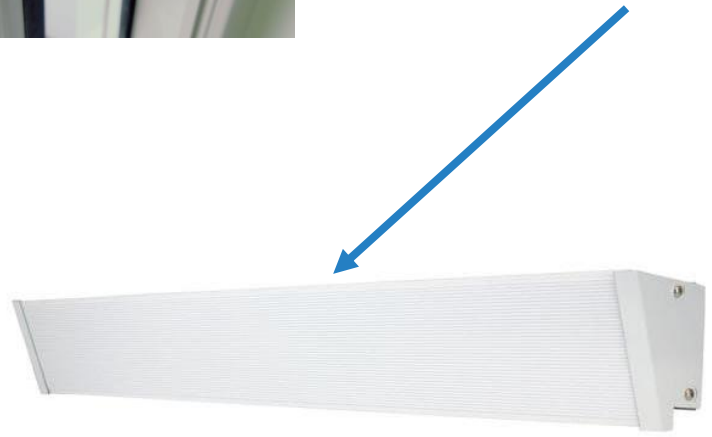


P2.0 - Improved Plumbing Distribution

- Reduce number of DHW/DCW rises. 24 -> 17
- 1” thicker pipe insulation
- Heat losses are estimated using 3EPlus with multiplier to align with observed value for a similar project
- Hot water is not recirc’ed back to plant in basement, but rather swing tank on L4.
- Heat losses are estimated to be
  - Baseline: 84 W/apt
  - Proposed: 43 W/apt

M2.0 - Thermostat with Window Switch

- Apartment cove heaters controlled by a line voltage thermostat, King Window Watcher (WRP-230).
- Encourage tenants to not open the windows during heating season.
- Window has magnetic switch wired to thermostat. When window is open, the heat setpoint is setback to 60°F with no delay and can't be overridden (required custom order).
- Baseline w/o window switch modeled with increased infiltration.



ECM Analysis

- Water heating energy is calculated using spreadsheet based model.
- The rest of the analysis is performed using eQUEST/DOE-2.2.
- Each run modeled with the baseline **plus** one individual ECM. (Non-interactive run), as well as one run of the proposed design with all ECMS included (Interactive run).
- The proportionate energy savings for each ECM was calculated as:

$$Individual\ ECM\ Savings = \left[\frac{Savings\ for\ individual\ ECM\ run}{Sum\ of\ savings\ for\ all\ ECM\ runs}\right] \times Savings\ for\ Proposed\ Design\ (Interactive\ run)$$

ECM Energy Saving/Measure Cost Summary

ECM ID	ECM Description	Interactive Annual Savings			Incremental 1st Cost	Simple Payback	Incremental O&M Cost
		kWh	$/year	%	$	years	$/year
A1.0	Thermally Improved Windows	15,039	$1.504	2.3%	$52,750	35	$ -
A2.0	Reduced Air Leakage	2,386	$239	0.4%	$80,783	339	$ -
E1.0	Reduced Lighting Power	4,079	$408	0.6%	$ -	0	$ -
E2.0	Energy Star Refrigerators	1,318	$132	0.2%	$6,900	52	$ -
E3.0	Energy Star common Laundry	15,005	$1,500	2.3%	$ -	0	$ -
M1.0	ERV System	118,545	$11,854	18.5%	$577,879	49	$ 4,400
M2.0	Thermostat with Window switch	14,623	$1,462	2.3%	$12,200	8	$ -
P1.0	Efficient Plumbing Fixtures	36,680	$3,668	5.7%	$ -	0	$ -
P2.0	Improved Plumbing Distribution	14,119	$1,412	2.2%	$30,500	22	$ -
P3.0	Heat Pump Water Heater	160,924	$16,092	25.1%	$73,000	5	$ 1,000
	Proposed	382,718	$38,272	60%	$834,012	21.8	$ 5,400

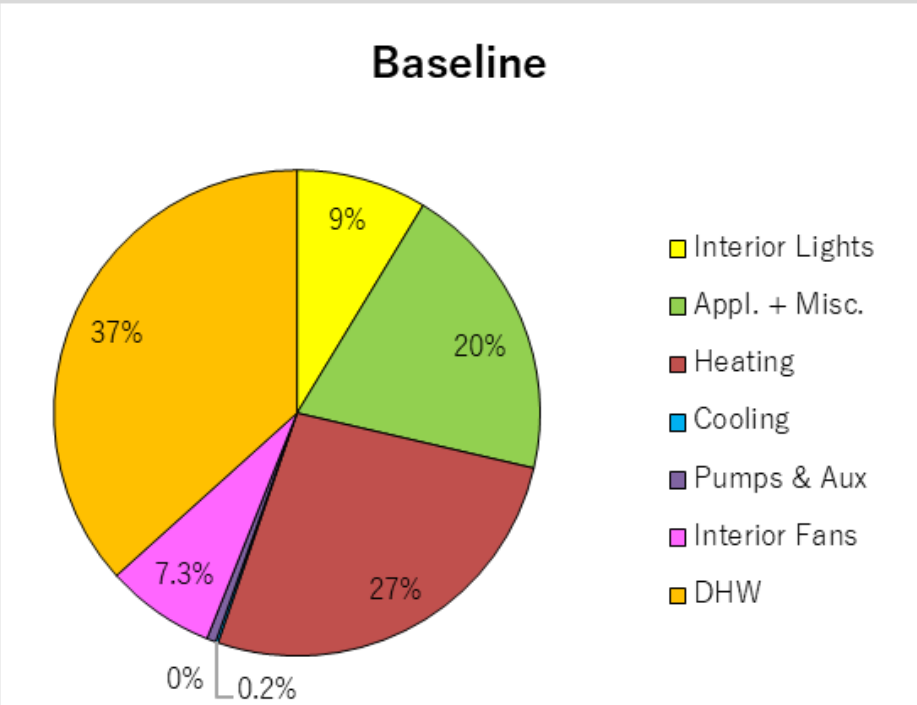
Impact of ECMs on Health, Comfort, and Longevity

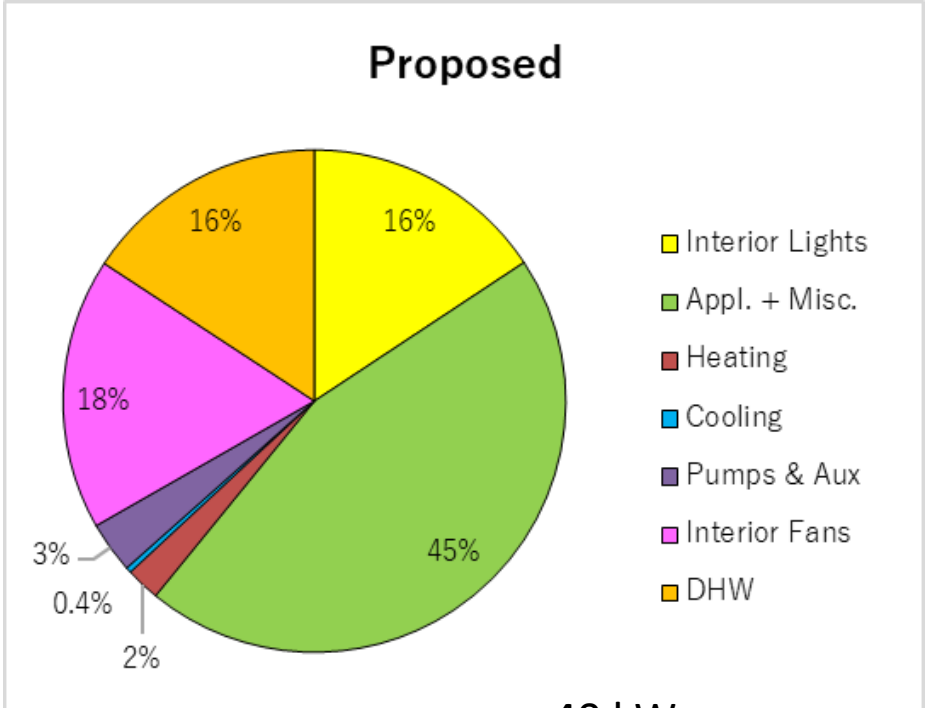
ECM ID	ECM Description	Indoor Air Quality	Thermal Comfort	Usability	Reliability	Ease of Maintenance	Maintenance Cost
A1.0	Thermally Improved Windows	0	+5	0	0	0	0
A2.0	Reduced Air Leakage	+3	+1	0	0	+5	0
E1.0	Reduced Lighting Power	0	0	0	0	0	+5
E2.0	Energy Star Refrigerators	0	+2	0	0	+3	0
E3.0	Energy Star common Laundry	0	+1	0	0	0	0
M1.0	ERV System	+5	+5	0	+5	+3	-3
M2.0	Thermostat with Window switch	0	-3	0	-3	-3	-3
P1.0	Efficient Plumbing Fixtures	0	0	0	0	0	0
P2.0	Improved Plumbing Distribution	0	+3	0	0	0	0
P3.0	Heat Pump Water Heater	0	0	-3	-3	-3	-3

*Rating (-5 to +5)

Overall Analysis Results

Overall Results

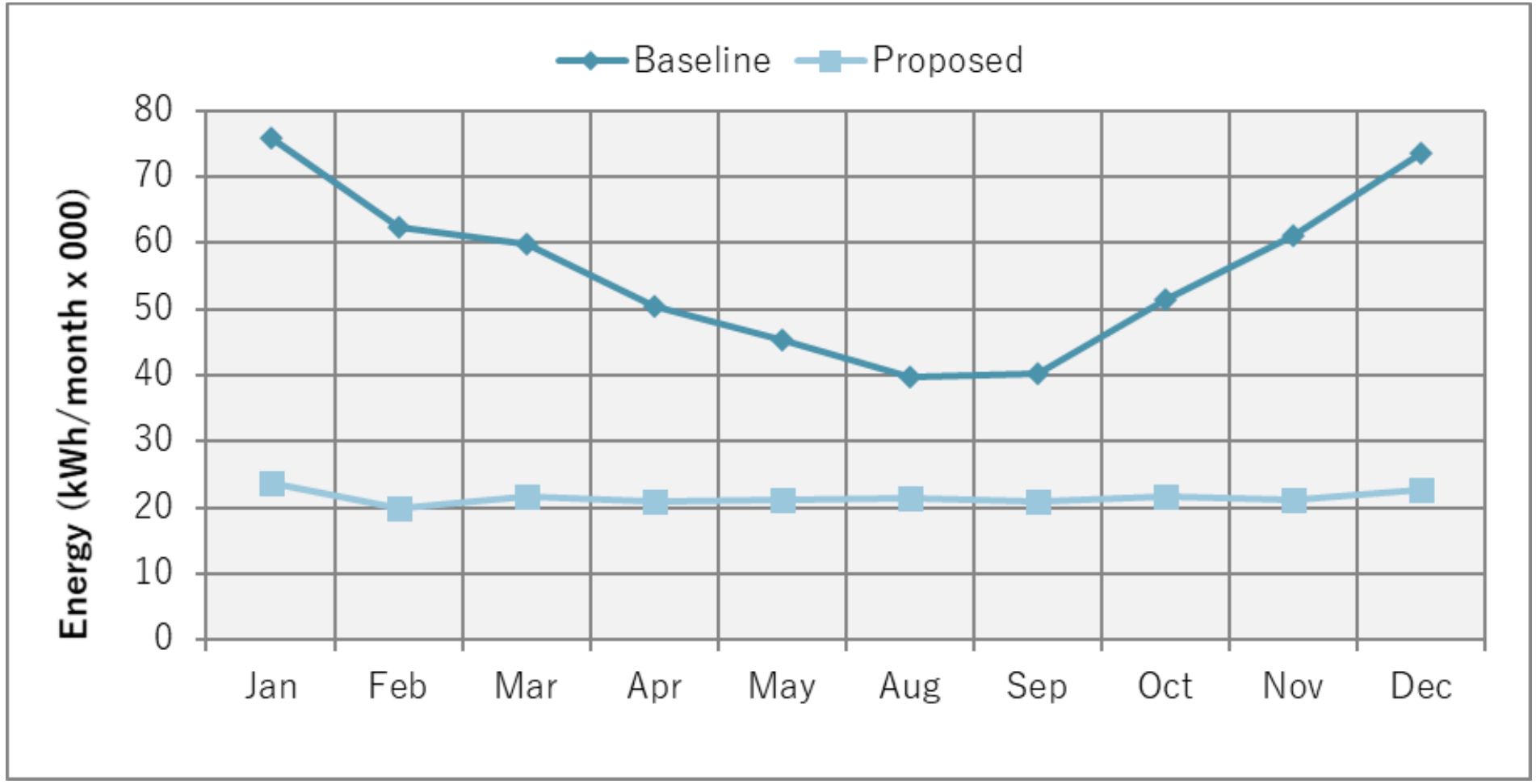




40 kW

Energy (kBtu/ft²)	Interior Lights	Appl. + Misc.	Heating	Cooling	Pumps & Aux	Interior Fans	DHW	Total	PV	Total (Incl.PV)
Baseline	4.3	9.8	13.2	0.1	0.3	3.6	18.2	49.5	(0.3)	49.1
Proposed	3.1	9.0	0.4	0.1	0.7	3.5	3.2	20.0	(3.1)	16.9
Reduction	27%	8%	97%	16%	-121%	3%	83%	60%		66%

Monthly Results



Life Cycle Cost Analysis

Key Analysis Variables		Building Characteristics	
Study Period (years)	50	Gross (Sq.Ft)	44,319
Nominal Discount Rate	3.11%	Useable (Sq.Ft)	44,319
Maintenance Escalation	1.00%	Space Efficiency	100.0%
Zero Year (Current Year)	2021	Project Phase	0
Construction Years	0	Building Type	0

Life Cycle Cost Analysis		BEST	
Alternative	Baseline	Alt. 1	Alt. 2
Energy Use Intenstity (kBtu/sq.ft)	49.1	16.9	16.9
1st Construction Costs	$ 16,299,771	$ 17,480,013	$ 17,634,805
PV of Capital Costs	$ 16,210,897	$ 17,961,630	$ 18,116,422
PV of Maintenance Costs	$ -	$ 344,656	$ 344,656
PV of Utility Costs	$ 3,502,973	$ 1,205,139	$ 1,205,139
Total Life Cycle Cost (LCC)	**$ 19,713,870**	**$ 19,511,425**	**$ 19,666,217**
Net Present Savings (NPS)	**N/A**	**$ 202,444**	**$ 47,652**

Societal LCC takes into consideration the social cost of carbon dioxide emissions caused by operational energy consumption

(GHG) Social Life Cycle Cost		BEST	
GHG Impact from Utility Consumption	Baseline	Alt. 1	Alt. 2
Tons of CO2e over Study Period	13,144	4,522	4,522
% CO2e Reduction vs. Baseline	N/A	66%	191%
Present Social Cost of Carbon (SCC)	$ 1,414,732	$ 486,715	$ 486,715
Total LCC with SCC	**$ 21,128,601**	**$ 19,998,140**	**$ 20,152,932**
NPS with SCC	**N/A**	**$ 1,130,461**	**$ 975,669**

Post-Construction Monitoring Recommendations

Energy Recovery Ventilation System

- NEEA Very High Efficiency (VHE) DOAS study
  - Monitoring both North Phase and South Phase
  - Quantify DOAS performance
  - Sampling (3) dwelling unit conditions:
    - Heating energy use
    - Temperature, RH, CO_2

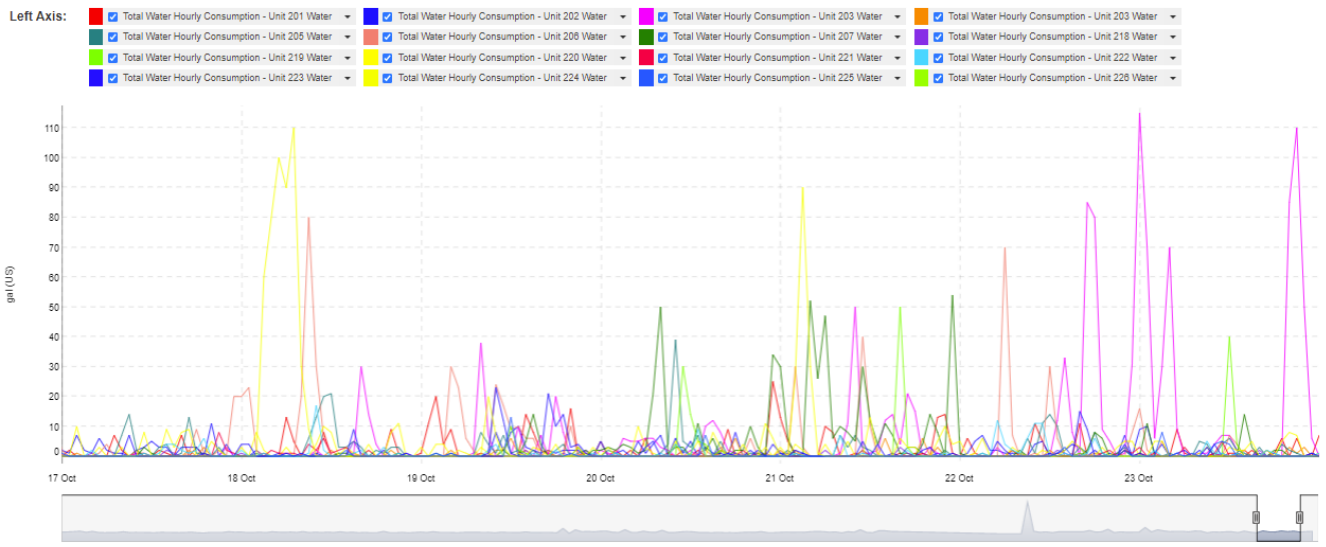
Heat Pump Water Heating Plant

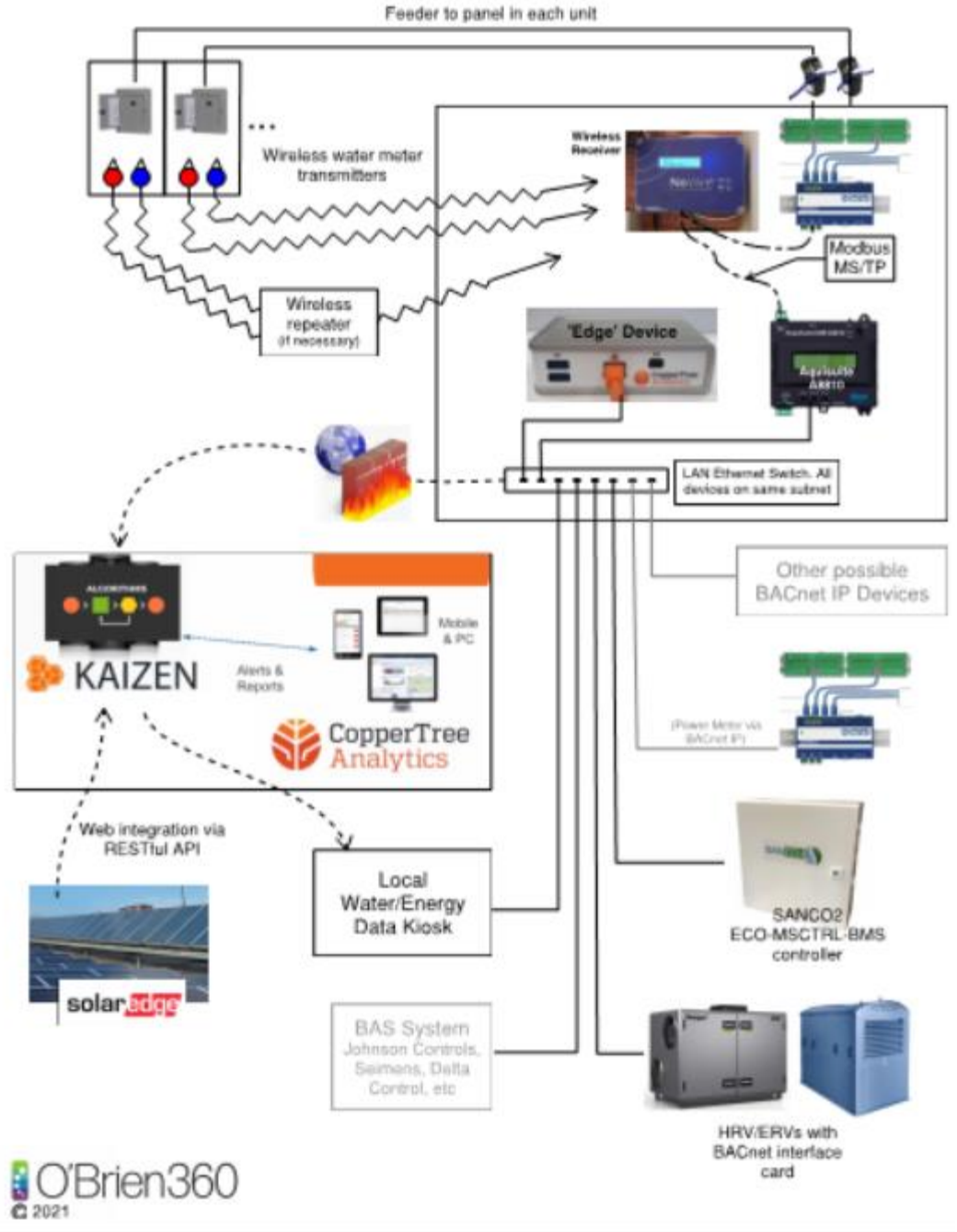
- Will have ability to trend points using DDC or water metering system:
  - HPWH controller
  - Additional temperature points (each HP, tanks, supply to L4, recirc return)
  - Hot/cold water for every apartment
  - C409 energy metering

Thermostats

- Investigated line-voltage thermostats with central networking (hard-wired)
- Estimated additional cost $300-400/unit
- WiFi networked thermostat is more promising
- Will have dwelling unit data from NEEA study

Water/Electric Sub-Metering





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Thank you!

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