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### Sustainability Impacts of Building Energy Use Management

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# Sustainability Impacts of Building Energy Use Management

February 24, 2021

**John Lattanze, WCU Energy Project Manager**

# Introduction & Responsibilities

- Energy & Utilities
- Energy Related Projects
- Operation/Performance of Geothermal System
- Compliance to Emissions Permit Requirements

# WCU Major Energy Sources

## Prior To Boiler Plant Decommissioning in 2014:

- Electricity
- Natural Gas
- Coal
- Fuel Oil

## After Phased Installation of Geothermal System:

- Electricity
- Natural Gas
- Fuel Oil
- Geothermal
- Solar

# Impact of Boiler Plant Decommissioning

- Elimination of Coal, Dramatic Reduction of Fuel Oil
- Decreased Emissions
- WCU Permit Reclassification
- Phased Implementation of the Geothermal System
- Installation of Gas-Fired, High Efficiency, Condensing Boilers

**Summary: CO2 Emissions From Utilities** (includes USH)

Source:	<u>Coal</u> (tons)	<u>#2 FO Blr Plt</u> (tons)	<u>Nat Gas</u> (tons)	<u>Electric</u> (tons)	<u>#2 FO House</u> (tons)	<u>WCU Totals</u> (tons)	<u>Change</u> (tons)	<u>Chg/yr</u> (tons)
1999-2000	16407	3208	2956	18829	56	41456		
FY2006	18715	2016	2688	24114	56	47589	6133	1022
FY2007	21612	2248	3209	25086	56	52211	4622	
FY2013	13289	396	2820	24956	56	41517	-10694	-1782
FY2014	10190	989	4411	24449	56	40095	-1422	
FY2015	0	0	5757	30207	113	36077	-4018	
FY2016	0	0	5792	25954	84	31830	-4247	
FY2017	0	0	6058	27412	106	33576	1746	
FY2018	0	0	6759	28422	114	35295	1719	
FY2019	0	0	6719	27668	74	34460	-835	
FY2020	0	0	5484	24674	73	30230	-4229	
FY2021 *	0	0	874	11616	33	12523		

\* to date

# Current Energy Sources

## Purchased Sources:

- Electricity
  - WCU Substation, Individual Services
  - Supplier contract
- Natural Gas
  - Individual Services
  - High & Low Pressure Service
  - Supplier Contract
- Fuel Oil
  - Seven Smaller Buildings
  - Diesel for Emergency Generators

## Generated Sources:

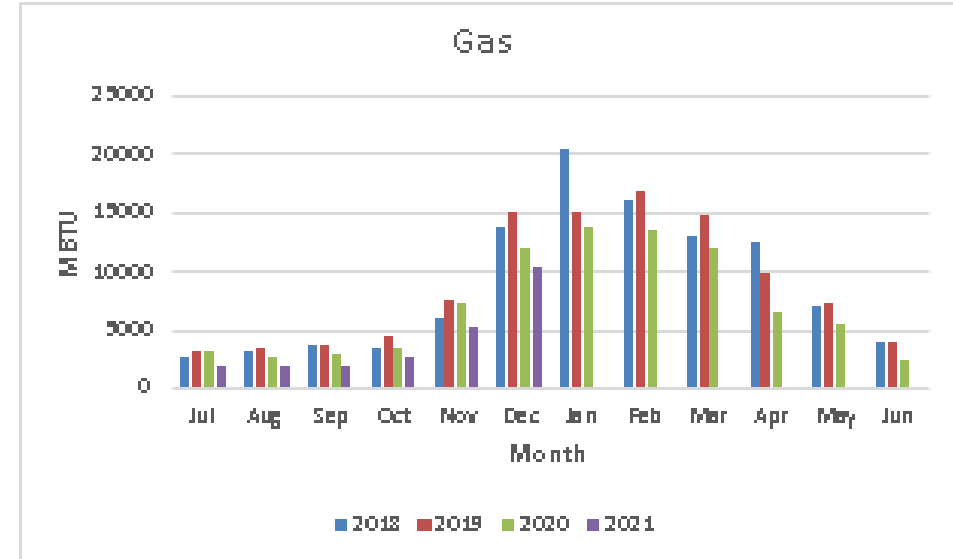
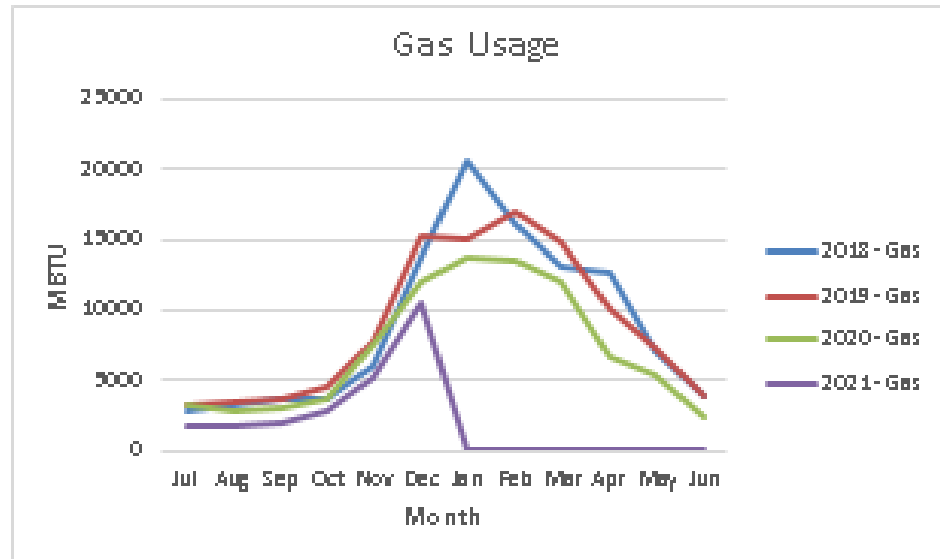
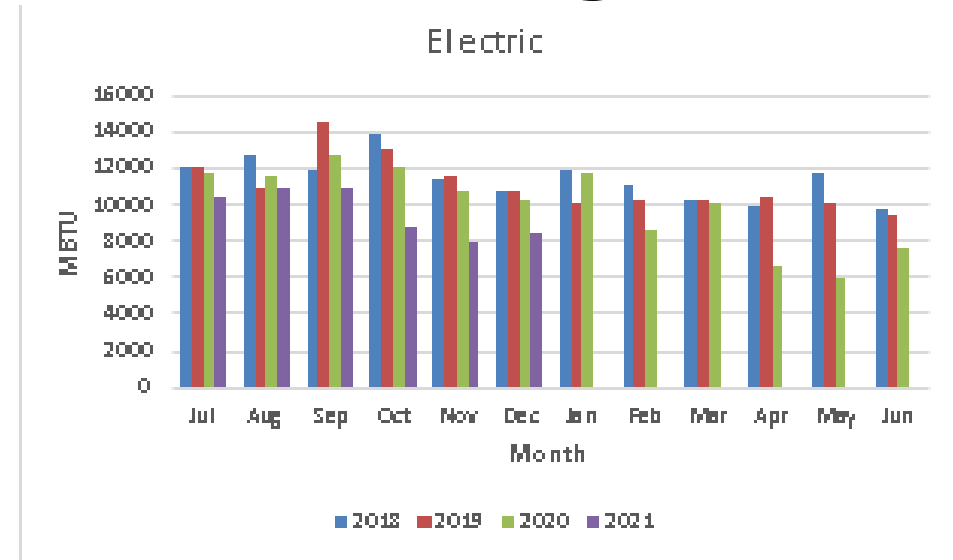
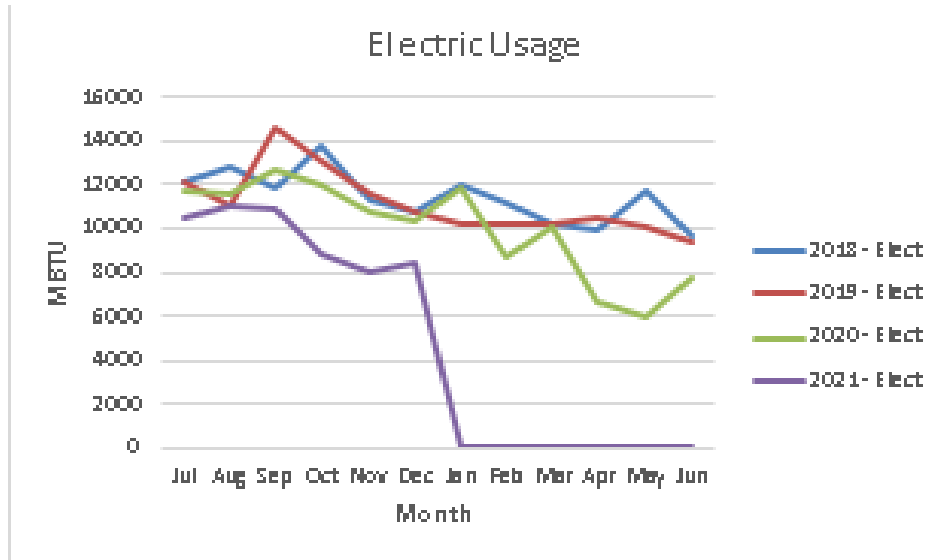
- Geothermal
  - Central & Local Systems
  - 16 Total North Campus Buildings
- Solar
  - Minor Amount from SRC Arrays

# Energy Usage: Monitor & Measure

- Based on Utility Invoices and BAS Records
- Campus Energy Usage Profiles, Distribution
- Building Energy Usage Profiles
- Energy Use Index, Energy Cost Index

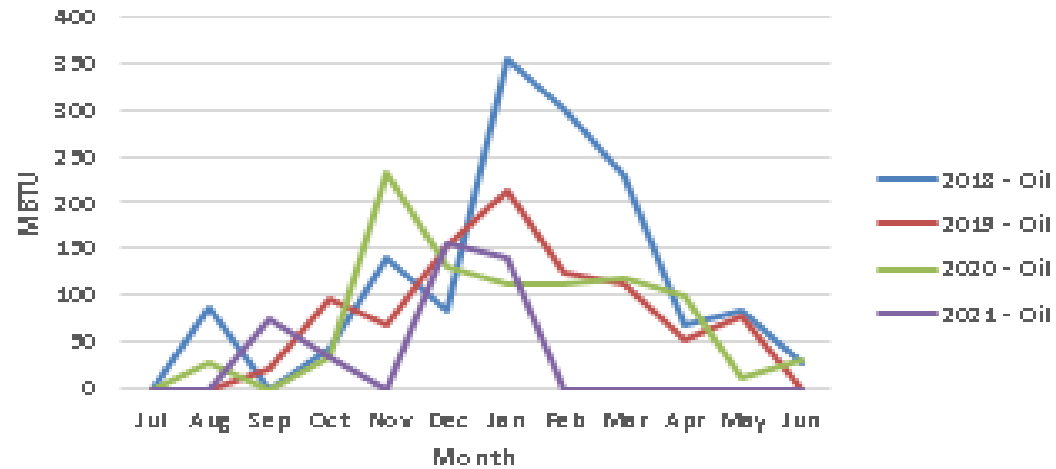


# Electric & Natural Gas Usage

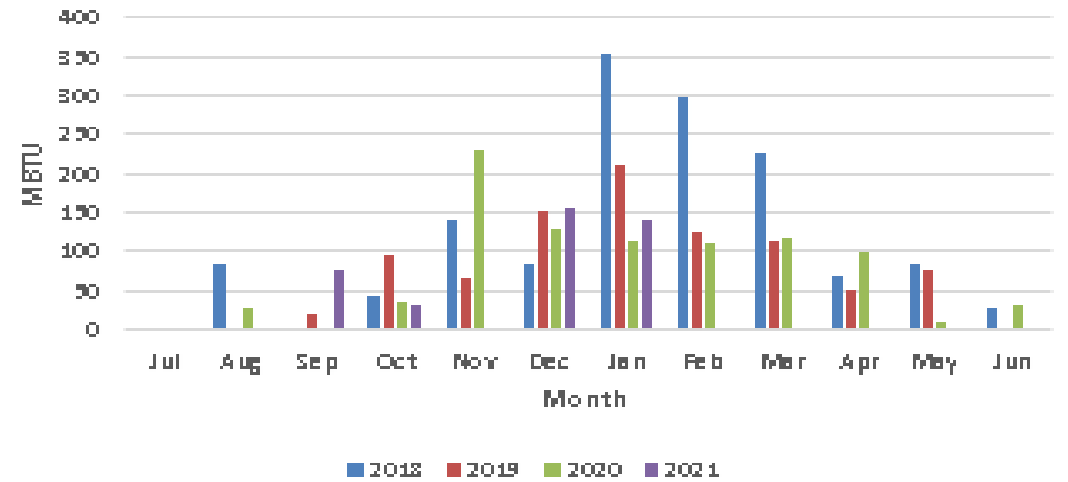


# Fuel Oil & Geothermal Usage

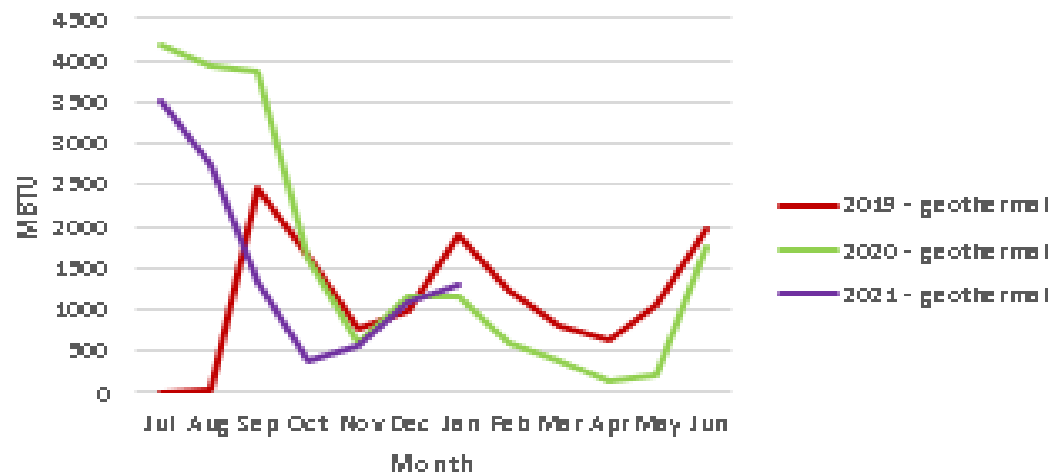
## Oil Usage



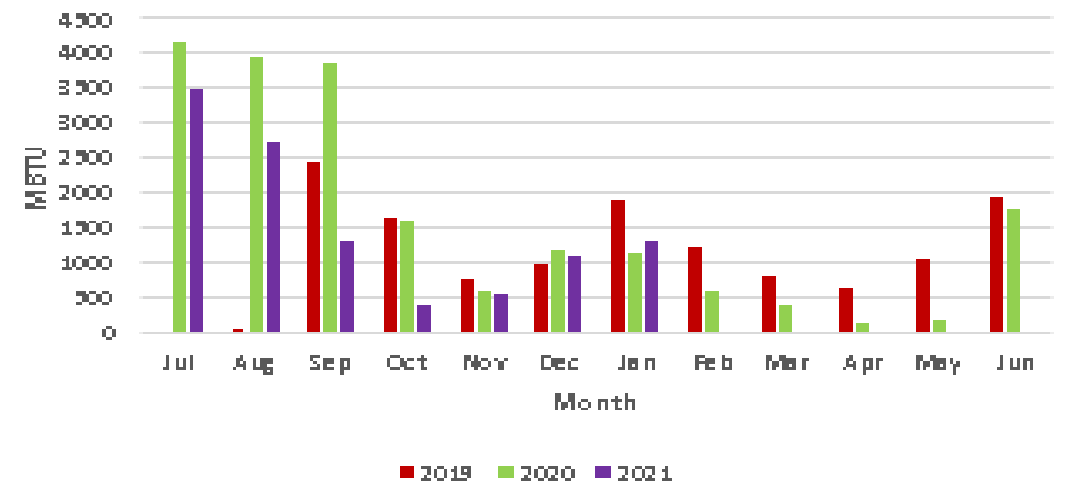
## Oil



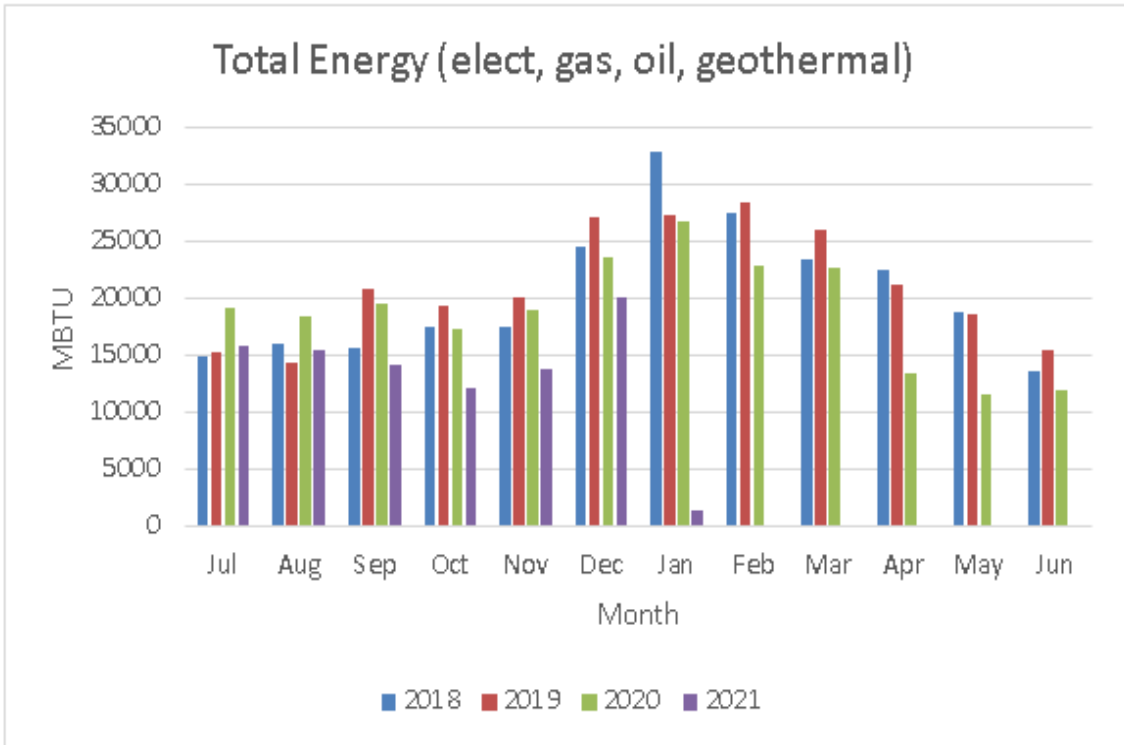
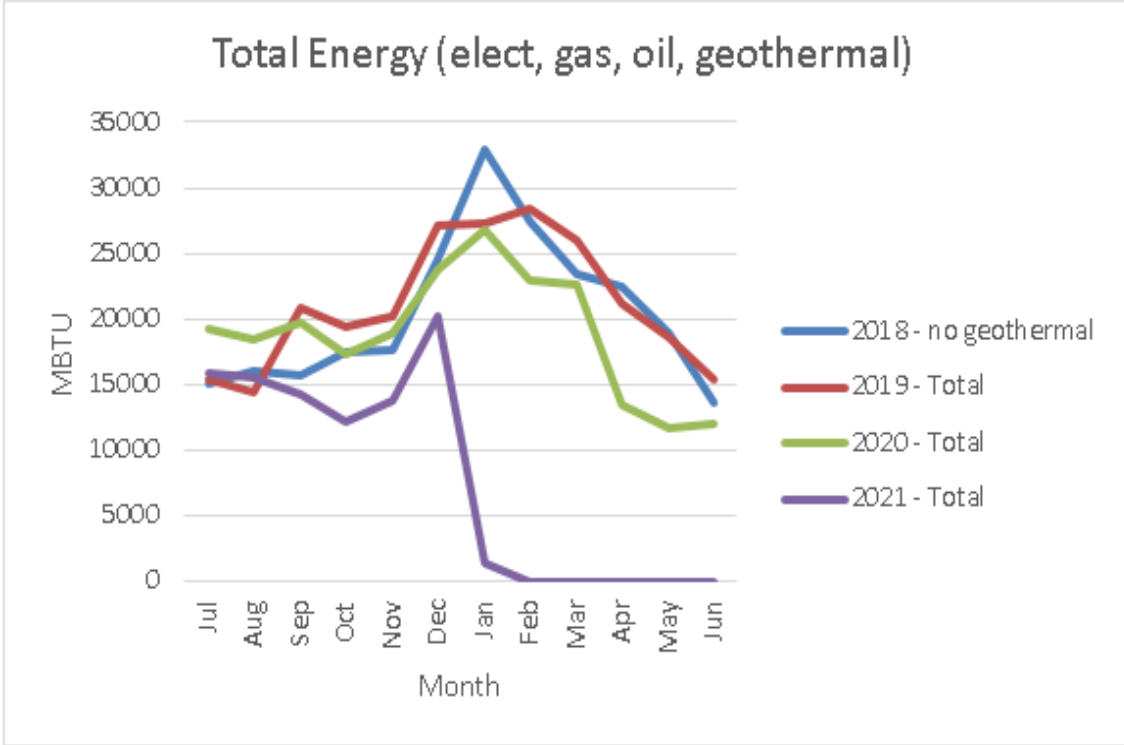
## Geothermal Usage



## Geothermal



# Total Sources



# Energy Usage Distribution

## FY2020 North Campus Energy Loads-to-Date by Building Category

(July, 2019 through Jun, 2020)

<u>Building Type</u>		<u>Electric</u>	<u>Gas</u>	<u>Oil</u>	<u>Geothermal</u>	<u>Totals</u>		
		(MBTU)	(MBTU)	(MBTU)	(MBTU)	(MBTU)	%	
<b>EG</b>	Geothermal	24900	5695	-	14415	45010	<b>20%</b>	57%
	Non-Geothermal	38755	44192	365	-	83311	<b>37%</b>	
<b>Aux, Res</b>	Geothermal	-	-	-	-	0	<b>0%</b>	27%
	Non-Geothermal	9350	22975	-	-	32325	<b>14%</b>	
<b>Aux, Other</b>	Geothermal	2726	704	-	1095	4525	<b>2%</b>	
	Non-Geothermal	10195	12634	-	-	22829	<b>10%</b>	
<b>USH</b>	Geothermal	17699	3338	-	9738	30775	<b>14%</b>	16%
	Non-Geothermal	3211	1942	-	-	5153	<b>2%</b>	
<b>Totals</b>		106836	91479	365	25248	223928		
<b>%</b>		<b>48%</b>	<b>41%</b>	<b>0%</b>	<b>11%</b>			

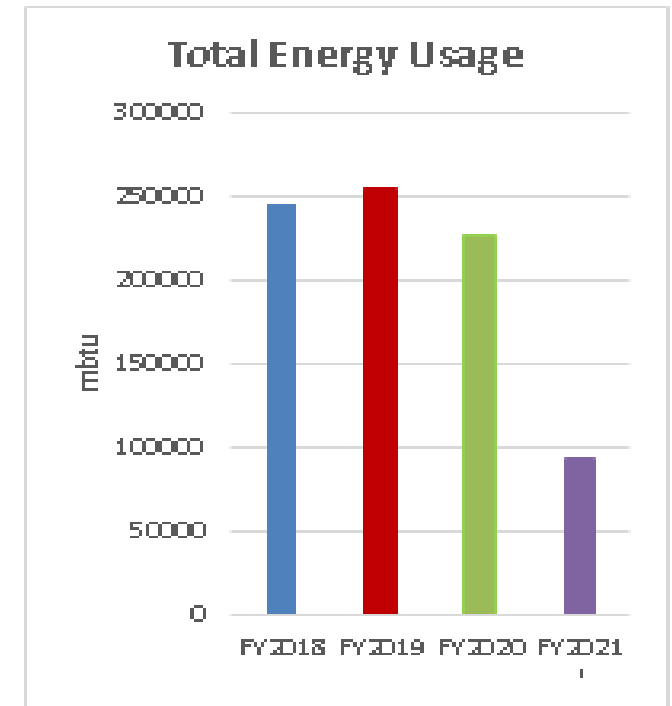
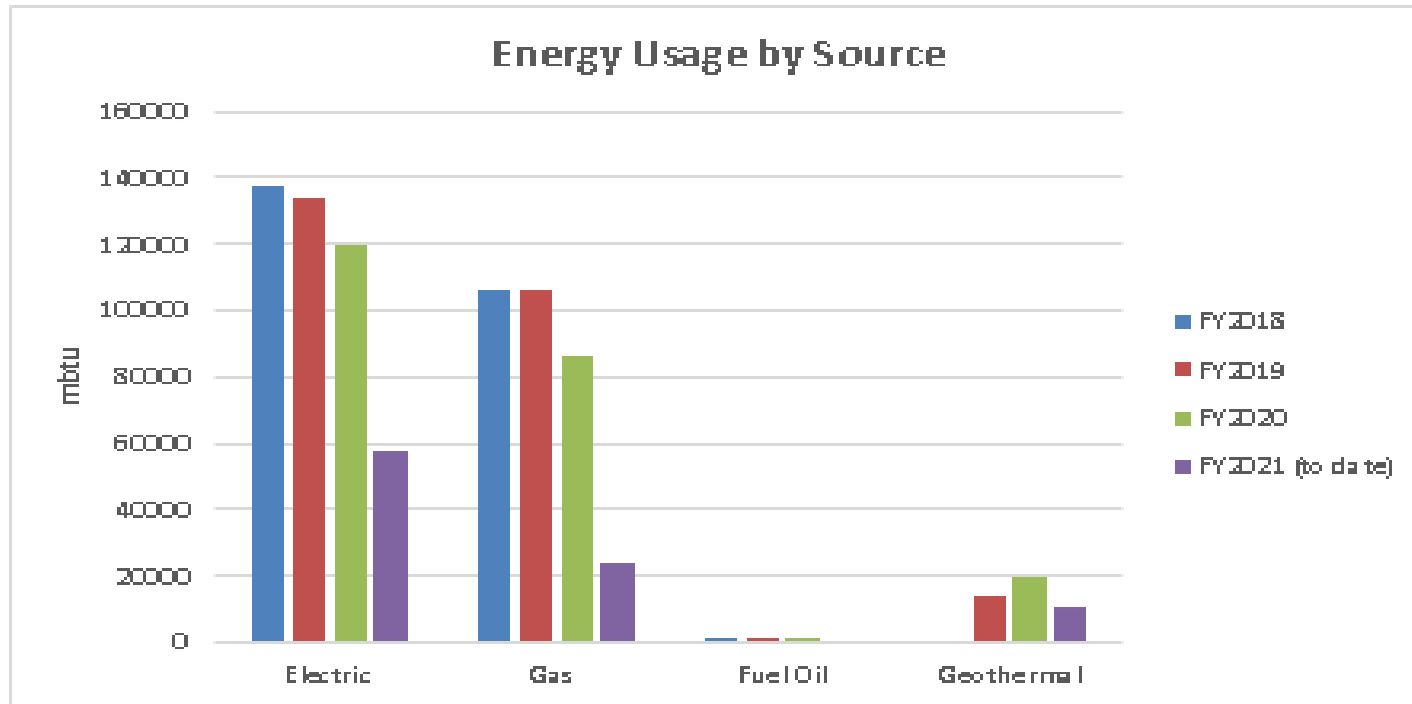
Note: Does not include South Campus buildings except HSC

# Energy Usage By Source

## ANNUAL USAGE

	<u>Electric</u> (mbtu)	<u>Gas</u> (mbtu)	<u>Fuel Oil</u> (mbtu)	<u>Geothermal</u> (mbtu)	<u>Total</u> (mbtu)	✓
FY2018	137394	106416	1412		245222	245222
FY2019	133887	105892	915	13474	254168	254168
FY2020	119904	86188	905	19626	226623	226623
FY2021 *	57518	24282	406	10901	93106	93106

\*to date



## U.S. National Averages for Site Energy Use Intensity (EUI)

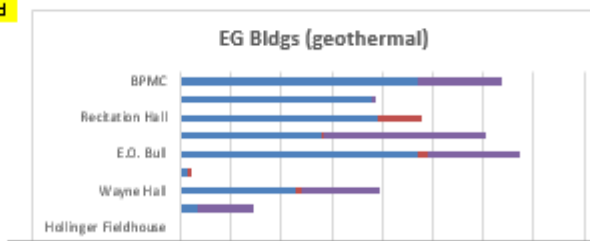
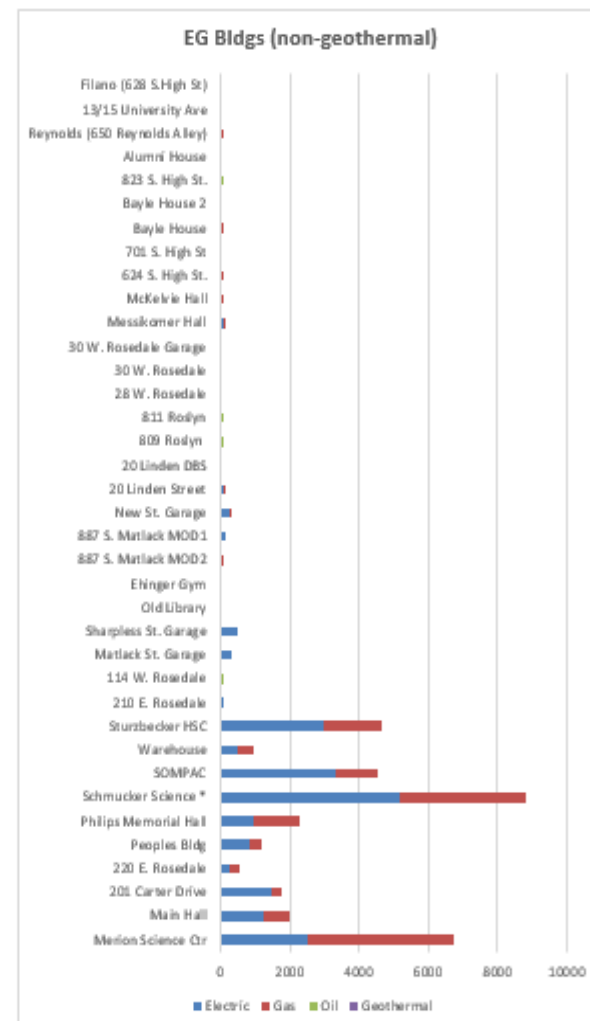
Building Type	Average Site Energy Use Intensity (annual kBtu/SF)
Health Care	135.7
Inpatient	253.8
Outpatient	84.4
Education	80.6
College/University (campus-level)	120
Food Sales	225
Food Service	351
Fast food	534
Restaurant/Cafeteria	302
Lodging	87
Office	88
Mercantile	94.4
Retail (Non-Malls)	86.4
Retail (Malls)	99.5
Public Assembly	66
Entertainment/Culture	95
Library	104
Recreation	65
Social/Meeting	52
Public Order and Safety	90
Fire Station/Police Station	78
Service (vehicle repair/service, postal service)	77
Storage/Warehouse	33.3
Non-refrigerated Warehouse	1
Religious Worship	46
Multifamily (5 or more units)	49.5
Other	104

# Energy Reports: FY2021 North Campus Recorded Energy Usage

Usages from July, 2020 through Jan, 2021

Note: Does Not Include South Campus Buildings (except Struzbecker)

FY2021 by Month (Conversion)		TOTAL USAGE (MBTU)					Energy Use Index (EUI)		Energy Cost	
		Electric	Gas	Oil	Geothermal	Total	sqft	Total MBTU/sqft	\$/mbtu	
EG Buildings	Non-geothermal	Merion Science Ctr	2544	4174			6719	79135	0.085	\$11.80
		Main Hall	1241	769			2010	73204	0.027	\$15.27
		201 Carter Drive	1492	296			1787	51539	0.035	\$18.00
		220 E. Rosedale	241	340			581	10348	0.056	\$11.76
		Peoples Bldg	835	369			1204	17895	0.067	\$16.28
		Philips Memorial Hall	940	1365			2305	53550	0.043	\$12.49
		Schmucker Science *	5189	3636			8825	75151	0.117	\$14.57
		SOMPAC	3347	1188			4535	87786	0.052	\$16.72
		Warehouse	499	467			965	46734	0.021	\$14.05
		Sturzbecker HSC	3001	1660			4661	203485	0.023	\$15.40
		210 E. Rosedale	83	0			83	4200	0.020	\$22.13
		114 W. Rosedale	10		14		24	3267	0.007	\$15.46
		Matlack St. Garage	337				337	151667	0.002	\$16.22
		Sharpless St. Garage	504				504	160728	0.003	\$16.22
		Old Library	-				0	22355	0.000	-
		Ehinger Gym	-				0	13675	0.000	-
		887 S. Matlack MOD2	37	16			53	28429	0.002	\$32.33
		887 S. Matlack MOD1	138	0			138	-	-	\$30.07
		New St. Garage	263	10			273	161071	0.002	\$24.70
		20 Linden Street	76	3			78	-	-	\$30.38
		20 Linden DBS	37	0			37	-	-	\$38.84
		809 Roslyn	25	0	7		32	2373	0.013	\$28.79
		811 Roslyn	18	0	11		29	2517	0.012	\$28.78
		28 W. Rosedale	16	0			16	-	-	\$38.23
		30 W. Rosedale	5	0			5	4886	0.001	\$63.68
		30 W. Rosedale Garage	1	0			1	1560	0.001	\$103.40
		Messikomer Hall	83	21			103	8470	0.012	\$24.36
		McKelvie Hall	51	50			101	4774	0.021	\$20.60
		624 S. High St.	25	45			69	5327	0.013	\$20.66
		701 S. High St	29	0			29	3596	0.003	\$59.00
		Bayle House	11	9			20	5246	0.004	\$31.69
		Bayle House 2	13	0			13	395	0.034	\$42.48
823 S. High St.	21	0	25		47	3179	0.015	\$18.62		
Alumni House	1	0			1	4710	0.000	\$117.39		
Reynolds (650 Reynolds Alley)	-	84			84	6313	0.013	\$9.87		
1315 University Ave	-	11			11	8340	0.001	\$25.05		
Filano (628 S. High St)	-	58			58	6390	0.009	\$10.83		
						avg:	0.022	\$23.13	not included	
EG Buildings	Geothermal	Mitchell Hall	586			52	638	38293	0.017	\$18.31
		25 University Bldg	1088			739	1828	53985	0.034	\$11.86
		FHG Library I, (II geo)	2408	46		341	2795	60042	0.047	\$17.38
		Hollinger Fieldhouse	1565	505		1616	3686	57049	0.065	\$9.52
		Hollinger Fieldhouse	-	1		0	1	-	-	-
		Ruby Jones Hall	160	0		574	734	22951	0.032	\$4.59
		Wayne Hall	1136	67		770	1973	92800	0.021	\$11.82
		Tanglewood	79	39		0	118	10246	0.012	\$17.39
E.O. Bull	2349	92		917	2259	62740	0.054	\$14.20		



# Pump House: Geothermal Usage & Unit Cost

Pumphouse - Geothermal Energy Consumption & Cost per Fiscal Year

Month	FY2019				FY2020				FY2021			
	Geothermal Loop Consumption	Pump House Electric Usage	Pump House Electric Cost	Geothermal Unit Cost	Geothermal Loop Consumption	Pump House Electric Usage	Pump House Electric Cost	Unit Cost	Geothermal Loop Consumption	Pump House Electric Usage	Pump House Electric Cost	Unit Cost
	*	**	***		*	**	***		*	**	***	
	(mbtu)	(kwh)	(\$)	(\$/mbtu)	(mbtu)	(kwh)	(\$)	(\$/mbtu)	(mbtu)	(kwh)	(\$)	(\$/mbtu)
Jul	-	-	-	-	4182	136270	\$9,266	\$2.22	3,508	114779	\$7,805	\$2.22
Aug	-	-	-	-	3948	137794	\$9,370	\$2.37	2,732	101780	\$6,921	\$2.53
Sep	2,458	100743	\$6,851	\$2.79	3865	123320	\$8,386	\$2.17	1,327	72571	\$4,935	\$3.72
Oct	1,637	65045	\$4,423	\$2.70	1618	73286	\$4,983	\$3.08	385	41485	\$2,821	\$7.33
Nov	782	56153	\$3,818	\$4.88	592	59315	\$4,033	\$6.81	555	47724	\$3,245	\$5.85
Dec	988	70629	\$4,803	\$4.86	1168	74607	\$5,073	\$4.34	1,092	83724	\$5,693	\$5.21
Jan	1894	107145	\$7,286	\$3.85	1,162	79014	\$5,373	\$4.62	1,301	92483	\$6,289	\$4.83
Feb	1224	78648	\$5,348	\$4.37	608	64719	\$4,401	\$7.24			\$0	
Mar	822	62029	\$4,218	\$5.13	377	49582	\$3,372	\$8.94			\$0	
Apr	643	28737	\$1,954	\$3.04	135	38596	\$2,625	\$19.49			\$0	
May	1046	37371	\$2,541	\$2.43	198	28566	\$1,942	\$9.83			\$0	
Jun	1955	66689	\$4,535	\$2.32	1,774	72257	\$4,913	\$2.77			\$0	
Totals	13,450	673189	\$45,777	\$3.40	19,626	937326	\$63,738	\$3.25	10,900	554545	\$37,709	\$3.46

COVID's shutdown period, unit costs not included in average

\* Energy Reports: loop BTU meter in Pump House

\*\* Energy Reports: electric meter in Pump House

\*\*\* usage x \$0.068/kwh

Other energy unit costs: (based on FY2020 averages)

Electricity: \$19.92/mbtu (\$0.068/kwh x 1 kwh/0.003414mbtu)

Natural Gas: \$ 7.88/mbtu (\$0.788/ccf x 1 ccf/0.1 mbtu)



# SRC Solar Arrays Energy Production

## SRC: Solar Arrays Energy Production

<u>Date</u>	<u>Energy Today</u> (kwh)	<u>Total Energy</u> (mwh)	<u>Month</u>	<u>Energy</u> (mwh)	
4/1/2020 12:00:00 AM EDT	19.501	199.418			
5/1/2020 12:00:00 AM EDT	37.471	201.658	Apr '20	2.24	2.24
6/1/2020 12:00:00 AM EDT	0	0			2.68
7/1/2020 12:00:00 AM EDT	102.461	207.023	May & Jun '20	5.37	2.68
8/1/2020 12:00:00 AM EDT	39.064	209.929	Jul '20	2.91	2.91
9/1/2020 12:00:00 AM EDT	36.057	212.509	Aug '20	2.58	2.58
10/1/2020 12:00:00AM EDT	107.895	214.854	Sep '20	2.35	2.35
11/1/2020 12:00:00AM EST	91.11	216.707	Oct '20	1.85	1.85
12/9/2020 09:10:00AM EST **	1.13	218.984	Nov '20	2.28	2.27
1/1/2021 12:00:00AM EST	6.43	219.947	Dec '20	0.96	0.96
2/1/2021 12:00:00AM EST	9.62	221.448	Jan '21	1.50	1.50
			Total:	22.03	22.03
			Monthly Avg*	2.20	

\* splitting May and Jun

<b>3 SOLAR ARRAYS ON SRC</b>	(1) 4 strings of 11 (2) 5 strings of 11 (3) 6 strings of 11	165 total panels
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# Energy Usage: Control

(from an operations standpoint)

- BAS Schedules and Setpoints
- Supplier Contracts
- REC's
- Policies and Culture

# Renewable Energy Credits

## Renewable Energy Credits: WCU Purchase History

<u>CY RECs</u>	<u>Number of RECs</u> (Mwh)	<u>Unit Price</u>	<u>Vendor</u>	<u>PO Number</u>	<u>Delivery Date *</u>
2016	12,000 (30%)	\$0.49	3Degrees Group	4500489666	Inv. #13283 paid 3/3/16
2017	12,000 (30%)	\$0.49	3Degrees Group	4500489666	Inv. #13283 paid 3/3/16
2018	12,000 (30%)	\$0.515	WGL Energy	4500550634	Inv. #207551 paid 1/11/18
2019	45,000 (100%)	\$0.835	3Degrees Group	4500574739	Inv. #18110 paid 3/3/20
2020	13,955 (30%)	\$0.74	3Degrees Group	4500587122	Inv. #18551 paid 6/11/20
2021	13,955 (30%)	\$0.74	3Degrees Group	4500587122	on or before <b>4/15/2022</b>
2022					

2 year contract

\* including REC's, invoice, attestation letter

# Energy Usage: Improvement/Opportunities

- Understanding Buildings and Building Systems
- Building Core Temperatures
- Electric Peak Demand
- AEC's, PPA, FCA's
- Expansion of Geothermal System
- Other:
  - LED's
  - Occupancy Sensors
  - Plug Loads, EV's, Bikes, Snow Melt Systems

# Thank You

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