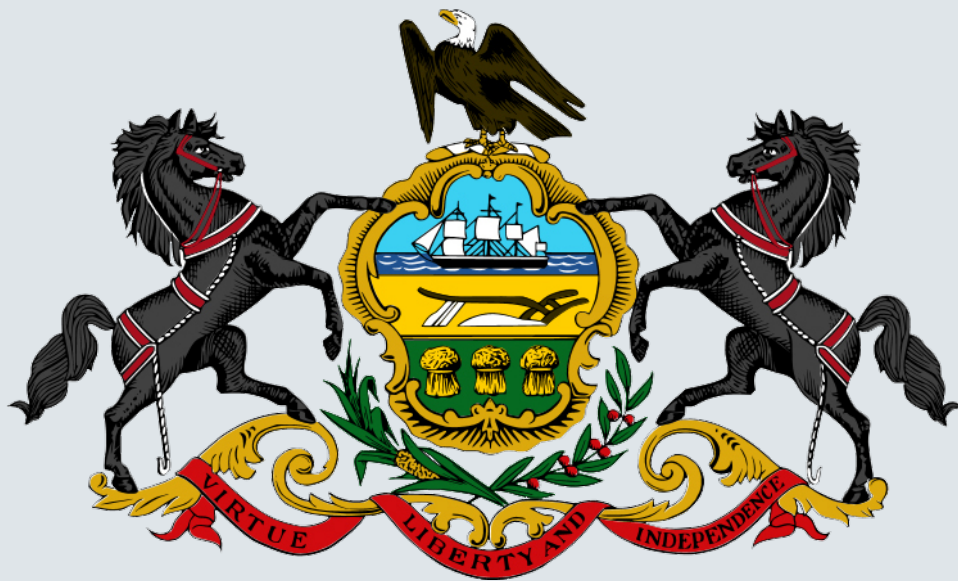


DEPARTMENT OF GENERAL SERVICES

Commonwealth of Pennsylvania



Energy & Utility Usage Report

Fiscal Year 2017–2018

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PENN STATE FACILITIES ENGINEERING INSTITUTE

OUR MISSION

To merit the public trust by meeting customer facility needs through engineering, information management, education, and applied research while exploring new and innovative ways to exceed customer expectations.

OUR VISION

Penn State Facilities Engineering Institute will impart significant value to the services provided to their customers, thereby earning their respect and enhancing Penn State's tradition of excellence.

Director

John Hajduk, MBA

Associate Director

Mark Bodenschatz, PE, CSSP

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EXECUTIVE SUMMARY

The Penn State Facilities Engineering Institute (PSFEI) provides the Pennsylvania Department of General Services (DGS) with essential energy and engineering services. Energy services include electricity and natural gas procurement and demand-side energy management. In support of these services, the PSFEI Energy Team performs database development and management and marketplace research and tracking. They educate consumers and provide assistance with virtually all energy and utility issues. Engineering services covered surveys, studies, and investigations at the Capital Complex.

PSFEI supports a DGS energy portfolio that covers 7,758 electric and 953 natural gas accounts. During fiscal year 2017–2018, PSFEI supported the Commonwealth of Pennsylvania’s (Commonwealth) web-based energy procurement activities by conducting electricity and natural gas commodity procurement events under the direction of the DGS Bureau of Procurement. Supply contracts were solicited through five electricity bidding events that included 1,351 accounts and resulted in \$3.7 million in projected annual avoided costs versus the utility-issued price to compare. Four natural gas procurement events were held for 35 accounts resulting in projected annual avoided costs of \$3.6 million when compared to natural gas utility sales service tariff rates. Long-term energy supplier contracts were awarded that align with budgetary goals through strategic energy procurement planning meetings and bid event scheduling, saving the Commonwealth over \$25 million dollars through 2022 compared to previous energy costs. Since 1998, PSFEI’s energy procurement services have saved the Commonwealth \$225 million in energy costs compared to utility tariff costs. The Energy Procurement section of this report presents detailed information about energy procurement activities.

In addition to the avoided energy costs, notable accomplishments during the year included:

- Enhancing the Energy Risk Management Application's functional capabilities to improve the Commonwealth’s energy procurement and account management capabilities.
- Attending and presenting at the National Governors Association Energy Retreat and the Energy Update conference, promoting energy conservation management strategies and Commonwealth accomplishments.
- Assisting the Commonwealth with securing an agreement to purchase EnergyCAP, an enterprise utility bill management system. EnergyCAP provides advanced energy analytics that will span the entire Commonwealth portfolio.
- Monitoring natural gas and electricity markets to time procurement events to secure excellent natural gas and electricity contract pricing.
- Supporting the DGS Guaranteed Energy Savings Act (GESA) program by visiting ten Commonwealth facility sites; preparing reports identifying energy-saving project opportunities; and providing assistance for five projects with ongoing activities, including completion of a project for the Keystone and Judicial Buildings. A major component of this project included retrofitting all lighting to utilize efficient light-emitting diode (LED) lamp technologies. The resulting savings from this retrofit are indicated in the electricity use and cost reduction trends provided in this report (Charts 6 and 7).
- Assisting with The Commonwealth’s total annual purchase of 243,733 Megawatt hours (MWh) of Green-e certified Renewable Energy Credits (RECs), which places Pennsylvania in the number

one position for state governments on the U.S. Environmental Protection Agency's Green Power Partnership National Top 100 list.

Energy and utility costs for DGS facilities increased by \$673,592 (5.3%) from the previous fiscal year. Overall energy use increased by approximately 42,780 million British thermal units (MMBtu) (7%). Continued favorable natural gas market pricing provided the Commonwealth with a supply of low-cost energy; however, a 22% more severe heating season and cost escalation built into the Lancaster County Solid Waste Management Authority Power Purchase Agreement impacted total utility costs for all DGS facilities. Purchased steam energy from NRG Energy Center Harrisburg LLC increased by 12%. The unit cost of steam decreased by roughly 1%.

PSFEI conducted a comparison of Commonwealth buildings to industry averages using the Commercial Buildings Energy Consumption Survey (revised in December 2012). The average site Energy Use Intensity (EUI) for an office building in the U.S. Northeast region was 93,900 British thermal units per square foot (Btu/sqft). For fiscal year 2017–2018, the average Commonwealth building site EUI was 84,313 Btu/sqft, 10% below the national average and 7% more than the previous fiscal year.

The Utility Summary section of this report provides information regarding utility usage and costs. Detailed utility usage and cost information by building is presented in the DGS Energy and Utility Usage section. Both sections have graphical and tabular comparisons of facilities and narrative descriptions.

The Energy Procurement section presents electricity and natural gas procurement activities and market commentaries and analysis.

The Summary of Energy and Engineering Services section provides a summary of the activities and services provided by PSFEI during fiscal year 2017–2018. Beginning in 2017–2018, PSFEI began to provide support for the operation and maintenance of electrical systems at the DGS Capitol Complex. An overview of this support, which included equipment and cable testing, is provided in this section under Engineering Services.

The Summary of Education Services section presents the educational opportunities offered by PSFEI and attendance by DGS personnel.

UTILITY SUMMARY

The Utility Summary section presents utility usage by fuel, provides six-year historical information (unless otherwise stated), compares overall use by building using a site-based Energy Use Intensity (EUI), and benchmarks buildings by their utility cost per square foot.

CONSUMPTION AND COSTS

The Department of General Services (DGS) energy and water cumulative costs totaled nearly \$15.6 million during fiscal year 2017–2018, an increase of 3% from the previous fiscal year. Electricity use declined by 6.2 million kilowatt-hours (kWh) or 5%. Natural gas use increased by 56% compared to the previous year, the result of a winter that was 22% colder. The remaining increased gas use was mostly caused by a meter error from the previous fiscal year. Steam use increased 11.9%. Water use decreased by 27%.

Thermal energy unit pricing decreased during the fiscal year. Natural gas unit costs decreased by 10.5% and purchased steam unit costs decreased by 1.4%. For the second year in a row, electricity use dropped by 4.6% (5.2 million kWh) while unit costs increased 5.9% (0.43 cents per kWh), largely the result of transmission cost increases and escalations built into the Power Purchase Agreement (PPA) with the Lancaster County Solid Waste Management Authority (LCSWMA). Water consumption decreased by 27% and water unit cost increased by 25%.

Table 1. Consumption and Costs 2017–2018

Utility	Annual Consumption	Unit Cost	Annual Cost
Electricity	108,249,179 kWh	7.930 ¢/kWh	\$8,583,792
Natural Gas	117,117 mcf	\$6.42 /mcf	\$752,129
Steam	164,356 mlbs	\$24.62 /mlbs	\$4,045,711
Water/Sewer	81,816 mgal	\$26.98 /mgal	\$2,207,550
Total			\$15,589,182

AVOIDED COSTS

During fiscal year 2017–2018, the Penn State Facilities Engineering Institute (PSFEI) helped DGS and other agencies avoid nearly \$7.4 million in projected annual electricity and natural gas expenditures as compared to utility-issued, price-to-compare costs.

Table 2. Avoided Energy Costs 2017–2018

Energy Events	Avoided Costs
Electricity Procurement (Annual Savings)	\$3,744,562
Natural Gas Procurement (Annual Savings)	\$3,618,807
Total	\$7,363,368

DGS SIX-YEAR ENERGY CONSUMPTION AND COSTS

Charts 1 and 2 illustrate energy costs and consumption trends for electricity, steam, and natural gas for DGS facilities over the past six fiscal years. During fiscal year 2017–2018, energy costs increased by \$673,592 or 5.3% from the previous fiscal year. Overall energy use increased from the previous year by 42,780 million British thermal units (MMBtu) or 7%. The Electricity and Natural Gas Procurement sections provide additional information regarding energy costs and market discussions.

Chart 1. Annual Energy Costs Trend

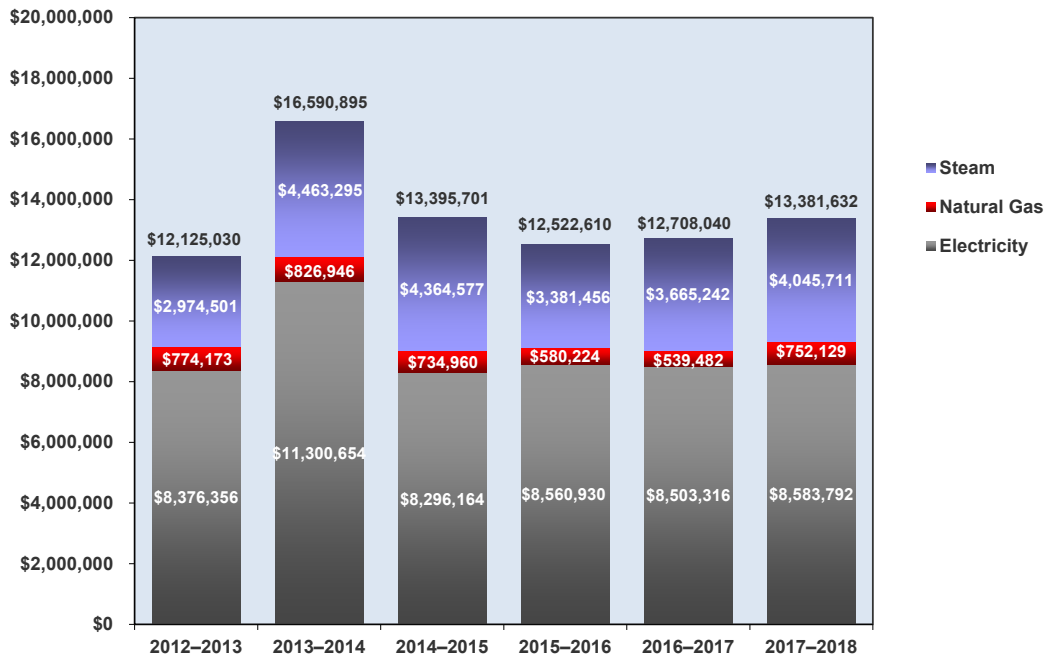


Chart 2. Annual Consumption Trend

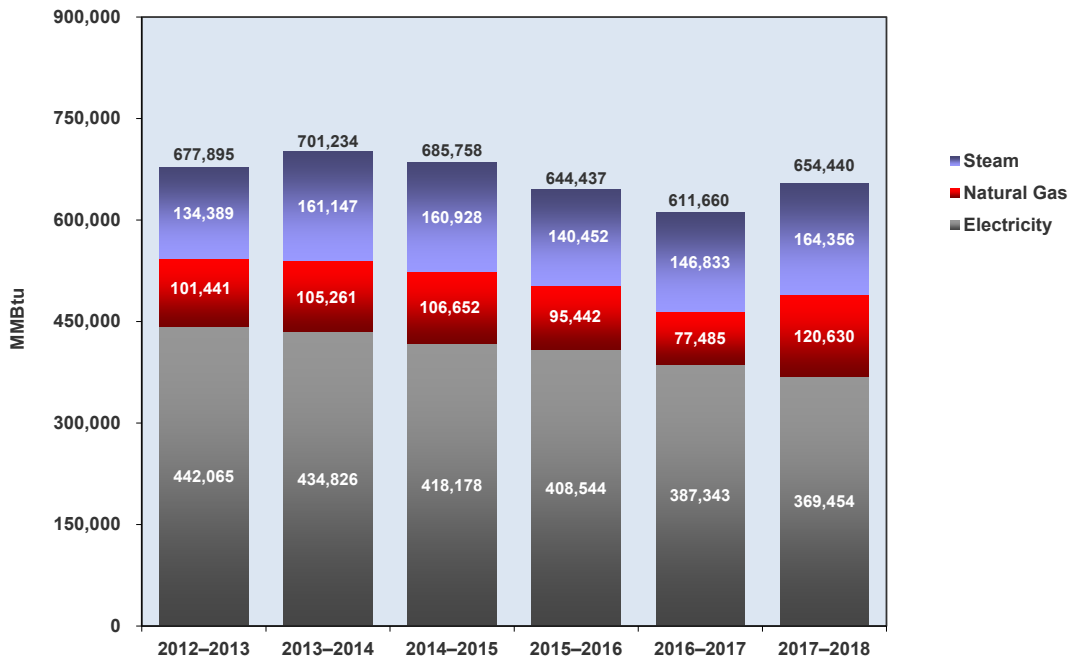


Table 3 provides a detailed agency-level view of energy use and cost information for the past six fiscal years.

Actual electricity consumption decreased by 5,241,231 kWh (4.6%), which was primarily due to a Guaranteed Energy Savings Act (GESA) project-based energy saving conversion to light-emitting diode (LED) lighting and cooling season that was 11% cooler than the previous fiscal year. Electricity cost increased \$80,476 (0.9%), largely due to the transmission cost increases and price escalations built into the LCSWMA PPA.

Purchased steam consumption increased by 17,523 thousand pounds (mlbs) (11.9%) and costs increased by \$380,469 (10.4%). The winter was 22% more severe than the previous year. The largest increases occurred at the Museum, the Keystone Building, and the Main Capitol. The overall steam unit cost decreased by \$0.34 per mlb (1.4%).

Natural gas consumption increased by 56% or 41,889 thousand cubic feet (mcf) and costs increased \$212,647 (39.4%). A billing error in the previous fiscal year resulted in 19,035 mcf of reported consumption this year, accounting for roughly half of the increased use. While the heating season was 22% colder, the DGS Annex use appears to account for most of the increase, well beyond the billing error. The average natural gas unit cost decreased to \$6.43 per mcf or 10.5%. For an expanded summary describing the natural gas market, refer to the Natural Gas Market section under Energy Procurement.

Table 3. Annual Energy Consumption and Costs Trend

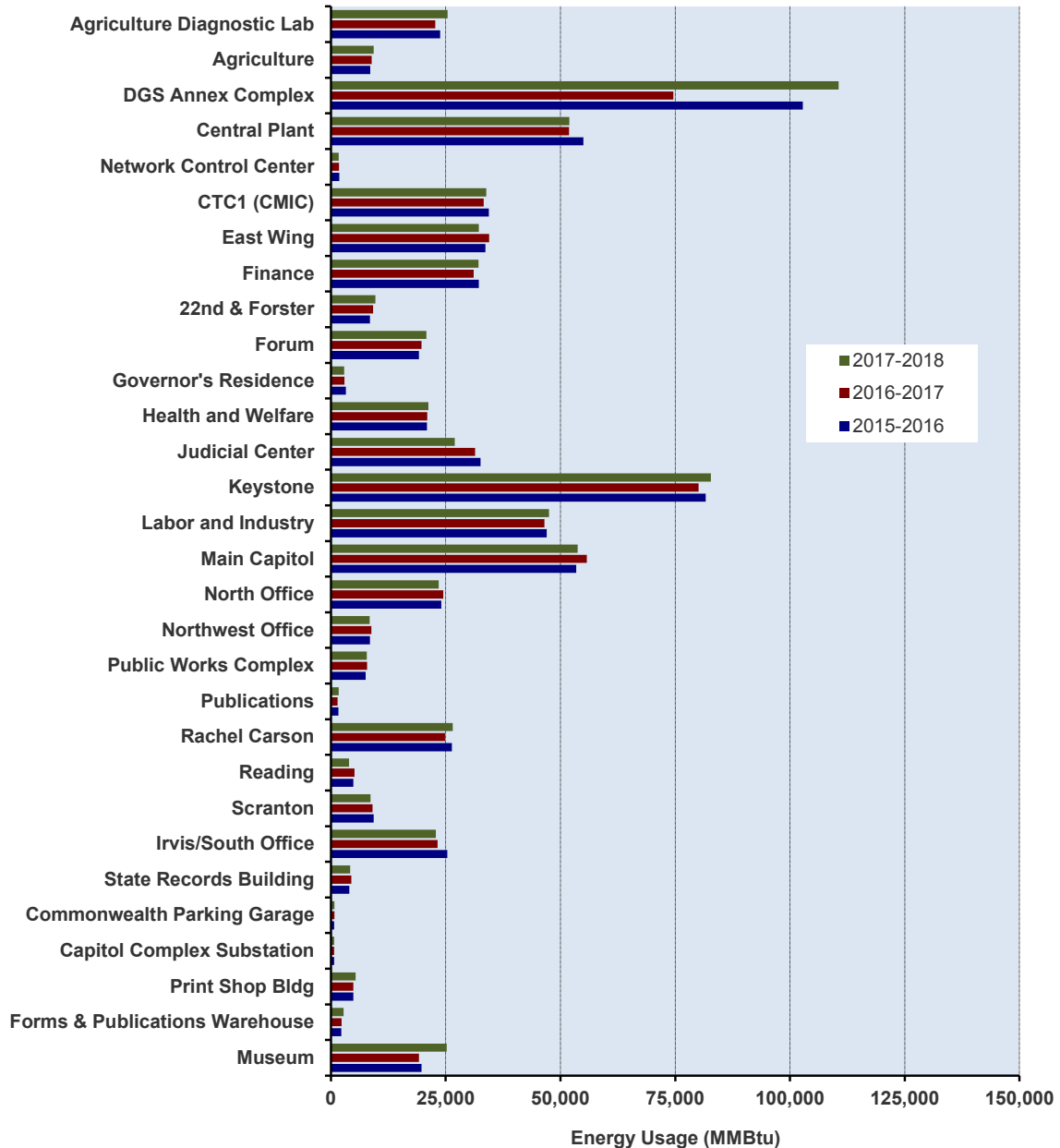
Energy Cost	Units	2012–2013	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
Electricity	\$	\$8,376,356	\$11,300,654	\$8,296,164	\$8,560,930	\$8,503,316	\$8,583,792
Natural Gas	\$	\$774,173	\$826,946	\$734,960	\$580,224	\$539,482	\$752,129
Steam	\$	\$2,974,501	\$4,463,295	\$4,364,577	\$3,381,456	\$3,665,242	\$4,045,711
Total	\$	\$12,125,030	\$16,590,895	\$13,395,701	\$12,522,610	\$12,708,040	\$13,381,632
Unit Energy Cost/MMBtu							
Electricity	\$/MMBtu	\$18.95	\$25.99	\$19.84	\$20.95	\$21.95	\$23.23
Natural Gas	\$/MMBtu	\$7.63	\$7.86	\$6.89	\$6.08	\$6.96	\$6.23
Steam	\$/MMBtu	\$22.13	\$27.70	\$27.12	\$24.08	\$24.96	\$24.62
Weighted Average	\$/MMBtu	\$17.89	\$23.66	\$19.53	\$19.43	\$20.78	\$20.45
Energy Consumption							
Electricity	MMBtu	442,065	434,826	418,178	408,544	387,343	369,454
Natural Gas	MMBtu	101,441	105,261	106,652	95,442	77,485	120,630
Steam	MMBtu	134,389	161,147	160,928	140,452	146,833	164,356
Total	MMBtu	677,895	701,234	685,758	644,437	611,660	654,440
Unit Fuel Cost							
Electricity	\$/kWh	\$0.0647	\$0.0887	\$0.0677	\$0.0715	\$0.0749	\$0.0793
Natural Gas	\$/mcf	\$7.86	\$8.09	\$7.10	\$6.26	\$7.17	\$6.42
Steam	\$/mlb	\$22.13	\$27.70	\$27.12	\$24.08	\$24.96	\$24.62
Fuel Consumption							
Electricity	kWh	129,524,013	127,402,938	122,525,079	119,702,221	113,490,410	108,249,179
Natural Gas	mcf	98,486	102,195	103,545	92,662	75,228	117,117
Steam	mlbs	134,389	161,147	160,928	140,452	146,833	164,356

Note: The historical data for fiscal years 2012–2013, 2013–2014, 2014–2015, 2015–2016, and 2016–2017 was updated to reflect the removal of the Altoona Office Building

ENERGY USAGE

Chart 3 shows the total usage in MMBtu for each DGS facility for the past three fiscal years. The largest users were the DGS Annex Complex (its use increased significantly, partly due to a billing error) and the Keystone Building. Energy consumption changed slightly or remained the same from the previous year at most facilities.

Chart 3. Annual Energy Usage Trend



ENERGY USE INTENSITY

Table 4 below and Charts 4A and 4B on page 6, show the EUI for each building for the past three fiscal years. The EUI is measured in annual British thermal units per square foot (Btu/sqft) and provides a normalized method to compare building energy use. The EUI is used throughout the energy industry to portray a facility's energy intensity. Chart 4B shows that the Agriculture Diagnostic Lab and CTC1 (CMIC) exhibited the highest energy intensities because of their concentrated end-use equipment and heating, ventilating, and air conditioning (HVAC) loads dictated by building operations. Their energy use has slightly increased over the past year.

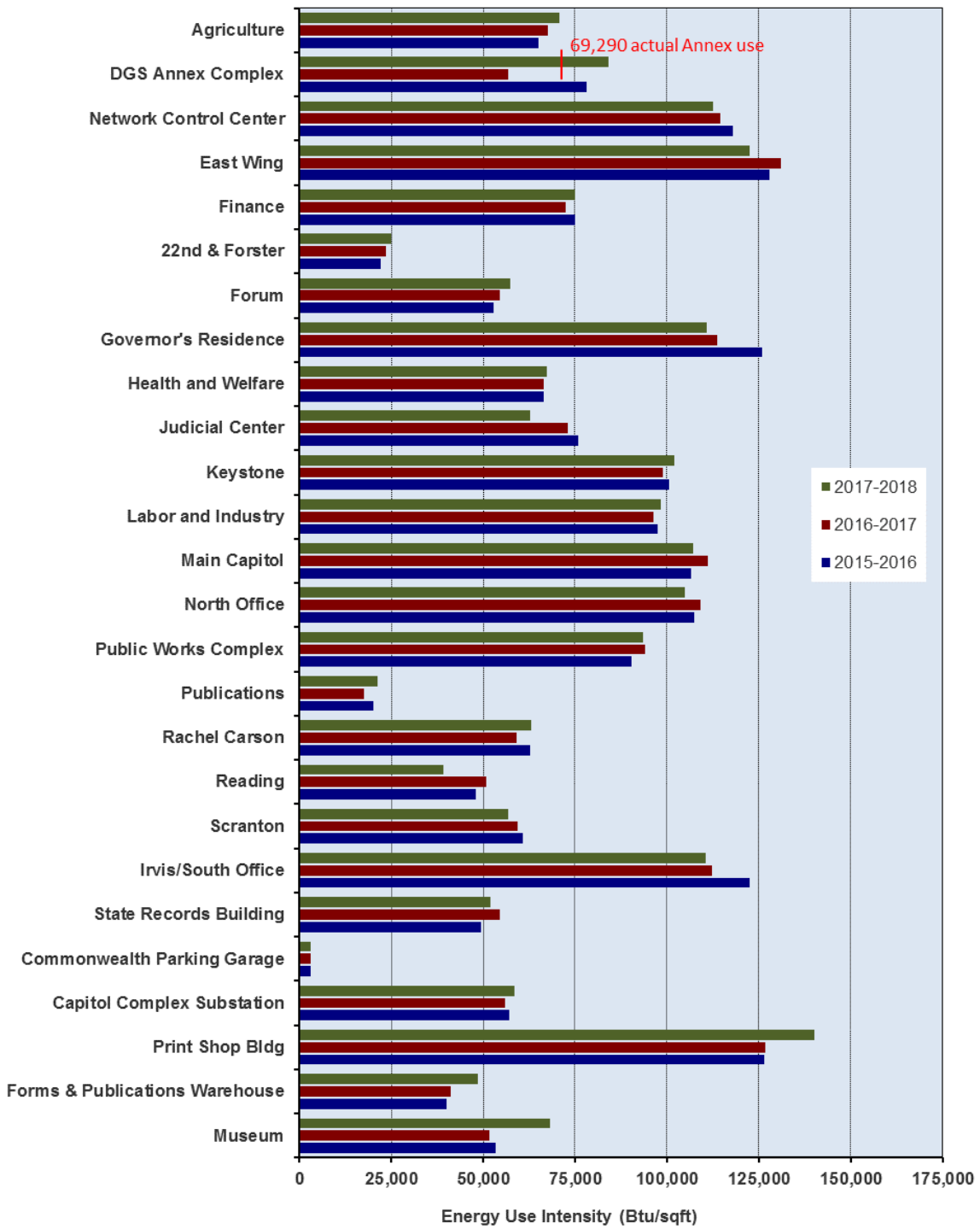
During fiscal year 2017–2018, building EUI increased by 7% to 84,313 Btu/sqft. The most significant increase in energy use occurred at the DGS Annex Complex (partly due to a natural gas billing error), the Print Shop Building, and the Museum. The Annex actual EUI is noted in red on Chart 4A on page 6.

Table 4. Annual Usage and Energy Intensity Trend

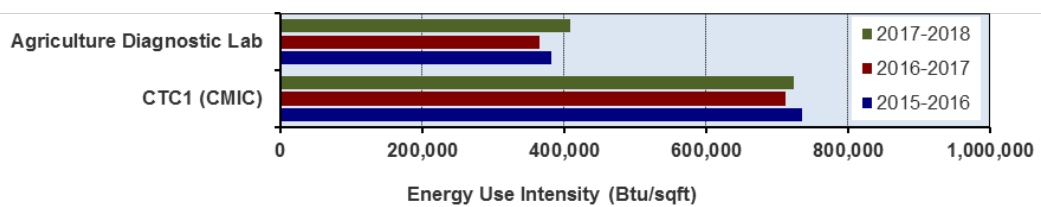
Facility	Total Space (sqft)	2015–2016		2016–2017		2017–2018	
		Btu Usage (MMBtu)	Energy Intensity (Btu/sqft)	Btu Usage (MMBtu)	Energy Intensity (Btu/sqft)	Btu Usage (MMBtu)	Energy Intensity (Btu/sqft)
Publications	81,948	1,648	20,112	1,447	17,660	1,733	21,143
22nd & Forster	388,544	8,537	21,972	9,186	23,641	9,708	24,985
Agriculture	131,391	8,553	65,099	8,900	67,738	9,305	70,818
Agriculture Diagnostic Lab	62,230	23,794	382,349	22,742	365,448	25,429	408,635
CTC1 (CMIC)	46,736	34,393	735,895	33,261	711,687	33,825	723,736
DGS Annex Complex	1,313,571	102,784	78,248	74,581	56,777	110,623	84,215
Fisher Plaza	---	565	---	552	---	554	---
Forms & Publications Warehouse	56,560	2,256	39,884	2,332	41,234	2,753	48,669
Governor's Residence	25,878	3,261	126,025	2,939	113,590	2,871	110,935
Network Control Center	15,400	1,815	117,859	1,762	114,446	1,732	112,452
Print Shop Bldg	38,688	4,893	126,462	4,909	126,884	5,421	140,134
Public Works Complex	83,670	7,570	90,470	7,876	94,127	7,824	93,513
Rachel Carson	420,125	26,353	62,726	24,877	59,212	26,542	63,175
Reading	101,626	4,869	47,907	5,166	50,829	3,980	39,161
Scranton	152,800	9,304	60,892	9,079	59,417	8,659	56,669
State Records Building	81,565	4,040	49,536	4,439	54,417	4,227	51,826
Capitol Complex Buildings¹							
Capitol Complex Substation	12,500	712	56,998	700	56,007	730	58,390
Commonwealth Parking Garage	248,188	732	2,950	778	3,136	772	3,113
East Wing	262,950	33,638	127,924	34,483	131,140	32,239	122,606
Finance	429,521	32,213	74,998	31,131	72,478	32,173	74,904
Forum	362,395	19,159	52,868	19,724	54,427	20,776	57,330
Health and Welfare	315,462	20,946	66,398	20,996	66,557	21,215	67,251
Irvis/South Office	207,138	25,389	122,570	23,257	112,279	22,878	110,446
Judicial Center	429,355	32,571	75,861	31,405	73,144	26,960	62,792
Keystone	811,147	81,629	100,634	80,104	98,754	82,782	102,056
Labor and Industry	483,161	47,040	97,358	46,526	96,294	47,532	98,376
Main Capitol	501,543	53,449	106,569	55,746	111,149	53,736	107,142
Museum	370,442	19,734	53,272	19,192	51,808	25,241	68,137
North Office	223,946	24,065	107,458	24,462	109,230	23,489	104,888
Complex Buildings Total	4,657,748	391,278		388,504		390,524	
Total	7,658,480	635,912		602,551		645,709	
Weighted Average			83,034		78,678		84,313

¹PPL serves the Capitol Complex with one main account. DGS submeters the individual buildings. Central Plant electric energy is distributed to Capitol Complex buildings served by central chilled water on a per square foot basis. The Main Capitol steam metered use and cost is distributed to the Main Capitol, East Wing, North Office, and South Office on a per square foot basis.

Chart 4A. Annual Energy Use Intensity Trend



**Chart 4B. Annual Energy Use Intensity Trend
Agriculture Diagnostic Lab and CTCI (CMIC)**



UTILITY COST PER SQUARE FOOT

Employing a utilities cost per square foot metric provides an additional benchmark to compare buildings of varying sizes and purposes. Components of the total cost include electricity, natural gas, steam, water, and sewer. Compared to the previous year, the utilities cost per square foot values varied from a 33% reduction at the Reading Office Building to a 34% increase at the Museum.

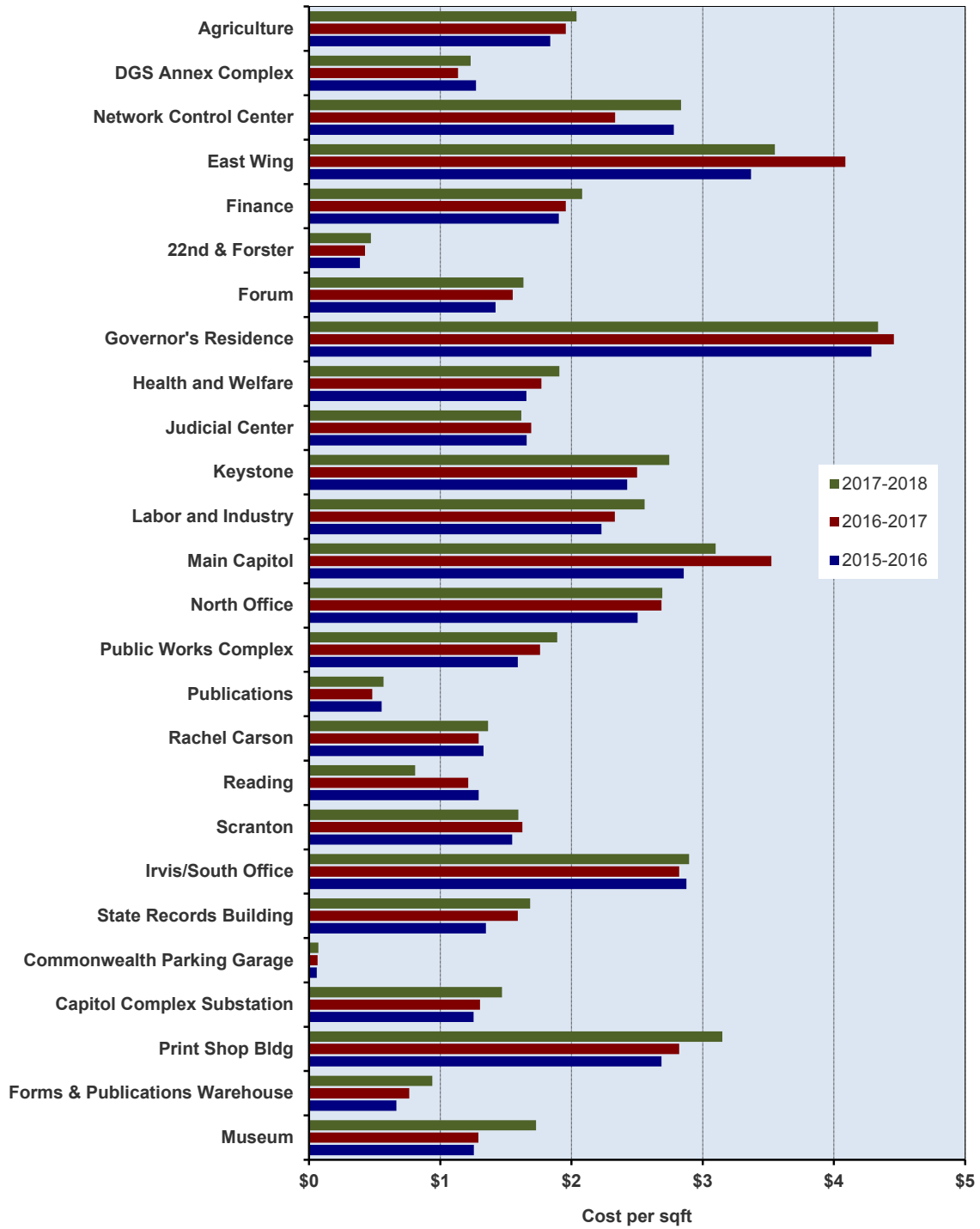
Table 5. Annual Utility Cost per Square Foot Trend

Facility	Total Space (sqft)	2015–2016		2016–2017		2017–2018	
		Cost	\$/sqft	Cost	\$/sqft	Cost	\$/sqft
Publications	81,948	\$45,269	\$0.55	\$39,553	\$0.48	\$46,464	\$0.57
22nd & Forster	388,544	\$150,679	\$0.39	\$165,933	\$0.43	\$183,438	\$0.47
Agriculture	131,391	\$241,655	\$1.84	\$257,111	\$1.96	\$267,941	\$2.04
Agriculture Diagnostic Lab	62,230	\$327,930	\$5.27	\$322,878	\$5.19	\$368,123	\$5.92
CTC-1 (CMIC)	46,736	\$689,654	\$14.76	\$725,110	\$15.52	\$740,334	\$15.84
DGS Annex Complex	1,313,571	\$1,672,604	\$1.27	\$1,492,825	\$1.14	\$1,616,883	\$1.23
Fisher Plaza	---	\$36,607	---	\$36,080	---	\$35,282	---
Forms & Publications Warehouse	56,560	\$37,648	\$0.67	\$43,182	\$0.76	\$53,109	\$0.94
Governor's Residence	25,878	\$110,888	\$4.29	\$115,357	\$4.46	\$112,225	\$4.34
Network Control Center	15,400	\$42,824	\$2.78	\$35,925	\$2.33	\$43,678	\$2.84
Print Shop Bldg	38,688	\$103,926	\$2.69	\$109,126	\$2.82	\$121,881	\$3.15
Public Works Complex	83,670	\$133,194	\$1.59	\$147,263	\$1.76	\$158,307	\$1.89
Rachel Carson	420,125	\$558,341	\$1.33	\$543,264	\$1.29	\$573,112	\$1.36
Reading	101,626	\$131,435	\$1.29	\$123,253	\$1.21	\$82,185	\$0.81
Scranton	152,800	\$236,441	\$1.55	\$248,283	\$1.62	\$243,878	\$1.60
State Records Building	81,565	\$109,919	\$1.35	\$129,720	\$1.59	\$137,496	\$1.69
Capitol Complex Buildings¹							
Capitol Complex Substation	12,500	\$15,683	\$1.25	\$16,294	\$1.30	\$18,382	\$1.47
Commonwealth Parking Garage	248,188	\$14,537	\$0.06	\$16,215	\$0.07	\$17,500	\$0.07
East Wing	262,950	\$886,499	\$3.37	\$1,074,887	\$4.09	\$933,368	\$3.55
Finance	429,521	\$818,935	\$1.91	\$840,300	\$1.96	\$894,120	\$2.08
Forum	362,395	\$514,926	\$1.42	\$562,593	\$1.55	\$592,068	\$1.63
Health and Welfare	315,462	\$523,654	\$1.66	\$558,552	\$1.77	\$601,660	\$1.91
Irvis/South Office	207,138	\$596,339	\$2.88	\$584,217	\$2.82	\$599,768	\$2.90
Judicial Center	429,355	\$713,109	\$1.66	\$727,244	\$1.69	\$694,366	\$1.62
Keystone	811,147	\$1,970,164	\$2.43	\$2,027,867	\$2.50	\$2,227,279	\$2.75
Labor and Industry	483,161	\$1,078,344	\$2.23	\$1,126,073	\$2.33	\$1,235,627	\$2.56
Main Capitol	501,543	\$1,433,846	\$2.86	\$1,767,580	\$3.52	\$1,553,811	\$3.10
Museum	370,442	\$465,490	\$1.26	\$477,903	\$1.29	\$640,772	\$1.73
North Office	223,946	\$561,674	\$2.51	\$601,531	\$2.69	\$602,968	\$2.69
Complex Buildings Total²	4,657,748	\$9,593,200		\$10,381,256		\$10,611,687	
Total	7,658,480	\$14,222,212		\$14,916,120		\$15,396,022	
Weighted Average			\$1.86		\$1.95		\$2.01

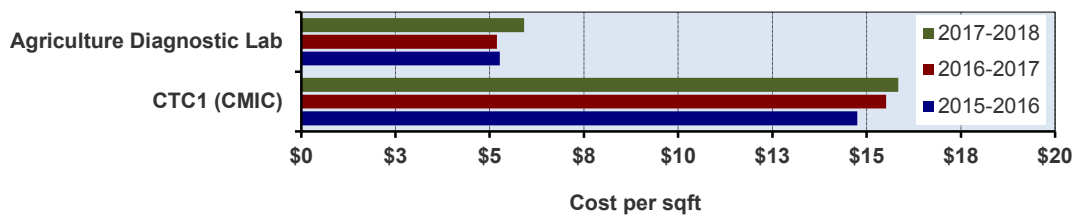
¹PPL serves the Capitol Complex with one main account. DGS submeters the individual buildings. Central Plant electric energy is distributed to the Capitol Complex buildings served by central chilled water on a per square foot basis. The Main Capitol steam metered use and cost is distributed to the Capitol, East Wing, North Office, and South Office on a per square foot basis.

²The Northwest Office Building is not included in this table because only electricity costs are known. The difference between the total current year costs shown in this table and in Table 1 represents the Northwest Office Building's annual electric cost.

Chart 5A. Annual Utility Cost per Square Foot Trend



**Chart 5B. Annual Utility Cost per Square Foot Trend
Agriculture Diagnostic Lab and CTCI (CMIC)**



DGS ENERGY AND UTILITY USAGE

Detailed energy consumption information by building for DGS facilities is presented in this section.

ELECTRICITY USAGE

During fiscal year 2017–2018, DGS facilities consumed 108,249,179 kWh of electricity at a cost of \$8,583,792, averaging a unit cost of \$0.0793 per kWh. This represented a use reduction of 5,241,231 kWh (4.6%) and a unit cost increase of 5.9% from fiscal year 2016–2017. The unit cost increase was primarily due to the price escalation provisions of the LCSWMA PPA (refer to the Intergovernmental Power Purchase and Sale Agreement section on page 34) and increased transmission charges for the PPL zone.

Table 6. Electricity Usage and Costs 2017–2018

Facility	Account	Utility	Total Space (sqft)	Annual Electricity Consumption					Annual Electricity Costs		
				kWh	kWh/sqft	Peak Demand KW	Peak Demand W/sqft	Average Monthly Load Factor	Cost	\$/kWh	\$/sqft
Publications	1326068018	PPL Utilities	81,948	94,880	1.2	49.0	0.60	0.35	\$9,158	9.652	\$0.11
22nd & Forster	6392068009	PPL Utilities	388,544	1,102,200	2.8	270.0	0.69	0.58	\$97,168	8.816	\$0.25
Agriculture	7499086008	PPL Utilities	131,391	2,674,000	20.4	857.0	6.52	0.46	\$235,606	8.811	\$1.79
Agriculture Diagnostic Lab	4559086014	PPL Utilities	62,230	2,498,400	40.1	604.0	9.71	0.64	\$205,577	8.228	\$3.30
CTC1 (CMIC)	5149982011	PPL Utilities	46,736	9,910,500	212.1	1,325.0	28.35	---	\$740,334	7.470	\$15.84
DGS Annex Complex	3690471029	PPL Utilities	---	2,411	---	1.0	---	0.41	\$505	20.929	---
DGS Annex Complex	7459086015	PPL Utilities	1,313,571	9,883,800	7.5	1,696.0	1.29	0.80	\$777,504	7.866	\$0.59
DGS Annex Complex	9949200005	PPL Utilities	---	222,458	---	---	---	---	\$79,069	35.544	---
Fisher Plaza	0540120009	PPL Utilities	---	162,296	---	---	---	---	\$35,282	21.739	---
Forms & Publications Warehouse	0442069007	PPL Utilities	56,560	213,160	3.8	86.0	1.52	0.33	\$21,800	10.227	\$0.39
Governor's Residence	7819078000	PPL Utilities	25,878	810,800	31.3	---	---	---	\$94,212	11.620	\$3.64
Network Control Center	7479086002	PPL Utilities	15,400	507,400	32.9	118.0	7.66	0.55	\$43,678	8.608	\$2.84
Print Shop Bldg	7791062048	PPL Utilities	38,688	1,474,560	38.1	312.0	8.06	0.62	\$117,890	7.995	\$3.05
Public Works Complex	6372068003	PPL Utilities	83,670	844,200	10.1	274.0	3.27	0.49	\$79,984	9.475	\$0.96
Public Works Complex	8860119006	PPL Utilities	---	0	---	---	---	---	\$362	---	---
Rachel Carson	6088070004	PPL Utilities	420,125	4,244,400	10.1	1,447.0	3.44	0.43	\$388,515	9.154	\$0.92
Reading	100013480650	MetEd	101,626	1,017,014	10.0	36.8	0.36	4.55	\$59,854	5.885	\$0.59
Scranton	7299129004	PPL Utilities	152,800	2,526,000	16.5	767.0	5.02	0.55	\$220,078	8.713	\$1.44
Scranton	7319129002	PPL Utilities	---	10,374	---	2.0	---	0.60	\$1,009	9.729	---
Scranton	8863773002	PPL Utilities	---	10,422	---	2.0	---	0.60	\$1,044	10.014	---
State Records Center	7235127006	PPL Utilities	81,565	456,900	5.6	136.0	1.67	0.46	\$44,258	9.687	\$0.54
Capitol Complex Buildings¹	4484815085	PPL Utilities									
Capitol Complex Substation	4484815085355	---	12,500	213,851	17.1	---	---	---	\$16,572	7.749	\$1.33
Central Plant	4484815085320	---	3,664,223	15,222,853	4.2	---	---	---	\$1,152,700	7.572	\$0.31
Commonwealth Parking Garage	4484815085352	---	248,188	226,338	0.9	---	---	---	\$17,500	7.732	\$0.07
East Wing	4484815085312	---	262,950	4,716,800	17.9	---	---	---	\$362,738	7.690	\$1.38
Finance	4484815085307	---	429,521	3,508,086	8.2	---	---	---	\$269,801	7.691	\$0.63
Forum	4484815085305	---	362,395	2,180,027	6.0	---	---	---	\$167,265	7.673	\$0.46
Health and Welfare	4484815085308	---	315,462	2,862,143	9.1	---	---	---	\$220,027	7.687	\$0.70
Iris/South Office	4484815085304	---	207,138	2,977,624	14.4	---	---	---	\$229,052	7.692	\$1.11
Judicial Center	4484815085000	---	429,355	3,761,608	8.8	---	---	---	\$288,498	7.670	\$0.67
Keystone	4484815085337	---	811,147	10,869,057	13.4	---	---	---	\$836,649	7.698	\$1.03
Labor and Industry	4484815085309	---	483,161	8,215,766	17.0	---	---	---	\$631,157	7.682	\$1.31
Main Capitol	4484815085301	---	501,543	6,724,136	13.4	---	---	---	\$517,366	7.694	\$1.03
Museum	4484815085311	---	370,442	2,774,303	7.5	---	---	---	\$212,789	7.670	\$0.57
North Office	4484815085303	---	223,946	2,854,547	12.7	---	---	---	\$219,269	7.681	\$0.98
Northwest Office	4484815085101	---	188,819	2,475,865	13.1	---	---	---	\$189,523	7.655	\$1.00
Complex Buildings Total			4,846,567	69,583,004	14.4	15,638	3.23	0.51	\$5,330,906	7.661	\$1.10
Total			7,847,299	108,249,179					\$8,583,792		
Weighted Average					13.8			0.76		7.930	\$1.09

¹PPL serves the Capitol Complex with one main account. DGS submeters the individual buildings.

Note that in Table 6 (page 9), the Reading Office Building’s load factor is 4.55. Load factor is equal to kWh use divided by the product of peak demand times hours of use. A load factor greater than 1 is not possible (the load factor was 2.67 for fiscal year 2016–2017 and 1.21 for 2015–2016). PSFEI recommends that DGS contact the serving utility and investigate the problem. Compared to the previous fiscal year, consumption remained similar except for notable reductions across the Capitol Complex. The DGS Annex Complex peak demand continued to decrease, 15% since the previous year likely due to the continued reduction in facility use.

Charts 6 and 7 compare electricity consumption and cost for the previous three fiscal years.

Chart 6. Annual Electricity Consumption Trend

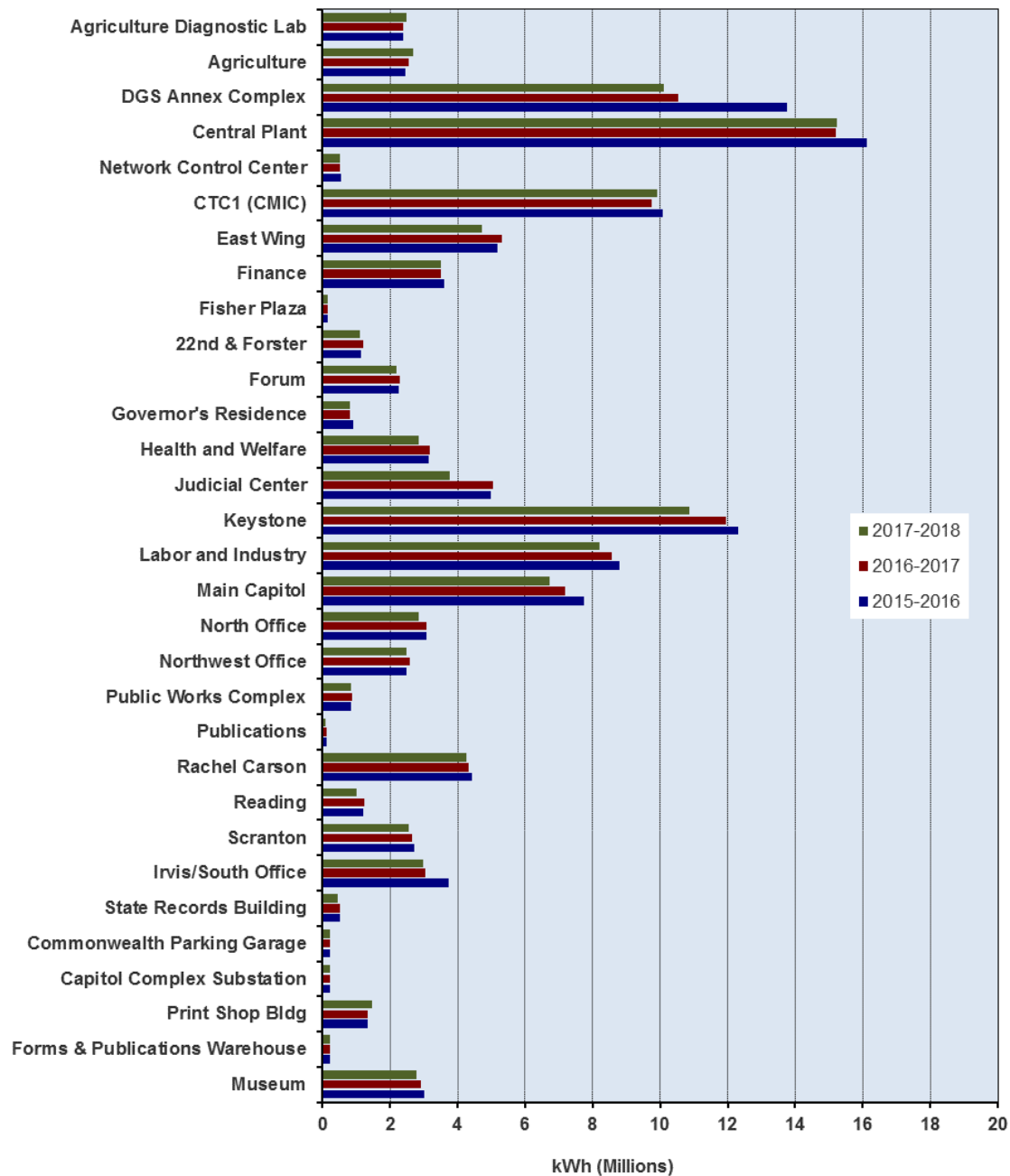
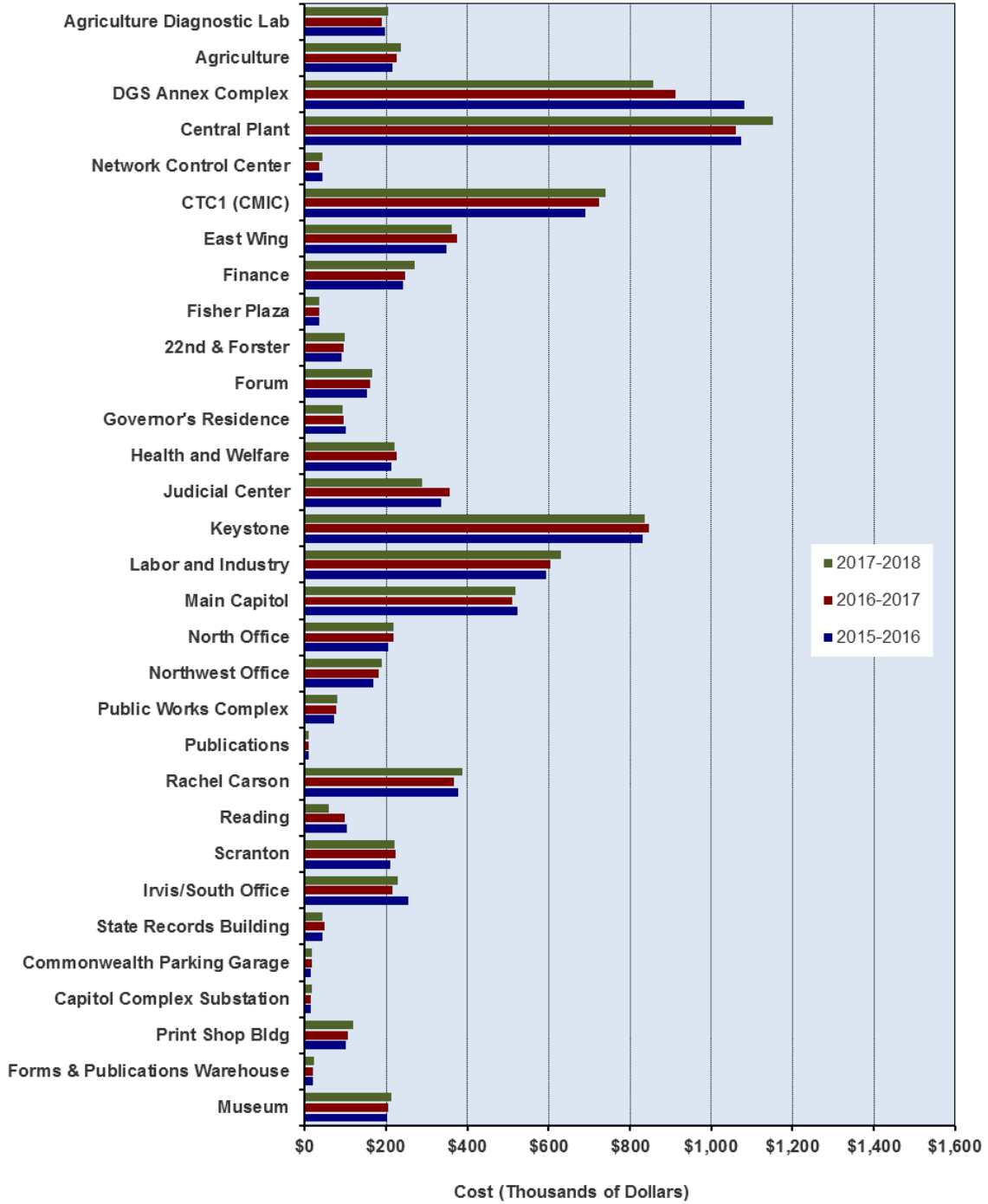


Chart 7. Annual Electricity Costs Trend



NATURAL GAS USAGE

In fiscal year 2017–2018, DGS facilities consumed 117,117 mcf of natural gas, 55.7% more than fiscal year 2016–2017, due to a more severe winter and a billing error at the DGS Annex Complex from 2016–2017. The error increased use in the current fiscal year by 19,035 mcf. The DGS Annex Complex remains the largest natural gas consumer (56%) of all DGS buildings, adjusted for actual fiscal year use. Table 7 provides a breakdown of natural gas consumption by facility.

Table 7. Natural Gas Consumption and Costs 2017–2018

Facility	Account	Utility	mcf	Cost	\$/mcf
Ag Diagnostic Lab	411005345896	UGI Utilities	7,028	\$58,724	\$8.36
	411005346258	UGI Utilities	9,382	\$75,539	\$8.05
Agriculture	411000265495	UGI Utilities	173	\$1,945	\$11.22
DGS Annex Complex	222199731207	UGI Utilities	73,905	\$369,326	\$5.00
	411001402907	UGI Utilities	2,637	\$26,868	\$10.19
22nd & Forster	411006982481	UGI Utilities	3,136	\$31,879	\$10.17
	202225616200	UGI Utilities	101	\$1,209	\$12.03
Lt. Governor's Residence	411000235126	UGI Utilities	239	\$2,594	\$10.86
Public Works Complex	411000805944	UGI Utilities	4,799	\$48,761	\$10.16
Publications	411000265065	UGI Utilities	2	\$218	\$94.74
Rachel Carson	411007714883	UGI Utilities	10,204	\$78,369	\$7.68
Reading	411003379095	UGI Utilities	494	\$4,636	\$9.39
Scranton	411006293004	UGI PNG	2	\$356	\$154.75
State Records Center	411000574060	UGI Utilities	2,590	\$26,450	\$10.21
Forms & Publications Warehouse	411000704642	UGI Utilities	1,966	\$20,062	\$10.20
Print Shop Bldg	411005973333	UGI Utilities	378	\$3,991	\$10.57
Capitol Complex Buildings					
Health and Welfare	411000264407	UGI Utilities	34	\$533	\$15.69
Labor and Industry	411000264621	UGI Utilities	47	\$669	\$14.23
Complex Buildings Total			81	\$1,202	\$14.85
Total			117,117	\$752,129	
Weighted Average					\$6.42

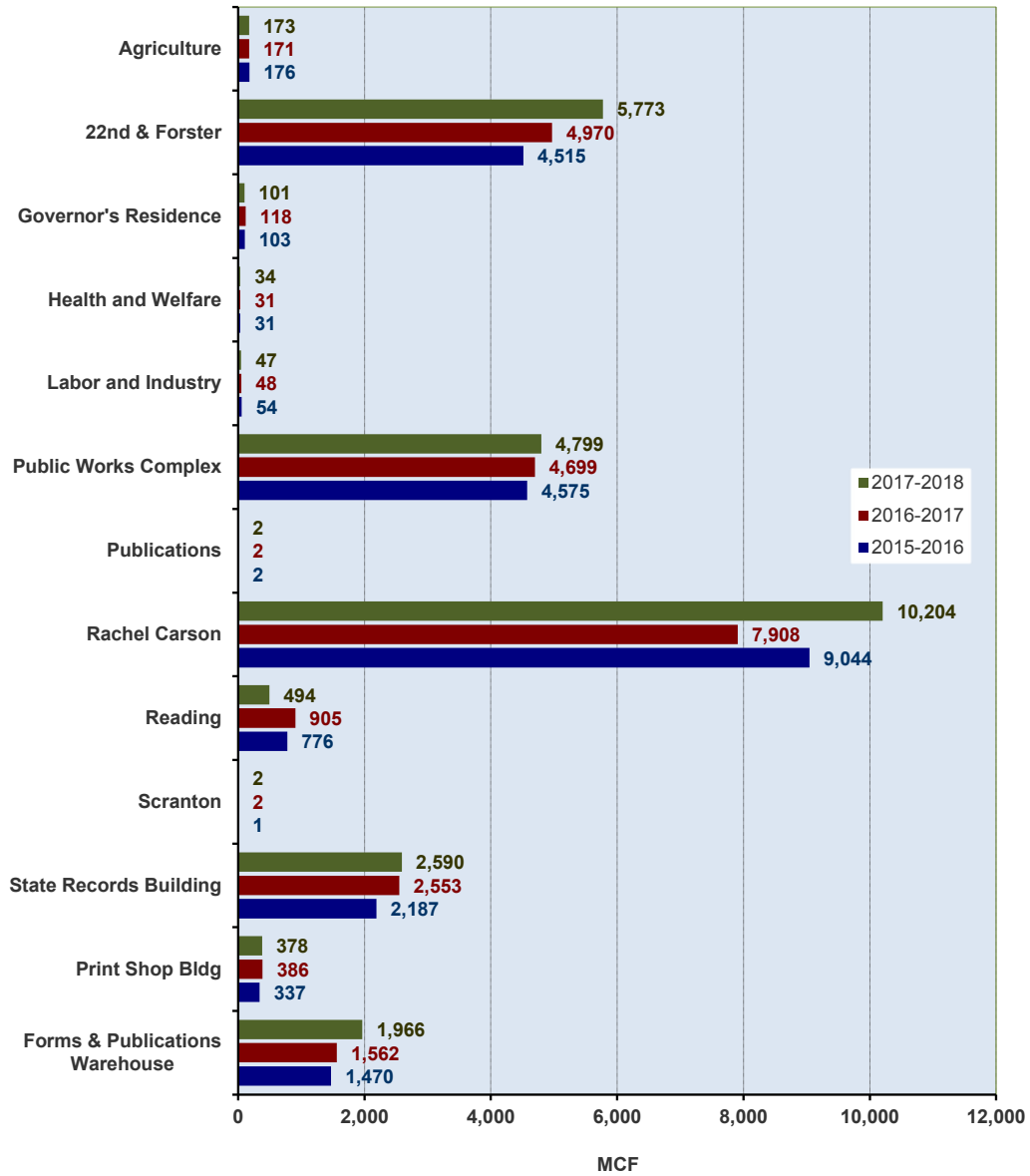
Charts 8A, 8B, 9A, and 9B (pages 13 and 14) compare the previous three fiscal years of annual natural gas consumption and cost. Following is a listing of changes observed for fiscal year 2017–2018.

- The 22nd and Forster Office Building consumption increased by 803 mcf or 16%.
- The Rachel Carson State Office Building natural gas consumption increased by 2,296 mcf or 29%; however, steam use decreased by 22%.
- The Reading Office Building consumption decreased by 411 mcf or 45%.
- The Forms and Publications Warehouse use increased by 404 mcf or 26%.
- The DGS Annex Complex actual use of 54,870 mcf noted in red on Chart 8B (page 13) for 2017–2018 was 3% less than actual use for 2016–2017. The remaining use resulted from a meter issue in the previous fiscal year.

- Use by the other facilities remained relatively the same even though the 2017–2018 winter was 22% more severe than the previous winter heating season.

Overall natural gas cost for all facilities increased by \$212,647 or 39% as a result of increased heating loads and the 2016–2017 DGS Annex billing error.

Chart 8A. Annual Natural Gas Consumption Trend



**Chart 8B. Annual Natural Gas Consumption Trend
Agriculture Diagnostic Lab and DGS Annex Complex**

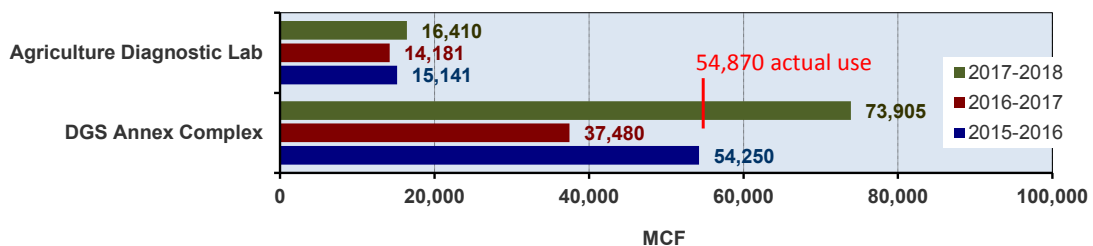
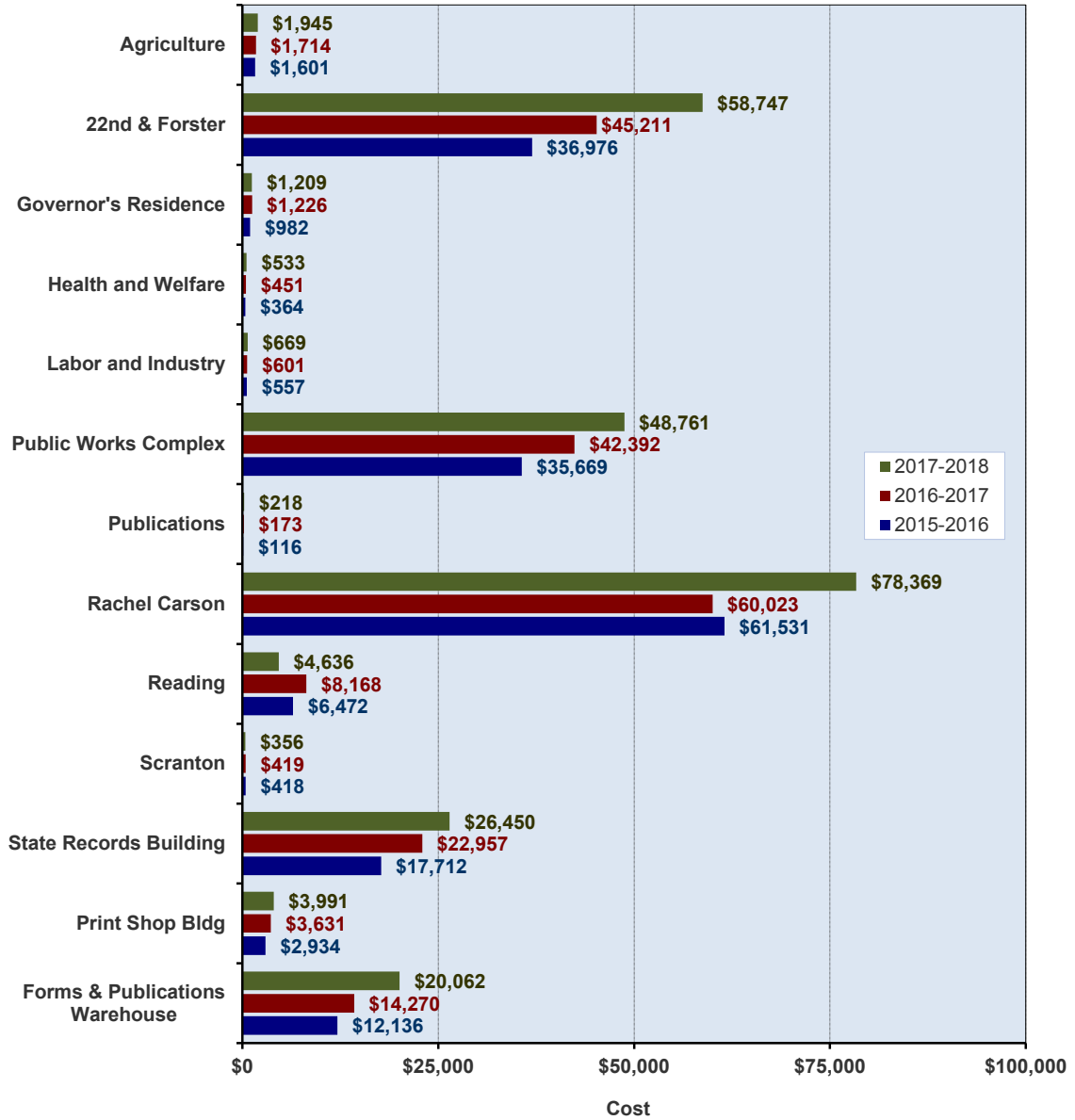
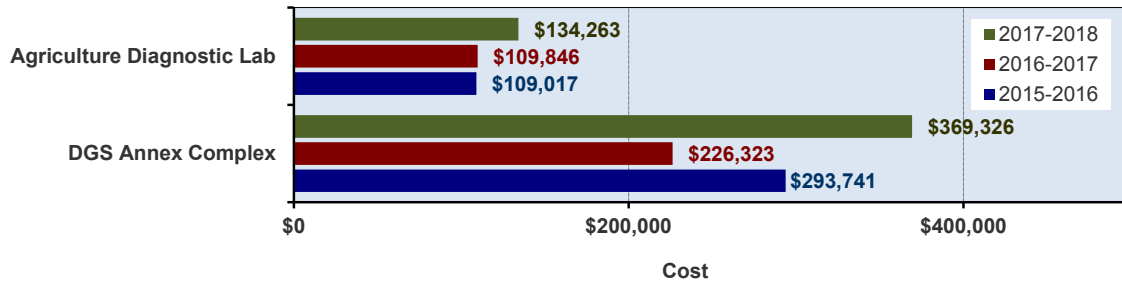


Chart 9A. Annual Natural Gas Costs Trend



**Chart 9B. Annual Natural Gas Costs Trend
Agriculture Diagnostic Lab and DGS Annex Complex**



STEAM USAGE

Table 8 shows detailed steam usage by facility. The Main Capitol remains the largest metered steam load. This account serves the Main Capitol, East Wing, North Office Building, and South Office Building. The Keystone Building is the second largest user of purchased steam. Overall steam use increased by 17,523 mlbs (12%) from the past fiscal year. Overall costs increased \$380,469 or 10.4%. The unit cost of purchased steam decreased 1.4% (from \$24.96 to \$24.62 per mlb).

Table 8. Steam Consumption and Costs 2017–2018

Facility	Account	Utility	mlbs	Cost	\$/mlb
Publications	001024	NRG	1,406	\$32,946	\$23.43
Rachel Carson	001037	NRG	1,545	\$35,758	\$23.14
Capitol Complex Buildings					
Forum	001005FORUM	NRG	13,336	\$328,765	\$24.65
Finance	001484	NRG	14,109	\$347,478	\$24.63
Health and Welfare	001014	NRG	6,939	\$171,760	\$24.75
Judicial Center	001480	NRG	8,034	\$187,920	\$23.39
Keystone	001004	NRG	34,185	\$845,821	\$24.74
Labor and Industry	001007	NRG	12,592	\$312,729	\$24.84
Main Capitol ¹	001002	NRG	56,437	\$1,393,363	\$24.69
Museum	001006	NRG	15,772	\$389,171	\$24.67
Complex Buildings Total			161,404	\$3,977,007	\$24.64
Total			164,356	\$4,045,711	
Weighted Average					\$24.62

¹Includes Main Capitol, East Wing, North Office Building, and South Office Building.

Charts 10 and 11 (pages 16 and 17) show annual steam consumption and cost for each applicable DGS facility for the past three fiscal years. The winter of fiscal year 2017–2018 was 22% more severe than the previous winter heating season. While a majority of facility steam use was similar to or slightly greater than the previous year, a significant increase occurred at the Keystone Building (22.8%) and the Museum (70%). Unless known operational issues occurred in these buildings, a follow-up investigation is warranted.

Chart 10. Annual Steam Consumption Trend

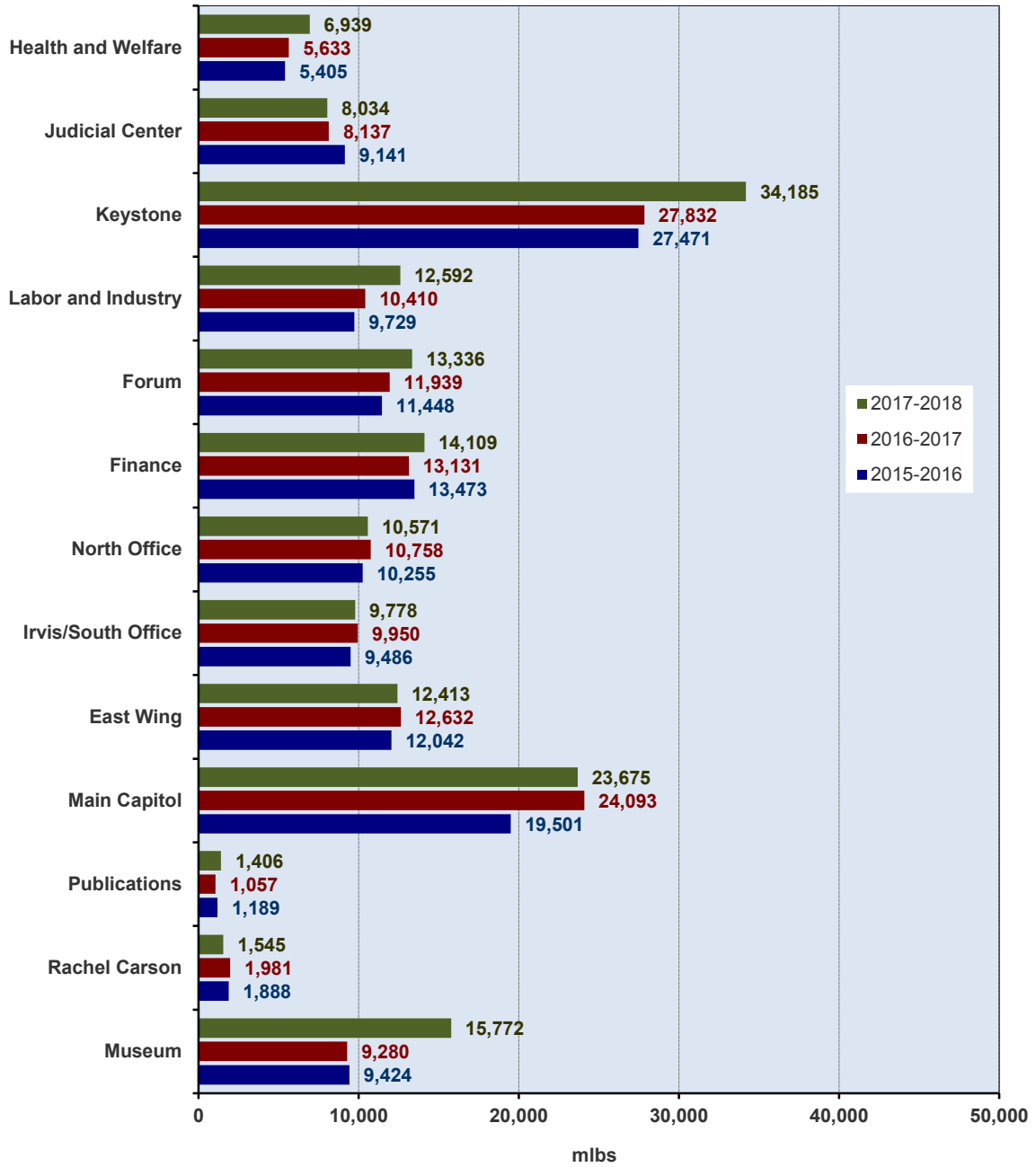
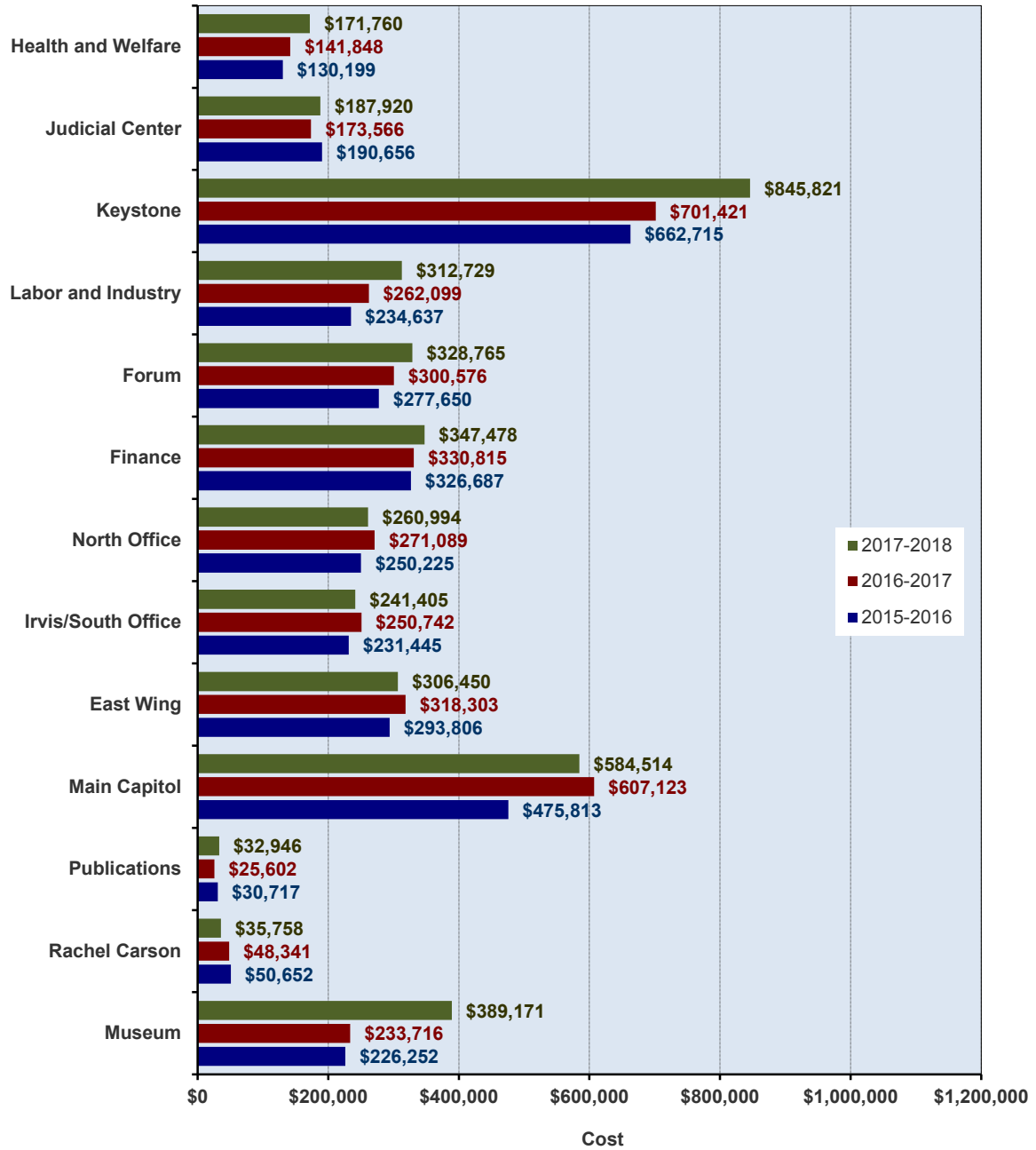


Chart 11. Annual Steam Costs Trend



WATER/SEWER USAGE

Water/sewer usage for DGS facilities during fiscal year 2017–2018 was 81,816 thousand gallons (mgal) at an average cost of \$26.98 per mgal. Compared to the previous fiscal year, consumption decreased by 29,577 mgal or 27%. Overall costs were \$2,207,550, representing a \$186,679 (7.8%) decrease from the previous year. Unit costs increased from \$21.49 to \$26.98 per mgal (26%). Five accounts serve fire suppression systems and are classified as ready-to-serve with little consumption. A 27% use reduction is the primary driver of the unit cost increase due to fixed account level charges. Except for Scranton and the Forms & Publications Warehouse, water/sewer charges were billed together based on metered water use.

Table 9. Water/Sewer Consumption and Costs 2017–2018

Facility	Account	Utility	mgal	Cost	\$/mgal
Publications	0900302100005	Capital Region Water	1	\$4,142	\$4,142.13
22nd & Forster	6204113200002	Capital Region Water	842	\$27,522	\$32.69
Agriculture	6202602200004	Capital Region Water	1,155	\$30,390	\$26.31
Agriculture Diagnostic Lab	1590031700009	Capital Region Water	524	\$28,282	\$53.97
DGS Annex Complex	1570002200006	Capital Region Water	9,855	\$236,136	\$23.96
DGS Annex Complex	1570202200004	Capital Region Water	8,496	\$154,344	\$18.17
Forms & Publications Warehouse	C0431600	Susquehanna Township Authority	491	\$3,943	\$8.03
Forms & Publications Warehouse	1601105300003	Capital Region Water	491	\$7,305	\$14.88
Governor's Residence	1100103400005	Capital Region Water	622	\$16,804	\$27.02
Public Works Complex	0708600200000	Capital Region Water	----	\$19,926	----
Public Works Complex	0709000300002	Capital Region Water	341	\$9,274	\$27.18
Rachel Carson	0900105000006	Capital Region Water	3,046	\$70,470	\$23.14
Reading	1250301	Reading Area Water Authority	593	\$17,695	\$29.84
Scranton	2405407533	Pennsylvania-American Water Company	1,031	\$22,435	\$21.77
State Records Building	1590017400003	Capital Region Water	1,082	\$16,641	\$15.38
State Records Building	6202603300001	Capital Region Water	10	\$50,147	\$5,014.66
Capitol Complex Buildings					
Capitol Complex Substation	1570050900004	Capital Region Water	22	\$1,809	\$82.25
Central Plant	1570002900002	Capital Region Water	23,046	\$387,110	\$16.80
East Wing	1570003800003	Capital Region Water	2,980	\$83,616	\$28.06
East Wing	1570003900001	Capital Region Water	2,180	\$70,064	\$32.14
Finance	0803600200008	Capital Region Water	1	\$50,217	\$50,216.50
Finance	0803610200006	Capital Region Water	2,920	\$46,128	\$15.80
Forum	0803600300006	Capital Region Water	5	\$50,134	\$10,026.85
Forum	0803610300004	Capital Region Water	2,868	\$45,905	\$16.01
Health and Welfare	1570002600008	Capital Region Water	1,525	\$44,206	\$28.99
Health and Welfare	1570002700006	Capital Region Water	795	\$32,567	\$40.96
Irvis/South Office	0404200700008	Capital Region Water	1,176	\$42,265	\$35.94
Judicial Center	1600060100000	Capital Region Water	1,105	\$37,521	\$33.96
Keystone	1570003000009	Capital Region Water	----	\$35,424	----
Keystone	1570003100007	Capital Region Water	----	\$19,926	----
Keystone	1570028800004	Capital Region Water	6,950	\$148,591	\$21.38
Labor and Industry	0710202500001	Capital Region Water	1,610	\$45,543	\$28.29
Labor and Industry	1570002400002	Capital Region Water	1,210	\$42,492	\$35.12
Main Capitol	0404200200008	Capital Region Water	2,758	\$46,064	\$16.70
Main Capitol	0803600100000	Capital Region Water	----	\$19,926	----
Main Capitol	1570002300004	Capital Region Water	5	\$50,131	\$9,676.01
Main Capitol	1570002800004	Capital Region Water	5	\$50,129	\$10,025.73
Main Capitol	1570004000008	Capital Region Water	185	\$52,994	\$286.46
Main Capitol	1570004100006	Capital Region Water	----	\$21,527	----
Main Capitol	1570102800000	Capital Region Water	25	\$397	\$15.87
Museum	0404201100009	Capital Region Water	1,770	\$38,078	\$21.51
Museum	1570102300000	Capital Region Water	47	\$735	\$15.81
North Office	0404200600000	Capital Region Water	540	\$28,597	\$52.96
Capitol Complex Buildings Total			53,728	\$1,492,095	\$27.77
Total			81,816	\$2,207,550	
Weighted Average					\$26.98

Note: No water/sewer reported for Northwest Office Building, Communications Network, or CTC1 (CMIC).

Chart 12 below and Chart 13 (page 20) trend water/sewer consumption and cost for the current and prior fiscal years for each facility. While water consumption for some facilities was similar to the previous fiscal year, significant decreased use occurred at the Main Capitol (-84%), East Wing (-67.5%), and DGS Annex Complex (-20%). For these buildings, the current year's use is more in line with their historical average. The Central Plant water use increased by 16.2%.

Chart 12. Annual Water/Sewer Consumption Trend

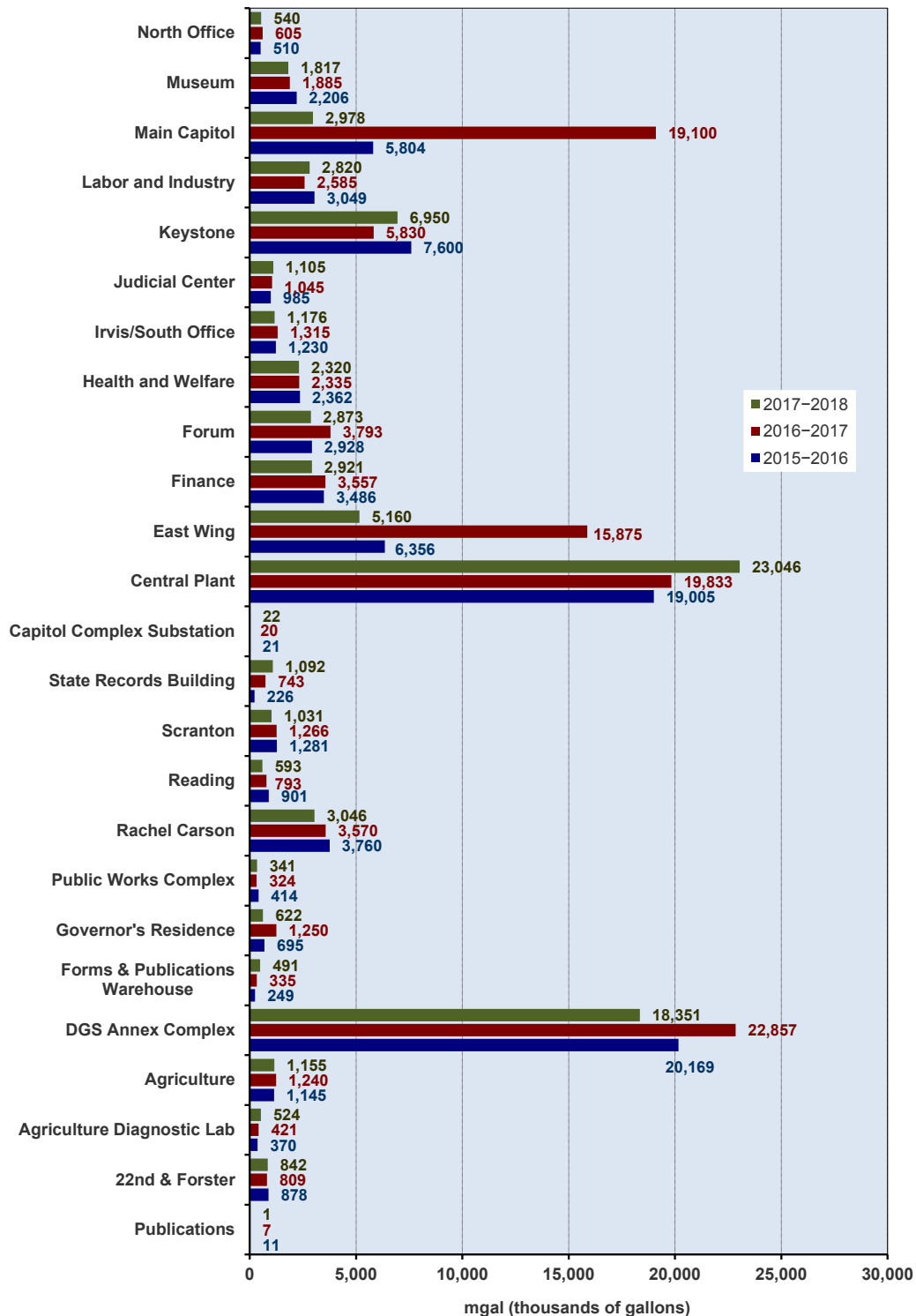


Chart 13. Annual Water/Sewer Costs Trend

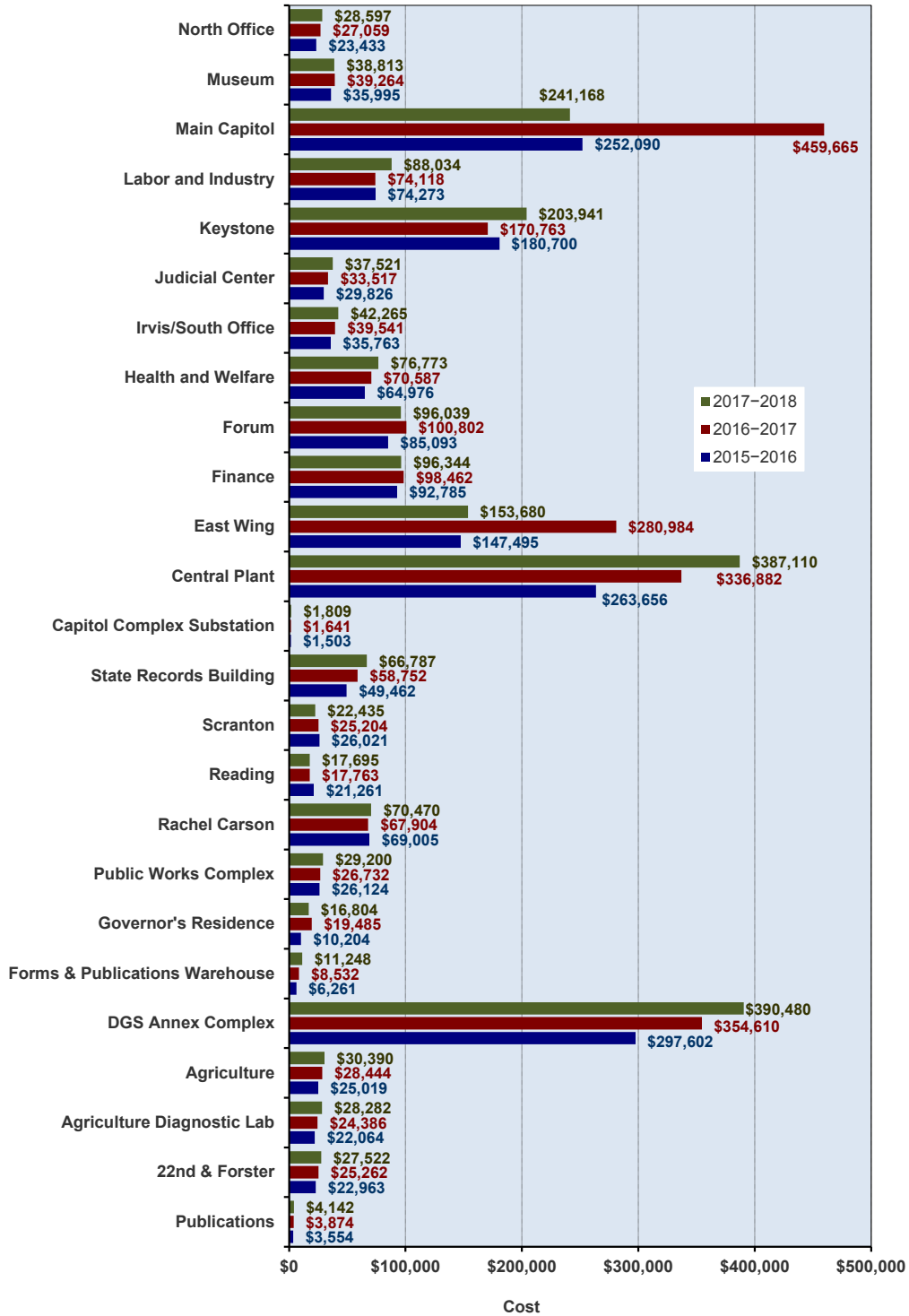


Table 10 shows a history of each facility's water/sewer use. During the 2017–2018 fiscal year, total water/sewer use decreased by 26.6%. A significant decrease in use occurred at several facilities. The average unit cost of water/sewer increased (\$21.49 to \$26.98 per mgal), resulting from the sizeable decrease in metered use and the impact “ready to serve” charges have on average unit cost. According to Capital Region Water, utility rates are increasing at approximately 3% annually.

Table 10. Annual Water/Sewer Consumption and Costs Trend

Facility	2014–2015		2015–2016		2016–2017		2017–2018	
	Cost	mgal	Cost	mgal	Cost	mgal	Cost	mgal
Publications	\$3,196	6	\$3,554	11	\$3,874	7	\$4,142	1
22nd & Forster	\$24,802	1,532	\$22,963	878	\$25,262	809	\$27,522	842
Agriculture Diagnostic Lab	\$24,492	537	\$22,064	370	\$24,386	421	\$28,282	524
Agriculture	\$28,383	1,208	\$25,019	1,145	\$28,444	1,240	\$30,390	1,155
DGS Annex Complex	\$363,074	22,469	\$297,602	20,169	\$354,610	22,857	\$390,480	18,351
Forms & Publications Warehouse	\$3,883	162	\$6,261	249	\$8,532	335	\$11,248	491
Governor's Residence	\$13,681	965	\$10,204	695	\$19,485	1,250	\$16,804	622
Public Works Complex	\$31,566	1,096	\$26,124	414	\$26,732	324	\$29,200	341
Rachel Carson	\$74,129	4,450	\$69,005	3,760	\$67,904	3,570	\$70,470	3,046
Reading	\$19,356	950	\$21,261	901	\$17,763	793	\$17,695	593
Scranton	\$22,136	1,104	\$26,021	1,281	\$25,204	1,266	\$22,435	1,031
State Records Building	\$42,728	352	\$49,462	226	\$58,752	743	\$66,787	1,092
Capitol Complex Buildings								
Capitol Complex Substation	\$2,526	111	\$1,503	21	\$1,641	20	\$1,809	22
Central Plant	\$218,960	16,745	\$263,656	19,005	\$336,882	19,833	\$387,110	23,046
East Wing	\$133,187	6,494	\$147,495	6,356	\$280,984	15,875	\$153,680	5,160
Finance	\$88,583	3,644	\$92,785	3,486	\$98,462	3,557	\$96,344	2,921
Forum	\$72,837	2,422	\$85,093	2,928	\$100,802	3,793	\$96,039	2,873
Health and Welfare	\$61,901	2,452	\$64,976	2,362	\$70,587	2,335	\$76,773	2,320
Irvis/South Office	\$32,255	1,230	\$35,763	1,230	\$39,541	1,315	\$42,265	1,176
Judicial Center	\$28,977	1,075	\$29,826	985	\$33,517	1,045	\$37,521	1,105
Keystone	\$135,245	5,060	\$180,700	7,600	\$170,763	5,830	\$203,941	6,950
Labor and Industry	\$70,431	3,181	\$74,273	3,049	\$74,118	2,585	\$88,034	2,820
Main Capitol	\$192,818	2,675	\$252,090	5,804	\$459,665	19,100	\$241,168	2,978
Museum	\$46,796	2,002	\$35,995	2,206	\$39,264	1,885	\$38,813	1,817
North Office	\$21,869	590	\$23,433	510	\$27,059	605	\$28,597	540
Complex Buildings Total	\$1,106,384	47,681	\$1,287,588	55,542	\$1,733,283	77,779	\$1,492,095	53,728
Total	\$1,757,809	82,512	\$1,867,129	85,641	\$2,394,229	111,393	\$2,207,550	81,816
Percent Change			6.2%	3.8%	28.2%	30.1%	-7.8%	-26.6%

ENERGY PROCUREMENT

PSFEI is the primary technical adviser to the Commonwealth for the procurement of electricity, natural gas, and coal. The Energy Procurement section provides information about PSFEI's activities and its partnership with the DGS Bureau of Procurement.

KEEPING PACE WITH THE ENERGY MARKETS

PSFEI keeps abreast of energy market trends through extensive relationships and attending meetings and conferences with Commonwealth utilities and nationwide energy suppliers. Similarly, PSFEI monitors regulatory developments by studying the Pennsylvania Public Utility Commission (PUC) rulings and activities. PSFEI also continually monitors the energy markets and policies of the New York Mercantile Exchange (NYMEX), PJM Interconnection, Federal Energy Regulatory Commission (FERC), and other energy organizations.

Trends and developments that affected Commonwealth budgets and energy planning were reported to the DGS Bureau of Procurement at regularly scheduled meetings to establish energy and procurement policies and direction. Combined with supplier contracts, these trends were considered when preparing and submitting utility budget projections to the DGS Bureau of Financial and Management Services.

The DGS Bureau of Procurement and PSFEI used the following energy price risk-management strategies to extend flexibility and ensure maximum cost avoidance in volatile energy markets:

- Applied swing clauses in natural gas and electricity supply contracts to offer price protection and mitigate the risk of market exposure due to variations in expected monthly nominations. The swing clause can protect against market volatility and reduce cost by requiring suppliers to apply the contract price to a specified percentage (typically 10%) above or below the monthly nominations.
- Examined electricity and natural gas bills for rate, energy consumption, demand charges, taxes, and potential tariff savings.
- Remained abreast of energy trends and developments on behalf of Commonwealth facilities. This information and knowledge help PSFEI advise the Commonwealth with regards to legislative actions, utility rate increases or decreases, market movements, and emerging procurement methods.
- Held one-day seminars and face-to-face meetings with Commonwealth facilities personnel on Marcellus Shale gas industry developments and utility and environmental issues.
- Selectively used a Block & Index (B&I) electricity commodity procurement product for soliciting large electricity accounts resulting in one account contract using a B&I product.

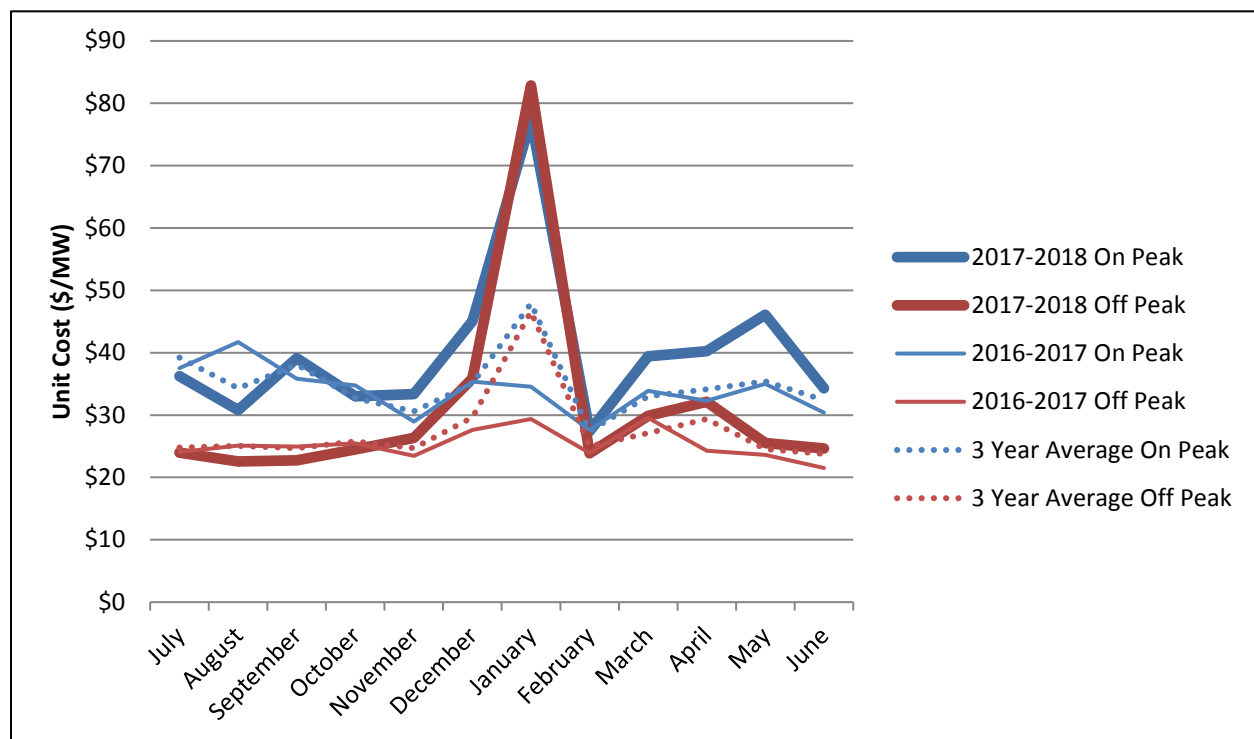
ELECTRICITY

ELECTRICITY MARKET

Throughout fiscal year 2017–2018, the energy markets continued to exhibit a strong correlation between natural gas and regional electricity pricing. With a slowly shifting regional electricity generation fleet that sees legacy generation fuels, such as coal, undercut by newer natural gas generators, the electricity markets are increasingly reliant on natural gas as a baseload fuel. While strong local gas production within the footprint of the Commonwealth assures that fuel is readily available, high-demand periods show that electricity pricing can still be extremely volatile.

To gain a more granular view of electricity market changes, PSFEI analyzed the PJM Western Hub Real Time Locational Marginal Price (LMP) hourly energy market data to compare and contrast fiscal years 2017–2018 and 2016–2017 with a three-year average. The average monthly on-peak and off-peak prices are shown in Chart 14.

Chart 14. PJM Western Hub Real-Time LMP Prices by Month



In fiscal year 2017–2018, the hourly LMP market shifted back toward a winter-peaking pricing pattern. This contrasts with the summer-peaking pattern seen in fiscal year 2016–2017 and is reminiscent of the winter-peaking pattern observed in fiscal year 2014–2015. In January 2018, an extended period of extreme cold temperatures across the region stressed natural gas pipeline capacity, forcing generators to switch to backup fuels while more expensive peaking generation plants were called on to meet the increased electricity demand. Accordingly, January 2018 represented the highest average on-peak LMP

price of \$77.43 per megawatt (MW); however, the highest average LMP price overall was observed in the January 2018 off-peak period at \$82.86 per MW.

Over the course of the fiscal year, on-peak pricing was approximately 19% higher while off-peak pricing was approximately 26% higher, leading to an around-the-clock average of a 21% increase in hourly LMP pricing for fiscal year 2017–2018 in comparison to 2016–2017. In addition to higher pricing, volatility in the hourly LMP market increased a staggering 155% on a year-over-year basis and was 109% higher than the three-year average.

By all accounts, the hourly LMP market was much more active than the last fiscal year. Elevations in overall pricing and volatility allude to an hourly market that is attempting to balance a shifting generation fleet and reliability with slowing load growth.

The cost of generation capacity, set by PJM’s Reliability Pricing Model and effective on a June through May cycle, increased in the western portion of the Commonwealth and decreased slightly in the eastern portion of the Commonwealth during 2017–2018, as compared to fiscal year 2016–2017. In general, capacity prices across the entire Commonwealth ranged tightly between \$170 and \$177 per MW-day. Capacity charges represent approximately 15–20% of total electric bill charges for larger Commonwealth facilities. It is important to note the capacity prices quoted in Chart 14 include final zonal scaling factors and forecast pool requirements.

Significant increases in 2017–2018 capacity pricing in West Penn Power, Penn Power, and Duquesne were experienced in comparison to fiscal year 2016–2017 with 48%, 15%, and 52% cost increases, respectively. MetEd, PECO, Penelec, and PPL experienced decreases of 8%, 7%, 3%, and 7%, respectively. Looking ahead, in general, capacity costs will rise in 2018–2019 before sharply decreasing in 2019–2020. The sharp decrease in pricing in 2019–2020 will be followed by another moderate decrease in 2020–2021 across all zones except PECO. In 2021–2022, capacity prices will bounce back to 2017–2018 levels.

Transmission rates in fiscal year 2017–2018 increased in the PPL, MetEd, Penelec, and Penn Power territories. PPL’s transmission rate experienced an approximate increase of 40%, MetEd and Penelec increased by 50%, and Penn Power increased by approximately 13%. PECO and Duquesne experienced slight decreases while transmission rates in West Penn Power remained the same. Transmission charges account for approximately 15% of the total cost of electricity for larger Commonwealth facilities.

All transmission territories in the Commonwealth, except for West Penn Power, now utilize a formula rate structure for recovering transmission costs. Consequently, transmission rates for these territories will be updated on an annual basis. Aging infrastructure, introduction of more renewable generation resources, and the ever-growing threat of cyber and terrorist attacks will require significant investment in the electrical grid. It is expected transmission rates will continue to rise to cover costs associated with replacement of aging assets and fortification of transmission lines and equipment.

During the fiscal year, several developments occurred at the regulatory level with regards to electric distribution. UGI Electric, Duquesne Light, and PECO requested rate increases before the PUC. The impact on customer distribution rates will vary by rate class and individual account usage characteristics. In addition to these base rate case proceedings, two other significant regulatory developments occurred.

On April 19, 2018, the PUC implemented Act 40 that requires solar projects under the Alternative Energy Portfolio Standard (AEPS) to be built in Pennsylvania. Previously, the Commonwealth allowed solar from anywhere within PJM to be used for compliance with the AEPS. The consensus is that Act 40 will increase the price of Solar Alternative Energy Credits; however, the impact may not be felt for a few years.

On June 28, 2018, House Bill (HB) 1782¹ was signed into law. HB 1782 allows utilities to propose new ratemaking approaches, including decoupling, performance-based rates, formula rates, and multiyear rates. The bill is designed to allow utilities to encourage energy efficiency and conservation as well as distributed and renewable generation projects. HB 1782 only impacts the distribution portion of the electricity bill and will not impact the generation portion. Any alternative rate structures proposed by utilities will still require PUC review and approval.

TAKING ADVANTAGE OF CURRENT ENERGY MARKETS

During fiscal year 2017–2018, PSFEI and the DGS Bureau of Procurement continued to engage a balanced strategy to maximize overall savings potential while providing budget certainty through stable, long-term energy pricing.

Throughout the year, the electricity futures market continued to exhibit a backwardated² pattern, where the market prices for each successive year in the future are progressively lower than the year before it. In order to take advantage of this market condition, 36- and 48-month contract terms were solicited by the Commonwealth in addition to 12- and 24-month terms. In a backwardated market, the lower-priced future years have a positive effect for the consumer by lowering the overall average price.

ELECTRICITY PROCUREMENT

Under the direction of the DGS Bureau of Procurement, PSFEI held five procurement events during fiscal year 2017–2018 and awarded 1,351 Commonwealth, Pennsylvania’s State System of Higher Education (PASSHE), and COSTARS members’ electricity accounts using the Energy Risk Management Application (ERMA), PSFEI’s web-based procurement platform. The net result was approximately \$3.7 million in projected annual avoided costs versus utility-issued price to compare (where available) and previous year contracts. Individual agency cost reductions are in Table 11 on page 27.

The Commonwealth and its energy partners benefited from the contracts awarded during the 2017–2018 fiscal year, as well as the multi-year contracts awarded in fiscal year 2016–2017. Residual avoided costs from these 2016–2017 multi-year contracts are projected to be approximately \$3.2 million.

¹ An Act amending Title 66 (Public Utilities) of the Pennsylvania Consolidated Statutes, in rates and distribution systems, providing for alternative ratemaking for utilities.

² When a near-month futures contract is trading at a premium to more distant contracts, that commodity’s futures curve is in “backwardation” or the commodity is “backwardated.” This occurs when inventories of commodities are tight, so market participants are willing to pay a premium to buy the immediate deliverable commodity. Theoretically, there is no value to carrying costs such as storage, insurance and interest costs since there is a scarcity of the commodities.

Fixed-price and B&I bids were solicited for accounts demonstrating billing demands greater than 1,000 kilowatts (KW), where applicable. While only one B&I contract was awarded, the result of this dual product solicitation provided DGS Bureau of Procurement personnel with an opportunity to diversify their procurement portfolio to achieve maximum avoided cost savings while still adhering to internal risk-management strategies.

The remaining Commonwealth, PASSHE, and COSTARS commercial accounts were aggregated by a major rate class to provide the most attractive load profile for suppliers. This resulted in price realignment across each major rate class. A similar strategy of aggregation was adopted for residential-classed accounts belonging to the Commonwealth, PASSHE, and COSTARS facilities.

Table 11 summarizes electricity procurement avoided costs by agency.

Table 11. Avoided Costs for Electricity Procurement 2017–2018

Agency	Number of Accounts	Cost Reduction (Annual)	Cost Avoidance (Annual)	Cost Avoidance (Total) ¹
COSTARS (including Penn State Hershey Medical Center)	824	\$630,308	\$698,585	\$2,633,662
Department of Agriculture ²	2	\$51,514	(\$36,362)	(\$72,725)
Department of Conservation & Natural Resources	69	\$23,524	\$30,351	\$68,042
Department of Corrections	35	\$964,507	\$1,125,265	\$2,256,994
Department of Environmental Protection ²	5	\$10,574	(\$1,394)	(\$2,265)
Department of Human Services	25	\$434,460	\$926,215	\$1,809,489
Department of Labor and Industry	1	\$54,429	\$231,954	\$463,909
Department of Military & Veterans Affairs	32	\$254,707	\$590,545	\$1,027,264
Other Agencies ³	15	\$43,383	\$181	\$11,562
Pennsylvania Department of Transportation	221	\$180,285	\$64,123	\$186,305
Pennsylvania Fish & Boat Commission ²	6	\$22,992	(\$2,683)	(\$5,366)
Pennsylvania Game Commission ²	16	\$7,287	(\$5,641)	(\$10,649)
Pennsylvania Historical and Museum Commission ²	19	\$10,218	(\$8,457)	(\$9,214)
Pennsylvania Liquor Control Board	34	\$22,402	\$29,990	\$81,792
Pennsylvania State Police	14	\$61,792	\$4,779	\$7,565
Pennsylvania State System of Higher Education	18	\$1,699	\$7,366	\$26,628
Pennsylvania Turnpike Commission	15	\$50,593	\$89,743	\$166,958
Total	1351	\$2,824,676	\$3,744,562	\$8,639,948

¹Some contracts awarded were less than or greater than one year.

²To eliminate price risk from hourly default pricing, fixed-price contracts were awarded resulting in a projected negative contract avoided cost versus the retail tariff hourly pricing.

³Other Agencies include Revenue, Senate, Health, and various other small accounts.

NATURAL GAS MARKET

The natural gas market continues to be very dynamic, with many factors affecting supply, demand, and pricing. Over the last ten years, natural gas monthly settlement prices trended generally downward at a rate of approximately 16% per year (refer to Chart 15). With U.S. natural gas production at an all-time high of approximately 93 billion cubic feet (BCF) per day over the past three fiscal years, the rate of price decrease began to level out as global demand began to catch up to production. According to Bloomberg New Energy Finance, at current conditions, demand could catch up to production within two years. However, new global production set to come on line in the coming years will put more gas back into the markets, keeping prices relatively stable.

Chart 15. NYMEX Natural Gas Monthly Settlement Price Trend

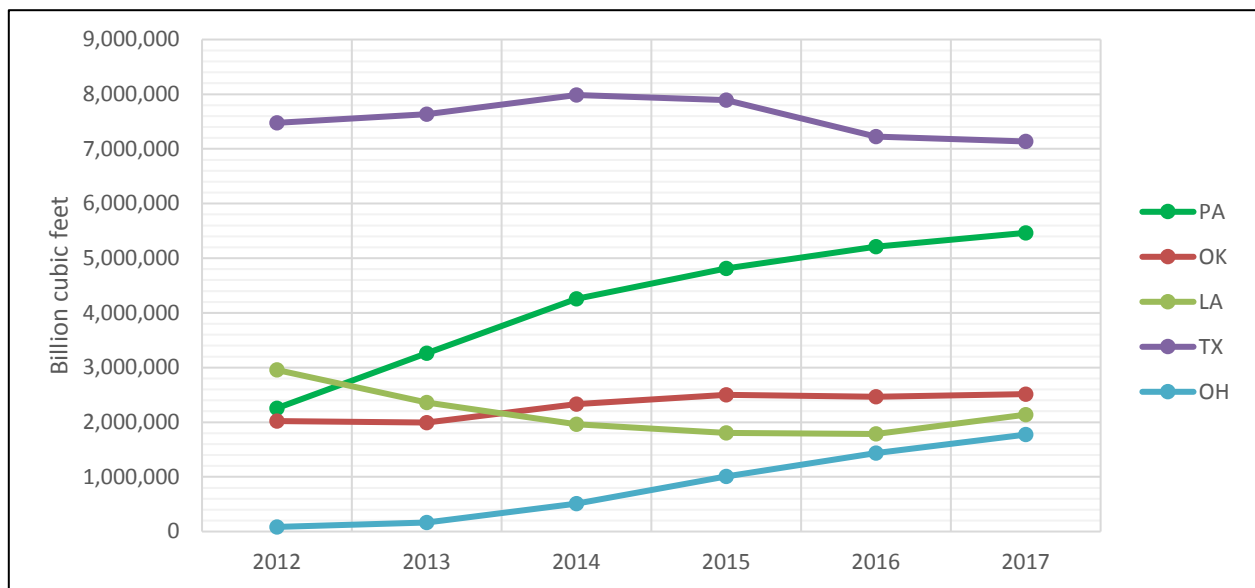


As of June 2018, natural gas storage inventory was 2,152 BCF, a decrease of 717 BCF (25%) from a year ago and 493 BCF (19%) below the five-year average of gas in storage. Lower volumes of gas in storage typically result in higher natural gas prices. Likewise, increased demand from gas-fired power generation and increased liquefied natural gas (LNG) exports would normally lead to rising natural gas prices. However, the average monthly NYMEX natural gas settlement price decreased 4.6% from \$3.07 per MMBtu in fiscal year 2016–2017 to \$2.93 per MMBtu in fiscal year 2017–2018. Even during occasional cold snaps during the 2017–2018 winter months, market price reaction has been minimal and short-term. The consensus in the marketplace is that the reason for low prices is due to the expectation that production will keep up with or outpace demand, keeping prices less reactive and more stable.

Pennsylvania’s contribution to U.S. natural gas production is significant, second only to Texas and far outpacing the next three largest producing states as shown Chart 16. As in the past several years, Pennsylvania and the mid-Atlantic region continued to experience discounted gas prices in reaction to weak demand in the local marketplace coupled with pipeline capacity limitations. However, this is changing. According to the U.S. Energy Information Administration, over 23 BCF per day of takeaway capacity from Pennsylvania will be online by the end of 2018, an increase of 38% over 2017. Local natural gas prices could potentially rise as the mid-Atlantic region market becomes coordinated with higher-priced national and global markets.

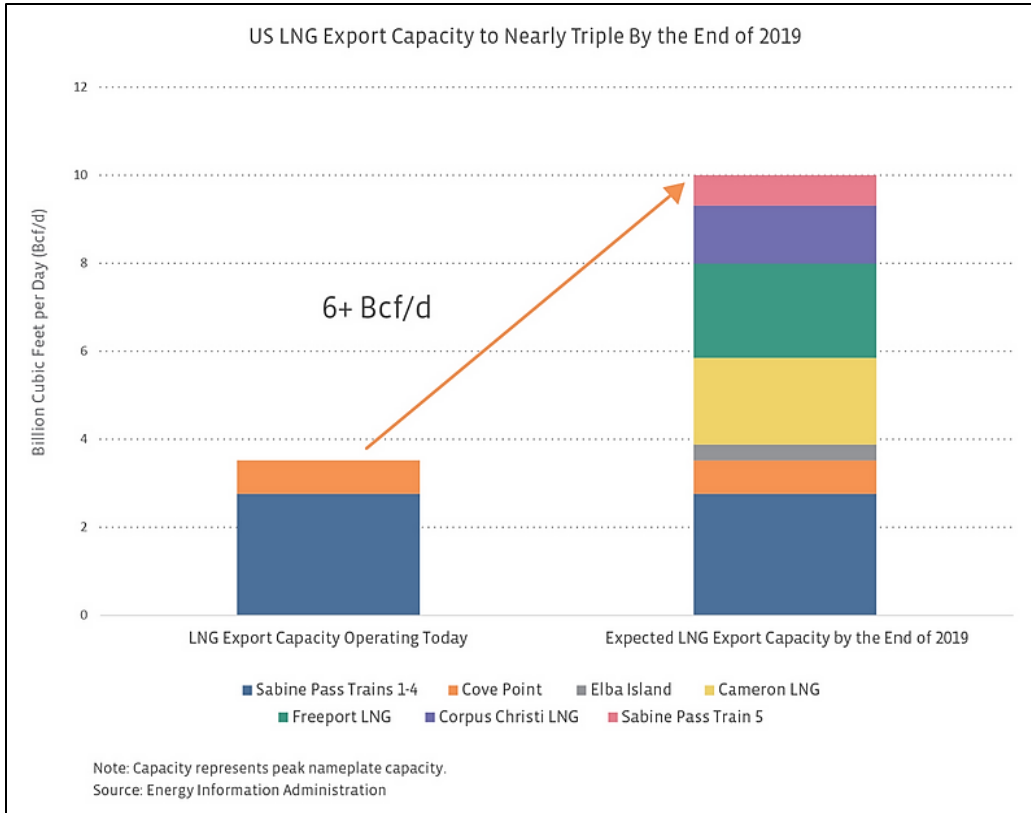
The U.S. exported more natural gas than it imported beginning in early 2017. LNG is accounting for a large and growing portion of gas exports. Many new LNG export terminals are under construction or in planning. In 2017, U.S. LNG exports were approximately 2 BCF per day. By the end of 2019, LNG exports could increase to 10 BCF per day with five additional LNG export terminals coming online as shown Chart 17 on page 30. The impact on northeast regional pricing due to LNG exports remains to be seen. Currently, all eastern U.S. terminals, except for Cove Point in Maryland, are located in the Gulf of Mexico or southeast U.S. With takeaway capacity expected to increase, the effect of increased LNG exports on Pennsylvania natural gas pricing may be delayed or minimal.

Chart 16. Annual Natural Gas Production



Source: U.S. Energy Information Administration

Chart 17. U.S. LNG Export Capacity



As in past years, the major factors affecting natural gas price are gas in storage, demand, supply, and weather, with the latter being the most unpredictable. Given the recent trend of warmer than normal winters coupled with the ability of supply to exceed demand and the decreasing relevance of storage volumes on price, natural gas will likely continue to be a cost-efficient fuel for Commonwealth facilities for the next several years.

NATURAL GAS PROCUREMENT

Four natural gas commodity procurement events were held during the fiscal year for Commonwealth and the Commonwealth’s COSTARS partners’ natural gas accounts. PSFEI collected billing data, developed and confirmed monthly nomination quantities with facility managers, analyzed tariff issues, and conducted competitive bidding events with prequalified suppliers for each of the accounts. Thirty-five contracts were awarded resulting in a projected annual avoided cost of \$3,618,807 as compared to utility retail tariff rates. Projected avoided costs by agency are shown in Table 12 on page 31.

Both fixed-price and index price (basis price plus variable NYMEX natural gas commodity price) supply contracts were solicited, allowing the DGS Bureau of Procurement to manage price risk and maximize cost-avoidance opportunities.

In addition to the thirty-five contracts awarded during the 2017–2018 fiscal year, the Commonwealth and its energy partners continued to benefit from nineteen multi-year contracts awarded in fiscal year 2016–2017. Due to the market-driven component of the vast majority of these multi-year contracts,

avoided costs varied depending on NYMEX market conditions and the price risk management strategies employed.

PSFEI contributed to the success of the natural gas procurement program by managing and compiling historical usage and cost data for each account. The data was formatted for integration into a Request for Quotation (RFQ) package, along with gas utility tariff and price-to-compare calculations for fiscal year 2017–2018. The RFQ and associated usage data was sent electronically to all pre-qualified natural gas suppliers. Table 12 details the results of the natural gas procurement events. Other accounts in the DGS procurement portfolio that are not identified in Table 12 were shopped in prior years with contracts awarded for multiple years.

Table 12. Avoided Costs for Natural Gas Procurement 2017–2018

Agency	Number of Accounts	Cost Avoidance (Annual)	Cost Avoidance (Total)¹
COSTARS (including Milton Hershey Medical Center)	3	\$369,283	\$861,660
Department of Conservation and Natural Resources	1	\$6,531	\$19,594
Department of Corrections	12	\$2,318,009	\$5,084,035
Department of General Services	3	\$81,113	\$146,955
Department of Human Services	7	\$693,065	\$1,457,436
Department of Military & Veterans Affairs	1	\$13,544	\$40,633
Department of Transportation	1	\$92,297	\$276,892
Pennsylvania Emergency Management Agency	1	\$15,946	\$46,510
Pennsylvania Turnpike Commission	6	\$29,017	\$89,470
Totals	35	\$3,618,807	\$8,023,185

¹Accounts for multi-year contracts.

RENEWABLE ENERGY CREDITS

RENEWABLE ENERGY CREDIT PROCUREMENT

The Commonwealth continues to offset approximately 30% of its electricity load, through 2018, via the purchase of Green-e certified Renewable Energy Certificates (RECs). A collaborative purchase that included Commonwealth agencies, West Chester University, and the Pennsylvania Turnpike Commission totaled 243,733 Megawatt-hours (MWh) of Green-e certified RECs. The purchased RECs for the Commonwealth’s consumption were derived from wind energy representing 231,735 MWh of certified, carbon-free generation. This purchase was made possible by the over \$2 million in Commonwealth-wide annual savings through calendar year 2019 achieved in the form of price reductions versus the electricity contracts that expired at the end of 2015. The total annual cost of the REC purchases for the Commonwealth was less than 6% of the annual savings realized from the decreased electricity rates.

The total annual quantity of RECs was distributed to each agency by weighting that agency’s electricity usage in proportion to the Commonwealth’s overall usage. Information by agency is shown in Table 13 on page 32.

Table 13. REC Apportionment by Agency

Agency	CY 2016 Total		CY 2017 Total		CY 2018 Total		Total	
	MWh Credits	Annual Cost	MWh Credits	Annual Cost	MWh Credits	Annual Cost	MWh Credits	3-Year Cost
Department of Agriculture	2,396	\$1,197	2,396	\$1,197	2,396	\$1,243	7,188	\$3,638
Department of Conservation & Natural Resources	6,562	\$3,279	6,562	\$3,279	6,562	\$3,406	19,686	\$9,963
Department of Corrections	74,473	\$37,212	74,473	\$37,212	74,473	\$38,651	223,419	\$113,075
Department of Education	119	\$59	119	\$59	119	\$62	357	\$181
Department of Environmental Protection	2,062	\$1,030	2,062	\$1,030	2,062	\$1,070	6,186	\$3,131
Department of General Services	37,136	\$18,556	37,136	\$18,556	37,136	\$19,273	111,408	\$56,385
Department of Health	685	\$342	685	\$342	685	\$355	2,055	\$1,040
Department of Human Services	20,787	\$10,387	20,787	\$10,387	20,787	\$10,788	62,361	\$31,562
Department of Labor & Industry	1,502	\$751	1,502	\$751	1,502	\$780	4,506	\$2,281
Department of Military & Veterans Affairs	29,026	\$14,503	29,026	\$14,503	29,026	\$15,065	87,078	\$44,071
Department of Revenue	1,326	\$663	1,326	\$663	1,326	\$688	3,978	\$2,013
Department of Transportation	27,035	\$13,508	27,035	\$13,508	27,035	\$14,031	81,105	\$41,048
PA Emergency Management Agency	765	\$382	765	\$382	766	\$397	2,296	\$1,162
PA Fish & Boat Commission	2,647	\$1,323	2,647	\$1,323	2,647	\$1,374	7,941	\$4,019
PA Game Commission	957	\$478	957	\$478	956	\$496	2,870	\$1,453
PA Historical and Museum Commission	2,264	\$1,131	2,264	\$1,131	2,264	\$1,175	6,792	\$3,438
PA Liquor Control Board	11,979	\$5,986	11,979	\$5,986	11,978	\$6,217	35,936	\$18,188
PA State Police	10,014	\$5,004	10,014	\$5,004	10,014	\$5,197	30,042	\$15,205
Commonwealth Total	231,735	\$115,790	231,735	\$115,790	231,733	\$120,270	695,203	\$351,850

To qualify as a Green-e certified resource, providers must meet criteria set forth by the Center for Resource Solutions in the Green-e National Standard document.

The Commonwealth's total annual purchase of 231,735 MWh of Green-e certified RECs places Pennsylvania in the number one position for state governments on the U.S. Environmental Protection Agency's (EPA's) Green Power Partnership National Top 100 list.

According to the EPA's Greenhouse Gas Equivalencies Calculator, the Commonwealth's purchase led to an annual offset of approximately 160,000 metric tons of carbon dioxide or the electricity use of roughly 22,000 average American homes for one year. The annual carbon sequestered by this purchase is approximately equivalent to 131,000 acres of U.S. forestland, i.e., a parcel of forested land slightly larger than Delaware County.

On March 19, 2018, the Commonwealth issued RFQ DGS 17-09 to solicit prices for calendar year 2019 RECs to offset 40% and 50% of its annual load. The Commonwealth elected to reject all bids and reissued the RFQ later in the year. The results will be published in next year's annual report.

SUMMARY OF ENERGY AND ENGINEERING SERVICES

GENERAL

With a sharp focus on operational efficiency and cost-control objectives, PSFEI assisted DGS and DGS-supported agencies with the following services:

- Energy information updates
- Energy market trends and regulatory policy updates
- Energy procurement services
- Energy and utility database development and support
- Engineering advisory services
- Research and education
- Review and resolution of utility billing, rates, and service issues

PSFEI conducted meetings with DGS to ensure proper communication and project prioritization. The meetings included topics such as energy-data management, energy procurement, facility systems issues, regulatory issues, and strategic planning.

ENERGY COUNCIL MEETINGS

The Energy Council, consisting of representatives from all major Commonwealth agencies, promotes communication and education on all energy issues. While there were no energy council meetings in the 2017–2018 fiscal year, two meetings, supported by the National Governors Association, occurred that focused on energy efficiency. The first meeting was an energy efficiency retreat held at Weiser State Forest District Office on July 20, 2017, that was attended by representatives from most Commonwealth agencies. PSFEI collaborated with energy industry experts and provided a presentation on the need for energy and utility bill management. A second follow-up meeting was held on January 16, 2018, to review Commonwealth agency energy accomplishments and provide an update on the Commonwealth's utility bill management implementation. PSFEI participated in a panel discussion that provided brief presentations and answered questions from the attendees.

ENERGY SERVICES

GENERAL

Since 1998, PSFEI has helped Commonwealth facilities avoid over \$225 million in energy expenditures via competitive bidding in the electricity and natural gas commodity markets. During fiscal year 2017–2018, procurement avoided contract costs totaled nearly \$7.4 million.

ENERGY RISK MANAGEMENT APPLICATION

PSFEI continued development efforts to improve ERMA, its proprietary, advanced, multifunction, web-based application that provides online access to detailed procurement and utility billing information allowing facility management personnel to make informed utility and commodity decisions.

Development efforts during the fiscal year focused on expanding administrative import functions, adding a new fixed with pass-through electricity bid type, general bug fixes, system optimization, and enhanced reporting.

ACT 129 SUMMARY REPORT

Act 129 amends the Public Utility Code and includes an Energy Efficiency and Conservation (EE&C) Program that requires each of the seven major Commonwealth electrical distribution companies (EDCs) to adopt plans that reduce energy demand and consumption within their service territory. It includes incentives for energy-efficient equipment upgrades, smart-meter technology, time-of-use rates, real-time pricing plans with conservation components, and alternative energy sources. Since the consumers fund the cost of this program, it is advantageous to participate in the program.

Act 129 Phase III will operate from June 2016 through May 2021 and provide cash rebates for electricity saving initiatives. The program includes an EDC-based demand response program that started in June 2017, which provides a financial benefit to users who can reduce their electric demand during periods of peak grid electric demand. Program specifics are available through each EDC.

The DGS Energy and Resource Management group plays an active role in assisting the Commonwealth with taking advantage of the Act 129 program. PSFEI continues to serve in a supporting role to DGS and any agency who requests program information.

PJM DEMAND RESPONSE PROGRAM AND PLC MANAGEMENT SERVICES

PSFEI supported Commonwealth agencies with the PJM Emergency Demand Response program by soliciting Curtailment Service Providers (CSP) for new and expiring contracts, helping improve communications during scheduled events, and collecting and reporting facility-specific program information. DGS facilities opted out of participating in the 2017–2018 PJM program and instead focused resources on participating in the Peak Load Contribution (PLC) management services initiative during the 2017–2018 season. Because the LCSWMA agreement utilizes a pass-through structure with regards to capacity costs, any PLC reductions that DGS facilities can obtain will result in avoided capacity costs in the subsequent energy year. Reductions in usage at DGS facilities on potential coincident peak days are achieved using building automation control systems.

INTERGOVERNMENTAL POWER PURCHASE AND SALE AGREEMENT

In late 2013, a twenty-year PPA (Agreement) was executed between the Commonwealth and the Borough of Columbia (Borough) in Pennsylvania. The Agreement enabled the sale of the Harrisburg Incinerator to the LCSWMA. The incinerator generates steam that is used to generate electricity. The LCSWMA leases the electric generation plant to the Borough. The Borough sells electricity to the Commonwealth under specific contract terms and pricing that includes annual escalation factors and

discounts. The Agreement contains a clawback provision to protect the Commonwealth from making electricity payments in excess of market rates during the Agreement’s final ten years.

There are nineteen electric accounts assigned to the Agreement—seventeen accounts are DGS-operated facilities, one account is a Department of Corrections (DOC) facility, and one account is a Pennsylvania Emergency Management Agency (PEMA) facility. Approximately 81% of the entire electric load for these accounts was provided by the Borough. The remaining power was purchased from the retail market either from a competitively procured block or the Day-Ahead energy market.

Table 14 includes the total electric usage and cost in fiscal year 2017–2018 for the Commonwealth accounts assigned to the contract.

Table 14. Purchased LCSWMA Electricity Summary 2017–2018

Month	Usage (kWh)	Cost (excluding GRT ¹)	Unit Cost (\$/kWh) (excluding GRT)	Cost (including GRT)	Unit Cost (\$/kWh) (including GRT)
July 2017	13,391,315	\$849,721	\$0.06345	\$902,631	\$0.06740
August 2017	12,188,901	\$841,863	\$0.06907	\$894,282	\$0.07337
September 2017	11,078,680	\$760,590	\$0.06865	\$806,094	\$0.07276
October 2017	10,201,365	\$800,820	\$0.07850	\$850,689	\$0.08339
November 2017	9,196,204	\$680,085	\$0.07395	\$722,338	\$0.07855
December 2017	9,427,685	\$668,020	\$0.07086	\$707,948	\$0.07509
January 2018	10,012,368	\$736,688	\$0.07358	\$781,996	\$0.07810
February 2018	9,513,187	\$634,156	\$0.06666	\$671,796	\$0.07062
March 2018	9,079,459	\$644,359	\$0.07097	\$683,730	\$0.07531
April 2018	9,883,316	\$663,729	\$0.06716	\$705,016	\$0.07133
May 2018	10,348,425	\$713,188	\$0.06892	\$757,034	\$0.07315
June 2018	10,370,091	\$743,746	\$0.07172	\$789,877	\$0.07617
Total/Average	124,690,996	\$8,736,964	\$0.07007	\$9,273,431	\$0.07437

¹Pennsylvania Gross Receipts Tax

The unit cost for electricity, excluding utility distribution charges, averaged 7.437 cents per kWh. For comparative purposes, a procurement event held in October 2017 for a large account in the PPL territory secured a twelve-month rate of 4.855 cents per kWh. The excellent electricity pricing obtained through DGS Bureau of Procurement events, coupled with the price escalation provisions of the PPA, likely caused this economic disadvantage for the accounts included in the PPA.

ENGINEERING SERVICES

ELECTRICAL TESTING

Beginning in fiscal year 2017–2018, PSFEI staff supported DGS with the operation and maintenance of electrical systems at the Capitol Complex. The support included testing for medium voltage relays, medium-voltage air and vacuum circuit breakers, low- and medium-voltage cables, and low-voltage circuit breakers. PSFEI supplied DGS with resulting testing reports; calibration and inspection stickers for installation on equipment; and infrared scanning of circuit breakers, bus ducts, distribution panels, and

similar power system equipment. Table 15 lists the reports issued during the fiscal year that documented this effort.

Table 15. Engineering Services Reports 2017–2018

Report No.	Report Date	Location	Noted Deficiencies
TR 1718-1	08/23/17	Rachel Carson Building	Instantaneous and overcurrent coils failed; intermittent breaker trip
TR 1718-3	09/07/17	Labor & Industry Building	Corrected panel labels and replaced deficient fuse
ER 1718-8	11/07/17	Capitol Complex Substation	GE relay failures
TR 1718-4	12/13/17	Substation Unit No. 1	Replaced SR 350 relays due to factory issue
TR 1718-6	02/15/18	Substation Unit No. 2	Replaced SR 350 relays due to factory issue
TR 1718-7	05/02/18	Finance Building	No deficiencies noted
TR 1718-8	05/02/18	Health & Welfare Building	No deficiencies noted
TR 1718-10	06/21/18	North Office Building	Adjusted relay settings; contact resistance higher than specification
TR 1718-11	06/21/18	South Office Building	No deficiencies noted

Note: TR = Testing Report, ER = Electric Report

SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEM REPLACEMENT

During the fiscal year, PSFEI assisted DGS with developing a Supervisory Control and Data Acquisition (SCADA) replacement system scope of work for the Capitol Complex. The existing SCADA system operates on a single server with limited controls and no backup system. The server units are dated and at the end of their useful life expectancy. The SCADA software was developed to run on a version of Windows that is obsolete and no longer supported by Microsoft, creating security vulnerabilities. The replacement scope was based on a simplified programmable logic controller (PLC) system with human machine interface (HMI), which would allow for interaction between human operators and the system. The proposed solution is more cost-effective, reliable, and does not depend on a Windows-based server system with custom software, thus extending the life cycle.

SUMMARY OF SERVICES BY QUARTER

The summary list of services provided by PSFEI throughout the fiscal year is organized by quarter and separated by type of service.

FIRST QUARTER

PROCUREMENT

Continued providing purchased electricity versus contracted obligation comparisons for the LCSWMA.

Attended and hosted a vendor booth at the PA Procurement Expo in Harrisburg, PA on September 20, 2017, promoting COSTARS electricity procurement services.

Secured and finalized broker agreements with five qualified electricity suppliers specifically for the COSTARS procurement initiative.

Processed UGI account number changes in ERMA and ensured existing commodity contracts were not affected.

Researched and compiled anthracite coal market information to assist DOC and DGS in preparing for a hearing from a coal supplier who claimed damages from the loss of coal sales at SCI Camp Hill.

Provided an initial review of the WGL Energy contract price extension quotes, assembled a list of comments, and recommended an evaluation follow-up via email on September 28, 2017.

Conducted two natural gas RFQ procurement events: 1) DGS 17-02 for twenty-four Commonwealth accounts on August 22, 2017, and 2) DGS 17-03 for five Commonwealth accounts on September 19, 2017. The two events resulted in a combined total of \$2,884,725 in annual avoided costs versus the utilities price to compare, and \$6,241,054 in total avoided costs versus the utilities price to compare, respectively.

FACILITIES

Provided support to DGS regarding the Selinsgrove Center GESA initiative. Support included natural gas service capacity, boiler plant steam loads, and historical project information.

Attended and presented at the National Governors Association Energy Retreat on July 20, 2017, and participated in preparation calls with the various retreat organizers.

Reviewed the Thaddeus Stevens College (TSC) detailed energy audit report and provided review comments to DGS. Provided historical bin weather data to DGS for Lancaster PA. Participated in a site-visit meeting with the TSC representative, The Efficiency Network (TEN), and the GESA project contractor. Assisted in revising a recommended energy conservation measure.

Participated in the GESA interview with McClure Company on July 31, 2017, regarding the Capitol Complex project. Submitted review comments to DGS on July 27, 2017, in advance of the interview.

Provided a copy of the Building Heating Plant Feasibility Study prepared and submitted by PSFEI to DGS in August 2013 to the Energy & Resource Management Energy Engineer.

Continued providing PLC management services to DGS, identifying high-probability PLC days where DGS could take proactive steps to reduce their electricity use thereby lowering their PLC value and reducing next year's energy charges.

Worked with the DGS Bureau of Real Estate (BRE) to update DGS building square feet shown in the DGS annual utilities and energy usage report that are consistent with DGS BRE records.

Assisted with a preliminary initiative to have energy informational kiosks installed at two DGS buildings in Harrisburg, PA. Collected information and advised DGS on the most cost-effective solution. The initiative was placed on hold by DGS.

Worked with DGS Facility and Asset Management to determine annual facility management costs and developed benchmark comparisons to the Building Owners and Managers Association (BOMA) facilities database.

Identified the existing Penn State BL3 lab location and contact information as requested by the DGS Fire Safety and Environmental Division Chief and provided this information to DGS on September 29, 2017.

Provided the following facilities engineering services to DGS maintenance management:

- Completed electrical testing and maintenance at the Rachel Carson Building; issued PSFEI Report TR 17/18-1 to document the results.
- Completed electrical testing and maintenance at the Labor & Industry Building; issued PSFEI Report TR 17/18-3 to document the results.
- Started electrical testing and maintenance at the PA Capital Complex substation.

Prepared a dashboard report to compare utility use and cost for Q4 2017 (Apr-Jun) versus Q4 2016 (Apr-Jun). Following are dashboard report comments:

- Electricity
Electricity consumption was 4.2% less in Q4 2017 than in Q4 2016. Costs were 5.2% higher in Q4 2017 than in Q4 2016 as average unit costs were approximately 10% higher.
- Heating
Steam consumption was 7.9% lower in Q4 2017 than Q4 2016; steam cost decreased by 7.2%. Natural gas consumption was 55% lower, yet natural gas costs dropped by only 11.8%. The DGS Annex used considerably less natural gas (79%) resulting in an additional utility minimum annual bill charge of over \$21,000 in April 2017. The thermal energy consumption decrease was likely due to reduced heating loads at the DGS Annex and 47% fewer heating degree-days during the period. Overall heating costs for Q4 2017 were \$60,074 (8%) lower compared to Q4 2016.
- Water
Water use decreased by 16% for Q4 2017 compared to Q4 2016. Costs increased by \$3,197 or 0.6%. The increased cost is the result of a rate increase by the Capitol Region Water Authority.

MEETINGS

Organized and participated in the DGS-PSFEI bi-monthly meeting in Harrisburg, PA on August 16, 2017.

Assisted in scheduling and attending a meeting with DGS at the EnergyCAP office in State College, PA on September 8, 2017.

Attended the Pennsylvania Facilities Managers Association (PFMA) annual conference in State College, PA on September 19 and 20, 2017.

OTHER

Scheduled and participated in conference call meetings and discussions with the Commonwealth Office of Administration to determine a process to obtain portable document files (PDF) of incoming electricity and natural gas utility bills for the EnergyCAP initiative.

Continued to support the DGS EnergyCAP utility bill management software initiative. Assisted in the transition of the Commonwealth procuring the software directly from EnergyCAP.

Prepared and submitted Q4 216-2017 report on July 28, 2017.

Prepared and submitted utility budget projections for fiscal years 2017–2018 and 2018–2019 to the DGS Bureau of Financial Management on August 28, 2017.

Provided the following lease management services to DGS BRE:

- Lease Condition Assessments
 - Harrisburg Community Corrections Center—site visit and report completed.
 - Pottsville Workers' Compensation Office of Adjudication—site visit completed, report in progress.
- DGS BRE Documents
 - Drafted new Standard Terms and Conditions—waiting for final comments from DGS BRE to finalize.

SECOND QUARTER

PROCUREMENT

Submitted an email report on October 2, 2017, providing recommendations for WGL quoted electricity price extensions. Provided follow-up work to adjust Slippery Rock University's McKeever Environmental Center to a shorter contract term.

Continued to market the COSTARS electricity procurement program. Coordinated communication opportunities with the Department of Community and Economic Development. Competitive bids for the initial COSTARS shopping event that contained broker fee pricing were received on November 9, 2017.

Submitted a response to DGS on November 3, 2017, regarding the Deputy Secretary of Procurement's email about magazine articles focused on future electricity generation and pricing.

Worked with DGS and UGI to determine a fair and reasonable approach for UGI billing for unmetered natural gas use from February to August 2017 at the DGS Annex.

Executed, on DGS's behalf, winter blocks of electricity to hedge risk on November 22, 2017.

Initiated adding another supplier (First Energy Solutions) to the COSTARS program including development of a broker agreement.

Participated in a teleconference with Direct Energy on December 11, 2017, to discuss their load following block product and how it may benefit the Commonwealth.

Conducted one natural gas RFQ procurement event DGS 17-07 for three Penn State Health St. Joseph accounts on November 21, 2017. The event resulted in a combined total of \$369,283 in annual avoided costs versus the utilities price to compare, and \$861,660 in total avoided costs versus the utilities price to compare.

Conducted three electricity RFQ procurement events: 1) DGS 17-04 for 330 Commonwealth accounts on October 24, 2017, 2) DGS 17-05 for 47 Penn State Health Milton S. Hershey Medical Center (PSHMC) accounts on October 25, 2017, and 3) 453 COSTARS accounts on November 9, 2017. The three events resulted in a combined total of \$793,497 in annual avoided costs versus the utilities price to compare, and \$2,634,057 in total avoided costs versus the utilities price to compare.

FACILITIES

Developed a list of recommended Pennsylvania Department of Transportation (PennDOT) sites for DGS to consider for development of a GESA project and submitted via email on October 20, 2017.

Attended a DGS meeting with UGI Utilities, Inc. on October 4, 2017, to review various Commonwealth projects.

Worked with DGS Property and Asset Management personnel to collect facility management cost information for development of a DGS a facility management report. The initiative involved several submissions of cost allocations and telephone discussions to ensure an accurate understanding of facility management activities and cost information. The final report will be delivered in January 2018.

Reviewed and provided comment regarding the question of having a code-required waterside economizer at the Capitol Complex central plant on October 12, 2017. The questions were raised as part of the Capitol Complex GESA Request for Proposal (RFP) process.

Submitted water use trends via email to DGS on October 12 and 16, 2017, notifying personnel of a marked increase in water use at several Capitol Complex facilities during the 2016–2017 fiscal year; review and comments were requested regarding the information provided.

Continued supporting the Thaddeus Stevens College of Technology GESA project to help ensure the modifications made to the library would help improve the building's high humidity problems.

Submitted revised Commercial Building Energy Consumption Survey 2012 information and requested DGS approval for using a revised benchmark comparison on October 23, 2017.

Submitted an email report on October 30, 2017, regarding the Reading Office Building's load factor being greater than 1, which is not possible.

Provided a point of contact at PSHMC for DGS to schedule a visit and review PSHMC's Optimum Energy chiller optimization program.

Provided feedback December 13, 2017, via email regarding the results of DGS activities in the Demand Response program.

Provided the following facilities engineering services to DGS maintenance management:

- Continued electrical testing and maintenance at the Capital Complex substation.

Prepared a dashboard report to compare utility use and cost for Q1 2018 (Jul–Sep) versus Q1 2017 (Jul–Sep). Following are dashboard report comments:

- Electricity
Electricity consumption was 3.8% less in Q1 2018 than in Q1 2017. Costs were 1.15% higher in Q1 2018 than in Q1 2017 as average unit costs were approximately 5% higher.
- Heating
Steam consumption was 3.6% higher in Q1 2018 than Q1 2017; steam cost increased by 11.7%. Natural gas consumption was 6.8% lower; however, natural gas costs increased by 6.1%. The DGS Annex used 64% of the previous year’s natural gas, apparently the result of a meter error. The reduced quantity of gas consumed resulted in a higher unit cost. Overall heating costs for Q1 2018 were \$50,265 (11%) higher compared to Q1 2017.
- Water
Water use decreased by 42% for Q1 2018 compared to Q1 2017. Costs decreased by \$203,197 or 24%. As identified in the *Energy & Utility Usage Report 2016–2017*, a significant increase in water use occurred, the cause of which has yet to be determined.

MEETINGS

Hosted a DGS-PSFEI bi-monthly meeting in State College, PA on October 18, 2017.

Attended a meeting with DGS and DOC on November 14, 2017, to review natural gas supply and GESA project issues. Assisted DGS in developing the meeting agenda.

Attended the DGS–PSFEI bi-monthly meeting in Harrisburg, PA on December 18, 2017.

OTHER

Worked with DGS BRE to coordinate building square feet used in the *Energy & Utility Usage Report 2016–2017*.

Developed two building performance poster boards (as requested on October 12, 2017), one each for the Rachel Carson and Keystone Buildings. The final posters were delivered via email on December 6, 2017.

Submitted an electronic and hard copy of a 2013 report on October 16, 2017, regarding DGS water treatment services as requested.

Submitted the DGS first quarter report on October 19, 2017.

Supported the DGS utility bill management initiative, which included telephone discussions with Commonwealth personnel regarding their gaining the ability to capture PDF copies of natural gas and electric utility bills, assistance with developing the final DGS contract documents to purchase the EnergyCAP software solution, in-person meetings, and conference calls.

Scheduled a telephone discussion with DGS on November 9, 2017, to address their questions regarding the EnergyCAP scope of work and PSFEI support services.

Provided updated executive slide deck information to DGS on December 5, 2017.

THIRD QUARTER

PROCUREMENT

Facilitated negotiations with UGI Utilities, Inc. in March 2018 to increase natural gas interruption notification time from a two-hour to six-hour allowance for the Department of Corrections' (DOC) Elizabethtown Academy, thus helping to avoid future gas-to-oil switching issues

Supported DGS in preparing to procure natural gas for the Pennsylvania Emergency Management Agency (PEMA) facility on Elmerton Avenue in Harrisburg, PA.

Investigated increased natural gas billing costs at the DGS Annex, as requested by DGS. Determined that a meter error resulted in increased costs from previous natural gas used, but not billed. Provided information to DGS via email on February 21, 2018.

Worked on a broker agreement to add another qualified supplier, UGI Energy Services, to the COSTARS program.

Requested energy-use models for SCI Phoenix from DOC on March 1, 2018, in an effort to develop projected natural gas and electricity use for future procurement purposes.

Supported DGS in preparing RFQ documents and contacted PASSHE and Pennsylvania Turnpike Commission (PTC) staff to gauge their interest in participating in RFQ DGS 17-09, request for renewable energy credit supplier quotes.

Provided detailed follow-up commentary on March 1, 2018, regarding DGS interest in offering contract extensions to existing suppliers. Commentary resulted in scheduling a meeting with DGS to review and discuss a procurement strategy, which was included in the fourth quarter report.

Continued to market the COSTARS electricity procurement program. Attended and presented at the Pennsylvania Association of School Business Officials (PASBO) Conference in Hershey on March 8, 2018.

Supported DGS with solicitation number RFQ DGS 17-08: Electricity Supply and Management Services for the Commonwealth, Borough of Columbia, and LCSWMA. The RFQ was issued on February 8, 2018. Competitive bids were received on March 2, 2018. A 36-month contract was awarded to American PowerNet on March 5, 2018, with services beginning June 1, 2018.

FACILITIES

Attended the GESA kick-off meeting at SCI Muncy on January 9, 2018. Provided follow-up review on comments issued by DGS consultant CJL Engineering.

Finalized and submitted to DGS the Facility Management Benchmarking Fiscal Year 2016–2017 report on January 18, 2018.

Participated in the Energy Efficiency Workshop panel preparation and discussion on January 16, 2018, at the Keystone Building Conference Center.

Investigated increased steam use at the Capitol Complex in January 2018. Compiled weather and steam usage and provided tables and graphs of the increased steam use from the previous year on February 16, 2018.

Provided review comments on February 21, 2018, regarding the Energy Service Company's (ESCO) proposed boiler testing at Selinsgrove Center.

Reviewed and provided comments regarding the Measurement and Verification Report Year 1 for SCI Dallas.

Reviewed the DGS fleet of building accounts to determine the feasibility for participation in the RFQ for PJM Demand Response services. It was determined the accounts would not be good candidates for the PJM program due to strides made in energy reduction through GESA projects and participation in the pilot program for PLC Management.

Supported DGS in their discussions with UGI Utilities, Inc. regarding locations where conversion to natural gas was feasible.

Responded to Request for Information (RFI) questions on March 12, 2018, regarding SCI Muncy's GESA project.

Provided the following facilities engineering services to DGS maintenance management:

- Completed initial maintenance and testing on the Health and Welfare Building, Finance Building, and North and South Office Buildings. Follow-up testing that requires power outages will be scheduled in the future.

Prepared a dashboard report to compare utility use and cost for Q2 2018 (Oct–Dec) versus Q2 2017 (Oct–Dec). Following are dashboard report comments:

- **Electricity**
Electricity consumption was 6.3% less in Q2 2018 than in Q2 2017. Costs were 8.04% higher in Q2 2018 than in Q2 2017 as average unit costs were approximately 15% higher.
- **Heating**
Steam consumption was 2.6% higher in Q2 2018 than Q2 2017; however, steam cost decreased by 4.02%. Natural gas consumption was 6.3% higher and natural gas costs increased by 17.4%. The average unit cost of natural gas was 10.4% higher in Q2 2018 than Q2 2017. Overall heating costs for Q2 2018 versus Q2 2017 were essentially unchanged.
- **Water**
Water use decreased by 14.2% for Q2 2018 compared to Q2 2017. Costs decreased by \$11,235 or 2.3%.

MEETINGS

Hosted and participated in the DGS-PSFEI bi-monthly meeting on February 14, 2018 in State College, PA.

Developed and co-presented with DGS at the 2018 National Facilities Management & Technology (NFMT) conference in Baltimore on March 21, 2018. The presentation focused on strategic electricity and natural gas procurement and included a discussion on DGS procurement methods and program achievements.

Supported the DGS Capitol Complex GESA project by participating in meetings in person or via conference calls. Discussion topics included energy conservation measure (ECM) concepts and measurement and verification methods. Meeting dates included March 1, 15, and 19, 2018.

OTHER

Supported DGS in preparing for EnergyCAP utility bill management implementation. Activities included conference calls and meetings to discuss EnergyCAP requirements and the need to establish and interface with the DGS Schneider Electric metering system. Attended a project kick-off meeting in Harrisburg, PA on February 8, 2018. Assisted in working with Commonwealth agencies to determine recommended primary points of contact for EnergyCAP implementation and support.

Participated in conference calls and discussions clarifying the support required by DGS for the EnergyCAP implementation and support (January 23 and February 9, 2018). Submitted the proposed scope and cost of services to DGS on February 8, 2018.

Submitted the DGS second quarter report on January 26, 2018.

Submitted average electricity and heating fuel costs to the Director, Sustainable Engineering & Development, PA Governor's Green Government Council, on February 21, 2018, as requested by DGS.

Participated in a conference call with DGS to discuss PPL Utilities' (PPL) proposed energy efficiency forum on March 6, 2018. Captured comments and provided a proposed modified forum agenda to PPL; a follow-up discussion with PPL is pending.

Developed a revised infographic for the SCI Dallas GESA project's actual savings, as requested by DGS.

FOURTH QUARTER

PROCUREMENT

Supported DGS in convincing CPower to reconsider their position on paying the Department of Military and Veterans Affairs (DMVA) for their demand response efforts in the 2017–2018 program, resulting in a reimbursement of an additional \$26,309.

Worked with DOC personnel to facilitate the transfer of electricity and natural gas service from the contractor to DOC at SCI Phoenix.

Secured two additional suppliers to the COSTARS procurement program, UGI Energy Services and Direct Energy, which will increase the opportunity for competition.

Updated an information sheet portraying electricity procurement savings from spring 2018 and submitted to DGS on May 22, 2018.

Provided COSTARS procurement savings information to DGS on May 31, 2018.

Developed and assisted DGS in executing blocks of electricity for the on-peak summer months for LCSWMA portfolio on May 31, 2018.

Forwarded DGS Bureau of Procurement contact information to Kinect Energy on June 28, 2018; they are interested in becoming a qualified supplier of electricity and natural gas for the Commonwealth.

Conducted two electricity RFQ procurement events: DGS 17-11 for 232 Commonwealth accounts on May 2, 2018, and DGS 17-12 for 324 COSTARS accounts on May 24, 2018. The two events resulted in an annual savings versus current contracts of \$2,468,848, a combined total of \$3,029,843 in annual avoided costs versus the utilities price to compare, and \$6,176,564 in total avoided costs versus the utilities price to compare.

Conducted one natural gas RFQ procurement event: DGS 17-10 for 3 Commonwealth accounts on April 17, 2018. The event resulted in an annual savings versus current contracts of \$26,198, a combined total of \$364,796 in annual avoided costs versus the utilities price to compare, and \$920,471 in total avoided costs versus the utilities price to compare.

Reviewed and provided comments on HB 1782 on June 25, 2018, as requested by DGS.

FACILITIES

Continued providing GESA project support. Active projects included the Capitol Complex, SCI Muncy, Department of Conservation and Natural Resources (DCNR) Central, and SCI Houtzdale. Additional specific project details are as noted in following listed items.

Participated in site visits to several DCNR facilities, including Bald Eagle and Hills Creek State Parks (April 4, 2018), Parker Dam and Black Moshannon State Parks (April 5, 2018), and Prince Gallitzin State Park (April 20, 2018). Submitted site visit reports via email May 3, 2018.

Met with DGS facilities personnel on May 9, 2018, to review and discuss go-forward plans for the SCADA electrical system replacement. Using information provided by DGS, the project scope document was finalized and submitted to DGS on June 29, 2018.

Conducted several investment grade audit (IGA) project reviews, attended several review meetings with the GESA contractor, and provided review comments on the Capitol Complex GESA project. Specific focus near the end of the review process addressed electrical system deficiencies, specifically the original 1960s vintage 4160-volt switchgear located in the chiller plant.

Considered the DGS-based suggestion to consider a lake-based geothermal system at a DCNR facility. Provided initial opinions to DGS through emails and telephone discussions.

Visited SCI Houtzdale on June 15, 2018, to meet with facility staff and conduct a facility walk-through with the DGS consultant. Developed revised list of ECMs and submitted to the project scoping team on June 21, 2018. Additional information regarding the compressed natural gas (CNG) system will be provided in the future.

Conveyed information received from UGI that SCI Dallas was receiving a refund check for their LED retrofit project. Provided additional requested information regarding the number of electric utility accounts that exist in UGI's territory.

Worked with SCI Laurel Highlands and Penelec, their serving utility, to schedule an on-site meeting to determine the utility requirements to change the supply tariff to a net metering configuration.

Reviewed and provided comments on SCI Muncy's five GESA ECM cost proposals. Attended and participated in four of five GESA interviews during the weeks of June 11 and June 18, 2018. Distributed submission review and interview comments to the appropriate DGS and DOC representatives.

Requested and attended a meeting with DGS maintenance services on June 20, 2018, to review PSFEI's HVAC services capabilities and developed a list of DGS mechanical and HVAC service's needs (meeting notes were submitted to DGS July 2, 2018).

Provided potential peak-day notifications to DGS via email for the 2018 season (June through September). Notifications are sent to DGS on days when a very high probability exists of being a peak day in the PJM regional transmission organization. Reducing electricity load on peak days can reduce future utility bill costs.

Evaluated a water conservation product recommended to DGS as requested on June 25, 2018; provided feedback on June 26, 2018.

Provided the following facilities engineering services to DGS maintenance management:

- Completed initial maintenance and testing on the Keystone Building. Follow-up testing that requires power outages will be scheduled in the future.
- Submitted maintenance and testing reports for Finance and Health & Welfare Buildings on May 2, 2018, and the North and South Office Buildings on June 20, 2018.

Prepared a dashboard report to compare utility use and cost for Q3 2018 (Jan–Mar) versus Q3 2017 (Jan–Mar). Following are dashboard report comments:

- Electricity
Electricity consumption was 3.3% less in Q3 2018 than in Q3 2017. Costs were 2.3% lower in Q3 2018 than in Q3 2017. Average unit costs were essentially unchanged.
- Heating
Steam consumption was 17.2% higher in Q3 2018 than Q3 2017 and steam cost increased by 22.1%. Natural gas consumption was 200% higher and natural gas costs increased by 64.3%. The average unit cost of natural gas was 18% lower in Q3 2018 than Q3 2017. Overall heating costs for Q3 2018 versus Q3 2017 were 27% higher. There are two reasons for the significant increase in use:
First, the DGS Annex experienced a meter problem in 2017 resulting in underreported metered use. The underreported use and cost were applied in the January 2018 bill, resulting in an increased Annex use of 285%.
Second, there were 20% more heating degree days for the period this year compared to the previous year.
- Water
Water use decreased by 23.3% for Q3 2018 compared to Q3 2017. Costs decreased by \$2,539 or 0.5%.

MEETINGS

Attended the DGS-PSFEI bi-monthly meeting on April 18, 2018, at DGS in Harrisburg, PA.

Attended a meeting at the DOC Central Office with DGS representatives regarding a solar offering from the ARM Group on April 25, 2018.

Hosted and participated in the DGS-PSFEI bi-monthly meeting on June 21, 2018, in State College, PA.

OTHER

Prepared and submitted an updated GESA infographic to DGS on May 11, 2018, portraying the energy and cost savings benefit to the Commonwealth.

Participated in several discussions with PPL Utilities and DGS representatives in planning a future Energy Forum to be held at the PTC TIP Building. The event was postponed by PPL Utilities until fall.

Continued to provide DGS support in implementing EnergyCAP, working with DGS Bureau of Procurement on verifying appropriate accounts, reviewing bill images ready to be sent into the EnergyCAP BillCAPture system, and working with agencies to develop accurate physical and financial organizational structures, resulting in a utility bill management system that is usable for Commonwealth agencies.

Reviewed updated Act 129 costs from PPL Utilities and provide commentary to DGS.

SUMMARY OF EDUCATION SERVICES

EDUCATION OPPORTUNITIES

PSFEI developed and conducted technical short courses and special trainings to enable Commonwealth personnel to enhance their knowledge and sharpen their job skills. The short courses were held in State College, PA and workshops and seminars were held at convenient locations throughout the state. Sixteen DGS employees enhanced their skills by attending training events in fiscal year 2017–2018.

The following PSFEI short course opportunities were available in fiscal year 2017–2018:

- HVAC Technical Conference, July 26–28, 2017. Topics of instruction focused on basic HVAC thermodynamics and heat transfer, chiller fundamentals and the central plant, Legionella and water treatment, and predictive monitoring for uptime and reliability. Course attendees toured Penn State's West Campus Chiller Plant.
- Boiler Plant Operations and Maintenance Training, May 7–9, 2018. This course provided instruction on boiler properties of water and steam; boiler processes, controls, operations, safety, pumps and fans, and water treatment; and the impact of environmental regulations. Course attendees toured Penn State's East Campus Combined Heat and Power Plant
- Electrical Theory, May 23–25, 2018. Sessions taught during this course included confined space; lockout/tagout; Occupational Safety and Health Administration (OSHA) discussion (private versus public sector); effective safety training; mold awareness; asbestos in schools; medium voltage breaker life extension; transformer leak solutions; arc flash training, equipment, and equipment maintenance; relay testing demonstration; lighting demonstration; electrical system deficiencies; and a review and discussion of Commonwealth projects. Course attendees toured Penn State's Pegula Ice Arena's electrical switchgear.
- HVAC Technical Conference, June 11–13, 2018. Topics of instruction focused on basic HVAC thermodynamics, steam condensate, steam trap design and operating principals, safety with steam, water treatment, coil training, and heating plant essentials. Course attendees toured Penn State's East Campus Combined Heat and Power Plant.

Five half-day workshops in each of the following categories—boiler, electrical, and HVAC, were offered and hosted at various Commonwealth facilities across the state. Topics vary based on facility staff requests, changes in standards, safety needs, etc. DGS attendance at PSFEI educational training events is detailed in Table 16 on page 50.

Table 16. DGS Attendance at Short Courses and Workshops 2017–2018

Short Courses	DGS Attendance
Boiler Plant Operations and Maintenance Training	4
Electrical Theory	3
HVAC Technical Conference	9
Workshops and Special Courses	
Boiler Workshop	0
Electrical Workshop	0
HVAC Workshop	0
Total	16