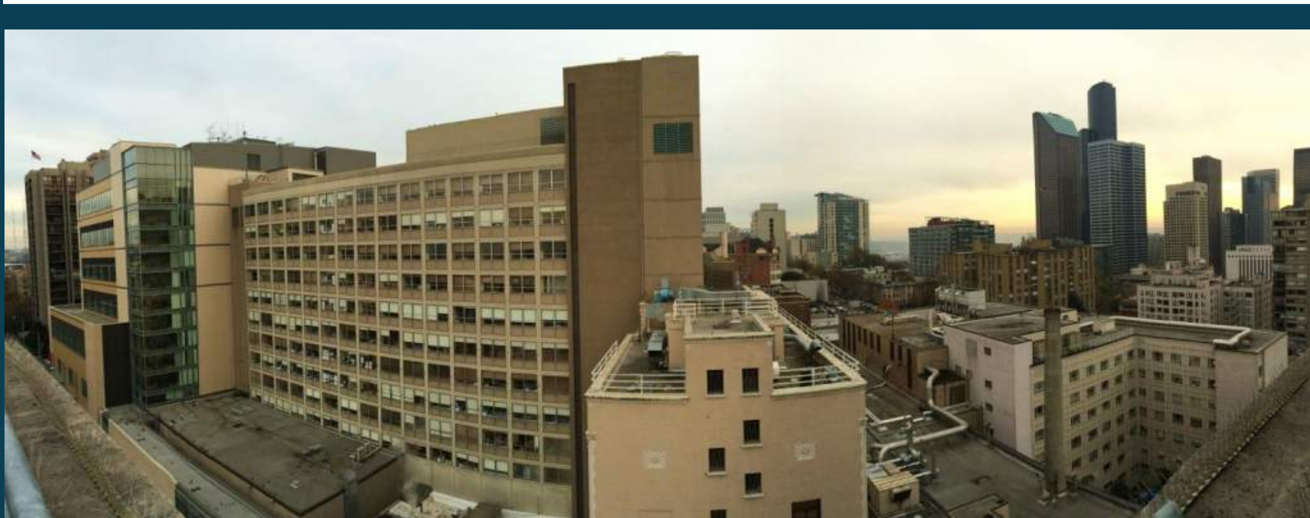
Virginia Mason Medical Center
Energy & Water Efficiency Master Plan

SEATTLE, WA
JANUARY 14, 2015



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1.1. EXECUTIVE SUMMARY

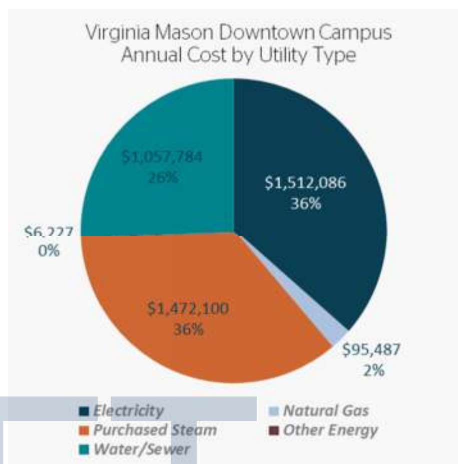
1.1.1. BACKGROUND

In August 2014, Virginia Mason Medical Center (VMMC) engaged McKinstry to create **a long-term energy and water use reduction master plan** focused on their downtown campus. The overarching goal during the development of the plan was to provide a roadmap and multi-year action plan for how VMMC can reduce energy and water use to achieve the 2030 Seattle District energy goals. **This is an opportunity to upgrade aging infrastructure and improve VMMC's facilities for better patient and staff satisfaction and patient outcomes.**

This document is the culmination of that development, and includes both the strategy needed to solidify the culture of sustainability as well as concrete measures and projects to be implemented over **the next 15 years**.

July 2014 | Jan 2016 | July 2017 | Jan 2019 | July 2020 | Jan 2022 | July 2023 | Jan 2025 | July 2026 | Jan 2028 | July 2029 | Jan 2031

1.1.2. CURRENT PERFORMANCE



In 2013 (most recent complete calendar year available), the annual utility spend for the included portions of the VMMC downtown campus was **~$4.1 million or $4.10 per square foot**. Of this, roughly 36% was for steam, 36% for electricity, and most of the remainder for water and sewer. **In terms of emissions, over 60% is from electricity** while most of the remainder is from steam purchases. VMMC's Energy Use Index (EUI) for the main campus facilities was **169 kBtu/sf/yr.** Compared to other hospitals, **VMMC is far from an "energy hog,"** rather it is already a leader in energy use and resource management. By most benchmarks – ENERGY STAR and Department of Energy Data – VMMC is a lower than average energy user. Compared to other Puget Sound hospitals, VMMC is also a lower than average water user. The most startling aspect of VMMC's water bill is not a growth in use, rather a growth in rates. **Just over the past three years, water and sewer rates have been increasing at a rate of 9% per year.**

1.1.3. GOALS

While VMMC is a solid energy and water performer, there is room for improvement – especially when the aggressive 2030 goals are in play. To meet the 2030 energy use target, a 31% reduction from today's usage is required (18% of which must come from on-site energy efficiency or renewables). For water use, a 20% reduction is the internal target.

Minimum 18% energy reduction from current performance

Minimum 20% potable water use reduction from current performance

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1.1.4. OPPORTUNITIES

To reach the 2030 targets, over 50 energy efficiency measures were identified and analyzed with inputs from VMMC staff, utility use and equipment inventory, site walks, building automation system trending, and McKinstry's experience. **Due to the breadth of measures explored, the cost and savings presented in this report are at the rough order of magnitude (ROM) level** with investment grade audits required to further define each measure prior to implementation.

1.1.5. OUTCOMES

The bottom line: Achieving the 2030 district energy target for existing buildings is possible and practical. For water an internal target of a 20% reduction has been established.

If all investigated measures were implemented tomorrow, it is estimated that the total cost is approximately **$31 million** with utility savings of approximately **$1.6 million** for an overall payback of roughly **19 years** with **energy savings of 19%, CO_2e savings of ~5,000 metric tons, and water savings of 16%.** However, as this plan is intended to be a long-term strategy implemented in concert with planned capital upgrades, the measures should be phased and re-evaluated along the way. One potential path for implementation includes five different bundles that will result in VMMC meeting the 2030 energy target: **2015 ROI Bundle, 2015 Capital Bundle, Phase 1 Bundle, Phase 2 Bundle, and Phase 3 Bundle**. The chart below illustrates each bundle with measures sorted from lowest to highest payback. The table below shows further detail on all evaluated measures.

Figure 1: Measure List sorted by Bundle then by Payback

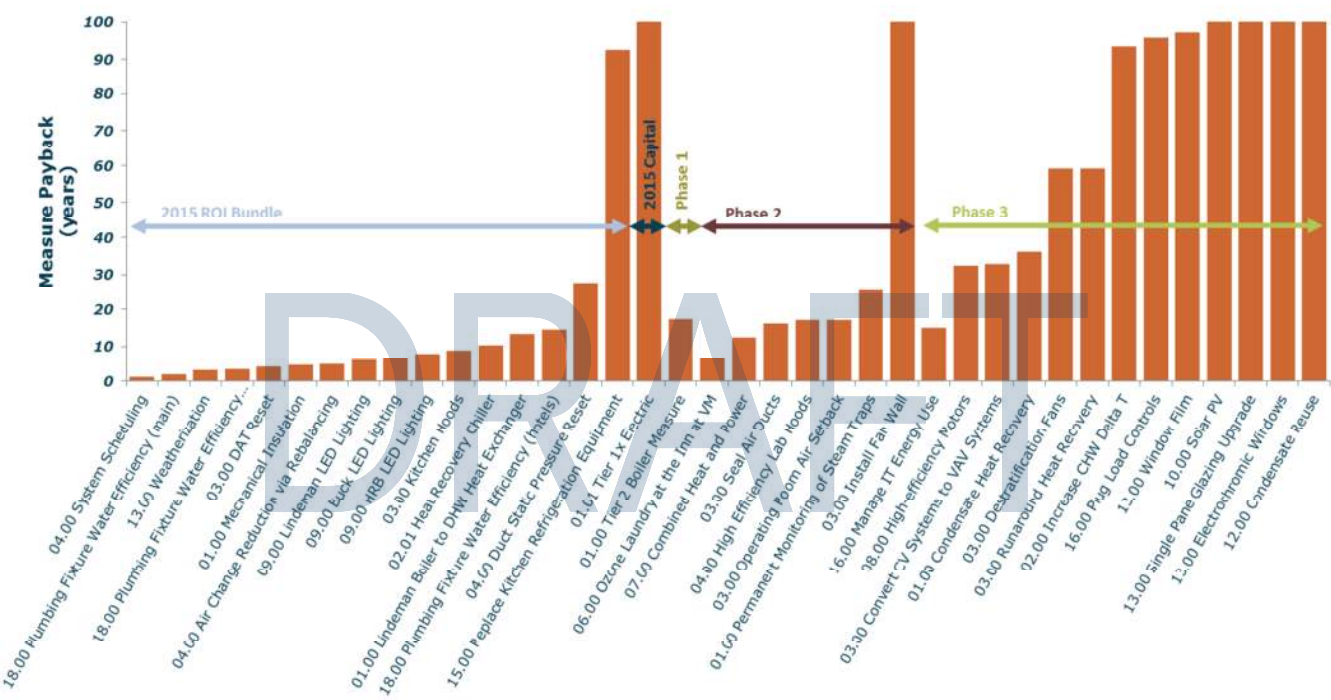

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*Table 1: Measure List sorted by Bundle then by SIR**

FIM Name	Annual CO2 Savings (Metric Tons)	Total Annual Savings	First Cost	Potential Incentives	Net Cost (After Incentives)	Simple Payback (yrs)	Cost paid for by Lifetime Savings (%)
18.00 Plumbing Fixture Water Efficiency (main)	122.1	$201,129	$377,365	TBD	$377,365	1.9	533%
04.00 System Scheduling	215.6	$53,335	$58,442	TBD	$58,442	1.1	456%
01.00 Mechanical Insulation	70.1	$13,800	$61,137	TBD	$61,137	4.4	451%
03.00 DAT Reset	54.4	$14,423	$55,733	TBD	$55,733	3.9	388%
09.00 Lindeman LED Lighting	151.3	$53,801	$399,508	$93,520	$305,988	5.7	352%
04.00 Air Change Reduction via Rebalancing	113.6	$27,984	$129,131	TBD	$129,131	4.6	325%
18.00 Plumbing Fixture Water Efficiency (Ben.)	7.9	$9,111	$28,592	TBD	$28,592	3.1	319%
09.00 Buck LED Lighting	146.2	$52,148	$430,421	$92,701	$337,720	6.5	309%
02.01 Heat Recovery Chiller	333.4	$99,418	$1,100,000	$90,000	$1,010,000	10.2	295%
09.00 HRB LED Lighting	40.3	$14,686	$142,656	$25,631	$117,025	8.0	251%
01.00 Lindeman Boiler to DHW Heat Exchanger	10.6	$5,899	$78,578	TBD	$78,578	13.3	225%
13.00 Weatherization	72.1	$12,103	$35,870	TBD	$35,870	3.0	169%
03.00 Kitchen Hoods	103.6	$17,967	$160,403	TBD	$160,403	8.9	168%
18.00 Plumbing Fixture Water Efficiency (hotels)	5.0	$9,888	$142,835	TBD	$142,835	14.4	69%
04.00 Duct Static Pressure Reset	22.1	$3,529	$97,930	TBD	$97,930	27.8	54%
15.00 Replace Kitchen Refrigeration Equipment	2.4	$387	$35,870	TBD	$35,870	92.6	32%
2015 ROI Subtotal	***1,500***	***$590,000***	***$3,334,000***	***$302,000***	***$3,033,000***	***5.1***	***-***
01.01 Tier 1x Electric	0.0	$0	$1,700,000	TBD	$1,700,000	0.0	0%
2015 Capital Subtotal	***0***	***$0***	***$1,700,000***	***TBD***	***$1,700,000***	***-***	***-***
01.00 Tier 2 Boiler Measure	526.5	$261,458	$4,500,000	TBD	$4,500,000	17.2	174%
Phase 1 Subtotal	***526***	***$261,000***	***$4,500,000***	***TBD***	***$4,500,000***	***17.2***	***-***
07.00 Combined Heat and Power	1,259.9	$445,113	$5,542,754	TBD	$5,542,754	12.5	241%
06.00 Ozone Laundry at the Inn at VM	34.2	$12,624	$84,635	TBD	$84,635	6.7	224%
03.00 Seal Air Ducts	45.4	$11,184	$179,350	TBD	$179,350	16.0	125%
04.00 High Efficiency Lab Hoods	42.0	$10,506	$178,378	TBD	$178,378	17.0	88%
03.00 Operating Room Air Setback	118.0	$30,065	$516,732	TBD	$516,732	17.2	87%
01.00 Permanent Monitoring of Steam Traps	79.6	$22,374	$561,681	TBD	$561,681	25.1	60%
03.00 Install Fan Wall	24.4	$3,904	$4,814,619	TBD	$4,814,619	1233.3	2%
Phase 2 Subtotal	***2,000***	***$536,000***	***$11,900,000***	***TBD***	***$11,900,000***	***22.2***	***-***
08.00 High-efficiency Motors	77.8	$12,449	$402,034	TBD	$402,034	32.3	93%
03.00 Convert CV Systems to VAV Systems	651.3	$147,608	$4,834,783	TBD	$4,834,783	32.8	92%
16.00 Manage IT Energy Use	126.8	$20,273	$304,547	TBD	$304,547	15.0	67%
03.00 Destratification Fans	2.8	$849	$50,218	TBD	$50,218	59.2	51%
03.00 Runaround Heat Recovery	76.7	$21,400	$1,267,878	TBD	$1,267,878	59.2	51%
01.00 Condensate Heat Recovery	21.1	$5,942	$214,060	TBD	$214,060	36.0	42%
02.00 Increase CHW Delta T	21.8	$3,494	$326,582	TBD	$326,582	93.5	32%
13.00 Window Film	5.5	$1,549	$150,654	TBD	$150,654	97.3	31%
10.00 Solar PV	6.4	$1,026	$107,610	TBD	$107,610	104.8	29%
13.00 Single Pane Glazing Upgrade	18.6	$5,211	$903,924	TBD	$903,924	173.5	17%
16.00 Plug Load Controls	19.0	$3,042	$291,110	TBD	$291,110	95.7	16%
13.00 Electrochromic Windows	14.3	$4,003	$1,280,559	TBD	$1,280,559	319.9	9%
12.00 Condensate Reuse	0.0	$615	$256,710	TBD	$256,710	417.6	7%
Phase 3 Subtotal	***1,000***	***$227,000***	***$10,391,000***	***TBD***	***$10,391,000***	***45.8***	***-***
TOTAL	***5,000***	***$1,614,000***	***$31,803,000***	***TBD***	***$31,501,000***	***19.5***	***-***

*Savings-to-investment ratio

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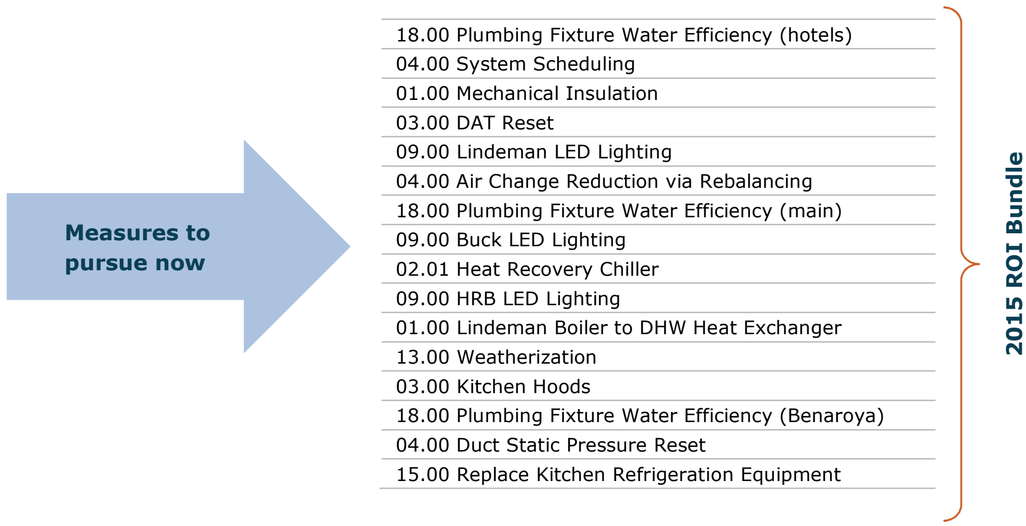
1.1.6. NEXT STEPS

The “2015 ROI” bundle – or **short-term strategy** – includes 16 measures with a total cost of ~$3m and a simple payback of ~5 years. **These measures alone get VMMC more than halfway towards the 2030 goal**. As a next step, these measures should be further investigated via the investment grade audit process and funding options should be explored.



Additionally, **all planned capital upgrades should be compared to the measures in this plan to see if there are any opportunities for integration**. As examples, any tenant improvement projects that involve lighting should pursue LED lighting with daylight controls and occupancy sensors. Any lab retrofits that involve fume hood replacement should pursue high efficiency lab hoods. Any HVAC work should involve control sequence updates and air re-balancing.

1.2. KEYS TO SUCCESS

Adopting and achieving this plan is a long-term effort. Most critically, it will require:

- Buy in at all levels of the organization and a commitment to follow and update this plan through the upcoming years;
- A commitment not only in terms of time and focus, but also in dollars;
- **A realization that just picking off the low-hanging fruit in order will leave longer payback items unattainable in the future**; and
- The right incentives to ensure everyone is working together to achieve the long-term goal.

Working to achieve the 2030 energy goals and water goals **will place VMMC in an elite class of hospitals**. Making incremental and long term changes like the ones outlined in this plan will not only reduce operational costs for VMMC, but will display VMMCs commitment to the planet and community; not only directly, by reducing the resource use of an individual hospital, but indirectly, by being a model by which other hospitals can follow, affecting change nationwide.

Several factors will determine the likelihood of VMMC reaching the 2030 targets. These include:

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- Administrative and **board adoption of the goals** – this is key to the long-term success of the program. If these goals aren't adopted at every level of the organization, achieving success will prove very difficult.
- Integration of energy reduction into the normal capital planning process. Many of the measures indicated in this report are incremental changes to projects that would need to be done to support normal infrastructure updates. **Every time a piece of infrastructure is updated without considering the long term impact to energy and water usage, an opportunity to improve is missed.**
- Outside of these incremental savings infrastructure projects, implement standalone Energy Savings measures with attractive aggregate paybacks.
- Having **dedicated engineering staff to focus on the day-to-day energy and sustainability efforts.** This person or team would be internal facing and would have more specific engineering experience in controls optimization, bill tracking, energy KPIs and operational strategies. This would allow the current Sustainability Director to focus on key external facing issues, and the overall strategy of the program, while not getting bogged down in the day to day engineering detail.
- **Dedicated tracking** of square footage, adjusted patient days, and utility data shared with everyone. The public display of goal and progress will help solidify organizational buy in. Keeping these issues "front of mind" will help ensure success.
- Develop various **incentive programs** to help staff and industry partners to focus on meeting the sustainability goals in all the work that they do. Currently there are no guidelines or contractual obligations to ensure industry partners are looking at the big picture, long-term benefit of the hospital.
- Revisit and **update this master plan** quarterly. Keep **track of successes** as they are implemented, as well as adjusting plans as campus strategies change.

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1.3. CONTACT INFORMATION

1.3.1. MCKINSTRY CONTACTS

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2. Performance & Goals

2. Performance & Goals

2.1. OVERVIEW

This section covers current campus performance, how VMMC compares to other hospitals, and long-term performance goals.

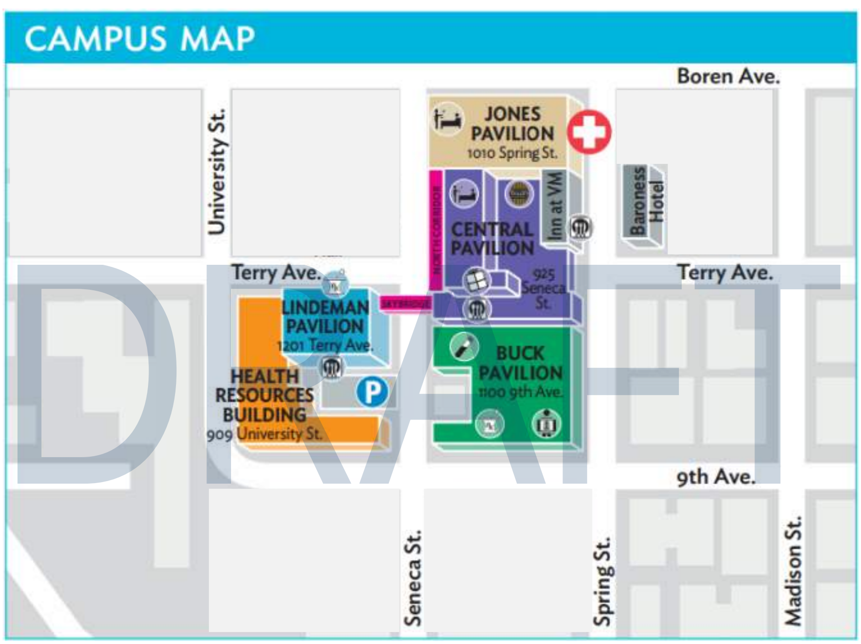
2.2. SCOPE

The scope of the study includes the buildings shown in the table below. Cassel Crag, Blackford Hall, MRI Building, Benaroya Research Institute, and the 9th avenue parking garage are not included in this study.

Table 2: Buildings and Square Footage

Facility	Square Footage	Study Status
Jones Pavilion	185,193	included
Central Pavilion	322,520	included
Buck Pavilion	186,240	included
Lindeman Pavilion	157,246	included
Baroness Hotel	35,770	included
Inn at Virginia Mason	48,006	included
Health Resources Building	81,300	included
9th Avenue Garage	69,786	excluded
Cassel Crag / Blackford Hall / MRI Building	66,085	excluded
Benaroya Research Institute	109,550	excluded

Figure 2: Campus Map Highlighting in Scope Buildings



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2.3. CURRENT USAGE SUMMARY

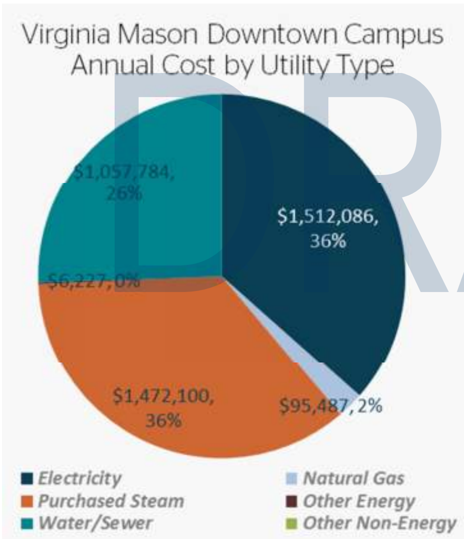
In 2013 (most recent complete calendar year available), the site Energy Use Index (EUI) for the main campus facilities was **169 kBtu/sf/yr** and the annual utility spend (including water and sewer) was **~$4.1 million**.

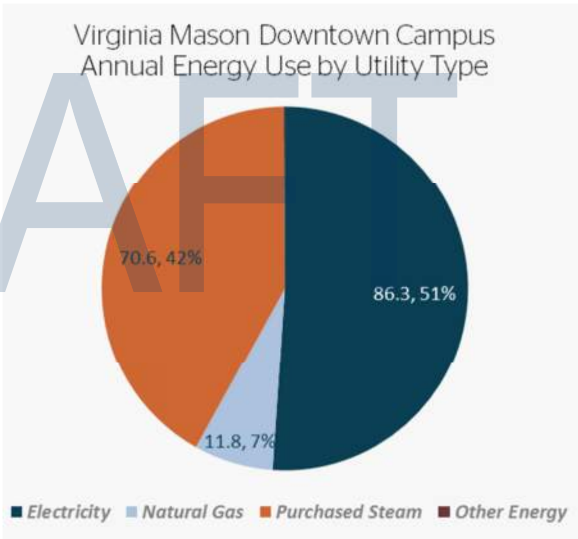
Key takeaways of the table and charts below:

- Electricity and steam are the key drivers of energy use (natural gas is less significant);
- Electricity and steam are tied for most cost per year;
- Electricity makes up 9% more of the energy use than steam does. This indicates that steam has a higher cost per BTU than electricity;
- Natural gas has a very low cost per BTU; and
- Water/sewer use makes up over 25% of utility cost.

Table 3: VMMC Main Campus Usage Summary

	1/1/2013	to	12/1/2013
	Value	Units	Notes
Electricity Use	25,536,674	kWh/yr	
Natural Gas Use	119,479	therms/yr	
Purchased Steam Use	59,746	klb/yr	
Fuel Oil Use	1,465	gal/yr	
Water Use	63,300	CCF/yr	
CO2e Emissions	15,754.3	metric tons/yr	
Energy Cost Intensity	$3.05	$/sf/yr	
Utility Cost Intensity	$4.10	$/sf/yr	
Energy Use Intensity	169	kBtu/sf/yr	
Water Use Intensity	46.9	gal/sf	
CO2e Emissions Intensity	34.4	lbs CO2/sf	





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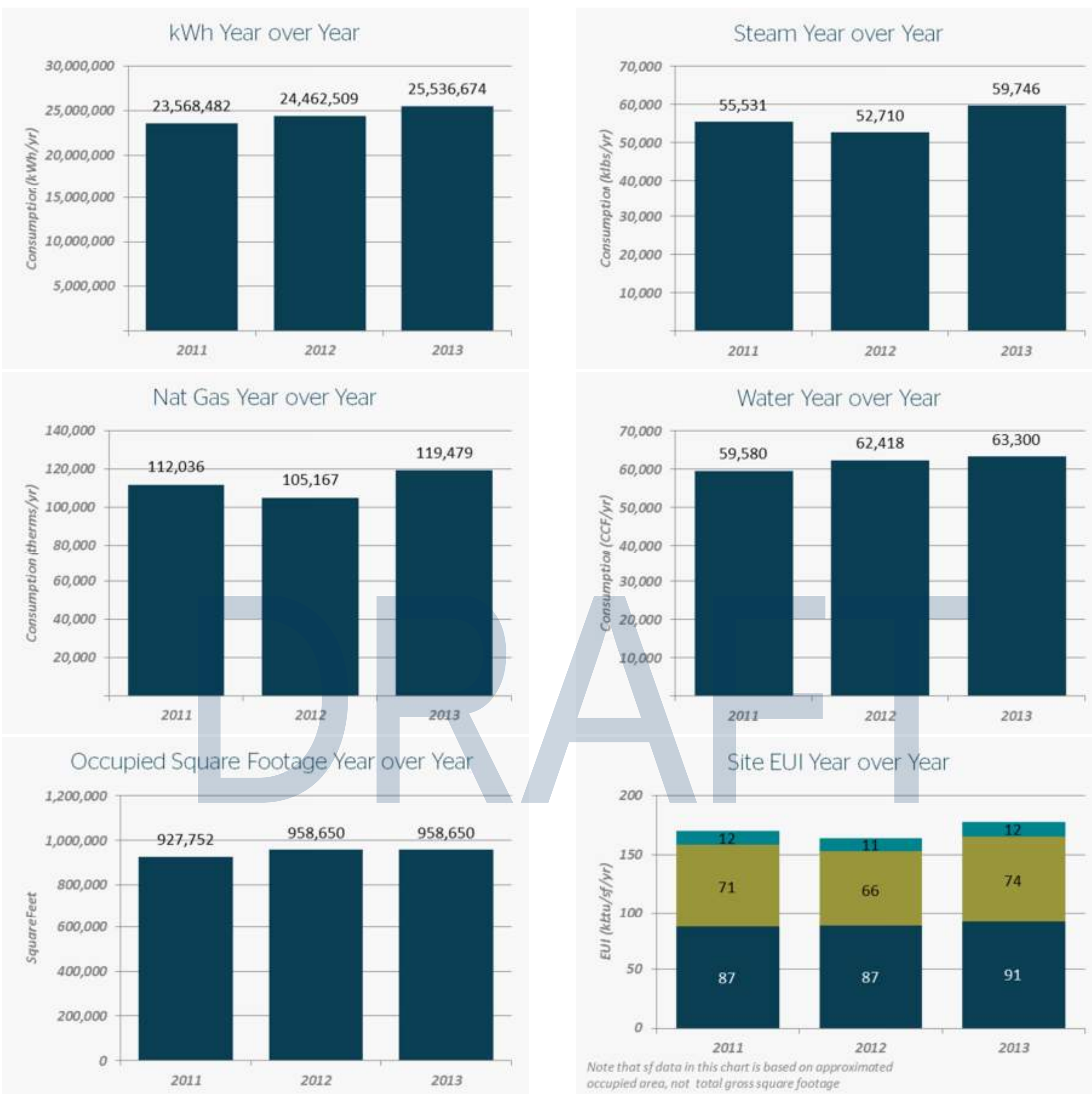
Key takeaways of the charts below:

- As expected with the addition of square footage, energy and water use have increased year over year;
- These charts also show a slight rise in energy use per square foot. However, due to construction activities and the gradual move-in of Jones, this does not appear to be a statistically significant finding. Small changes in EUI will be tough to detect until Jones reaches full occupancy.
- The heating and cooling degree days charts indicate how hot or cold Seattle weather has been over the past several years. On average, the past three years have been slightly warmer than typical which would point to higher cooling and kWh use (as seen in the kWh Year over Year chart).

Figure 3: VMMC Campus Year over Year Charts



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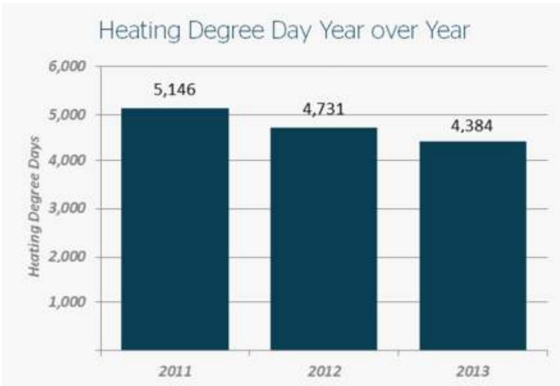

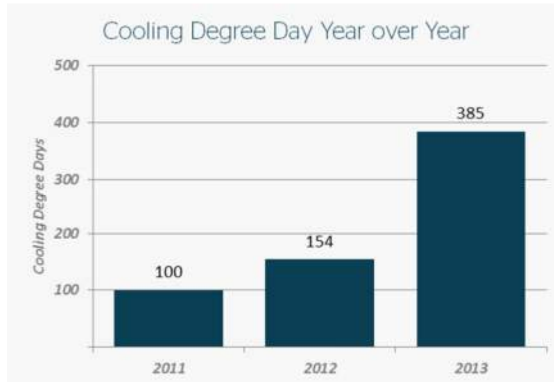

Data for the Inn at VM and the Baroness Hotel is provided in an Appendix.

2.3.1. ELECTRICITY DETAIL

2013 Electricity Use	25,536,674	kWh/yr
2013 Electricity Cost	$1,512,086	$/yr (includes demand)

Key takeaways of the charts below:

- Winter electricity use is steady year over year;
- The annual minimum occurs in the winter which indicates that there is very little electric heat on campus (Lindeman is the main exception);
- Summer electricity use is increasing. This would seem to indicate additional cooling energy, partly due to hotter weather year over year the past several years.

Figure 4: VMMC Campus Electric Profile by Month

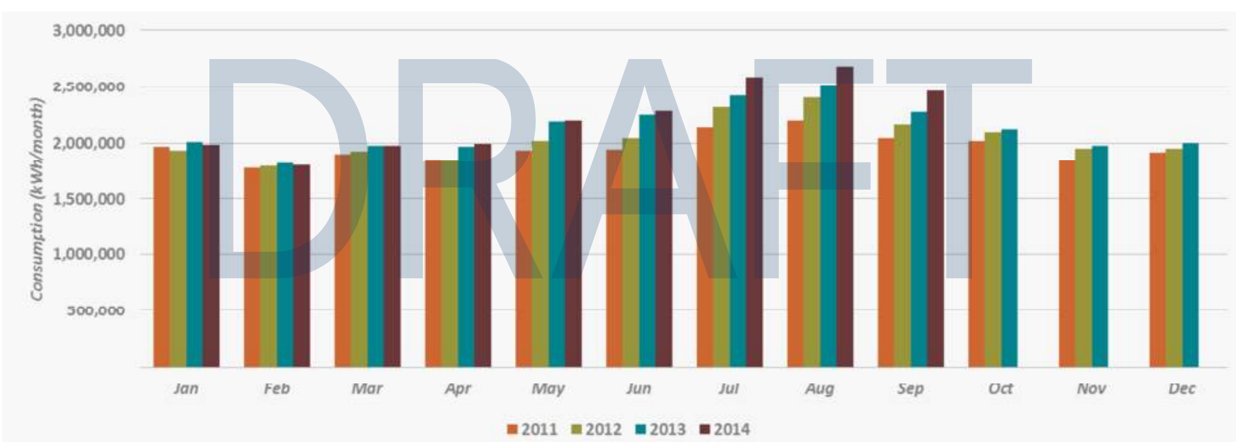

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Figure 5: VMMC Campus Electric Profile Chronological

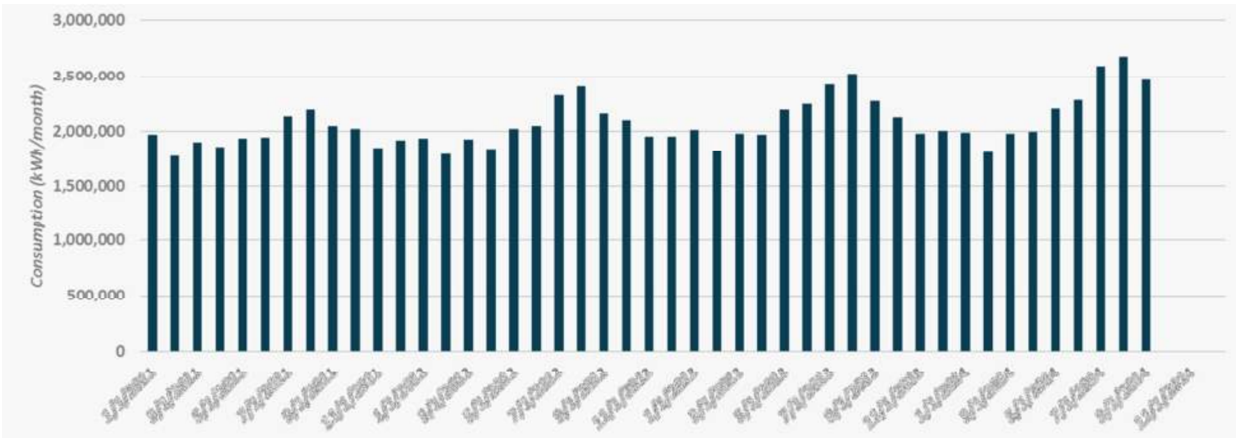
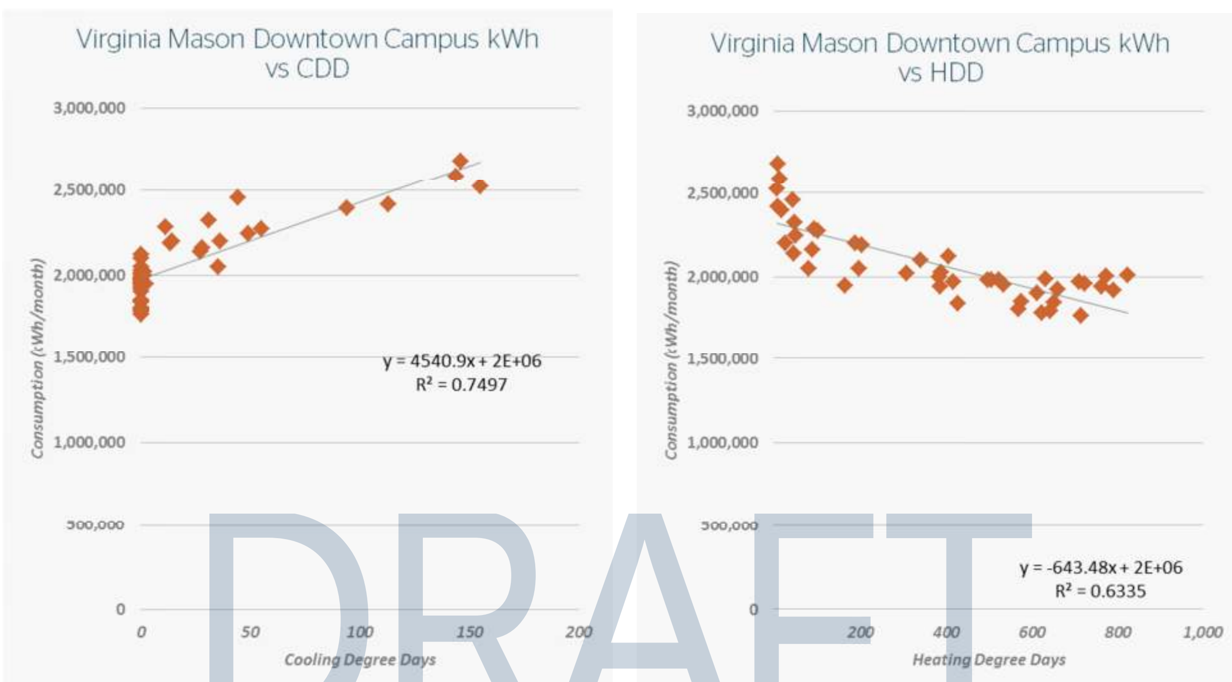


Figure 6: VMMC Campus Electric Use Compared to Historical Weather Data



2.3.2. STEAM DETAIL

2013 Steam Use	59,746	klbs/yr
2013 Steam Cost	$1,472,100	$/yr

Key takeaways of the charts below:

- The minimum usage occurs in the summer but is still significant at roughly $75,000 per month. This is a combination of domestic hot water and reheat energy thermal use. Proposed measures including water efficiency, DAT reset, and rebalancing FIMs would help reduce this 'base load" steam use;
- Heating Degree Days have been declining. This means that VMMC should not budget utilities based on 2013 use since a "normal" winter would have higher steam use than 2013 because 2013 was warmer than a normal year.

Figure 7: VMMC Campus Steam Profile by Month

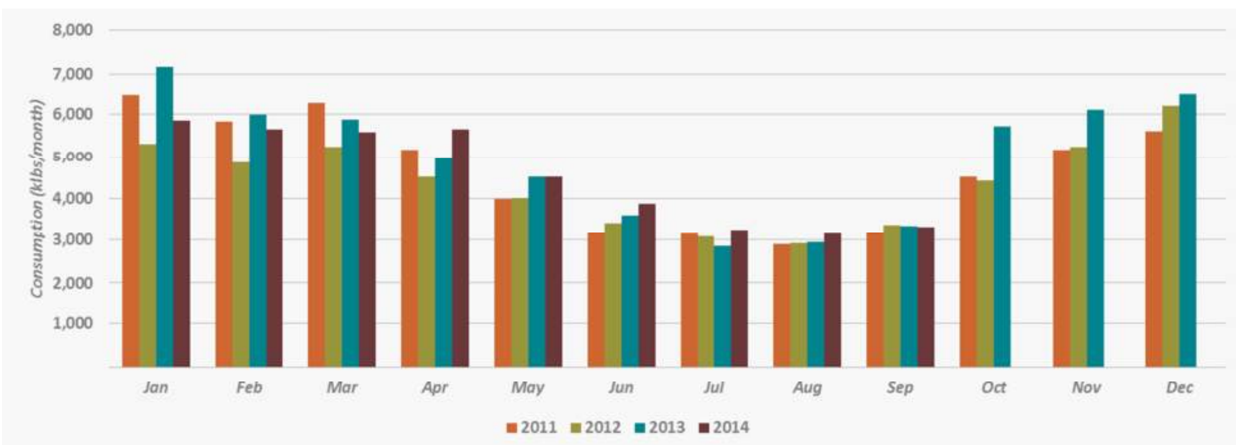


Figure 8: VMMC Campus Steam Profile Chronological

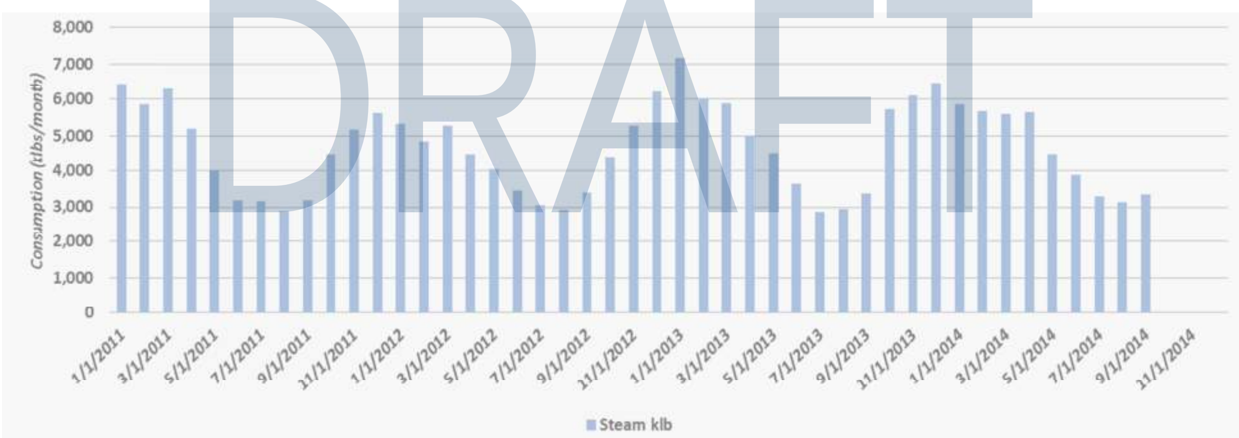


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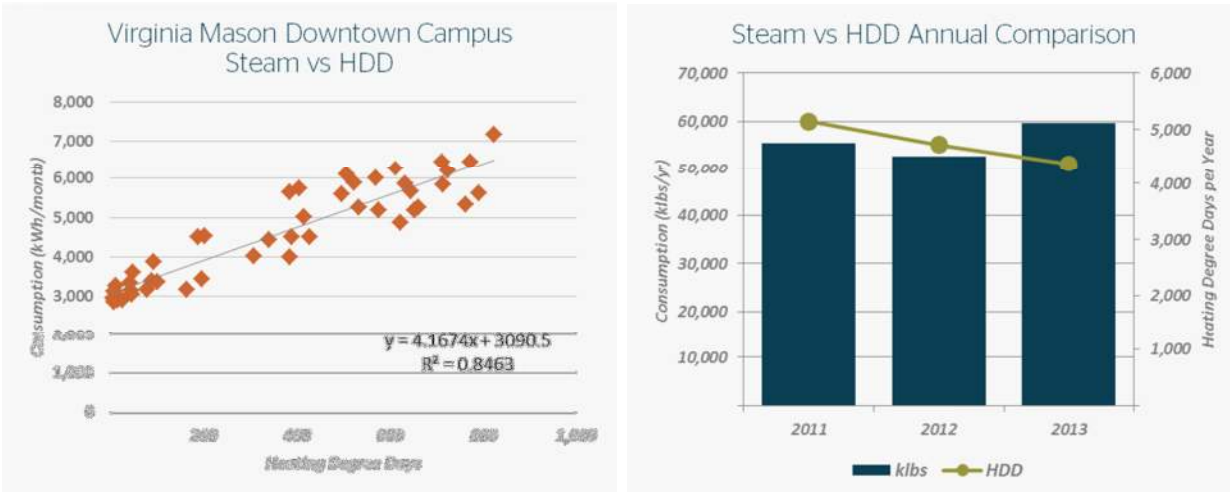
Figure 9: VMMC Campus Steam Use Compared to Historical Weather Data



2.3.3. NATURAL GAS DETAIL

2013 Gas Use	119,479	therms/yr
2013 Gas Cost	$95,487	$/yr

Key takeaways of the charts below:

- As with steam, the minimum usage occurs in the summer. Also, VMMC should not budget utilities based on 2013 use since a "normal" winter would have higher gas use than 2013 because 2013 was warmer than a normal year (although currently gas cost for VMMC is very low).
- Many hospitals buy wholesale gas, but it does not appear VMMC has enough usage to make this cost effective currently as wholesale gas has higher fixed monthly meter charges. However, if steam is partly or fully converted to gas in the future, wholesale gas should be explored as a way to lower the gas $/BTU even further.

Figure 10: VMMC Campus Gas Profile by Month

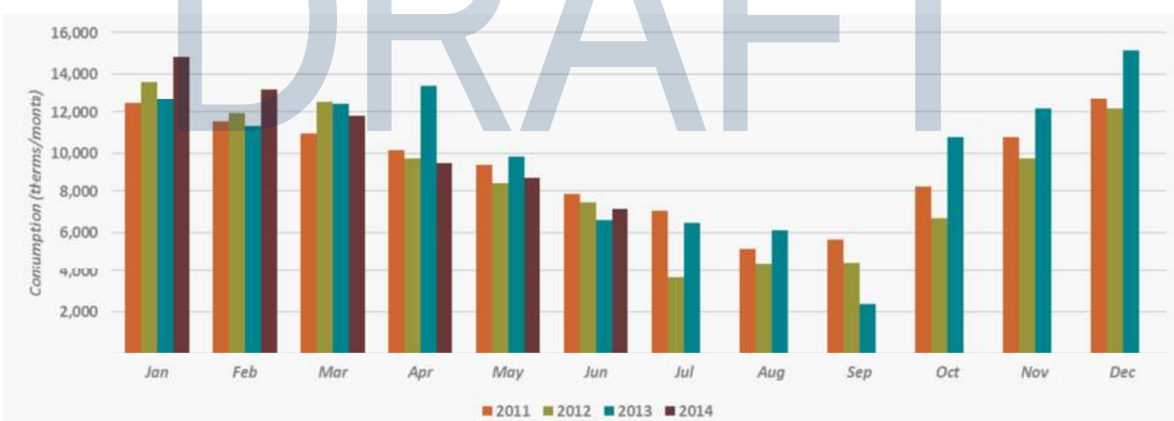


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Figure 11: VMMC Campus Gas Profile Chronological

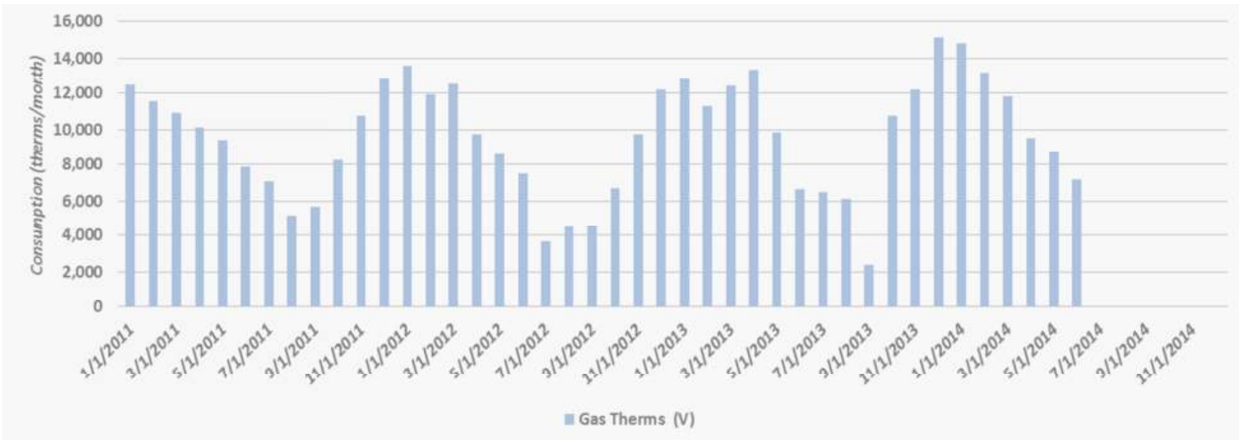
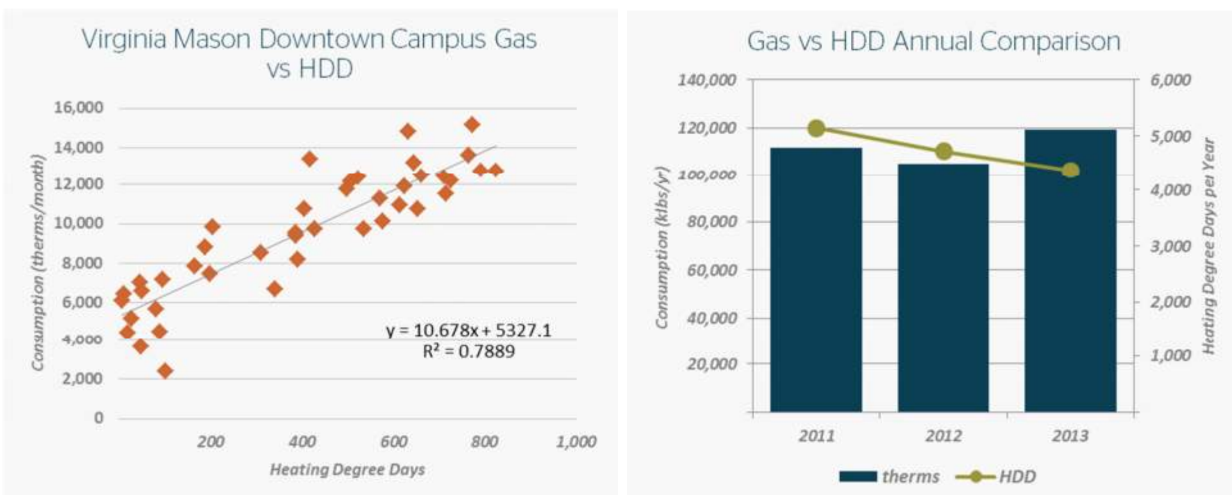


Figure 12: VMMC Campus Gas Use Compared to Historical Weather Data



2.3.4. DIESEL

2013 Diesel Use	1,465	gal/yr
2013 Diesel Cost	$6,227	$/yr

Diesel use is not significant.

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2.3.5. WATER / SEWER DETAIL

2013 Water/Sewer Use	63,300	CCF/yr
2013 Water/Sewer Cost	$1,057,784	$/yr

Key takeaways of the charts below:

- The fact that usage is higher in the winter than in the Spring/Fall seems to indicate tempering of hot steam condensate. Proposed condensate heat recovery, condensate reuse, Tier 2 boiler, and Lindeman domestic water heating measures would help reduce this;
- Higher summer use is expected from cooling tower water use at the hospital, Buck, Lindeman, and Jones cooling towers. Proposed DAT reset and rebalancing measures will help reduce this usage.

Figure 13: VMMC Campus Water Profile by Month

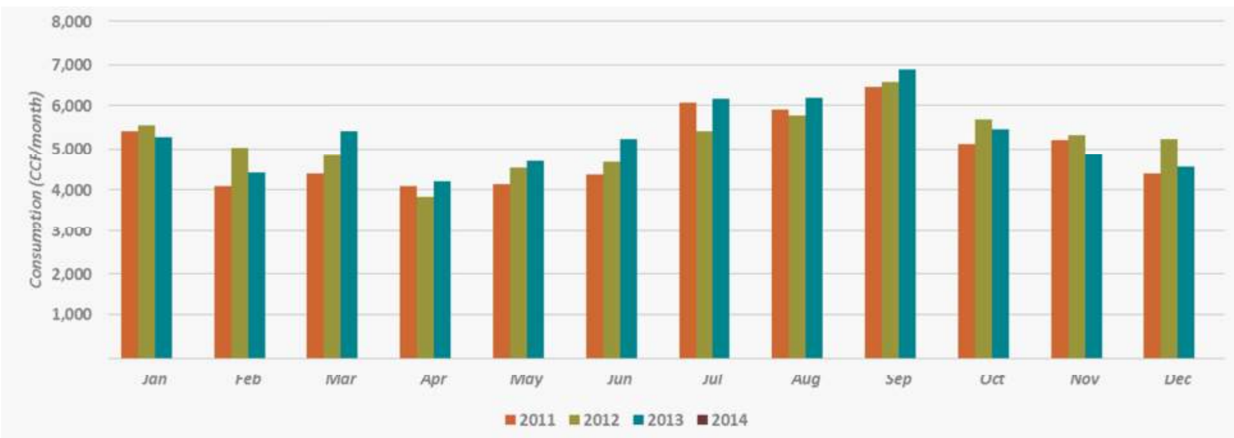
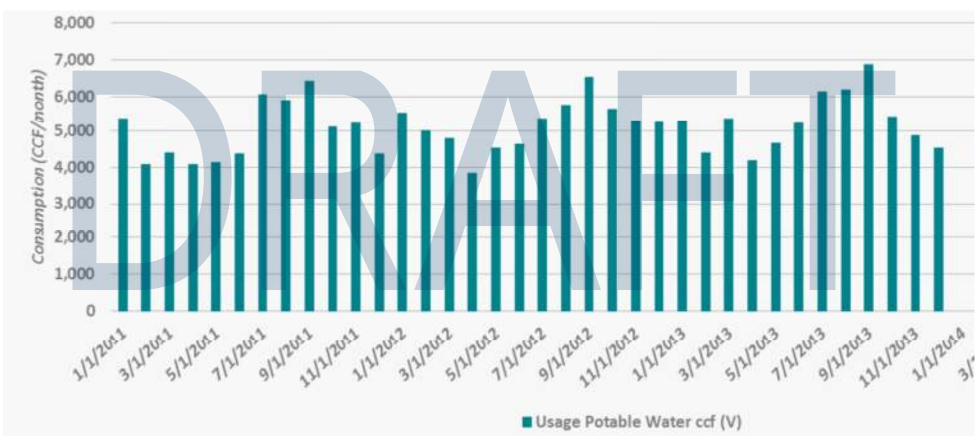


Figure 14: VMMC Campus Water Profile Chronological



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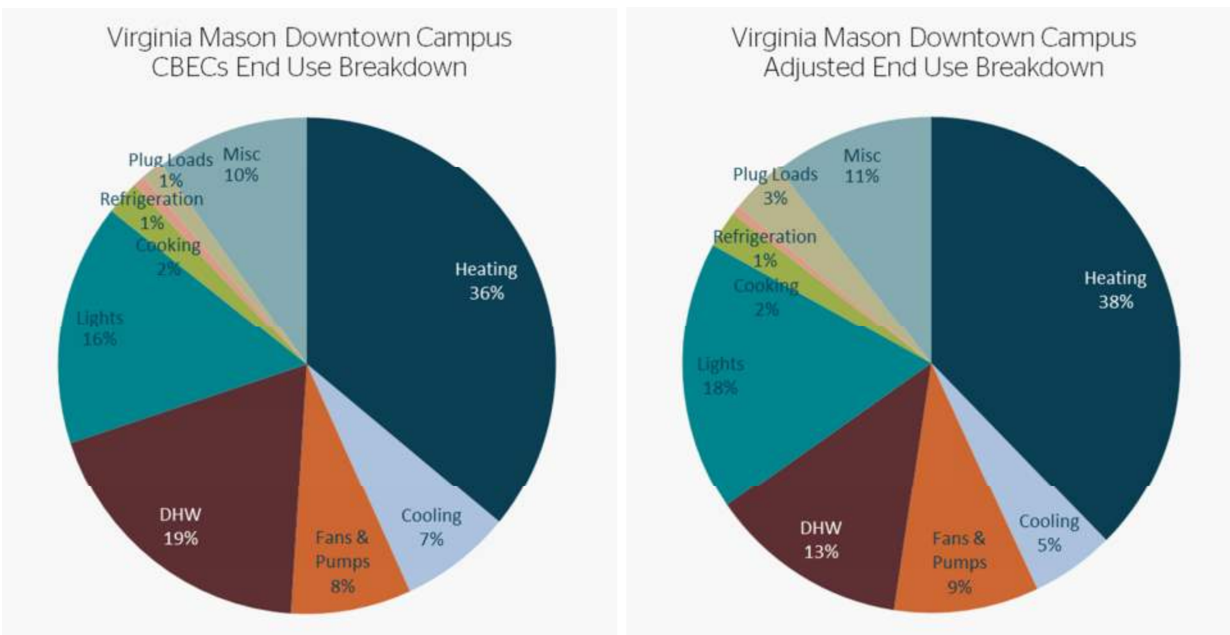
2.4. END-USE ANALYSIS

Based on DOE CBECs (Commercial Building Energy Consumption Survey) data for hospitals, the typical breakdown of energy use by end-use is shown in the chart on the left side below. This data was adjusted slightly in the chart on the right to account for the actual ratio of steam and gas use (for heating) compared to other electric uses (cooling, fans, pumps, etc.). Key takeaways include:

- Overall, heating, domestic hot water, and lighting are the largest slices of the pie; and
- A large portion of the heating energy is for re-heat of sub-cooled air during the summer and swing months.

Figure 15: VMMC Main Campus End-Use Breakdown



2. Performance & Goals

2.5. RATE & FUEL COSTS

The utility rates used to calculate energy savings are provided here as well as in Section 3. These are based on the most current effective unit rates from each utility provider.

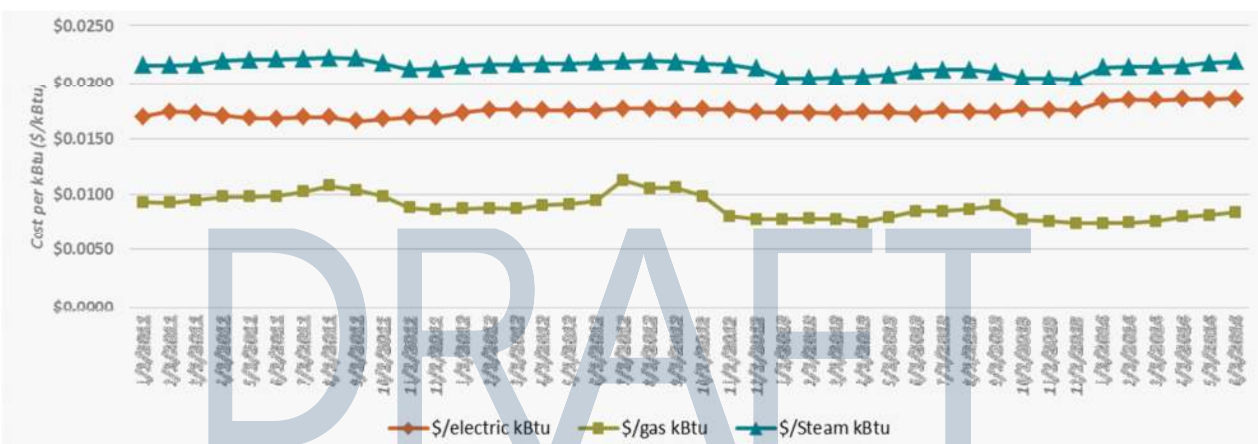
Table 4: Utility Rates for Savings Calculations

Utility Provider	Utility Type	$ per Unit	Units	Effective Date
Enwave Seattle	Purchased Steam	$24.860000	klbs	1/1/2014
Seattle City Light	Electricity Demand	$1.520000 (1)	kW	1/1/2014
Seattle City Light	Electricity	$0.061433 (2)	kWh	1/1/2014
Puget Sound Energy (PSE)	Natural Gas	$0.961450 (3)	Therms	11/1/2014
Seattle Public Utilities (SPU)	Sewer	$11.840000	CCF	1/1/2015
Seattle Public Utilities (SPU)	Water	$5.440000 (4)	CCF	1/1/2014

(1) Peak rate
(2) Weighted average of on-peak and off-peak rates
(3) Rate 31
(4) Weighted average of winter and summer rates

As shown in the chart below, once converted to the common unit of BTU, steam is the most expensive fuel per BTU (besides diesel, which VMMC uses very little of). Thus, in terms of cost savings, saving a BTU of steam is more valuable than saving electricity or gas. In addition, since gas is significantly less expensive than both electricity and steam, converting existing systems to gas and installing gas for any new construction will reduce ongoing utility costs.

Figure 16: VMMC Historical Energy Cost per kBTU

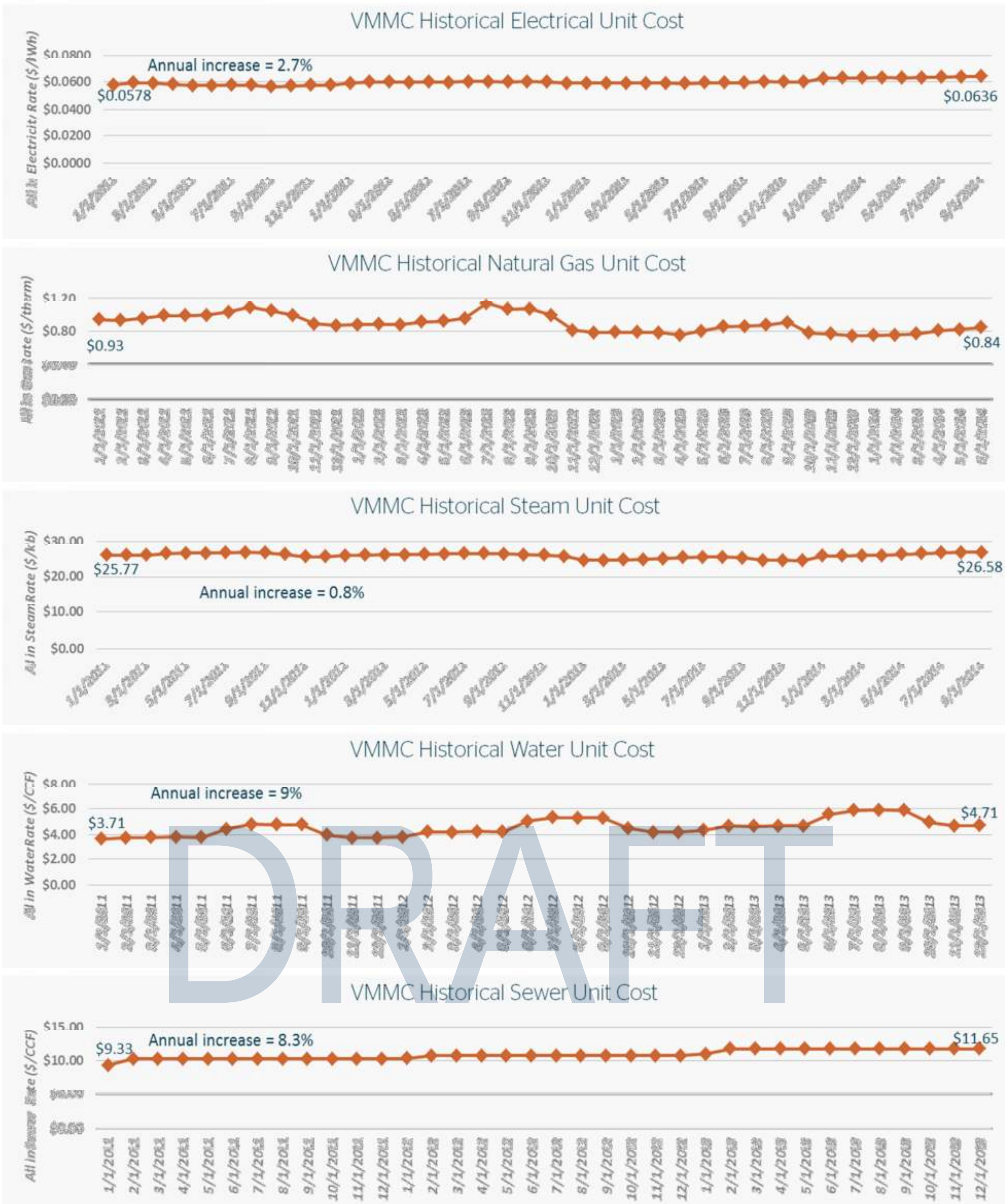


The charts on the following page illustrate how utility costs for each utility have been changing over the past several years. For reference, general inflation has been roughly 2% over this same time period. Key takeaways include:

- Electricity has been increasing at a rate of 2.7% per year;
- Gas has been variable;
- Steam (which is linked to the steam supplier's gas cost) has increased by 1% per year;
- Water and sewer have been increasing at a high rate of ~9% per year.

2. Performance & Goals

Figure 17: VMMC Historical Unit Costs



2. Performance & Goals

2.6. BENCHMARKING

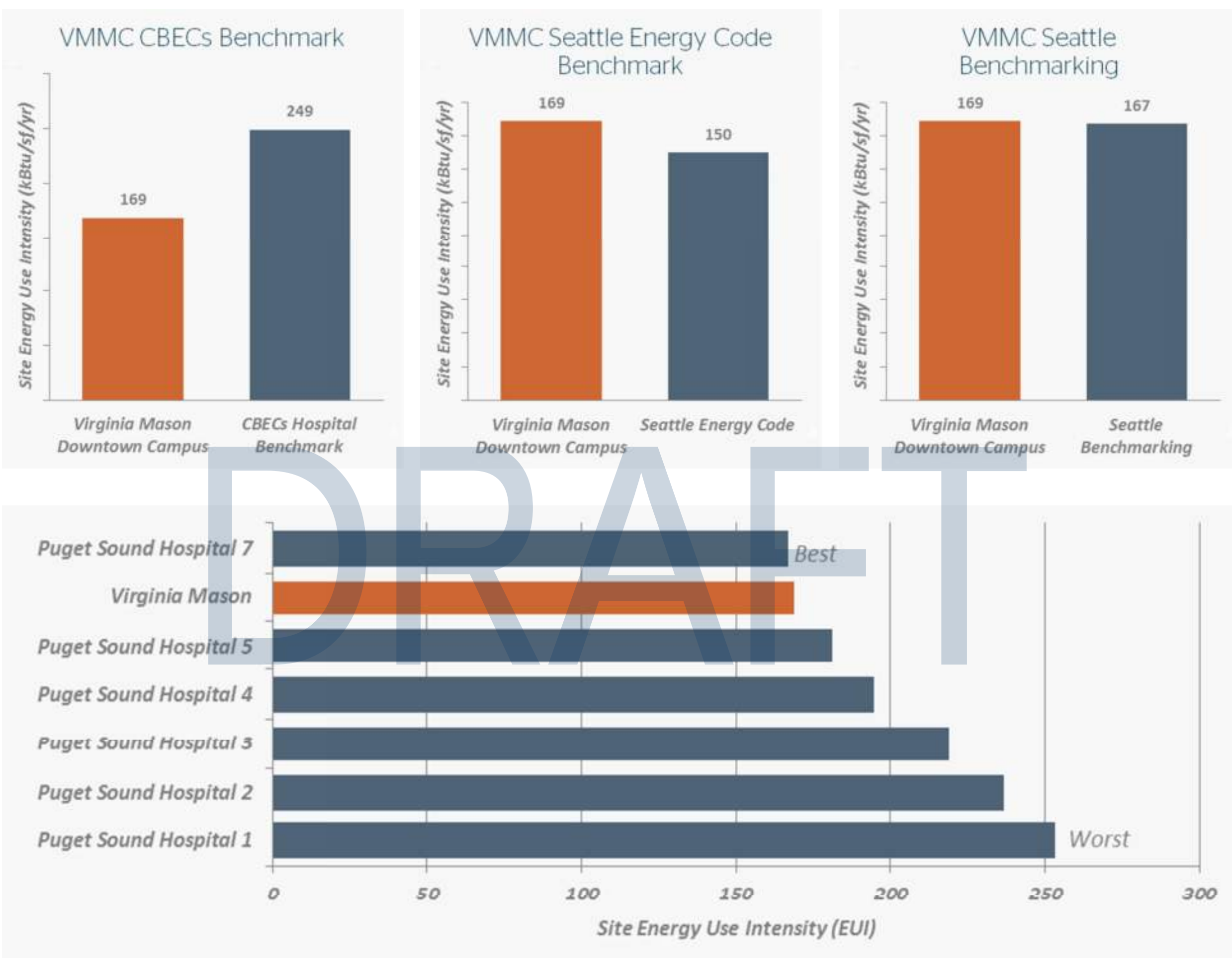
In order to get a feel for how a facility is performing, it can be helpful to compare performance to datasets of similar facilities. There are several datasets and sources for this purpose including:

- CBECs (Department of Energy Commercial Building Energy Consumption Survey);
- Seattle Energy Code new construction target EUI;
- Seattle 2011/2012 Energy Benchmarking report;
- Seattle 2030 District Baselines; and
- McKinstry internal datasets.

These comparisons are shown in the charts below. Key takeaways include:

- Compared to most of these benchmarks, VMMC is a good to great performer in terms of energy use. Overall, VMMC is far from an "energy hog," rather is a leading example of energy and resource management;
- That said, the 2030 goals are very aggressive and performing only slightly better than common benchmarks will not be adequate to achieve them.

Figure 18: VMMC Energy Benchmarking

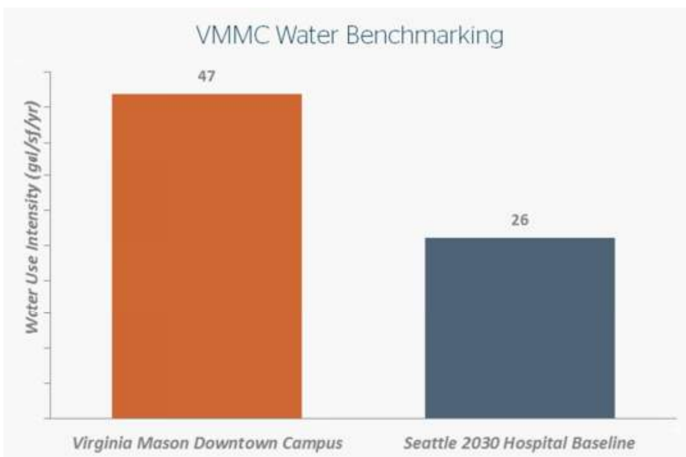


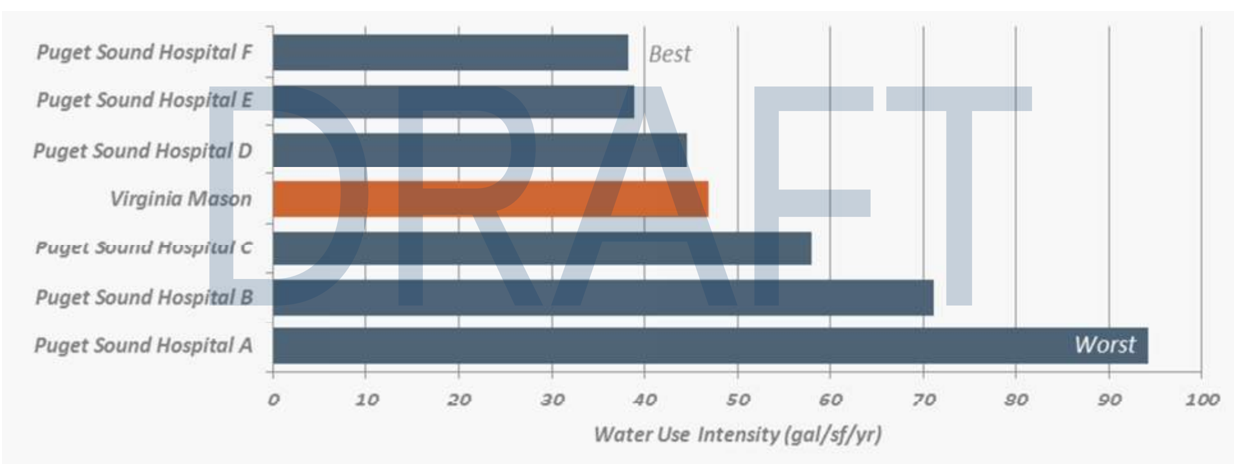
2. Performance & Goals

There are fewer datasets available for water benchmarking. The *Seattle 2030 District Performance Metric Baselines* document[1] provides a Water Use Intensity Baselines table for a variety of building uses including hospitals. The baseline is for the years 2002 – 2010. Also, McKinstry has performed water audits for most of the major Puget Sound hospitals and has water benchmarking available for those facilities. Key takeaways include:

- Compared to the 2030 baseline of 26 gal/sf/yr, VMMC is a very high user of water.
  - This is reflected in overall utility costs, where water and sewer makes up over 25% of the total annual spend.
  - Meeting the 2030 district target is a significant challenge, so proposed measures that save water such as fixture recommissioning and the heat recovery chiller measure should be a high priority.
- Compared with other Puget Sound hospitals, VMMC water usage is typical.

Figure 19: VMMC Water Benchmarking





1 http://2030districts.org/sites/default/files/atoms/files/2030_District_Baselines.pdf

2.Performance & Goals

2.7. GOALS

Long-term energy and water use performance goals for Virginia Mason Medical Center are identical to those for the 2030 Seattle District. The 2030 district goals are tied to the Site Energy Use Intensity which does not penalize growth or an increase in square footage (as anticipated for VMMC per the 2013 MIMP). The specific goals and tailored metrics related to VMMC's 2030 goals are described and illustrated in the tables and figures below.

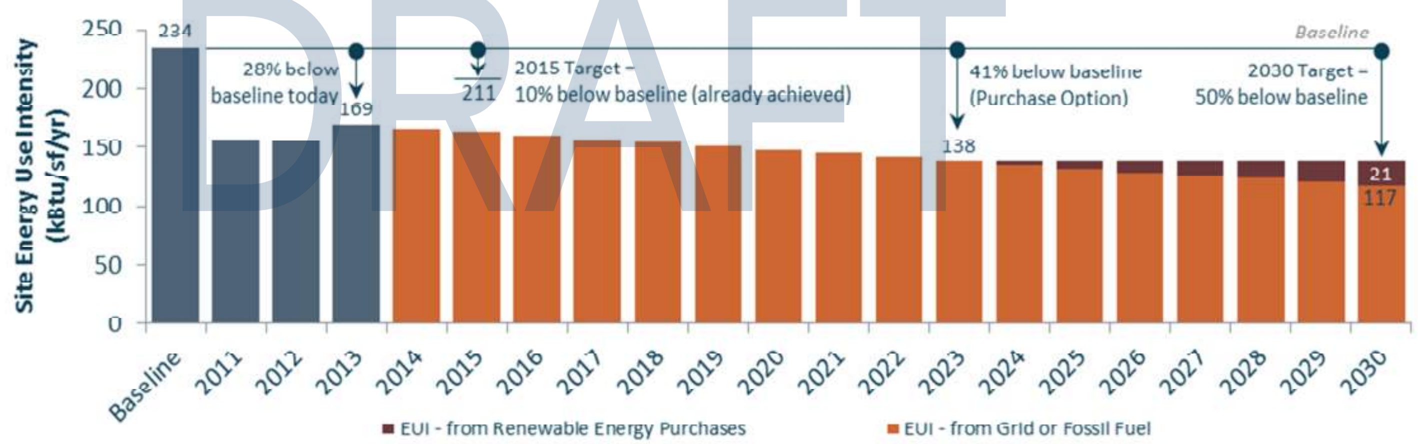
Figure 20: 2030 District Energy and Water Performance Goals – Summary

NEW BUILDINGS, MAJOR RENOVATIONS, AND NEW INFRASTRUCTURE:	EXISTING BUILDINGS AND INFRASTRUCTURE OPERATIONS:
• **Energy Use:** an immediate 60% reduction below the National average, with incremental targets, reaching carbon neutral by 2030.	• **Energy Use:** A minimum 10% reduction below the National average by 2015 with incremental targets, reaching a 50% reduction by 2030.
• **Water Use:** An immediate 50% reduction below the current District average.	• **Water Use:** A minimum 10% reduction below the District average by 2015, with incremental targets, reaching a 50% reduction by 2030.
• **CO_2e of Auto and Freight:** An immediate 50% reduction below the current District average.	• **CO_2e of Auto and Freight:** A minimum 10% reduction below the current District average by 2015 with incremental targets, reaching a 50% reduction by 2030.
Note: CO2e of Auto and Freight is not addressed as part of this plan	

2.7.1. ENERGY TARGET: EXISTING BUILDINGS

As shown in the figure below, the baseline EUI for the downtown VMMC campus is 234 kBtu/sf/yr. In 2013, the actual campus EUI was 169 – already a 28% reduction below the baseline. The 2030 goal targets a 50% reduction by 2030, equivalent to an EUI of 117 kBtu/sf/yr. The chart below shows the required reduction assuming a linear year over year implementation. The 2030 Challenge allows for a maximum of 20% of the reduction to come from renewable energy purchases, so once VMMC achieves an EUI of less than 138, the remainder of the "reduction" could be procured through renewable energy purchases in lieu of continued energy efficiency (or on-site renewables).

Figure 21: 2030 Energy Roadmap – Existing Buildings



2.7.2. ENERGY TARGET: NEW BUILDINGS

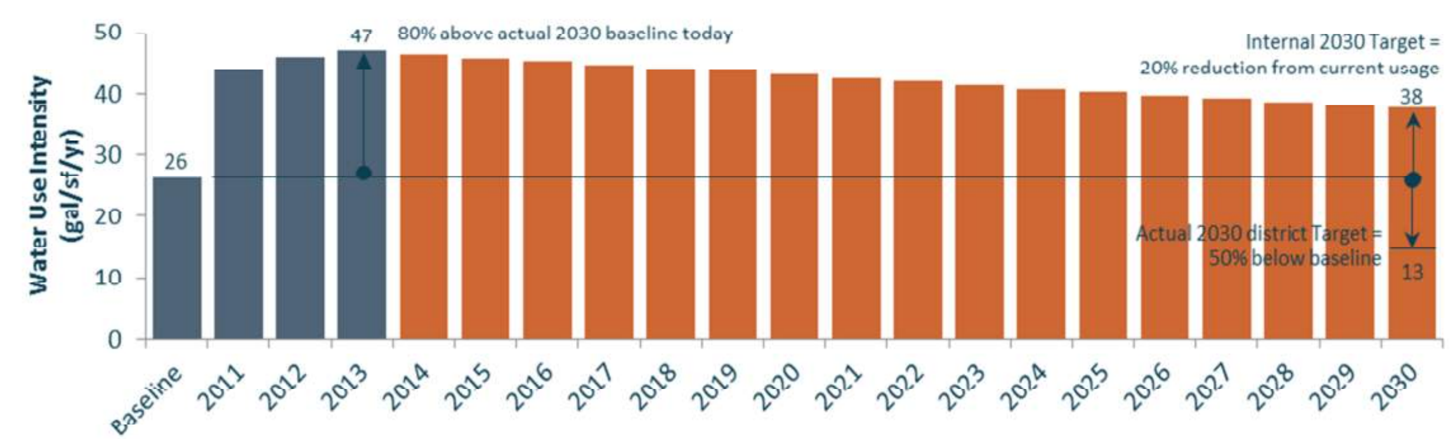
As with existing buildings, the baseline EUI for new buildings for the downtown VMMC campus is 234 kBtu/sf/yr. However, the 2030 District goals are much more aggressive for new buildings. Any new building must perform 60% below the current baseline; in this case, that translates to an EUI of 93 kBtu/sf/yr. No hospital in the U.S. currently performs at this level. Were a new building to pursue the performance path under the new 2012 Seattle Energy Code, the target would only be 150 kBtu/sf/yr. Further, the goals require that the facility pursue carbon neutrality by 2030. This requires that over time all fossil fuel or grid energy purchases are replaced by on-site renewables and renewable energy purchases. One potential pathway for accomplishing this is shown in the chart below. As with existing buildings, the renewable energy purchases are limited to 20% of the total reduction from the baseline.

Figure 22: Energy Target – New Construction

2.7.3. WATER TARGETS: NEW AND EXISTING BUILDINGS

The baseline water use for hospitals for the 2030 goals is 26 gal/sf/yr. At present, VMMC is nearly 80% above this baseline. As such, reaching (and then exceeding the 2030 district baseline by 50%) is unrealistic. A more attainable goal of a 20% reduction from current usage is thus the defined target. This goal is challenging though possible by 2030.

Figure 23: Water Target – Existing Buildings



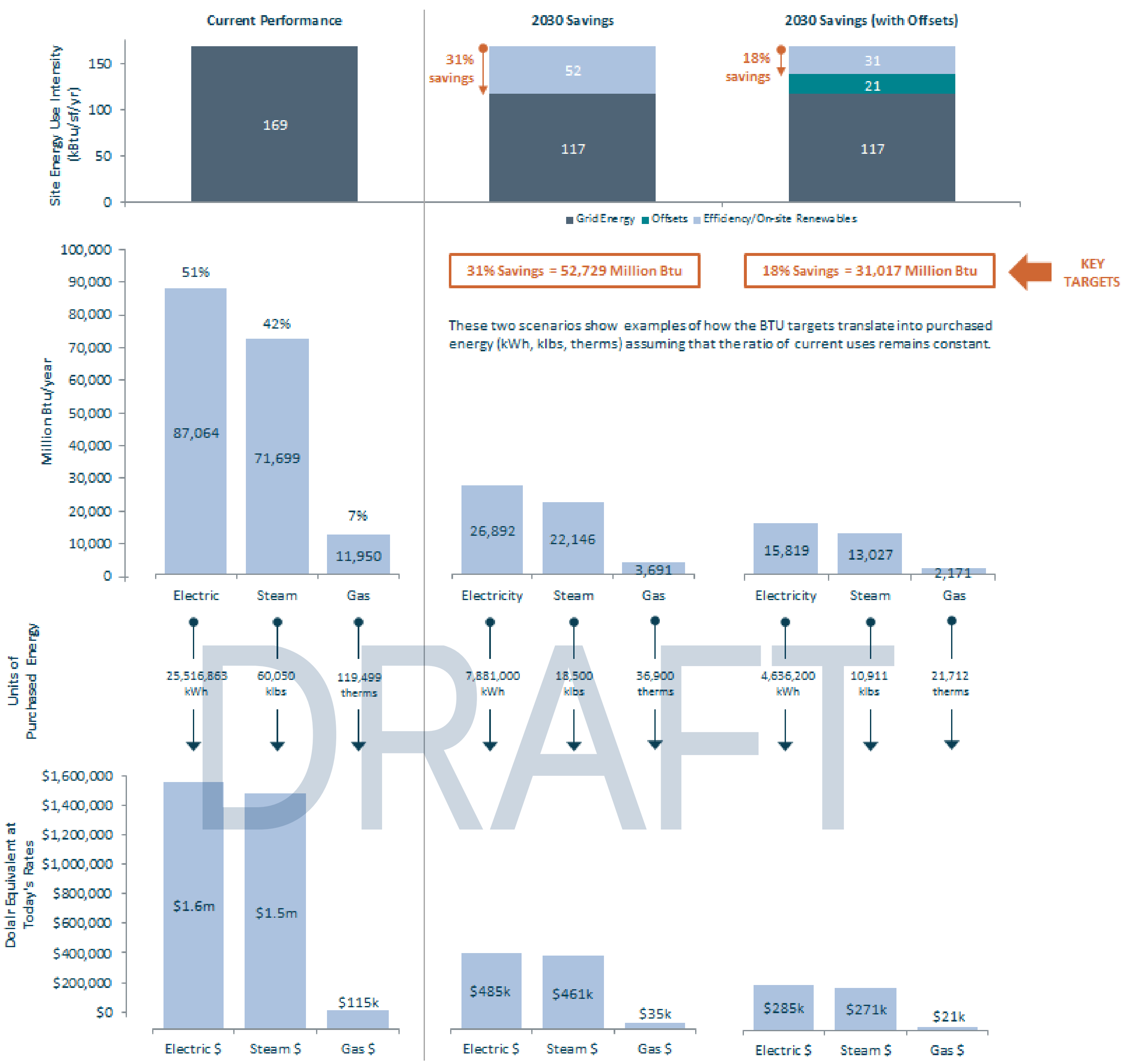
3. Opportunities

3. Opportunities

3.1. FACILITY OPPORTUNITIES

To reach the 2030 targets stated in the Goals section of this report, large reductions for existing facilities will be required. The graphic below illustrates the total BTU reduction that will be necessary to reach the 2030 target. Two scenarios are shown: 1) savings required if no green power purchases are made and 2) savings required if green power purchases are made. In the scenario where no green power is purchased, savings of 31% from today's performance is necessary. With green power, only an 18% reduction is needed.

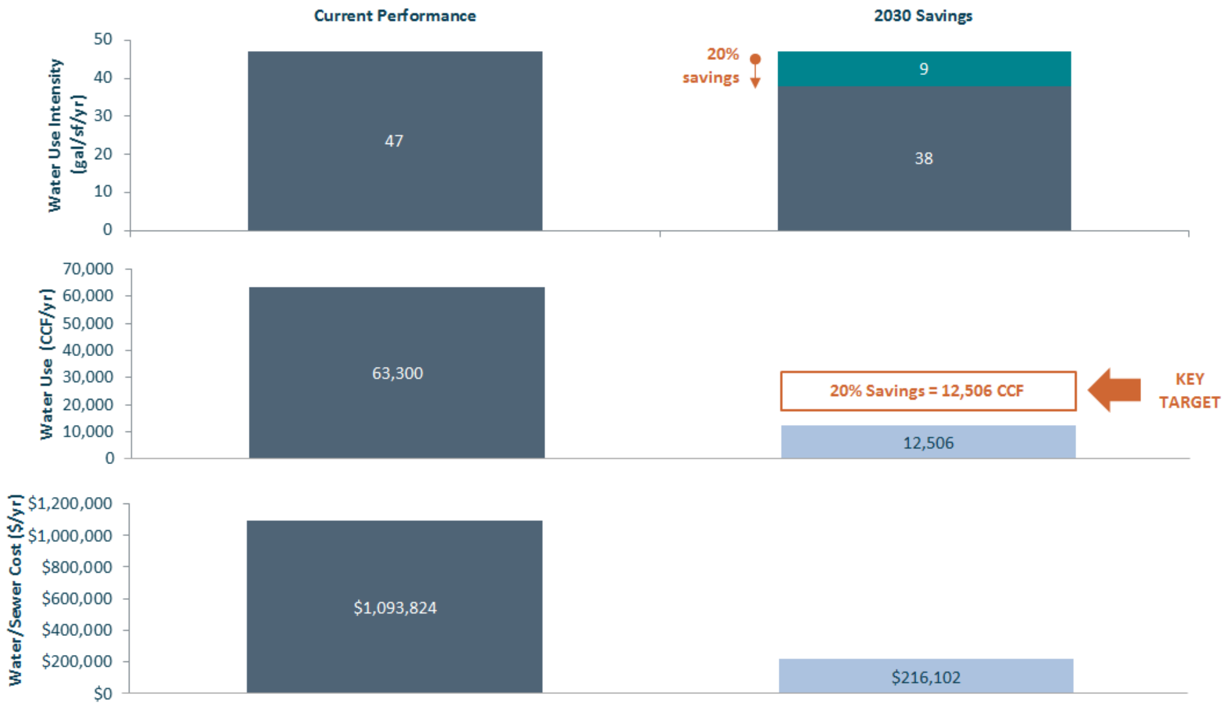
Figure 24: Required Energy Reductions to Meet 2030 Goals



3. Opportunities

For water, a 20% reduction is necessary to meet the internal 20% reduction target.

Figure 25: Required Water Reductions to Meet 2030 Goals



3.2. APPROACH

Based on interviews with VMMC staff, research on utility use and equipment inventory, site walks, building automation system trending, and McKinstry's experience, a broad list of facility improvement measures (FIM's) was identified. The goal of the effort was to identify as many items as possible that could help VMMC reach the 2030 targets to understand if reaching the targets will be feasible.

The identified measures range from upgrading building envelope components to replacing major mechanical equipment. Due to the breadth of measures explored, the cost and savings presented in this report are very much at the rough order of magnitude (ROM) level with investment grade audits required to further define each measure prior to implementation.

Further, it is not expected that all of the measures will be implemented immediately. A key component to reaching the target in a financially responsible way will involve "piggybacking" efficiency measures on top of planning capital work whenever possible.

When evaluating potential energy and water efficiency measures at VMMC, key criteria for implementation include:

- ➔ First cost – what is the total investment required?
- ➔ Incremental cost (if applicable) – what is the total investment required beyond the base case planned capital investment?
- ➔ Annual energy savings (and EUI reduction / greenhouse gas savings) – how much does it move the needle towards the desired end-goal?

- Annual water savings – how much does it move the needle towards the desired end-goal?
- Annualized maintenance/repair/replacement savings – how much does the measure reduce cost for maintenance and repairs?
- Simple payback – how many years does it take to recoup the initial investment?
- Savings to investment ratio – over the lifetime of the measure, how much of the first cost is paid for by the cumulative savings?
- Impact on patient experience – how does the measure enhance the patient experience at VMMC?
- Impact on medical staff – how does the measure facilitate a higher quality of health care?
- Impact on engineering staff– how does the measure reduce labor hours or ease monitoring or maintenance?
- Impact on facility redundancy and reliability – how does the measure reduce the risk of downtown for critical systems?

3.3. UTILITY RATES

This section documents the utility rates and utility escalation rates used for all calculations.

Table 5: Utility Rates for Savings Calculations

Utility Provider	Utility Type	$ per Unit	Units	Effective Date
Enwave Seattle	Purchased Steam	$24.860000	klbs	1/1/2014
Seattle City Light	Electricity Demand	$1.520000 (1)	kW	1/1/2014
Seattle City Light	Electricity	$0.061433 (2)	kWh	1/1/2014
Puget Sound Energy (PSE)	Natural Gas	$0.961450 (3)	Therms	11/1/2014
Seattle Public Utilities (SPU)	Sewer	$11.840000	CCF	1/1/2015
Seattle Public Utilities (SPU)	Water	$5.440000 (4)	CCF	1/1/2014

(5) Peak rate
(6) Weighted average of on-peak and off-peak rates
(7) Rate 31
(8) Weighted average of winter and summer rates

3.4. FACILITY IMPROVEMENT MEASURES

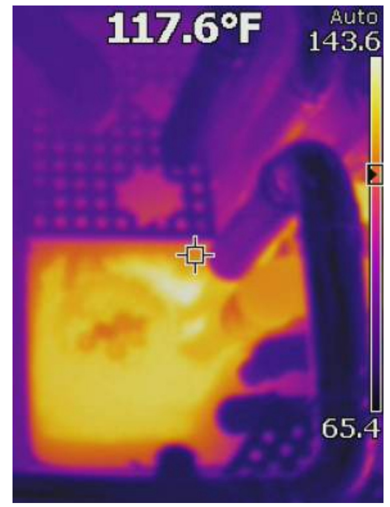
This section provides a one-page overview for each facility improvement measure for which cost and savings were approximated. At the end of the section is a list of additional measures that were not evaluated, though may be evaluated in the future. A summary of all the measures investigated as well as the impact they have on the 2030 targets is provided at the end of this section.

3. Opportunities

01.00 Condensate Heat Recovery

GENERAL DESCRIPTION

Once steam transfers its heat to a heat exchanger or heating coil, it changes into its liquid form of hot condensate. In most cases at VMMC, this hot condensate is piped to a condensate heat recovery unit so that additional heat can be recovered. In a few isolated cases, the hot condensate goes directly down the sewer without having any heat recovered. This measure involves eliminating those few remaining instances where heat is not currently recovered (fire pump room, ICU, and hot water tanks on 7th floor east wing roof garden).



KEY ASSUMPTIONS

Cost and savings potential is based on using a water-to-water heat exchanger to pre-heat cold domestic water, assuming a constant 0.5gpm flow and a 40 degree delta T. No pumping energy penalty is yet accounted for, though cost for a small pump is included.

NEXT STEPS

A full audit of all three spaces (fire pump room, ICU, and hot water tanks) will be required to accurately determine flow rate as well as the best location to pipe condensate to for each case. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is purely an energy saving measure with few non-energy benefits. There may actually be additional facilities staff impact as the new piping and pumps will need minor maintenance over time.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

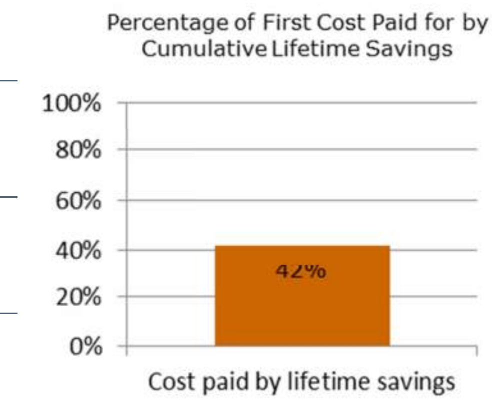
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

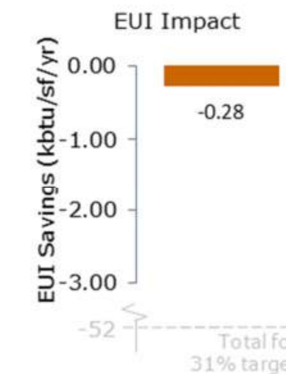
$214,100
First Cost

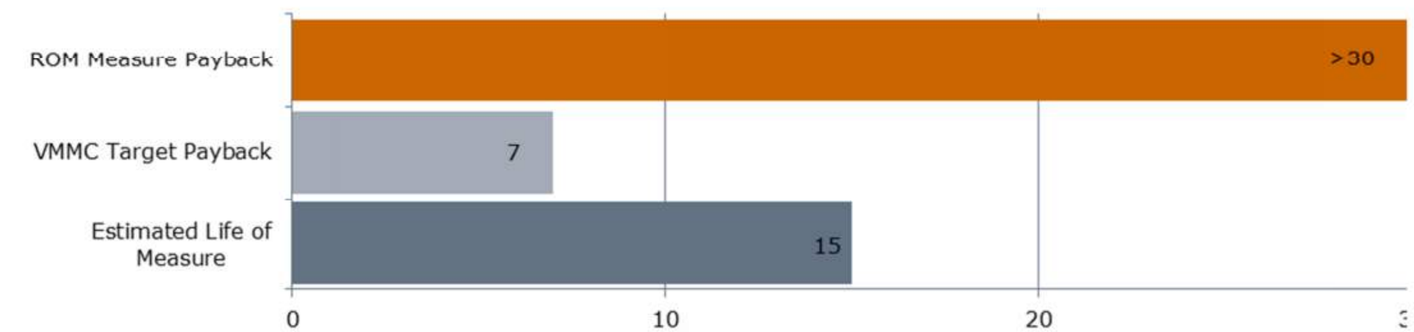
$5,900
Annual Utility Savings

200 klbs/yr steam

21 MT CO2e/yr
Carbon Dioxide

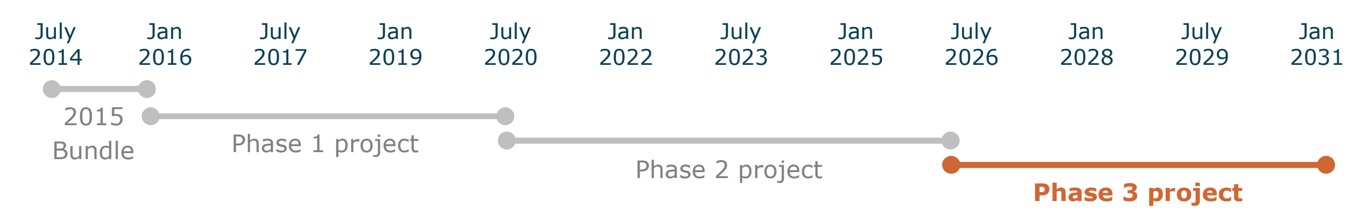






IMPLEMENTATION TIMING

Given that this measure does pay for itself over time, it is recommended that this measure be implemented as a Phase 3 project.



3. Opportunities

01.00 Lindeman Boiler to DHW Heat Exchanger

GENERAL DESCRIPTION

Lindeman Pavilion has three natural gas boilers for space heating, but the domestic hot water is still produced via Seattle Steam which has a much higher cost per BTU than natural gas. This measure will use the spare natural gas existing boiler capacity to produce domestic hot water (DHW). This will be accomplished by installing a heat exchanger between the heating water and DHW systems.

KEY ASSUMPTIONS

Cost and savings potential is based the existing purchased steam bills and assuming that 75% of this can be converted to natural gas.

NEXT STEPS

A directed engineering study will allow us to convert this rough cost, scope, and savings into guaranteed cost, scope, and savings. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This measure will impact patients and staff by adding additional redundancy to Lindeman's domestic hot water system. If a seismic event or other factor causes a steam outage, the gas boilers would not be affected and would be able to provide DHW for hand washing and other medical and non-medical uses.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

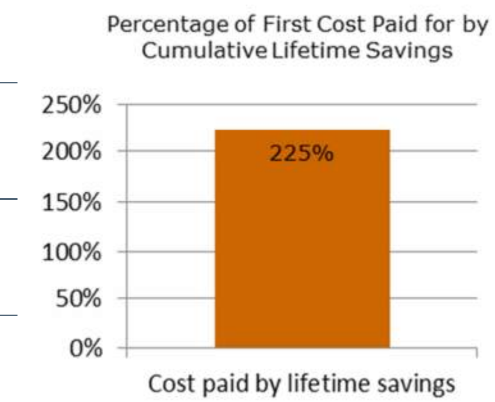
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

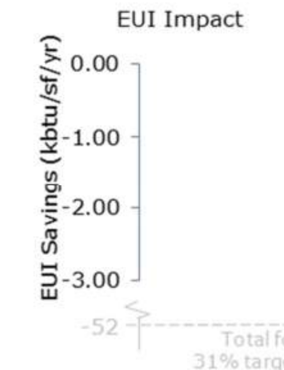
$78,600
First Cost

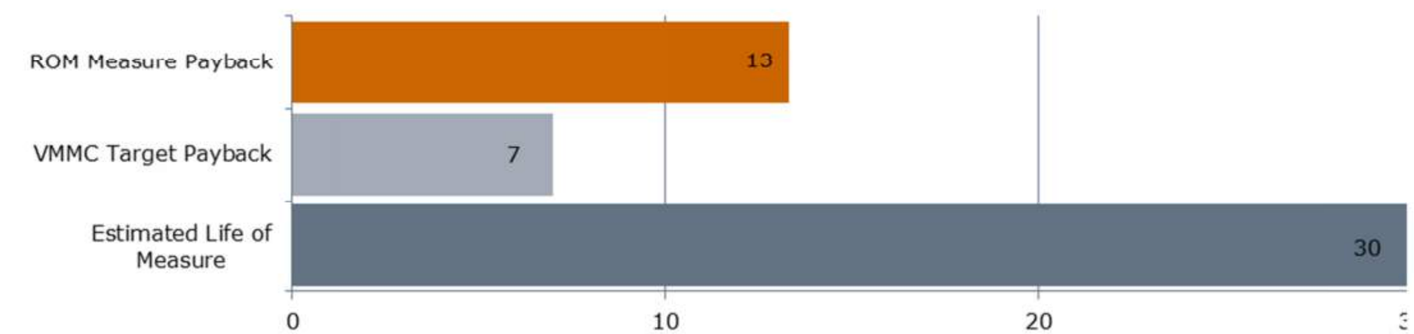
$5,900
Annual Utility Savings

500 klbs/yr steam
-5,500 therms/yr nat gas

11 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

It is recommended that this measure be implemented as part of the 2015 bundle.

3. Opportunities

01.00 Mechanical Insulation

GENERAL DESCRIPTION

Any piping that carries a fluid that is hotter or colder than the surrounding space will transfer energy to that space. At VMMC, the vast majority of all piping is well insulated; however some spots of uninsulated hot water and steam pipe for domestic hot water or space heating remain. Insulating this remaining piping will reduce unnecessary heat losses and reduce steam and natural gas use and annual operating cost.

KEY ASSUMPTIONS

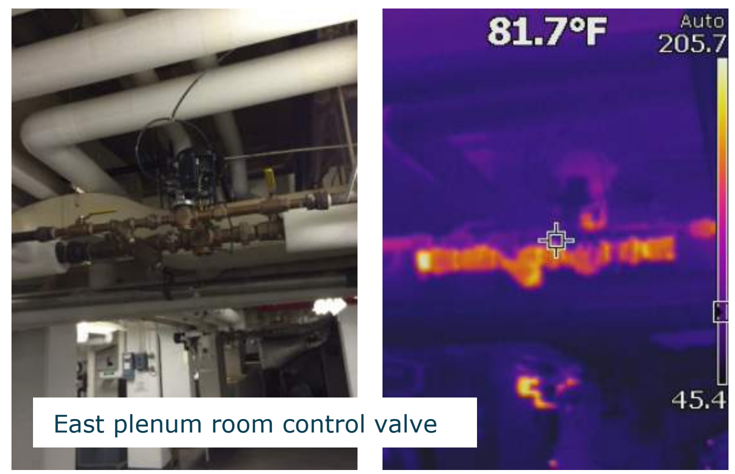
Cost and savings potential is based on insulating 90' each of steam, HW, and condensate pipe of varying diameters throughout the hospital.

NEXT STEPS

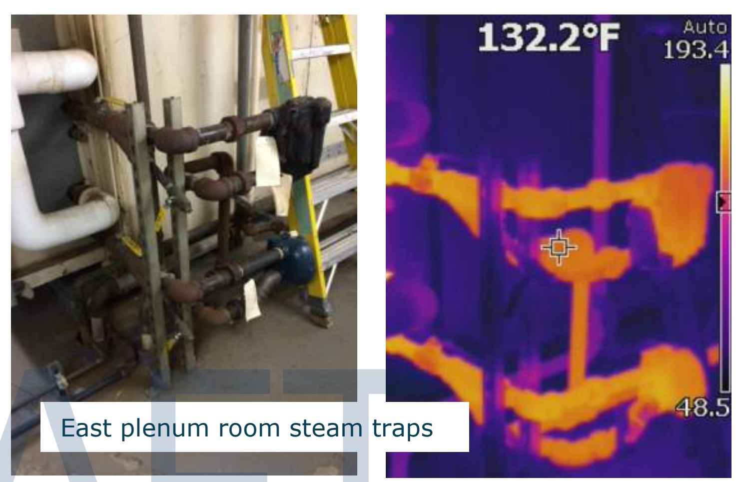
During the site walk, several areas for additional insulation were identified. An updated detailed audit will help identify the true remaining potential for this measure as some insulation work has been completed recently. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is purely an energy saving measure with few non-energy benefits.



East plenum room control valve



East plenum room steam traps

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

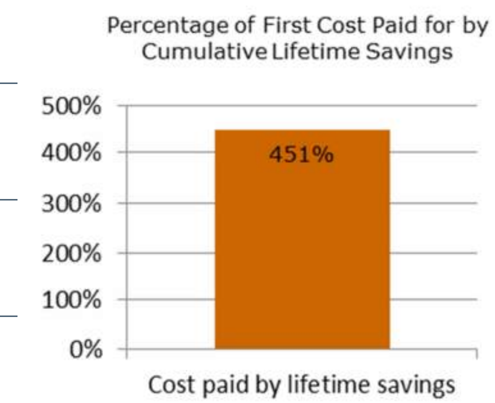
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

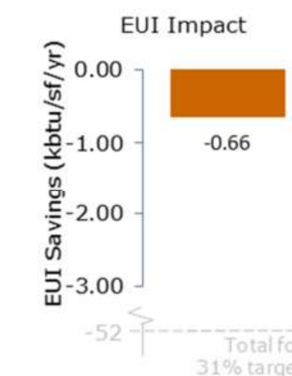
$61,100 First Cost

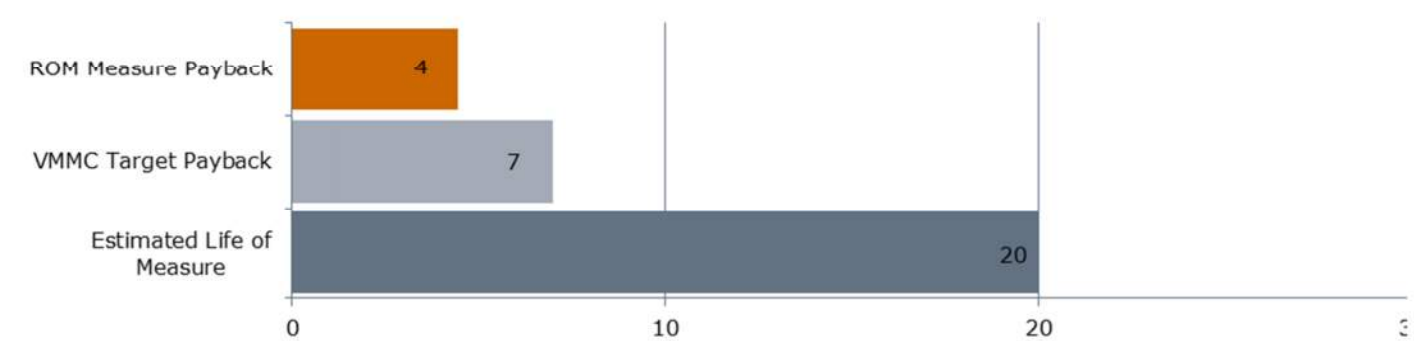
$13,800 Annual Utility Savings

600 klbs/yr steam

70 MT CO2e/yr Carbon Dioxide







IMPLEMENTATION TIMING

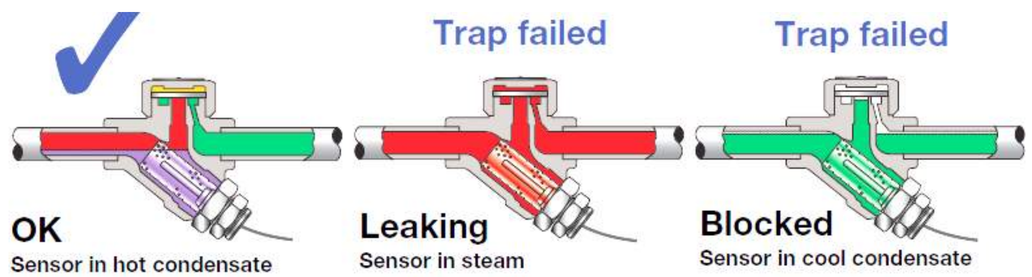
Given that this measure does pay for itself over time, it is recommended that this measure be implemented as part of the 2015 bundle.

3. Opportunities

01.00 Permanent Monitoring of Steam Traps

GENERAL DESCRIPTION

Properly operating steam traps open to remove condensate and noncondensable gases from a steam system, while limiting steam loss. Malfunctioning steam traps can operate improperly for years, wasting steam and money. The installation of permanent wireless steam trap monitors will identify issues immediately and save resources. Though it can be cost-prohibitive to monitor all traps in a facility, monitoring the largest traps can be beneficial.[2]



KEY ASSUMPTIONS

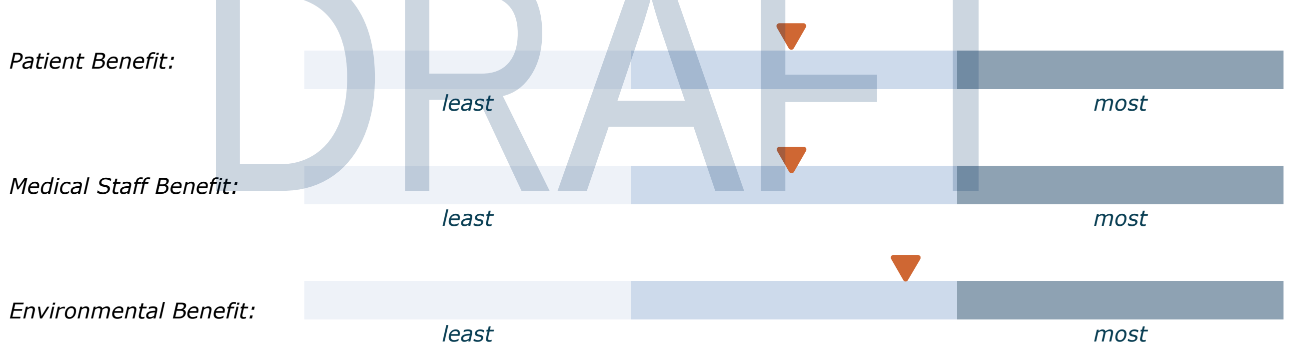
Costs are based on installing temperature sensors as well as continuous steam trap monitoring for the 75 largest traps within the hospital. Savings are based on a 10% failure rate and steam loss estimates from the US Department of Energy.

NEXT STEPS

Detailed review of the completed steam trap audit could help identify which steam traps are best suited for continuous monitoring. Costs and savings estimates can then be refined based on an updated quantity and actual trap orifice diameters. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is purely an energy saving measure with few non-energy benefits. There may be maintenance labor savings as traps need not be manually checked as frequently.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

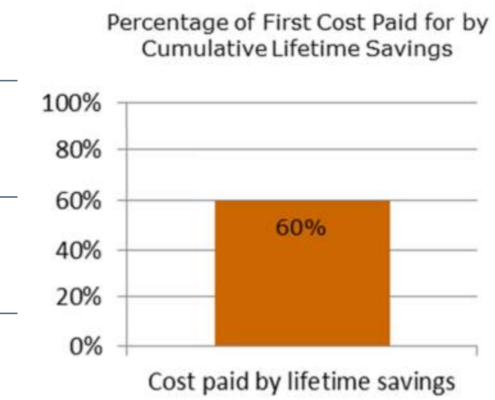
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

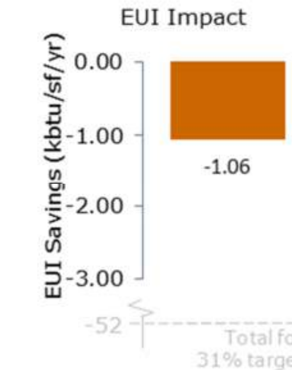
$562,000 First Cost

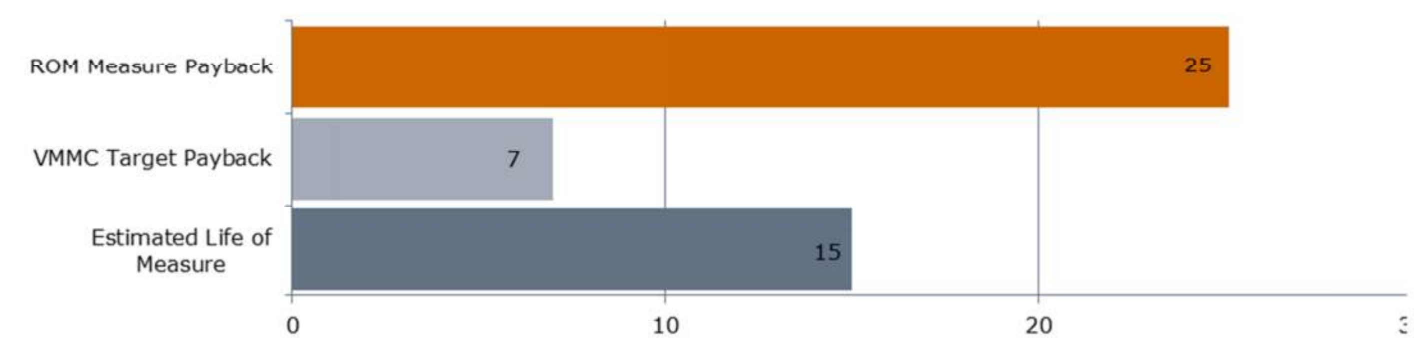
$22,400 Annual Utility Savings

900 klbs/yr steam

80 MT CO2e/yr Carbon Dioxide







IMPLEMENTATION TIMING

It is recommended that this measure be implemented as a phase 2 project.

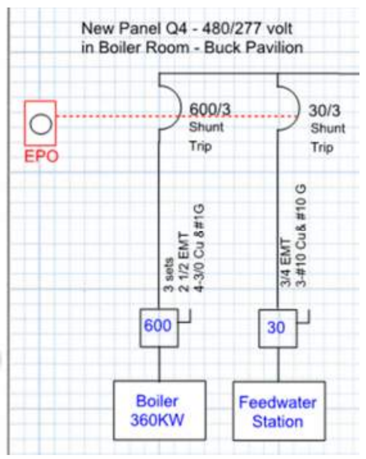
[2] Photo graphic from: http://www2.spiraxsarco.com/pdfs/SB/s34_01.pdf

3. Opportunities

01.00 Tier 1 Boiler Measure

GENERAL DESCRIPTION

There is currently no back-up to central sterile in the event of a steam outage caused by seismic or other events. This measure would provide an electric boiler on equipment branch stand-by power with back-up water to supply two concurrent sterilizers in the event of a steam outage.



KEY ASSUMPTIONS

The measure was developed to a "qualified ROM" level as part of a prior McKinstry study. The costs and savings are within +/- 10%.

NEXT STEPS

After budget approval, McKinstry would begin the design/permitting phase followed by construction, commissioning, and ongoing performance assurance.

NON-ENERGY MEASURE IMPACTS

All the benefits of this measure are non-energy. This measure is intended solely to improve redundancy and reliability for staff and patient benefit.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

$1,700,000
First Cost

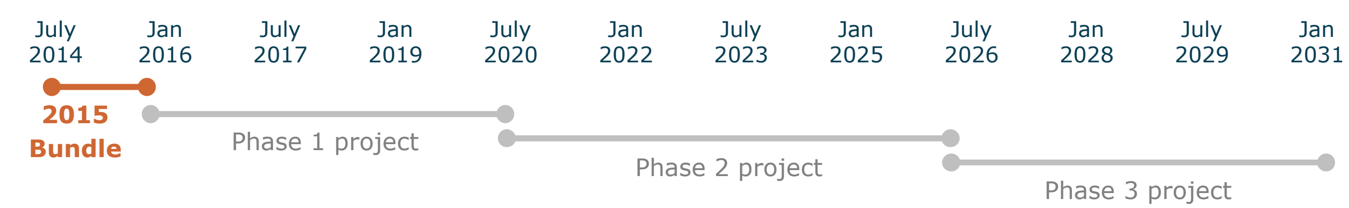
$0
Annual Utility Savings

0

0 MT CO_2e/yr
Carbon Dioxide

IMPLEMENTATION TIMING

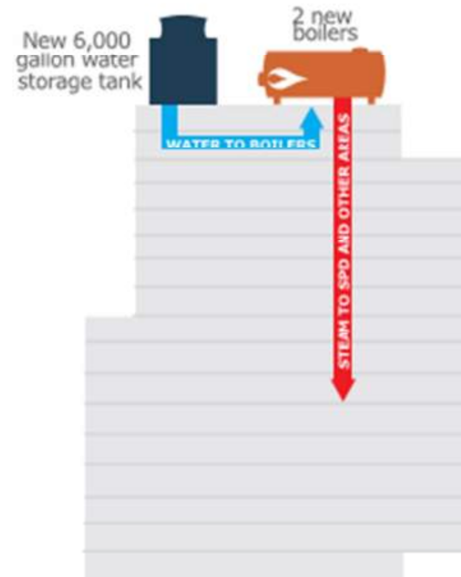
The implementation of this measure is yet to be determined by VMMC.



3. Opportunities

01.00 Tier 2 Boiler Measure

GENERAL DESCRIPTION



In the event of a purchased steam outage due to seismic or other events, all of VMMCs existing heating sources would be inoperable. This measure involves the installation of two new dual-fuel boilers along with water storage to ensure heating capabilities in the event of a failure. VMMC could choose to let the plant sit idle (as back-up only) or could choose to operate the plant to reduce cost, since natural cost has a significantly lower cost per BTU than purchased steam.

KEY ASSUMPTIONS

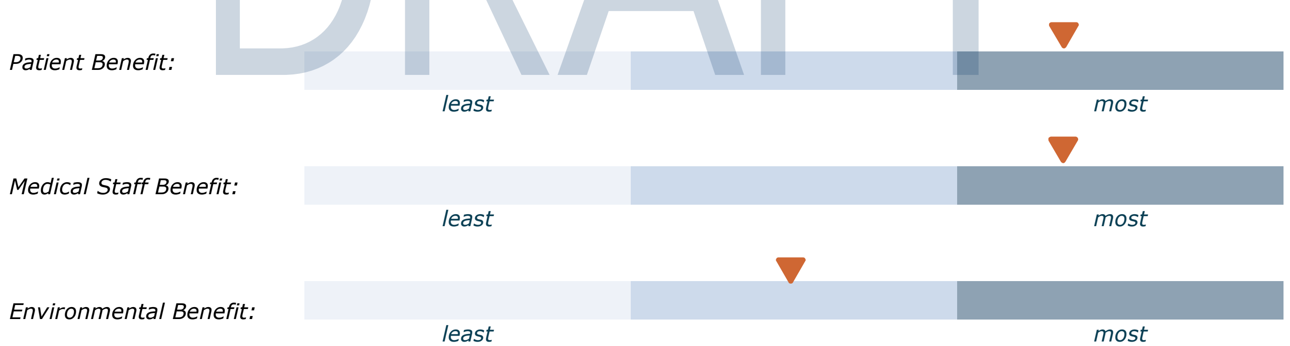
This measure was developed to a "qualified ROM" level as part of a prior McKinstry study. The costs and savings are within +/- 10%.

NEXT STEPS

After budget approval, McKinstry would begin the design/permitting phase followed by construction, commissioning, and ongoing performance assurance.

NON-ENERGY MEASURE IMPACTS

This measure would drastically reduce VMMC's risk of losing heating, sterilization, and domestic hot water to Jones and to a large portion of the central pavilion due seismic or other events.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

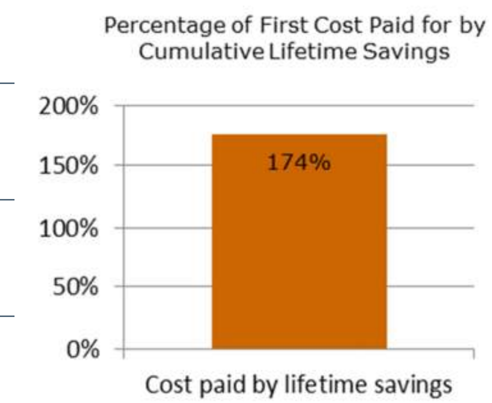
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

$4,500,000
First Cost

$261,500
Annual Utility Savings

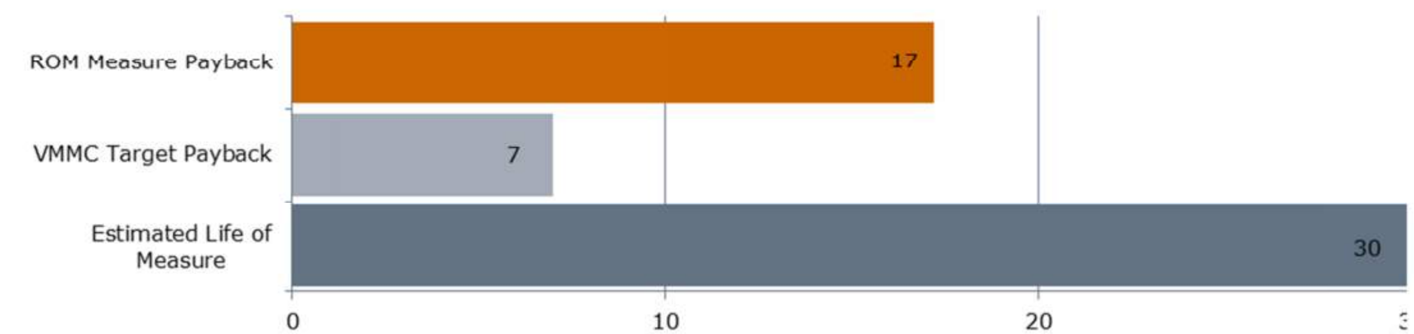
34,000 klbs/yr steam
-120,100 kWh/yr electric
-1,300 CCF/yr water/sewer
-573,700 therms/yr gas

526 MT CO_2e/yr
Carbon Dioxide



This measure has a LARGE NEGATIVE site EUI impact of 17 kBtu/sf/yr. This is due to the fact that the inefficiency of steam production is now done on site after the meter.

From a source energy perspective and a GHG perspective, this measure has positive impacts, but from a purely site EUI perspective (that taken by the 2030 District), this measure has very negative impacts.



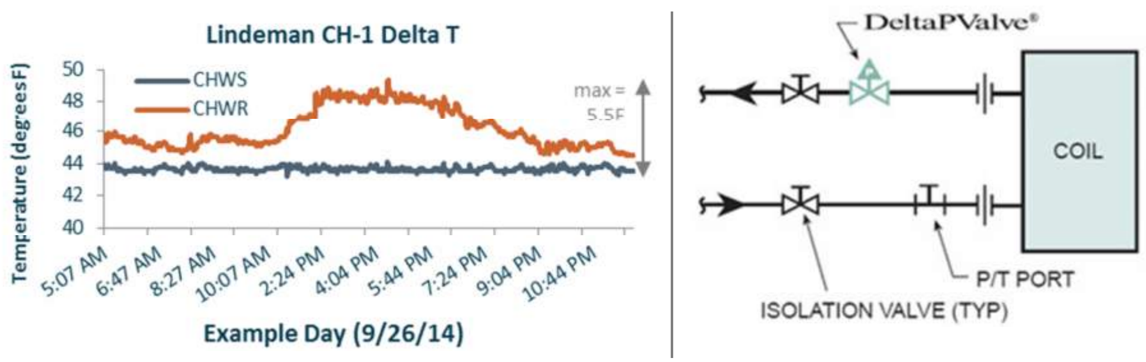
IMPLEMENTATION TIMING

The implementation of this measure is yet to be determined by VMMC.

3. Opportunities

01.00 Increase CHW Delta T

GENERAL DESCRIPTION



Given that the cooling BTUH delivered is proportional to the chilled water flow rate (GPM) as well as the temperature difference between the chilled water supply and chilled water return (delta T), if the delta T decreases, the GPM must increase to meet the same load. An increase in GPM causes an increase in pumping energy and can cause an additional chiller to come online when it is not needed (and operate at an inefficient point on its operating curve). This measure involves the installation of high-end pressure independent chilled water valves to increase and better manage the delta T between the chilled water supply and the chilled water return temp.[3]

KEY ASSUMPTIONS

Costs are based on the installation of (27) 2-way Delta P valves (one for each affected air handler). Savings are based on a 5-degree increase in CHW delta T for 1400 tons of cooling and a reduction in pumping energy.

NEXT STEPS

A full audit of all existing air handlers will determine an accurate quantity of valves for replacement. Additional trend data will help refine the savings calculations. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with few non-energy benefits.

[3] DeltaP graphic from: http://www.flowcontrol.com/whydeltap/firstcostsavings.aspx

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

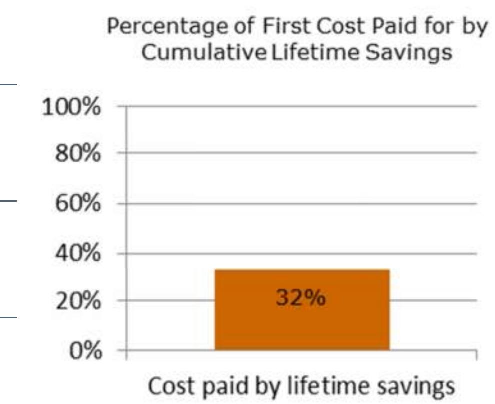
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

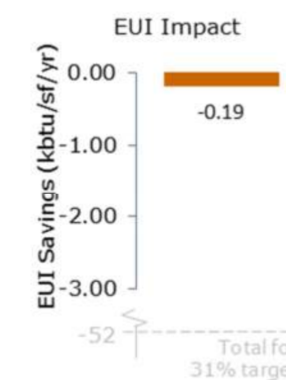
$326,600
First Cost

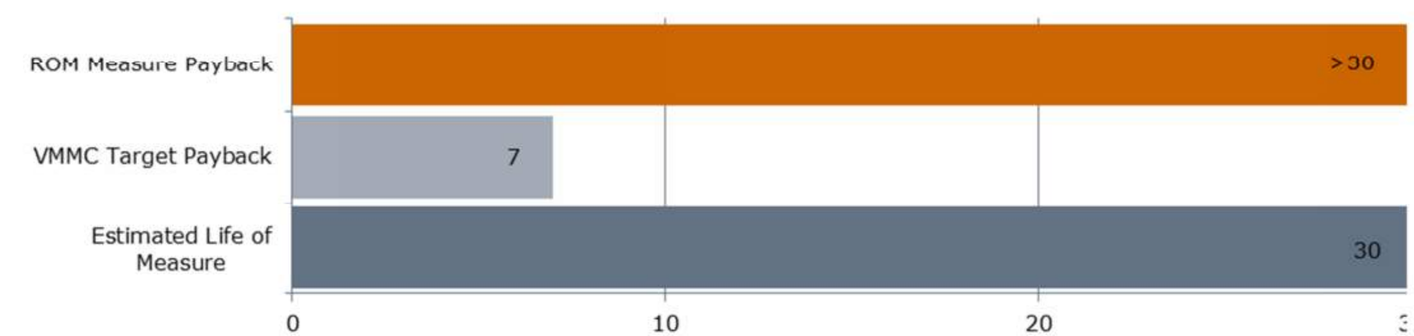
$3,500
Annual Utility Savings

56,900 kWh/yr electricity

22 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

Given the poor financial return for this measure, it is recommended that it only be implemented as a phase 3 project if additional energy savings are required to meet the 2030 target.

3. Opportunities

02.00 Heat Recovery Chiller

GENERAL DESCRIPTION

There are three existing chillers located on Buck Level 2 connected. Keep the existing CH-3 and add a 50 ton heat recovery chiller. Use the hot side to provide DHW heating (saves Seattle Steam) and heating water (saves Seattle Steam and natural Gas). Use the cold side to cool the year round condenser water loop and the main chilled water loop.

The sterilizers currently use city water cooling that consumes 15,000 gallons per day. This measure includes tying the sterilizers to the chilled water loop for closed loop cooling to eliminate this waste of city water.

KEY ASSUMPTIONS

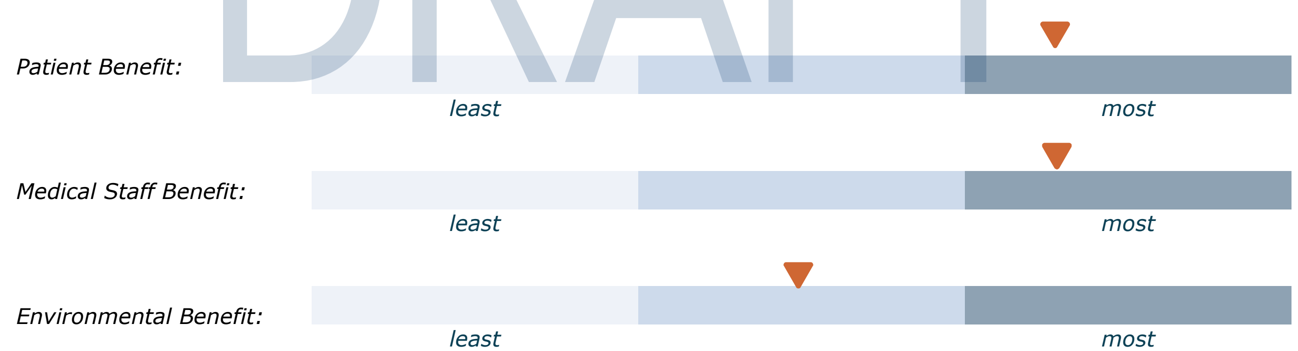
The loads are based on data logging and the cycles per day of sterilizer user were provided by VMMC staff. This measure was developed to a "qualified ROM" level as part of a prior McKinstry study. The costs and savings are within +/- 10%.

NEXT STEPS

After budget approval, McKinstry would begin the design/permitting phase followed by construction, commissioning, and ongoing performance assurance. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates. Initial rebates are based on a quote provided by SPU for water savings.

NON-ENERGY MEASURE IMPACTS

This measure will increase heating reliability in the event of a purchased steam outage. The sterilizer cooling will dramatically increase the time that any stored water or well water would last during a water outage since it reduces sterilizer water consumption down to nearly zero.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

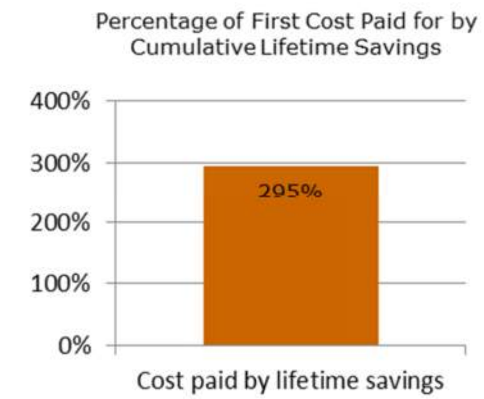
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

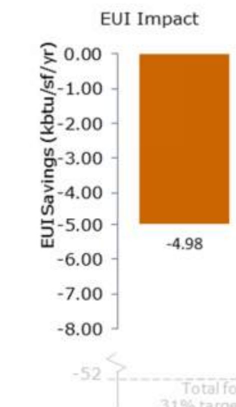
$1,100,000
First Cost

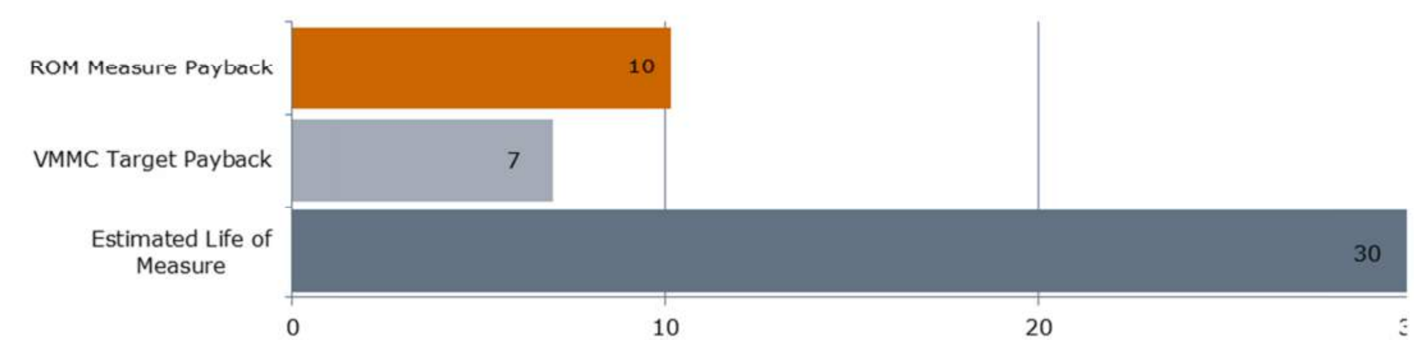
$96,900
Annual Utility Savings

4,300 klbs/yr steam
-354,200 kWh/yr electric
600 CCF/yr water/sewer
10,500 therms/yr gas

333 MT CO2e/yr
Carbon Dioxide

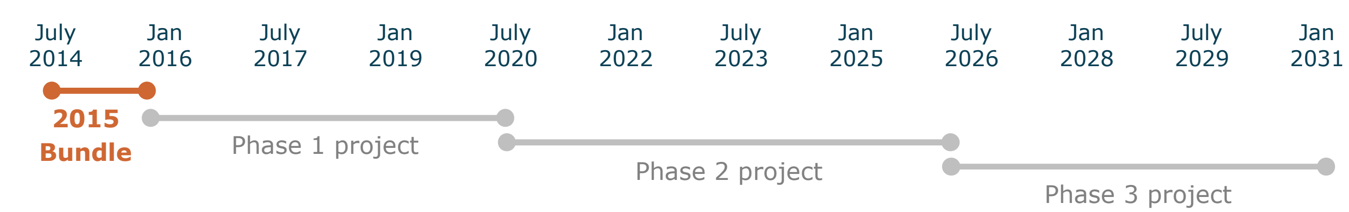






IMPLEMENTATION TIMING

Given the good financial returns and positive impact on medical staff and patients, it is recommended that this measure be implemented as soon as possible.



3. Opportunities

03.00 Convert CV Systems to VAV Systems

GENERAL DESCRIPTION

The majority of the air handling systems in the main hospital are constant volume systems operating 24x7. The air for these systems is cooled to a low temperature to satisfy potentially only one or two zones. The remainder of the air is then re-heated to satisfy all of the other zones with less cooling load. Retrofitting these systems to variable air volume systems will save significantly on fan energy and reheat energy. To accomplish this, VAV terminals need to be installed in each space. This will most cost-effectively be accomplished in concert with a planned TI.


Constant volume SF-1

KEY ASSUMPTIONS

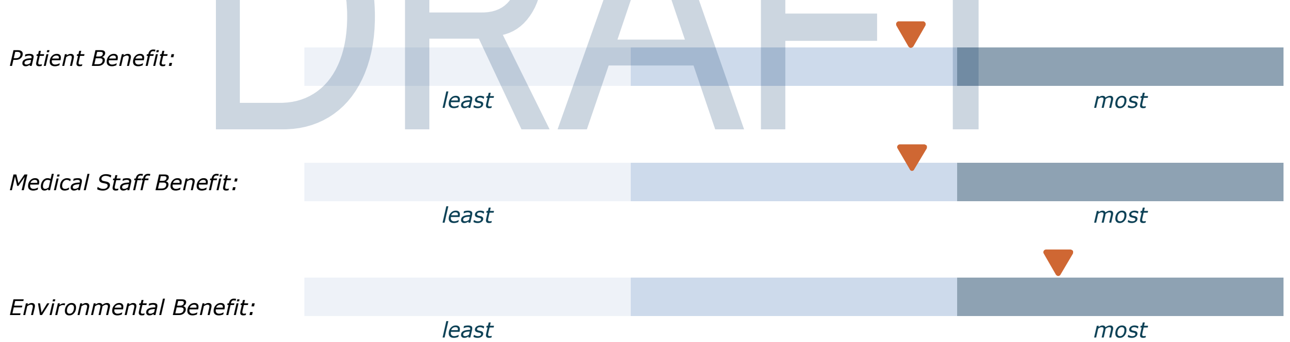
Costs are based on the installation of (250) new 10” VAV boxes with HW coils, adding VFDs to (10) air handlers, and replacing (10) fan motors. For pressure critical spaces, (100) phoenix valves are included for exhaust along with (10) new exhaust fan motors and VFDs. Energy savings are based on changing fan operation from constant volume to variable volume and reducing the minimum allowable airflow from 100% to 70%.

NEXT STEPS

A full audit of all remaining constant volume air handlers and associated zones will determine which remaining supply fans and exhaust fans can accommodate variable operation. Understanding planned TI’s will help identify the most cost-effective opportunities. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with minimal non-energy benefits. Patients and staff may experience an improvement in temperature control and comfort. Old, high maintenance fans will be replaced with new motors and controls that will have a small positive impact on facilities staff.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

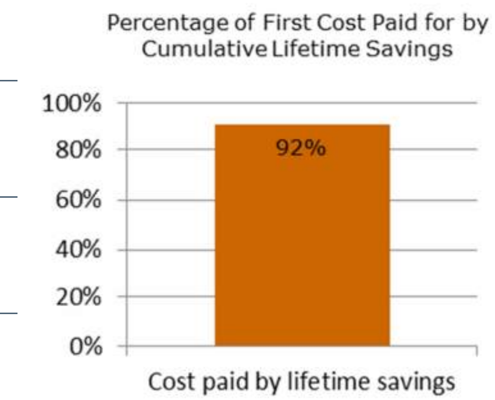
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

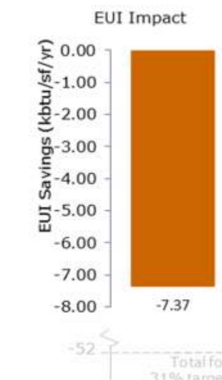
$4,834,800
First Cost

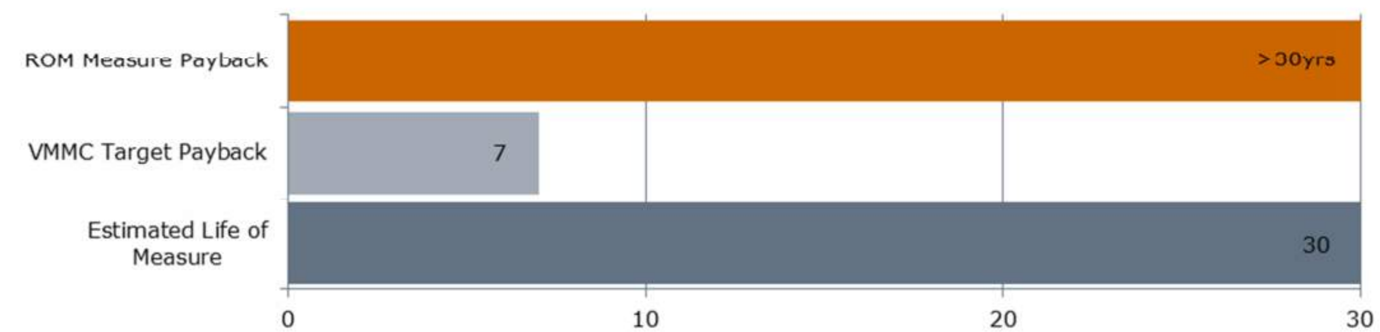
$147,600
Annual Utility Savings

4,100 klbs/yr steam
761,400 kWh/yr electric

651 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

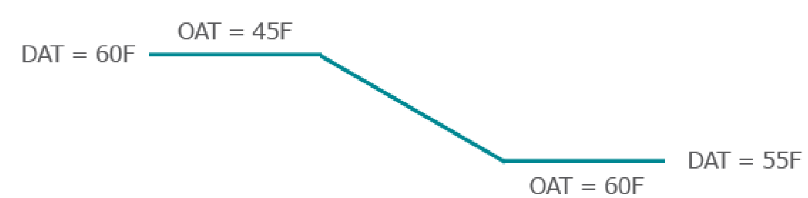
The cost and savings noted above assume a stand-alone implementation. With a planned TI or capital equipment upgrade (which will be required for some fans in the near future), the incremental cost to achieve the same savings will be much less than the full cost noted above. As such, this measure should be implemented in all three phases whenever an air handler is replaced.

3. Opportunities

03.00 Discharge Air Temp Reset

GENERAL DESCRIPTION

Implement a discharge air temperature (DAT) reset based on outside air temperature or zone demand using zone temp versus setpoint. When zone demand for cooling is low or OSA temperature is low, increase the discharge air temperature from the air handling unit to reduce the amount of zone reheat that occurs. Note this only applies to air handlers that are equipped with heat recovery or return air capability.



KEY ASSUMPTIONS

Cost is based on implementation of a discharge air temperature reset sequence at (5) air handlers. Savings are based on an affected airflow of 100,000cfm.

NEXT STEPS

A more detailed audit will help identify which specific air handlers could benefit from a discharge air temperature reset sequence. Costs and savings can then be refined. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is purely an energy saving measure with no non-energy benefits.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

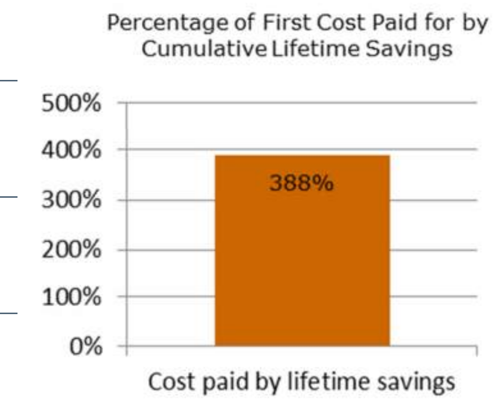
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

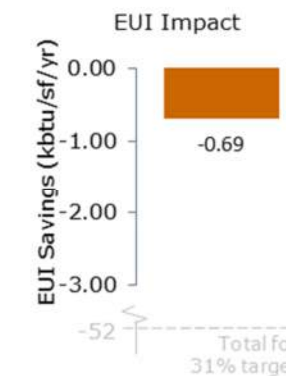
$55,700 First Cost

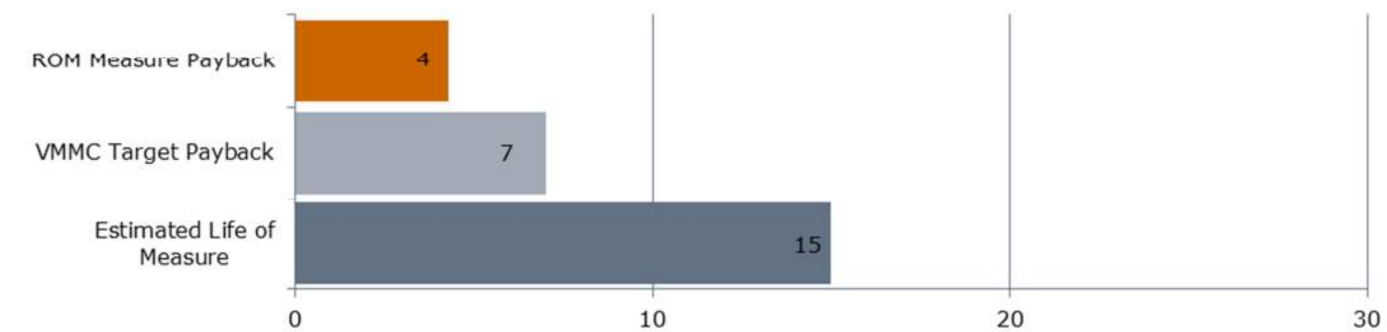
$14,400 Annual Utility Savings

500 klbs/yr steam
18,700 kWh/yr electric

54 MT CO2e/yr Carbon Dioxide

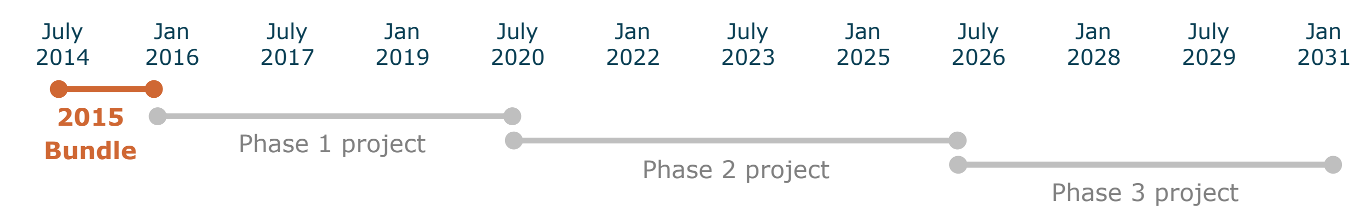






IMPLEMENTATION TIMING

Given the good financial return for this measure, it is recommended that this measure be implemented as soon as possible.



3. Opportunities

03.00 Destratification Fans

GENERAL DESCRIPTION

In spaces with tall ceilings, the air can stratify, pooling all the warm air at the ceiling instead of near the floor where occupants are located. Because the thermostat only senses the temperature 4-5' above the floor, additional heat is provided to ensure a comfortable temperature at occupant level while very warm temperatures are achieved above occupant level. This measure involves installing destratification ceiling fans in the lobby atrium area in the main entrance to help move warm air from the ceiling to the floor level. Because mixing the air decreases the temperature at the ceiling, it also decreases heat loss through the upper windows and walls.[4]

KEY ASSUMPTIONS

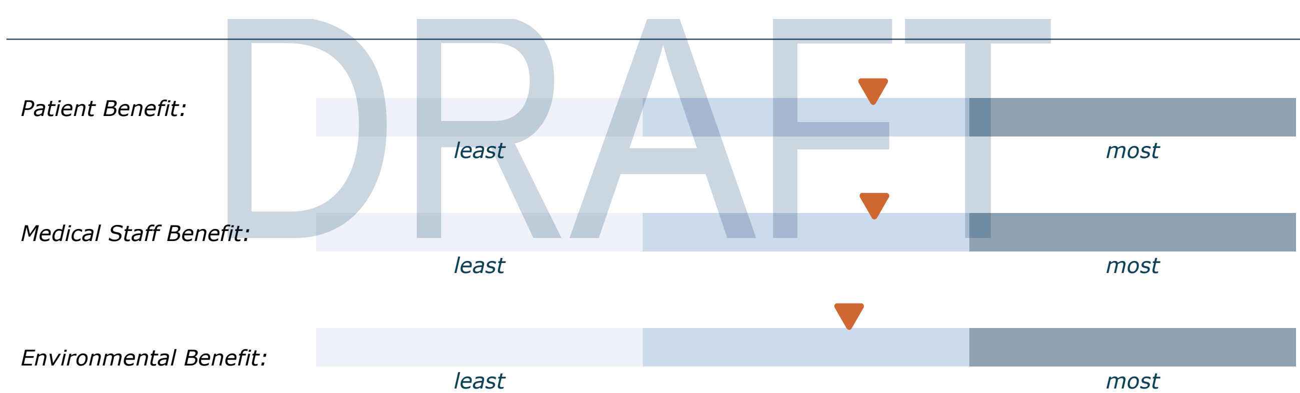
Cost is based on the installed of (4) thermal equalizer fans including motors, controls, and mounting hardware. Savings are based on a reduction in heat transfer from the lobby to the outdoors as the average room temperature is decreased during the heating season.

NEXT STEPS

Temperature loggers should be deployed to determine how much stratification is occurring. Additionally, the best model of destratification fan should be identified (suspending, in ceiling tile, etc.). Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

If the space is unable to be heated properly due to stratification, this measure can improve occupant comfort. Else it is mostly for energy saving purposes. The new equipment will also require maintenance and monitoring over time.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

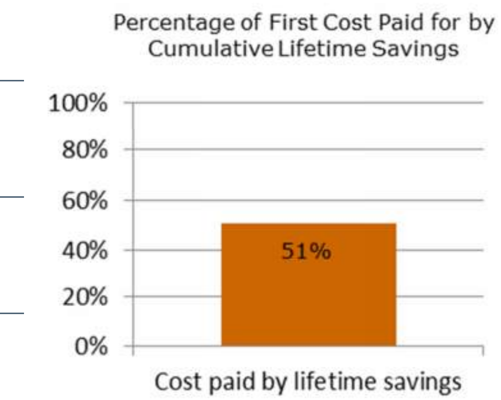
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

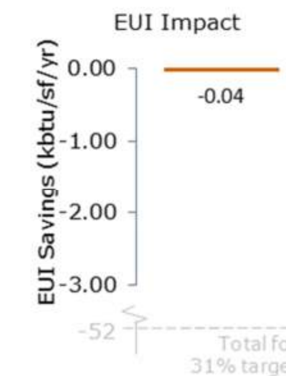
$50,200
First Cost

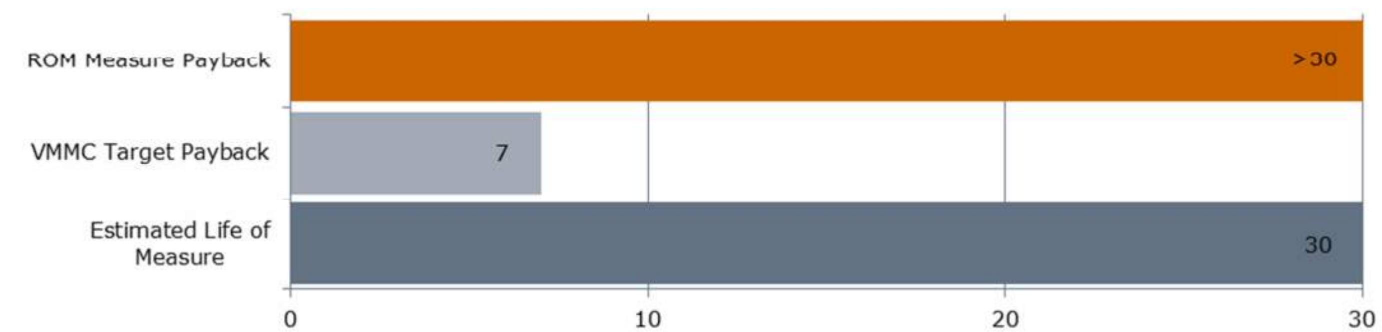
$800
Annual Utility Savings

40 klbs/yr steam
-1,200 kWh/yr electric

3 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

Given the poor financial return for this measure, it is recommended that it only be implemented as a phase 3 project if additional energy savings are required to meet the 2030 target.

[4] Image from: http://www.theairpear.com/suspendedceilingkit.html

3. Opportunities

03.00 Install Fan Wall

GENERAL DESCRIPTION

Fan walls consist of multiple small fans stacked adjacent to each other to create an array. Fan walls can be a better choice than one large fan in cases where redundancy, installation space, noise, vibration, and energy efficiency are important. This measure involves providing fan arrays to replace existing supply fans and providing for VFDs on existing exhaust fans. This retrofit has already been completed on SF-2 at VMMC in the Terry Avenue mechanical room. The new fan arrays will drive energy savings through increased fan efficiency and reduced airflow during low occupancy periods. The fan arrays will also provide for redundancy should a fan motor fail.

McKinstry Harrison Hospital retrofit with existing fan running during construction to avoid downtime.

KEY ASSUMPTIONS

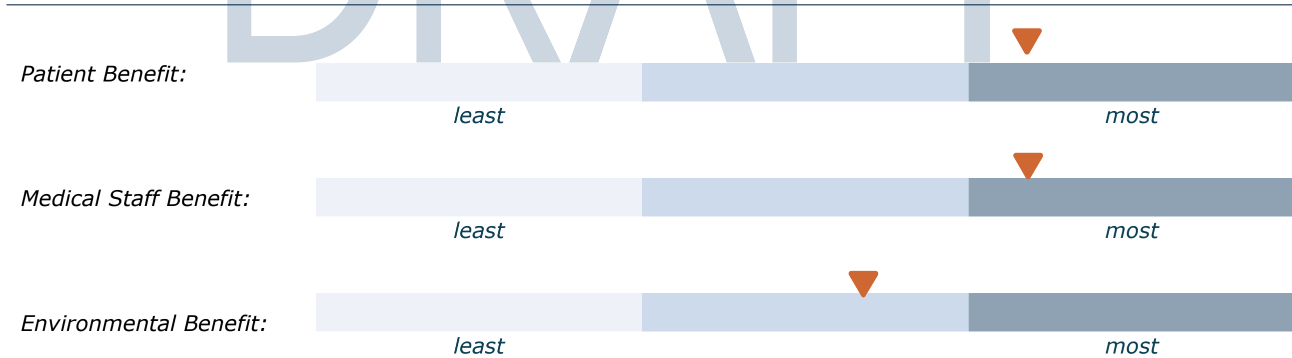
The cost approximation for this measure is based on the installation of (6) fanwalls. The stated cost also includes the replacement of cooling and steam coils. Savings are based only on an increase in fan efficiency, as turndown, VAV, and static pressure adjustments are accounted for in other measures.

NEXT STEPS

A detailed discussion with the facilities leadership regarding existing air handlers will determine which air handlers are suited for fanwalls and what is the best order for implementation. Cost and savings can then be refined based on supply fan selection. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure though provides important non-energy benefits including equipment redundancy, noise reduction, and reduced maintenance from replacing aged equipment.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

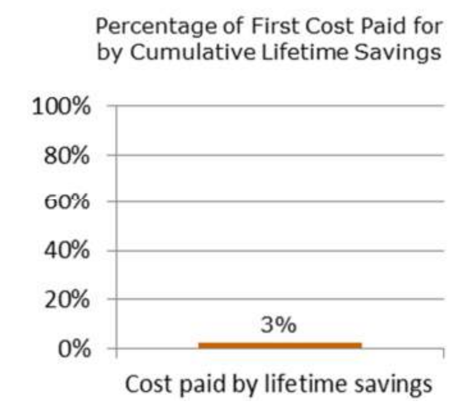
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

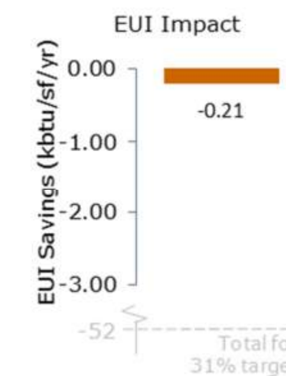
$4,814,600 First Cost

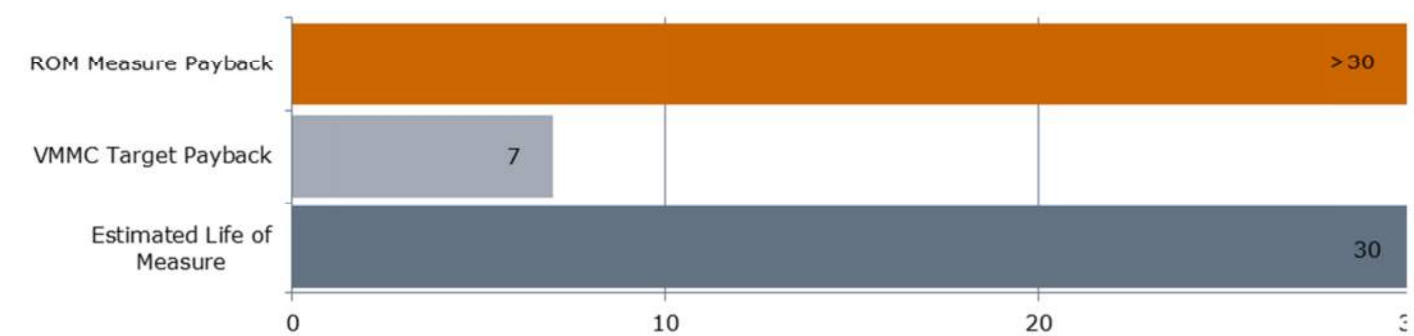
$3,900 Annual Utility Savings

63,500 kWh/yr electric

24 MT CO2e/yr Carbon Dioxide







IMPLEMENTATION TIMING

This measure is best implemented when a supply fan is up for replacement. It should be considered throughout all phases when the opportunity arises due to non-energy reasons.

3. Opportunities

03.00 Kitchen Hoods

GENERAL DESCRIPTION

This measure includes two components: 1) Schedule kitchen make-up air unit and kitchen exhaust fans off at night, and 2) Install VFDs on main kitchen exhaust fan and make-up air unit. The installation of VFDs will allow for variable speed operation of the make-up air unit and exhaust fans depending on the intensity of cooking and the associated sensed exhaust temp or specific pollutants. This measure will provide gas energy savings by lowering the amount of makeup air to the space that needs to be conditioned, as well as provide electrical energy savings by lowering the amount of fan energy that is used by the kitchen make-up air and exhaust systems.[5]

Note: The red line represents an infrared beam that detects smoke and vapors inside the hood, increasing the fan speed to 100% only when necessary.

KEY ASSUMPTIONS

Cost is based on connecting (3) exhaust and (3) make-up air units to the Alerton control system for nighttime scheduling as well as installing VFDs on each exhaust fan and make-up air unit with the Melink Intellihood sensors. Savings are based on a reduction in operating hours and variable speed fan operation.

NEXT STEPS

A detailed audit of kitchen exhaust and make-up air equipment will help refine the scope for this measure. Savings can be updated based on actual unit size and fan power measurements. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This energy saving measure has benefits for staff who can work in a quieter environment without fans running full speed all day long.

[5] Photo from: http://www.melinkcorp.com/pdf/Intelli-Hood/062014_Melink%20Intelli-Hood%20Next%20Generation%20Brochure.pdf

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

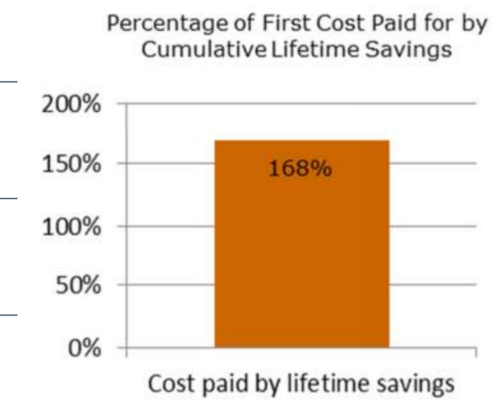
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

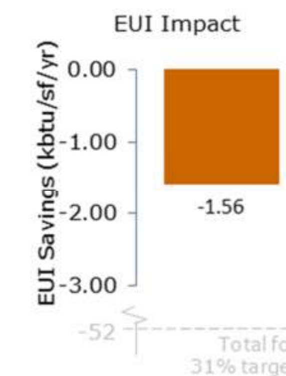
$160,400
First Cost

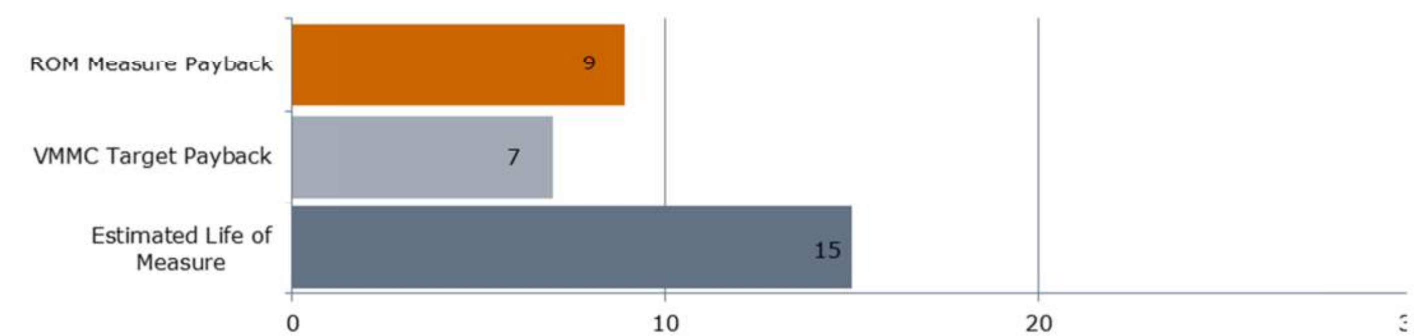
$18,000
Annual Utility Savings

97,200 kWh/yr electric
12,500 therms/yr gas

104 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

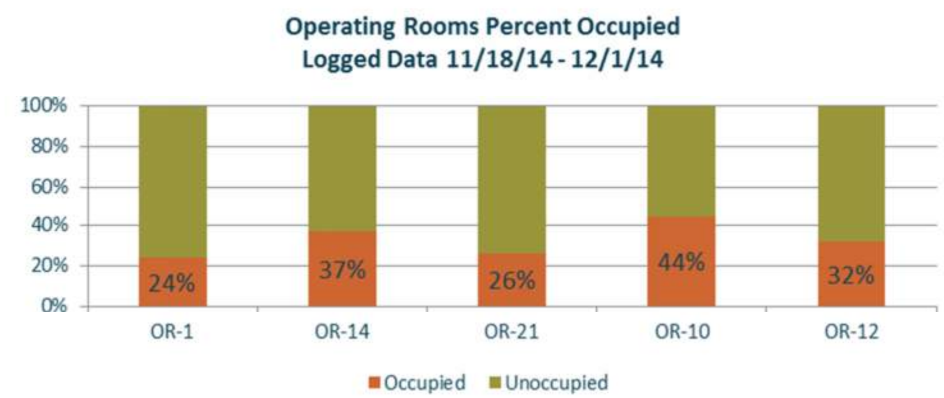
Given the good financial returns and positive impact on staff, it is recommended that this measure be implemented as soon as possible.

3. Opportunities

03.00 Operating Room Air Setback

GENERAL DESCRIPTION

An air setback reduces the amount of air supplied to an operating room when it is unoccupied, potentially also allowing temperature or humidity setpoints to vary from occupied conditions. This saves both fan energy and cooling and heating energy. Code requires a minimum air change rate (ACH) of 20 ACH total and 4 ACH of outdoor air when occupied. During unoccupied periods, the ACH will be reduced to 4 ACH. Setback strategies require that the pressure relationship to adjacent spaces is maintained. Exhaust boxes may also be required if not already installed.



KEY ASSUMPTIONS

Cost is based on providing (20) Phoenix exhaust boxes and (20) Phoenix supply boxes at 1700cfm each for the main hospital ORs. For Jones and Lindeman, costs are based on changing ACH setpoints. Energy savings are based 8hrs per day of unoccupied operation at 4ACH. VMMC engineering placed data loggers provided by McKinstry, and the results are shown above.

NEXT STEPS

A review of the proposal by the environmental health and safety team should be completed to allow for discussion of the proposed ACH setpoints. Costs and savings should be updated based on actual box counts and CFM values. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with few non-energy benefits.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

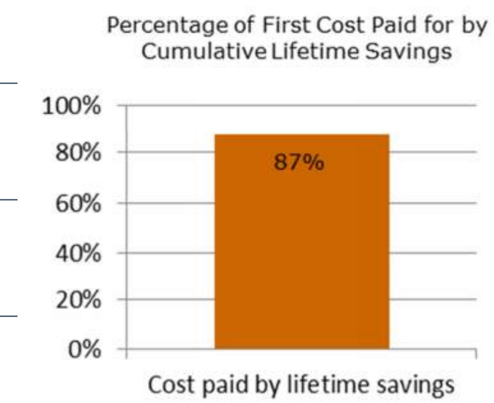
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

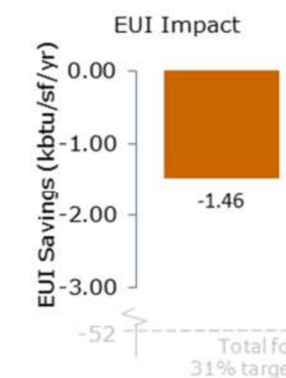
$516,700
First Cost

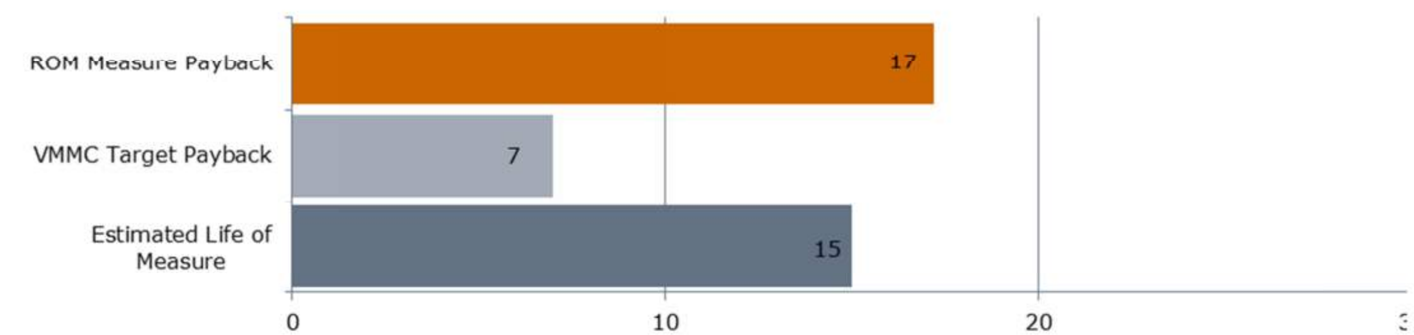
$30,100
Annual Utility Savings

1000 klbs/yr steam
66,900 kWh/yr electric

118 MT CO2e/yr
Carbon Dioxide







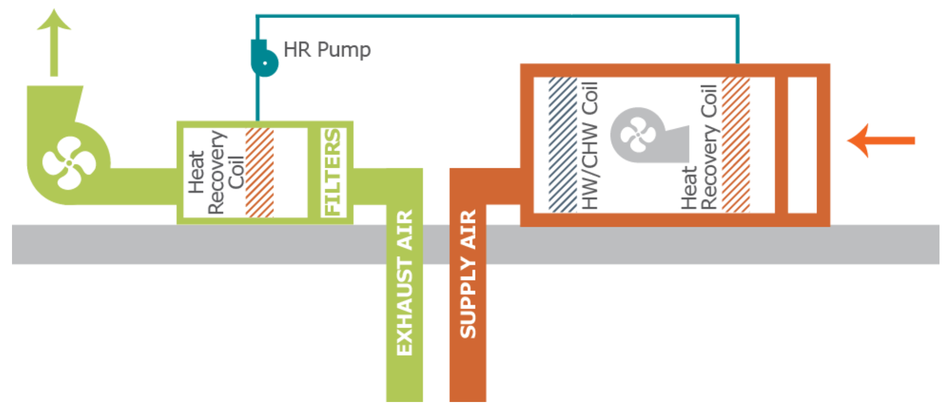
IMPLEMENTATION TIMING

Given the reasonable return on this measure, it merits greater investigation and possible implementation in Phase 2. Areas that don't require new supply or exhaust boxes should be implemented earlier.

03.00 Run-around Heat Recovery

GENERAL DESCRIPTION

Recovering heat from exhaust air streams to pre-heat outside air can be very cost-effective especially in situations where the supply air is 100% outside air (as is the case with most of the VMMC air handlers). Thus, where not already installed, provide for a heat recovery coil in exhaust air streams to recover heat. Use this heat in a run-around coil to pre-heat incoming outside air for supply fans. A small pump is required to pump the heat recovery fluid from the exhaust stream to the supply stream.



KEY ASSUMPTIONS

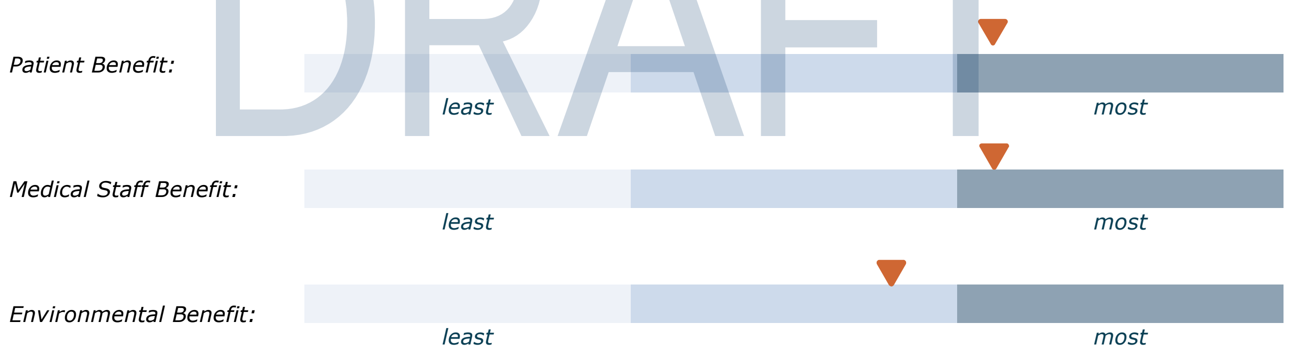
Cost and savings potential is based on recovering heat from (6) ~25,000cfm exhaust coils and supplying to (6) ~25,000cfm air handlers. A pumping penalty is included in the savings.

NEXT STEPS

A full audit of all existing air handlers will determine which remaining supply fans and exhaust fans can accommodate heat recovery coils. Quantities and CFM estimates can then be refined for more accurate cost estimates and savings calculations. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

Patient and staff impact would be positive since the heat recovery would provide some tempering even during a steam outage.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

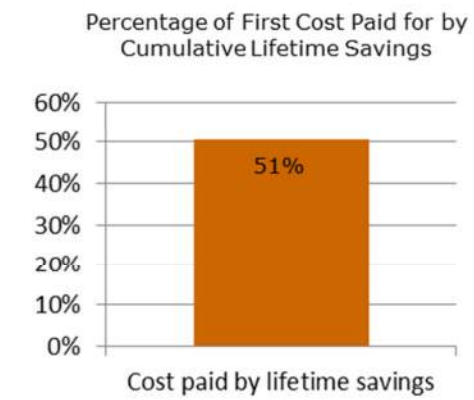
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

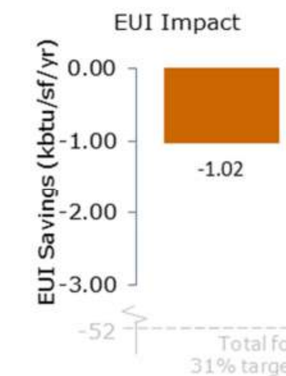
$1,267,900
First Cost

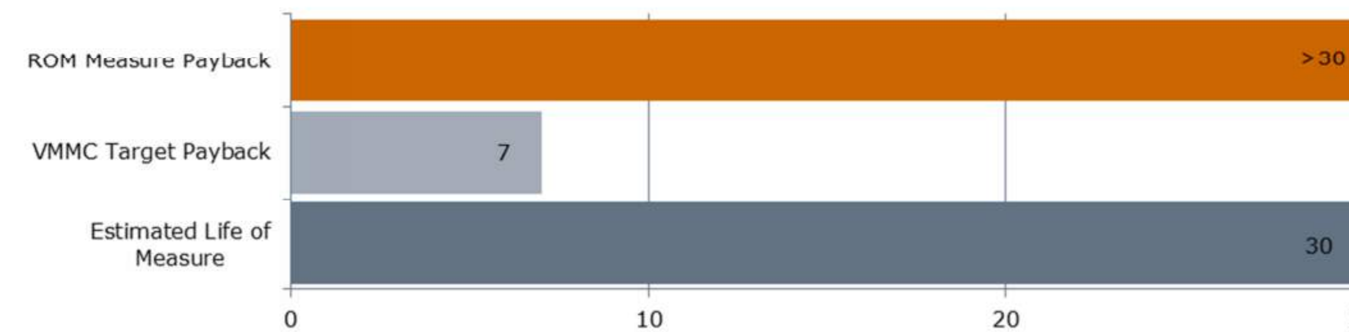
$21,400
Annual Utility Savings

900 klbs/yr steam
3,600 kWh/yr electric

77 MT CO_2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

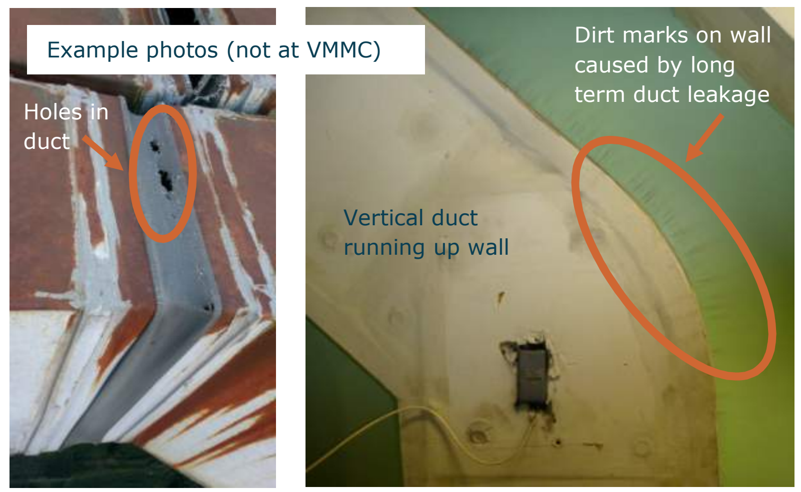
Given the poor financial return for this measure, it is recommended that it only be implemented as a phase 3 project if additional energy savings are required to meet the 2030 target.

3. Opportunities

03.00 Seal Air Ducts

GENERAL DESCRIPTION

Air leakage in ductwork causes air not to reach its destination, thus supply fans must run harder to supply more air and to maintain static pressure set points. Sealing leaky ductwork reduces fan energy use and increases comfort by helping to deliver the desired amount of conditioned air to each space. This measure involves sealing leaky ducts to minimize air leakage.



KEY ASSUMPTIONS

Cost and savings potential is based on sealing ductwork carrying 100,00cfm with a 5% leakage rate.

NEXT STEPS

Discussions with maintenance staff will help identify key areas of the hospital to investigate. A full audit and measurement of airflow from the supply fan compared to that at terminal units will help solidify the magnitude of leakage that is occurring and will impact pricing and savings. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

If leakage is causing a lack of airflow to certain spaces, sealing ducts can improve comfort.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

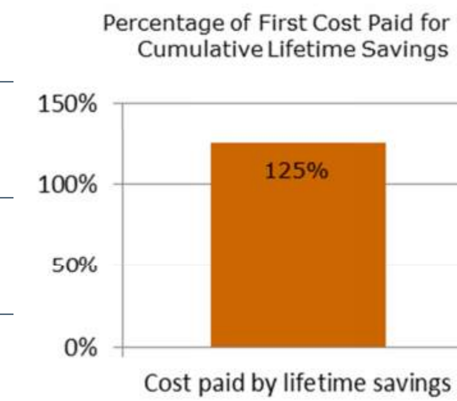
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

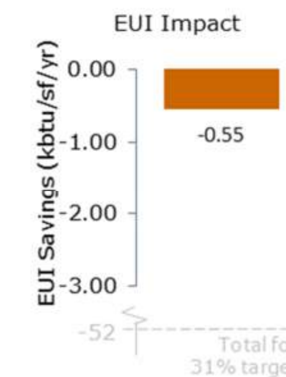
$179,400
First Cost

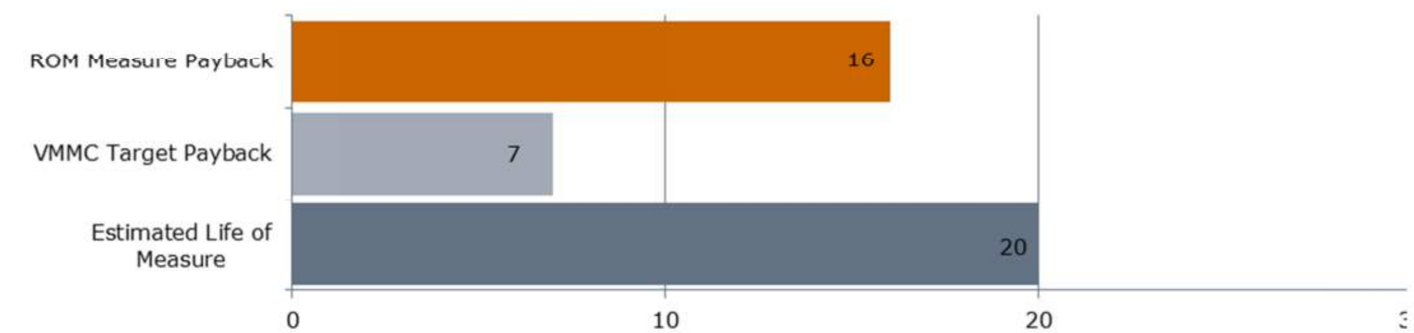
$11,200
Annual Utility Savings

400 klbs/yr steam
33,900 kWh/yr electric

45 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

Given the good financial returns, it is recommended that this measure be implemented as a Phase 2 project.

3. Opportunities

04.00 Air Change Reduction via Rebalancing

GENERAL DESCRIPTION

It is possible that some zones within the hospital are getting more airflow than what is required per ASHRAE 170 or the cooling load (whichever is greater). By re-calculating the required flow for each area and comparing that to the actual measured airflow, the rebalancing potential can be determined. For this measure, it is assumed that there is a rebalancing opportunity across many zones at the hospital.

KEY ASSUMPTIONS

Cost estimating is based on rebalancing across (20) air handlers and (200) VAV boxes totaling 250,000CFM. Energy savings are based upon a 5% reduction in airflow across all investigated areas.

NEXT STEPS

Detailed calculations based on VMMC touring plans will establish the design values for each area. Pre-TAB measurements at every diffuser will estimated the baseline condition. For areas that have more flow than required, boxes can be rebalanced. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with minor comfort benefits for zones that are perpetually overcooled or overheated.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

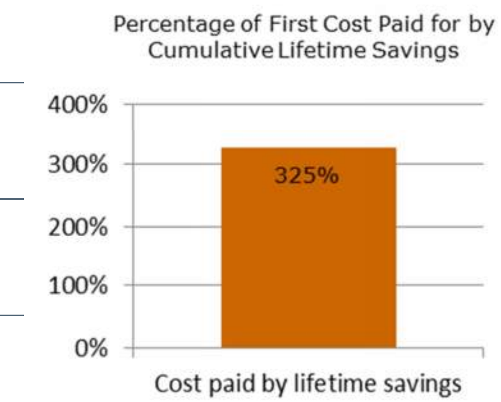
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

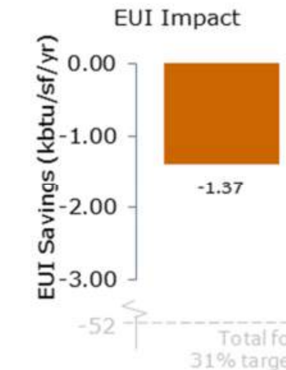
$129,100
First Cost

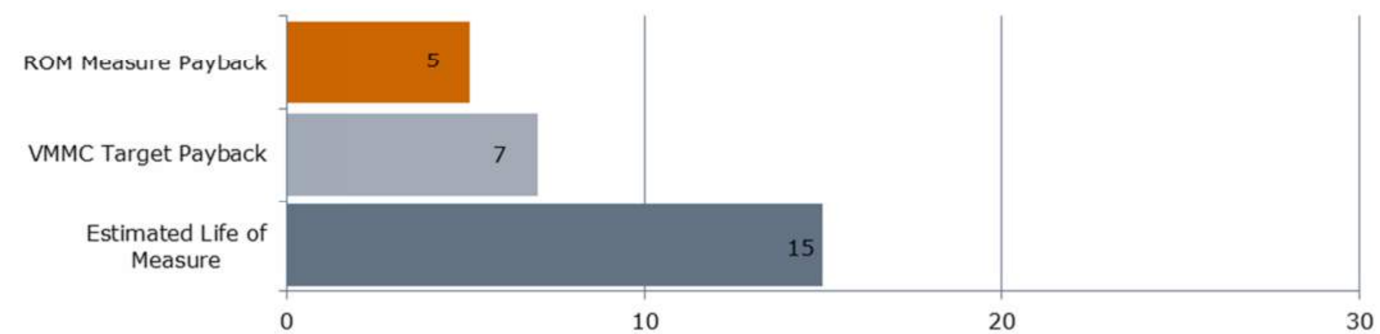
$28,000
Annual Utility Savings

900 klbs/yr steam
84,800 kWh/yr electric

114 MT CO_2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

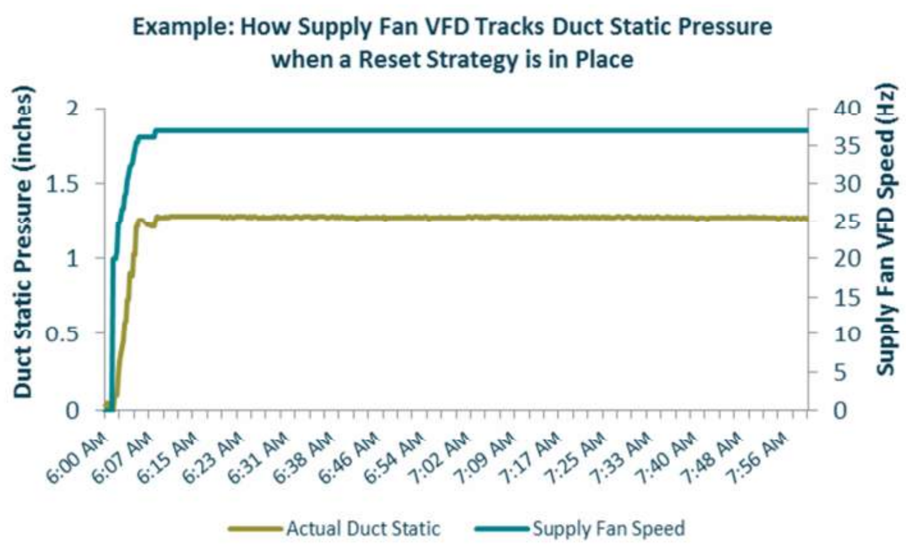
Given the good financial returns and potential positive impact on occupant comfort, it is recommended that this measure be implemented as soon as possible.

3. Opportunities

04.00 Duct Static Pressure Reset

GENERAL DESCRIPTION

During low load heating or cooling conditions, the goal is to keep terminal boxes open to reduce static pressure while lowering the supply fan speed. Without a duct static pressure reset in place, this cannot be achieved. Instead, the boxes start to shut, increasing static pressure and causing the fan to work the same or harder. This measure involves implementing a duct static pressure reset strategy to allow for fans to slow under low load conditions.



KEY ASSUMPTIONS

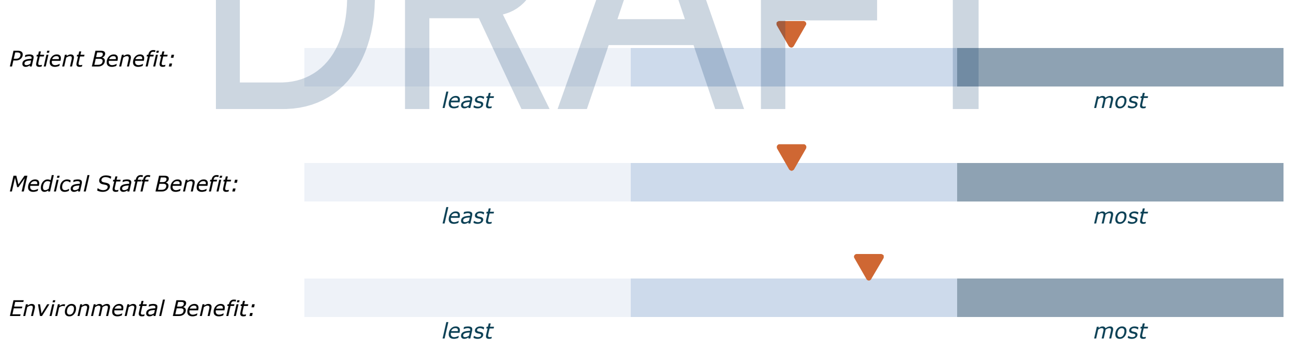
Cost and savings potential is based on implementing a duct static pressure reset reduction programming strategy that affects 50,000cfm. A one-inch reduction in static pressure is assumed.

NEXT STEPS

A full audit will help determine where duct static pressure reset could be implemented without capital upgrades. Savings and costs will then be updated. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is purely an energy saving measure with few non-energy benefits.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

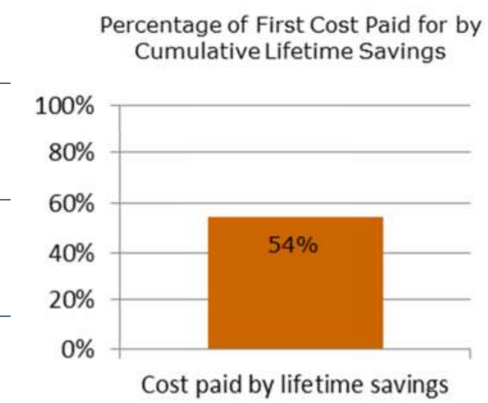
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

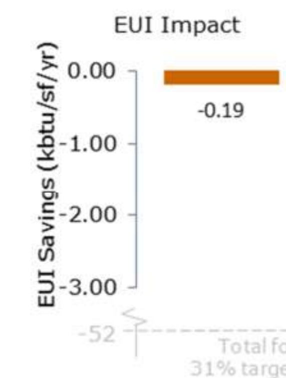
$97,900
First Cost

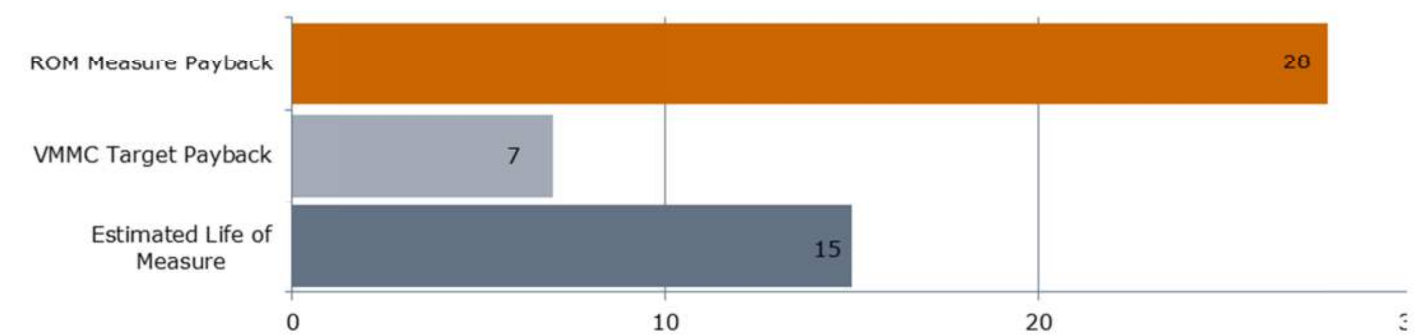
$3,500
Annual Utility Savings

57,400 kWh/yr electric

22 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

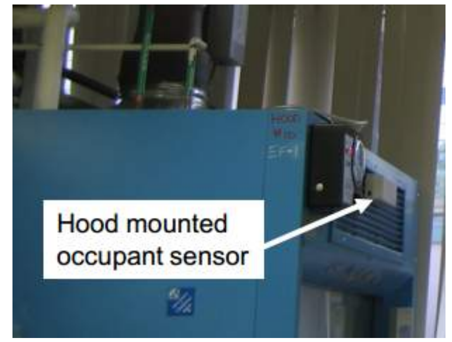
It is recommended that this measure be implemented as part of the 2015 bundle.

3. Opportunities

04.00 High Efficiency Lab Hoods

GENERAL DESCRIPTION

Constant volume fume hoods serve to contain and exhaust hazardous fumes. They do this effectively although it typically also involves exhausting large quantities of conditioned air. VAV fume hoods help to minimize the amount of conditioned air that is exhausted by ramping down the exhaust fans when sashes are closed or partially closed by occupants. For new tenant fit outs, high efficiency lab hoods provide good value over traditional hoods (even vs. relocating hoods already owned by VMMC), assuming that the hood density is high. For areas where hood density is low, standard hoods are recommended.[6]



High efficiency hood strategies include:

1. Low flow constant volume hoods.
2. Low flow variable volume hoods based on sash position. (not recommended due to hood density and complexity of VAV)
3. Occupancy sensors and pushbutton overrides at hoods.

KEY ASSUMPTIONS

Costs and savings are based on installing (6) new low flow hoods with occupancy sensors.

NEXT STEPS

A detailed audit of proposed replacements will help identify the best technology for the specific lab. Costs and savings can then be refined. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure that also improves medical staff safety.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

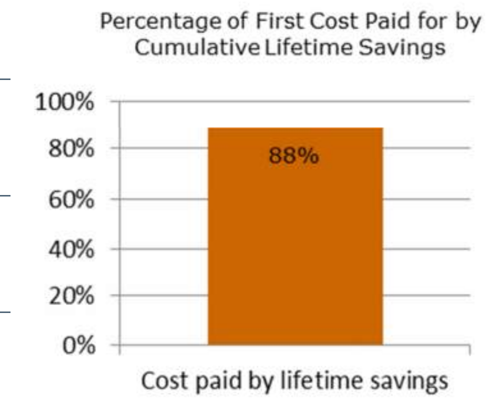
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

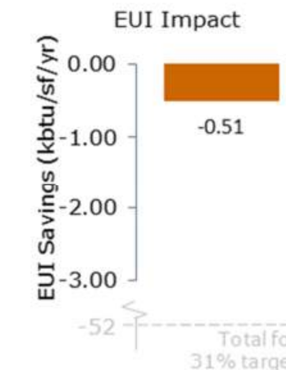
$178,400
First Cost

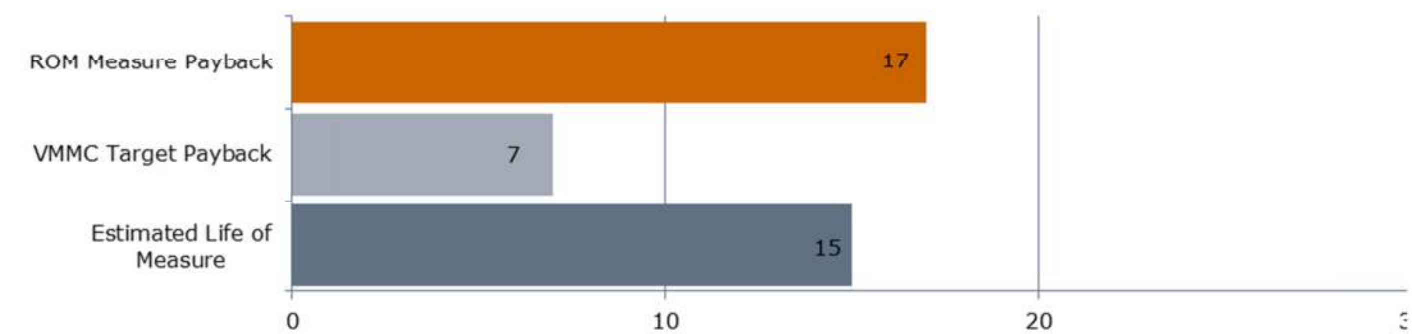
$10,500
Annual Utility Savings

400 klbs/yr steam
27,800 kWh/yr electric

42 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

When new fume hoods are required over the next 15 years, it is recommended that this measure be implemented.

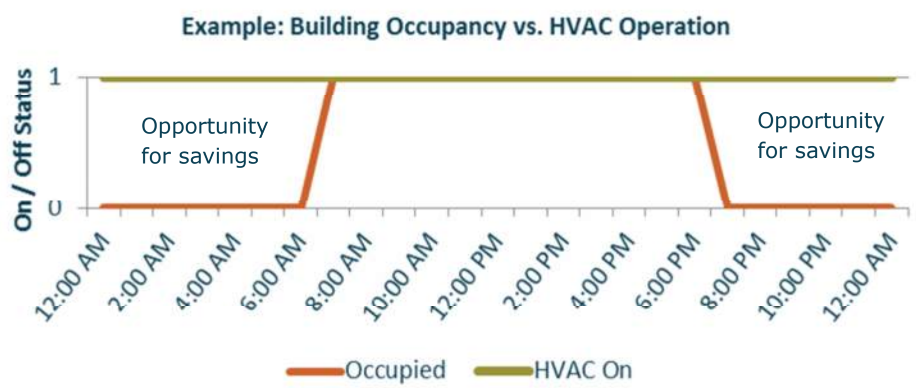
[6] Photo from: http://www.taylor-engineering.com/downloads/presentations/Energy%20Efficient%20Laboratory%20Retrofits.pdf

3. Opportunities

04.00 System Scheduling

GENERAL DESCRIPTION

One of the most cost-effective strategies for reducing energy consumption in any facility is to reduce equipment run-time hours. At VMMC, this involves determining which spaces need not be conditioned for comfort or safety 24x7 and identifying new schedules for those areas. Depending on HVAC zoning and existing equipment, not all non-24x7 areas may be able to benefit from schedule changes.



KEY ASSUMPTIONS

Estimated costs are based on baselining schedules in the DDC system, meeting with hospital staff to determine non 24x7 areas, and installing up to (20) branch dampers. Savings are based on setting back space temperatures and limiting HVAC operation to 12hrs/day in non 24x7 areas, served by 50,000cfm.

NEXT STEPS

Meetings with facilities and staff will help identify potential areas for schedule changes. Once spaces and affected supply fans are identified, costs and savings can be updated. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with few non-energy benefits.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

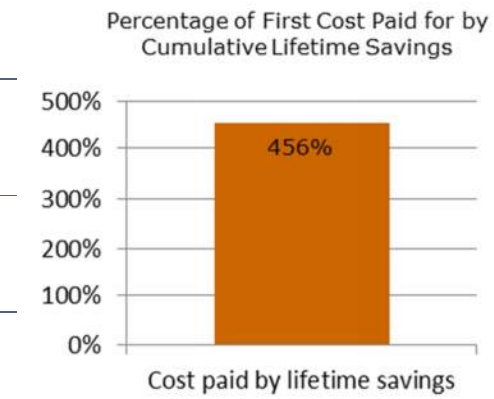
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

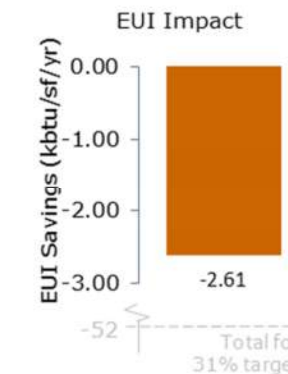
$58,400 First Cost

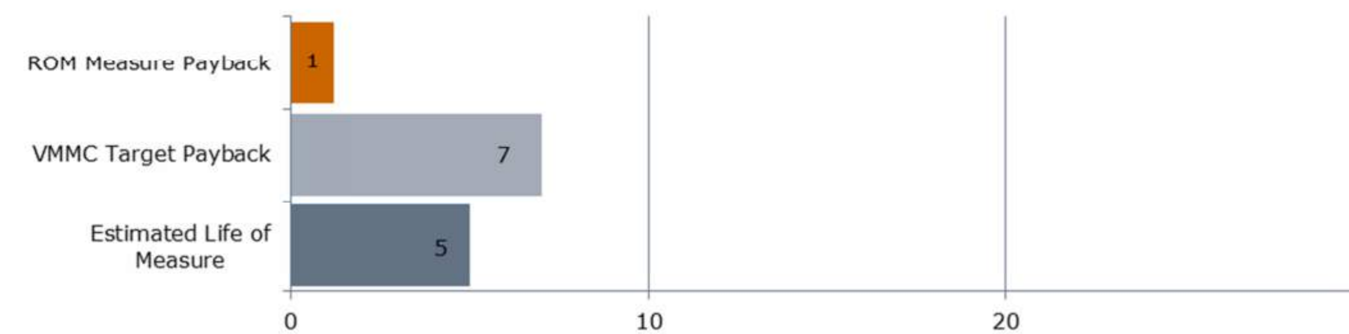
$53,300 Annual Utility Savings

1,800 klbs/yr steam
156,000 kWh/yr electric

216 MT CO_2e/yr Carbon Dioxide

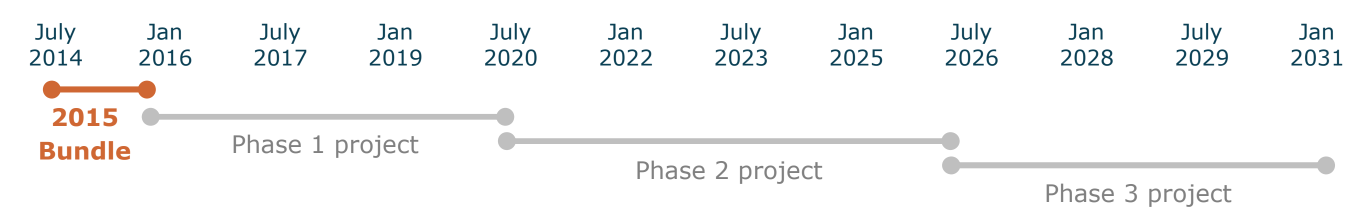






IMPLEMENTATION TIMING

Given the good financial returns, it is recommended that this measure be implemented as soon as possible.



3. Opportunities

06.00 Ozone Laundry at the Inn at VM

GENERAL DESCRIPTION

The laundry systems at the The Inn at VM provide a great opportunity to reap water and thermal savings by installing an ozone injection system. This system will measure and monitor the injection of ozone into the wash water of upgraded machines. The addition of the third oxygen atom attaches to and breaks down organic materials that are then easily removed by detergent during the wash cycle. This process works best in cold water, reducing the hot water required. As ozone leaves only oxygen behind, it is environmentally friendly and reduces both the rinse cycles and drying time, and leaves linens feeling softer.[7]

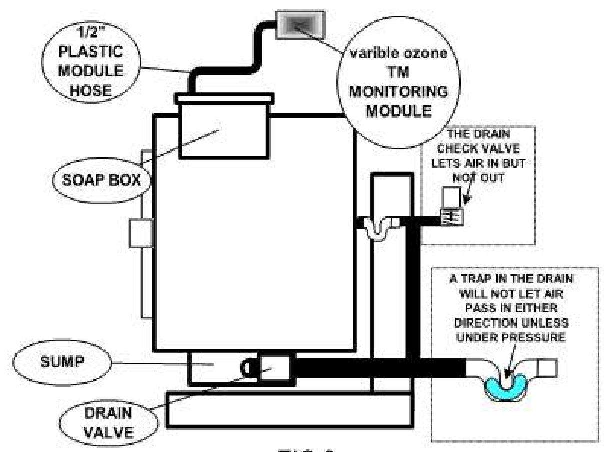


FIG 2
Plumbing overview

KEY ASSUMPTIONS

Cost and savings for this measure are based on installing ozone systems with monitors, injectors, generators, and controls to serve the (3) existing washers.

NEXT STEPS

A full audit has already been completed for this measure. Discussion with staff will help determine what operational changes are needed and whether the change to ozone injection is desired. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is mostly a water saving measure with other benefits including reduced drying time and softer linens. The new equipment will require maintenance and monitoring.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

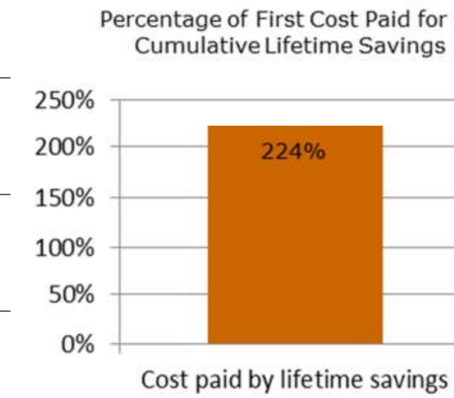
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

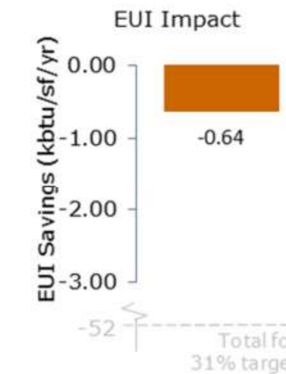
$84,600
First Cost

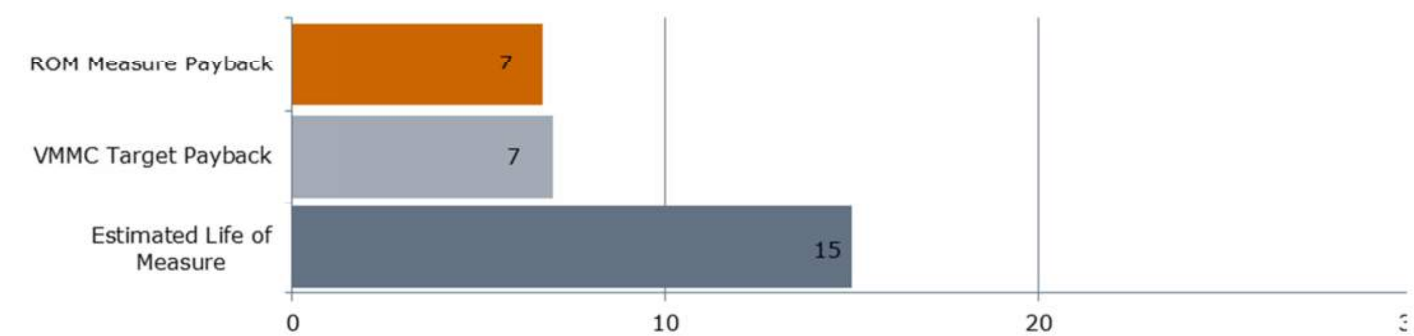
$12,600
Annual Utility Savings

400 CCF/yr water/sewer
6,400 therms/yr gas

34 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

Given the good financial returns and positive impact on patients and staff, it is recommended that this measure be as a Phase 2 project.

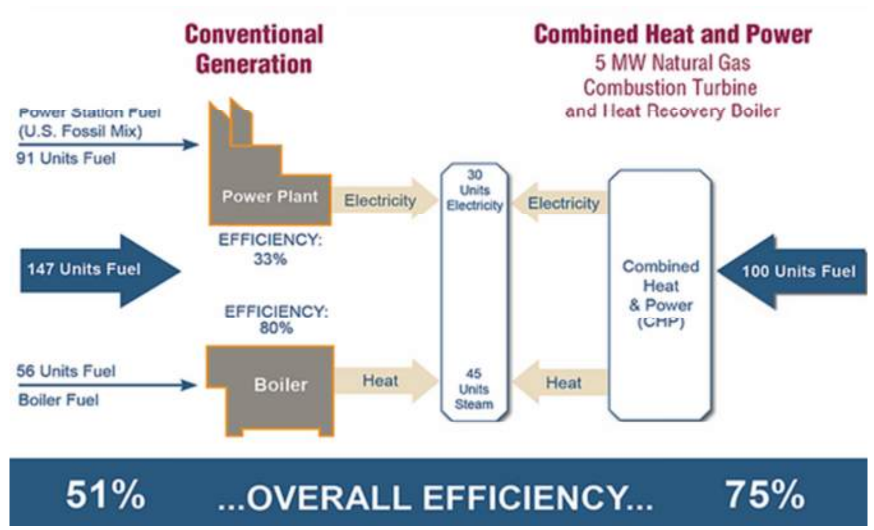
[7] Graphic from Aquawing Ozone tower installation manual.

3. Opportunities

07.00 Combined Heat and Power

GENERAL DESCRIPTION

If VMMC is planning to spend money to add back-up generator capacity, consider installed a combined heat and power (CHP) system instead. Instead of just acting as a back-up system, the CHP system would operate 24x7 and use natural gas to generate both a continuous supply of electrical power and hot water for use throughout the facility. The endless need for both electricity and heat makes VMMC an optimal location for this type of system. The considerably low natural gas rate improves the financials even further when compared to the cost per unit of energy from steam.[8]



KEY ASSUMPTIONS

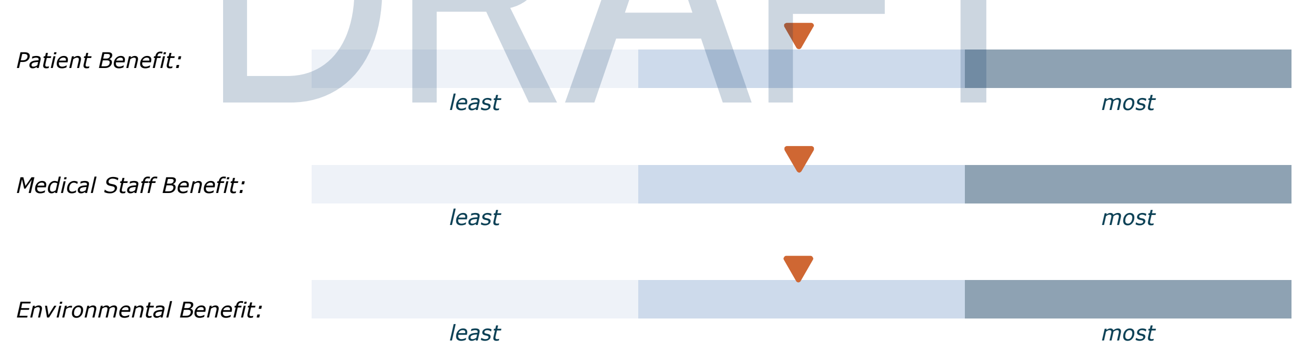
The cost for this measure is based on installation of a 1.5MW output natural gas turbine with heat recovery. Savings are based on operating the system for half the year so that steam output does not outpace steam demand at any point.

NEXT STEPS

Significant design and investigation are required to determine the true feasibility of this measure. Included in the detailed investigation should be a discussion with 2030 district officials to better understand the penalty of on-site energy generation to site EUI. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is a cost saving measure with dramatic negative energy impacts. The new equipment would also require significant maintenance.



[8] Image from EPA.gov

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

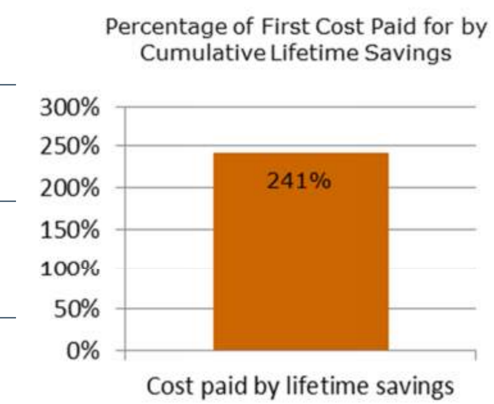
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

$5,542,800
First Cost

$445,100
Annual Utility Savings

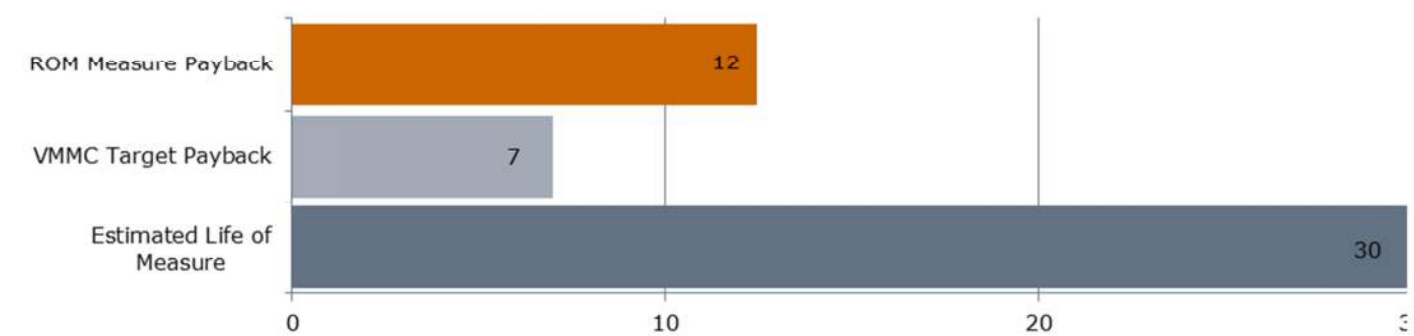
30,600 klbs/yr steam
6,570,000 kWh/yr electric
-747,200 therms/yr gas

1260 MT CO2e/yr
Carbon Dioxide



This measure has a LARGE NEGATIVE site EUI impact of 28 kBtu/sf/yr. This is due to the fact that the inefficiencies of electrical and steam production are now done on site after the meter.

From a source energy perspective and a GHG perspective, this measure has positive impacts, from a purely site EUI perspective (that taken by the 2030 District), this measure has very negative impacts.



IMPLEMENTATION TIMING

Given the tradeoffs associated with this measure, further investigation is required before an implementation recommendation can be made. For now, Phase 2 is assumed.

3. Opportunities

08.00 High-efficiency Motors

GENERAL DESCRIPTION

Besides motor size and operating hours, motor efficiency is a key driver of motor energy consumption. This measure involves upgrading motors to higher efficiency models whenever existing motors fail.[9]

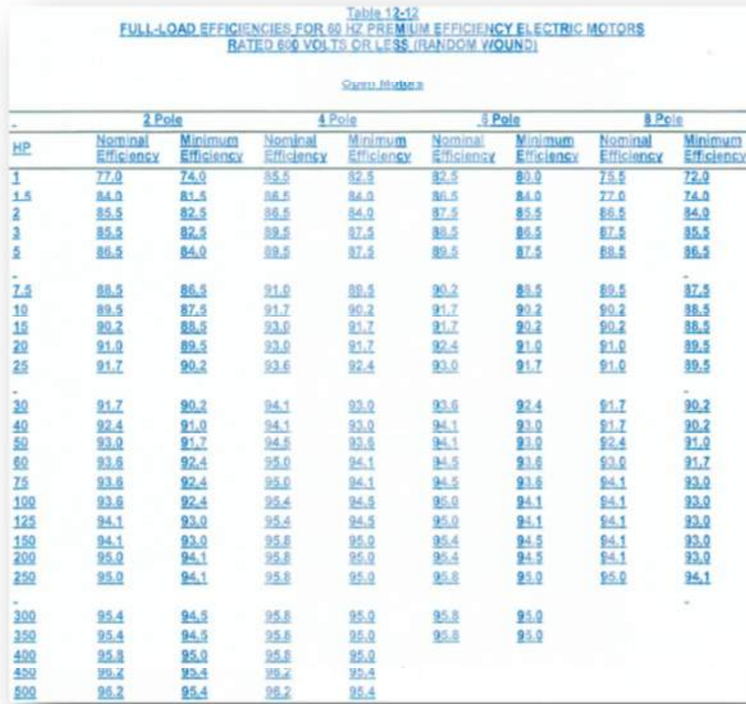


Table 12-12
FULL-LOAD EFFICIENCIES FOR 60 HZ PREMIUM EFFICIENCY ELECTRIC MOTORS
RATED 600 VOLTS OR LESS (RANDOM WOUND)

Open Motors

	2 Pole		4 Pole		6 Pole		8 Pole	
HP	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	77.0	74.0	85.5	82.5	82.5	80.0	75.5	72.0
1.5	84.0	81.5	86.5	84.0	86.5	84.0	77.0	74.0
2	85.5	82.5	86.5	84.0	87.5	85.5	86.5	84.0
3	85.5	82.5	89.5	87.5	88.5	86.5	87.5	85.5
5	86.5	84.0	89.5	87.5	89.5	87.5	88.5	86.5
7.5	88.5	86.5	91.0	89.5	90.2	88.5	89.5	87.5
10	89.5	87.5	91.7	90.2	91.7	90.2	90.2	88.5
15	90.2	88.5	93.0	91.7	91.7	90.2	90.2	88.5
20	91.0	89.5	93.0	91.7	92.4	91.0	91.0	89.5
25	91.7	90.2	93.6	92.4	93.0	91.7	91.0	89.5
30	91.7	90.2	94.1	93.0	93.6	92.4	91.7	90.2
40	92.4	91.0	94.1	93.0	94.1	93.0	91.7	90.2
50	93.0	91.7	94.5	93.6	94.1	93.0	92.4	91.0
60	93.6	92.4	95.0	94.1	94.5	93.6	93.0	91.7
75	93.6	92.4	95.0	94.1	94.5	93.6	94.1	93.0
100	93.6	92.4	95.4	94.5	95.0	94.1	94.1	93.0
125	94.1	93.0	95.4	94.5	95.0	94.1	94.1	93.0
150	94.1	93.0	95.8	95.0	95.4	94.5	94.1	93.0
200	95.0	94.1	95.8	95.0	95.4	94.5	94.1	93.0
250	95.0	94.1	95.8	95.0	95.8	95.0	95.0	94.1
300	95.4	94.5	95.8	95.0	95.8	95.0		
350	95.4	94.5	95.8	95.0	95.8	95.0		
400	95.8	95.0	95.8	95.0				
450	96.2	95.4	96.2	95.4				
500	96.2	95.4	96.2	95.4				

KEY ASSUMPTIONS

Cost and savings potential is based on upgrading (50) 25hp motors that operate 75% of the year.

NEXT STEPS

As is evident from the results for this measure, it is not cost-effective to upgrade a motor unless it has failed and dollars will need to be spent to replace it. As such, this measure should only be considered when existing motors fail, as is presently a best practice at VMMC. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with a small positive facilities staff impact. New motors reduce maintenance on the motors they replace.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

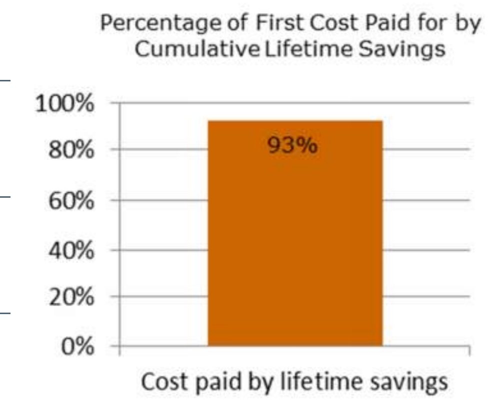
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

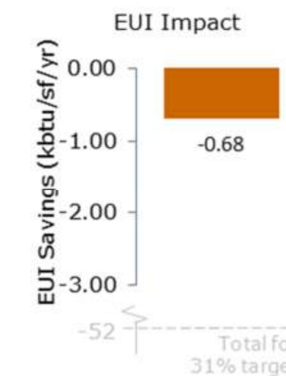
$402,000
First Cost

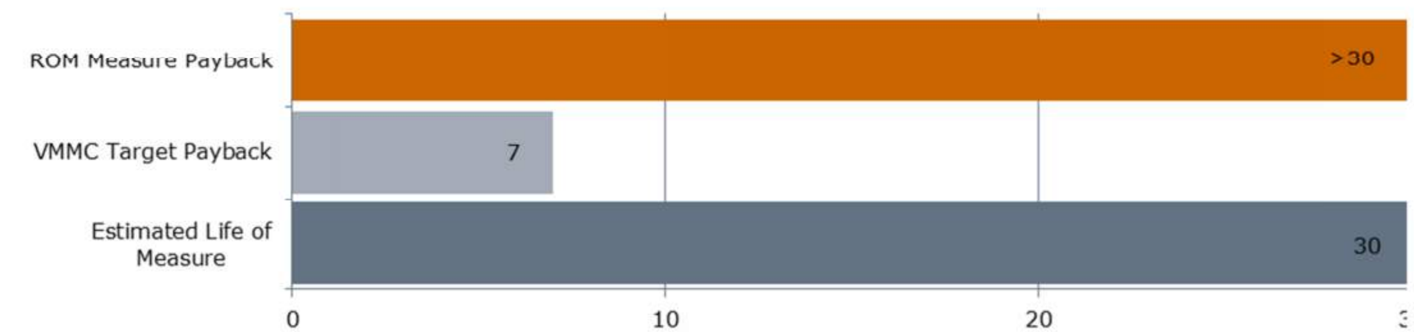
$12,400
Annual Utility Savings

202,600 kWh/yr electric

78 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

As the cost above reflects the fully burdened cost, it does not account for the required investment when motors fail. When that investment is accounted for, the incremental cost of selecting a premium efficiency motor is small, making the return attractive. Thus, this measure should be implemented throughout all phases as motors fail.

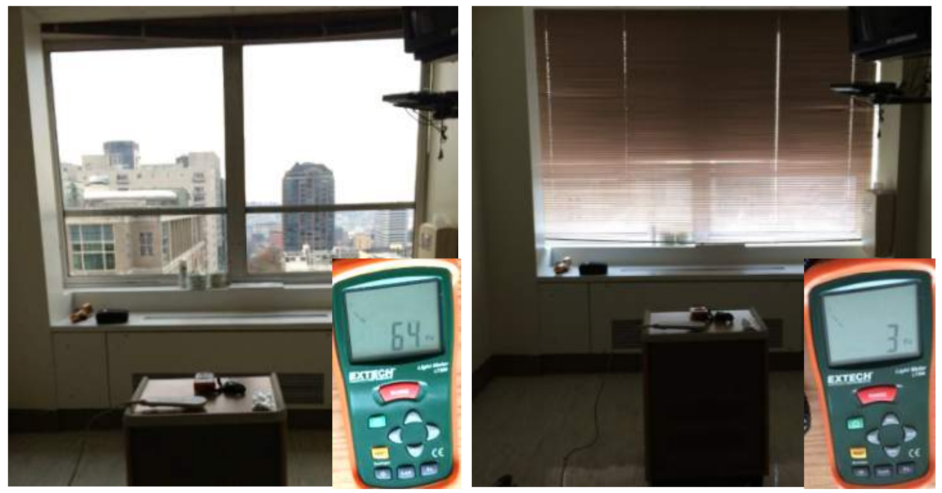
[9] Applicable NEMA motor efficiency table

3. Opportunities

09.00 Buck LED Lighting

GENERAL DESCRIPTION

Install LED lighting retrofit troffers, recessed cans, tubes, and wall occupancy sensors. Affected space types include common hallways, offices, restrooms, elevators, and stairs.



Not yet included in this measure is the potential for daylighting control in patient rooms. As one example, with the blinds open and lights off in a patient room, the foot-candle reading is 64. With the blinds drawn and lights off, the foot-candle reading is only 3. Providing privacy blinds that still allow for daylighting could save significantly on daytime lighting energy use.

KEY ASSUMPTIONS

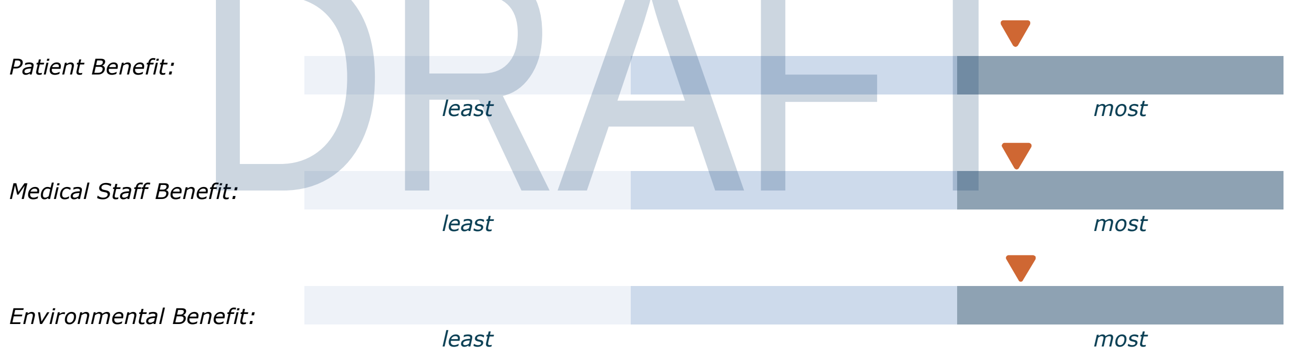
Costs and savings are from the Resound Energy proposals. Note that daylighting is not included. Savings also do not include demand savings or heating or cooling benefits/penalties.

NEXT STEPS

Additional investigation of daylighting opportunities, patient room retrofits, and high-end trim control strategies may be warranted.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with numerous patient and staff impacts including better lighting quality and reduced maintenance due to longer lamp life.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

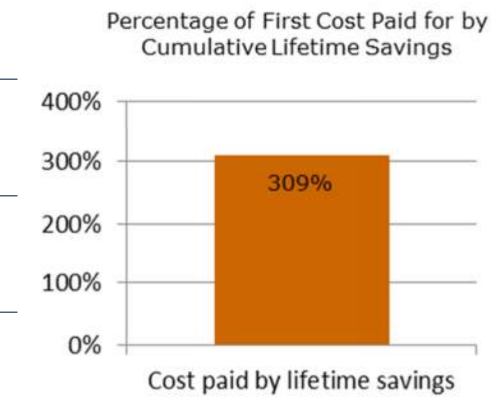
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

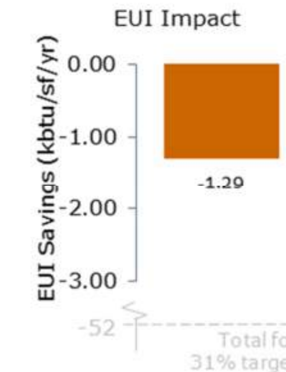
$337,700
First Cost

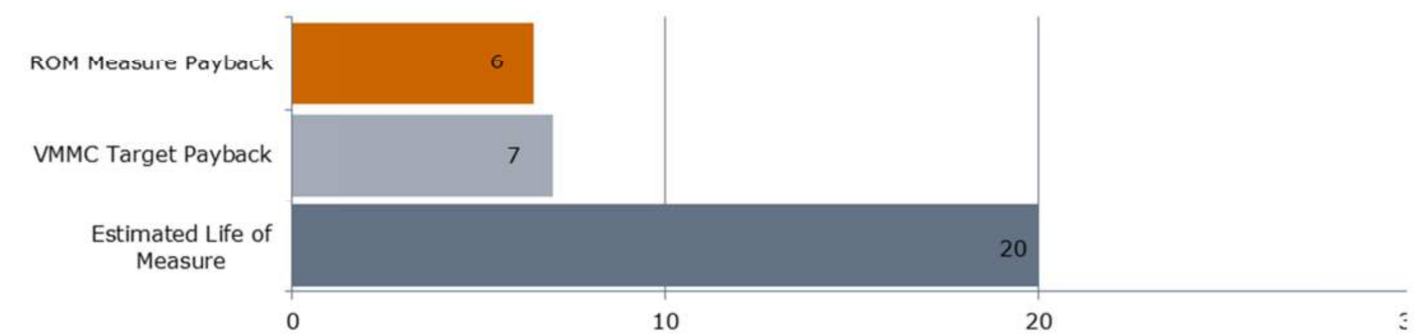
$23,400
Annual Utility Savings

380,400 kWh/yr electric

146 MT CO_2e/yr
Carbon Dioxide

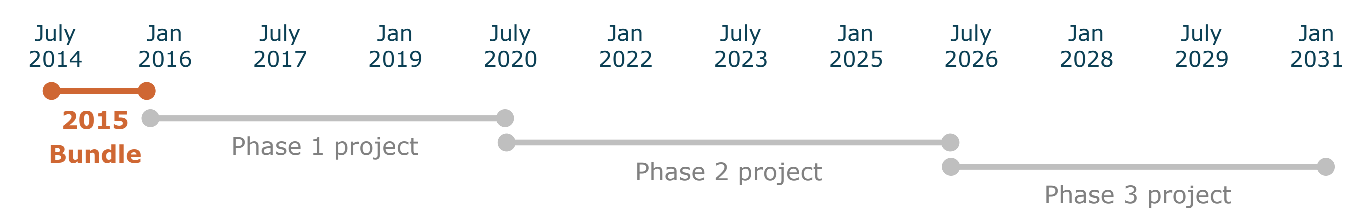






IMPLEMENTATION TIMING

Given the good financial returns and positive impact on patients and staff, it is recommended that this measure be implemented as soon as possible.

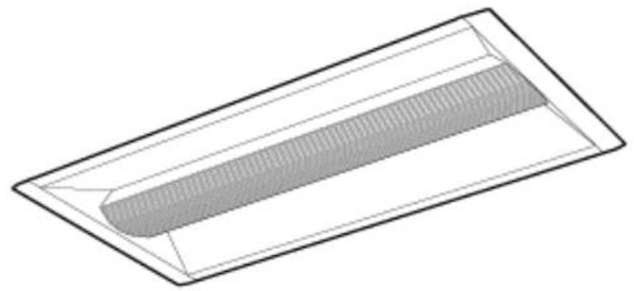


3. Opportunities

09.00 HRB LED Lighting

GENERAL DESCRIPTION

Install LED lighting retrofit troffers, recessed cans, tubes, and wall occupancy sensors. Affected space types include common hallways, offices, and stairwells. One of the proposed LED fixture types (the Philips EvoKit LED Retrofit Kit) is shown in the diagram to the right.



KEY ASSUMPTIONS

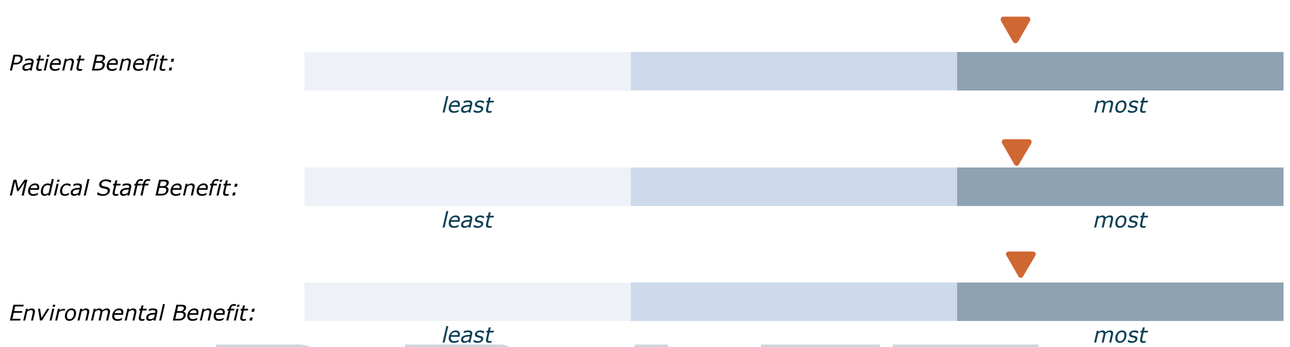
Costs and savings are from the Resound Energy proposals. Note that daylighting is not included. Savings also do not include demand savings or heating or cooling benefits/penalties.

NEXT STEPS

Additional investigation of daylighting and high-end trim opportunities may be warranted.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with numerous patient and staff impacts including better lighting quality and reduced maintenance due to longer lamp life.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

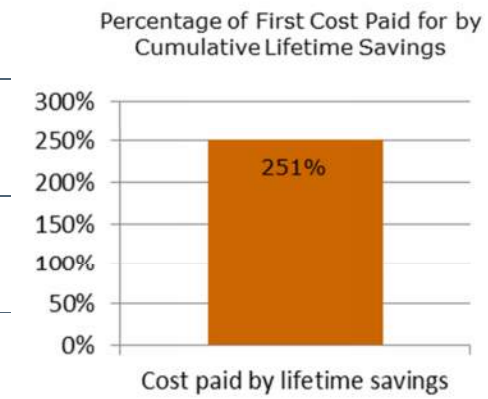
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

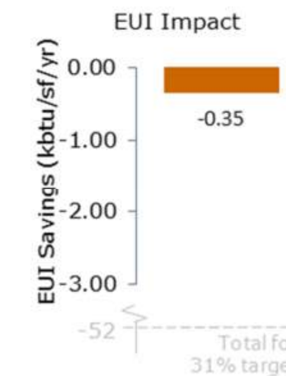
$117,000
First Cost

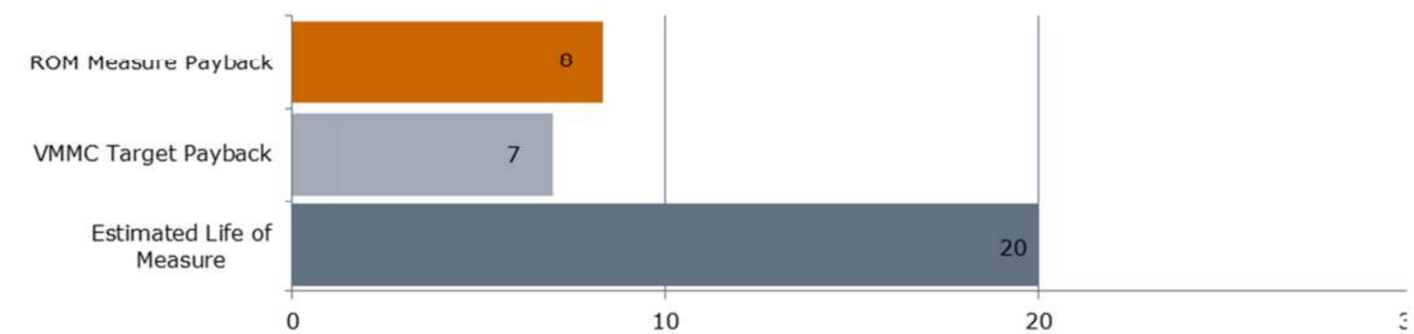
$6,400
Annual Utility Savings

104,900 kWh/yr electric

40 MT CO2e/yr
Carbon Dioxide

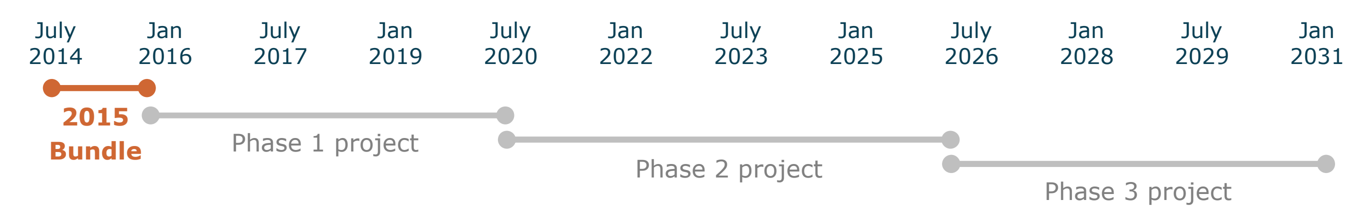






IMPLEMENTATION TIMING

Given the good financial returns and positive impact on patients and staff, it is recommended that this measure be implemented as soon as possible.



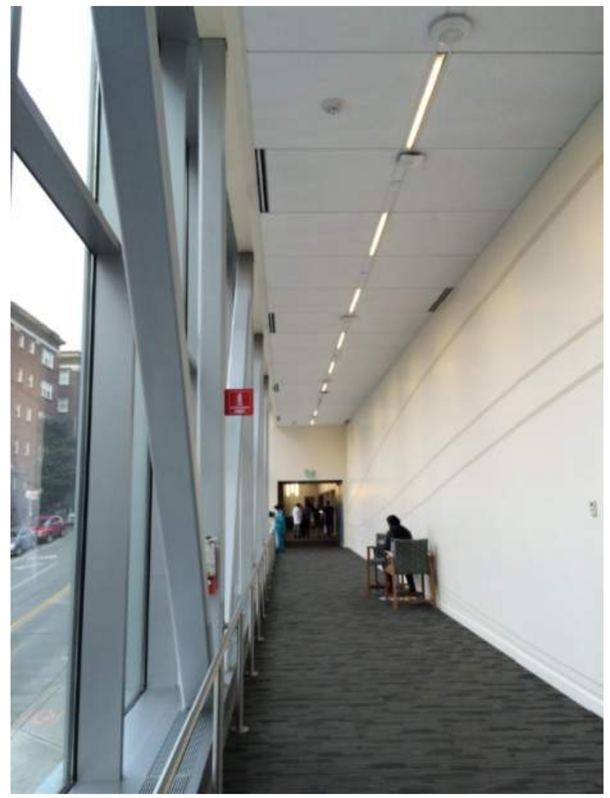
3. Opportunities

09.00 Lindeman LED Lighting

GENERAL DESCRIPTION

Install LED lighting retrofit troffers, recessed cans, tubes, and wall occupancy sensors. Affected space types include common hallways, elevator lobbies, offices, stairs, garage, and exterior.

Not yet included in this measure is the potential for daylighting control in walkways and common areas. There are several walkways (one in main hospital pictured at right) with plenty of daylight where electric lighting could be off or significantly dimmed during daytime hours.



KEY ASSUMPTIONS

Costs and savings are from the Resound Energy proposals. Note that daylighting is not included. Savings also do not include demand savings or heating or cooling benefits/penalties.

NEXT STEPS

Additional investigation of daylighting opportunities and high-end trim control strategies may be warranted.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with numerous patient and staff impacts including better lighting quality and reduced maintenance due to longer lamp life.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

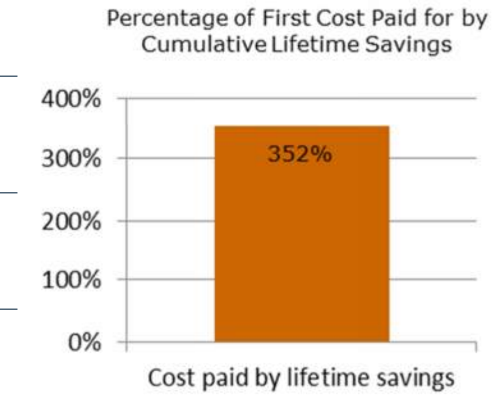
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

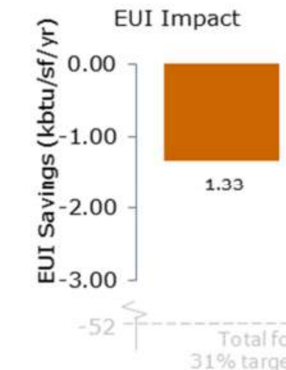
$306,000 First Cost

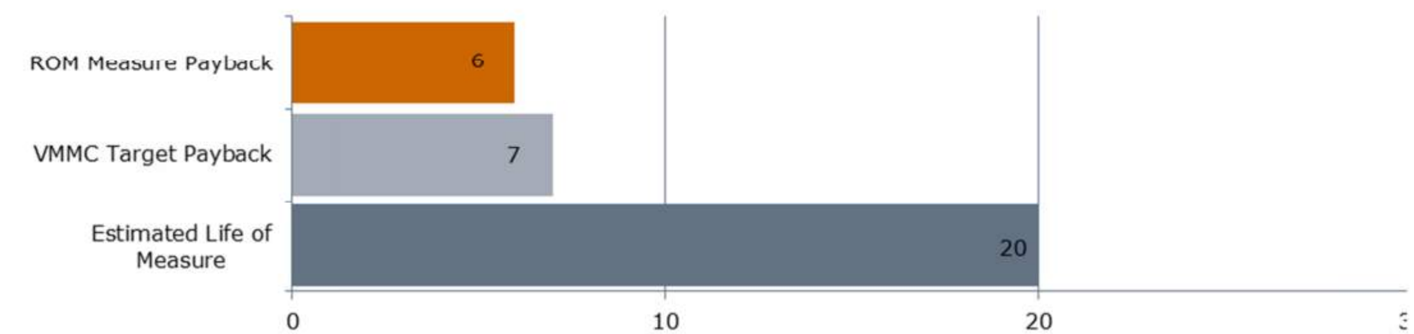
$24,200 Annual Utility Savings

393,800 kWh/yr electric

151 MT CO2e/yr Carbon Dioxide

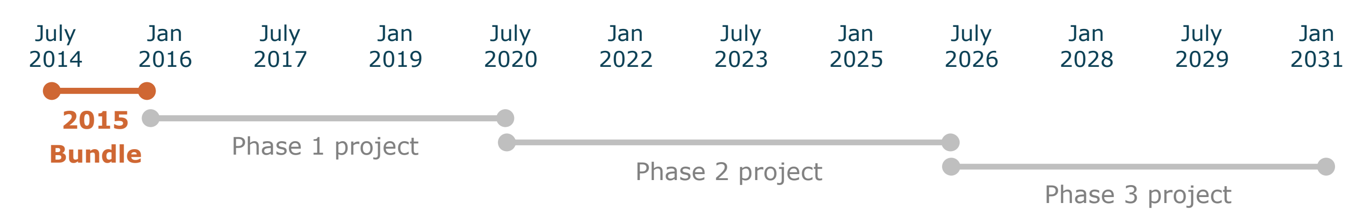






IMPLEMENTATION TIMING

Given the good financial returns and positive impact on patients and staff, it is recommended that this measure be implemented as soon as possible.



3. Opportunities

10.00 Solar PV

GENERAL DESCRIPTION

While solar energy in the Northwest is not as productive as in other parts of the country, it can still sometimes prove to be a better investment than efficiency. This may be the case for Virginia Mason as 2030 approaches and all low-hanging fruit has been implemented and solar costs have continued to drop. This measure involves providing a small 15 kW solar electric system on the Lindeman roof. The panel shown to the right is a made in Washington, itek Energy solar module that has a 25-yr warranty.

KEY ASSUMPTIONS

The cost estimate for this measure is based on the installation of a 15kW photovoltaic system including mounting hardware, inverter, and monitoring. Savings are based on the Seattle, WA TMY2 file and output calculated by the National Renewable Energy Lab (NREL) PV Watts calculator.

NEXT STEPS

A survey of the proposed location will help identify potential installation issues and/or planned alternate uses for the roof area. VMMC may have recommendations for more visible locations. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy generating measure that demonstrates VMMC’s commitment to clean energy. For facilities staff, it will mean another system to maintain.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

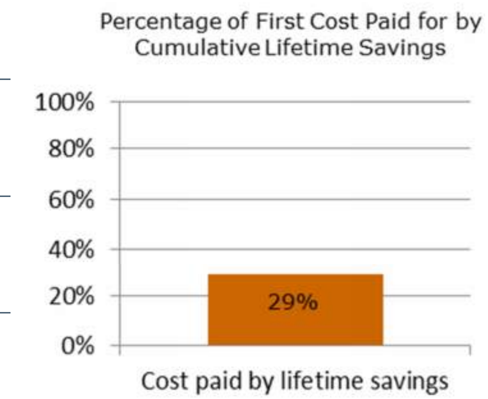
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

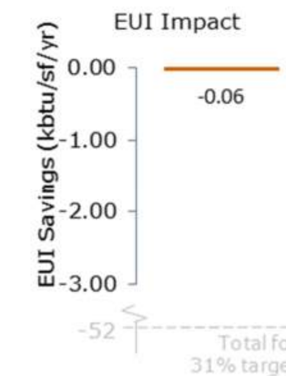
$107,600
First Cost

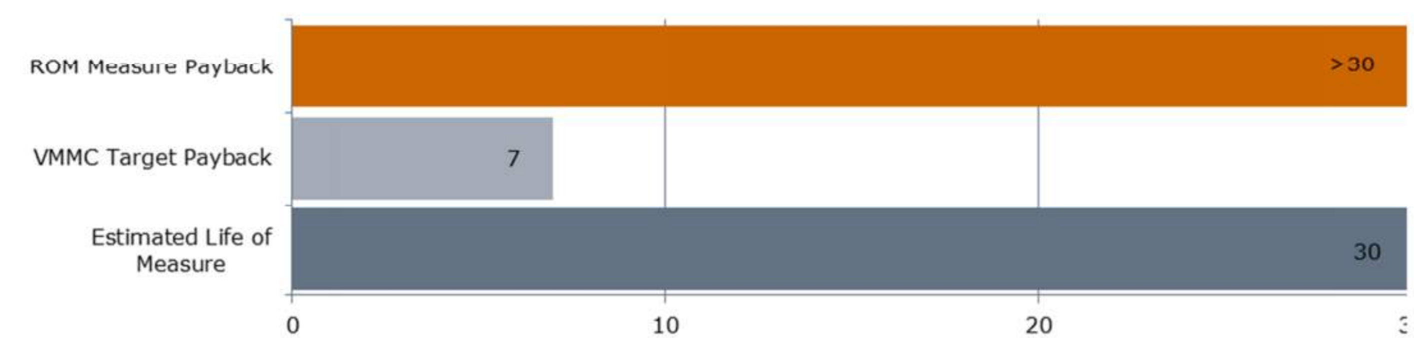
$1,000
Annual Utility Savings

16,700 kWh/yr electric

6 MT CO2e/yr
Carbon Dioxide

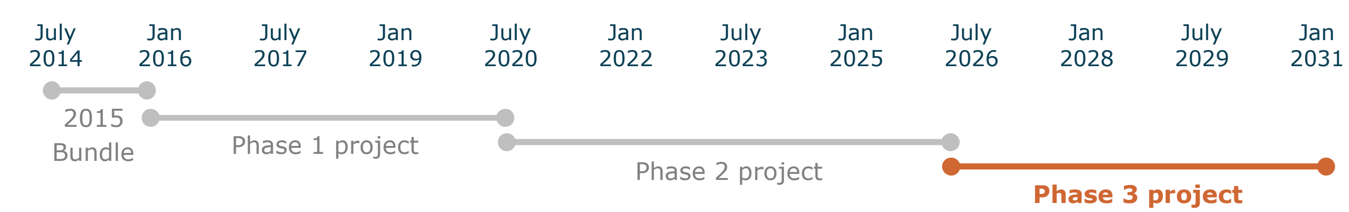






IMPLEMENTATION TIMING

Given the poor financial returns for this measure and the fact that solar costs continue to drop, it is recommended that this measure be implemented potentially as a Phase 3 project. If a grant or donor opportunity for the system arises, it may be implemented sooner.



3. Opportunities

12.00 Condensate Reuse

GENERAL DESCRIPTION

Once steam transfers its heat to a heat exchanger or heating coil, it changes into its liquid form of hot condensate. In most cases at VMMC, this hot condensate is then piped to a condensate heat recovery unit. After passing through the heat recovery unit, all condensate (e.g. warm water) goes down the sewer drain and ends up at one of King County's water treatment plants. This measure would capture that condensate and reuse it for cooling towers or for future green space irrigation, thereby reducing VMMC's purchase of water. Unfortunately, the condensate that goes down the drain does not incur sewer charges from Seattle Public Utilities due to an agreement between SPU and Enwave (formerly Seattle Steam), so there are no sewer savings for this measure.

KEY ASSUMPTIONS

The cost for this measure is based upon the installation of a 5,000 gallon tank where SF-4 is currently located as well as piping to capture the condensate and deliver it to where it will be used. For this ROM, it is assumed that the water will be used to offset Buck cooling tower use.

NEXT STEPS

A determination regarding the location of the storage tank as well as the optimal use of the stored water will be required. Costs and savings can then be refined accordingly. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is a water saving measure with few non-water benefits. There may actually be a negative facilities staff impact as the new tank and pump will need maintenance over time.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

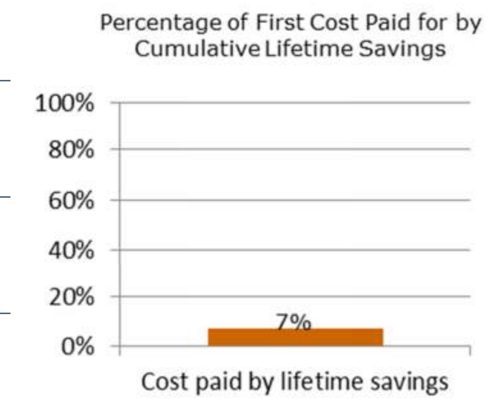
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

$256,700 First Cost

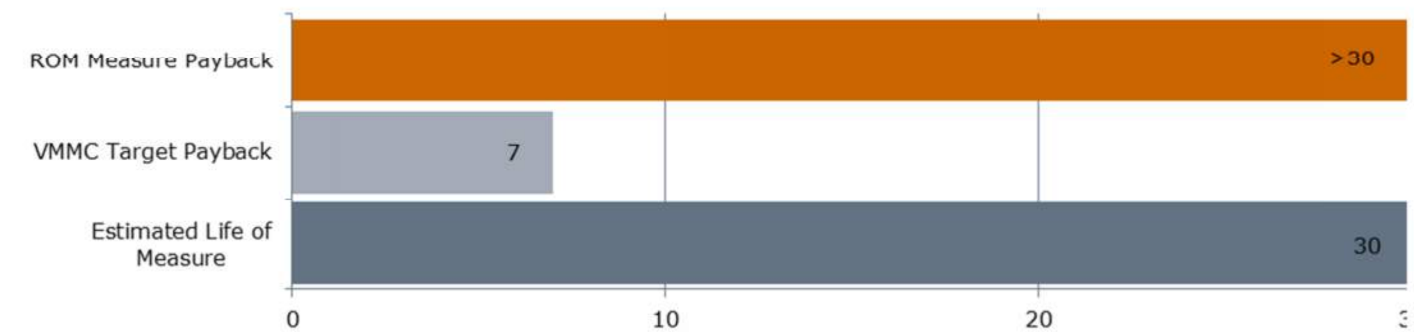
$600 Annual Utility Savings

100 CCF/yr water

0 MT CO2e/yr Carbon Dioxide



This measure saves 0.07 gal/sf/yr helping to move VMMC towards the 2030 water target in a small way.



IMPLEMENTATION TIMING

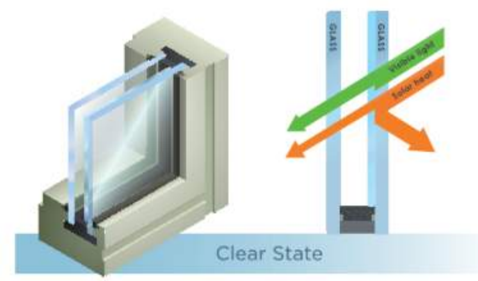
Given the poor financial return for this measure, it is recommended that it possibly be implemented in phase 3.

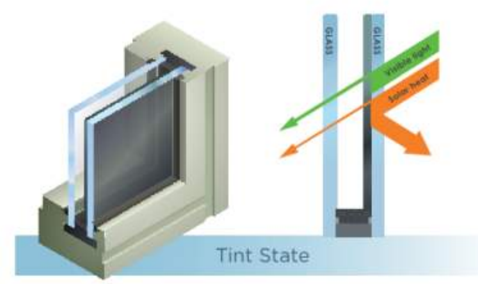
3. Opportunities

13.00 Electrochromic Windows

GENERAL DESCRIPTION

Dynamic windows can change the amount of daylight or heat transmission based on environmental conditions (passive control) or an external control (active control). These windows can replace the need for blinds or window coverings. An electrochromic window, an example of an actively control window, is an electrically powered insulated glazing panel that tints to reduce glare and heat without the use of blinds (very minimal electric use). This measure involves installing electrochromic windows on the West facade of Buck North and Buck South. Electrochromic windows can change the solar heat gain coefficient and visible light transmittance based on low voltage control. Energy savings result from reduced heating and cooling loads as well as a reduced demand for electric lighting.





KEY ASSUMPTIONS

The approximate cost is based on a total installed square footage of 4,200sf. Energy savings are based on a reduction in the window u-value as well as a reduction in the solar heat gain coefficient.

NEXT STEPS

A detailed investigation of the façade will help determined which technology (double pane, film, etc.) is best suited for the location.
Costs and savings can be refined based on more detailed take-offs and documentation of existing conditions. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with numerous non-energy benefits including improved patient privacy and comfort.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

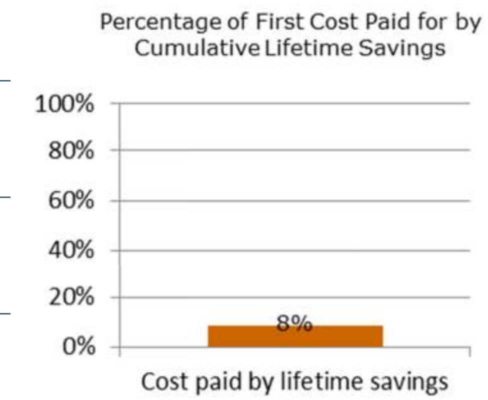
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

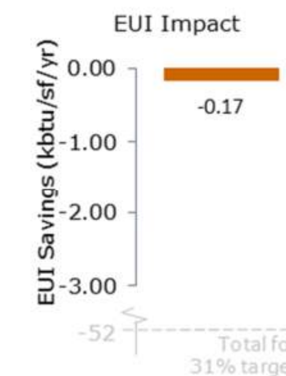
$1,280,600
First Cost

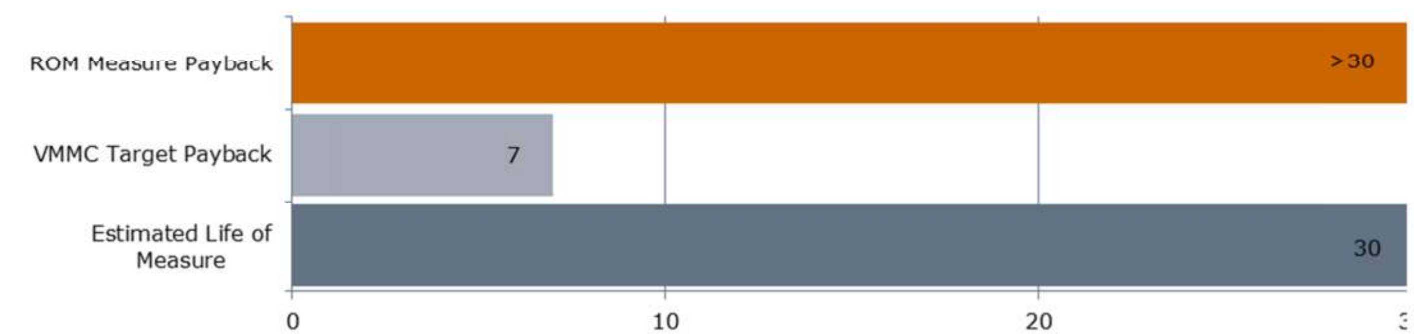
$4,000
Annual Utility Savings

200 klbs/yr steam
400 kWh/yr electric

14 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

Given the poor financial returns, it is not recommended that electrochromic windows be considered unless a window replacement is already planned.

3. Opportunities

13.00 Single Pane Glazing Upgrade

GENERAL DESCRIPTION

Replace existing single pane windows on West façade of Buck South and Buck North with new high performance double pane low-e windows with thermally broken frames. This will eliminate the largest thermal bridge in this building and significantly improve thermal comfort for occupants near the windows during cold weather. New windows will also reduce solar heat gain by using spectrally selective (Solarban 60 or 70XL) coatings which transmit the visible spectrum while filtering out non-visible light.

KEY ASSUMPTIONS

The cost and savings for this measure are based on replacing 4,200sf of single pane glazing with new double pane thermally broken frames units with an argon fill and low-e Solarban 60 glass.

NEXT STEPS

A detailed investigation of the façade will help determined which technology (double pane, film, etc.) is best suited for the location. Costs and savings can be refined based on more detailed take-offs and documentation of existing conditions. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with numerous non-energy benefits including improved patient comfort.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

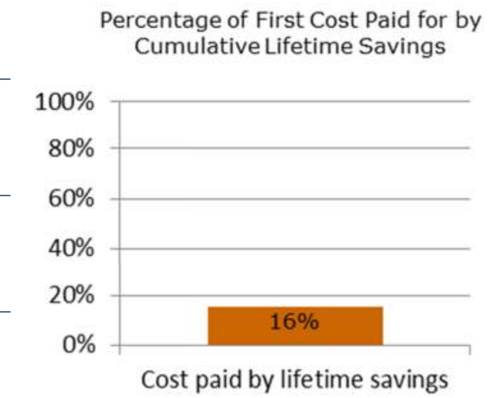
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

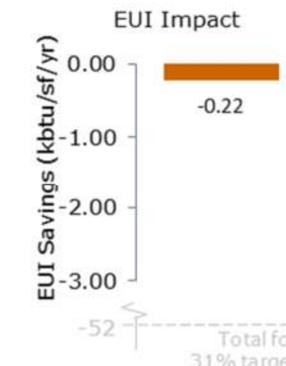
$903,900
First Cost

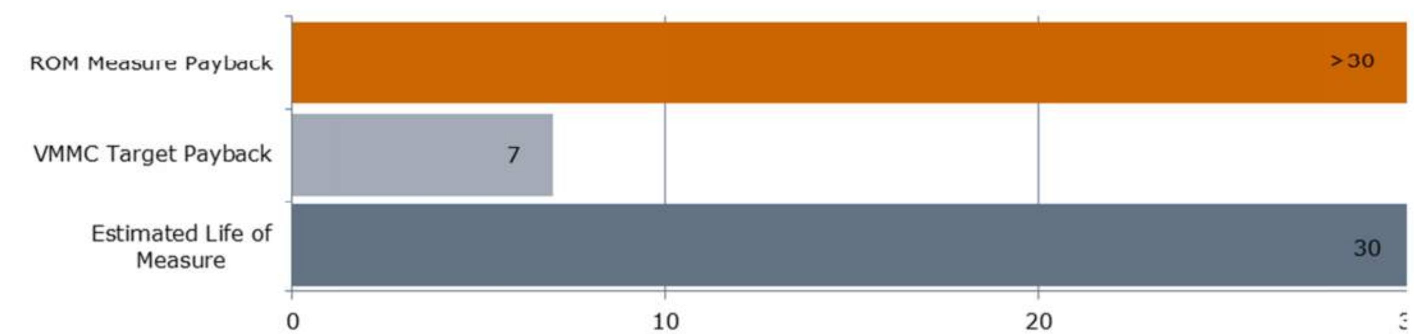
$5,200
Annual Utility Savings

200 klbs/yr steam
300 kWh/yr electric

19 MT CO2e/yr
Carbon Dioxide

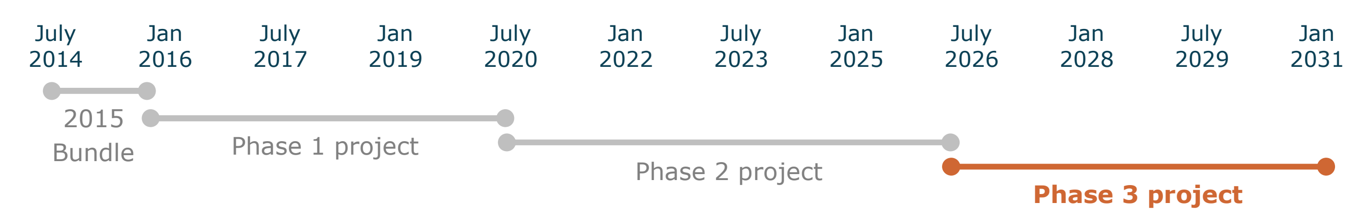






IMPLEMENTATION TIMING

Given the poor financial returns, it is not recommended that a window upgrade be considered unless a window replacement is already planned.



3. Opportunities

13.00 Weatherization

GENERAL DESCRIPTION

Similar to residential buildings, commercial buildings can leak conditioned air, wasting energy and causing comfort issues. Common areas of air leakage include around windows, at roof/wall intersections, and surrounding doorways. Sealing leaks will provide for a tighter, more comfortable, more easily pressurized building. Costs and savings are based on estimated potential in HRB and Buck.

KEY ASSUMPTIONS

Cost and savings potential is based on finding and a sealing a total leakage area of 20 square feet.

NEXT STEPS

A full audit of all windows, doors, roof/wall interfaces, and other common leakage sites will help determine locations of leakage, actual leakage area, and method of remediation. Costs and savings can then be refined. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with a comfort benefit to occupants.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

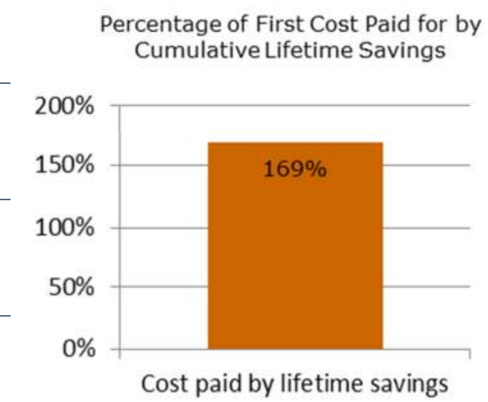
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

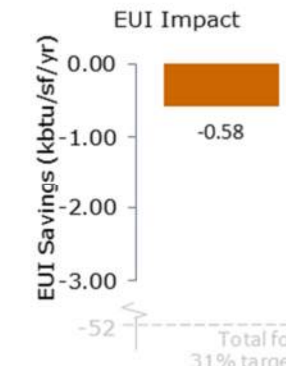
$35,900
First Cost

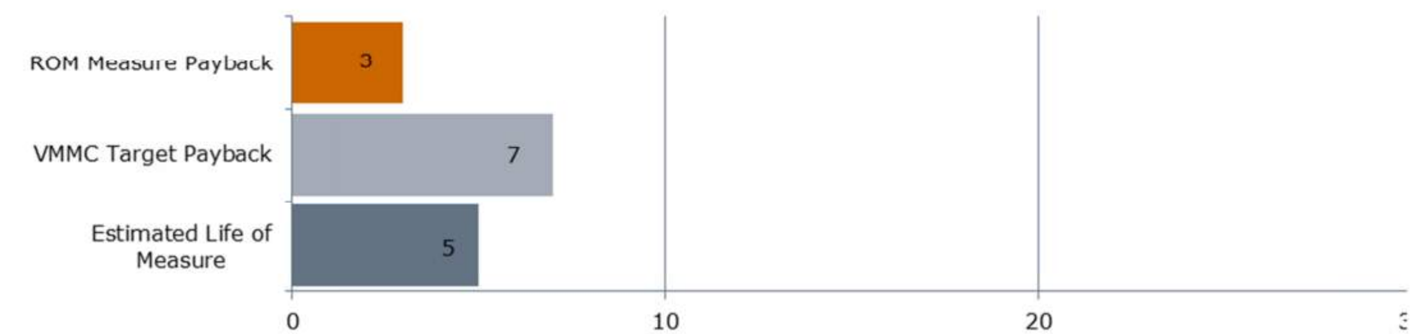
$12,100
Annual Utility Savings

500 klbs/yr steam
1,300 kWh/yr electric

72 MT CO2e/yr
Carbon Dioxide

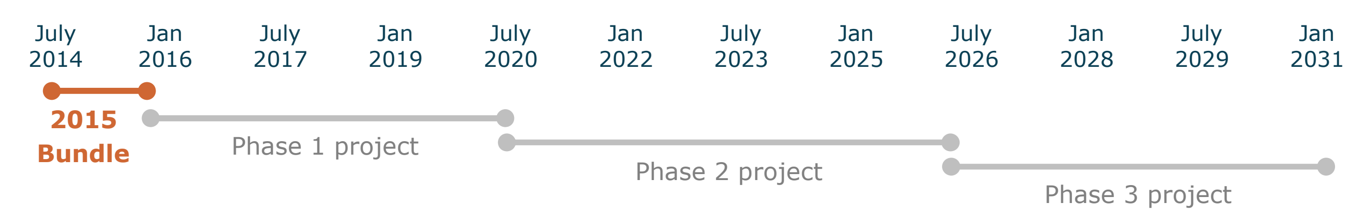






IMPLEMENTATION TIMING

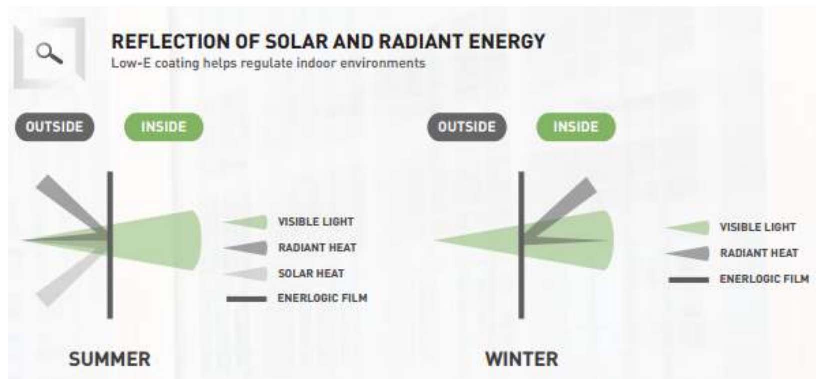
Given the good financial returns and positive impact on medical staff, it is recommended that this measure be implemented as soon as possible.



13.00 Window Film

GENERAL DESCRIPTION

Next generation window films not only provide the traditional benefit of reducing summer heat gain, but they can also now provide improved insulation in winter via the inclusion of a low-e coating. Traditional challenges with window films include bubbling and/or condensation. New, clear distortion free adhesives avoid these issues and some installers provide lifetime warranties against bubbling or peeling. This measure involves providing Enerlogic 70 window film for West façade of Buck North and Buck South. The film will help reduce peak cooling and heating loads and provide for greater occupant comfort.[10]



KEY ASSUMPTIONS

The cost and savings for this measure are based on installing 4,200sf of Enerlogic 70 window film.

NEXT STEPS

A detailed investigation of the façade will help determined which technology (double pane, film, etc.) is best suited for the location. Costs and savings can be refined based on more detailed take-offs and documentation of existing conditions. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with numerous non-energy benefits including improved patient comfort.

Patient Benefit: *least* — *most*

Medical Staff Benefit: *least* — *most*

Environmental Benefit: *least* — *most*

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

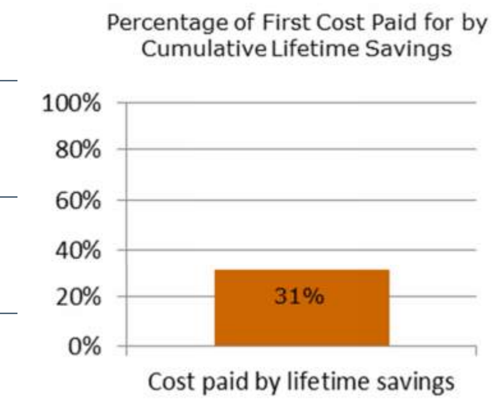
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

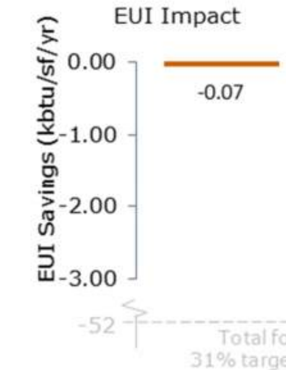
$150,700 First Cost

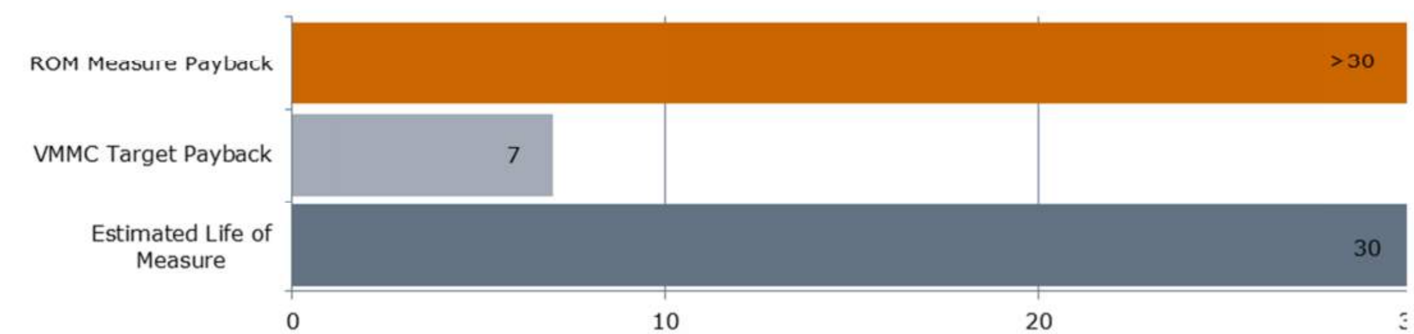
$1,500 Annual Utility Savings

100 klbs/yr steam
100 kWh/yr electric

6 MT CO2e/yr Carbon Dioxide







IMPLEMENTATION TIMING

Given the poor financial returns, it is not recommended that window film not be considered unless driven by the need for greater privacy or thermal or visual comfort.

[10] Graphic from: http://prodenerlogicfilm.blob.core.windows.net/prodenerlogicfilm/Commercial-EnerLogic-Brochure.pdf

3. Opportunities

15.00 Replace Refrigeration Equipment

GENERAL DESCRIPTION

Several of the kitchen walk-ins (4, 5, and 8) located in the café in the main pavilion currently use R-12 or R-22 refrigerant. This refrigerant is now obsolete and will run out in approximately 18 months which will necessitate replacement of these systems. This measure involves replacing the refrigeration systems for these three walk-ins with updated systems and replacing existing induction motors with new ECM motors.

KEY ASSUMPTIONS

Cost and savings potential is based on replacing compressor and evaporator equipment for (3) walk-ins, reducing estimated power density by 10%.

NEXT STEPS

More detailed investigation by Ecolab will help refine costs and savings for this measure. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with benefits including improved reliability and food safety and reduced maintenance.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

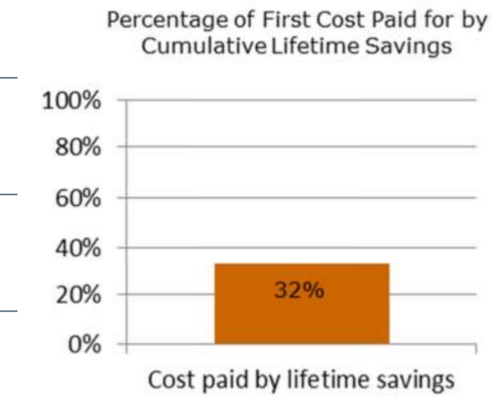
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

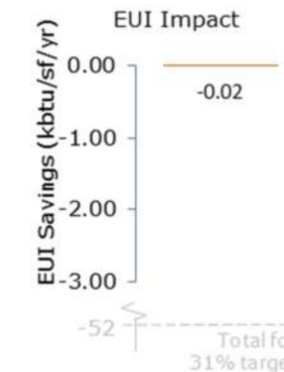
$35,900
First Cost

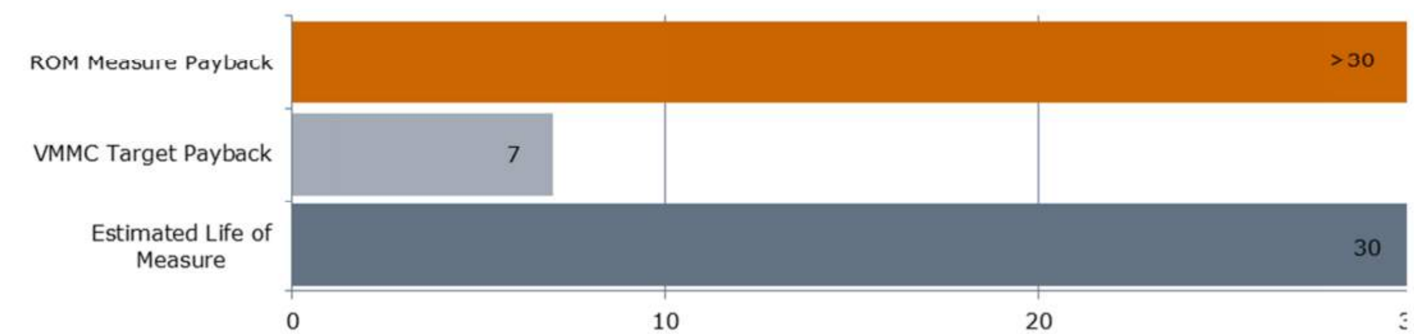
$400
Annual Utility Savings

6,300 kWh/yr electric

2 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

TBD

3. Opportunities

15.00 Retrofit Refrigeration Equipment

GENERAL DESCRIPTION

Older walk-ins tend to have inefficient shaded pole evaporator motors that add unnecessary heat to the space that you are trying to cool. Similarly, inefficient defrost cycles are on timers, defrosting whether it is needed or not, wasting energy. This measure involves retrofitting (5) existing commercial walk-in refrigerators and freezers with ECM motors and implementing smart defrost controls to only defrost when needed.[11]

KEY ASSUMPTIONS

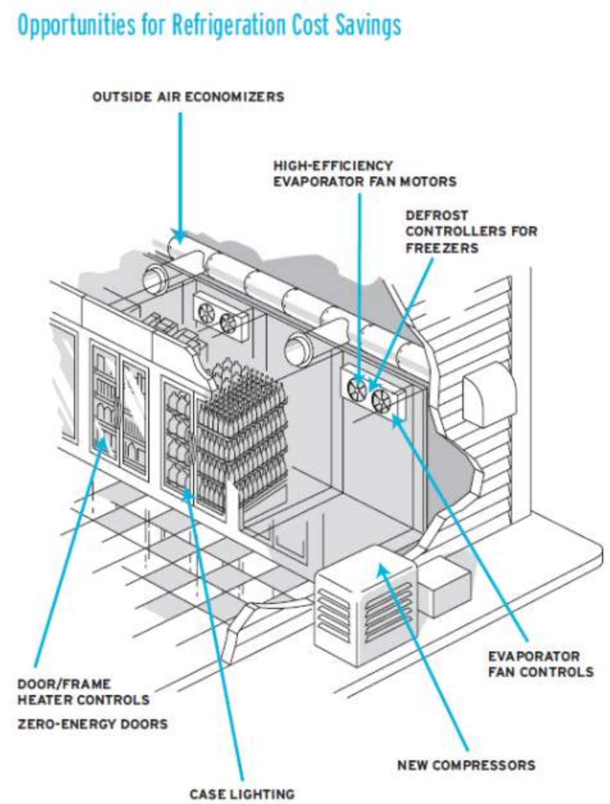
Cost and savings potential is based on implementing smart defrost controls as well as an ECM motor retrofit.

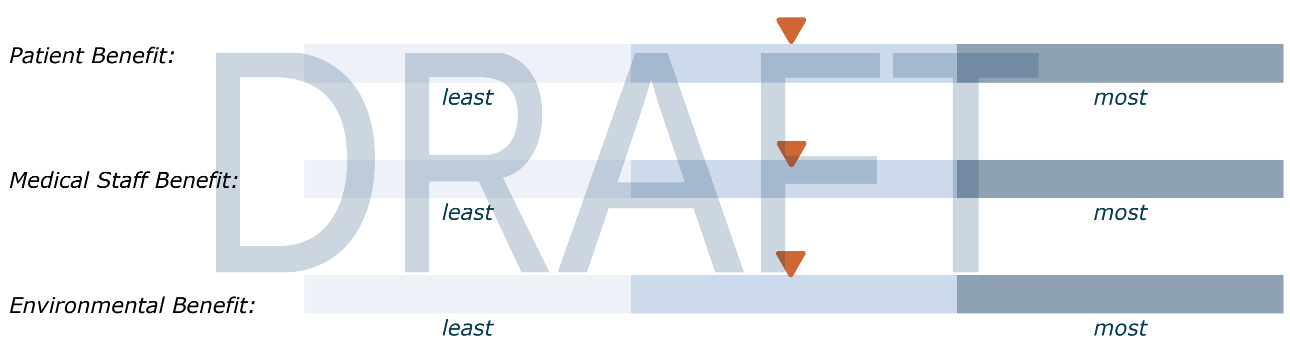
NEXT STEPS

A detailed audit of the refrigeration equipment will help determine what kind of control solution will be best suited for the existing equipment and usage patterns. Costs and savings can then be refined. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with benefits including reduced motor maintenance and improved reliability and food safety.





ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

$TBD
First Cost

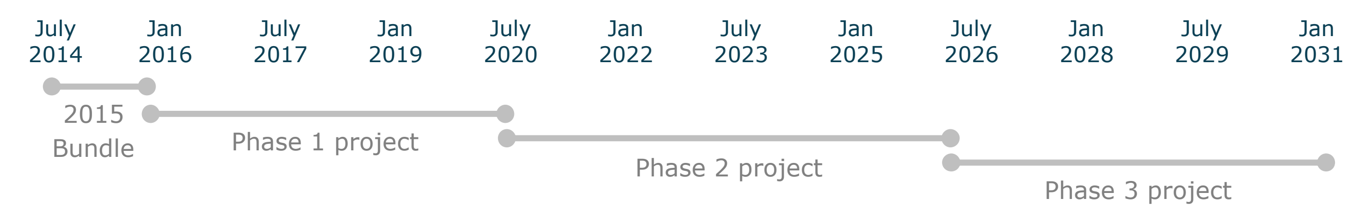
$TBD
Annual Utility Savings

TBD

TBD MT CO_2e/yr
Carbon Dioxide

IMPLEMENTATION TIMING

Given the poor financial returns, it is not recommended that window film not be considered unless driven by the need for new plug strips.



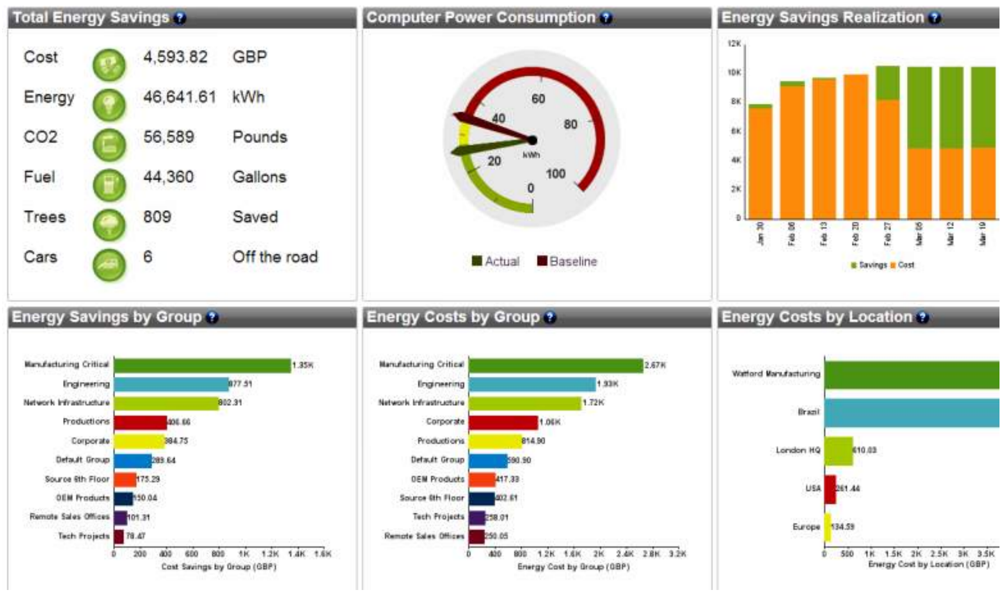
[11] Graphic from: http://www.efficiencyvermont.com/docs/for_my_business/publications_resources/RefrigerationGuideToSavings.pdf

3. Opportunities

16.00 Manage IT Energy Use

GENERAL DESCRIPTION

Centralized software solutions for PC power management help to actively manage and track PC power states and device utilization. With this information, PCs can be better controlled and managed to reduce energy use in a reliable way. This measure involves deploying aggressive PC power management across the entire VMMC desktop fleet of 6,000 PCs.[12]



KEY ASSUMPTIONS

Cost and savings potential is implementing PC power management across 6,000 desktop PCs.

NEXT STEPS

Deployment of the audit software on a sample of PCs will help identify the true opportunity at VMMC by documenting the off, sleep, and on states of the CPU for each device. Costs and savings can then be refined. Investigation of print management strategies to reduce ink and paper expenditure is also warranted. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure with few non-energy benefits.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

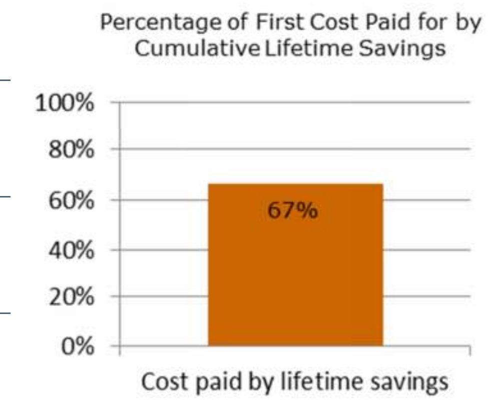
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

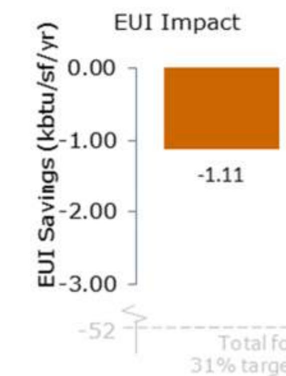
$304,500
First Cost

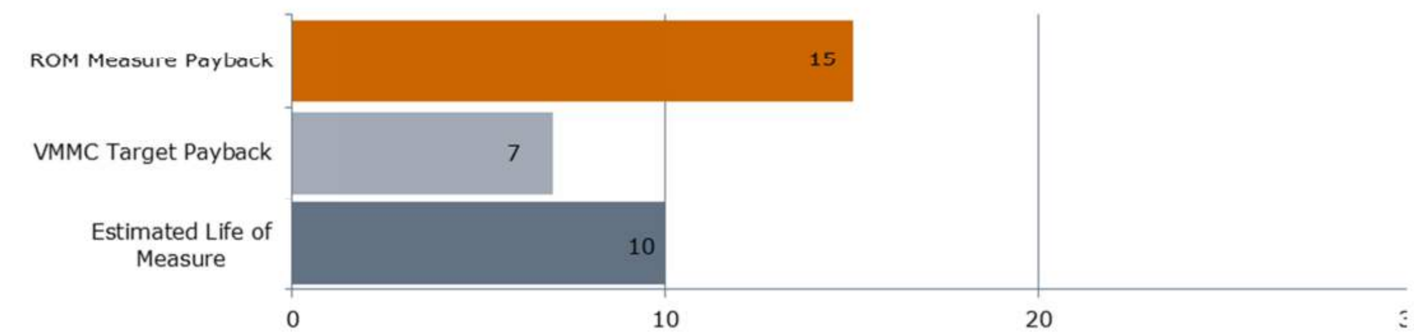
$20,300
Annual Utility Savings

330,000 kWh/yr electric

127 MT CO2e/yr
Carbon Dioxide







IMPLEMENTATION TIMING

It is recommended that this measure be implemented as a Phase 3 project.

[12] Example dashboard from: http://www.verdiem.com/products/pc-power-management

3. Opportunities

16.00 Plug Load Controls

GENERAL DESCRIPTION

As the efficiency of building envelopes, HVAC, and lighting systems increases, the percentage of energy use apportioned to “plug loads” in buildings is growing. Office equipment is often left on at night or during breaks during the day. Even when turned off, vampire loads draw power. This measure involves providing smart plug strips for all office workers based on timer, load sensing, and/or motion sensing and providing vending misers for all beverage and snack machines.[13]

KEY ASSUMPTIONS

Cost and savings potential is based on providing 1,000 smart plug load strips to control workstations (excepting PCs and monitors which are accounted for in the IT measure) at an average of 0.5W/sf. The measure also includes vending misers for vending machines.

NEXT STEPS

Prior to making a large purchase, a small sample pilot could be tested to determine how staff engages with the plug strips. If desired, energy use per workstation could be measured using a power meter to measure actual pre and post energy use. Additionally, looking at opportunities to remove excess equipment (personal mini-fridges, space heaters, etc.) that are not in line with VMMC policy could be explored. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is an energy saving measure that also enhances staff awareness regarding energy efficiency and resource conservation.

ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

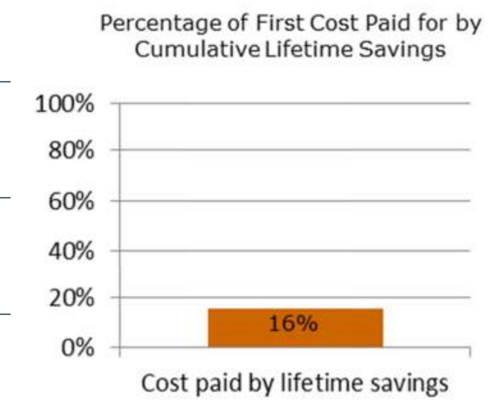
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

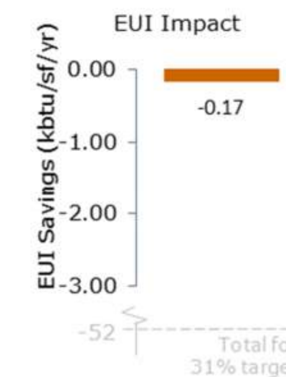
$291,100 First Cost

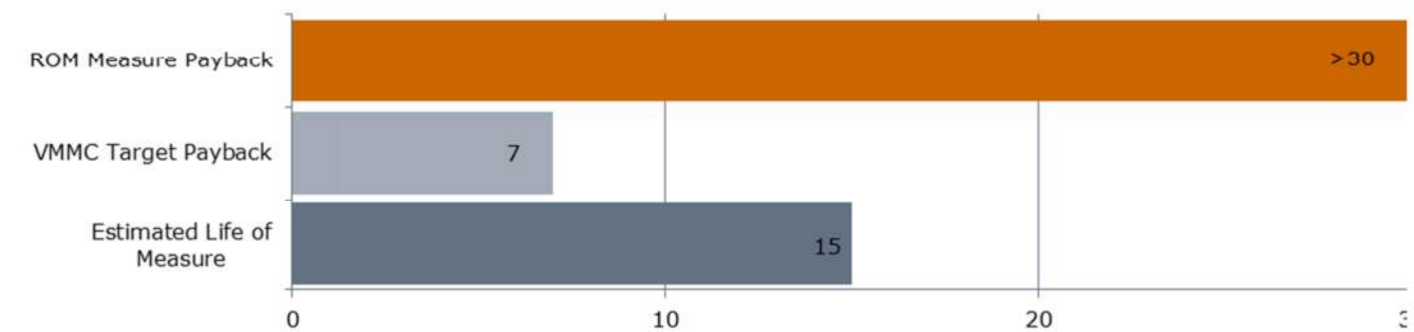
$3,000 Annual Utility Savings

49,500 kWh/yr electric

19 MT CO2e/yr Carbon Dioxide







IMPLEMENTATION TIMING

It is recommended that this measure be implemented as a Phase 3 project.

[13] Image from: http://www.bpa.gov/EE/Sectors/Commercial/Pages/Plug-Load.aspx

3. Opportunities

18.00 Plumbing Fixture Water Conservation (main, BRI, and INNs)

GENERAL DESCRIPTION

During the audit, a variety of flow rates and performance characteristics in toilets, urinals, sinks, and showers were found throughout the Central Pavilion, Buck, Jones, Lindeman, HRB, Benaroya Research Institute, The Inn at VM, and the Baroness Hotel. By recommissioning and rebuilding valve bodies, the individual performance of each fixture can be improved while also saving water. This measure also includes new water efficient aerators on sinks and new water efficient showerheads.

KEY ASSUMPTIONS

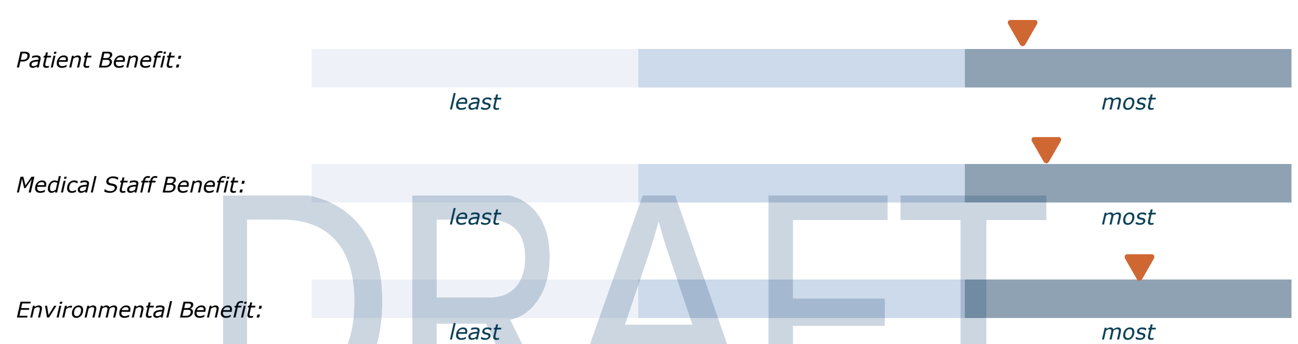
Cost and savings potential is based on recommissioning, tuning, and upgrading toilet, sink, and shower components identified during the detailed water audit.

NEXT STEPS

As the detailed audit for this measure has already been completed, discussion with VMMC staff will help determine whether implementation is desired. Discussion with SCL, PSE, and/or SPU will help identify available utility rebates.

NON-ENERGY MEASURE IMPACTS

This is a water and energy saving measure with benefits including better system performance for occupants and reduced maintenance for facilities staff.



ROUGH ORDER OF MAGNITUDE RESULTS BASED ON KEY ASSUMPTIONS

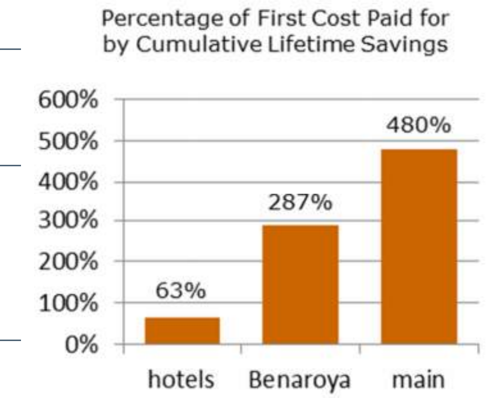
First cost, annual cost savings, annual energy savings, greenhouse gas savings, measure payback, and the cost of the measure paid for by the present value of the savings over the life of the measure are provided.

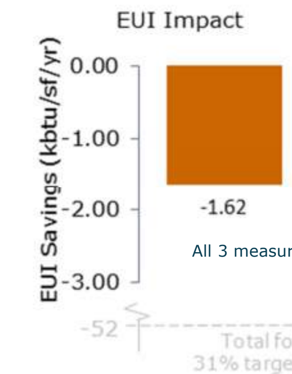
$142,800 – hotels
$28,600 – Benaroya
$377,400 – main
First Cost

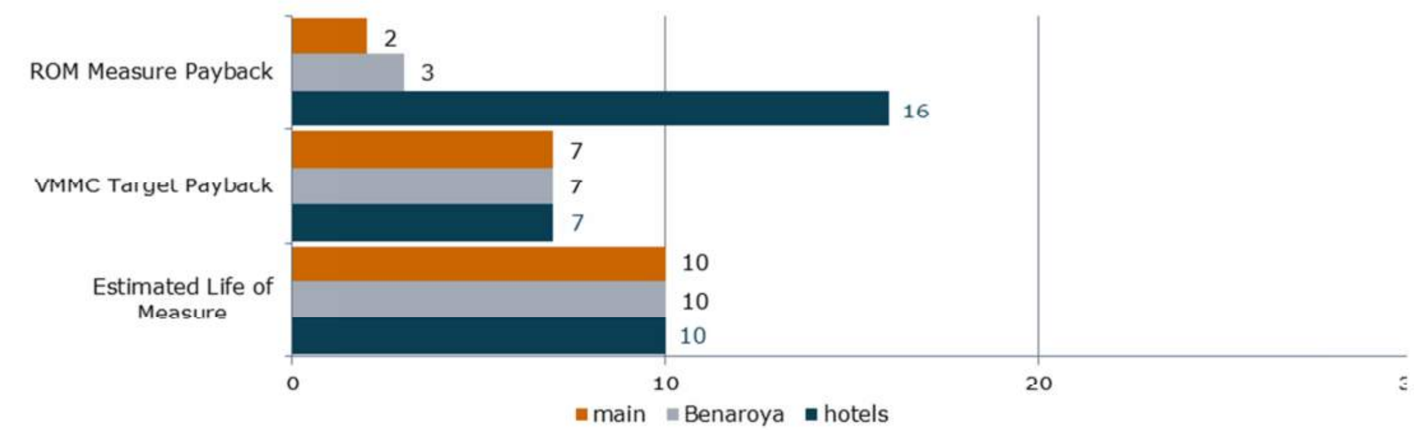
$8,300 – hotels
$8,100 – Benaroya
$178,500 – main
Annual Utility Savings

100 klbs/yr steam – hotels
400 CCF kWh/yr electric – hotels
100 klbs/yr steam – Benaroya
400 CCF kWh/yr electric – Benaroya
1200 klbs/yr steam – Benaroya
8500 CCF kWh/yr electric – Benaroya

5 MT CO2e/yr Carbon Dioxide – hotels
8 MT CO2e/yr Carbon Dioxide – Bena
122 MT CO2e/yr Carbon Dioxide - main







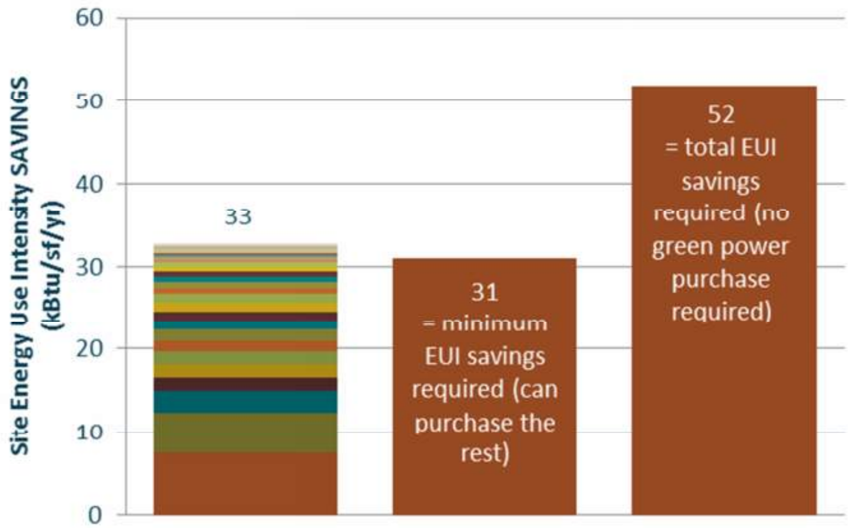
IMPLEMENTATION TIMING

Given the good financial returns and positive impact on medical staff, it is recommended that this measure be implemented as soon as possible.

3.5. FIM SAVINGS RESULTS

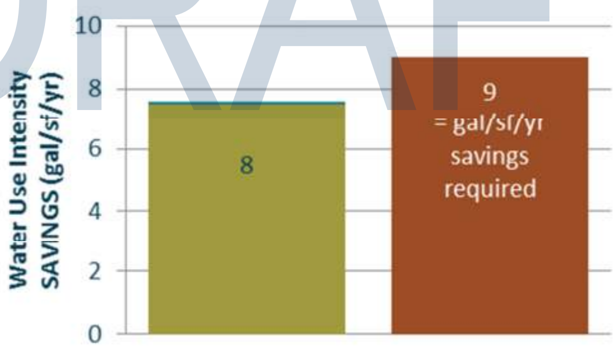
When the cost and savings for all the measures quantified to date are summed together, the bigger picture becomes clear: **achieving the 2030 district energy target is possible, though challenging**. When all measures are summed, the total EUI savings is ~33, just above the minimum required of 31 kBtu/sf/yr. Note that the chart below excludes measures that either have no savings, are not part of the main campus, or are for fuel switching purposes (e.g. combined heat and power).

Figure 26: Combined Energy Savings of all Quantified Measures



Regarding water, reaching the 20% reduction target is within reach. Note that as the targets discussed in this report are only for the main campus, the savings shown below exclude those for the Inns and Benaroya. Note that the additional water savings required to meet the 20% goal could be achieved if DCPM specifies pint flush urinals, WaterSense toilets, WaterSense showerheads, and WaterSense laminar flow tips for any remodel projects when they occur.

Figure 27: Combined Water Savings of all Quantified Measures



3. Opportunities

3.6. FIM COST AND SAVINGS SUMMARY

The total cost of all quantified measures is approximately **$31 million** with savings of approximately **$1.6 million** for an overall payback of roughly **19 years**. However, as articulated in the individual FIM sheets, some measures are more attractive than others, and bundling them makes sense. The bundles are described in the roadmap section. **Also of note is that two of the measures (Combined Heat and Power and the Tier 2 Boiler) have negative site EUI impacts and positive source EUI impacts. A discussion must be had with the 2030 district to better understand their stance on site versus source and how that affects members who wish to reduce their reliance on district steam systems.**

Details on all individual measures can be found in the table on the following page.

3.7. OTHER OPPORTUNITIES NOT YET QUANTIFIED

In addition to the ideas already quantified, there is a host of other ideas for VMMC to consider (not to mention new emerging technologies that may be available in the next 5 – 10 years). These additional ideas include:

- Medical equipment behavioral management program;
- Electric sub-metering;
- Add daylight sources when roofs are replaced;
- Check for compressed air leaks;
- Investigate the possibility of a green roof;
- Rainwater harvesting;
- On-site sewage treatment;
- OR LED lighting;
- Daylight controls;
- Drain water heat recovery;
- Demand control ventilation for the few larger gathering spaces on campus;
- Cooling tower VFD (already planned for implementation); and
- Domestic hot water heat pumps.

3. Opportunities

Table 6: Measure and Bundle Savings Summary Table – Rough Order of Magnitude

FIM Name	Annual kW Savings	Annual kWh Savings	Annual Therm Savings	Annual Steam klb Savings	Annual CCF Savings	EUI Impact kBtu/sf/yr	Annual CO2 Savings (Metric Tons)	Annual Utility Savings	Annual Operational Savings	Total Annual Savings	First Cost	Potential Incentives	Net Cost (After Incentives)	Measure Life	Simple Payback (yrs)	Cost paid for by Lifetime Savings (%)	Bundle
18.00 Plumbing Fixture Water Efficiency (main)	0	0	0	1,380	9,494	1.63	122.1	$198,363	$2,766	$201,129	$377,365	TBD	$377,365	10.0	1.9	533%	2015 ROI
04.00 System Scheduling	0	155,965	0	1,760	0	2.61	215.6	$53,335	$0	$53,335	$58,442	TBD	$58,442	5.0	1.1	456%	2015 ROI
01.00 Mechanical Insulation	0	0	0	555	0	0.66	70.1	$13,800	$0	$13,800	$61,137	TBD	$61,137	20.0	4.4	451%	2015 ROI
03.00 DAT Reset	0	18,679	0	534	0	0.69	54.4	$14,423	$0	$14,423	$55,733	TBD	$55,733	15.0	3.9	388%	2015 ROI
09.00 Lindeman LED Lighting	0	393,822	0	0	0	1.33	151.3	$24,194	$29,607	$53,801	$399,508	$93,520	$305,988	20.0	5.7	352%	2015 ROI
04.00 Air Change Reduction via Rebalancing	0	84,844	0	916	0	1.37	113.6	$27,984	$0	$27,984	$129,131	TBD	$129,131	15.0	4.6	325%	2015 ROI
18.00 Plumbing Fixture Water Efficiency (Benaroya)	0	0	0	89	390	0.11	7.9	$8,952	$159	$9,111	$28,592	TBD	$28,592	10.0	3.1	319%	2015 ROI
09.00 Buck LED Lighting	0	380,446	0	0	0	1.29	146.2	$23,372	$28,776	$52,148	$430,421	$92,701	$337,720	20.0	6.5	309%	2015 ROI
02.01 Heat Recovery Chiller	-418	-354,158	10,487	4,343	637	4.98	333.4	$96,918	$2,500	$99,418	$1,100,000	$90,000	$1,010,000	30.0	10.2	295%	2015 ROI
09.00 HRB LED Lighting	0	104,938	0	0	0	0.35	40.3	$6,447	$8,239	$14,686	$142,656	$25,631	$117,025	20.0	8.0	251%	2015 ROI
01.00 Lindeman Boiler to DHW Heat Exchanger	0	0	-5,500	450	0	-0.01	10.6	$5,899	$0	$5,899	$78,578	TBD	$78,578	30.0	13.3	225%	2015 ROI
13.00 Weatherization	0	1,318	0	484	0	0.58	72.1	$12,103	$0	$12,103	$35,870	TBD	$35,870	5.0	3.0	169%	2015 ROI
03.00 Kitchen Hoods	0	97,154	12,480	0	0	1.56	103.6	$17,967	$0	$17,967	$160,403	TBD	$160,403	15.0	8.9	168%	2015 ROI
18.00 Plumbing Fixture Water Efficiency (hotels)	0	0	0	57	452	0.07	5.0	$9,228	$660	$9,888	$142,835	TBD	$142,835	10.0	14.4	69%	2015 ROI
04.00 Duct Static Pressure Reset	0	57,444	0	0	0	0.19	22.1	$3,529	$0	$3,529	$97,930	TBD	$97,930	15.0	27.8	54%	2015 ROI
15.00 Replace Kitchen Refrigeration Equipment	0	6,307	0	0	0	0.02	2.4	$387	$0	$387	$35,870	TBD	$35,870	30.0	92.6	32%	2015 ROI
2015 ROI Subtotal	***-418***	***947,000***	***17,000***	***11,000***	***11,000***	***17***	***1,500***	***$517,000***	***$73,000***	***$590,000***	***$3,334,000***	***$302,000***	***$3,033,000***	***-***	***5.1***	***-***	***-***
01.01 Tier 1x Electric	0	0	0	0	0	0.00	0.0	$0	$0	$0	$1,700,000	TBD	$1,700,000	30.0	0.0	0%	2015 Capital
2015 Capital Subtotal	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***$0***	***$0***	***$0***	***$1,700,000***	***TBD***	***$1,700,000***	***-***	***-***	***-***	***-***
01.00 Tier 2 Boiler Measure	-473	-120,124	-573,678	33,963	-1,343	-17.05*	526.5	$261,458	$0	$261,458	$4,500,000	TBD	$4,500,000	30.0	17.2	174%	Phase 1
Phase 1 Subtotal	***-473***	***-120,000***	***-574,000***	***34,000***	***-1,000***	***0***	***526***	***$261,000***	***$0***	***$261,000***	***$4,500,000***	***TBD***	***$4,500,000***	***-***	***17.2***	***-***	***-***
07.00 Combined Heat and Power	0	6,570,000	-747,228	30,568	0	-15.6*	1,259.9	$445,113	$0	$445,113	$5,542,754	TBD	$5,542,754	30.0	12.5	241%	Phase 2
06.00 Ozone Laundry at the Inn at VM	0	0	6,444	0	372	0.64	34.2	$12,624	$0	$12,624	$84,635	TBD	$84,635	15.0	6.7	224%	Phase 2
03.00 Seal Air Ducts	0	33,938	0	366	0	0.55	45.4	$11,184	$0	$11,184	$179,350	TBD	$179,350	20.0	16.0	125%	Phase 2
04.00 High Efficiency Lab Hoods	0	27,757	0	354	0	0.51	42.0	$10,506	$0	$10,506	$178,378	TBD	$178,378	15.0	17.0	88%	Phase 2
03.00 Operating Room Air Setback	0	66,915	0	1,044	0	1.46	118.0	$30,065	$0	$30,065	$516,732	TBD	$516,732	15.0	17.2	87%	Phase 2
01.00 Permanent Monitoring of Steam Traps	0	0	0	900	0	1.06	79.6	$22,374	$0	$22,374	$561,681	TBD	$561,681	15.0	25.1	60%	Phase 2
03.00 Install Fan Wall	0	63,546	0	0	0	0.21	24.4	$3,904	$0	$3,904	$4,814,619	TBD	$4,814,619	30.0	1233.3	2%	Phase 2
Phase 2 Subtotal	***0***	***6,762,000***	***-741,000***	***33,000***	***400***	***4***	***2,000***	***$536,000***	***$0***	***$536,000***	***$11,900,000***	***TBD***	***$11,900,000***	***-***	***22.2***	***-***	***-***
08.00 High-efficiency Motors	0	202,638	0	0	0	0.68	77.8	$12,449	$0	$12,449	$402,034	TBD	$402,034	30.0	32.3	93%	Phase 3
03.00 Convert CV Systems to VAV Systems	0	761,408	0	4,056	0	7.37	651.3	$147,608	$0	$147,608	$4,834,783	TBD	$4,834,783	30.0	32.8	92%	Phase 3
16.00 Manage IT Energy Use	0	330,000	0	0	0	1.11	126.8	$20,273	$0	$20,273	$304,547	TBD	$304,547	10.0	15.0	67%	Phase 3
03.00 Destratification Fans	0	-1,156	0	37	0	0.04	2.8	$849	$0	$849	$50,218	TBD	$50,218	30.0	59.2	51%	Phase 3
03.00 Runaround Heat Recovery	0	3,575	0	852	0	1.02	76.7	$21,400	$0	$21,400	$1,267,878	TBD	$1,267,878	30.0	59.2	51%	Phase 3
01.00 Condensate Heat Recovery	0	0	0	239	0	0.28	21.1	$5,942	$0	$5,942	$214,060	TBD	$214,060	15.0	36.0	42%	Phase 3
02.00 Increase CHW Delta T	0	56,867	0	0	0	0.19	21.8	$3,494	$0	$3,494	$326,582	TBD	$326,582	30.0	93.5	32%	Phase 3
13.00 Window Film	0	126	0	62	0	0.07	5.5	$1,549	$0	$1,549	$150,654	TBD	$150,654	30.0	97.3	31%	Phase 3
10.00 Solar PV	0	16,708	0	0	0	0.06	6.4	$1,026	$0	$1,026	$107,610	TBD	$107,610	30.0	104.8	29%	Phase 3
13.00 Single Pane Glazing Upgrade	0	253	0	209	0	0.25	18.6	$5,211	$0	$5,211	$903,924	TBD	$903,924	30.0	173.5	17%	Phase 3
16.00 Plug Load Controls	0	49,512	0	0	0	0.17	19.0	$3,042	$0	$3,042	$291,110	TBD	$291,110	15.0	95.7	16%	Phase 3
13.00 Electrochromic Windows	0	415	0	160	0	0.19	14.3	$4,003	$0	$4,003	$1,280,559	TBD	$1,280,559	30.0	319.9	9%	Phase 3
12.00 Condensate Reuse	0	0	0	0	113	0.00	0.0	$615	$0	$615	$256,710	TBD	$256,710	30.0	417.6	7%	Phase 3
Phase 3 Subtotal	***0***	***1,420,000***	***0***	***6,000***	***113***	***11***	***1,000***	***$227,000***	***$0***	***$227,000***	***$10,391,000***	***TBD***	***$10,391,000***	***-***	***45.8***	***-***	***-***
TOTAL	***-891***	***9,009,000***	***-1,297,000***	***83,000***	***10,000***	***33***	***5,000***	***$1,542,000***	***$73,000***	***$1,614,000***	***$31,803,000***	***TBD***	***$31,501,000***	***-***	***19.5***	***-***	***-***

* Not included in totals

4. Roadmap

4. Roadmap

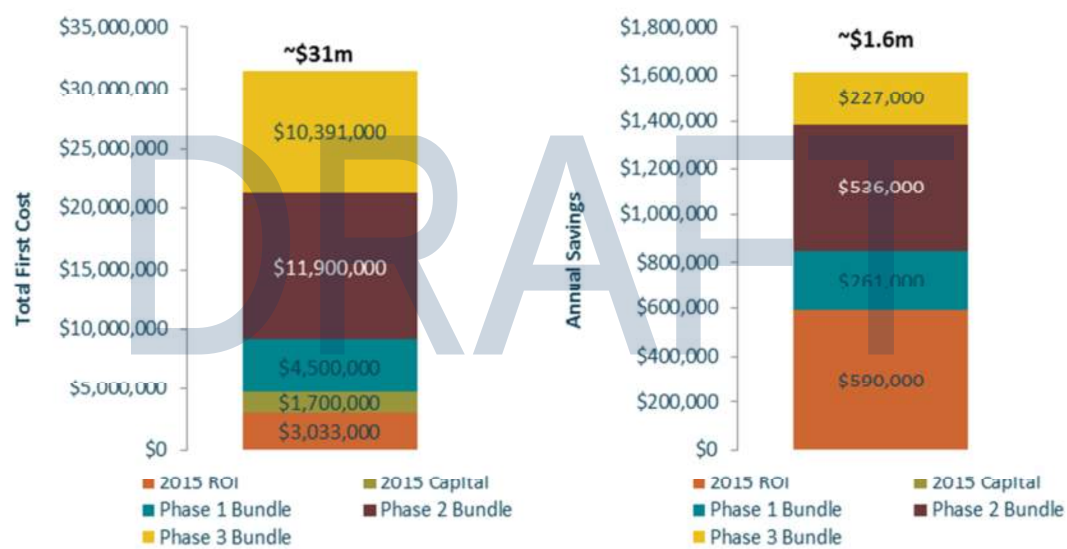
4.1. OVERVIEW

Often there is a "right order" in which to implement efficiency measures. Reducing demand or load prior to purchasing new cooling or heating equipment is an example. Other times, the order is dictated by a specific need. For example, a tenant remodeling project creates an ideal opportunity to piggyback an efficiency measure on a planned capital expenditure. Piecing together the right order in which to implement efficiency measures for VMMC includes quantifying all the measures and considering capital needs. With this in mind, five bundles have been created with the intent that they get completed over time:

- 2015 ROI Bundle
- 2015 Capital Bundle
- Phase 1 Bundle
- Phase 2 Bundle
- Phase 3 Bundle

As shown in the detailed measure table in the prior section, the "quick-win" or shorter-term measures are proposed for the first bundle cycles while the longer-term measures that must be coordinated with need-based capital replacements are proposed for later phases. **Importantly, the roadmap provided is just one pathway for implementation.** New technologies may be on the horizon in ten years that may be more advantageous to implement than those currently proposed. As such, revisiting the roadmap every funding cycle will be important in order to keep the plan technologically relevant as well as in concert with new capital plans.

Figure 28: Total Cost and Savings of all Quantified Measures



4. Roadmap

4.2. ROADMAP

The roadmap below shows which measures end up in which bundle (just one option).

Figure 29: Implementation Roadmap

ROI Bundle

- *01.00 Lindeman Boiler to DHW Heat Exchanger*
- *01.00 Mechanical Insulation*
- *02.01 Heat Recovery Chiller*
- *03.00 DAT Reset*
- *03.00 Kitchen Hoods*
- *04.00 Air Change Reduction via Rebalancing*
- *04.00 Duct Static Pressure Reset*
- *09.00 Buck LED Lighting*
- *09.00 HRB LED Lighting*
- *09.00 Lindeman LED Lighting*
- *13.00 Weatherization*
- *18.00 Plumbing Fixture Water Efficiency (Benaroya)*
- *18.00 Plumbing Fixture Water Efficiency (main)*
- *18.00 Plumbing Fixture Water Efficiency (hotels)*

Capital Bundle

- *Tier 1X Electric Boiler*

Phase 1

- *01.00 Tier 2 Boiler Measure*

Phase 2

- *01.00 Permanent Monitoring of Steam Traps*
- *03.00 Install Fan Wall*
- *03.00 Operating Room Air Setback*
- *03.00 Seal Air Ducts*
- *04.00 High Efficiency Lab Hoods*
- *06.00 Ozone Laundry at the Inn at VM*
- *07.00 Combined Heat and Power*

Phase 3

- *01.00 Condensate Heat Recovery*
- *02.00 Increase CHW Delta T*
- *03.00 Convert CV Systems to VAV Systems*
- *03.00 Destratification Fans*
- *03.00 Runaround Heat Recovery*
- *08.00 High-efficiency Motors*
- *10.00 Solar PV*
- *12.00 Condensate Reuse*
- *13.00 Electrochromic Windows*
- *13.00 Window Film*
- *16.00 Manage IT Energy Use*
- *16.00 Plug Load Controls*

5. Appendices

5. Appendices

5.1. APPENDIX A: 2030 DISTRICT BASELINES

Table 7: CBECS 2003 Table C3 Data

	Number of Buildings (thousand)	Floorspace (million square feet)	Floorspace per Building (thousand square feet)	Total (trillion Btu)	per Building (million Btu)	per Square Foot (thousand Btu)	per Worker (million Btu)
All Buildings*	4,645	64,783	13.9	5,820	1,253	89.8	79.9
Principal Building Activity							
Education	386	9,874	25.6	820	2,125	83.1	65.7
Food Sales	226	1,255	5.6	251	1,110	199.7	175.2
Food Service	297	1,654	5.6	427	1,436	258.3	136.5
Health Care	129	3,163	24.6	594	4,612	187.7	94.0
Inpatient	8	1,905	241.4	475	60,152	249.2	127.7
Outpatient	121	1,258	10.4	119	985	94.6	45.8
Lodging	142	5,096	35.8	510	3,578	100.0	207.5
Retail (Other Than Mall)	443	4,317	9.7	319	720	73.9	92.1
Office	824	12,208	14.8	1,134	1,376	92.9	40.3
Public Assembly	277	3,939	14.2	370	1,338	93.9	154.5
Public Order and Safety	71	1,090	15.5	126	1,791	115.8	93.7
Religious Worship	370	3,754	10.1	163	440	43.5	95.6
Service	622	4,050	6.5	312	501	77.0	85.0
Warehouse and Storage	597	10,078	16.9	456	764	45.2	104.3
Other	79	1,738	21.9	286	3,600	164.4	157.1
Vacant	182	2,567	14.1	54	294	20.9	832.1

Table 8: Seattle 2030 District Water Baseline

PREDOMINANT BUILDING USE	GAL/SF/YR	ADDITIONAL METRICS OF INTEREST
Restaurant	125.99	119 Gal/Employee/Day
Hotel	50.07	70 Gal/Room/Day
Multi-Family Residential	41.14	42 Gal/Resident/Day
Social/meeting	36.95	
Industrial	32.53	
Nursing/Assisted Living	30.11	
Hospital	26.12	53 Gal/Bed/Day
Retail	24.77	41 Gal/Employee/Day
Medical Office	21	32 Gal/Employee/Day
Office	14.21	
Warehouse	13	
Entertainment/culture	12.88	
Service (vehicle repair/service, postal service)	11.74	
House of Worship	11.31	
K-12 School	11.09	

Table 1. Seattle 2030 District Water Use Intensity Baselines
Source: Seattle 2030 District, Seattle public Utilities, and the Partnership for Water Conservation

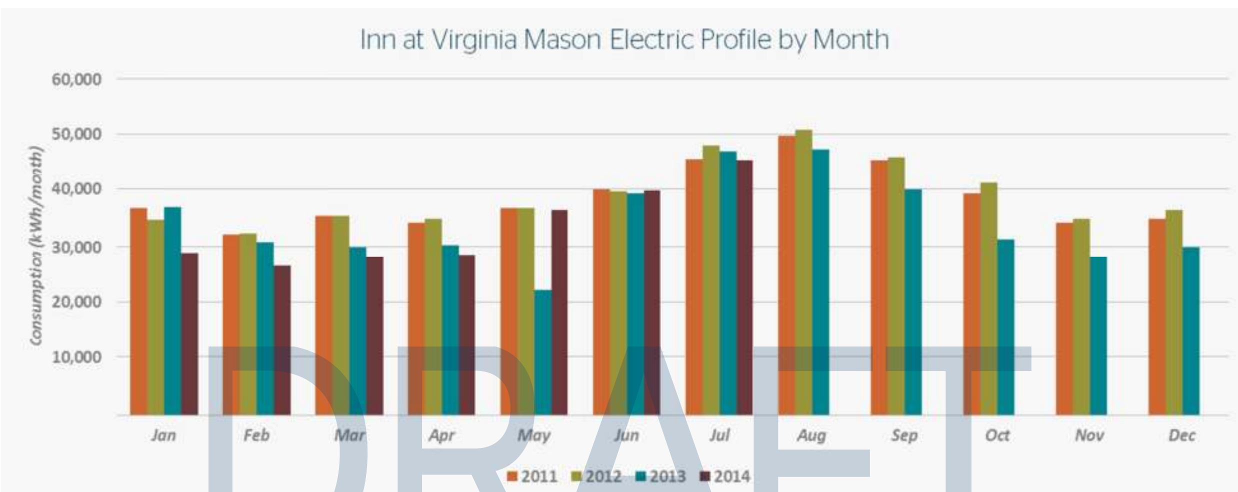
5. Appendices

5.2. APPENDIX B: INN AT VM AND BARONESS UTILITY DATA

Building	Inn at Virginia Mason
Address	1006 Spring St Seattle wa 98104
Square Footage	48,006

Baseline Performance Summary for	**1/1/2013**	to	**12/1/2013**
	Value	Units	Notes
Electricity Use	413,340	kWh/yr	
Natural Gas Use	12,080	therms/yr	
Purchased Steam Use	0	klb/yr	
Fuel Oil Use	0	gal/yr	
Water Use	4,255	CCF/yr	
CO2e Emissions	222.9	metric tons/yr	
Energy Cost Intensity	$0.72	$/sf/yr	
Utility Cost Intensity	$2.21	$/sf/yr	
Energy Use Intensity	55	kBtu/sf/yr	
Water Use Intensity	66.3	gal/sf	
CO2e Emissions Intensity	10.2	lbs CO2/sf	

* note that some steam used at the Inn is not accounted for in these metrics



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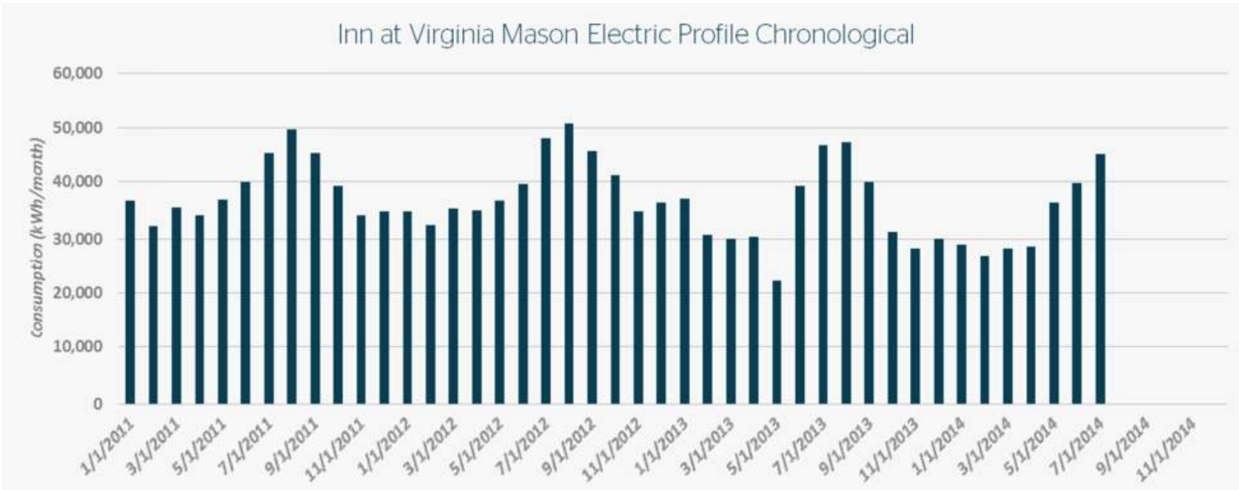

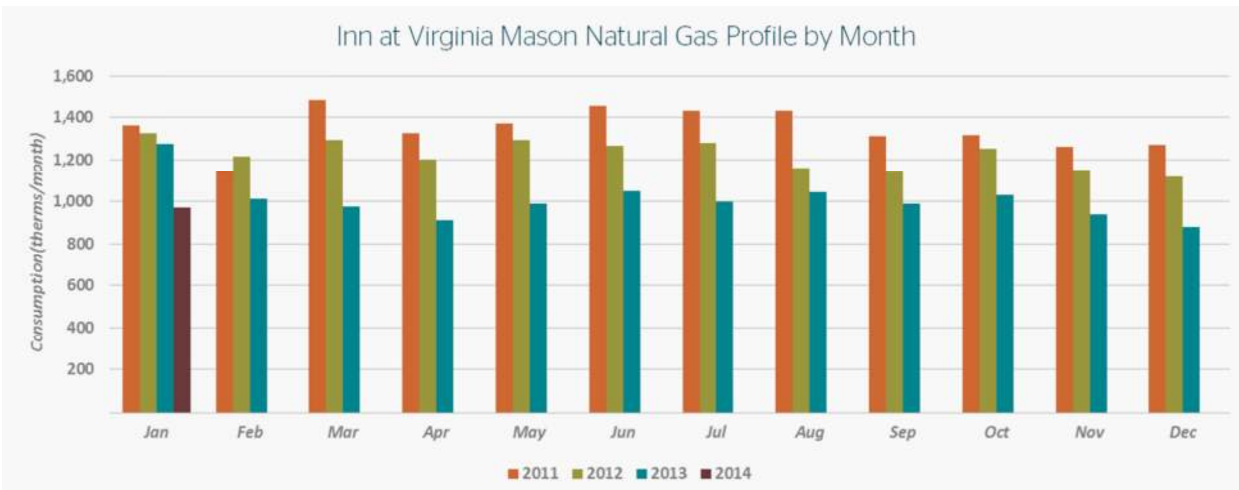

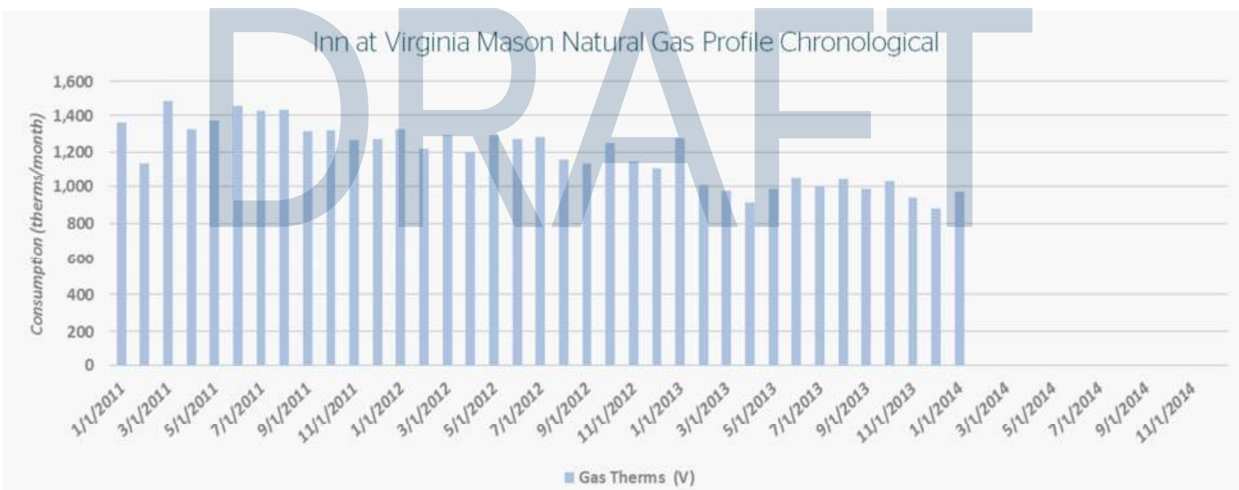

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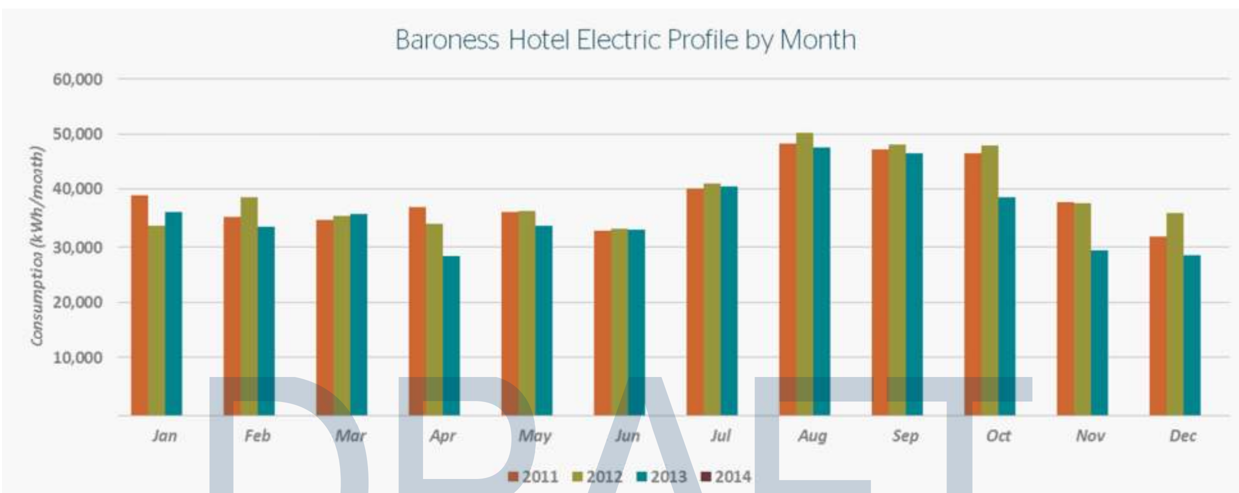
Building	Baroness Hotel
Address	1005 Spring St Seattle wa 98104
Square Footage	35,770

Baseline Performance Summary for	1/1/2013	to	12/1/2013
	Value	Units	Notes
Electricity Use	432,041	kWh/yr	
Natural Gas Use	21,681	therms/yr	
Purchased Steam Use	0	klb/yr	
Fuel Oil Use	0	gal/yr	
Water Use	0	CCF/yr	
CO2e Emissions	281.1	metric tons/yr	
Energy Cost Intensity	$1.18	$/sf/yr	
Utility Cost Intensity	$1.18	$/sf/yr	
Energy Use Intensity	102	kBtu/sf/yr	
Water Use Intensity	0.0	gal/sf	
CO2e Emissions Intensity	17.3	lbs CO2/sf	



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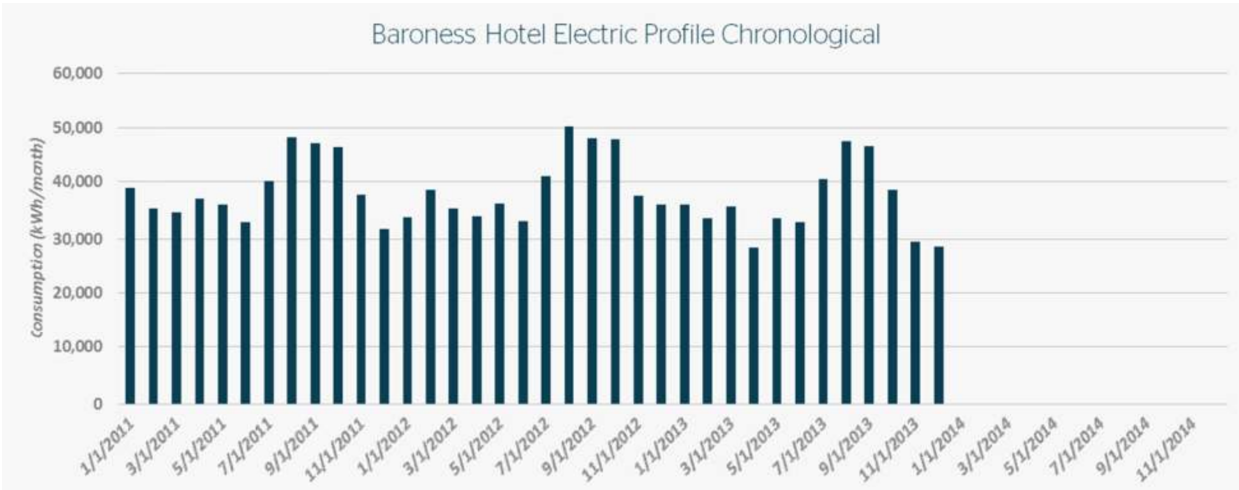

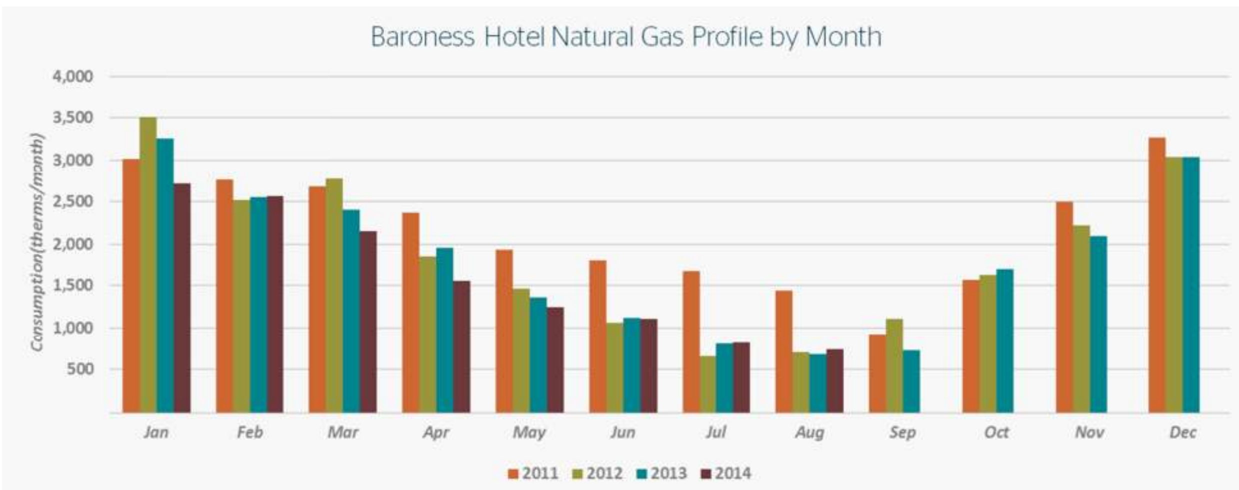

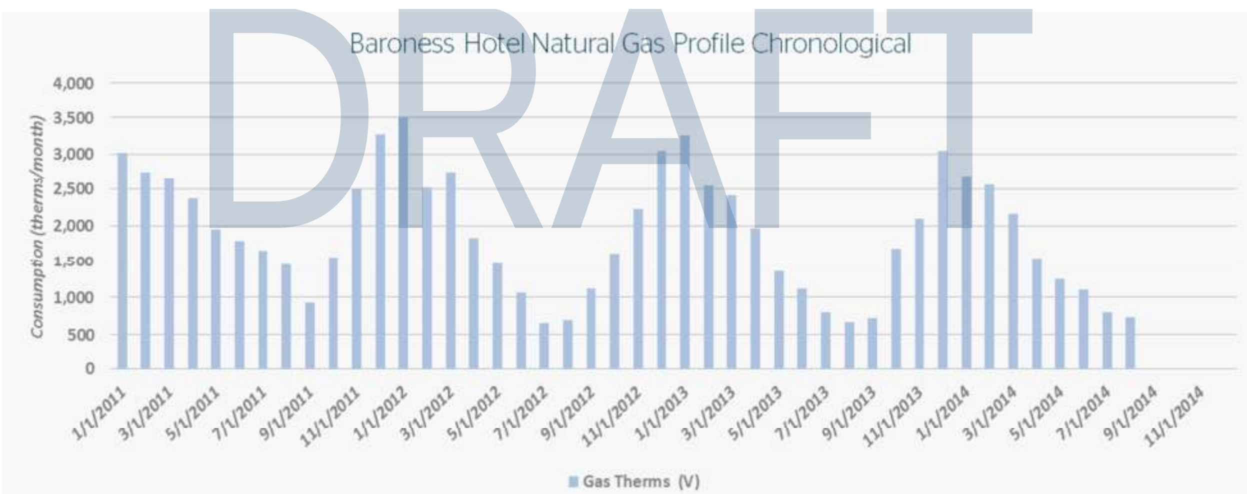

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5.3. APPENDIX C: KEY RESOURCES

- *Healthcare without Harm:* https://noharm.org/
- *The Green Guide for Health Care:* http://www.gghc.org/
- *Practice Greenhealth:* https://practicegreenhealth.org/
- *Portfolio Manager:* http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager
- *Seattle 2030 District:* http://www.2030districts.org/seattle
- *American Society for Healthcare Engineering:* http://www.ashe.org/
- *EnviroMason:* https://www.virginiamason.org/EnviroMason
- *Targeting 100!* http://idlseattle.com/t100/

5. Appendices

5.4. APPENDIX D: PRE-ROM SCOPES OF WORK

Please refer to the Boiler and Heat Recovery Chiller Development Compilation Report dated December 5, 2014 for details on the Tier 1 Boiler, Tier 2 Boiler, and Heat Recovery Chiller measures.

Detailed Scope of Work

FIM ID # 26596
01.00 Condensate Heat Recovery
Virginia Mason Downtown Campus

GENERAL

Once steam transfers its heat to a heat exchanger or heating coil, it changes into its liquid form of hot condensate. In most cases at VMMC, this hot condensate is piped to a condensate heat recovery unit so that additional heat can be recovered. In a few isolated cases, the hot condensate goes directly down the sewer without having any heat recovered. This measure involves eliminating those few remaining instances where heat is not currently recovered (fire pump room, ICU, and hot water tanks on 7th floor east wing roof garden).

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Install water to water heat exchanger. Hot side is steam condensate, cold side is domestic water make-up.
      1) 5 gpm condensate. 200 deg EWT, 160 deg LWT.
      2) 5 gpm city water. 60 deg EWT, 100 deg LWT.
   B. Install 5 gpm ½ hp condensate receiver/pump.
   C. Provide 50 feet on new insulated condensate pipe.
2. Controls
   A. Provide 3-way valve to control condensate. Controlled by ATS.
3. Electrical
   A. Power to new ½ hp pump.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Start-up new system.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. Provide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26901
01.00 Lindeman Boiler to DHW Heat Exchanger
Virginia Mason Downtown Campus

GENERAL

Lindeman Pavilion has three natural gas heating water boiler, but the domestic hot water is still produced via Seattle Steam which has a much higher cost per BTU than natural gas. This measure will use the spare natural gas existing boiler capacity to produce domestic hot water (DHW). This will be accomplished by installing a heat exchanger between the heating water and DHW systems.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Provide a plate and frame heat exchanger and piping to pre-heat the domestic hot water using the heating water.
   B. This will a single heat exchanger, and the piping is very short since the boilers sit 6' away from the DHW make-up.
   C. A pump may be needed on the heating water side, but city pressure will provide flow on the DHW side..
   D. The steam heat exchangers will remain in place for very cold days and to serve as redundancy and trim.
2. Controls
   A. Provide controls for the new heat exchanger.
3. Electrical
   A. Not applicable unless a pump is added.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26449
01.00 Mechanical Insulation
Virginia Mason Downtown Campus

GENERAL

Any piping that carries a fluid that is hotter or colder than the surrounding space will transfer energy to that space. At VMMC, the vast majority of all piping is well insulated, however some spots of uninsulated hot water and steam pipe for domestic hot water or space heating remain. Insulating this remaining piping will reduce unnecessary heat losses and reduce steam and natural gas use and annual operating cost.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Insulate 30 feet of 2” steam pipe.
   B. Insulate 30 feet of 4” steam pipe.
   C. Insulate 30 feet of 6” steam pipe.
   D. Insulate 20 steam valves.
   E. Insulate 30 feet of 2” HW pipe.
   F. Insulate 30 feet of 4” HW pipe.
   G. Insulate 30 feet of 6” HW pipe.
   H. Insulate 20 HW valves.
   I. Insulate 30 feet of 2” DHW pipe.
   J. Insulate 30 feet of 4” DHW pipe.
   K. Insulate 30 feet of 6” DHW pipe.
   L. Insulate 20 DHW valves.
   M. Insulate 30 feet of 2” condensate pipe.
   N. Insulate 30 feet of 4” condensate pipe.
   O. Insulate 30 feet of 6” condensate pipe.
   P. Insulate 20 condensate valves.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should

contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26450
01.00 Permanent Monitoring of Steam Traps
Virginia Mason Downtown Campus

GENERAL

Properly operating steam traps open to remove condensate and noncondensable gases from a steam system, while limiting steam loss. Malfunctioning steam traps can operate improperly for years, wasting steam and money. The installation of permanent wireless steam trap monitors will identify issues immediately and save resources. Though it can be cost-prohibitive to monitor all traps in a facility, monitoring the largest traps can be beneficial.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Install temperature sensors downstream of 75 steam traps. Connect to Alerton BAS.
   B. Install Spirax/Sarco continuous steam trap monitoring for 75 steam traps.
      1) http://www2.spiraxsarco.com/pdfs/SB/s34_01.pdf
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26478
02.00 Increase CHW Delta T
Virginia Mason Downtown Campus

GENERAL

Given that the cooling BTUH delivered is proportional to the chilled water flow rate (GPM) as well as the temperature difference between the chilled water supply and chilled water return (delta T), if the delta T decreases, the GPM must increase to meet the same load. An increase in GPM causes an increase in pumping energy and can cause an additional chiller to come online when it is not needed (and operate at an inefficient point on its operating curve). This measure involves the installation of high-end pressure independent chilled water valves to increase and better manage the delta T between the chilled water supply and the chilled water return temp.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Install CHW 2-way valves provide by control contractor. (Note that some existing valves will be 3-way valves)
      1) Valve size Qty
      2) 2" 3
      3) 2 1/2" 6
      4) 3" 8
      5) 4" 5
      6) 5" 2
      7) 6" 3.
2. Controls
   A. Provide 2 way CHW Delta P valves to be installed by mech contractor.
      1) Valve size Qty
      2) 2" 3
      3) 2 1/2" 6
      4) 3" 8
      5) 4" 5
      6) 5" 2
      7) 6" 3.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and

Detailed Scope of Work

our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.

2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26442
03.00 Convert CV Systems to VAV Systems
Virginia Mason Downtown Campus

GENERAL

The majority of the air handling systems in the main hospital are constant volume systems operating 24x7. The air for these systems is cooled to a low temperature to satisfy potentially only one or two zones. The remainder of the air is then re-heated to satisfy all of the other zones with less cooling load. Retrofitting these systems to variable air volume systems will save significantly on fan energy and reheat energy. To accomplish this, VAV terminals need to be installed in each space. This will most cost-effectively be accomplished in concert with a planned TI.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Non-Pressure critical spaces.
      1) Demo 250 existing reheat coils.
      2) Provide and install 250 VAV boxes (assume 10" boxes.) Non-fan powered. With HW coils. (
         (i) To reduce cost, a damper only option could be done, but we have priced as new VAV boxes with HW coils since the existing reheat coils are old.
      3) Add VFD to 10 AHUs. Assume 30 hp each.
      4) Replace 10 AHU motors. Assume 30 hp each.
   B. Pressure critical spaces.
      1) Provide 100 phoenix valves for exhaust. Valves provided by control contractor.
      2) Add VFD to 10 exhaust fans. Assume 20 hp each.
      3) Replace 10 exhaust fan motors. Assume 20 hp each.
2. Controls
   A. Provide VAV box controller and space temperature sensor for each new VAV box. VAV boxes provided by mech contractor.
   B. Provide phoenix valves to be installed by the mech contractor.
   C. Provide control to each new VFD supply.
   D. Provide control to each new VFD exhaust.
3. Electrical
   A. Provide electrical support for VFD and motor installation supply.
   B. Provide electrical support for VFD and motor installation exhaust.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Provide TAB for each new VAV box.
   B. Provide TAB (separate quote) for each new exhaust box.
9. Commissioning
   A. Start-up new VFDs.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts

Detailed Scope of Work

for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.

2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 21773
03.00 DAT Reset
Virginia Mason Downtown Campus

GENERAL

Implement a discharge air temperature (DAT) reset based on outside air temperature or zone demand using zone temp versus setpoint. When zone demand for cooling is low or OSA temperature is low, increase the discharge air temperature from the air handling unit to reduce the amount of zone reheat that occurs. Note this only applies to air handlers that are equipped with heat recovery or return air capability.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Implement DAT reset sequence.
      1) For AHUs that don't have downstream DDC, reset based on outside air temperature.
         (i) Assume qty 5 AHUs.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Commissioning
   A. Commission new sequence.
9. Demolition and Removal
   A. Not applicable.
10. Allotments
    A. Not applicable.
11. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
12. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
13. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. Hazardous material survey and abatement are excluded unless specifically noted in the scope above.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26483
03.00 Destratification Fans
Virginia Mason Downtown Campus

GENERAL

In spaces with tall ceilings, the air can stratify, pooling all the warm air at the ceiling instead of near the floor where occupants are located. Because the thermostat only senses the temperature 4-5' above the floor, additional heat is provided to ensure a comfortable temperature at occupant level while very warm temperatures are achieved above occupant level. This measure involves installing destratification ceiling fans in the lobby atrium area in the main entrance to help move warm air from the ceiling to the floor level. Because mixing the air decreases the temperature at the ceiling, it also decreases heat loss through the upper windows and walls.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Control via the Alerton BAS the single relay. Include two space temperature sensors, one mounted at ceiling height and one at 4' AFF.
3. Electrical
   A. Provide and install 4 25-120v Airius thermal equalizer fans including motors and mounting hardware.
   B. Provide necessary 120 volt power, conduit, etc.
   C. Provide single relay for control.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26486
03.00 Install Fan Wall
Virginia Mason Downtown Campus

GENERAL

Fan walls consist of multiple small fans stacked adjacent to each other to create an array. Fan walls can be a better choice than one large fan in cases where redundancy, installation space, noise, vibration, and energy efficiency are important. This measure involves providing fan arrays to replace existing supply fans and providing for VFDs on existing exhaust fans. This retrofit has already been completed on SF-2 at VMMC in the Terry Avenue mechanical room. The new fan arrays will drive energy savings through increased fan efficiency and reduced airflow during low occupancy periods. The fan arrays will also provide for redundancy should a fan motor fail.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Provide qty 10 fanwalls at 25,000 CFM each to replace existing fans.
      1) Demo as required.
   B. Replace qty 10 cooling coils.
   C. Replace qty 10 steam coils.
2. Controls
   A. Existing AHUs already have DDC so disconnect reconnect.
3. Electrical
   A. Provide electrical disconnect reconnect.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. During detailed design, deleting sound traps might be possible.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Balance new Fanwall to match existing.
9. Commissioning
   A. Commission and start-up new fan wall.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 21967
03.00 Kitchen Hoods
Virginia Mason Downtown Campus

GENERAL

This measure includes two components: 1) Schedule kitchen make-up air unit and kitchen exhaust fans off at night, and 2) Install VFDs on main kitchen exhaust fan and make-up air unit. The installation of VFDs will allow for variable speed operation of the make-up air unit and exhaust fans depending on the intensity of cooking and the associated sensed exhaust temp or specific pollutants. This measure will provide gas energy savings by lowering the amount of makeup air to the space that needs to be conditioned, as well as provide electrical energy savings by lowering the amount of fan energy that is used by the kitchen make-up air and exhaust systems.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Add Alerton BAS control of 3 exhaust fans and 3 make-up air units. Schedule off automatically at night. Provide button for each of the 3 hood for manual on in the morning.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Contact Melink for turn-key installed pricing.
      1) Refer to Melink worksheet.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Commission new controls.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. Provide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26443
03.00 Operating Room Air Setback
Virginia Mason Downtown Campus

GENERAL

An air setback reduces the amount of air supplied to an operating room when it is unoccupied, potentially also allowing temperature or humidity setpoints to vary from occupied conditions. This saves both fan energy and cooling and heating energy. Code requires a minimum air change rate (ACH) of 20 ACH total and 4 ACH of outdoor air when occupied. During unoccupied periods, the ACH will be reduced to 4 ACH. Setback strategies require that the pressure relationship to adjacent spaces is maintained. Exhaust boxes may also be required if not already installed.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Main Hospital
      1) Install Phoenix exhaust boxes. Qty 20 at 1700 CFM each. Provided by controls contractor.
      2) Install phoenix supply boxes. Qty 20 at 1700 CFM each. . Provided by controls contractor.
2. Controls
   A. Jones (These ORs already have Alerton controlled supply and return boxes.)
      1) OR 31, 32, 33, and 34 go from 24 to 27 down to 9 ach unocc.
         (i) Change occupied to 20 ach to match current FGI.
         (ii) Change unoccupied to 4 ach pending DOH and VMMC review. (Note that 4 ach is the minimum OSA listed in table 7.1 in ASHRAE 170-2013 which is part of FGI 2014.)
      2) OR 25, 26, 27, 28, 29, and 30 are unused but still operate at 9 ach.
         (i) Schedule completely off or schedule to 4 ach.
            (a) Investigate DOH rules and VMMC needs for how quickly the rooms could be put into use.
   B. Lindeman (These ORs already have Alerton controlled supply and return boxes.)
      1) Qty 4 ORs.
         (i) Change occupied to 20 ach to match current FGI.
         (ii) Change unoccupied to 4 ach pending DOH and VMMC review. (Note that 4 ach is the minimum OSA listed in table 7.1 in ASHRAE 170-2013 which is part of FGI 2014.)
   C. Main Hospital
      1) Qty 20 ORs.
         (i) Provide phoenix exhaust boxes. Qty 20 at 1700 CFM each. Installed by mech contractor.
         (ii) Provide phoenix supply boxes. Qty 20 at 1700 CFM each. Installed by mech contractor.
         (iii) Take over control of reheat coils by Alerton BAS.
         (iv) Set to 20 ach occupied and 4 ach unoccupied.
         (v) Include 2 motion sensors per OR.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Provide TAB of occupied and unoccupied ach and pressure relationships.
9. Commissioning
   A. Commission new sequences and setpoints.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training

Detailed Scope of Work

A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 21769
03.00 Runaround Heat Recovery
Virginia Mason Downtown Campus

GENERAL

Recovering heat from exhaust air streams to pre-heat outside air can be very cost-effective especially in situations where the supply air is 100% outside air (as is the case with most of the VMMC air handlers). Thus, where not already installed, provide for a heat recovery coil in exhaust air streams to recover heat. Use this heat in a run-around coil to pre-heat incoming outside air for supply fans. A small pump is required to pump the heat recovery fluid from the exhaust stream to the supply stream.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Provide qty 6 supply AHU heat recovery coils at 25,000 CFM each
   B. Provide qty 6 exhaust coils at 25,000 CFM each.
      1) Include 2” filter rack.
   C. Qty 6. Provide 2 hp, 130 gpm, circ pump with VFD.
   D. Qty 6, provide 200 feet of insulated 3” pipe between the supply and exhaust.
      1) Fill with glycol at 20%.
2. Controls
   A. Provide control of each pump VFD based on AHU DAT.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. TAB
   A. Provide TAB for new equipment.
8. Commissioning
   A. Commission new equipment and controls.
9. Demolition and Removal
   A. Not applicable.
10. Allotments
    A. Not applicable.
11. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
12. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
13. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. Hazardous material survey and abatement are excluded unless specifically noted in the scope above.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26477
03.00 Seal Air Ducts
Virginia Mason Downtown Campus

GENERAL

Air leakage in ductwork causes air not to reach its destination, thus supply fans must run harder to supply more air and to maintain static pressure set points. Sealing leaky ductwork reduces fan energy use and increases comfort by helping to deliver the desired amount of conditioned air to each space. This measure involves sealing leaky ducts to minimize air leakage.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Assume 100,000 CFM for estimating purposes.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26895
04.00 Air Change Reduction via Rebalancing
Virginia Mason Downtown Campus

GENERAL

It is possible that some zones within the hospital are getting more airflow than what is required per ASHRAE 170 or the cooling load (whichever is greater). By re-calculating the required flow for each area and comparing that to the actual measured airflow, the rebalancing potential can be determined. For this measure, it is assumed that there is a rebalancing opportunity across many zones at the hospital.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. For AHUs that have terminal unit DDC. (Assume 20 AHUs and 200 VAV boxes) 100,000 CFM
      1) Note CFM setpoints at BAS
      2) Post-TAB
         (i) Change terminal unit minimum and maximum CFM setpoints at the BAS to design calculated values.
            (a) Lower duct static pressure setpoint
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB) (Assume 150,000 CFM
   A. For AHUs that don't have terminal unit DDC
      1) Take pre-TAB at every diffuser.
      2) Post-TAB
         (i) Rebalance to design calculated values.
            (a) Lower duct static pressure setpoint
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignLook at VMMC "touring plans" and assume space type based on room name.
    1) Look up ASHRAE 170 ach requirements.
    2) Assume cooling load based on exposure and space type.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.
3. Since this measure is intended to save energy, any diffusers that are low on air will be left as-is. If VMMC elects to increase airflow to those diffusers, the energy use will be impacted.

Detailed Scope of Work

FIM ID # 26466
04.00 Duct Static Pressure Reset
Virginia Mason Downtown Campus

GENERAL

During low load heating or cooling conditions, the goal is to keep terminal boxes open to reduce static pressure while lowering the supply fan speed. Without a duct static pressure reset in place, this cannot be achieved. Instead, the boxes start to shut, increasing static pressure and causing the fan to work the same or harder. This measure involves implementing a duct static pressure reset strategy to allow for fans to slow under low load conditions.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Assume 50,000 CFM of air handlers than have downstream VAV or CV boxes on the Alerton DDC and don't already have duct static pressure reset.
      1) Assume applied to 10 AHUs. Programming only.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Commission new DSP reset sequence.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26467
04.00 High Efficiency Lab Hoods
Virginia Mason Downtown Campus

GENERAL

1. Constant volume fume hoods serve to contain and exhaust hazardous fumes. They do this effectively although it typically also involves exhausting large quantities of conditioned air. VAV fume hoods help to minimize the amount of conditioned air that is exhausted by ramping down the exhaust fans when sashes are closed or partially closed by occupants. For new tenant fit outs, high efficiency lab hoods provide good value over traditional hoods (even vs. relocating hoods already owned by VMMC), assuming that the hood density is high. For areas where hood density is low, standard hood are recommended.

   High efficiency hood strategies include:
   a. Low flow constant volume hoods.
   b. Low flow variable volume hoods based on sash position. (not recommended due to hood density and complexity of VAV)
   c. Occupancy sensors and pushbutton overrides at hoods.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. For the VAV hood option, provide DDC tie-in and adjust VAV box minimum position based on button status and sash position.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Relocate 6 existing hoods.
   B. Provide 6 standard hoods.
   C. Provide 6 low flow hoods.
   D. Provide 6 occupancy override buttons. (Assume cost is the same for installing on a new hood vs. retrofitting an existing)
      1) If multiple hoods are served by the same fan, one button
      2) Assumes the supply fan is already variable flow.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should

Detailed Scope of Work

contract directly with qualified abatement specialists.

2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26465
04.00 System Scheduling
Virginia Mason Downtown Campus

GENERAL

One of the most cost-effective strategies for reducing energy consumption in any facility is to reduce equipment run-time hours. At VMMC, this involves determining which spaces need not be conditioned for comfort or safety 24x7 and identifying new schedules for those areas. Depending on HVAC zoning and existing equipment, not all non-24x7 areas may be able to benefit from schedule changes.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Document all existing schedules in DDC.
   B. Meet with hospital staff to determine non 24/7 areas using the "touring plans"
   C. For AHUs that serve no 24/7 spaces, apply schedules from item B above.
   D. For AHUs that have terminal unit VAV dampers on the DDC, apply schedules from item B above to each damper.
   E. For AHUs that have terminal unit CV dampers on the DDC, apply schedules from item B above to each damper.
      1) This assumes the AHU either has a VFD with static pressure control or assumes the reduced CFM is small enough to not cause overpressuriztion of the ductwork.
   F. For AHUs that don't have terminal unit DDC and have a mixture of 24/7 and non 24/7 space. Determine where branch dampers would be needed. Install branch dampers and tie-into the DDC.
      1) Price assuming 20 dampers using the UWMC $/damper estimate.
   G. Tie into EPIC system to shut down patient rooms that are not booked.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26446
07.00 Combined Heat and Power
Virginia Mason Downtown Campus

GENERAL

If VMMC is planning to spend monety to add back-up generator capacity, consider installed a combined heat and power (CHP) system instead. Instead of just acting as a back-up system, the CHP system would operate 24x7 and use natural gas to generate both a continuous supply of electrical power and hot water for use throughout the facility. The endless need for both electricity and heat makes VMMC an optimal location for this type of system. The considerably low natural gas rate improves the financials even further when compared to the cost per unit of energy from steam.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Pipe steam from gas turbine to the TAA steam header and the East Plenum room steam header.
      1) Note this steam piping was already priced for the Tier 2 boiler FIM.
   B. Pipe steam from the TAA steam header to the sterilizers
      1) Note that this steam piping was already priced for the Tier 2 boiler FIM as an add alt.
   C. Pipe condensate from the TAA mech room and the East Plenum mech room steam header back to the Turbine.
      1) Note this condensate piping was already priced for the Tier 2 boiler FIM.
2. Controls
   A. Integrate power into the existing power control system.
      1) Include kW totalization at the Alerton system for monitoring only.
   B. Integrate steam generation into Alerton controls.
3. Electrical
   A. Install a 1.5 MW diesel generator in the future generator location in the Jones basement.
   B. Install a 1.5 MW natural gas turbine with heat recovery.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26472
08.00 High-efficiency Motors
Virginia Mason Downtown Campus

GENERAL

Besides motor size and operating hours, motor efficiency is a key driver of motor energy consumption. This measure involves upgrading motors to higher efficiency models whenever existing motors fail.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Assume qty 50 motors at 25 hp each.
      1) Replace with premium efficiency motors.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26951
09.00 Buck LED Lighting
Virginia Mason Downtown Campus

GENERAL

Install LED lighting retrofit troffers, recessed cans, tubes, and wall occupancy sensors. Affected space types include common hallways, offices, restrooms, elevators, and stairs.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. See Resound Energy proposal.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26952
09.00 HRB LED Lighting
Virginia Mason Downtown Campus

GENERAL

Install LED lighting retrofit troffers, recessed cans, tubes, and wall occupancy sensors. Affected space types include common hallways, offices, and stairwells.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. See Resound Energy proposal.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26950
09.00 Lindeman LED Lighting
Virginia Mason Downtown Campus

GENERAL

Install LED lighting retrofit troffers, recessed cans, tubes, and wall occupancy sensors. Affected space types include common hallways, elevator lobbies, offices, stairs, garage, and exterior.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. See Resound Energy proposal.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26593
10.00 Solar PV
Virginia Mason Downtown Campus

GENERAL

While solar energy in the Northwest is not as productive as in other parts of the country, it can still sometimes prove to be a better investment than efficiency. This may be the case for Virginia Mason as 2030 approaches and all low-hanging fruit has been implemented and solar costs have continued to drop. This measure involves providing a small 15 kW solar electric system on the Lindeman roof.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Provide panels, inverter, and mounting hardware for a 15 kW array located on the Lindeman building roof..
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26599
12.00 Condensate Reuse
Virginia Mason Downtown Campus

GENERAL

Once steam transfers its heat to a heat exchanger or heating coil, it changes into its liquid form of hot condensate. In most cases at VMMC, this hot condensate is then piped to a condensate heat recovery unit. After passing through the heat recovery unit, all condensate (e.g. warm water) goes down the sewer drain and ends up at one of King County's water treatment plants. This measure would capture that condensate and reuse it for cooling towers or for future green space irrigation, thereby reducing VMMC's purchase of water. Unfortunately, the condensate that goes down the drain does not incur sewer charges from Seattle Public Utilities due to an agreement between SPU and Enwave (formerly Seattle Steam), so there are no sewer savings for this measure.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Install a 5,000 gallon tank where SF-4 West Wing currently is.
   B. Pipe condensate from the North Court mech room to the tank.
      1) 200 feet of 2" pipe. Uninsulated.
      2) Include a 1 hp receiver pump.
   C. Pipe reclaim water from tank to either the hospital and buck cooling towers or the East Plenum green roof or to the MIMP proposed new landscaping. See page 51 of the MIMP.
      1) Use Tier 1 pricing for pipe from the level 2 mech room to the roof and double the length. 2" pipe with a 1 hp pump.
2. Controls
   A. Provide level control of pumps tied into BAS.
3. Electrical
   A. Provide power to two 1hp pumps.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Provide start-up.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26832
13.00 Electrochromic Windows
Virginia Mason Downtown Campus

GENERAL

Dynamic windows can change the amount of daylight or heat transmission based on environmental conditions (passive control) or an external control (active control). These windows can replace the need for blinds or window coverings. An electrochromic window, an example of an actively control window, is an electrically powered insulated glazing panel that tints to reduce glare and heat without the use of blinds (very minimal electric use). This measure involves installing electrochromic windows on the West facade of Buck North and Buck South. Electrochromic windows can change the solar heat gain coefficient and visible light transmittance based on low voltage control. Energy savings result from reduced heating and cooling loads as well as a reduced demand for electric lighting.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. 7 levels of Buck West facing. Punched openings. 6' tall x 100' x 7 floors. Use View as the brand. www.viewglass.com.
      1) Provide power.
      2) Provide 120 controllers so that each occupant can individually control privacy.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26444
13.00 Single Pane Glazing Upgrade
Virginia Mason Downtown Campus

GENERAL

Replace existing single pane windows on West façade of Buck South and Buck North with new high performance double pane low-e windows with thermally broken frames. This will eliminate the largest thermal bridge in this building and significantly improve thermal comfort for occupants near the windows during cold weather. New windows will also reduce solar heat gain by using spectrally selective (Solarban 60 or 70XL) coatings which transmit the visible spectrum while filtering out non-visible light.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. 7 levels of Buck West facing. Punched openings. 6' tall x 100' x 7 floors. Provide double pane thermally broken aluminum. Argon filled low e Solarban 60.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 21772
13.00 Weatherization
Virginia Mason Downtown Campus

GENERAL

Similar to residential buildings, commercial buildings can leak conditioned air, wasting energy and causing comfort issues. Common areas of air leakage include around windows, at roof/wall intersections, and surrounding doorways. Sealing leaks will provide for a tighter, more comfortable, more easily pressurized building. Costs and savings are based on estimated potential in HRB and Buck.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Estimate 20 SF of leakage area with fixed first cost for installation per SF of leakage area.
8. Commissioning
   A. Not applicable.
9. Demolition and Removal
   A. Not applicable.
10. Allotments
    A. Not applicable.
11. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
12. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
13. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. Hazardous material survey and abatement are excluded unless specifically noted in the scope above.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26445
13.00 Window Film
Virginia Mason Downtown Campus

GENERAL

Next generation window films not only provide the traditional benefit of reducing summer heat gain, but they can also now provide improved insulation in winter via the inclusion of a low-e coating. Traditional challenges with window films include bubbling and/or condensation. New, clear distortion free adhesives avoid these issues and some installers provide lifetime warranties against bubbling or peeling. This measure involves providing Enerlogic 70 window film for West façade of Buck North and Buck South. The film will help reduce peak cooling and heating loads and provide for greater occupant comfort.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. 7 levels of Buck West facing. Punched openings. 6' tall x 100' x 7 floors. Provide Enerlogic 70 film. Apply to the inside surface.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Not applicable.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26786
15.00 Replace Kitchen Refrigeration Equipment
Virginia Mason Downtown Campus

GENERAL

Several of the kitchen walk-ins (4, 5, and 8) located in the café in the main pavilion currently use R-12 or R-22 refrigerant. This refrigerant is now obselete and will run out in approximately 18 months which will necessitate replacement of these systems. This measure involves replacing the refrigeration systems for these three walk-ins with updated systems and replacing existing induction motors with new ECM motors.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Several of the kitchen walk-ins (labeled 4, 5, and 8) currently use R-12 or R-22 refrigerant. This refrigerant is now obsolete and will run out in ~18mo. This measure involves replacing the refrigeration systems for these three walk-ins with updated systems.
      1) Contact Ecolab (Shawn Bockes. 510-376-5231 or shawn.bockes@ecolab.com)
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26482
15.00 Retrofit Refrigeration Equipment
Virginia Mason Downtown Campus

GENERAL

Older walk-ins tend to have inefficient shaded pole evaporator motors that add unnecessary heat to the space that you are trying to cool. Similarly, inefficient defrost cycles are on timers, defrosting whether it is needed or not, wasting energy. This measure involves retrofitting (5) existing commercial walk-in refrigerators and freezers with ECM motors and implementing smart defrost controls to only defrost when needed.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Call KE2 for smart defrost pricing.
   B. Call John to call Ecolab for pricing. Shawn Bockes. 510-376-5231 or shawn.bockes@ecolab.com
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26448
16.00 Manage IT Energy Use
Virginia Mason Downtown Campus

GENERAL

Centralized software solutions for PC power management help to actively manage and track PC power states and device utilization. With this information, PCs can be better controlled and managed to reduce energy use in a reliable way. This measure involves deploying aggressive PC power management across the entire VMMC desktop fleet of 6,000 PCs.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Purchase 6,000 Verdium surveyor licenses.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

Detailed Scope of Work

FIM ID # 26469
16.00 Plug Load Controls
Virginia Mason Downtown Campus

GENERAL

As the efficiency of building envelopes, HVAC, and lighting systems increases, the percentage of energy use apportioned to "plug loads" in buildings is growing. Office equipment is often left on at night or during breaks during the day. Even when turned off, vampire loads draw power. This measure involves providing smart plug strips for all office workers based on timer, load sensing, and/or motion sensing and providing vending misers for all beverage and snack machines.

SCOPE OF WORK INCLUDES

1. Mechanical
   A. Not applicable.
2. Controls
   A. Not applicable.
3. Electrical
   A. Not applicable.
4. Structural
   A. Not applicable.
5. Architectural
   A. Not applicable.
6. Acoustical
   A. Not applicable.
7. Specialty
   A. Provide and install 10 vending misers.
   B. Provide 1,000 smart plug strips.
8. Testing, Adjusting and Balancing (TAB)
   A. Not applicable
9. Commissioning
   A. Not applicable.
10. Demolition and Removal
    A. Not applicable.
11. Allotments
    A. Not applicable.
12. DesignProvide design as required for this FIM. If applicable, pricing for design is included in Table 4.1.
13. Measurement and Verification (M&V)
    A. Refer to table 3.2. If applicable, pricing for M&V is included in Table 4.1.
14. Training
    A. Provide training as required for this FIM.

CLARIFICATIONS AND EXCLUSIONS

1. For the safety of our people and avoidance of potential long-term liability, McKinstry no longer executes subcontracts for abatement of asbestos and lead paint. Any exceptions to this policy must be approved by our CEO or President and our General Counsel. Abatement of asbestos and lead paint shall be the responsibility of the building owner who should contract directly with qualified abatement specialists.
2. If existing equipment or components are reused, repairs to existing are not included unless specifically noted in the scope above.

IIydraMetrics

Virginia Mason Medical Center

Scope of Work by Building

Site Information			Quantities on Site											Scope of Work Option #2: Flushometers Recommissioning									
Building or Meter	Recommended Option # for Scope of Work	In Scope of Work	Lavatory Sinks	General Use Sinks	Multipurpose Lav Sinks	Tank Toilets	Pressure Assist Toilet	Flushometer Toilets	Urinals	CONRUN Urinals	Hoppers	Wall Showers	Handheld Showers	Valve Recommissioning	Valve Rebuilding	New Valve X-Body	New Piston Valve Body	Spud Replacement	Flushtube Replacement	Control Stop Rebuilding	Control Stop Adapt/Replace	Handle-Mount Hands-Free	Piston Valve Hands-Free
Central Pavilion	Blended	x	94	96	221	5		291	9		13	80	89	186	122	5		29	29		1	4	
Buck Pavilion	Blended	x	59	29	214			66	11				1		77			15	15				
Jones Pavilion	Blended	x	70	71	30			70			1	1	55	30	2	6		6	6			6	
Lindeman Pavlion	Blended	x	68	31	203			77	11			4	1	3	85			17	17				
Health Resources	Blended	x	26	4	23	10		23	4			1			22	5		9	9		2		
Benaroya Research Institute	Blended	x	23	7				31	10				2		41			8	8				
The Inn at VM	Blended	x	7	3	88	94		2	1			49	41		3			1	1				
Baroness Hotel	3	x	2	39	57			59				57				59		41	41		31		
Total from above		x	**349**	**280**	**836**	**109**	**0**	**619**	**46**	**0**	**14**	**192**	**189**	**219**	**352**	**75**	**0**	**126**	**126**	**0**	**34**	**10**	**0**

Building or Meter	Tank Toilets				Sinks			Showers			Flushometer Toilet Replacements						Tank Toilet Replacements						Urinal Replacements				
	System Tuning	Retrofit Upgrade	Angle Stop "Adder Valve"	Fill Valve & Tank Gasket	Vandal-Resistant Flow Ctrl	Manual Faucet	Hands-Free Sink Faucet	Wall Showerhead	Handheld Showerhead	Shower Diverter	Wall-Hung Toilet	Wall-Hung Toilet - ADA	Floor-Mount Toilet	Floor-Mount Toilet - ADA	Floor-Mount, Wall-Exit Toilet	Floor-Mount, Wall-Exit Toilet - ADA	High Performance Gravity	High Performance Gravity - ADA	Pressure Assist	Pressure Assist - ADA	Dual Flush	Dual Flush - ADA	Siphon Jet Urinal Bowl	Washout Urinal Bowl	Floor-Mount Urinal Stall	Waterless Urinal	Kitchen Sprayers
Central Pavilion	2	3			395			76	89																		1
Buck Pavilion					302				1																		
Jones Pavilion					106				27																		
Lindeman Pavlion					302			1																			
Health Resources	4	6	1		53			1																			
Benaroya Research Institute					30																						
The Inn at VM	1	93	9		97			49	41																		
Baroness Hotel					98			57																			
Total from above	**7**	**102**	**10**	**0**	**####**	**0**	**0**	**184**	**158**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

Note:
Jones Pavilion "Quantities on Site" include the 9th Floor CCU. This floor is **NOT** in scope due to age (opened Sept 8, 2014).
Jones Pavilion "Quantities on Site" does **NOT** include the 3rd Floor Surgery Center (opening week of Sept 22).
Central Pavilion excludes Old CCU on 7th Floor (to be remodeled we show no quantities on site or in scope for that area).

5. Appendices

5.5. APPENDIX E: PRE-ROM SAVINGS CALCULATIONS

Please refer to the Boiler and Heat Recovery Chiller Development Compilation Report dated December 5, 2014 for details on the Tier 1 Boiler, Tier 2 Boiler, and Heat Recovery Chiller measures.

McKinstry Calculation Template
01.00 Condensate Heat Recovery

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	01.00 Condensate Heat Recovery
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26596	Date	11/18/2014

Description of FIM From TCO Tool:

Once steam transfers its heat to a heat exchanger or heating coil, it changes into its liquid form of hot condensate. In most cases at VMMC, this hot condensate is piped to a condensate heat recovery unit so that additional heat can be recovered. In a few isolated cases, the hot condensate goes directly down the sewer without having any heat recovered. This measure involves eliminating those few remaining instances where heat is not currently recovered (fire pump room, ICU, and hot water tanks on 7th floor east wing roof garden).

FIM Calculation Method From TCO Tool:

Savings are based on an estimated flow rate, condensate temperature, and heat recovery efficiency. Pumping penalty not accounted for in this version.

Inputs:

		Base	Proposed	Savings	Units	Basis of Value
C17	Condensate average annual flow rate	0.5	0.0	0.5	gpm	Field estimate
C18	Condensate delta T	40	40	0	degrees F	Field estimate
C19	Steam enthalpy	1,100	1,100	0	Btu/lb	Field estimate

Calculated Values:

		Base	Proposed	Savings	Units	
C22	Energy savings per heat exchanger	87,600,000	0	87,600,000	Btu	=(500*C17*(C18)*8760)
C23	Steam savings per heat exchanger	80	0	80	klbs	=C22/(1100*1000)

DRAFT

McKinstry Calculation Template
01.00 Lindeman Boiler to DHW Heat Exchanger

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	01.00 Lindeman Boiler to DHW Heat Exchanger
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26901	Date	12/18/2014

Description of FIM From TCO Tool:

Lindeman Pavilion has three natural gas heating water boiler, but the domestic hot water is still produced via Seattle Steam which has a much higher cost per BTU than natural gas. This measure will use the spare natural gas existing boiler capacity to produce domestic hot water (DHW). This will be accomplished by installing a heat exchanger between the heating water and DHW systems.

FIM Calculation Method From TCO Tool:

Since steam for Lindeman is just for domestic hot water, the savings was based on the entire steam meter historical consumption.

Inputs:

		Value	Units	
C17	Existing Steam Use	600	klbs/yr	Lindeman steam usage in Portfolio Manager
C18	Boiler Efficiency	90%	%	Based on Condensing Heating Water Boilers
C19	Percent of Annual Use to Convert	75%	%	Assumption based on temperatures avaialable and possible summer shutdown

Calculated Values:

		Value	Units	
C22	Natural Gas Savings	-5,500	therms/yr	=-C17*1100000/100000/C18*C19
C23	Steam Savings	450	klbs/yr	=C17*C19

McKinstry Calculation Template
01.00 Mechanical Insulation

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	01.00 Mechanical Insulation
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26449	Date	11/18/2014

Description of FIM From TCO Tool:

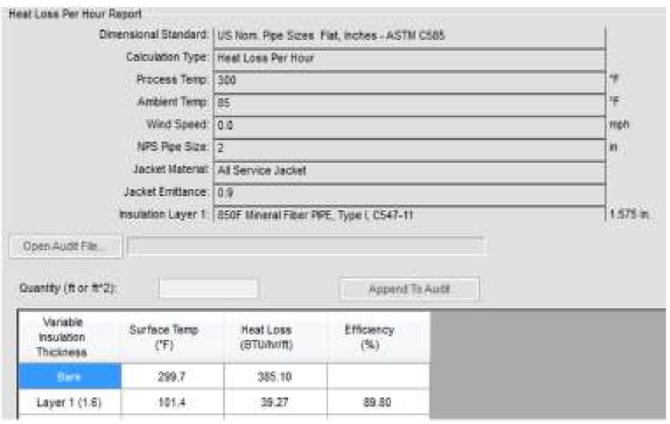
Any piping that carries a fluid that is hotter or colder than the surrounding space will transfer energy to that space. At VMMC, the vast majority of all piping is well insulated, however some spots of uninsulated hot water and steam pipe for domestic hot water or space heating remain. Insulating this remaining piping will reduce unnecessary heat losses and reduce steam and natural gas use and annual operating cost.

FIM Calculation Method From TCO Tool:

Savings are based on comparing insulated pipe to bare pipe using the North American Insulation Manufacturers Association 3E Plus v4.1 calculator. Key inputs include pipe diameter and process water temperature.

Inputs:

	Inputs:	Base	Proposed	Savings	Units	Basis of Value
C17	Heating loss per hour for 2" steam pipe @ 300F	385.1	39.3	345.8	Btu/hr/ft	Field estimate
C18	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C19	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate


Heat Loss Per Hour Report

Dimensional Standard: US Nom. Pipe Sizes Flat, Inches - ASTM C585
Calculation Type: Heat Loss Per Hour
Process Temp: 300 °F
Ambient Temp: 85 °F
Wind Speed: 0.0 mph
NPS Pipe Size: 2 in
Jacket Material: All Service Jacket
Jacket Emittance: 0.9
Insulation Layer 1: 850F Mineral Fiber PIPE, Type I, C547-11 1.575 in.

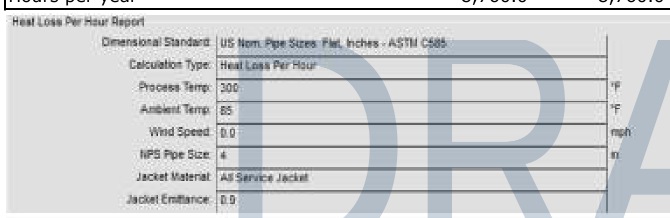
Open Audit File...

Quantity (ft or ft^2): Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	299.7	385.10	
Layer 1 (1.6)	101.4	39.27	89.80

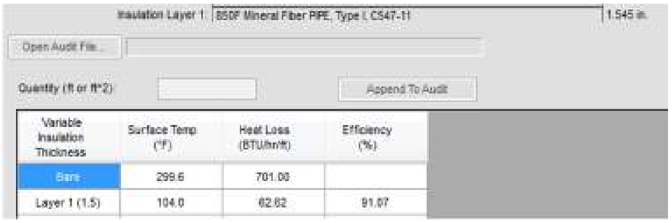
* assumes steam pipe is for heating

C42	4" steam pipe @ 300F	701.0	62.6	638.4	Btu/hr/ft	Field estimate
C43	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C44	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate


Heat Loss Per Hour Report

Dimensional Standard: US Nom. Pipe Sizes Flat, Inches - ASTM C585
Calculation Type: Heat Loss Per Hour
Process Temp: 300 °F
Ambient Temp: 85 °F
Wind Speed: 0.0 mph
NPS Pipe Size: 4 in
Jacket Material: All Service Jacket
Jacket Emittance: 0.9

* assumes steam pipe is for heating

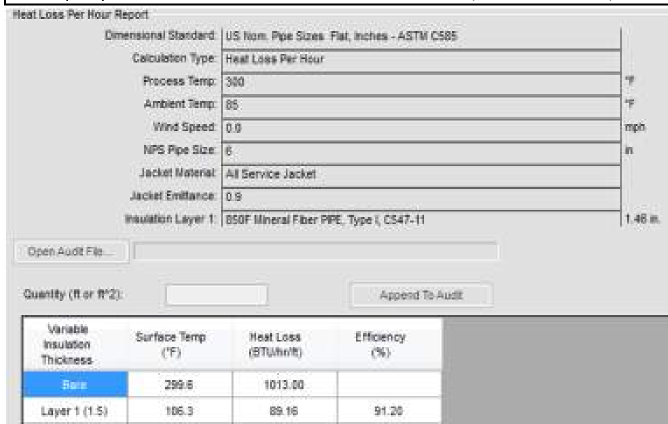

Insulation Layer 1: 850F Mineral Fiber PIPE, Type I, C547-11 1.545 in.

Open Audit File...

Quantity (ft or ft^2): Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	299.6	701.00	
Layer 1 (1.5)	104.0	62.62	91.07

C66	6" steam pipe @ 300F	1,013.0	89.2	923.8	Btu/hr/ft	Field estimate
C67	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C68	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate


Heat Loss Per Hour Report

Dimensional Standard: US Nom. Pipe Sizes Flat, Inches - ASTM C585

Calculation Type: Heat Loss Per Hour

Process Temp: 300 °F

Ambient Temp: 85 °F

Wind Speed: 0.0 mph

NPS Pipe Size: 6 in

Jacket Material: All Service Jacket

Jacket Emittance: 0.9

Insulation Layer 1: 850F Mineral Fiber PIPE, Type I, C547-11 1.48 in.

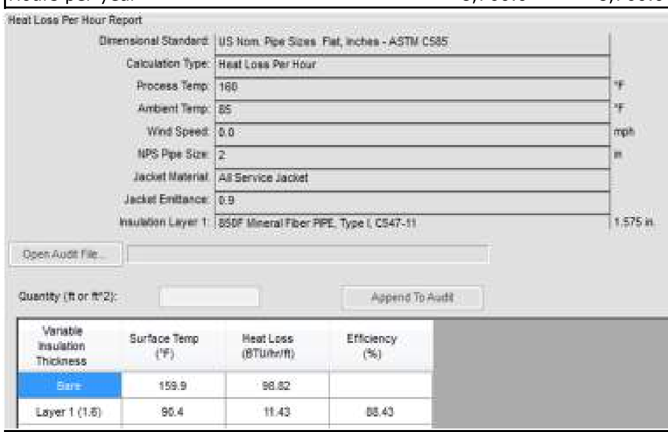
Open Audit File...

Quantity (ft or ft^2): Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	299.6	1013.00	
Layer 1 (1.5)	106.3	89.16	91.20

* assumes steam pipe is for heating

C90	2" HW pipe @ 160F	98.8	11.4	87.4	Btu/hr/ft	Field estimate
C91	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C92	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate


Heat Loss Per Hour Report

Dimensional Standard: US Nom. Pipe Sizes Flat, Inches - ASTM C585

Calculation Type: Heat Loss Per Hour

Process Temp: 160 °F

Ambient Temp: 85 °F

Wind Speed: 0.0 mph

NPS Pipe Size: 2 in

Jacket Material: All Service Jacket

Jacket Emittance: 0.9

Insulation Layer 1: 850F Mineral Fiber PIPE, Type I, C547-11 1.575 in.

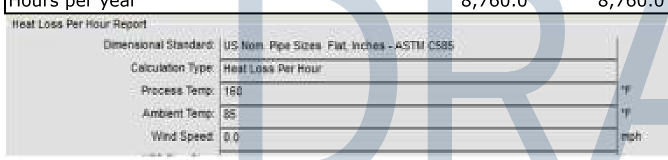
Open Audit File...

Quantity (ft or ft^2): Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	159.9	98.82	
Layer 1 (1.6)	90.4	11.43	88.43

* assumes pipe is for heating

C114	4" HW pipe @ 160F	178.9	18.2	160.7	Btu/hr/ft	Field estimate
C115	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C116	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate


Heat Loss Per Hour Report

Dimensional Standard: US Nom. Pipe Sizes Flat, Inches - ASTM C585

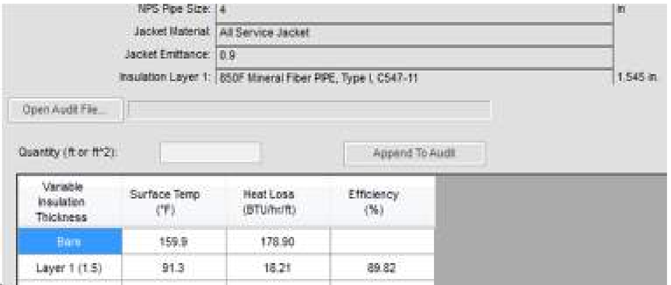
Calculation Type: Heat Loss Per Hour

Process Temp: 160 °F

Ambient Temp: 85 °F

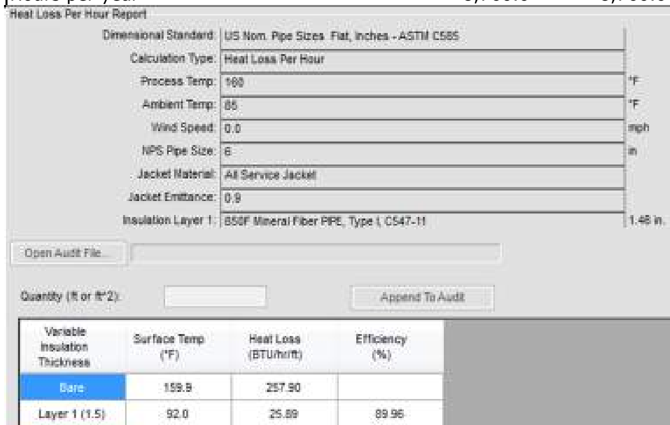
Wind Speed: 0.0 mph

* assumes pipe is for heating


NPS Pipe Size: 4 in
Jacket Material: All Service Jacket
Jacket Emittance: 0.9
Insulation Layer 1: 850F Mineral Fiber PIPE, Type I, C547-11 1.545 in.
Open Audit File...
Quantity (ft or ft^2): Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	159.9	178.90	
Layer 1 (1.5)	91.3	18.21	89.82

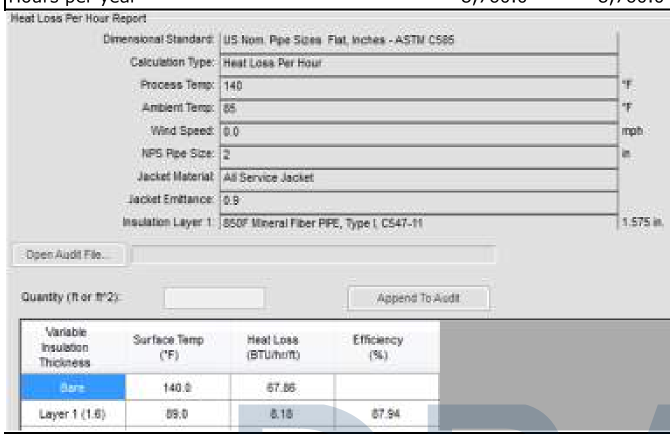
C138	6" HW pipe @ 160F	257.9	25.9	232.0	Btu/hr/ft	Field estimate
C139	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C140	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate


Heat Loss Per Hour Report
Dimensional Standard: US Nom. Pipe Sizes Flat, inches - ASTM C585
Calculation Type: Heat Loss Per Hour
Process Temp: 160 °F
Ambient Temp: 85 °F
Wind Speed: 0.0 mph
NPS Pipe Size: 6 in
Jacket Material: All Service Jacket
Jacket Emittance: 0.9
Insulation Layer 1: 850F Mineral Fiber PIPE, Type I, C547-11 1.46 in.
Open Audit File...
Quantity (ft or ft^2): Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	159.9	257.90	
Layer 1 (1.5)	92.0	25.89	89.96

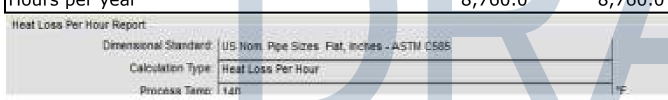
* assumes pipe is for heating

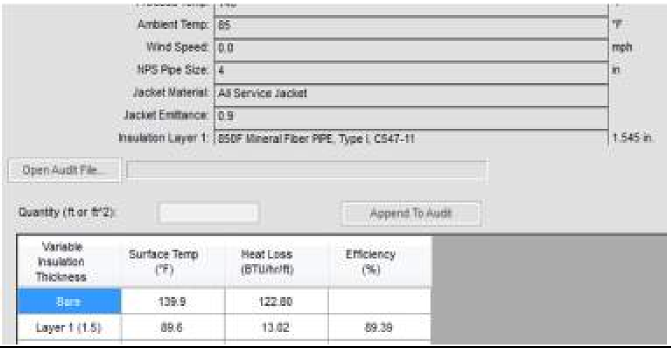
C162	2" DHW pipe @ 140F	67.9	8.2	59.7	Btu/hr/ft	Field estimate
C163	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C164	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate


Heat Loss Per Hour Report
Dimensional Standard: US Nom. Pipe Sizes Flat, inches - ASTM C585
Calculation Type: Heat Loss Per Hour
Process Temp: 140 °F
Ambient Temp: 85 °F
Wind Speed: 0.0 mph
NPS Pipe Size: 2 in
Jacket Material: All Service Jacket
Jacket Emittance: 0.9
Insulation Layer 1: 850F Mineral Fiber PIPE, Type I, C547-11 1.575 in.
Open Audit File...
Quantity (ft or ft^2): Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	140.0	67.86	
Layer 1 (1.6)	89.0	8.18	87.94

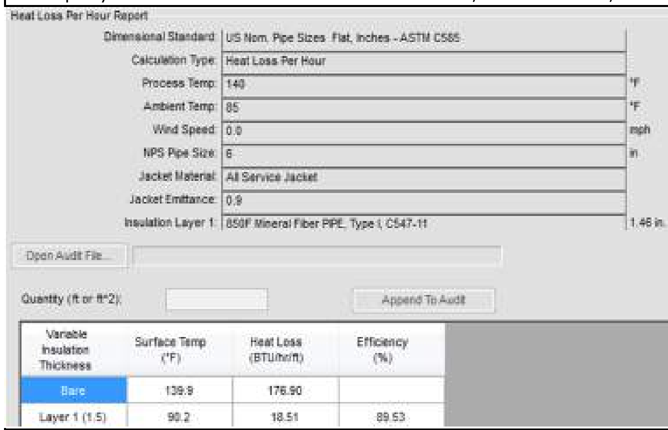
C186	4" DHW pipe @ 140F	122.8	13.0	109.8	Btu/hr/ft	Field estimate
C187	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C188	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate


Heat Loss Per Hour Report
Dimensional Standard: US Nom. Pipe Sizes Flat, inches - ASTM C585
Calculation Type: Heat Loss Per Hour
Process Temp: 140 °F


Ambient Temp: 85 °F
Wind Speed: 0.0 mph
NPS Pipe Size: 4 in
Jacket Material: All Service Jacket
Jacket Emittance: 0.9
Insulation Layer 1: 850F Mineral Fiber PIPE, Type I, C547-11 1.545 in.
Open Audit File...
Quantity (ft or ft^2):
Append To Audit

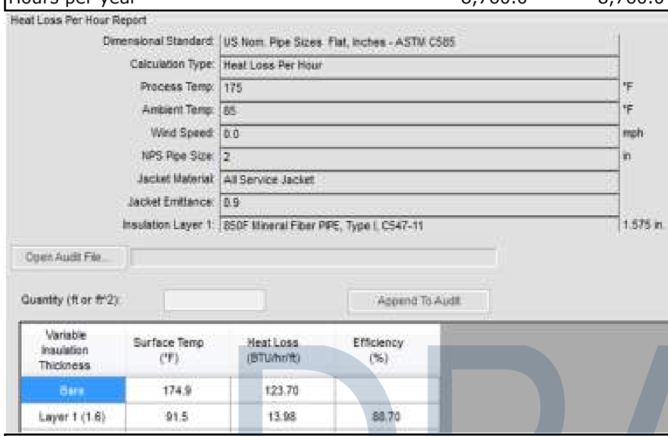
Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	139.9	122.80	
Layer 1 (1.5)	89.6	13.02	89.39

C210	6" DHW pipe @ 140F	176.9	18.5	158.4	Btu/hr/ft	Field estimate
C211	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C212	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate


Heat Loss Per Hour Report
Dimensional Standard: US Nom. Pipe Sizes Flat, Inches - ASTM C585
Calculation Type: Heat Loss Per Hour
Process Temp: 140 °F
Ambient Temp: 85 °F
Wind Speed: 0.0 mph
NPS Pipe Size: 6 in
Jacket Material: All Service Jacket
Jacket Emittance: 0.9
Insulation Layer 1: 850F Mineral Fiber PIPE, Type I, C547-11 1.46 in.
Open Audit File...
Quantity (ft or ft^2):
Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	139.9	176.90	
Layer 1 (1.5)	90.2	18.51	89.53

C234	2" condensate pipe @ 175F	123.7	14.0	109.7	Btu/hr/ft	Field estimate
C235	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C236	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate

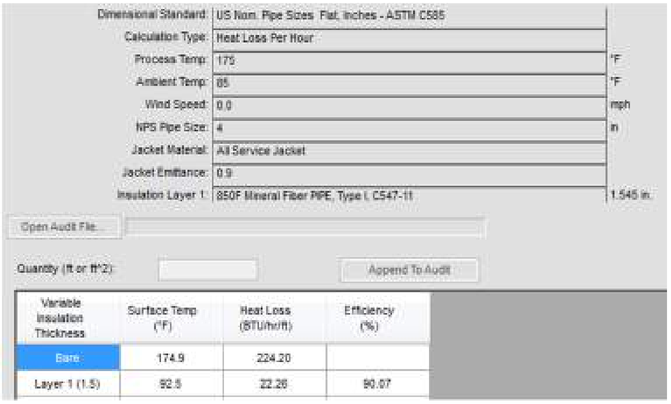

Heat Loss Per Hour Report
Dimensional Standard: US Nom. Pipe Sizes Flat, Inches - ASTM C585
Calculation Type: Heat Loss Per Hour
Process Temp: 175 °F
Ambient Temp: 85 °F
Wind Speed: 0.0 mph
NPS Pipe Size: 2 in
Jacket Material: All Service Jacket
Jacket Emittance: 0.9
Insulation Layer 1: 850F Mineral Fiber PIPE, Type I, C547-11 1.575 in.
Open Audit File...
Quantity (ft or ft^2):
Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	174.9	123.70	
Layer 1 (1.6)	91.5	13.98	88.70

* assumes pipe is for heating

C258	4" condensate pipe @ 175F	224.2	22.3	201.9	Btu/hr/ft	Field estimate
C259	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C260	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate

Heat Loss Per Hour Report



Dimensional Standard:	US Nom. Pipe Sizes Flat, Inches - ASTM C585
Calculation Type:	Heat Loss Per Hour
Process Temp:	175 °F
Ambient Temp:	85 °F
Wind Speed:	0.0 mph
NPS Pipe Size:	4 in
Jacket Material:	All Service Jacket
Jacket Emittance:	0.9
Insulation Layer 1:	850F Mineral Fiber PIPE, Type I, C547-11 1.545 in.

Open Audit File...

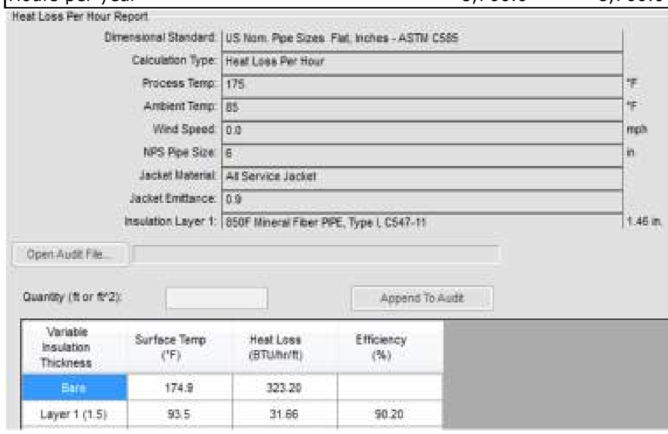
Quantity (ft or ft^2):

Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	174.9	224.20	
Layer 1 (1.5)	92.5	22.26	90.07

* assumes pipe is for heating

C282	6" condensate pipe @ 175F	323.2	31.7	291.5	Btu/hr/ft	Field estimate
C283	Lineal feet	30.0	30.0	0.0	feet	Field estimate
C284	Hours per year	8,760.0	8,760.0	0.0	hrs	Field estimate



Heat Loss Per Hour Report

Dimensional Standard:	US Nom. Pipe Sizes Flat, Inches - ASTM C585
Calculation Type:	Heat Loss Per Hour
Process Temp:	175 °F
Ambient Temp:	85 °F
Wind Speed:	0.0 mph
NPS Pipe Size:	6 in
Jacket Material:	All Service Jacket
Jacket Emittance:	0.9
Insulation Layer 1:	850F Mineral Fiber PIPE, Type I, C547-11 1.46 in.

Open Audit File...

Quantity (ft or ft^2):

Append To Audit

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/hr/ft)	Efficiency (%)
Bare	174.9	323.20	
Layer 1 (1.5)	93.5	31.66	90.20

* assumes pipe is for heating

	Calculated Values:	Base	Proposed	Savings	Units	
C309	Annual heat loss	965,364,264	93,081,132	872,283,132	Btu	C188)+(C210*C211*C212)+(C234*C235*C236)+(C258*C259*C260)+(C282*C283*C284)

McKinstry Calculation Template
01.00 Permanent Monitoring of Steam Traps

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	01.00 Permanent Monitoring of Steam Traps
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26450	Date	11/18/2014

Description of FIM From TCO Tool:

Properly operating steam traps open to remove condensate and noncondensable gases from a steam system, while limiting steam loss. Malfuntioning steam traps can operate improperly for years, wasting steam and money. The installation of permanent wireless steam trap monitors will identify issues immediately and save resources. Though it can be cost-prohibitive to monitor all traps in a facility, monitoring the largest traps can be beneficial.

FIM Calculation Method From TCO Tool:

Savings are based on an estimated quantity of steam traps, annual failure rate, steam loss per failed trap, and hours of operation.

Inputs:

	Inputs:	Base	Proposed	Savings	Units	Basis of Value
C17	Trap Quantity	75	75	0.0	quantity	Field estimate
C18	Failure rate per year	10%	0%	0.1	percentage	Field estimate
C19	Estimated heat loss per trap	13.7	13.7	0.0	lb/hr	Field estimate
C20	Hours per year	8,760	8,760	0.0	hrs	Field estimate

Calculated Values:

	Calculated Values:	Base	Proposed	Savings	Units	
C23	Annual heat loss	990,099,000	0	990,099,000	Btu	=(C17*C18*C19*C20)*1100

McKinstry Calculation Template
02.00 Increase CHW Delta T

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	02.00 Increase CHW Delta T
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26478	Date	11/18/2014

Description of FIM From TCO Tool:

Given that the cooling BTUH delivered is proportional to the chilled water flow rate (GPM) as well as the temperature difference between the chilled water supply and chilled water return (delta T), if the delta T decreases, the GPM must increase to meet the same load. An increase in GPM causes an increase in pumping energy and can cause an additional chiller to come online when it is not needed (and operate at an inefficient point on its operating curve). This measure involves the installation of high-end pressure independent chilled water valves to increase and better manage the delta T between the chilled water supply and the chilled water return temp.

FIM Calculation Method From TCO Tool:

Savings result from reduced pumping energy. As CHW delta T increases, gpm decreases and pump energy is reduced according to the pump laws. Savings are based on estimated annual pump operating hours and the calculated change in pump power.

Inputs:

		Base	Proposed	Savings	Units	Basis of Value
C17	Chiller capacity	1,400	1,400	0	tons	Cooling capacity
C18	Delta T	5	10	-5	degrees F	Field estimate
C19	Pumping exponent	1.5	1.5	0	-	Engineering estimate
C20	Pump energy	29.0	10.3	19	hp	Engineering estimate
C21	Annual hrs over 50F OAT	4,518	4,518	0	hrs	Bin data

Calculated Values:

		Base	Proposed	Savings	Units	
C24	Annual electricity savings	87,968	31,101	56,867	kWh	=(C20*0.746*0.9)*C21

McKinstry Calculation Template
03.00 Destratification Fans

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	03.00 Destratification Fans
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26483	Date	11/18/2014

Description of FIM From TCO Tool:

In spaces with tall ceilings, the air can stratify, pooling all the warm air at the ceiling instead of near the floor where occupants are located. Because the thermostat only senses the temperature 4-5' above the floor, additional heat is provided to ensure a comfortable temperature at occupant level while very warm temperatures are achieved above occupant level. This measure involves installing destratification ceiling fans in the lobby atrium area in the main entrance to help move warm air from the ceiling to the floor level. Because mixing the air decreases the temperature at the ceiling, it also decreases heat loss through the upper windows and walls.

FIM Calculation Method From TCO Tool:

Savings for this measure result from a decrease in steam heating energy use as room setpoints can be reduced by 1-2 degrees while achieving the same level of thermal comfort. A small fan energy penalty is also accounted for in the calculation.

Inputs:

Variable	Units	Value
INPUTS		
Floor to Ceiling Ht	ft	20
Wall Area	sf	5,000
Ave wall + win U-value (80% win)	Btu/hr-sf-F	0.4
Ave wall + window UA	Btu/hr-F	2000
Heating Thermostat Setpoint	degF	71
Cooling Thermostat Setpoint	degF	73
Thermostat Height	ft	4
Air stratification (1degF per 2')	degF/ft	2
Htg Temp at Ceiling Pre-Retrofit	degF	79
Htg Temp at Ceiling Post-Retrofit	degF	73
Htg Ave Wall Temp Pre-Retrofit	degF	75
Htg Ave Wall Temp Post-Retrofit	degF	72
Total Airius Fan Power (4 @33W)	Watts	132

		Baseline		Proposed	
OAT	# Occupied hrs	UA*Delta T (Btu/hr)	Heating Energy Use (Btu)	UA*Delta T (Btu/hr)	Heating Energy Use (Btu)
97.5	7	-	-	-	-
92.5	58	-	-	-	-
87.5	189	-	-	-	-
82.5	391	-	-	-	-
77.5	432	-	-	-	-
72.5	366	-	-	-	-
67.5	615	-	-	-	-
62.5	900	-25,000	22,500,000	-19,000	17,100,000
57.5	730	-35,000	25,550,000	-29,000	21,170,000
52.5	830	-45,000	37,350,000	-39,000	32,370,000
47.5	642	-55,000	35,310,000	-49,000	31,458,000
42.5	801	-65,000	52,065,000	-59,000	47,259,000
37.5	875	-75,000	65,625,000	-69,000	60,375,000
32.5	730	-85,000	62,050,000	-79,000	57,670,000
27.5	466	-95,000	44,270,000	-89,000	41,474,000
22.5	293	-105,000	30,765,000	-99,000	29,007,000
17.5	152	-115,000	17,480,000	-109,000	16,568,000
12.5	97	-125,000	12,125,000	-119,000	11,543,000
7.5	85	-135,000	11,475,000	-129,000	10,965,000
2.5	64	-145,000	9,280,000	-139,000	8,896,000
-2.5	30	-155,000	4,650,000	-149,000	4,470,000
-7.5	7	-165,000	1,155,000	-159,000	1,113,000
	8760		431,650,000		391,438,000

Annual Fan Power	1,156

Calculated Values:

		Base	Proposed	Savings	Units	
C49	Annual electricity savings	0	1,156	-1,156	kWh	0

McKinstry Calculation Template
03.00 Kitchen Hoods

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	03.00 Kitchen Hoods
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	21967	Date	11/18/2014

Description of FIM From TCO Tool:

This measure includes two components: 1) Schedule kitchen make-up air unit and kitchen exhaust fans off at night, and 2) Install VFDs on main kitchen exhaust fan and make-up air unit. The installation of VFDs will allow for variable speed operation of the make-up air unit and exhaust fans depending on the intensity of cooking and the associated sensed exhaust temp or specific pollutants. This measure will provide gas energy savings by lowering the amount of makeup air to the space that needs to be conditioned, as well as provide electrical energy savings by lowering the amount of fan energy that is used by the kitchen make-up air and exhaust systems.

FIM Calculation Method From TCO Tool:

Fan and heating energy savings result from a reduction in operating hours and variable speed operation.

Inputs:

Basis of Value

			Estimated Flow (CFM)				Calculated kW			
	hp	kW	100%	75%	50%	25%	100%	75%	50%	25%
Hood 1	5	3.0	8000	6000	4000	2000	3.0	1.5	0.6	0.1
Hood 2	5	3.0	8000	6000	4000	2000	3.0	1.5	0.6	0.1
Hood 3	2	1.2	3200	2400	1600	800	1.2	0.6	0.2	0.0
MAU	15	9.0	20000	15000	10000	5000	9.0	4.6	1.8	0.4
Exponent	2.3									

								Proposed Fan kWh					Proposed therms				
OAT	Baseline Hrs	Indoor Temp	Delta T	Baseline Fan kWh	Baseline Therms	Proposed Hrs	Hrs per quarter	100%	75%	50%	25%	Total	100%	75%	50%	25%	Total
97.5	7	65	0	113	0	7	2	28	15	6	1	50	0	0	0	0	0
92.5	58	65	0	935	0	58	15	234	121	47	10	411	0	0	0	0	0
87.5	189	65	0	3,045	0	189	47	761	393	155	31	1340	0	0	0	0	0
82.5	391	65	0	6,300	0	391	98	1575	813	320	65	2773	0	0	0	0	0
77.5	432	65	0	6,961	0	431	108	1736	896	353	72	3056	0	0	0	0	0
72.5	366	65	0	5,898	0	355	89	1430	738	290	59	2517	0	0	0	0	0
67.5	615	65	0	9,910	0	525	131	2115	1091	429	87	3723	0	0	0	0	0
62.5	900	65	3	14,502	486	589	147	2373	1224	482	98	4177	80	80	80	80	318
57.5	730	65	8	11,763	1,183	451	113	1817	937	369	75	3198	183	183	183	183	731
52.5	830	65	13	13,374	2,241	593	148	2389	1233	485	99	4205	400	400	400	400	1601
47.5	642	65	18	10,345	2,427	431	108	1736	896	353	72	3056	407	407	407	407	1629
42.5	801	65	23	12,907	3,893	494	124	1990	1027	404	82	3503	600	600	600	600	2401
37.5	875	65	28	14,099	5,198	605	151	2437	1258	495	100	4290	898	898	898	898	3594
32.5	730	65	33	11,763	5,125	446	112	1797	927	365	74	3163	783	783	783	783	3131
27.5	466	65	38	7,509	3,775	243	61	979	505	199	40	1723	492	492	492	492	1968
22.5	293	65	43	4,721	2,690	136	34	548	283	111	23	964	312	312	312	312	1248
17.5	152	65	48	2,449	1,560	87	22	350	181	71	14	617	223	223	223	223	893
12.5	97	65	53	1,563	1,100	68	17	274	141	56	11	482	193	193	193	193	771
7.5	85	65	58	1,370	1,056	61	15	246	127	50	10	433	189	189	189	189	758
2.5	64	65	63	1,031	864	34	9	137	71	28	6	241	115	115	115	115	459
-2.5	30	65	68	483	437	11	3	44	23	9	2	78	40	40	40	40	160
-7.5	7	65	73	113	110	0	0	0	0	0	0	0	0	0	0	0	0
	8760			141,155	32,142	6205						44,001					19,662

Calculated Values:

		Base	Proposed	Savings	Units	
C48	Annual electricity use	141,155	44,001	97,154	kWh	141155

McK8760 - General Information

Multiple

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	Multiple
TCO Project ID	300	Tech Contact	Ron Fues
TCO Tool FIM ID	-	Date	12/19/2014

Weather Data:

Nearest Weather Station	WA, SEATTLE BOEING FIELD [ISIS]	Station ID	727935TY.xls

Description of FIM From TCO Tool:

Stacked measures

HVAC & Load Schedules:

Schedule A Title	Load Schedule A	ASHRAE Schedule Type	Health
Schedule B Title	Load Schedule B	ASHRAE Schedule Type	Health
Schedule C Title	Load Schedule C	ASHRAE Schedule Type	Health

Utility Rate Schedules

Schedule 1 Title	Rate Schedule 1
Schedule 2 Title	Rate Schedule 2
Schedule 3 Title	Rate Schedule 3

Zone Data (for multi-model buildings)

Zone Name	
Zone Description	

Savings Tracker - Individual Measure and Stacked Savings

Measure Description		Electric Demand (kW)	Electricity (kWh)	Natural Gas (Therm)	Steam (kLB)	EUI (kBTU/SqFt/Yr)
Baseline Building Performance		4,673	2,215,266	0	7,600	151.60
DAT Reset	Savings ▶		*30,451*		*754*	*8.58*
	Usage ▶		2,184,815		6,845	143.02
Seal Air Ducts	Savings ▶		*55,326*		*517*	*-1.52*
	Usage ▶		2,159,940		7,082	144.54
Runaround Heat Recovery	Savings ▶		*3,885*		*802*	*1.09*
	Usage ▶		2,211,381		6,798	143.45
Convert CV to VAV Systems	Savings ▶		*496,505*		*2,290*	*31.70*
	Usage ▶		1,718,761		5,310	111.76
Install Fan Wall	Savings ▶		*78,038*		*0*	*-37.18*
	Usage ▶		2,137,228		7,600	148.94
Air Change Reduction via Rebalancing	Savings ▶		*55,326*		*517*	*4.40*
	Usage ▶		2,159,940		7,082	144.54
Duct Static Pressure Reset	Savings ▶		*187,291*		*0*	*-0.67*
	Usage ▶		2,027,975		7,600	145.21
System Scheduling	Savings ▶		*508,513*		*4,970*	*60.67*
	Usage ▶		1,706,754		2,629	84.54
ALL MEASURES STACKED	Savings ▶		*868,187*		*6,978*	*32.35*
	Usage ▶		1,347,080		622	52.20
	Savings ▶					*52.20*
	Usage ▶					0.00

Notes:

McK8760 - HVAC Schedules

Multiple

Baseline HVAC Equipment Daily Schedules

0 = Unoccupied Mode 1 = Occupied Mode

Schedule A - Load Schedule A								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule B - Load Schedule B								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule C - Load Schedule C								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Proposed HVAC Equipment Daily Schedules

0 = Unoccupied Mode 1 = Occupied Mode

Schedule A - Load Schedule A								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	0	0	0	0	0	0	0
1	2	0	0	0	0	0	0	0
2	3	0	0	0	0	0	0	0
3	4	0	0	0	0	0	0	0
4	5	0	0	0	0	0	0	0
5	6	0	0	0	0	0	0	0
6	7	0	0	0	0	0	0	0
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	0	0	0	0	0	0	0
20	21	0	0	0	0	0	0	0
21	22	0	0	0	0	0	0	0
22	23	0	0	0	0	0	0	0
23	24	0	0	0	0	0	0	0
Daily Totals		12	12	12	12	12	12	12

Schedule B - Load Schedule B								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule C - Load Schedule C								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

McK8760 - Calendar

Multiple

Calendar

Weekends Highlighted Yellow For Reference Year 1989

Month	1	2	3	4	5	6	7	8	9	10	11	12
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	A	A	A	A	A	A	A	A	A	A	A	A
2	A	A	A	A	A	A	A	A	A	A	A	A
3	A	A	A	A	A	A	A	A	A	A	A	A
4	A	A	A	A	A	A	A	A	A	A	A	A
5	A	A	A	A	A	A	A	A	A	A	A	A
6	A	A	A	A	A	A	A	A	A	A	A	A
7	A	A	A	A	A	A	A	A	A	A	A	A
8	A	A	A	A	A	A	A	A	A	A	A	A
9	A	A	A	A	A	A	A	A	A	A	A	A
10	A	A	A	A	A	A	A	A	A	A	A	A
11	A	A	A	A	A	A	A	A	A	A	A	A
12	A	A	A	A	A	A	A	A	A	A	A	A
13	A	A	A	A	A	A	A	A	A	A	A	A
14	A	A	A	A	A	A	A	A	A	A	A	A
15	A	A	A	A	A	A	A	A	A	A	A	A
16	A	A	A	A	A	A	A	A	A	A	A	A
17	A	A	A	A	A	A	A	A	A	A	A	A
18	A	A	A	A	A	A	A	A	A	A	A	A
19	A	A	A	A	A	A	A	A	A	A	A	A
20	A	A	A	A	A	A	A	A	A	A	A	A
21	A	A	A	A	A	A	A	A	A	A	A	A
22	A	A	A	A	A	A	A	A	A	A	A	A
23	A	A	A	A	A	A	A	A	A	A	A	A
24	A	A	A	A	A	A	A	A	A	A	A	A
25	A	A	A	A	A	A	A	A	A	A	A	A
26	A	A	A	A	A	A	A	A	A	A	A	A
27	A	A	A	A	A	A	A	A	A	A	A	A
28	A	A	A	A	A	A	A	A	A	A	A	A
29	A		A	A	A	A	A	A	A	A	A	A
30	A		A	A	A	A	A	A	A	A	A	A
31	A		A		A		A	A		A		A

Holidays and Observances: (Reference Year 1989)

Jan 1	New Year's Day	May 29	Memorial Day	Oct 31	Halloween
Jan 16	MLK Day	Jul 4	Independence Day	Nov 11	Veterans Day
Feb 20	Presidents' Day	Sep 4	Labor Day	Nov 23	Thanksgiving Day
Mar 26	Easter Sunday	Oct 9	Columbus Day	Dec 25	Christmas Day

Schedules Summary

Schedule	Schedule Description	Total Days/Yr	Total Hrs/Yr	Baseline HVAC On Hrs/Yr	Proposed HVAC On Hrs/Yr
Schedule A	Load Schedule A	365	8,760	8,760	4,380
Schedule B	Load Schedule B	0	0	0	0
Schedule C	Load Schedule C	0	0	0	0
Totals		365	8,760	8,760	4,380

McK8760 - Inputs

Multiple

McKinstry
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Zone Inputs:

Tag	Variable Description		Units	Baseline	Proposed	Basis
I7	Floor Area		ft^2	100,000	100,000	Based on CFM
I8	Roof Area		ft^2	10,000	10,000	10% floor area
I9	Opaque Wall Area		ft^2	30,000	30,000	30% floor area
I10	Glazing Area	***Glazing***	ft^2	4,500	4,500	15% wall area
I12	Roof U-Factor	***Roof***	BTU/ft^2/°F	0.050	0.050	R-20
I13	Opaque Wall U-Factor	***Walls***	BTU/ft^2/°F	0.100	0.100	R-10
I14	Glazing U-Factor	***Glazing***	BTU/ft^2/°F	0.667	0.667	R-1.5
I15	Glazing Solar Heat Gain Coefficient (SHGC)	***Glazing***	-	0.500	0.500	Engineering estimate
I16	Glazing Solar Gain Bldg Shape Factor		-	0.300	0.300	Engineering estimate
I17	Average Space Height (Floor to Ceiling)		ft	10.0	10.0	Engineering estimate
I18	Infiltration		ach	0.150	0.150	Engineering estimate
I19	Peak Number of Occupants		Qty	500	500	200 sf per person
I20	Sensible Heat Gain Per Person		Btu/h	250	250	Engineering estimate
I21	Latent Heat Gain Per Person		Btu/h	200	200	Engineering estimate
I22	Peak Lighting Load Power Density		W/ft^2	1.200	1.200	Engineering estimate
I23	Peak Plug Load Power Density		W/ft^2	1.000	1.000	Engineering estimate
I24	Peak Exterior Lighting Load		kW	0	0	Not included
I25	Peak Miscellaneous Load (Electrical)		Watt	0	0	Not included
I26	Miscellaneous Load Located in Conditioned Space		Yes/No	No	No	Not included
I27	HVAC On Cooling Space Temperature Set Point		°F	72.0	72.0	Engineering estimate
I28	HVAC Off Cooling Space Temperature Set Point		°F	72.0	80.0	Engineering estimate
I29	HVAC On Heating Space Temperature Set Point		°F	68.0	68.0	Engineering estimate
I30	HVAC Off Heating Space Temperature Set Point		°F	68.0	65.0	Engineering estimate

AHU & Plant Inputs:

Tag	Variable Description		Units	Baseline	Proposed	Basis
I34	AHU Fan Power based on Control Type		Type	CV	VFD	
I35	Occupied Fan Operation		Type	Continuous	Continuous	No small DX
I36	Occupied Fan Operation Percent Per Hour (CV + Cycles Only)		%	~~50%~~	~~50%~~	-
I37	Maximum AHU CFM		CFM	100,000	90,000	Engineering estimate
I38	Minimum AHU CFM (% of Maximum CFM)		%	90.0%	70.0%	100% OA units
I39	Maximum % Outside Air (Economizer % OSA)		%	100.0%	100.0%	100% OA units
I40	Minimum % Outside Air (Occupied)		%	100.0%	100.0%	100% OA units
I41	Minimum % Outside Air (Unoccupied)		%	100.0%	100.0%	100% OA units
I42	Economizer High Limit Set Point		°F	65.0	65.0	Engineering estimate
I43	Demand Controlled Ventilation (For Outside Air Control)		Yes/No	No	No	N/A
I44	DCV Airflow Per Person (Based on Space Type)	***DCV Tab***	CFM/Per	~~10.00~~	~~10.00~~	-
I45	DCV Airflow Per Area (Based on Space Type)	***DCV Tab***	CFM/ft^2	~~0.06~~	~~0.06~~	-
I46	AHU Fan TSP (At Max CFM)		in w.c.	5.000	4.000	Engineering estimate
I47	Fan Efficiency		%	55.0%	60.0%	Engineering estimate
I48	Supply Air Temperature @ OAT --------------------->	70.0	°F	55	55	Proposed
I49	Supply Air Temperature @ OAT --------------------->	45.0	°F	55	60	Proposed
I50	AHU Cooling Efficiency (EER)		BTU/Watt	20.0	20.0	Equivalent to 0.6 kW/ton
I51	Evaporative Cooling Effectiveness (Air side)		%	0.0%	0.0%	N/A
I52	AHU Cooling Lockout Below		°F	10.0	10.0	N/A
I53	AHU Heating Efficiency or COP @ OAT -------------->	28.0	COP	1.00	1.00	Purchased steam
I54	AHU Heating Efficiency or COP @ OAT -------------->	27.0	COP	1.00	1.00	Purchased steam
I55	AHU Heating Energy Source		Type	Steam	Steam	-
I56	AHU Heating Lockout Above		°F	100.0	100.0	N/A
I57	Evaporative Pre-Cooling on Condenser		Yes/No	No	No	N/A
I58	Heat Recovery % Effectiveness		%	30.0%	45.0%	Assume portion of flow has HR

Terminal Devices Inputs (Reheat Coils, VAV Boxes, Baseboard Heaters, etc)

Tag	Variable Description		Units	Baseline	Proposed	Basis
I62	Terminal Devices		Yes/No	Yes	Yes	Existing and proposed design
I63	Zone Heating Lockout Above		°F	100.0	100.0	N/A
I64	Zone Heating Efficiency or COP @ OAT ------------->	60.0	COP	1.00	1.00	Same as AHU
I65	Zone Heating Efficiency or COP @ OAT ------------->	50.0	COP	1.00	1.00	Same as AHU
I66	Heating Energy Source Zone		Type	Steam	Steam	-
I67	Unoccupied Heating Done By		Zone, AHU	Zone Coil	Zone Coil	Per design
I68	SFPMB Terminal Unit Power		W/CFM	0.00	0.00	No fan boxes

Domestic Hot Water Inputs:

Tag	Variable Description	Units	Baseline	Proposed	Basis
I72	DHW Fuel Type	Type	Natural Gas	Natural Gas	N/A
I73	Energy Factor	-	0.95	0.95	N/A
I74	Working Days Per Year (Used Only For DHW Calc)	Qty	0	0	N/A
I75	Average Daily Hot Water Consumption Per Person	Gallons	1.0	1.0	N/A
I76	Average Entering Cold Water Temperature	°F	50.0	50.0	N/A
I77	Supply Hot Water Temperature	°F	120.0	120.0	N/A

McK8760 - Outputs
Multiple

Electric Demand

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O7	Cooling Peak kW	kW	167	-	106	-	61	-
O8	AHU Heating Peak kW	kW	0	-	0	-	0	-
O9	Zone Heating Peak kW	kW	0	-	0	-	0	-
O10	Fan Peak kW	kW	107	-	36	-	71	-
O11	Interior Lighting Peak kW	kW	108	-	108	-	0	-
O12	Exterior Lighting Peak kW	kW	0	-	0	-	0	-
O13	Plug Load Peak kW	kW	90	-	90	-	0	-
O14	Miscellaneous Load Peak kW	kW	0		0	-	0	-
O15	Other Peak kW	kW	0	-	0	-	0	-
O16	Peak kW	kW	467	-	336	-	131	-
O17	Peak kW (Sum 12 Monthly Peaks)	kW	4,673	-	3,465	-	1,207	-

Electricity

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O21	Cooling	kWh/Yr	170,671	5.82	81,334	2.78	89,337	3.05
O22	AHU Heating	kWh/Yr	0	0.00	0	0.00	0	0.00
O23	Zone Heating	kWh/Yr	0	0.00	0	0.00	0	0.00
O24	AHU Fans	kWh/Yr	936,455	31.96	157,605	5.38	778,850	26.58
O25	Zone Fans	kWh/Yr	0	0.00	0	0.00	0	0.00
O26	Interior Lighting	kWh/Yr	604,440	20.63	604,440	20.63	0	0.00
O27	Exterior Lighting	kWh/Yr	0	0.00	0	0.00	0	0.00
O28	Plug Loads	kWh/Yr	503,700	17.19	503,700	17.19	0	0.00
O29	Miscellaneous Loads	kWh/Yr	0	0.00	0	0.00	0	0.00
O30	Domestic Hot Water	kWh/Yr	0	0.00	0	0.00	0	0.00
O31	Other Electricity	kWh/Yr	0	0.00	0	0.00	0	0.00
O32	Total	kWh/Yr	2,215,266	75.61	1,347,080	45.98	868,187	29.63

Natural Gas

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O36	AHU Heating	Therm/Yr	0	0.00	0	0.00	0	0.00
O37	Zone Heating	Therm/Yr	0	0.00	0	0.00	0	0.00
O38	Domestic Hot Water	Therm/Yr	0	0.00	0	0.00	0	0.00
O39	Other Natural Gas	Therm/Yr	0	0.00	0	0.00	0	0.00
O40	Total	Therm/Yr	0	0.00	0	0.00	0	0.00

Steam

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O44	AHU Heating	kLB/Yr	1,104	11.04	342	3.42	762	7.62
O45	Zone Heating	kLB/Yr	6,496	64.96	280	2.80	6,216	62.16
O46	Domestic Hot Water	kLB/Yr	0	0.00	0	0.00	0	0.00
O47	Other Steam	kLB/Yr	0	0.00	0	0.00	0	0.00
O48	Total Steam	kLB/Yr	7,600	76.00	622	6.22	6,978	69.78

Total Energy

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O52	Total Energy	kBtu/Yr	15,160,343	151.60	5,219,547	52.20	9,940,796	99.41

ACCOUNTING METHODOLOGY FOR INTERACTIVE MEASURES

1. Run each measure against the same baseline
2. Run all measures together
3. Determine derate factor
4. Determine CFM factor

ID	Measure	HVAC On Cooling	HVAC Off Cooling	HVAC On Heating	HVAC Off Heating	Schedules	AHU Control Type	Max AHU CFM	Min AHU CFM	AHU Fan TSP	Fan Efficiency	SAT at OAT = 70	SAT at OAT = 40	Heat Recovery %	Max AHU CFM - Modeled	CFM Multiplier	Steam Savings	kWh Savings	Steam Savings with Derate Factor & CFM Multiplier	kWh Savings with Derate Factor & CFM Multiplier
-	BASELINE	72	72	68	68	24x7	CV	100000	90%	5"	55%	55	55	30%	100000	1	-	-	-	-
21773	03.00 DAT Reset	72	72	68	68	24x7	CV	100000	90%	5"	55%	55	60	30%	100000	1	754	30,451	534	18,679
26477	03.00 Seal Air Ducts	72	72	68	68	24x7	CV	100000	90%	5"	55%	55	55	30%	100000	1	517	55,326	366	33,938
21769	03.00 Runaround Heat Recovery	72	72	68	68	24x7	CV	150000	90%	5"	55%	55	55	45%	100000	1.5	802	3,885	852	3,575
26442	03.00 Convert CV Systems to VAV Systems	72	72	68	68	24x7	VFD	250000	70%	5"	55%	55	55	30%	100000	2.5	2,290	496,505	4,056	761,408
26486	03.00 Install Fan Wall	72	72	68	68	24x7	CV	132748	90%	5"	60%	55	55	30%	100000	1.3	0	78,038	0	63,546
26895	04.00 Air Change Reduction via Rebalancing	72	72	68	68	24x7	CV	250000	90%	5"	55%	55	55	30%	100000	2.5	517	55,326	916	84,844
26466	04.00 Duct Static Pressure Reset	72	72	68	68	24x7	CV	50000	90%	4"	55%	55	55	30%	100000	0.5	0	187,291	0	57,444
26465	04.00 System Scheduling	72	80	68	65	12hrs off	CV	50000	90%	5"	55%	55	55	30%	100000	0.5	4,970	508,513	1,760	155,965
															Sum of Individual Runs		9,850	1,415,335	8,484	1,179,398
-	Combined All Measures	72	80	72	65	12hrs off	VFD	100000	80%	4"	60%	55	60	45%	Combined all Measures		6,978	868,187	-	-
															Derate Factor		71%	61%	-	-

McK8760 - General Information
04.00 High Efficiency Lab Hoods

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	04.00 High Efficiency Lab Hoods
TCO Project ID	300	Tech Contact	Ron Fues
TCO Tool FIM ID	26467	Date	12/19/2014

Weather Data:

Nearest Weather Station	WA, SEATTLE BOEING FIELD [ISIS]	Station ID	727935TY.xls

Description of FIM From TCO Tool:

For new tenant fit outs, high efficiency lab hoods provide good value over traditional hoods (even vs. relocating hoods already owned by VMMC), assuming that the hood density is high. For areas where hood density is low, standard hood are recommended.Constant volume fume hoods serve to contain and exhaust hazardous fumes. They do this effectively although it typically also involves exhausting large quantities of conditioned air. VAV fume hoods help to minimize the amount of conditioned air that is exhausted by ramping down the exhaust fans when sashes are closed or partially closed by occupants.Strategies include:Low flow constant volume hoods.Low flow variable volume hoods based on sash position.Occupancy sensors and pushbutton overrides at hoods.

HVAC & Load Schedules:

Schedule A Title	Load Schedule A	ASHRAE Schedule Type	Health
Schedule B Title	Load Schedule B	ASHRAE Schedule Type	Health
Schedule C Title	Load Schedule C	ASHRAE Schedule Type	Health

Utility Rate Schedules

Schedule 1 Title	Rate Schedule 1
Schedule 2 Title	Rate Schedule 2
Schedule 3 Title	Rate Schedule 3

Zone Data (for multi-model buildings)

Zone Name	
Zone Description	

Savings Tracker (Use if Modeling Multiple Efficiency Measures)

Measure Description		Electric Demand (kW)	Electricity (kWh)	Natural Gas (Therm)	Steam (kLB)	EUI (kBTU/SqFt/Yr)
Baseline Building Performance		209	92,442	0	617	466.47
High Efficiency Lab Hoods	Savings ►	*0*	*27,757*	*0*	*354*	*224.47*
	Usage ►	156	64,685	0	263	242.00
	Savings ►					*242.00*
	Usage ►					0.00
	Savings ►					*0.00*
	Usage ►					0.00
	Savings ►					*0.00*
	Usage ►					0.00
	Savings ►					*0.00*
	Usage ►					0.00
	Savings ►					*0.00*
	Usage ►					0.00
	Savings ►					*0.00*
	Usage ►					0.00
	Savings ►					*0.00*
	Usage ►					0.00
	Savings ►					*0.00*
	Usage ►					0.00
	Savings ►					*0.00*
	Usage ►					0.00

Notes:

McK8760 - HVAC Schedules

04.00 High Efficiency Lab Hoods

Baseline HVAC Equipment Daily Schedules

0 = Unoccupied Mode   1 = Occupied Mode

Schedule A - Load Schedule A								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule B - Load Schedule B								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule C - Load Schedule C								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Proposed HVAC Equipment Daily Schedules

0 = Unoccupied Mode   1 = Occupied Mode

Schedule A - Load Schedule A								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	0	0	0	0	0	0	0
3	4	0	0	0	0	0	0	0
4	5	0	0	0	0	0	0	0
5	6	0	0	0	0	0	0	0
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		20	20	20	20	20	20	20

Schedule B - Load Schedule B								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule C - Load Schedule C								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

McK8760 - Calendar

04.00 High Efficiency Lab Hoods

Calendar

Weekends Highlighted Yellow For Reference Year 1989

Month	1	2	3	4	5	6	7	8	9	10	11	12
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	A	A	A	A	A	A	A	A	A	A	A	A
2	A	A	A	A	A	A	A	A	A	A	A	A
3	A	A	A	A	A	A	A	A	A	A	A	A
4	A	A	A	A	A	A	A	A	A	A	A	A
5	A	A	A	A	A	A	A	A	A	A	A	A
6	A	A	A	A	A	A	A	A	A	A	A	A
7	A	A	A	A	A	A	A	A	A	A	A	A
8	A	A	A	A	A	A	A	A	A	A	A	A
9	A	A	A	A	A	A	A	A	A	A	A	A
10	A	A	A	A	A	A	A	A	A	A	A	A
11	A	A	A	A	A	A	A	A	A	A	A	A
12	A	A	A	A	A	A	A	A	A	A	A	A
13	A	A	A	A	A	A	A	A	A	A	A	A
14	A	A	A	A	A	A	A	A	A	A	A	A
15	A	A	A	A	A	A	A	A	A	A	A	A
16	A	A	A	A	A	A	A	A	A	A	A	A
17	A	A	A	A	A	A	A	A	A	A	A	A
18	A	A	A	A	A	A	A	A	A	A	A	A
19	A	A	A	A	A	A	A	A	A	A	A	A
20	A	A	A	A	A	A	A	A	A	A	A	A
21	A	A	A	A	A	A	A	A	A	A	A	A
22	A	A	A	A	A	A	A	A	A	A	A	A
23	A	A	A	A	A	A	A	A	A	A	A	A
24	A	A	A	A	A	A	A	A	A	A	A	A
25	A	A	A	A	A	A	A	A	A	A	A	A
26	A	A	A	A	A	A	A	A	A	A	A	A
27	A	A	A	A	A	A	A	A	A	A	A	A
28	A	A	A	A	A	A	A	A	A	A	A	A
29	A		A	A	A	A	A	A	A	A	A	A
30	A		A	A	A	A	A	A	A	A	A	A
31	A		A		A		A	A		A		A

Holidays and Observances: (Reference Year 1989)

Jan 1	New Year's Day	May 29	Memorial Day	Oct 31	Halloween
Jan 16	MLK Day	Jul 4	Independence Day	Nov 11	Veterans Day
Feb 20	Presidents' Day	Sep 4	Labor Day	Nov 23	Thanksgiving Day
Mar 26	Easter Sunday	Oct 9	Columbus Day	Dec 25	Christmas Day

Schedules Summary

Schedule	Schedule Description	Total Days/Yr	Total Hrs/Yr	Baseline HVAC On Hrs/Yr	Proposed HVAC On Hrs/Yr
Schedule A	Load Schedule A	365	8,760	8,760	7,300
Schedule B	Load Schedule B	0	0	0	0
Schedule C	Load Schedule C	0	0	0	0
Totals		365	8,760	8,760	7,300

McK8760 - Inputs

04.00 High Efficiency Lab Hoods

Zone Inputs:

Tag	Variable Description		Units	Baseline	Proposed	Basis
I7	Floor Area		ft^2	2,000	2,000	Engineering estimate
I8	Roof Area		ft^2	0	0	N/A
I9	Opaque Wall Area		ft^2	0	0	N/A
I10	Glazing Area	***Glazing***	ft^2	0	0	N/A
I12	Roof U-Factor	***Roof***	BTU/ft^2/°F	0.067	0.067	N/A
I13	Opaque Wall U-Factor	***Walls***	BTU/ft^2/°F	0.100	0.100	N/A
I14	Glazing U-Factor	***Glazing***	BTU/ft^2/°F	0.667	0.667	N/A
I15	Glazing Solar Heat Gain Coefficient (SHGC)	***Glazing***	-	0.500	0.500	N/A
I16	Glazing Solar Gain Bldg Shape Factor		-	0.300	0.300	N/A
I17	Average Space Height (Floor to Ceiling)		ft	10.0	10.0	Engineering estimate
I18	Infiltration		ach	0.000	0.000	N/A
I19	Peak Number of Occupants		Qty	10	10	200 sf per person
I20	Sensible Heat Gain Per Person		Btu/h	250	250	Engineering estimate
I21	Latent Heat Gain Per Person		Btu/h	200	200	Engineering estimate
I22	Peak Lighting Load Power Density		W/ft^2	1.500	1.500	Engineering estimate
I23	Peak Plug Load Power Density		W/ft^2	2.000	2.000	Engineering estimate
I24	Peak Exterior Lighting Load		kW	0	0	Not included
I25	Peak Miscellaneous Load (Electrical)		Watt	0	0	Not included
I26	Miscellaneous Load Located in Conditioned Space		Yes/No	No	No	Not included
I27	HVAC On Cooling Space Temperature Set Point		°F	70.0	70.0	Engineering estimate
I28	HVAC Off Cooling Space Temperature Set Point		°F	70.0	70.0	Engineering estimate
I29	HVAC On Heating Space Temperature Set Point		°F	70.0	70.0	Engineering estimate
I30	HVAC Off Heating Space Temperature Set Point		°F	70.0	70.0	Engineering estimate

AHU & Plant Inputs:

Tag	Variable Description		Units	Baseline	Proposed	Basis
I34	AHU Fan Power based on Control Type		Type	VFD	VFD	
I35	Occupied Fan Operation		Type	Continuous	Continuous	No small DX
I36	Occupied Fan Operation Percent Per Hour (CV + Cycles Only)		%	~~50%~~	~~50%~~	-
I37	Maximum AHU CFM		CFM	6,750	4,050	Based on fume hood fpm
I38	Minimum AHU CFM (% of Maximum CFM)		%	100%	100%	-
I39	Maximum % Outside Air (Economizer % OSA)		%	100%	100%	-
I40	Minimum % Outside Air (Occupied)		%	100%	100%	-
I41	Minimum % Outside Air (Unoccupied)		%	100%	100%	100% OA units
I42	Economizer High Limit Set Point		°F	65.0	65.0	Engineering estimate
I43	Demand Controlled Ventilation (For Outside Air Control)		Yes/No	No	No	N/A
I44	DCV Airflow Per Person (Based on Space Type)	***DCV Tab***	CFM/Per	~~10.00~~	~~10.00~~	-
I45	DCV Airflow Per Area (Based on Space Type)	***DCV Tab***	CFM/ft^2	~~0.06~~	~~0.06~~	-
I46	AHU Fan TSP (At Max CFM)		in w.c.	4.000	4.000	Engineering estimate
I47	Fan Efficiency		%	60.0%	60.0%	Assumes post-fan wall measure
I48	Supply Air Temperature @ OAT --------------------->	70.0	°F	55	55	Assumes no DAT reset
I49	Supply Air Temperature @ OAT --------------------->	40.0	°F	60	60	Assumes no DAT reset
I50	AHU Cooling Efficiency (EER)		BTU/Watt	20.0	20.0	Equivalent to 0.6 kW/ton
I51	Evaporative Cooling Effectiveness (Air side)		%	0.0%	0.0%	N/A
I52	AHU Cooling Lockout Below		°F	10.0	10.0	N/A
I53	AHU Heating Efficiency or COP @ OAT -------------->	28.0	COP	1.00	1.00	Purchased steam
I54	AHU Heating Efficiency or COP @ OAT -------------->	27.0	COP	1.00	1.00	Purchased steam
I55	AHU Heating Energy Source		Type	Steam	Steam	-
I56	AHU Heating Lockout Above		°F	100.0	100.0	N/A
I57	Evaporative Pre-Cooling on Condenser		Yes/No	No	No	N/A
I58	Heat Recovery % Effectiveness		%	45.0%	45.0%	Assume half of units have HR

Terminal Devices Inputs (Reheat Coils, VAV Boxes, Baseboard Heaters, etc)

Tag	Variable Description		Units	Baseline	Proposed	Basis
I62	Terminal Devices		Yes/No	Yes	Yes	Existing and proposed design
I63	Zone Heating Lockout Above		°F	100.0	100.0	N/A
I64	Zone Heating Efficiency or COP @ OAT ------------->	60.0	COP	1.00	1.00	Same as AHU
I65	Zone Heating Efficiency or COP @ OAT ------------->	50.0	COP	1.00	1.00	Same as AHU
I66	Heating Energy Source Zone		Type	Steam	Steam	-
I67	Unoccupied Heating Done By		Zone, AHU	Zone Coil	Zone Coil	Per design
I68	SFPMB Terminal Unit Power		W/CFM	0.00	0.00	No fan boxes

Domestic Hot Water Inputs:

Tag	Variable Description	Units	Baseline	Proposed	Basis
I72	DHW Fuel Type	Type	Natural Gas	Natural Gas	N/A
I73	Energy Factor	-	0.95	0.95	N/A
I74	Working Days Per Year (Used Only For DHW Calc)	Qty	0	0	N/A
I75	Average Daily Hot Water Consumption Per Person	Gallons	1.0	1.0	N/A
I76	Average Entering Cold Water Temperature	°F	50.0	50.0	N/A
I77	Supply Hot Water Temperature	°F	120.0	120.0	N/A

McK8760 - Outputs

04.00 High Efficiency Lab Hoods

Electric Demand

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O7	Cooling Peak kW	kW	11	-	7	-	4	-
O8	AHU Heating Peak kW	kW	0	-	0	-	0	-
O9	Zone Heating Peak kW	kW	0	-	0	-	0	-
O10	Fan Peak kW	kW	5	-	3	-	2	-
O11	Interior Lighting Peak kW	kW	3	-	3	-	0	-
O12	Exterior Lighting Peak kW	kW	0	-	0	-	0	-
O13	Plug Load Peak kW	kW	4	-	4	-	0	-
O14	Miscellaneous Load Peak kW	kW	0		0	-	0	-
O15	Other Peak kW	kW	0	-	0	-	0	-
O16	Peak kW	kW	23	-	16	-	6	-
O17	Peak kW (Sum 12 Monthly Peaks)	kW	209	-	156	-	53	-

Electricity

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O21	Cooling	kWh/Yr	10,828	18.48	6,249	10.66	4,579	7.81
O22	AHU Heating	kWh/Yr	0	0.00	0	0.00	0	0.00
O23	Zone Heating	kWh/Yr	0	0.00	0	0.00	0	0.00
O24	AHU Fans	kWh/Yr	46,355	79.10	23,177	39.55	23,177	39.55
O25	Zone Fans	kWh/Yr	0	0.00	0	0.00	0	0.00
O26	Interior Lighting	kWh/Yr	15,111	25.79	15,111	25.79	0	0.00
O27	Exterior Lighting	kWh/Yr	0	0.00	0	0.00	0	0.00
O28	Plug Loads	kWh/Yr	20,148	34.38	20,148	34.38	0	0.00
O29	Miscellaneous Loads	kWh/Yr	0	0.00	0	0.00	0	0.00
O30	Domestic Hot Water	kWh/Yr	0	0.00	0	0.00	0	0.00
O31	Other Electricity	kWh/Yr	0	0.00	0	0.00	0	0.00
O32	Total	kWh/Yr	92,442	157.75	64,685	110.39	27,757	47.37

Natural Gas

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O36	AHU Heating	Therm/Yr	0	0.00	0	0.00	0	0.00
O37	Zone Heating	Therm/Yr	0	0.00	0	0.00	0	0.00
O38	Domestic Hot Water	Therm/Yr	0	0.00	0	0.00	0	0.00
O39	Other Natural Gas	Therm/Yr	0	0.00	0	0.00	0	0.00
O40	Total	Therm/Yr	0	0.00	0	0.00	0	0.00

Steam

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O44	AHU Heating	kLB/Yr	73	36.68	33	16.28	41	20.40
O45	Zone Heating	kLB/Yr	544	272.04	231	115.33	313	156.71
O46	Domestic Hot Water	kLB/Yr	0	0.00	0	0.00	0	0.00
O47	Other Steam	kLB/Yr	0	0.00	0	0.00	0	0.00
O48	Total Steam	kLB/Yr	617	308.72	263	131.61	354	177.10

Total Energy

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O52	Total Energy	kBtu/Yr	932,941	466.47	484,000	242.00	448,942	224.47

The Inn at VM

Ozone Laundry System Savings Calculations

WATER SAVINGS CALCS		Pounds per day
		Days per year
	655,200	lbs per year
	2.5	gals per pound
	1,638,000	total gals per year used currently
	20%	savings (potentially could be up to 30%)
	327,600	gals SAVED per Year
WATER SAVINGS AFTER SAFETY FACTOR	**278,460**	**NET gallons saved with 15% safety factor**
	372	CCF
THERMAL CALCS - WASH	120	wash water temp
	52	incoming temp
	68	increase needed
	80%	efficiency rating
	6,413	Therms saved annually
THERMAL SAVINGS AFTER SAFETY FACTOR	**5,451**	**NET therms saved with 15% safety factor**
THERMAL CALCS - DRYER	9,927	Dryer Therms NOW
	20%	Dryer Therms Savings
	1,985	Therms saved annually
THERMAL SAVINGS AFTER SAFETY FACTOR	**993**	**NET therms saved with 50% safety factor**
	6444	**total therms**

McKinstry Calculation Template
07.00 Combined Heat and Power

Project Information:

Project Name	Virginia Mason Medical Cente	FIM Name	07.00 Combined Heat and Power
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26446	Date	11/18/2014

Description of FIM From TCO Tool:

If VMMC is planning to spend money to add back-up generator capacity, consider installed a combined heat and power (CHP) system instead. Instead of just acting as a back-up system, the CHP system would operate 24x7 and use natural gas to generate both a continuous supply of electrical power and hot water for use throughout the facility. The endless need for both electricity and heat makes VMMC an optimal location for this type of system. The considerably low natural gas rate improves the financials even further when compared to the cost per unit of energy from steam.

FIM Calculation Method From TCO Tool:

Fuel use calculations are based on 30% electrical efficiency and 45% heating efficiency. Note that this measure does not generate site energy savings, rather substantial cost savings.

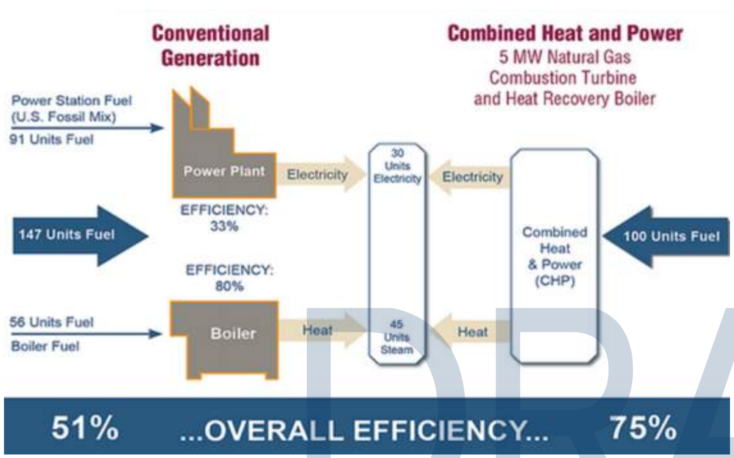
Inputs:

	Proposed	Units
Electrical output	1.5	MW
Electrical efficiency	30%	%
Heating efficiency	45%	%
Annual operating hours	4,380	hrs

Calculated Values:

	Base	Units	
Cogen Fuel Input	171	therms/hr	=(C17/C18)*1000*3412/100000
Cogen Steam Output	7	klbs/hr	=C23*100000*C19/(1100*1000)
Cogen Electrical Output	1,500	kW	=C17*1000
Annual Cogen Fuel Input	747,228	therms	=C23*C20
Annual Cogen Steam Output	30,568	klbs	=C24*C20
Annual Cogen Electrical Output	6,570,000	kWh	=C25*C20

From EPA.gov



McKinstry Calculation Template
08.00 High-efficiency Motors

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	08.00 High-efficiency Motors
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26472	Date	11/18/2014

Description of FIM From TCO Tool:

Besides motor size and operating hours, motor efficiency is a key driver of motor energy consumption. This measure involves upgrading motors to higher efficiency models whenever existing motors fail.

FIM Calculation Method From TCO Tool:

Savings are based on an increase in motor efficiency per NEMA Table MG-1.

Inputs:

	Baseline	Proposed	Savings	Units
Motor hp	25	25	0	hp
Motor quantity	50	50	0	-
Load factor	80%	80%	0%	%
Motor efficiency	89%	92.4%	0.0	%
Annual operating hours	6,570	6,570	0	-

Calculated Values:

		Baseline	Proposed	Savings	Units	
C24	Total savings	5,506,989	5,304,351	202,638	kWh	=(C17*C19*0.746/C20)*C21*C18

McKinstry Calculation Template

09.00 Buck LED Lighting

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	09.00 Buck LED Lighting
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26951	Date	12/9/2014

Description of FIM From TCO Tool:

Install LED lighting retrofit troffers, recessed cans, tubes, and wall occupancy sensors. Affected space types include common hallways, offices, restrooms, elevators, and stairs.

FIM Calculation Method From TCO Tool:

Savings are based on a reduction in wattage per fixture though do not include demand (kW savings) or heating and cooling penalties.

Inputs:

	Base	Proposed	Savings	Units	Basis of Value

Savings Estimates and Payback

[illegible]	[illegible]	Estimated Savings [illegible]	Estimated Annual Cost [illegible]	Simple Energy Payback Estimate [illegible]	Annual Replacement [illegible]	Annual Lamp Replacement [illegible]	Total Annual Cost [illegible]	Total Investment Payback Estimate [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]

Calculated Values:

		Base	Proposed	Savings	Units	
C51	Annual electricity savings	-	-	380,446	kWh	'-

Project Information:

Project Name	Virginia Mason Medical Cente	FIM Name	09.00 HRB LED Lighting
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26952	Date	12/9/2014

Description of FIM From TCO Tool:

Install LED lighting retrofit troffers, recessed cans, tubes, and wall occupancy sensors. Affected space types include common hallways, offices, and stairwells.

FIM Calculation Method From TCO Tool:

Savings are based on a reduction in wattage per fixture though do not include demand (kW savings) or heating and cooling penalties.

Inputs:

	Base	Proposed	Savings	Units	Basis of Value

Savings Estimates and Payback

Lamp Description:	Annual Hours of Operation	Estimated Savings kWh	Estimated Annual Cost Savings	Simple Energy Payback Estimate (Yrs.)	Annual Replacement Lamps Saved	Annual Lamp Replacement Cost Savings	Total Annual Cost Savings	Total Investment Payback Estimate (Yrs.)
Luma Vue LED tube (2L 18.5w)	8,760	6,244	$ 437.09	11.6	19	$ 655.25	$ 1,092.34	4.6
Philips 2 x 4 LED Retrofit Troffer (34w)	8,760	18,501	$ 1,295.08	13.9	48	$ 2,023.56	$ 3,318.64	5.4
Luma Vue LED tube (2L 18.5w)	8,760	4,683	$ 327.82	11.6	14	$ 491.44	$ 819.25	4.6
Luma Vue LED tube (1L 18.5w)	8,760	710	$ 49.67	17.8	4	$ 148.92	$ 198.59	4.4
Philips 2 x 4 LED Retrofit Troffer (34w) + Wall Occ Sensor	5,840	67,305	$ 4,711.34	14.7	98	$ 4,120.70	$ 8,832.04	7.9
Cree CR6 LED Recessed Can (9.5w)	5,840	2,365	$ 165.56	16.3	15	$ 248.20	$ 413.76	6.5
Luma Vue LED tube (2L 18.5w)	8,760	2,271	$ 158.94	11.6	7	$ 238.27	$ 397.21	4.6
Philips 2 x 4 LED Retrofit Troffer (34w)	8,760	2,859	$ 200.15	13.9	7	$ 312.73	$ 512.88	5.4
		104,938	$ 7,345.65	15.9		$ 8,239.07	$ 15,584.72	7.5

Calculated Values:

		Base	Proposed	Savings	Units	
C46	Annual electricity savings	-	-	104,938	kWh	'-

McKinstry Calculation Template
09.00 Lindeman LED Lighting

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	09.00 Lindeman LED Lighting
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26950	Date	12/9/2014

Description of FIM From TCO Tool:

Install LED lighting retrofit troffers, recessed cans, tubes, and wall occupancy sensors. Affected space types include common hallways, elevator lobbies, offices, stairs, garage, and exterior.

FIM Calculation Method From TCO Tool:

Savings are based on a reduction in wattage per fixture though do not include demand (kW savings) or heating and cooling penalties.

Inputs:

Base | Proposed | Savings | Units | Basis of Value

Savings Estimates and Payback

Lamp Description:	Annual Hours of Operation	Estimated Savings kWh	Estimated Annual Cost Savings	Simple Energy Payback Estimate (Yrs.)	Annual Replacement Lamps Saved	Annual Lamp Replacement Cost Savings	Total Annual Cost Savings	Total Investment Payback Estimate (Yrs.)
Philips 2 x 4 LED Retrofit Troffer (34w)	8,760	59,550	$ 4,168.53	12.7	135	$ 5,143.00	$ 9,311.53	5.7
Philips 2 x 2 LED Retrofit Troffer (23w)	8,760	29,600	$ 2,072.00	6.1	48	$ 2,243.87	$ 4,315.88	2.9
Philips 2 x 4 LED Retrofit Troffer (34w)	8,760	34,882	$ 2,441.76	11.7	79	$ 3,329.68	$ 5,771.44	4.9
Cree CR6 LED Recessed Can (9.5w)	8,760	58,226	$ 4,075.82	5.8	254	$ 4,318.68	$ 8,394.50	2.8
Luma Vue LED tube (2L 18.5w)	8,760	1,293	$ 90.51	6.7	3	$ 99.86	$ 190.37	3.2
Luma Vue LED tube (1L 18.5w)	8,760	12,930	$ 905.08	9.0	53	$ 1,787.04	$ 2,692.12	3.0
Philips 2 x 4 LED Retrofit Troffer (34w) + Wall Occ Sensor	5,840	128,684	$ 9,007.91	12.5	165	$ 6,929.16	$ 15,937.07	7.1
Luma Vue LED tube (1L 18.5w)	5,840	8,189	$ 573.22	12.1	33	$ 1,131.79	$ 1,705.01	4.1
Luma Vue LED tube (2L 18.5w)	5,840	1,724	$ 120.68	11.4	4	$ 133.15	$ 253.83	5.4
Philips LED MR16 (7w)	5,840	13,812	$ 966.81	0.5	128	$ 642.40	$ 1,609.21	0.3
Cree CR6 LED Recessed Can (9.5w)	5,840	5,354	$ 374.79	10.5	23	$ 397.12	$ 771.91	5.1
Luma Vue LED tube (1L 18.5w)	8,760	7,327	$ 512.88	9.0	30	$ 1,012.66	$ 1,525.54	3.0
Luma Vue LED tube (2L 18.5w)	8,760	29,307	$ 2,051.52	6.7	60	$ 2,263.58	$ 4,315.11	3.2
Light Efficient Design LED Retrofit (21w)	8,760	2,943	$ 206.04	3.6	4	$ 175.20	$ 381.24	1.9
		393,822	$ 27,567.55	11.1		$ 29,607.19	$ 57,174.74	5.3

Calculated Values:

		Base	Proposed	Savings	Units	
C51	Annual electricity savings	-	-	393,822	kWh	'-

McKinstry Calculation Template
10.00 Solar PV

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	10.00 Solar PV
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26593	Date	11/18/2014

Description of FIM From TCO Tool:

While solar energy in the Northwest is not as productive as in other parts of the country, it can still sometimes prove to be a better investment than efficiency. This may be the case for Virginia Mason as 2030 approaches and all low-hanging fruit has been implemented and solar costs have continued to drop. This measure involves providing a small 15 kW solar electric system on the Lindeman roof.

FIM Calculation Method From TCO Tool:

Savings are estimated using NREL's PV Watts calculator based on a 15kW system at 30deg tilt.

Inputs:

PVWatts® Calculator — NREL

My Location: 1100 9th Ave Seattle WA 98101

RESULTS — 16,708 kWh per Year *

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Energy Value ($)
January	1.38	548	N/A
February	2.32	810	N/A
March	3.62	1,377	N/A
April	4.51	1,661	N/A
May	5.70	2,104	N/A
June	6.06	2,143	N/A
July	6.37	2,292	N/A
August	5.41	1,953	N/A
September	4.87	1,706	N/A
October	2.82	1,060	N/A
November	1.62	613	N/A
December	1.13	443	N/A
Annual	3.82	16,708	0

Calculated Values:

		Savings	Units
C48	Total savings	16,708	kWh

McKinstry Calculation Template
12.00 Condensate Reuse

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	12.00 Condensate Reuse
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26599	Date	12/10/2014

Description of FIM From TCO Tool:

Once steam transfers its heat to a heat exchanger or heating coil, it changes into its liquid form of hot condensate. In most cases at VMMC, this hot condensate is then piped to a condensate heat recovery unit. After passing through the heat recovery unit, all condensate (e.g. warm water) goes down the sewer drain and ends up at one of King County's water treatment plants. This measure would capture that condensate and reuse it for cooling towers or for future green space irrigation, thereby reducing VMMC's purchase of water. Unfortunately, the condensate that goes down the drain does not incur sewer charges from Seattle Public Utilities due to an agreement between SPU and Enwave (formerly Seattle Steam), so there are no sewer savings for this measure.

FIM Calculation Method From TCO Tool:

Given the large annual production of condensate (>6,000,000 gallons), the restricting factor for re-use is the demand for reuse and the storage capacity. For this measure, it is estimated that the 5,000 gallon storage tank could fully supply water for the Buck Cooling tower (and possibly other uses, though those are not accounted for here).

Inputs:

	Inputs	Base	Proposed	Savings	Units	Basis of Value
C17	Buck Cooling Tower Deduct Use	113	113	0	CCF	
C18	Gallons per CCF	748	748	0	gallons/CCF	

Calculated Values:

	Calculated Values	Base	Proposed	Savings	Units	
C21	Buck Annual Cooling Tower Use	84,524	84,524	0	gallons	=C17*C18
C22	Annual water use	113	0	113	CCF	=C17

McK8760 - General Information

13.00 Electrochromic Windows

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	13.00 Electrochromic Windows
TCO Project ID	300	Tech Contact	Ron Fues
TCO Tool FIM ID	26832	Date	12/19/2014

Weather Data:

Nearest Weather Station	WA, SEATTLE BOEING FIELD [ISIS]	Station ID	727935TY.xls

Description of FIM From TCO Tool:

Dynamic windows can change the amount of daylight or heat transmission based on environmental conditions (passive control) or an external control (active control). These windows can replace the need for blinds or window coverings. An electrochromic window, an example of an actively control window, is an electrically powered insulated glazing panel that tints to reduce glare and heat without the use of blinds (very minimal electric use). This measure involves installing electrochromic windows on the West facade of Buck North and Buck South. Electrochromic windows can change the solar heat gain coefficient and visible light transmittance based on low voltage control. Energy savings result from reduced heating and cooling loads as well as a reduced demand for electric lighting.

HVAC & Load Schedules:

Schedule A Title	Load Schedule A	ASHRAE Schedule Type	Health
Schedule B Title	Load Schedule B	ASHRAE Schedule Type	Health
Schedule C Title	Load Schedule C	ASHRAE Schedule Type	Health

Utility Rate Schedules

Schedule 1 Title	Rate Schedule 1
Schedule 2 Title	Rate Schedule 2
Schedule 3 Title	Rate Schedule 3

Zone Data (for multi-model buildings)

Zone Name	
Zone Description	

Savings Tracker - Individual Measure Savings NOT STACKED

Measure Description		Electric Demand (kW)	Electricity (kWh)	Natural Gas (Therm)	Steam (kLB)	EUI (kBTU/SqFt/Yr)
Baseline Building Performance		1,218	564,312	0	2,857	189.80
Electrochromic Windows	Savings ►		*415*		*160*	*6.40*
	Usage ►	1,212	563,897	0	2,697	183.41

Notes:

Baseline HVAC Equipment Daily Schedules

0 = Unoccupied Mode 1 = Occupied Mode

Schedule A - Load Schedule A								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule B - Load Schedule B								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule C - Load Schedule C								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Proposed HVAC Equipment Daily Schedules

0 = Unoccupied Mode 1 = Occupied Mode

Schedule A - Load Schedule A								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule B - Load Schedule B								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule C - Load Schedule C								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

McK8760 - Calendar

13.00 Electrochromic Windows

Calendar

Weekends Highlighted Yellow For Reference Year 1989

Month	1	2	3	4	5	6	7	8	9	10	11	12
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	A	A	A	A	A	A	A	A	A	A	A	A
2	A	A	A	A	A	A	A	A	A	A	A	A
3	A	A	A	A	A	A	A	A	A	A	A	A
4	A	A	A	A	A	A	A	A	A	A	A	A
5	A	A	A	A	A	A	A	A	A	A	A	A
6	A	A	A	A	A	A	A	A	A	A	A	A
7	A	A	A	A	A	A	A	A	A	A	A	A
8	A	A	A	A	A	A	A	A	A	A	A	A
9	A	A	A	A	A	A	A	A	A	A	A	A
10	A	A	A	A	A	A	A	A	A	A	A	A
11	A	A	A	A	A	A	A	A	A	A	A	A
12	A	A	A	A	A	A	A	A	A	A	A	A
13	A	A	A	A	A	A	A	A	A	A	A	A
14	A	A	A	A	A	A	A	A	A	A	A	A
15	A	A	A	A	A	A	A	A	A	A	A	A
16	A	A	A	A	A	A	A	A	A	A	A	A
17	A	A	A	A	A	A	A	A	A	A	A	A
18	A	A	A	A	A	A	A	A	A	A	A	A
19	A	A	A	A	A	A	A	A	A	A	A	A
20	A	A	A	A	A	A	A	A	A	A	A	A
21	A	A	A	A	A	A	A	A	A	A	A	A
22	A	A	A	A	A	A	A	A	A	A	A	A
23	A	A	A	A	A	A	A	A	A	A	A	A
24	A	A	A	A	A	A	A	A	A	A	A	A
25	A	A	A	A	A	A	A	A	A	A	A	A
26	A	A	A	A	A	A	A	A	A	A	A	A
27	A	A	A	A	A	A	A	A	A	A	A	A
28	A	A	A	A	A	A	A	A	A	A	A	A
29	A		A	A	A	A	A	A	A	A	A	A
30	A		A	A	A	A	A	A	A	A	A	A
31	A		A		A		A	A		A		A

Holidays and Observances: (Reference Year 1989)

Jan 1	New Year's Day	May 29	Memorial Day	Oct 31	Halloween
Jan 16	MLK Day	Jul 4	Independence Day	Nov 11	Veterans Day
Feb 20	Presidents' Day	Sep 4	Labor Day	Nov 23	Thanksgiving Day
Mar 26	Easter Sunday	Oct 9	Columbus Day	Dec 25	Christmas Day

Schedules Summary

Schedule	Schedule Description	Total Days/Yr	Total Hrs/Yr	Baseline HVAC On Hrs/Yr	Proposed HVAC On Hrs/Yr
Schedule A	Load Schedule A	365	8,760	8,760	8,760
Schedule B	Load Schedule B	0	0	0	0
Schedule C	Load Schedule C	0	0	0	0
Totals		365	8,760	8,760	8,760

McK8760 - Inputs

13.00 Electrochromic Windows

Zone Inputs:

Tag	Variable Description		Units	Baseline	Proposed	Basis
I7	Floor Area		ft^2	25,200	25,200	Based on CFM
I8	Roof Area		ft^2	3,600	3,600	15' depth on top floor
I9	Opaque Wall Area		ft^2	15,960	15,960	240' x 12' x 7 floors less win area
I10	Glazing Area	***Glazing***	ft^2	4,200	4,200	100' x 6' x 7 floors
I12	Roof U-Factor	***Roof***	BTU/ft^2/°F	0.050	0.050	R-20
I13	Opaque Wall U-Factor	***Walls***	BTU/ft^2/°F	0.100	0.100	R-10
I14	Glazing U-Factor	***Glazing***	BTU/ft^2/°F	1.000	0.400	Single pane vs Solarban 60 low-e
I15	Glazing Solar Heat Gain Coefficient (SHGC)	***Glazing***	-	0.600	0.285	Ave of 0.48 bleached, 0.09 tinted
I16	Glazing Solar Gain Bldg Shape Factor		-	0.500	0.500	Engineering estimate
I17	Average Space Height (Floor to Ceiling)		ft	12.0	12.0	Engineering estimate
I18	Infiltration		ach	0.150	0.150	Engineering estimate
I19	Peak Number of Occupants		Qty	126	126	200 sf per person
I20	Sensible Heat Gain Per Person		Btu/h	250	250	Engineering estimate
I21	Latent Heat Gain Per Person		Btu/h	200	200	Engineering estimate
I22	Peak Lighting Load Power Density		W/ft^2	1.200	1.200	Engineering estimate
I23	Peak Plug Load Power Density		W/ft^2	1.000	1.000	Engineering estimate
I24	Peak Exterior Lighting Load		kW	0	0	Not included
I25	Peak Miscellaneous Load (Electrical)		Watt	0	0	Not included
I26	Miscellaneous Load Located in Conditioned Space		Yes/No	No	No	Not included
I27	HVAC On Cooling Space Temperature Set Point		°F	72.0	72.0	Engineering estimate
I28	HVAC Off Cooling Space Temperature Set Point		°F	72.0	72.0	Engineering estimate
I29	HVAC On Heating Space Temperature Set Point		°F	70.0	70.0	Engineering estimate
I30	HVAC Off Heating Space Temperature Set Point		°F	70.0	70.0	Engineering estimate

AHU & Plant Inputs:

Tag	Variable Description		Units	Baseline	Proposed	Basis
I34	AHU Fan Power based on Control Type		Type	CV	CV	
I35	Occupied Fan Operation		Type	Continuous	Continuous	No small DX
I36	Occupied Fan Operation Percent Per Hour (CV + Cycles Only)		%	~~50%~~	~~50%~~	-
I37	Maximum AHU CFM		CFM	25,200	25,200	Engineering estimate
I38	Minimum AHU CFM (% of Maximum CFM)		%	100.0%	100.0%	100% OA units
I39	Maximum % Outside Air (Economizer % OSA)		%	100.0%	100.0%	100% OA units
I40	Minimum % Outside Air (Occupied)		%	100.0%	100.0%	100% OA units
I41	Minimum % Outside Air (Unoccupied)		%	100.0%	100.0%	100% OA units
I42	Economizer High Limit Set Point		°F	65.0	65.0	Engineering estimate
I43	Demand Controlled Ventilation (For Outside Air Control)		Yes/No	No	No	N/A
I44	DCV Airflow Per Person (Based on Space Type)	***DCV Tab***	CFM/Per	~~10.00~~	~~10.00~~	-
I45	DCV Airflow Per Area (Based on Space Type)	***DCV Tab***	CFM/ft^2	~~0.06~~	~~0.06~~	-
I46	AHU Fan TSP (At Max CFM)		in w.c.	5.000	5.000	Engineering estimate
I47	Fan Efficiency		%	55.0%	55.0%	Engineering estimate
I48	Supply Air Temperature @ OAT --------------------->	70.0	°F	55	55	Proposed
I49	Supply Air Temperature @ OAT --------------------->	40.0	°F	55	55	Proposed
I50	AHU Cooling Efficiency (EER)		BTU/Watt	20.0	20.0	Equivalent to 0.6 kW/ton
I51	Evaporative Cooling Effectiveness (Air side)		%	0.0%	0.0%	N/A
I52	AHU Cooling Lockout Below		°F	10.0	10.0	N/A
I53	AHU Heating Efficiency or COP @ OAT -------------->	28.0	COP	1.00	1.00	Purchased steam
I54	AHU Heating Efficiency or COP @ OAT -------------->	27.0	COP	1.00	1.00	Purchased steam
I55	AHU Heating Energy Source		Type	Steam	Steam	-
I56	AHU Heating Lockout Above		°F	100.0	100.0	N/A
I57	Evaporative Pre-Cooling on Condenser		Yes/No	No	No	N/A
I58	Heat Recovery % Effectiveness		%	30.0%	30.0%	Assume portion of flow has HR

Terminal Devices Inputs (Reheat Coils, VAV Boxes, Baseboard Heaters, etc)

Tag	Variable Description		Units	Baseline	Proposed	Basis
I62	Terminal Devices		Yes/No	Yes	Yes	Existing and proposed design
I63	Zone Heating Lockout Above		°F	100.0	100.0	N/A
I64	Zone Heating Efficiency or COP @ OAT ------------->	60.0	COP	1.00	1.00	Same as AHU
I65	Zone Heating Efficiency or COP @ OAT ------------->	50.0	COP	1.00	1.00	Same as AHU
I66	Heating Energy Source Zone		Type	Steam	Steam	-
I67	Unoccupied Heating Done By		Zone, AHU	Zone Coil	Zone Coil	Per design
I68	SFPMB Terminal Unit Power		W/CFM	0.00	0.00	No fan boxes

Domestic Hot Water Inputs:

Tag	Variable Description	Units	Baseline	Proposed	Basis
I72	DHW Fuel Type	Type	Natural Gas	Natural Gas	N/A
I73	Energy Factor	-	0.95	0.95	N/A
I74	Working Days Per Year (Used Only For DHW Calc)	Qty	0	0	N/A
I75	Average Daily Hot Water Consumption Per Person	Gallons	1.0	1.0	N/A
I76	Average Entering Cold Water Temperature	°F	50.0	50.0	N/A
I77	Supply Hot Water Temperature	°F	120.0	120.0	N/A

McK8760 - Outputs

13.00 Electrochromic Windows

Electric Demand

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O7	Cooling Peak kW	kW	48	-	48	-	1	-
O8	AHU Heating Peak kW	kW	0	-	0	-	0	-
O9	Zone Heating Peak kW	kW	0	-	0	-	0	-
O10	Fan Peak kW	kW	27	-	27	-	0	-
O11	Interior Lighting Peak kW	kW	27	-	27	-	0	-
O12	Exterior Lighting Peak kW	kW	0	-	0	-	0	-
O13	Plug Load Peak kW	kW	23	-	23	-	0	-
O14	Miscellaneous Load Peak kW	kW	0		0	-	0	-
O15	Other Peak kW	kW	0	-	0	-	0	-
O16	Peak kW	kW	124	-	123	-	1	-
O17	Peak kW (Sum 12 Monthly Peaks)	kW	1,218	-	1,212	-	6	-

Electricity

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O21	Cooling	kWh/Yr	49,074	6.65	48,659	6.59	415	0.06
O22	AHU Heating	kWh/Yr	0	0.00	0	0.00	0	0.00
O23	Zone Heating	kWh/Yr	0	0.00	0	0.00	0	0.00
O24	AHU Fans	kWh/Yr	235,987	31.96	235,987	31.96	0	0.00
O25	Zone Fans	kWh/Yr	0	0.00	0	0.00	0	0.00
O26	Interior Lighting	kWh/Yr	152,319	20.63	152,319	20.63	0	0.00
O27	Exterior Lighting	kWh/Yr	0	0.00	0	0.00	0	0.00
O28	Plug Loads	kWh/Yr	126,932	17.19	126,932	17.19	0	0.00
O29	Miscellaneous Loads	kWh/Yr	0	0.00	0	0.00	0	0.00
O30	Domestic Hot Water	kWh/Yr	0	0.00	0	0.00	0	0.00
O31	Other Electricity	kWh/Yr	0	0.00	0	0.00	0	0.00
O32	Total	kWh/Yr	564,312	76.43	563,897	76.37	415	0.06

Natural Gas

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O36	AHU Heating	Therm/Yr	0	0.00	0	0.00	0	0.00
O37	Zone Heating	Therm/Yr	0	0.00	0	0.00	0	0.00
O38	Domestic Hot Water	Therm/Yr	0	0.00	0	0.00	0	0.00
O39	Other Natural Gas	Therm/Yr	0	0.00	0	0.00	0	0.00
O40	Total	Therm/Yr	0	0.00	0	0.00	0	0.00

Steam

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O44	AHU Heating	kLB/Yr	264	10.47	264	10.47	0	0.00
O45	Zone Heating	kLB/Yr	2,593	102.90	2,433	96.56	160	6.34
O46	Domestic Hot Water	kLB/Yr	0	0.00	0	0.00	0	0.00
O47	Other Steam	kLB/Yr	0	0.00	0	0.00	0	0.00
O48	Total Steam	kLB/Yr	2,857	113.37	2,697	107.03	160	6.34

Total Energy

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O52	Total Energy	kBtu/Yr	4,783,029	189.80	4,621,820	183.41	161,209	6.40

McK8760 - General Information

13.00 Single Pane Glazing Upgrade

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	13.00 Single Pane Glazing Upgrade
TCO Project ID	300	Tech Contact	Ron Fues
TCO Tool FIM ID	26444	Date	12/19/2014

Weather Data:

Nearest Weather Station	WA, SEATTLE BOEING FIELD [ISIS]	Station ID	727935TY.xls

Description of FIM From TCO Tool:

Replace existing single pane windows on West façade of Buck South and Buck North with new high performance double pane low-e windows with thermally broken frames. This will eliminate the largest thermal bridge in this building and significantly improve thermal comfort for occupants near the windows during cold weather. New windows will also reduce solar heat gain by using spectrally selective (Solarban 60 or 70XL) coatings which transmit the visible spectrum while filtering out non-visible light.

HVAC & Load Schedules:

Schedule A Title	Load Schedule A	ASHRAE Schedule Type	Health
Schedule B Title	Load Schedule B	ASHRAE Schedule Type	Health
Schedule C Title	Load Schedule C	ASHRAE Schedule Type	Health

Utility Rate Schedules

Schedule 1 Title	Rate Schedule 1
Schedule 2 Title	Rate Schedule 2
Schedule 3 Title	Rate Schedule 3

Zone Data (for multi-model buildings)

Zone Name	
Zone Description	

Savings Tracker - Individual Measure Savings NOT STACKED

Measure Description		Electric Demand (kW)	Electricity (kWh)	Natural Gas (Therm)	Steam (kLB)	EUI (kBTU/SqFt/Yr)
Baseline Building Performance		1,218	564,312	0	2,857	189.80
Electrochromic Windows	Savings ►		*209*		*253*	*10.06*
	Usage ►	1,216	564,103	0	2,604	179.74

DRAFT

Notes:

McK8760 - HVAC Schedules

13.00 Single Pane Glazing Upgrade

Baseline HVAC Equipment Daily Schedules

0 = Unoccupied Mode 1 = Occupied Mode

Schedule A - Load Schedule A								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule B - Load Schedule B								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule C - Load Schedule C								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Proposed HVAC Equipment Daily Schedules

0 = Unoccupied Mode 1 = Occupied Mode

Schedule A - Load Schedule A								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule B - Load Schedule B								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule C - Load Schedule C								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

McK8760 - Calendar

13.00 Single Pane Glazing Upgrade

Calendar

Weekends Highlighted Yellow For Reference Year 1989

Month	1	2	3	4	5	6	7	8	9	10	11	12
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	A	A	A	A	A	A	A	A	A	A	A	A
2	A	A	A	A	A	A	A	A	A	A	A	A
3	A	A	A	A	A	A	A	A	A	A	A	A
4	A	A	A	A	A	A	A	A	A	A	A	A
5	A	A	A	A	A	A	A	A	A	A	A	A
6	A	A	A	A	A	A	A	A	A	A	A	A
7	A	A	A	A	A	A	A	A	A	A	A	A
8	A	A	A	A	A	A	A	A	A	A	A	A
9	A	A	A	A	A	A	A	A	A	A	A	A
10	A	A	A	A	A	A	A	A	A	A	A	A
11	A	A	A	A	A	A	A	A	A	A	A	A
12	A	A	A	A	A	A	A	A	A	A	A	A
13	A	A	A	A	A	A	A	A	A	A	A	A
14	A	A	A	A	A	A	A	A	A	A	A	A
15	A	A	A	A	A	A	A	A	A	A	A	A
16	A	A	A	A	A	A	A	A	A	A	A	A
17	A	A	A	A	A	A	A	A	A	A	A	A
18	A	A	A	A	A	A	A	A	A	A	A	A
19	A	A	A	A	A	A	A	A	A	A	A	A
20	A	A	A	A	A	A	A	A	A	A	A	A
21	A	A	A	A	A	A	A	A	A	A	A	A
22	A	A	A	A	A	A	A	A	A	A	A	A
23	A	A	A	A	A	A	A	A	A	A	A	A
24	A	A	A	A	A	A	A	A	A	A	A	A
25	A	A	A	A	A	A	A	A	A	A	A	A
26	A	A	A	A	A	A	A	A	A	A	A	A
27	A	A	A	A	A	A	A	A	A	A	A	A
28	A	A	A	A	A	A	A	A	A	A	A	A
29	A		A	A	A	A	A	A	A	A	A	A
30	A		A	A	A	A	A	A	A	A	A	A
31	A		A		A		A	A		A		A

Holidays and Observances: (Reference Year 1989)

Jan 1	New Year's Day	May 29	Memorial Day	Oct 31	Halloween
Jan 16	MLK Day	Jul 4	Independence Day	Nov 11	Veterans Day
Feb 20	Presidents' Day	Sep 4	Labor Day	Nov 23	Thanksgiving Day
Mar 26	Easter Sunday	Oct 9	Columbus Day	Dec 25	Christmas Day

Schedules Summary

Schedule	Schedule Description	Total Days/Yr	Total Hrs/Yr	Baseline HVAC On Hrs/Yr	Proposed HVAC On Hrs/Yr
Schedule A	Load Schedule A	365	8,760	8,760	8,760
Schedule B	Load Schedule B	0	0	0	0
Schedule C	Load Schedule C	0	0	0	0
Totals		365	8,760	8,760	8,760

McK8760 - Inputs

13.00 Single Pane Glazing Upgrade

Zone Inputs:

Tag	Variable Description		Units	Baseline	Proposed	Basis
I7	Floor Area		ft^2	25,200	25,200	Based on CFM
I8	Roof Area		ft^2	3,600	3,600	15' depth on top floor
I9	Opaque Wall Area		ft^2	15,960	15,960	240' x 12' x 7 floors less win area
I10	Glazing Area	***Glazing***	ft^2	4,200	4,200	100' x 6' x 7 floors
I12	Roof U-Factor	***Roof***	BTU/ft^2/°F	0.050	0.050	R-20
I13	Opaque Wall U-Factor	***Walls***	BTU/ft^2/°F	0.100	0.100	R-10
I14	Glazing U-Factor	***Glazing***	BTU/ft^2/°F	1.000	0.400	Single pane vs Solarban 60 low-e
I15	Glazing Solar Heat Gain Coefficient (SHGC)	***Glazing***	-	0.600	0.450	Solarban 60 SHGC
I16	Glazing Solar Gain Bldg Shape Factor		-	0.500	0.500	Engineering estimate
I17	Average Space Height (Floor to Ceiling)		ft	12.0	12.0	Engineering estimate
I18	Infiltration		ach	0.150	0.150	Engineering estimate
I19	Peak Number of Occupants		Qty	126	126	200 sf per person
I20	Sensible Heat Gain Per Person		Btu/h	250	250	Engineering estimate
I21	Latent Heat Gain Per Person		Btu/h	200	200	Engineering estimate
I22	Peak Lighting Load Power Density		W/ft^2	1.200	1.200	Engineering estimate
I23	Peak Plug Load Power Density		W/ft^2	1.000	1.000	Engineering estimate
I24	Peak Exterior Lighting Load		kW	0	0	Not included
I25	Peak Miscellaneous Load (Electrical)		Watt	0	0	Not included
I26	Miscellaneous Load Located in Conditioned Space		Yes/No	No	No	Not included
I27	HVAC On Cooling Space Temperature Set Point		°F	72.0	72.0	Engineering estimate
I28	HVAC Off Cooling Space Temperature Set Point		°F	72.0	72.0	Engineering estimate
I29	HVAC On Heating Space Temperature Set Point		°F	70.0	70.0	Engineering estimate
I30	HVAC Off Heating Space Temperature Set Point		°F	70.0	70.0	Engineering estimate

AHU & Plant Inputs:

Tag	Variable Description		Units	Baseline	Proposed	Basis
I34	AHU Fan Power based on Control Type		Type	CV	CV	
I35	Occupied Fan Operation		Type	Continuous	Continuous	No small DX
I36	Occupied Fan Operation Percent Per Hour (CV + Cycles Only)		%	~~50%~~	~~50%~~	-
I37	Maximum AHU CFM		CFM	25,200	25,200	Engineering estimate
I38	Minimum AHU CFM (% of Maximum CFM)		%	100.0%	100.0%	100% OA units
I39	Maximum % Outside Air (Economizer % OSA)		%	100.0%	100.0%	100% OA units
I40	Minimum % Outside Air (Occupied)		%	100.0%	100.0%	100% OA units
I41	Minimum % Outside Air (Unoccupied)		%	100.0%	100.0%	100% OA units
I42	Economizer High Limit Set Point		°F	65.0	65.0	Engineering estimate
I43	Demand Controlled Ventilation (For Outside Air Control)		Yes/No	No	No	N/A
I44	DCV Airflow Per Person (Based on Space Type)	***DCV Tab***	CFM/Per	~~10.00~~	~~10.00~~	-
I45	DCV Airflow Per Area (Based on Space Type)	***DCV Tab***	CFM/ft^2	~~0.06~~	~~0.06~~	-
I46	AHU Fan TSP (At Max CFM)		in w.c.	5.000	5.000	Engineering estimate
I47	Fan Efficiency		%	55.0%	55.0%	Engineering estimate
I48	Supply Air Temperature @ OAT --------------------->	70.0	°F	55	55	Proposed
I49	Supply Air Temperature @ OAT --------------------->	40.0	°F	55	55	Proposed
I50	AHU Cooling Efficiency (EER)		BTU/Watt	20.0	20.0	Equivalent to 0.6 kW/ton
I51	Evaporative Cooling Effectiveness (Air side)		%	0.0%	0.0%	N/A
I52	AHU Cooling Lockout Below		°F	10.0	10.0	N/A
I53	AHU Heating Efficiency or COP @ OAT -------------->	28.0	COP	1.00	1.00	Purchased steam
I54	AHU Heating Efficiency or COP @ OAT -------------->	27.0	COP	1.00	1.00	Purchased steam
I55	AHU Heating Energy Source		Type	Steam	Steam	-
I56	AHU Heating Lockout Above		°F	100.0	100.0	N/A
I57	Evaporative Pre-Cooling on Condenser		Yes/No	No	No	N/A
I58	Heat Recovery % Effectiveness		%	30.0%	30.0%	Assume portion of flow has HR

Terminal Devices Inputs (Reheat Coils, VAV Boxes, Baseboard Heaters, etc)

Tag	Variable Description		Units	Baseline	Proposed	Basis
I62	Terminal Devices		Yes/No	Yes	Yes	Existing and proposed design
I63	Zone Heating Lockout Above		°F	100.0	100.0	N/A
I64	Zone Heating Efficiency or COP @ OAT ------------->	60.0	COP	1.00	1.00	Same as AHU
I65	Zone Heating Efficiency or COP @ OAT ------------->	50.0	COP	1.00	1.00	Same as AHU
I66	Heating Energy Source Zone		Type	Steam	Steam	-
I67	Unoccupied Heating Done By		Zone, AHU	Zone Coil	Zone Coil	Per design
I68	SFPMB Terminal Unit Power		W/CFM	0.00	0.00	No fan boxes

Domestic Hot Water Inputs:

Tag	Variable Description	Units	Baseline	Proposed	Basis
I72	DHW Fuel Type	Type	Natural Gas	Natural Gas	N/A
I73	Energy Factor	-	0.95	0.95	N/A
I74	Working Days Per Year (Used Only For DHW Calc)	Qty	0	0	N/A
I75	Average Daily Hot Water Consumption Per Person	Gallons	1.0	1.0	N/A
I76	Average Entering Cold Water Temperature	°F	50.0	50.0	N/A
I77	Supply Hot Water Temperature	°F	120.0	120.0	N/A

McK8760 - Outputs

13.00 Single Pane Glazing Upgrade

Electric Demand

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O7	Cooling Peak kW	kW	48	-	48	-	0	-
O8	AHU Heating Peak kW	kW	0	-	0	-	0	-
O9	Zone Heating Peak kW	kW	0	-	0	-	0	-
O10	Fan Peak kW	kW	27	-	27	-	0	-
O11	Interior Lighting Peak kW	kW	27	-	27	-	0	-
O12	Exterior Lighting Peak kW	kW	0	-	0	-	0	-
O13	Plug Load Peak kW	kW	23	-	23	-	0	-
O14	Miscellaneous Load Peak kW	kW	0		0	-	0	-
O15	Other Peak kW	kW	0	-	0	-	0	-
O16	Peak kW	kW	124	-	123	-	0	-
O17	Peak kW (Sum 12 Monthly Peaks)	kW	1,218	-	1,216	-	2	-

Electricity

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O21	Cooling	kWh/Yr	49,074	6.65	48,865	6.62	209	0.03
O22	AHU Heating	kWh/Yr	0	0.00	0	0.00	0	0.00
O23	Zone Heating	kWh/Yr	0	0.00	0	0.00	0	0.00
O24	AHU Fans	kWh/Yr	235,987	31.96	235,987	31.96	0	0.00
O25	Zone Fans	kWh/Yr	0	0.00	0	0.00	0	0.00
O26	Interior Lighting	kWh/Yr	152,319	20.63	152,319	20.63	0	0.00
O27	Exterior Lighting	kWh/Yr	0	0.00	0	0.00	0	0.00
O28	Plug Loads	kWh/Yr	126,932	17.19	126,932	17.19	0	0.00
O29	Miscellaneous Loads	kWh/Yr	0	0.00	0	0.00	0	0.00
O30	Domestic Hot Water	kWh/Yr	0	0.00	0	0.00	0	0.00
O31	Other Electricity	kWh/Yr	0	0.00	0	0.00	0	0.00
O32	Total	kWh/Yr	564,312	76.43	564,103	76.40	209	0.03

Natural Gas

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O36	AHU Heating	Therm/Yr	0	0.00	0	0.00	0	0.00
O37	Zone Heating	Therm/Yr	0	0.00	0	0.00	0	0.00
O38	Domestic Hot Water	Therm/Yr	0	0.00	0	0.00	0	0.00
O39	Other Natural Gas	Therm/Yr	0	0.00	0	0.00	0	0.00
O40	Total	Therm/Yr	0	0.00	0	0.00	0	0.00

Steam

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O44	AHU Heating	kLB/Yr	264	10.47	264	10.47	0	0.00
O45	Zone Heating	kLB/Yr	2,593	102.90	2,340	92.87	253	10.03
O46	Domestic Hot Water	kLB/Yr	0	0.00	0	0.00	0	0.00
O47	Other Steam	kLB/Yr	0	0.00	0	0.00	0	0.00
O48	Total Steam	kLB/Yr	2,857	113.37	2,604	103.34	253	10.03

Total Energy

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O52	Total Energy	kBtu/Yr	4,783,029	189.80	4,529,560	179.74	253,469	10.06

McKinstry Calculation Template
13.00 Weatherization

Project Information:

Project Name	Virginia Mason Medical Cente	FIM Name	13.00 Weatherization
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	21772	Date	12/10/2014

Description of FIM From TCO Tool:

Similar to residential buildings, commercial buildings can leak conditioned air, wasting energy and causing comfort issues. Common areas of air leakage include around windows, at roof/wall intersections, and surrounding doorways. Sealing leaks will provide for a tighter, more comfortable, more easily pressurized building. Costs and savings are based on estimated potential in HRB and Buck.

FIM Calculation Method From TCO Tool:

Savings are based on an effective leakage area of 20sf (2880in2).

Inputs:

Effective leakage area	2,880	in^2
Stack coefficient	0.12583	-
Wind coefficient	0.00330	-
Average wind speed	5	mph

Hrs	OAT	Indoor Temp	Delta T	CFM	Btu/hr	Cooling kWh	Steam klbs
7	97.5	74	23.5	5,021	127,434	59	0
58	92.5	74	18.5	4,471	89,336	345	0
189	87.5	74	13.5	3,844	56,041	706	0
391	82.5	74	8.5	3,091	28,377	740	0
432	77.5	74	3.5	2,083	7,872	227	0
366	72.5	70	2.5	1,815	4,900	120	0
615	67.5	70	2.5	0	0	0	0
900	62.5	70	7.5	0	0	0	0
730	57.5	70	12.5	0	0	0	0
830	52.5	65	12.5	3,705	50,024	0	38
642	47.5	65	17.5	4,353	82,272	0	48
801	42.5	65	22.5	4,916	119,459	0	87
875	37.5	65	27.5	5,421	160,999	0	128
730	32.5	65	32.5	5,883	206,476	0	137
466	27.5	65	37.5	6,311	255,575	0	108
293	22.5	65	42.5	6,711	308,046	0	82
152	17.5	65	47.5	7,089	363,685	0	50
97	12.5	65	52.5	7,448	422,321	0	37
85	7.5	65	57.5	7,791	483,807	0	37
64	2.5	65	62.5	8,119	548,018	0	32
30	-2.5	65	67.5	8,434	614,841	0	17
7	-7.5	65	72.5	8,738	684,180	0	4
						2,197	806

Calculated Values:

		Base	Proposed	Savings	Units	
C45	Electricity savings	0	0	2,197	kWh	0
C46	Steam savings	0	0	806	klbs	0

McK8760 - General Information

13.00 Window Film

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	13.00 Window Film
TCO Project ID	300	Tech Contact	Ron Fues
TCO Tool FIM ID	26445	Date	12/19/2014

Weather Data:

Nearest Weather Station	WA, SEATTLE BOEING FIELD [ISIS]	Station ID	727935TY.xls

Description of FIM From TCO Tool:

Next generation window films not only provide the traditional benefit of reducing summer heat gain, but they can also now provide improved insulation in winter via the inclusion of a low-e coating. Traditional challenges with window films include bubbling and/or condensation. New, clear distortion free adhesives avoid these issues and some installers provide lifetime warranties against bubbling or peeling. This measure involves providing Enerlogic 70 window film for West façade of Buck North and Buck South. The film will help reduce peak cooling and heating loads and provide for greater occupant comfort.

HVAC & Load Schedules:

Schedule A Title	Load Schedule A	ASHRAE Schedule Type	Health
Schedule B Title	Load Schedule B	ASHRAE Schedule Type	Health
Schedule C Title	Load Schedule C	ASHRAE Schedule Type	Health

Utility Rate Schedules

Schedule 1 Title	Rate Schedule 1
Schedule 2 Title	Rate Schedule 2
Schedule 3 Title	Rate Schedule 3

Zone Data (for multi-model buildings)

Zone Name	
Zone Description	

Savings Tracker - Individual Measure Savings NOT STACKED

Measure Description		Electric Demand (kW)	Electricity (kWh)	Natural Gas (Therm)	Steam (kLB)	EUI (kBTU/SqFt/Yr)
Baseline Building Performance		1,218	564,312	0	2,857	189.80
Electrochromic Windows	Savings ▶		*126*		*62*	*2.49*
	Usage ▶	1,218	564,186	0	2,795	187.31

Notes:

McK8760 - HVAC Schedules

13.00 Window Film

Baseline HVAC Equipment Daily Schedules

0 = Unoccupied Mode 1 = Occupied Mode

Schedule A - Load Schedule A								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule B - Load Schedule B								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule C - Load Schedule C								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Proposed HVAC Equipment Daily Schedules

0 = Unoccupied Mode 1 = Occupied Mode

Schedule A - Load Schedule A								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule B - Load Schedule B								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

Schedule C - Load Schedule C								
Hour		Sun	Mon	Tue	Wed	Thu	Fri	Sat
From	To	1	2	3	4	5	6	7
0	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1
2	3	1	1	1	1	1	1	1
3	4	1	1	1	1	1	1	1
4	5	1	1	1	1	1	1	1
5	6	1	1	1	1	1	1	1
6	7	1	1	1	1	1	1	1
7	8	1	1	1	1	1	1	1
8	9	1	1	1	1	1	1	1
9	10	1	1	1	1	1	1	1
10	11	1	1	1	1	1	1	1
11	12	1	1	1	1	1	1	1
12	13	1	1	1	1	1	1	1
13	14	1	1	1	1	1	1	1
14	15	1	1	1	1	1	1	1
15	16	1	1	1	1	1	1	1
16	17	1	1	1	1	1	1	1
17	18	1	1	1	1	1	1	1
18	19	1	1	1	1	1	1	1
19	20	1	1	1	1	1	1	1
20	21	1	1	1	1	1	1	1
21	22	1	1	1	1	1	1	1
22	23	1	1	1	1	1	1	1
23	24	1	1	1	1	1	1	1
Daily Totals		24	24	24	24	24	24	24

McK8760 - Calendar

13.00 Window Film

Calendar

Weekends Highlighted Yellow For Reference Year 1989

Month	1	2	3	4	5	6	7	8	9	10	11	12
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	A	A	A	A	A	A	A	A	A	A	A	A
2	A	A	A	A	A	A	A	A	A	A	A	A
3	A	A	A	A	A	A	A	A	A	A	A	A
4	A	A	A	A	A	A	A	A	A	A	A	A
5	A	A	A	A	A	A	A	A	A	A	A	A
6	A	A	A	A	A	A	A	A	A	A	A	A
7	A	A	A	A	A	A	A	A	A	A	A	A
8	A	A	A	A	A	A	A	A	A	A	A	A
9	A	A	A	A	A	A	A	A	A	A	A	A
10	A	A	A	A	A	A	A	A	A	A	A	A
11	A	A	A	A	A	A	A	A	A	A	A	A
12	A	A	A	A	A	A	A	A	A	A	A	A
13	A	A	A	A	A	A	A	A	A	A	A	A
14	A	A	A	A	A	A	A	A	A	A	A	A
15	A	A	A	A	A	A	A	A	A	A	A	A
16	A	A	A	A	A	A	A	A	A	A	A	A
17	A	A	A	A	A	A	A	A	A	A	A	A
18	A	A	A	A	A	A	A	A	A	A	A	A
19	A	A	A	A	A	A	A	A	A	A	A	A
20	A	A	A	A	A	A	A	A	A	A	A	A
21	A	A	A	A	A	A	A	A	A	A	A	A
22	A	A	A	A	A	A	A	A	A	A	A	A
23	A	A	A	A	A	A	A	A	A	A	A	A
24	A	A	A	A	A	A	A	A	A	A	A	A
25	A	A	A	A	A	A	A	A	A	A	A	A
26	A	A	A	A	A	A	A	A	A	A	A	A
27	A	A	A	A	A	A	A	A	A	A	A	A
28	A	A	A	A	A	A	A	A	A	A	A	A
29	A		A	A	A	A	A	A	A	A	A	A
30	A		A	A	A	A	A	A	A	A	A	A
31	A		A		A		A	A		A		A

Holidays and Observances: (Reference Year 1989)

Jan 1	New Year's Day	May 29	Memorial Day	Oct 31	Halloween
Jan 16	MLK Day	Jul 4	Independence Day	Nov 11	Veterans Day
Feb 20	Presidents' Day	Sep 4	Labor Day	Nov 23	Thanksgiving Day
Mar 26	Easter Sunday	Oct 9	Columbus Day	Dec 25	Christmas Day

Schedules Summary

Schedule	Schedule Description	Total Days/Yr	Total Hrs/Yr	Baseline HVAC On Hrs/Yr	Proposed HVAC On Hrs/Yr
Schedule A	Load Schedule A	365	8,760	8,760	8,760
Schedule B	Load Schedule B	0	0	0	0
Schedule C	Load Schedule C	0	0	0	0
Totals		365	8,760	8,760	8,760

McK8760 - Inputs

13.00 Window Film

Zone Inputs:

Tag	Variable Description		Units	Baseline	Proposed	Basis
I7	Floor Area		ft^2	25,200	25,200	Based on CFM
I8	Roof Area		ft^2	3,600	3,600	15' depth on top floor
I9	Opaque Wall Area		ft^2	15,960	15,960	240' x 12' x 7 floors less win area
I10	Glazing Area	***Glazing***	ft^2	4,200	4,200	100' x 6' x 7 floors
I12	Roof U-Factor	***Roof***	BTU/ft^2/°F	0.050	0.050	R-20
I13	Opaque Wall U-Factor	***Walls***	BTU/ft^2/°F	0.100	0.100	R-10
I14	Glazing U-Factor	***Glazing***	BTU/ft^2/°F	1.000	0.800	Single pane vs with film
I15	Glazing Solar Heat Gain Coefficient (SHGC)	***Glazing***	-	0.600	0.490	Enerlogic 70 film
I16	Glazing Solar Gain Bldg Shape Factor		-	0.500	0.500	Engineering estimate
I17	Average Space Height (Floor to Ceiling)		ft	12.0	12.0	Engineering estimate
I18	Infiltration		ach	0.150	0.150	Engineering estimate
I19	Peak Number of Occupants		Qty	126	126	200 sf per person
I20	Sensible Heat Gain Per Person		Btu/h	250	250	Engineering estimate
I21	Latent Heat Gain Per Person		Btu/h	200	200	Engineering estimate
I22	Peak Lighting Load Power Density		W/ft^2	1.200	1.200	Engineering estimate
I23	Peak Plug Load Power Density		W/ft^2	1.000	1.000	Engineering estimate
I24	Peak Exterior Lighting Load		kW	0	0	Not included
I25	Peak Miscellaneous Load (Electrical)		Watt	0	0	Not included
I26	Miscellaneous Load Located in Conditioned Space		Yes/No	No	No	Not included
I27	HVAC On Cooling Space Temperature Set Point		°F	72.0	72.0	Engineering estimate
I28	HVAC Off Cooling Space Temperature Set Point		°F	72.0	72.0	Engineering estimate
I29	HVAC On Heating Space Temperature Set Point		°F	70.0	70.0	Engineering estimate
I30	HVAC Off Heating Space Temperature Set Point		°F	70.0	70.0	Engineering estimate

AHU & Plant Inputs:

Tag	Variable Description		Units	Baseline	Proposed	Basis
I34	AHU Fan Power based on Control Type		Type	CV	CV	
I35	Occupied Fan Operation		Type	Continuous	Continuous	No small DX
I36	Occupied Fan Operation Percent Per Hour (CV + Cycles Only)		%	~~50%~~	~~50%~~	-
I37	Maximum AHU CFM		CFM	25,200	25,200	Engineering estimate
I38	Minimum AHU CFM (% of Maximum CFM)		%	100.0%	100.0%	100% OA units
I39	Maximum % Outside Air (Economizer % OSA)		%	100.0%	100.0%	100% OA units
I40	Minimum % Outside Air (Occupied)		%	100.0%	100.0%	100% OA units
I41	Minimum % Outside Air (Unoccupied)		%	100.0%	100.0%	100% OA units
I42	Economizer High Limit Set Point		°F	65.0	65.0	Engineering estimate
I43	Demand Controlled Ventilation (For Outside Air Control)		Yes/No	No	No	N/A
I44	DCV Airflow Per Person (Based on Space Type)	***DCV Tab***	CFM/Per	~~10.00~~	~~10.00~~	-
I45	DCV Airflow Per Area (Based on Space Type)	***DCV Tab***	CFM/ft^2	~~0.06~~	~~0.06~~	-
I46	AHU Fan TSP (At Max CFM)		in w.c.	5.000	5.000	Engineering estimate
I47	Fan Efficiency		%	55.0%	55.0%	Engineering estimate
I48	Supply Air Temperature @ OAT --------------------->	70.0	°F	55	55	Proposed
I49	Supply Air Temperature @ OAT --------------------->	40.0	°F	55	55	Proposed
I50	AHU Cooling Efficiency (EER)		BTU/Watt	20.0	20.0	Equivalent to 0.6 kW/ton
I51	Evaporative Cooling Effectiveness (Air side)		%	0.0%	0.0%	N/A
I52	AHU Cooling Lockout Below		°F	10.0	10.0	N/A
I53	AHU Heating Efficiency or COP @ OAT -------------->	28.0	COP	1.00	1.00	Purchased steam
I54	AHU Heating Efficiency or COP @ OAT -------------->	27.0	COP	1.00	1.00	Purchased steam
I55	AHU Heating Energy Source		Type	Steam	Steam	-
I56	AHU Heating Lockout Above		°F	100.0	100.0	N/A
I57	Evaporative Pre-Cooling on Condenser		Yes/No	No	No	N/A
I58	Heat Recovery % Effectiveness		%	30.0%	30.0%	Assume portion of flow has HR

Terminal Devices Inputs (Reheat Coils, VAV Boxes, Baseboard Heaters, etc)

Tag	Variable Description		Units	Baseline	Proposed	Basis
I62	Terminal Devices		Yes/No	Yes	Yes	Existing and proposed design
I63	Zone Heating Lockout Above		°F	100.0	100.0	N/A
I64	Zone Heating Efficiency or COP @ OAT ------------->	60.0	COP	1.00	1.00	Same as AHU
I65	Zone Heating Efficiency or COP @ OAT ------------->	50.0	COP	1.00	1.00	Same as AHU
I66	Heating Energy Source Zone		Type	Steam	Steam	-
I67	Unoccupied Heating Done By		Zone, AHU	Zone Coil	Zone Coil	Per design
I68	SFPMB Terminal Unit Power		W/CFM	0.00	0.00	No fan boxes

Domestic Hot Water Inputs:

Tag	Variable Description	Units	Baseline	Proposed	Basis
I72	DHW Fuel Type	Type	Natural Gas	Natural Gas	N/A
I73	Energy Factor	-	0.95	0.95	N/A
I74	Working Days Per Year (Used Only For DHW Calc)	Qty	0	0	N/A
I75	Average Daily Hot Water Consumption Per Person	Gallons	1.0	1.0	N/A
I76	Average Entering Cold Water Temperature	°F	50.0	50.0	N/A
I77	Supply Hot Water Temperature	°F	120.0	120.0	N/A

McK8760 - Outputs

13.00 Window Film

Electric Demand

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O7	Cooling Peak kW	kW	48	-	48	-	0	-
O8	AHU Heating Peak kW	kW	0	-	0	-	0	-
O9	Zone Heating Peak kW	kW	0	-	0	-	0	-
O10	Fan Peak kW	kW	27	-	27	-	0	-
O11	Interior Lighting Peak kW	kW	27	-	27	-	0	-
O12	Exterior Lighting Peak kW	kW	0	-	0	-	0	-
O13	Plug Load Peak kW	kW	23	-	23	-	0	-
O14	Miscellaneous Load Peak kW	kW	0		0	-	0	-
O15	Other Peak kW	kW	0	-	0	-	0	-
O16	Peak kW	kW	124	-	124	-	0	-
O17	Peak kW (Sum 12 Monthly Peaks)	kW	1,218	-	1,218	-	1	-

Electricity

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O21	Cooling	kWh/Yr	49,074	6.65	48,948	6.63	126	0.02
O22	AHU Heating	kWh/Yr	0	0.00	0	0.00	0	0.00
O23	Zone Heating	kWh/Yr	0	0.00	0	0.00	0	0.00
O24	AHU Fans	kWh/Yr	235,987	31.96	235,987	31.96	0	0.00
O25	Zone Fans	kWh/Yr	0	0.00	0	0.00	0	0.00
O26	Interior Lighting	kWh/Yr	152,319	20.63	152,319	20.63	0	0.00
O27	Exterior Lighting	kWh/Yr	0	0.00	0	0.00	0	0.00
O28	Plug Loads	kWh/Yr	126,932	17.19	126,932	17.19	0	0.00
O29	Miscellaneous Loads	kWh/Yr	0	0.00	0	0.00	0	0.00
O30	Domestic Hot Water	kWh/Yr	0	0.00	0	0.00	0	0.00
O31	Other Electricity	kWh/Yr	0	0.00	0	0.00	0	0.00
O32	Total	kWh/Yr	564,312	76.43	564,186	76.41	126	0.02

Natural Gas

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O36	AHU Heating	Therm/Yr	0	0.00	0	0.00	0	0.00
O37	Zone Heating	Therm/Yr	0	0.00	0	0.00	0	0.00
O38	Domestic Hot Water	Therm/Yr	0	0.00	0	0.00	0	0.00
O39	Other Natural Gas	Therm/Yr	0	0.00	0	0.00	0	0.00
O40	Total	Therm/Yr	0	0.00	0	0.00	0	0.00

Steam

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O44	AHU Heating	kLB/Yr	264	10.47	264	10.47	0	0.00
O45	Zone Heating	kLB/Yr	2,593	102.90	2,531	100.43	62	2.48
O46	Domestic Hot Water	kLB/Yr	0	0.00	0	0.00	0	0.00
O47	Other Steam	kLB/Yr	0	0.00	0	0.00	0	0.00
O48	Total Steam	kLB/Yr	2,857	113.37	2,795	110.90	62	2.48

Total Energy

Tag	Description	Units	Baseline	EUI	Proposed	EUI	Savings	EUI
O52	Total Energy	kBtu/Yr	4,783,029	189.80	4,720,221	187.31	62,808	2.49

McKinstry Calculation Template
15.00 Replace Kitchen Refrigeration Equipment

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	15.00 Replace Kitchen Refrigeration Equipment
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26786	Date	11/18/2014

Description of FIM From TCO Tool:

Several of the kitchen walk-ins (4, 5, and 8) located in the café in the main pavilion currently use R-12 or R-22 refrigerant. This refrigerant is now obselete and will run out in approximately 18 months which will necessitate replacement of these systems. This measure involves replacing the refrigeration systems for these three walk-ins with updated systems and replacing existing induction motors with new ECM motors.

FIM Calculation Method From TCO Tool:

Savings are based upon a 10% decrease in equipment power density.

Inputs:

		Base	Proposed	Savings	Units	Basis of Value
C17	Refrigeration Walk-In Quantity	3.0	3.0	0.0	-	Field estimate
C18	Refrigeration Floor Area	120.0	120.0	0.0	sf	Field estimate
C19	Refrigeration Power Density	10.0	8.0	2	w/sf	Comnet Commercial Refrigeration Tables
C20	Annual operating hours	8,760	8,760	0	hrs	Comnet Refrigeration schedule input recommendations

Calculated Values:

		Base	Proposed	Savings	Units	
C23	Annual energy use	31,536	25,229	6,307	kWh	=C17*C18*C19*C20/1000

McKinstry Calculation Template
15.00 Retrofit Refrigeration Equipment

Project Information:

Project Name	Virginia Mason Medical Cente	FIM Name	15.00 Retrofit Refrigeration Equipment
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26482	Date	11/18/2014

Description of FIM From TCO Tool:

Older walk-ins tend to have inefficient shaded pole evaporator motors that add unnecessary heat to the space that you are trying to cool. Similarly, inefficient defrost cycles are on timers, defrosting whether it is needed or not, wasting energy. This measure involves retrofitting (5) existing commercial walk-in refrigerators and freezers with ECM motors and implementing smart defrost controls to only defrost when needed.

FIM Calculation Method From TCO Tool:

Savings are based on estimates from the KE2 defrost control calculator as well as a reduction in peak kW of 132W (per unit) due to the retrofit from induction to ECM evaporator motors.

Inputs:

	Inputs	Base	Proposed	Savings	Units	Basis of Value
C17	Refrigeration Walk-In Quantity	3.0	3.0	0.0	-	Field estimate
C18	Freezer Walk-in Quantity	2.0	2.0	0.0		Field estimate

Refrigeration Defrost Savings per Unit

KE2 thermsolutions®
KE2 Evaporator Efficiency Savings Estimator

Customer:	VMMC	
Job Name:	Cafeteria	
Location:	Downtown Campus	
Length of walk-in	10	Ft
Width of walk-in	8	Ft
Height of walk-in	8	Ft
Number of glass doors	0	
Temperature of walk-in	35	°F
Type of Defrost	Electric	
Location (adjusts for ambient and utilities)	Washington	
Floor insulation type	oamed Urethane 4" Thick	
Ceiling insulation type	oamed Urethane 4" Thick	
Wall insulation type	oamed Urethane 4" Thick	
Type of product	Meat	
Temperature of product entering space	36	°F
Is the walk-in located inside or outside	Inside	
Estimated KW-hr saved annually	**1242**	

Freezer Defrost Savings per Unit

KE2 thermsolutions®
KE2 Evaporator Efficiency Savings Estimator

Customer:	VMMC	
Job Name:	Cafeteria	
Location:	Downtown Campus	
Length of walk-in	10	Ft
Width of walk-in	8	Ft
Height of walk-in	8	Ft
Number of glass doors	0	
Temperature of walk-in	-10	°F
Type of Defrost	Electric	
Location (adjusts for ambient and utilities)	Washington	
Floor insulation type	oamed Urethane 4" Thick	
Ceiling insulation type	oamed Urethane 4" Thick	
Wall insulation type	oamed Urethane 4" Thick	
Type of product	Meat	
Temperature of product entering space	10	°F
Is the walk-in located inside or outside	Inside	
Estimated KW-hr saved annually	**4055**	

	Base	Proposed	Savings	Units	Basis of Value
Savings per ECM motor	0.132	0.000	0.132	kW	Typical induction to ECM motor savings

Calculated Values:

	Calculated Values	Base	Proposed	Savings	Units	
C54	Annual energy use	12,414	0	12,414	kWh	=(1242*C17)+(4055*C18)+(C51*8760/2)

McKinstry Calculation Template
16.00 Manage IT Energy Use

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	16.00 Manage IT Energy Use
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26448	Date	11/18/2014

Description of FIM From TCO Tool:

Centralized software solutions for PC power management help to actively manage and track PC power states and device utilization. With this information, PCs can be better controlled and managed to reduce energy use in a reliable way. This measure involves deploying aggressive PC power management across the entire VMMC desktop fleet of 6,000 PCs.

FIM Calculation Method From TCO Tool:

The savings for this measure are based on a reduction in monitor and PC power use by putting more computers into sleep modes when they are not in use during evenings, daytime, or holiday periods.

Inputs:

		Base	Proposed	Savings	Units	Basis of Value
C17	PCs included	6,000	6,000	0	quantity	# of desktops per IT team

State	Power (Watts)	Baseline Annual Hours	Proposed Annual Hours	Baseline kWh per Year per PC	Proposed kWh per Year per PC
CPU On Power (average of PCs)	65	3200	2634	208	171
CPU Sleep Power (average of PCs)	4	500	560	2	2
CPU Off Power (average of PCs)	2	4970	5566	10	11
Display On Power (average of displays)	38	3200	2634	122	100
Display Sleep Power (average of displays)	2	5560	6126	11	12
			Total	352	297
			Average Savings per PC	56	-

Calculated Values:

		Base	Proposed	Savings	Units	
C29	Annual electricity use	2,112,000	1,782,000	330,000	kWh	=C17*352

McKinstry Calculation Template
16.00 Plug Load Controls

Project Information:

Project Name	Virginia Mason Medical Center	FIM Name	16.00 Plug Load Controls
TCO Project ID	300	Engineer	Ron Fues
TCO Tool FIM ID	26469	Date	11/18/2014

Description of FIM From TCO Tool:

As the efficiency of building envelopes, HVAC, and lighting systems increases, the percentage of energy use apportioned to "plug loads" in buildings is growing. Office equipment is often left on at night or during breaks during the day. Even when turned off, vampire loads draw power. This measure involves providing smart plug strips for all office workers based on timer, load sensing, and/or motion sensing and providing vending misers for all beverage and snack machines.

FIM Calculation Method From TCO Tool:

Savings are based on a 10% reduction in operating hours for workstation power (excluding PCs and monitors) and a 30% reduction in operating hours for vending machines.

Inputs:

		Base	Proposed	Savings	Units	Basis of Value
C17	Typical annual workstation power (exclude PC)	75.0	75.0	0.0	watts	0.5 W/sf for 150sf work space (excludes PCs and monitors)
C18	Workstation annual operating hours	2,080.0	1,560.0	520.0	hrs	Estimate 25% reduction for proposed
C19	Quantity of workstations	1,000.0	1,000.0	0.0	-	Estimate
C20	Vending machine power draw (beverage)	400.0	400.0	0.0	watts	Typical draw
C21	Vending machine annual operating hours	8,760.0	6,132.0	2,628.0	hrs	Estimate 30% reduction for proposed
C22	Quantity of vending machines	10.0	10.0	0.0	-	Estimate

Calculated Values:

		Base	Proposed	Savings	Units	
C25	Annual electricity use	191,040	141,528	49,512	kWh	=(C17*C18*C19+C20*C21*C22)/1000

HydraMetrics

Virginia Mason Medical Center

Consumption and Savings by Building

Building	Address	In Water Scope	Current Water Use (Gallons)	Post-Retrofit Water Use (Gallons)	Water Use Savings		CCF	Current Hot Water Use	Retrofit Hot Water Use	Current Thermal Energy (therms)	Retrofit Thermal Energy (therms)	Thermal Savings (therms)		Steam
			Domestic Water / Sewer					Thermal Energy						
Central Pavilion	925 Seneca St	x	12,084,473	8,221,612	3,862,862	5,185.05		3,243,347	2,274,040	22,973	16,107	6,866	686.57	
Buck Pavilion	1100 9th Ave	x	3,237,599	1,725,492	1,512,107	2,029.67		749,316	372,298	5,307	2,637	2,670	267.04	
Jones Pavilion	1010 Spring St	x	1,314,256	1,075,966	238,290	319.85		310,920	261,228	2,202	1,850	352	35.20	
Lindeman Pavlion	1201 Terry Ave	x	3,268,810	2,092,257	1,176,553	1,579.27		905,569	448,820	6,414	3,179	3,235	323.52	
Health Resources	909 University St	x	665,690	382,118	283,572	380.63	-9494	153,176	58,148	1,085	412	673	67.31	-1380
Benaroya Research Institute	1201 9th Ave	x	658,779	368,307	290,472	389.89	-390	248,650	122,462	1,761	867	894	89.38	-89
The Inn at VM	1006 Spring St	x	747,186	566,871	180,314	242.03	-452	310,107	247,254	2,197	1,751	445	44.52	-57
Baroness Hotel	1005 Spring St	x	555,156	398,602	156,554	210.14		198,276	181,101	1,404	1,283	122	12.17	
Totals (of Buildings in Scope)			**22,531,949**	**14,831,225**	**7,700,724**			**6,119,360**	**3,965,352**	**43,344**	**28,087**	**15,257**		