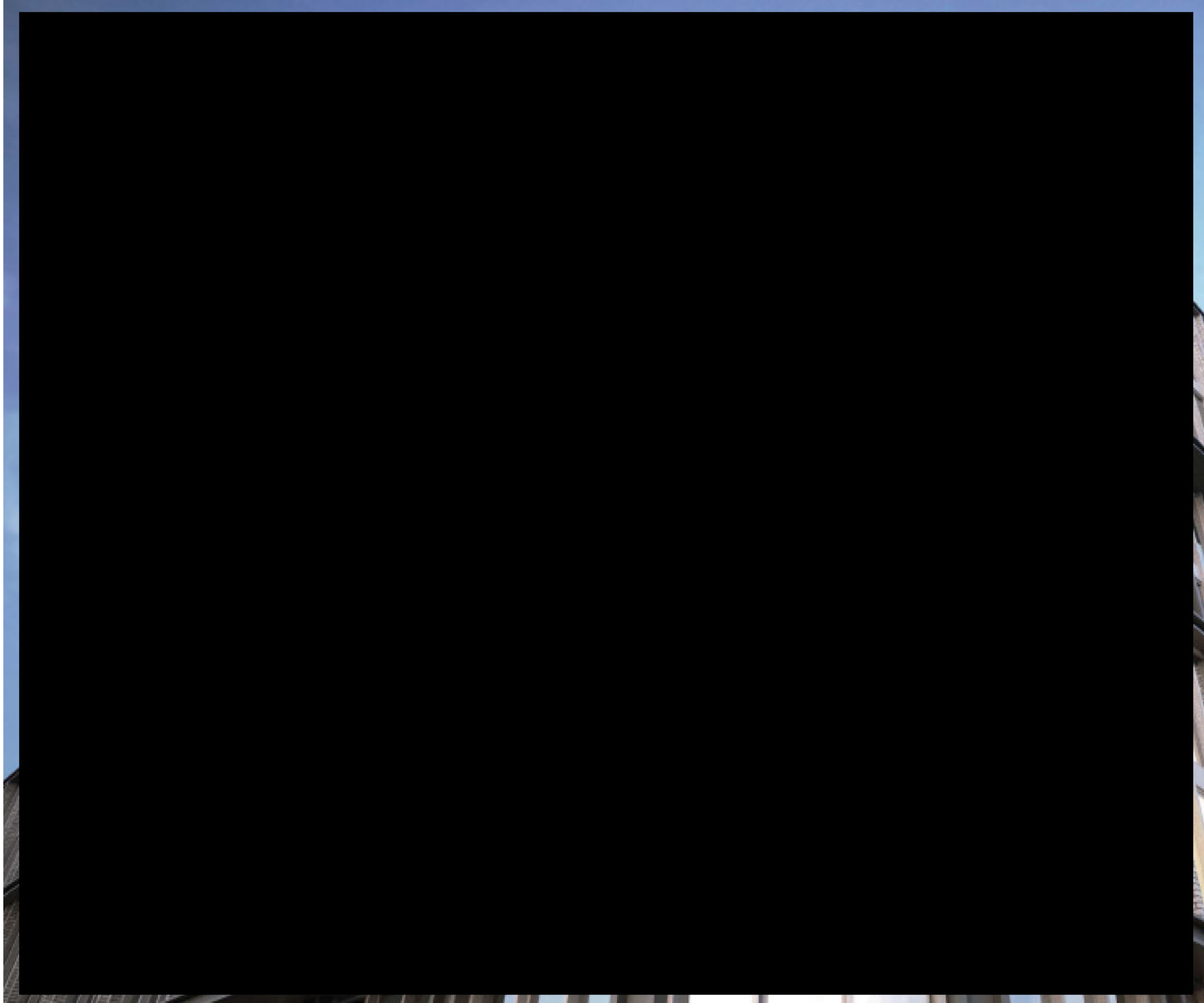
BUILT ECOLOGY

[redacted]

Schematic Design
Energy and Water
Performance Report
10/12/2017

[redacted]



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EXECUTIVE SUMMARY

Goals

This study is intended to provide early design guidance in support of optimizing energy performance, answering the questions:

- What are the contributions of the current design features to energy savings?
- How should energy conservation measures be prioritized as the design progresses?
- Will the project easily meet LEED v4 energy goals?
- What other opportunities are available for additional performance improvements?

The project's minimum energy target is a 5% reduction in total annual energy costs relative to the ASHRAE 90.1-2010 Appendix G baseline, which will comply with both the LEED prerequisite and the [redacted] energy code. The proposed design currently demonstrates an 18% energy cost reduction.

Background

Built Ecology has created a schematic-level energy model based on the design as of Sep-Oct 2017. Where parameters have not yet been determined, assumptions have been made based on Phase 1 (One Hill South). Full details of modeling assumptions are shown on the following page and on page 9.

The building has been split into residential and non-residential sections and is classified as mixed-fuel heating.

Energy conservation measures reference [redacted] High Performance Practices (developed for buildings in New York) and select features of the current design.

This report includes demand-side strategies only and excludes energy associated with the pools and spa.

Findings and Recommendations

1. All load-reducing strategies should be investigated to maximize opportunities for savings. Load reductions can be accomplished through a combination of low-cost measures (such as EnergyStar-rated residential appliances), or through an aggressive reduction in one area (such as all-LED lighting for corridors and stairs).

2. Both residential and non-residential ECMs should be pursued. Lighting power reductions in corridors, stairwells, back-of-house, and amenities are especially impactful in this study despite the relatively small area of those spaces in the program.

3. HVAC equipment efficiency should be maximized through selecting high-efficiency fan motors and heat pumps. Heat pump heating efficiency should be prioritized over increased central boiler efficiency improvements.

4. For the envelope, high-performance glazing should be prioritized over additional insulation for opaque surfaces. When balancing glazing specifications, U-value should be prioritized over SHGC.

5. Process energy represents over a third of total energy consumption, and when the pool and spa are fully incorporated, this will reduce overall savings demonstrated. Process energy reduction strategies should be considered as the design progresses.

Potential Additional Savings

Following the principles above, the Design + High Performance Practices (HPP) case shown to the right improves performance by 5% through incorporating:

- Improved insulation for walls, roof, and glazing
- 10% LPD reductions in all spaces, with vacancy sensors in BOH and occupancy sensors in amenities
- Low-flow plumbing fixtures
- Hybrid heat pumps (HVAC design alternative #3)

The enhanced design case shown to the right creates an additional 4% improvement by including all HPP ECMs (except hybrid heat pumps) and the following additional low-effort upgrades:

- EC motor WSHPs (HVAC design alternate #2)
- 20% LPD reductions with vacancy sensors in BOH areas and occupancy sensors in amenity spaces
- 25% LPD reductions for all hard-wired lighting provided for apartment units
- 25% parking garage LPD reduction and carbon monoxide-tied controls for exhaust
- EnergyStar appliances

Next Steps

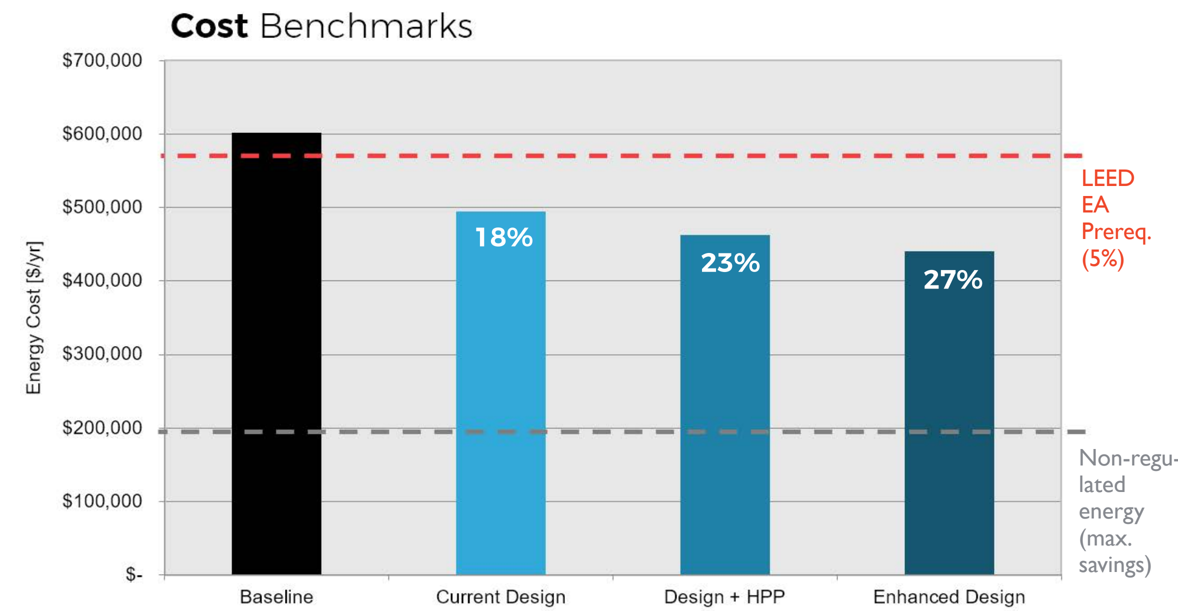
- Built Ecology proposes a follow up meeting with the design team to discuss recommendations, potential opportunities, and financial feasibility.

- Built Ecology will update model before the end of the DD phase to incoporate additional design information and re-benchmark against LEED goals.

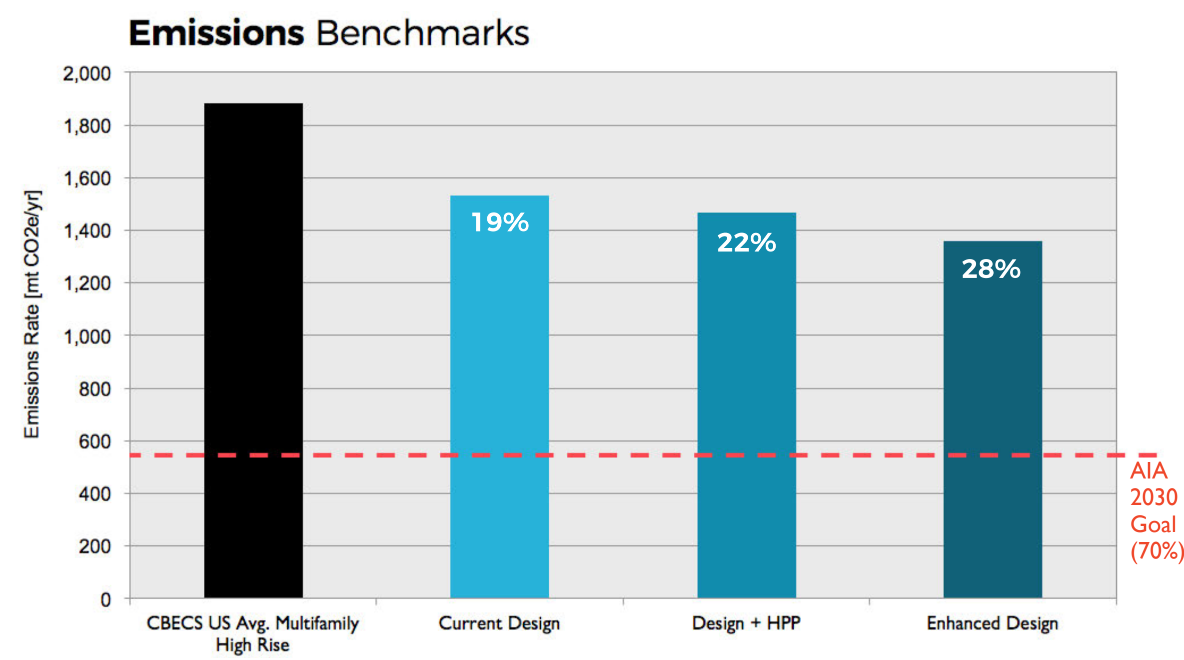
- Potential supply-side strategies, including on-site cogeneration, will be evaluated as target savings are determined and the load profile is refined.

- Additional process energy savings for the pool and spa will be assessed once incorporated into the model.

Performance Summaries



Selected elements of the proposed design contribute to **18%** energy cost savings over the LEED v4 energy baseline. With additional improvements, savings for the project could exceed **27%**.



Compared to the national average performance for high-rise multifamily buildings, the current design features are projected to reduce annual greenhouse gas emissions by **19%** and could reduce emissions up to **28%**, nearly halfway towards meeting the current AIA 2030 goal.

BASELINE AND PROPOSED DESIGNS

Program

Residential units represent the bulk of the building, with amenity spaces located on the first, second, and top floors. All internal loads and schedules have been taken from DOE and COMNET standard assumptions. The residential units comprise 72% of the baseline energy use and 75% of the proposed.

Envelope

The window-to-wall ratio of the proposed design is 47.5%. This is above the ASHRAE baseline 40% maximum, creating an energy cost penalty. Assuming the opaque constructions and glazing products in Phase 2 will be similar to Phase 1, the area-weighted thermal performance of the proposed envelope is 20% worse than the baseline.

Systems

The proposed design is a mixed-fuel heating system, with heat pumps serving the apartment units and central condensing boilers serving hot water coils for common area systems and dedicated outdoor air systems. In ASHRAE 90.1-2010, mixed-fuel heating cases must follow a fossil fuel baseline. Since natural gas is a cheaper fuel than electricity, this incurs an additional cost penalty for the building. If the DOAS was not served by hot water, absolute energy costs would increase, but the residential units would be classified as electric heating with a PTHP baseline and could show higher relative savings for LEED (refer to LEED Interpretation ID #10132).

Exclusions

For the purposes of this study, the following process energy uses have been excluded:

- Natatorium equipment for the pools and spa
- Exterior lighting and equipment
- Elevators

While non-regulated energy will increase and dilute the claimable percent savings, so will heating and cooling loads, which may improve relative savings based on efficiency. These effects may cancel.

At this stage of the design, many details regarding envelope constructions, equipment sizing, and control strategies are not available and will be incorporated into a future iteration. Along with the above, these additions are likely to change the final result from the estimate shown in this report, but are not anticipated to invalidate findings for individual measures.

Key Parameters

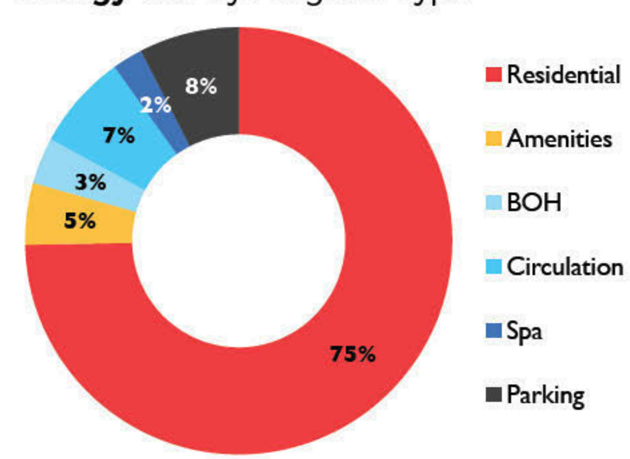
PARAMETER	ASHRAE BASELINE	HIGH PERFORMANCE PRACTICE	CURRENT DESIGN
Exterior Wall	R-15.6 assembly (Steel framed wall with R-13 batt, R-5 continuous insulation)	R-18.75 assembly (Equivalent to adding one inch of continuous insulation to baseline assembly)	R-13 Assembly * (Equivalent to subtracting half inch of continuous insulation from baseline assembly)
Exterior Roof	R-31.25 assembly (Concrete deck with R-20 continuous insulation)	R-37.5 assembly (Equivalent to adding two inches of continuous insulation to baseline assembly)	R-25 Assembly (Equivalent to subtracting two inches of continuous insulation assembly)
Window-to-Wall Ratio	40% maximum	N/A	47.5%
Residential Glazing	U-0.42 assembly, SHGC 0.40 (Double-glazed with vinyl frame)	U-0.34 assembly, SHGC-0.29 (Typically double-glazed with argon fill and thermally broken frame)	U-0.38 assembly, SHGC 0.27 *
Storefront Glazing	U-0.42 assembly, SHGC 0.40 (Double-glazed with vinyl frame)	U-0.32 assembly, SHGC-0.27 (Typically double-glazed with argon fill and thermally broken frame)	U-0.42 assembly, SHGC 0.27 *
Lighting Power	0.92 w/sf overall (see appendix for detailed breakdown by space type)	5-10% overall reduction from baseline	10% overall reduction from baseline in all nonresidential spaces
Lighting Controls	Occupancy sensors in open office, storage/mep, and common restrooms	Vacancy sensors for back of house Consider Lutron for residential units	Assumed same as baseline
Residential HVAC	Packaged terminal air conditioners for cooling (rated peak COP 2.78) with hot water heating (two 80% efficient central boilers)	Consider hybrid heat pumps ERV on exhaust ventilation	Water source heat pumps (4.2 rated peak COP cooling, 4.9 COP heating)
Non-Residential HVAC	Packaged VAV with DX cooling (rated COP 2.81-3.22) and hot water DX For spa, separate RTU (2.87 COP, 80% efficient furnace heating) required due to difference in loads for space	Airside economizer and DCV controls	Water-cooled DX VAV AC units (4.13-4.2 COP) with hot water heating (three 92% efficient central boilers)* On DOAS unit, 80% effective ERV

* - Assumed same as Phase I

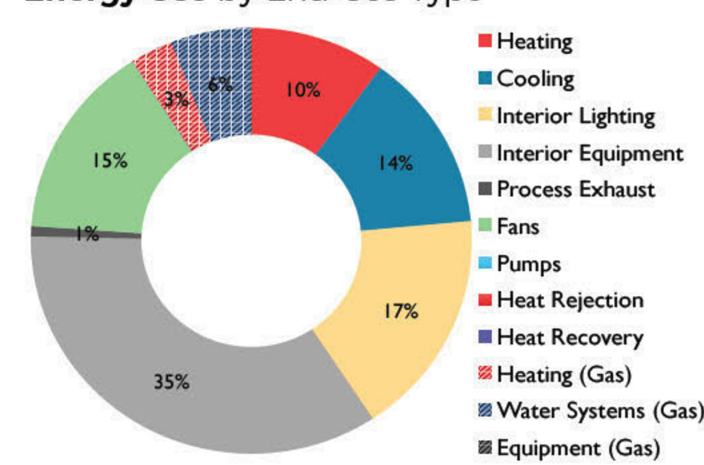
Model Geometry

[redacted]

Energy Use by Program Type



Energy Use by End-Use Type



PRIORITIES AND RECOMMENDATIONS

Proposed Design Features

Of the features in the current design studied in this analysis, the building envelope creates a slight overall penalty which is outweighed by additional energy-saving measures.

The pattern which emerges from these measures indicates that load reductions should be prioritized to maximize potential savings. Additional lighting power density reductions and controls, low-SHGC glazing, low-flow water fixtures, and energy recovery ventilation all contribute to this goal.

- The higher window-to-wall ratio (WWR) in the proposed design increases energy use by 1.4% and cost by 1.5%. This appears less significant than other buildings, which may be due to the residential use type, the massing, and the shading provided by Phase 1.

- The proposed envelope (based on Phase 1 specifications) is below the baseline minimum, but this does not create a significant penalty on energy cost performance, indicating that internal equipment and glazing drive the overall building loads.

- The proposed water source heat pumps are a high efficiency selection, and are able to conserve enough energy to overcome the cost penalty associated with electric heating. Overall, the HVAC system selections contribute the most to energy savings.

- For the purpose of this study, it was assumed that only a portion of each residential unit would be provided with hardwired lighting, resulting in modest lighting savings. If that value was increased, then greater credit could be taken for lighting power reductions in the model. If no hardwired lighting is provided, no savings may be credited to the project.

- Low-flow water fixtures (assuming a minimum 20% reduction per the LEED prerequisite) have a greater impact than improving the efficiency of hot water production alone. By reducing water consumption, low flow fixtures also lower pumping power and standby losses.

Influences on Energy Performance

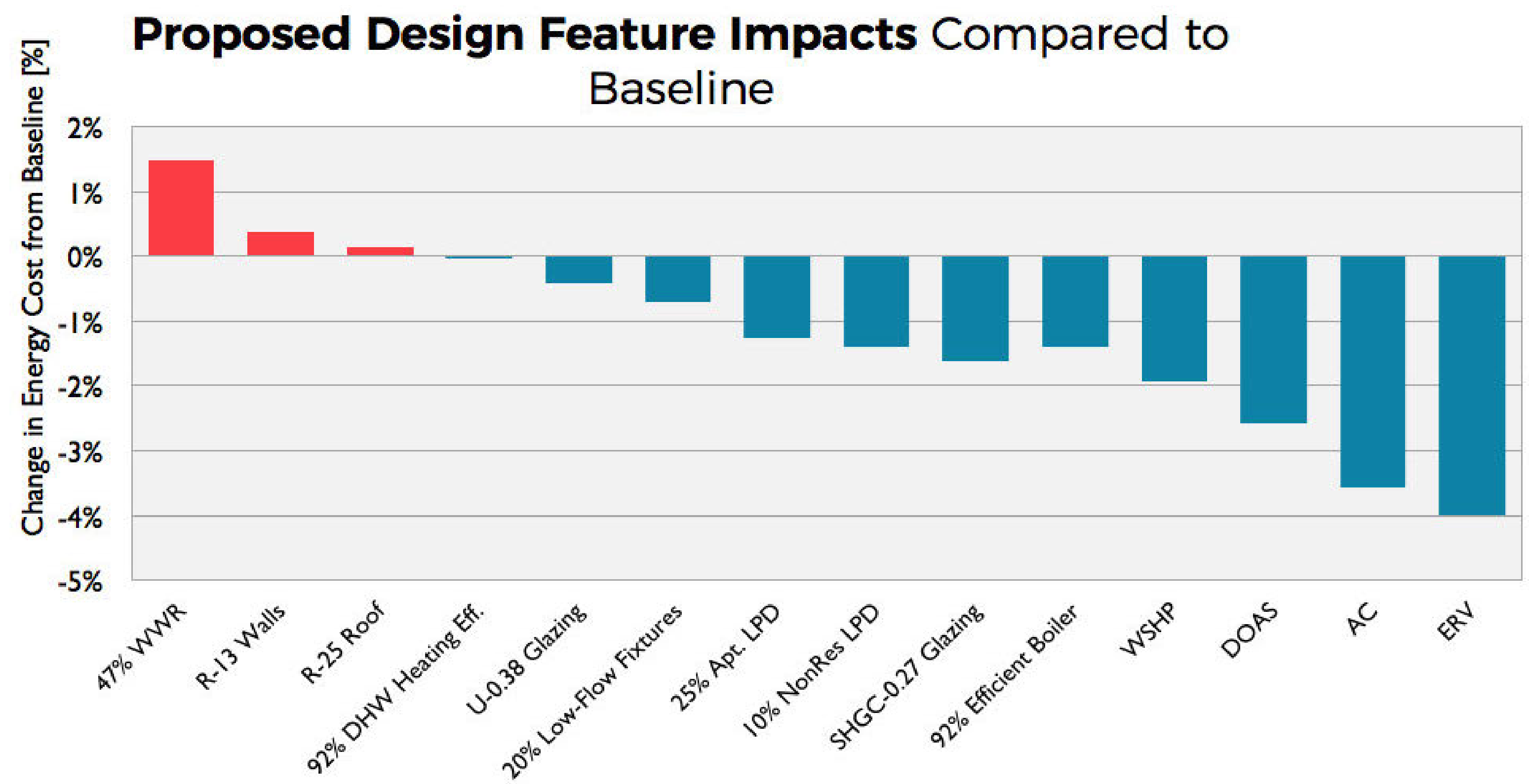
In addition to the proposed design features, this analysis investigated a range of values for each key parameter included in the previous table. These included the recommendations in [redacted] High Performance Practices, the current design specifications, and alternates. At least five different options were investigated per parameter, with a typical range of -20% to +20% improvement over the ASHRAE baseline. Each of these parameters are discussed in greater detail on the following pages.

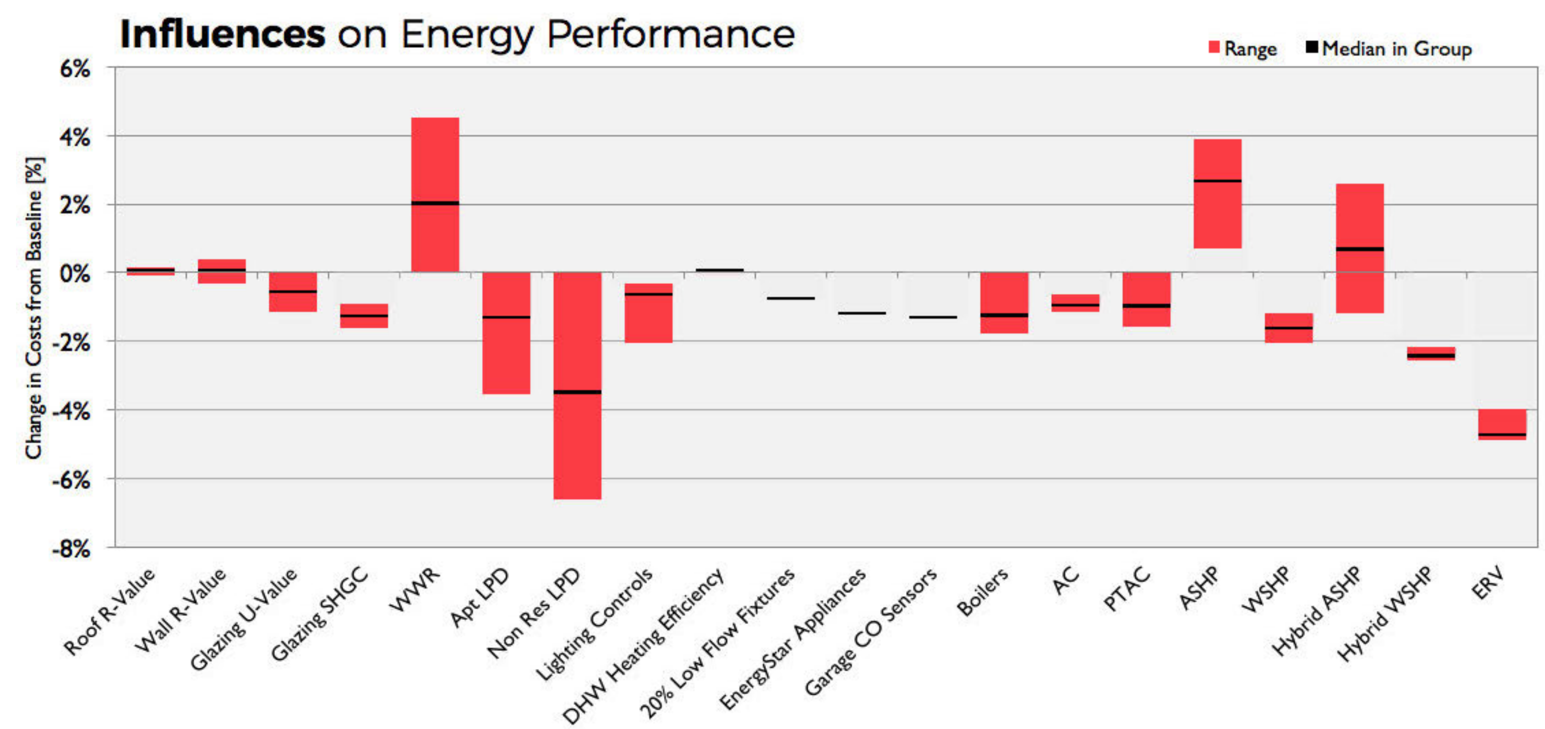
These results show that a few key parameters determine the project's energy performance and could provide additional opportunities for savings. Others do not have a significant impact and can be more flexible.

- Window-to-wall ratios up to 60% were studied. The energy cost penalty associated with higher WWRs is 2.5% per 10% increase in glazing.

- Non-residential lighting power reductions represent a significant opportunity. In particular, 24 hour spaces such as the corridors and stairs provide the best energy cost savings per watt reduction. An aggressive LED lighting design could contribute to much higher savings.

- Five different zone-level options for residential space conditioning were compared in this study (note that none of the results to the left incorporate a DOAS strategy, which softens the associated penalties). An air source heat pump (ASHP) at the same efficiency as the packaged terminal air conditioner (PTAC) baseline incurs a penalty, but a high performance ASHP can slightly outperform the baseline. Water-source heat pumps are more efficient than air-source heat pumps, despite the additional auxiliary energy associated with the condenser loop. A hybrid system with hot-water heating replacing the heat pump heating (HVAC Design Alernative #3) could provide marginal energy cost savings, but would not save energy consumption.





Note: Results shown in both charts above are based on each feature analyzed as a separate energy conservation measure over the ASHRAE 90.1 baseline

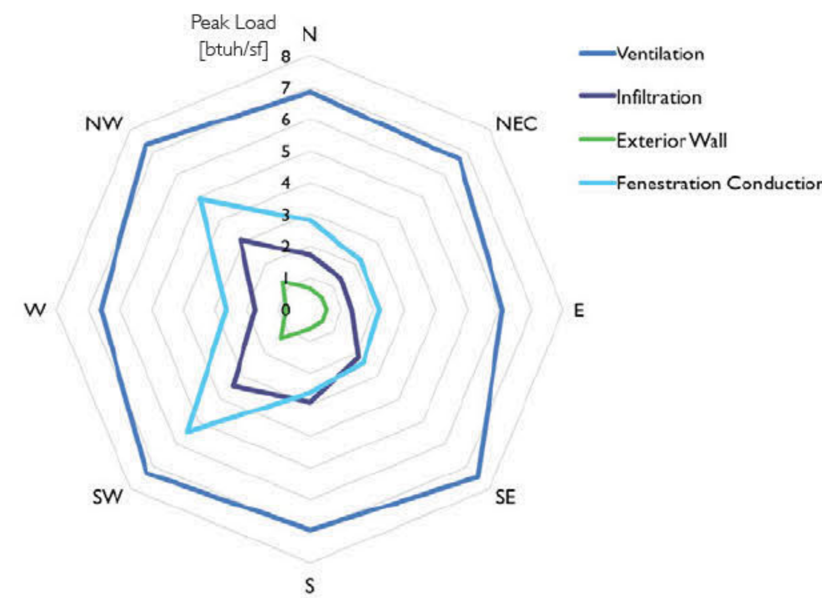
ORIENTATION AND RESIDENT COMFORT

Orientation

The orientation and shape of the project building are constrained by the lot shape and by Phase 1, reducing the opportunities for investigating massing options. As noted on page 3, the primary drivers of energy consumption are internal equipment, lighting, and ventilation. Minimal skin-driven energy use indicates that changes to form would not be impactful.

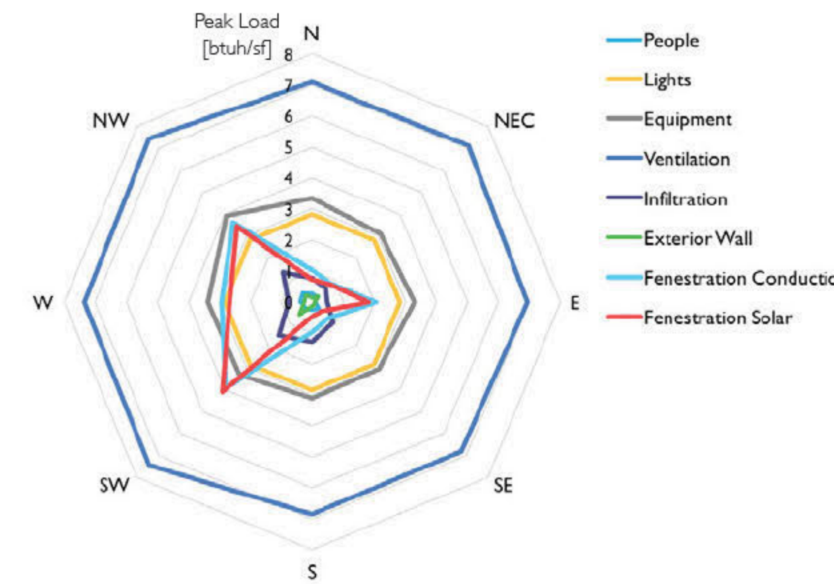
However, within the current form, different residential units do have different drivers of energy use. On the typical floors, the northwest and southwest units have a higher proportion of glazing, and therefore have the highest peak cooling loads due to solar heat gain and the highest peak heating loads due to thermal losses through the same glazing. The east courtyard-facing units also experience high solar loads, indicating that the Phase 1 building (which was modeled for shading studies) does not shelter the units too significantly. As expected, all street-facing units are less wind-sheltered and have higher infiltration loads.

Peak Heating Load Components by Orientation



[redacted]

Peak Cooling Load Components by Orientation



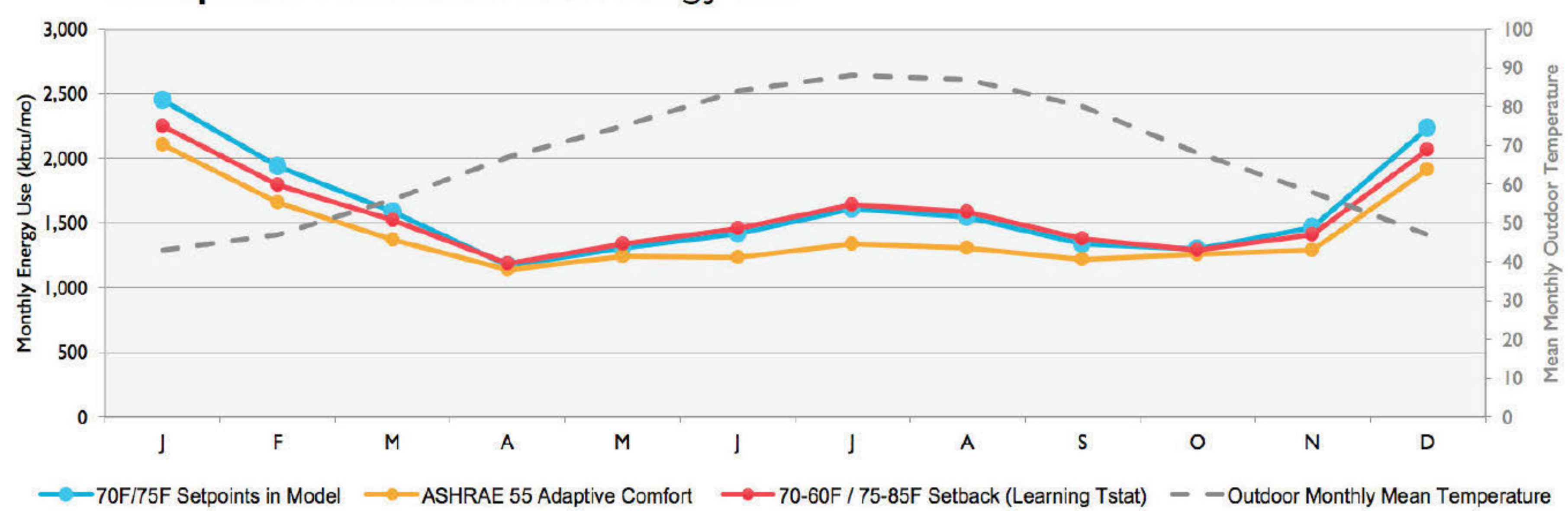
Resident Comfort

Because residents have control over their own thermostats, adjustments to setpoints cannot be included in the energy model. During actual operations, differences in resident preferences will vary from the constant 70°F heating and 75°F cooling setpoints used in this study.

The adaptive thermal comfort model is based on the theory that humans adjust their thermal preferences in accordance with outdoor temperatures. For [redacted] this results in a minimum 65-72°F range of setpoints in winter, and 75-87°F range in summer. If residents adjust their thermostats monthly to fall within these ranges, overall energy costs would be lower by 7%.

One way to encourage residents to conserve energy is to install programmable or learning thermostats. With this technology, residents can schedule dynamic temperature setpoints. These technologies also provide feedback to residents around patterns of use and adapt accordingly. The results to the right show a programmed schedule where temperatures are set back by 10°F when residences are unoccupied, which would save 3% in energy costs. Programmable thermostats are currently a LEED Pilot Credit: https://www.usgbc.org/node/10598759?return=/admin/credits

Occupant Preferences and Energy Use



ENVELOPE AND GLAZING

Window to Wall Ratio

There is a 2% overall increase in energy costs for every 10% increase in glazed area with baseline glazing specifications (U-0.42, SHGC-0.40). The current 47% WWR design incurs a 1.4% energy cost penalty.

At higher window-to-wall ratios, glazing specifications dominate the performance of the envelope, compounding with additional solar loads to incur higher energy costs.

Envelope Thermal Properties

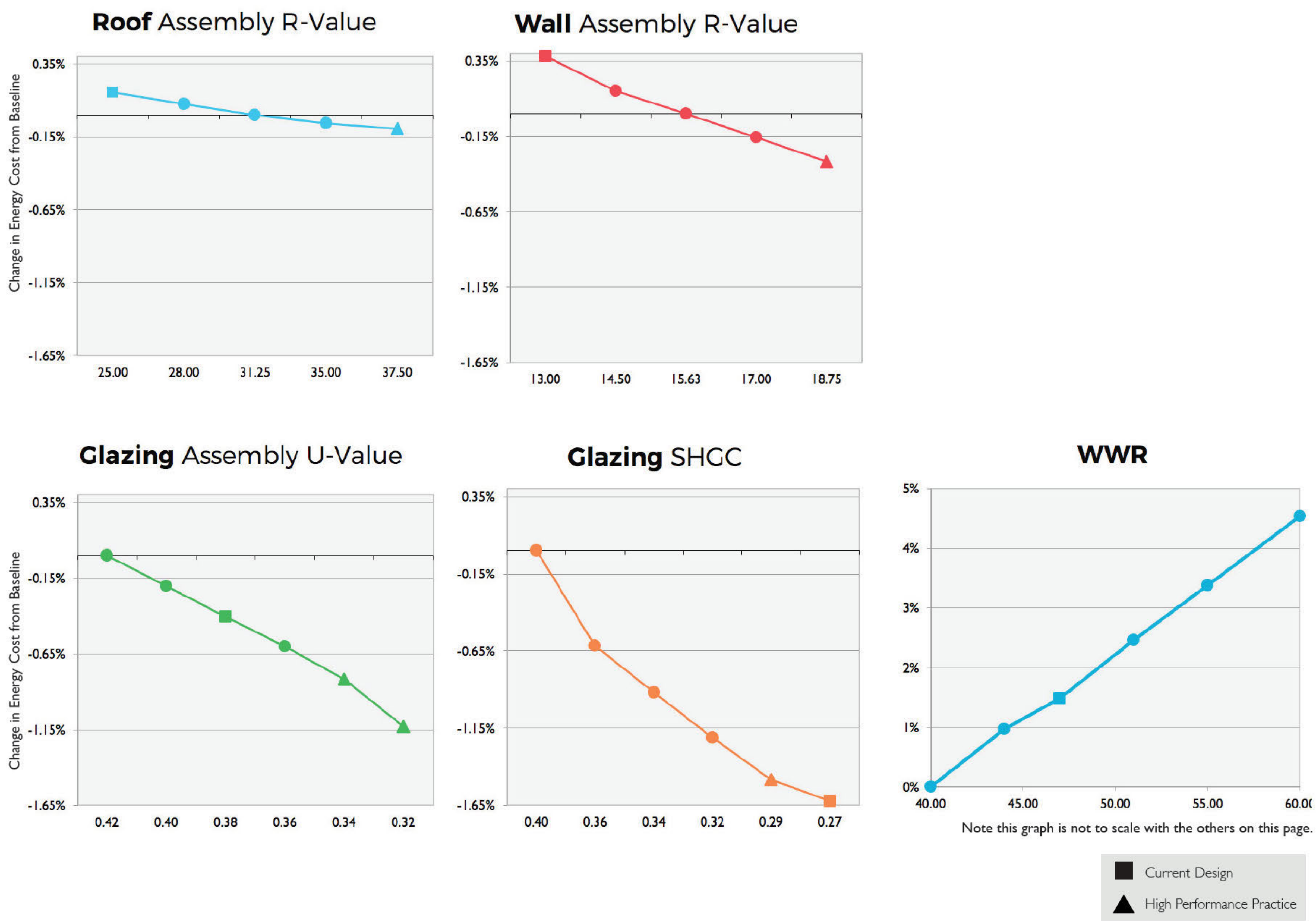
A range of thermal values within ±20% were studied for the roof, wall, and glazing.

- The roof R-value does not have a significant impact on energy performance, since the roof is much smaller in area than the walls. Between the current design case (R-25) and the High Performance Practices case (R-37.5), there is only a 0.25% performance improvement despite being 20% more insulated.

- The wall R-value provides slightly greater opportunities for improvement, but again the maximum savings is only 0.3%. The wall insulation may be kept minimal without a significant penalty.

- The project's energy performance is more sensitive to glazing specifications. The benefit of improving the U-value provides increasing savings through 0.34/0.32 (the High Performance Practices case). This is because improving the glazing U-value is beneficial for both heating and cooling.

- By contrast, the solar heat gain coefficient (SHGC) provides a high level of savings when improving from the baseline to 0.36, but as the heating penalty of having less free solar thermal gains outweighs the benefit of having less unwanted summer overheating, returns diminish.

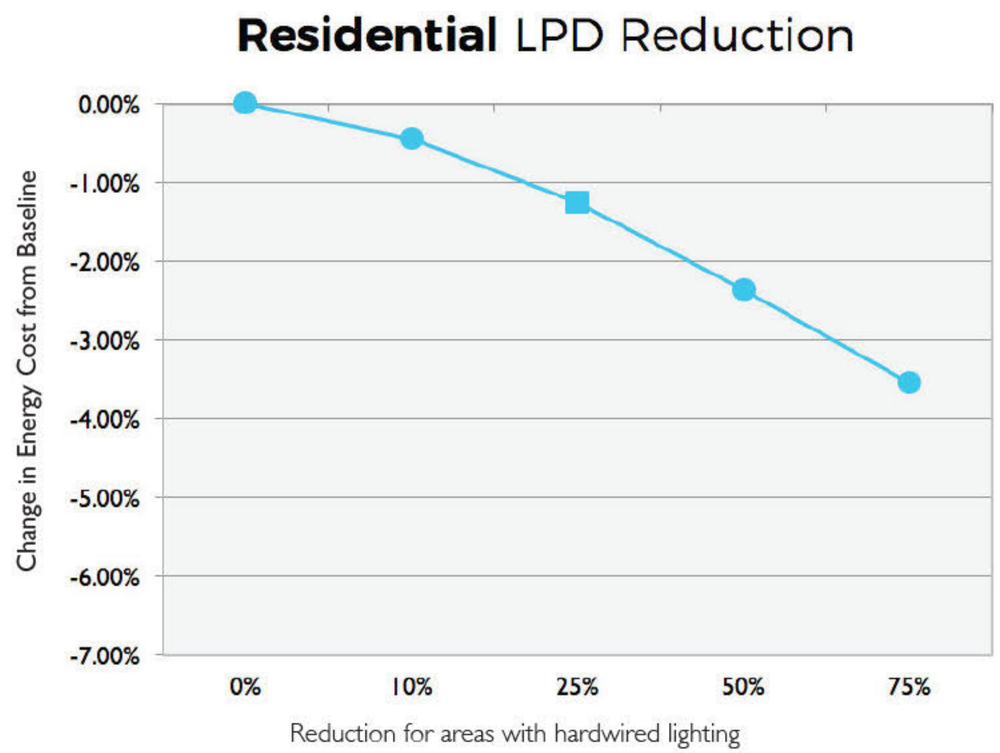


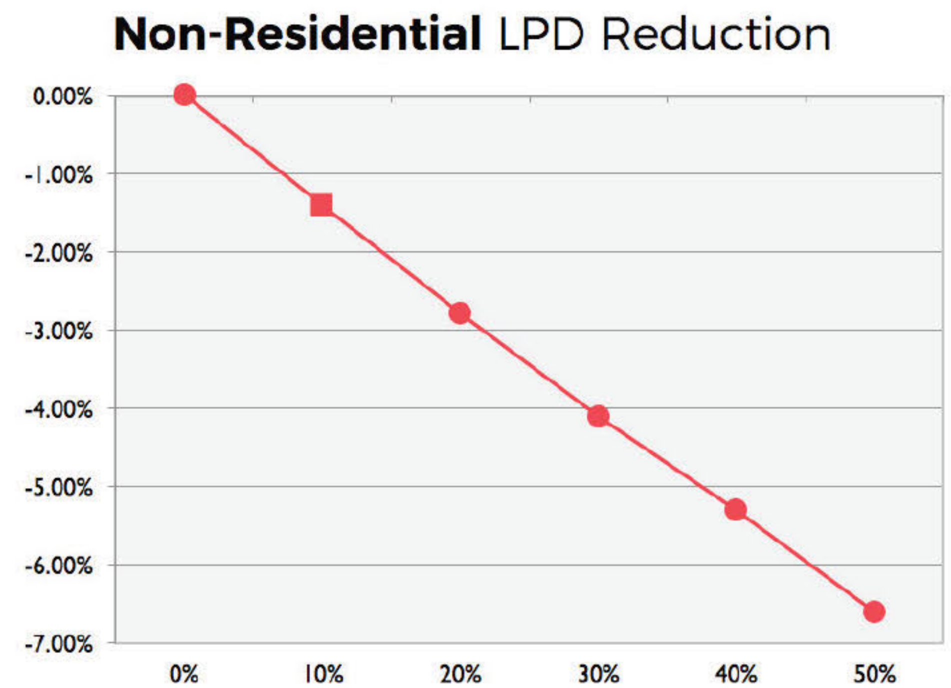
LIGHTING

- Hard-wired lighting is required to claim lighting savings in the residential units. For this study, it was assumed that lighting would be provided in restrooms, hallways, and kitchens/kitchenettes, and that this floor area would be approximately half of the total unit area (thus, a 10% reduction in provided lighting power results in an overall reduction of 5%). Most residential lighting is not on during the weekday or at night, reducing the impact of residential LPD reductions.

The 1.1 W/sf baseline is high for current technologies, and it is easy to find savings without sacrificing lighting levels. Reductions of 25% or greater (12.5% overall) begin to generate cooling load reductions, which result in higher savings per watt reduced.

- Non-residential areas take up less of the program and have lower maximum lighting power densities, but because they are typically on for more hours per day, reductions here provide greater overall savings. These results include corridors, where reducing lighting also reduces the load on the DOAS and has auxiliary performance benefits. These reductions can be achieved through installing LEDs and vacancy/occupancy sensors.

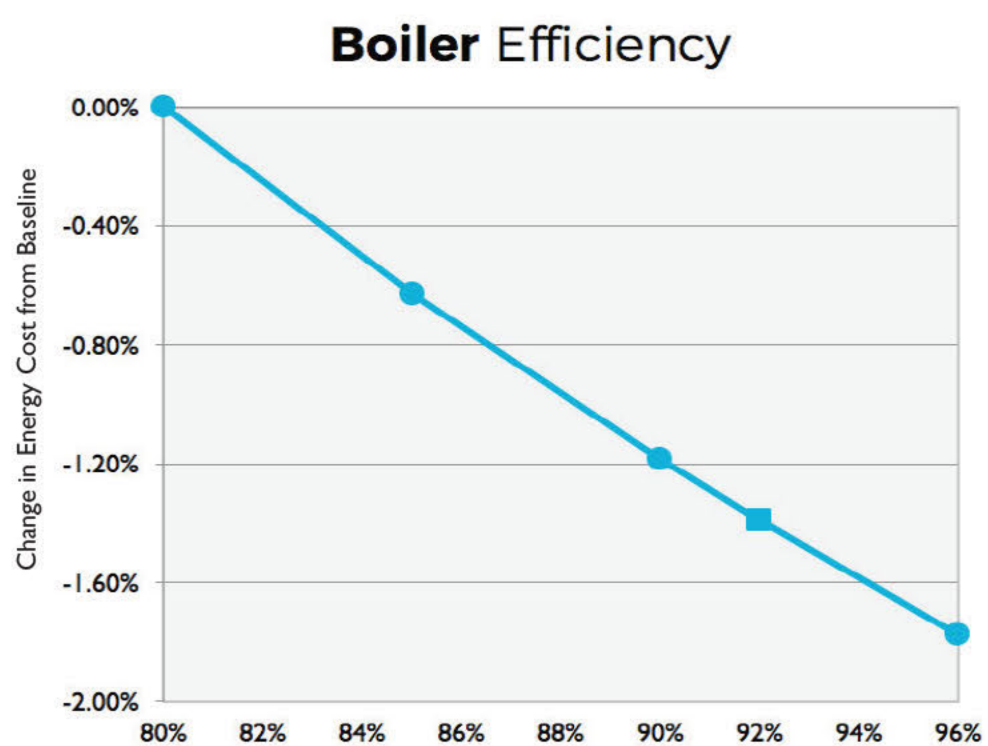




CENTRAL BOILERS

- Because natural gas is a lower-cost fuel than electricity, improving the boiler efficiency does not have a large impact on performance, with a 20% improvement saving only 1.7% in cost. Right-sizing equipment (not included in results to the left) can provide higher levels of savings than improving efficiency alone.

- Condensing boilers can also allow greater flexibility in hot water loop temperature, which is not included in the results to the right. These additional savings are accounted for in the current design results shown in the Executive Summary.



RESIDENTIAL SPACE CONDITIONING

Five different options for residential space conditioning were compared. For each, the rated cooling efficiency was increased (for the heat pumps the heating COP was also increased) with fanpower and central boiler efficiency held constant. Water-source heat pumps are shown to be a good choice for the project, outperforming the other options.

- In the proposed design (WSHP + DOAS), the addition of the DOAS for pre-conditioning improves performance by requiring less heating of the heat pumps themselves, and reducing the need for less efficient supplemental heating coils during low temperatures. These results may change when equipment sizing is refined for the proposed model, and additional controls such as outdoor air reset can be included to reduce the penalty.

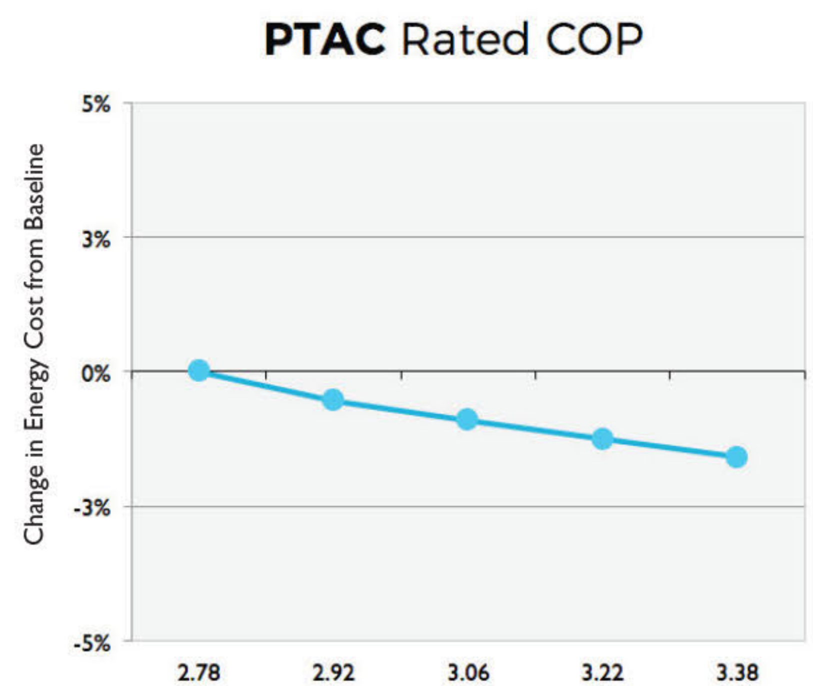
- Compared to the current design, the WSHP with ECM motor alternate would save an additional 0.2% in overall energy costs for a 2% improvement in heating efficiency and 3% improvement in cooling efficiency.

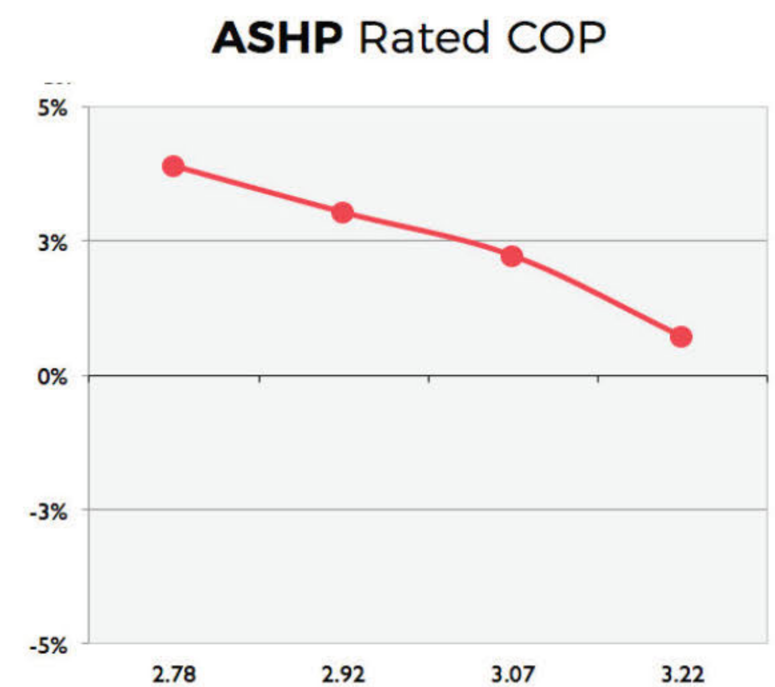
- The hybrid heat pump alternate (hybrid WSHP with hydronic heating + DOAS + high-efficiency boiler) would save an additional 1.5% in energy costs but increase actual consumption by 6%. Notably, there is very little difference between a high-efficiency and low-efficiency hybrid heat pump. As in the boiler cases, gas costs are low enough that heating savings here do not translate into significant overall savings, and changes in cooling efficiency are dampened by the additional pumps and heat rejection equipment compared to the similar PTAC system. This option could be implemented on the project with minimal aesthetic concerns, but would be higher cost due to added piping. It would also result in the installation of different types of equipment between Phase 1 and Phase 2, which may not be desirable from an operations and maintenance perspective.

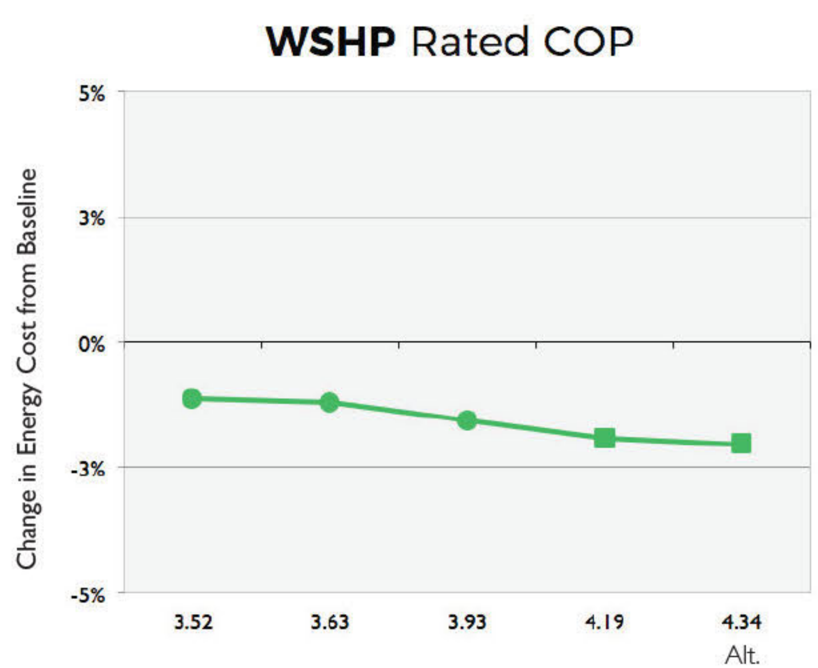
- The minimum efficiency air-source heat pump represents what the baseline LEED costs would be if the DOAS serving the apartment units was served by electric rather than gas fuel, which would change the baseline fuel source from mixed-fuel to electric. This would add an additional 3.5% in relative savings by increasing baseline costs.

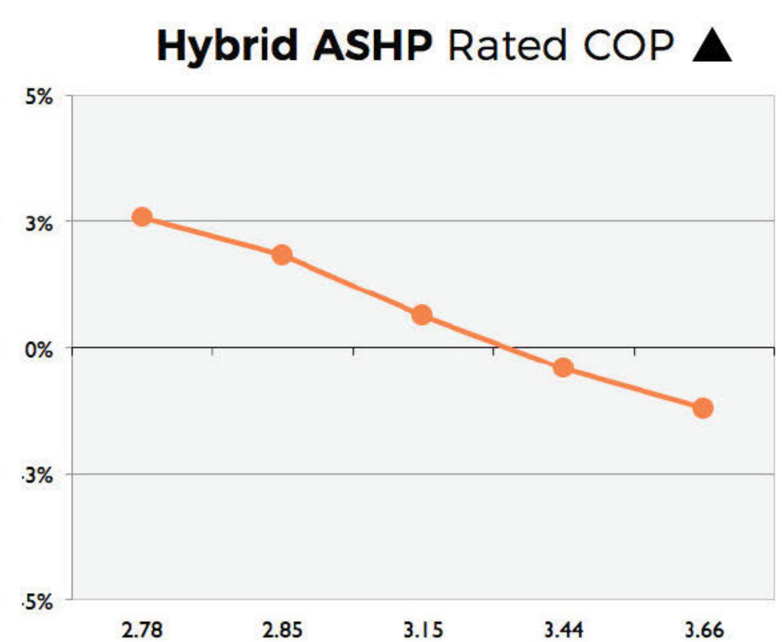
Air source heat pumps are penalized when looking at energy cost savings unless the heating COP is equal to or greater than the ratio between the fuel source costs. Installing either the ASHP or hybrid ASHP would also have an aesthetic impact as condensers would be visible from the exterior.

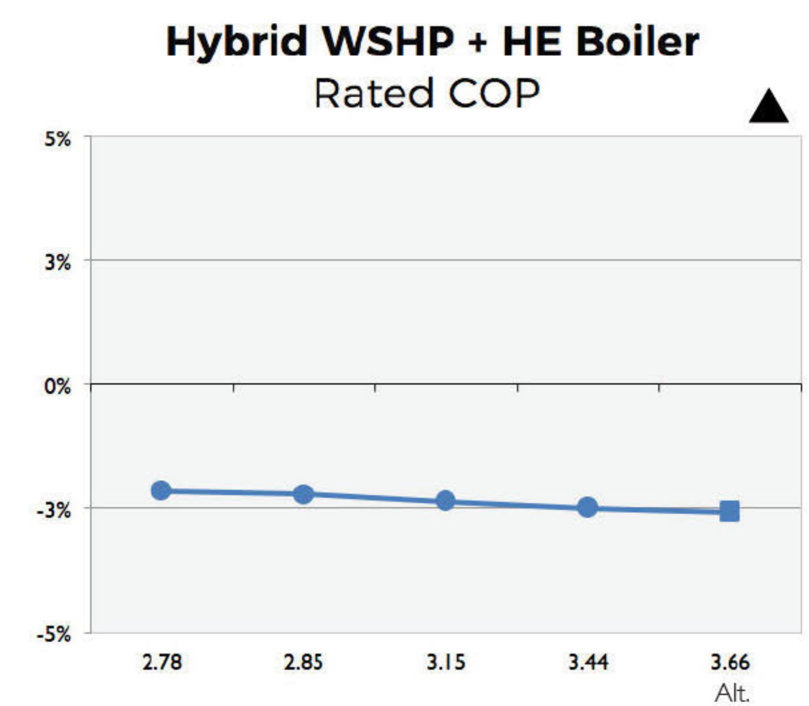
- Per the High Performance Practices recommendation, both hybrid air source heat pumps and hybrid water source heat pumps were investigated. For the hybrid air source heat pumps, furnace heating is used to replace heat pump heating at lower temperatures (45°F and below). This provides the advantage of allowing for direct metering of tenant energy use, and avoids the fuel-switching energy cost penalty mentioned above. The hybrid ASHP outperforms both the baseline system and the standard ASHP in terms of energy cost, but not in terms of absolute energy consumption. A hybrid ASHP with primarily hot water heating, similar in practice to a PTAC, would provide slightly lower savings than those shown to the right due to added pump power.











■ Current Design or Alternate
▲ High Performance Practice

STANDALONE ENERGY CONSERVATION MEASURES

Each additional energy conservation measure (ECM) included in the current design or the High Performance Practices but not tied to a variable value was evaluated individually.

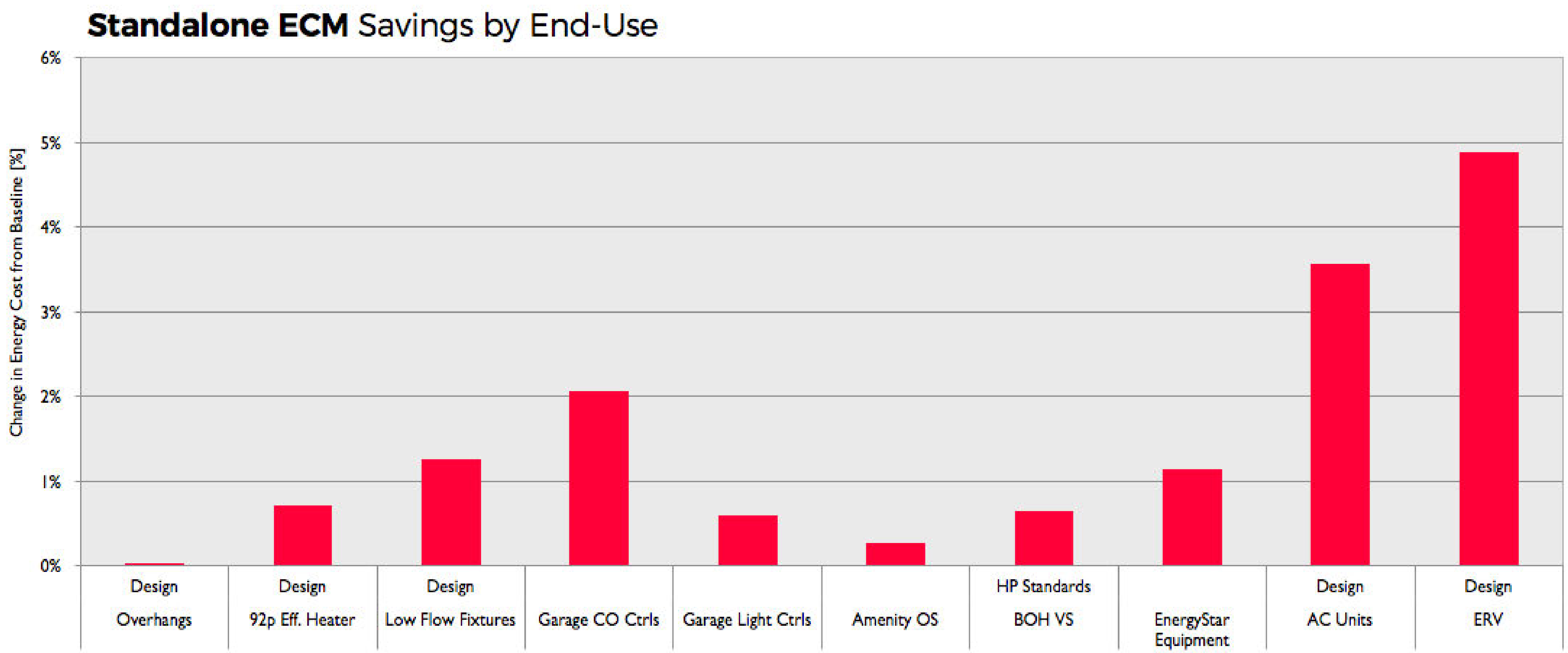
- Of these, the ERV on the DOAS provides the most savings. While the AC units serving non-residential spaces are themselves more efficient than the baseline, the DOAS ERV provides additional pre-cooling and heating benefits to the residential units as well as the corridors. This measure significantly reduces both heating and cooling energy for the apartment systems.

- ECMs which reduce equipment loads, such as low-flow fixtures, carbon monoxide-tied demand controlled ventilation for the parking garage, and EnergyStar residential appliances represent the next tier in savings. Equipment represents a high fraction of the overall energy costs and these strategies translate well into direct benefits for occupants. Equipment load ECMs are effective because they lower cooling energy costs as well. By allowing central equipment cooling capacity to be reduced, these measures could also create the opportunity for further capital cost savings.

- Lighting controls are more effective for spaces where lights would otherwise by on for long periods of time, such as the parking garage (where after-hours lighting could be reduced) and BOH spaces. Vacancy sensors (auto-off, manual-on controls) have been shown to provide greater savings than occupancy sensors (auto-off, auto-on controls) and should be favored wherever possible.

- The overhang design of the facade does not have any significant impact on the building's energy consumption. In part, this is because only some floors are shaded, but it is likely that this low impact is linked with the overall low envelope-driven loads shown previously.

The overhangs may provide thermal and visual comfort benefits outside of energy cost savings, especially for the corner apartments, and could also result in reduced equipment size requirements.



DETAILED INPUT TABLES

Energy modeling is a comparative exercise that predicts energy performance improvements relative to a standard baseline, based on measures within the design and construction team's control. Actual performance of the building will differ due to variations such as occupancy and maintenance, weather patterns, and various industry standard assumptions and simplifications within the modeling tool. The energy model will continue to be updated throughout the design process, and as the model is refined to reflect new design details and submittals, all results shown are subject to change.

Parameter	Units	90.1-2010	Proposed Design
ENVELOPE			
Ext. Wall R-Value	°F-ft2-hr/btu	15.625	R-13*
Ext. Roof R-Value	°F-ft2-hr/btu	31.25	R-25*
Glazing U-Factor	Btu/°F-ft2-hr	0.42	U-0.38* (Residential) U-0.42* (Storefront)
Glazing SHGC	0.0 - 1.0	0.4	0.27* (Residential) 0.26* (Storefront)
Window-to-Wall Ratio	%	40%	47.50%
Exterior Shading		None	0', 1.5', 3' setbacks
Loads			
Exhaust Fans	kW		45.295
Elevators	kW		Excluded
Plug Loads	W/ft2		
Enclosed Office	W/ft2		1
Lobby	W/ft2		0.65
Apartment Misc.	W/ft2	Same as proposed	0.82
Corridor	W/ft2		0.2
Mech/Elec	W/ft2		0.59
Lounge	W/ft2		0.72
Exercise/Spa	W/ft2		1.0 (Note - Pool energy has been excluded)
Parking Exhaust	W/ft2		0.9
Garage CO		50%	Same as baseline
Residential Kitchen Equipment	W/sf	1.0 overall (0.7 electric)	1.0 overall (0.7 electric)
HVAC: Equipment Summary			
System Type		Mixed Fuel Sources - Fossil Fuel Baseline Residential: System 1 - Constant-volume PTAC with HW fossil fuel Non-Residential: System 5 - Packaged VAV with DX cooling, HW fossil fuel heating Spa/Fitness: System 3 - Packaged RTU with DX cooling, furnace heating (Exeception G.3.1.1.b)	Residential: WSHP with DOAS Non-Residential: Water-cooled VAV with hydronic heating
DX Heating Efficiency	COP	N/A	WSHP: 4.9
DX Cooling Efficiency	EER (COP)	PTAC: 2.78 VAV: 2.81-3.22 RTU: 2.87	WSHP: 4.2 DOAS: 3.8* VAV: 4.13-4.2*
Boiler Efficiency	% Et	80%	92%*
Exhaust Air Energy Recovery		Required for first floor only (35% OA fraction, >5,500 cfm)	On DOAS unit, 80% cooling; 81.4% heating*
HVAC: Airside			
Total Supply Airflow		294,280 (autosized)	246,750 (autosized)
Ventilation OA		per ASHRAE 62.1	per ASHRAE 62.1
Infiltration Method		Flow/Ext Surface Area	Flow/Ext Surface Area

Parameter	Units	90.1-2010	Proposed Design
Infiltration Rate	cfm/sf	0.06	0.06
Ventilation Control		Required for amenity spaces	Required for amenity spaces
Fan Control Type		Constant for PTACs and RTU, variable for VAVs	Cycling for PTHPs, constant for DOAS, variable for AC
Airside Economizer		28 Btu/lb shutoff	Same as baseline
Waterside Economizer		HW Reset: 180° at 20° OA and below, 150° at 50° OA and above	Same as baseline
HVAC: Waterside			
Condenser Loop Setpoint Temperature	°F		60 - 85
Condenser Loop ΔT	°F		15
Cooling Tower Type		N/A	Single speed
Cooling Tower Configuration			2 cells
Condenser Loop Pump Power	W/gpm		26
Hot Water Loop Setpoint Temperature		180	180
Hot Water Loop ΔT		50	20
Hot Water Loop Pump Power	W/gpm	19	18.5
Utility			
Information Source		Same as Phase 1	
Blended Electricity Rate	¢/kWh	Same as proposed	12.96
Blended Natural Gas Rate	$/therm	Same as proposed	1.2

* - Assumed same as Phase 1

EXECUTIVE SUMMARY

Goals

This study is intended to provide early design guidance for reducing projected water use when the building is occupied. Understanding the different water demands and supply sources allows for the exploration of the reduction of potable water loads in the design and an assessment of non-potable supply sources.

Major considerations during the assessment include total water demand, process and non-process demand reductions, water supply, potable and non-potable demands, and on-site water reuse.

Background

Built Ecology has created a schematic-level water balance assessment based on the design as of Septermber 2017. Where parameters have not yet been determined, recommendations have been used to help guide the design to a lower water use impact.

The baseline parameters for indoor water use comply with LEED Version 4, as it will be used for the future LEED documentation when the design progresses. The baseline and proposed fixture parameters are listed on the next page.

The irrigation baseline and landscape water requirement was provided from the EPA's WaterSense Water Budget Tool.

Findings

This design has many opportunities to reduce the water use on site. With simple upgrades to more efficient water fixtures, appliances, and irrigation practices, the design can easily reduce the water demand to 30% below baseline.

The water fixtures in the residential units have the highest portion of overall water demand, so selecting toilets, faucets, showers, and washing machines with high efficiency flush and flow rates will have a great impact. LEED v4 requires that projects reduce indoor water use by a minimum of 20%, but it is easy to reduce it even further.

Other strategies assessed for water demand reduction include selecting native plant species for the landscape design. Based on the Schematic Design drawings dated 9/27/2017, the landscape design and irrigation requirements do not meet the LEED Prerequisite 30% reduction of outdoor water use from the established baseline, rather, the current design requires 29% more water than the baseline. Native or low water requirement plants need to be considered in order to meet the requirement.

Note that the remainder of this analysis was calculated based on the assumption that the landscape will be reassessed to achieve the 30% water reduction, as per LEED.

In addition to reducing the water demand, alternative sources of water have been evaluated and should be considered for the final design. The rainwater storage tank that is already part of the design to meet local code can act as a water supply for irrigation and cooling tower demands to reduce the amount of potable water needed.

Water reuse on site could also have a significant impact on reducing the potable water demand by implementing a graywater treatment system. Treated water from residential sinks and showers could be reused on site for flushing toilets and washing laundry. If these reuse options are applied along with the efficient fixtures and reduced irrigation requirements, the total potable water demand could be reduced 47% below the baseline.

Recommendations & Next Steps

With the understanding of how water is anticipated to be used on site, ensure that the follwing strategies are included in the design as it progresses.

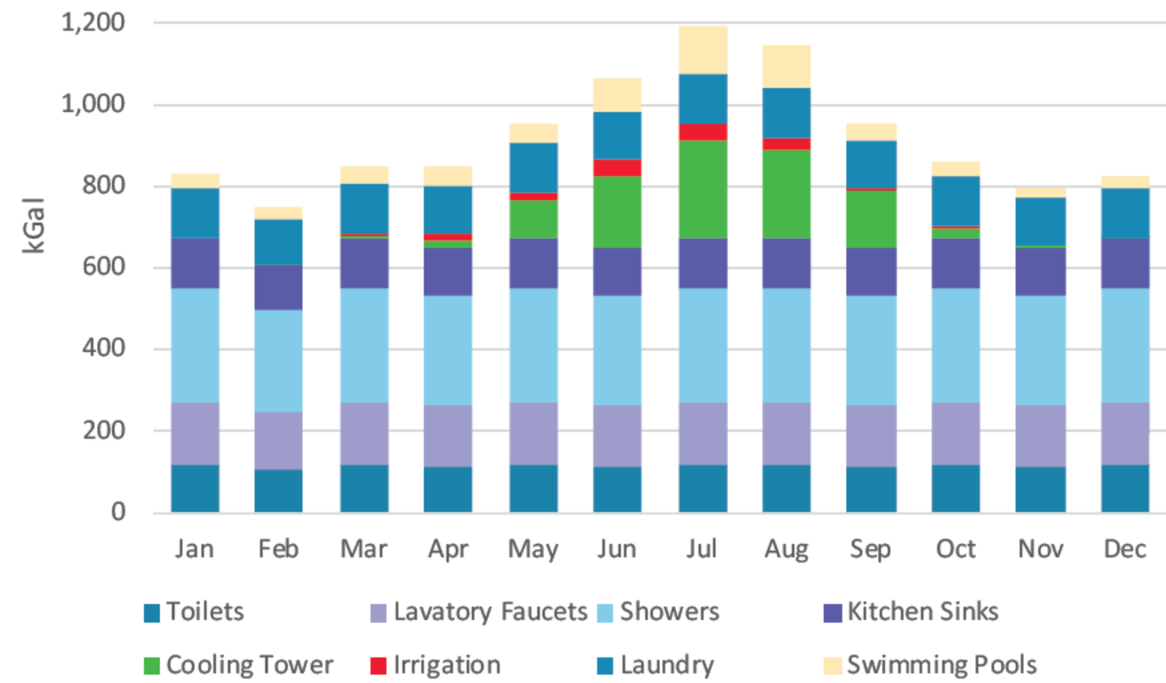
- Work with architect to ensure that all water fixtures are at a minimum WaterSense labeled, and exceed the minimum LEED reduction requirement.
- Work with landscape designer to confirm that the design will meet the LEED Prerequisite, considering water requirements and irrigation options for each plant selected.

Additionally, look further into recycling water on site to reduce the burden on the municipal potable water supply.

- Investigate water reuse on-site through use of the rainwater collection tank for both cooling tower makeup and irrigation.
- Investigate the implementation of a graywater treatment system to supply non-potable demands.

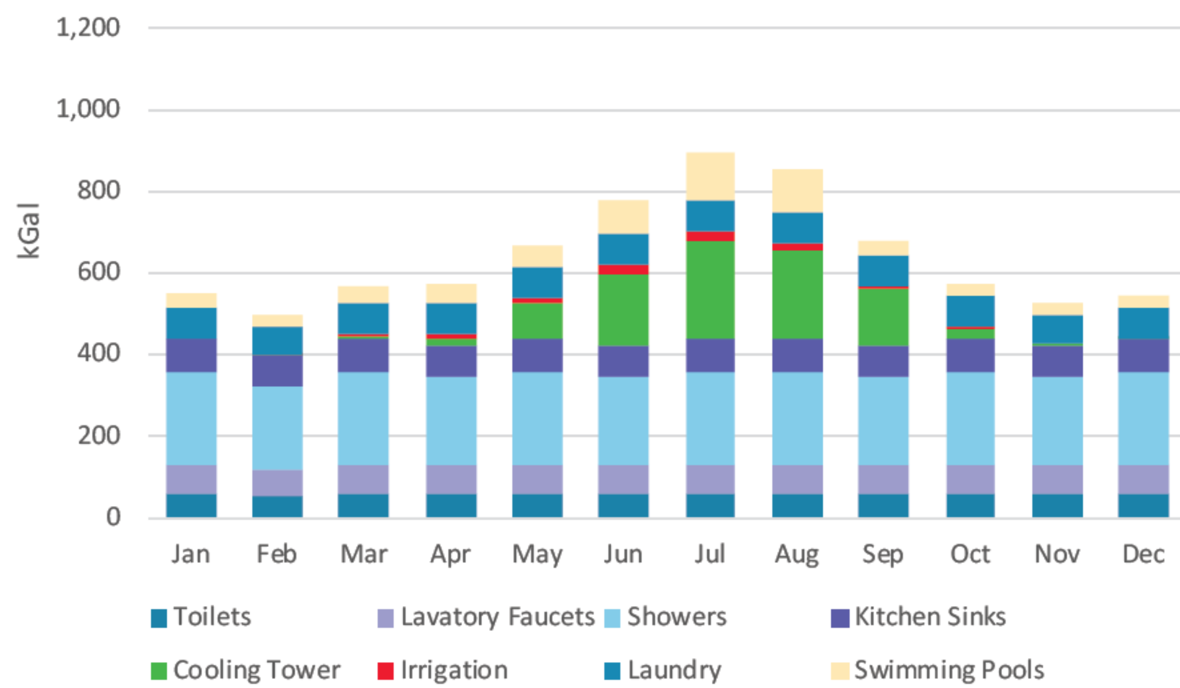
Demand Summaries

Baseline Water Demand Summary



Baseline water demand has been assessed for non-process and process uses according to LEED v4 and EPA WaterSense requirements. Year round, showers have the highest water demand, followed by lavatory faucets and laundry.

Proposed Design Water Demand Summary



Implementing water efficient strategies across the board can result in a 30% water use reduction, with showers showing a 6% improvement but still having the highest water demand, along with substantial reductions in the lavatory faucets, toilets, and laundry.

BASELINE AND PROPOSED WATER DEMANDS

Water Demands

This mixed use residential building with luxury amenities has typical water demands and therefore has plenty of opportunity to reduce water use. The water fixtures in the residences make up a majority of the water demands, while the building process loads require less water but still have significant opportunity for reduction.

Non-Process

The non-process water demand includes toilets, lavatory faucets, showers, and kitchen sinks. These make up the bulk of the water demand in the building, which means they also have the greatest potential for reduction. The Water Demand End Uses are shown in the table to the right, and include the baseline assumptions for flush and flow rates, as well as baseline requirements for the process loads. These rates are also shown for the proposed design, and represent the adjustment that has been made to result in the non-process portion of the 30% Potable Water Use Reduction.

Selecting water efficient fixtures is necessary for LEED v4 Certification, as there is a 20% indoor water use reduction minimum as well as a requirement to ensure all new water fixtures are WaterSense labeled.

Process

The process loads include cooling tower water makeup, irrigation, swimming pools, and laundry. Cooling tower water use can be reduced by having the makeup water chemically analyzed to adjust system settings to use water efficiently. This possibility was not assessed in the analysis due to not yet having the makeup water supply analyzed. Swimming pool efficiency measures were also excluded from this analysis.

Irrigation water use can be greatly reduced from the baseline by selecting native or adapted plant species, which require less irrigation than non-native species. Along with reducing the water demand, the supply can be distributed in a more efficient manner by selecting the proper irrigation methods. The savings represented in this analysis are a result of selecting trees, ground-cover, and turf grass with low water requirements.

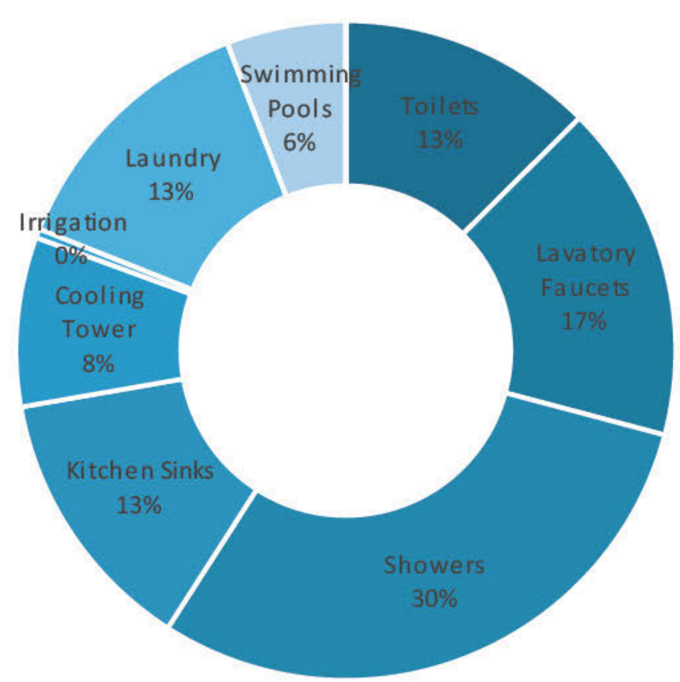
Water efficient washing machines should be considered, as the typical machine uses 24 gallons per load but much more efficient washers exist. The results shown for the 30% potable water reduction are a result of selecting a machine that uses 15 gallons per load.

Water Demand End Uses

END USE	BASELINE	PROPOSED DESIGN
Toilets (gpf)	1.6	0.83 Dual Flush (1.28/0.6)
Lavatory Faucets (gpm)	2.2	1
Showers (gpm)	2.5	2
Kitchen Sinks (gpm)	2.2	1.5
Laundry (gpl)	24	15
Cooling Tower (kGal/yr)	912	912
Irrigation (kGal/yr)	49	34
Swimming Pools (kGal/yr)	641	641

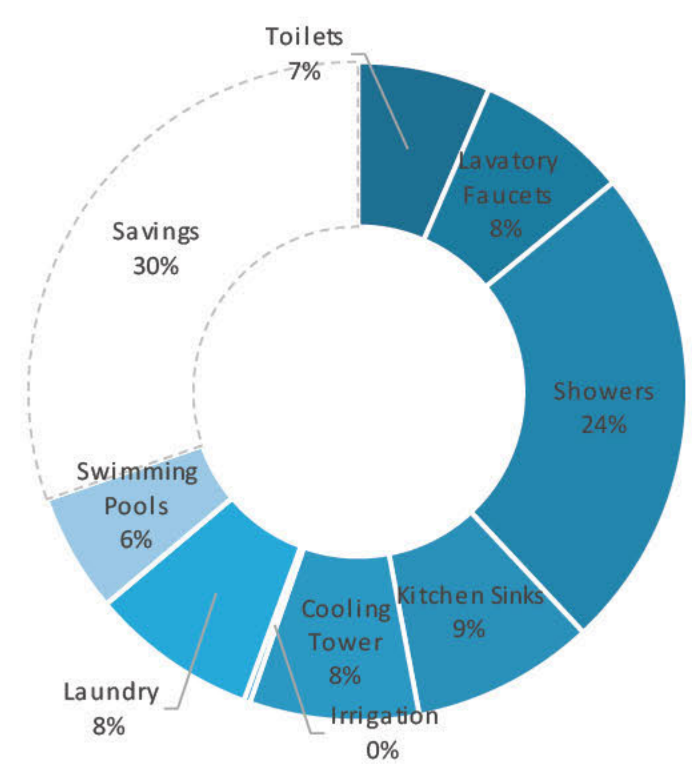
Project Totals - Potable Water Summary By End Use

Baseline



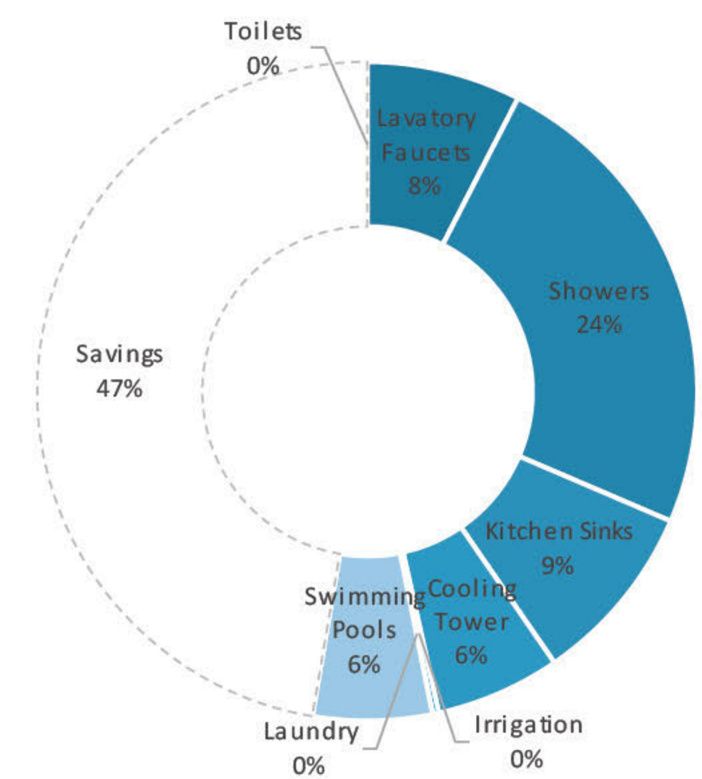
The baseline water use for this building is shown above. It is clear that the majority of the water demand is comprised of residential uses. The cooling tower, swimming pools, and irrigation make up a smaller portion but still have room for improvement.

Proposed Design



This chart represents the potable water use demands after applying water saving strategies to the design. Reducing the water demand in the bathrooms, kitchen, and laundry room makes up nearly the entire 30% potable water use reduction.

Proposed Design + Water Reuse



After applying the water saving features throughout the project, water reuse options were examined. This chart shows the further water reduction possibilities by collecting and reusing rainwater and implementing a graywater treatment system for reuse on site.

WATER SOURCES & ALTERNATIVES

Water Supply

Potable Water

The baseline water demand of a typical building with the same uses is 10,960 kGal/year. This is using typical flush and flow rates for indoor fixtures and process usage. By using water efficient fixtures and being conscious about the usage of water for the cooling tower, irrigation, laundry, and pools, the water needed can be reduced by 30% to 7,640 kGal/year. For further reductions, non-potable sources of water can be considered for water reuse.

Rainwater Collection

[redacted] has an average rainfall of 3.4 inches per month. The current design includes a tank for rainwater collection in the cellar, which can store approximately 22.5 kGal. The tank is required to meet local code, but can be used to supply water for non-potable demands such as irrigation and cooling tower water makeup. The baseline demand for these water uses are higher than rainwater collection could supply. However, when the water efficient strategies are applied such as increasing the cycles of concentration for the cooling tower and selecting native species for the landscape, these demands could be met almost entirely with rainwater. By taking advantage of rainwater capture and reuse, this project can reduce potable water supply by 2%.

Wastewater Treatment

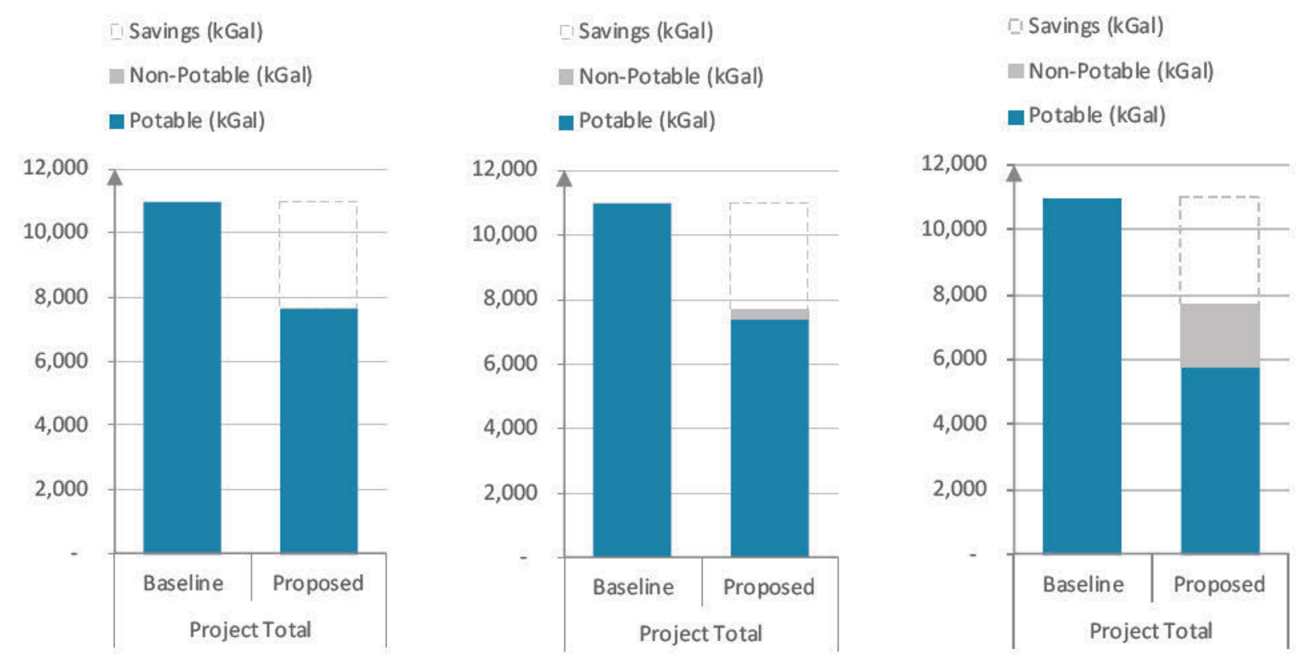
An additional source of water reuse on site is graywater, which would come from sinks or showers, be treated on site and reused for non-potable water demands such as flushing toilets or washing laundry.

The amount of graywater produced on site would immediately be reused, therefore only a small storage tank would be needed for the treated water. This water could then supply 100% of the toilet flushing and laundry needs every year.

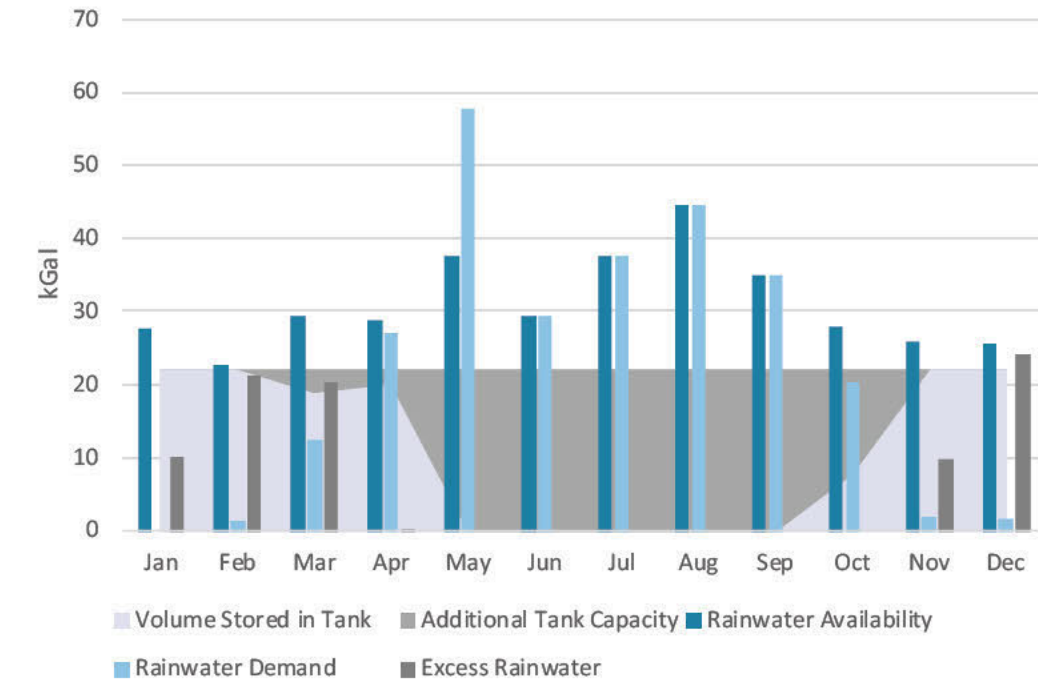
This option would require a water treatment system and would result in a significant impact on the total potable water demand. By implementing graywater treatment and reuse on site, this project can reduce potable water use by a further 15% compared to water reduction strategies alone.

Design Summary - Project Totals

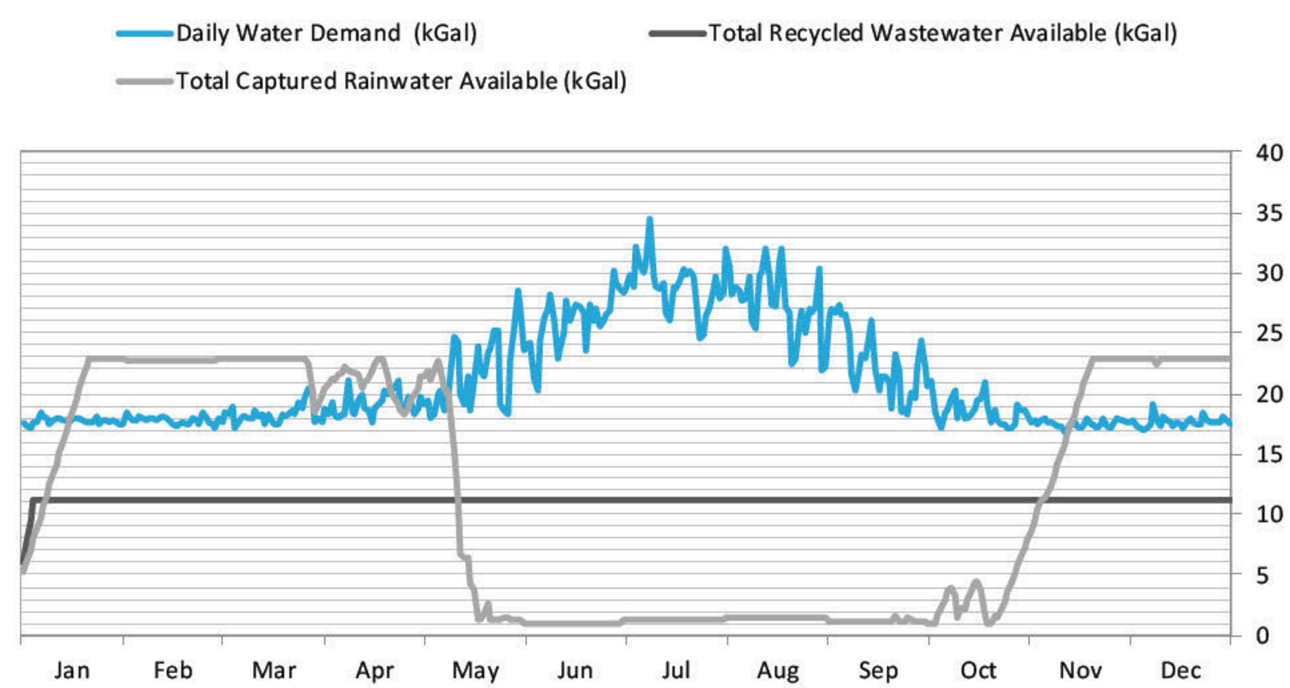
Potable Only | Potable & Rainwater | Potable, Rainwater & Graywater



Monthly Summary - Rainwater Tank



Daily Tank and Demand Volumes



Rainwater volume fluctuates throughout the year due to the weather, but note that the drop in available rainwater from May to October is due to increased demands on the irrigation and cooling tower system, which uses rainwater for its makeup water supply. Recycled graywater remains stable throughout the year because the water is coming from residential uses, which are not expected to fluctuate.

Monthly Summary - Graywater Tank