PROGRESS REPORT ON ENERGY PERFORMANCE CONTRACT FOR POLITEKNIK TUNKU SYED SIRAJUDDIN

(JUN 2023)

Prepared by: Taiace Engineering Sdn Bhd
No. 43A, Jalan Permata 1
Arab Malaysian Industrial Park
71800 Nilai, Negeri Sembilan

MEASUREMENT AND VERIFICATION REPORT ON ENERGY PERFORMANCE CONTRACT

1. Organization Profile Date of Report: 8th July 2023

Name and owner address	Politeknik Tuanku Syed Sirajuddin (PTSS) Pauh Putra 02600 Arau, Perlis
Name Telephone Email	En. Latif Ramli Certified Energy Manager (CEM) Tel : 019 577 5419 Email: ml_tif@yahoo.com.my
Name and ESCO address	Taiace Engineering Sdn Bhd No. 43A, Jalan Permata 1 Arab Malaysian Industrial Park 71800 Nilai Negeri Sembilan
Name Designation Telephone Fax Email	En. Isa Bin Ismail Executive Chairman +606-7997478 +606-7999739 isa.ismail@taiace-engineering.com
Type of Sector/Industry	Education
Occupants	Number of students: 7,746 Number of staff: 415 (2015)
Operating hours (day, week, month)	5 days/week, 10 months/year
Total Gross Floor Area (GFA)	204,369 m^2, Number of building blocks: 30
Average (Baseline)	Average electricity consumption/month: 511,523kWh Average maximum demand: 1,812kW

2. Energy Performance

POST-RETROFIT /REPORTING PERIOD DATA					ADJUSTED BASELINE DATA					AVOIDED ENERGY	
Month	No of Class Day (day)	No of Working Day	CDD	Consumptions (kWh)	FACTORS				Adjusted Baseline (kWh)	Energy Avoided	Energy Savings Percentage
					No of Class Day Sensitivity	No of Working Days Sensitivity	CDD Sensitivity	Intercept			
					$7,450.81x_1$	$9,667.68x_2$	$1,256.42x_3$	-194,076			
Jan-20	17	21	332.5	134,909	126,663.77	203,021.28	417,759.65	-194,076.00	553,368.70	418,459.70	76%
Feb-20	20	20	320.5	144,963	149,016.20	193,353.60	402,682.61	-194,076.00	550,976.41	406,013.41	74%
Mar-20	11	11	372.5	116,323	81,958.91	106,344.48	468,016.45	-194,076.00	462,243.84	345,920.84	75%
Apr-20	0	0	348	46,311	0.00	0.00	437,234.16	-194,076.00	243,158.16	196,847.16	81%
May-20	0	0	345	44,037	0.00	0.00	433,464.90	-194,076.00	239,388.90	195,351.90	82%
Jun-20	0	0	314.5	86,912	0.00	0.00	395,144.09	-194,076.00	201,068.09	114,156.09	57%
Jul-20	0	21	309.5	319,958	0.00	203,021.28	388,861.99	-194,076.00	397,807.27	77,849.27	20%
Aug-20	14	19	328	428,325	104,311.34	183,685.92	412,105.76	-194,076.00	506,027.02	77,702.02	15%
Sep-20	20	20	291	447,437	149,016.20	193,353.60	365,618.22	-194,076.00	513,912.02	66,475.02	13%
Oct-20	0	21	295.5	384,284	0.00	203,021.28	371,272.11	-194,076.00	380,217.39	-4,066.61	-1%
Nov-20	0	21	301.5	366,825	0.00	203,021.28	378,810.63	-194,076.00	387,755.91	20,930.91	5%
Dec-20	0	22	294	306,519	0.00	212,688.96	369,387.48	-194,076.00	388,000.44	81,481.44	21%
Average Monthly Saving on Previous Year - 2020										**166,426.76**	**43%**

POST-RETROFIT /REPORTING PERIOD DATA					ADJUSTED BASELINE DATA					AVOIDED ENERGY	
Month	No of Class Day (day)	No of Working Day	CDD	Consumptions (kWh)	FACTORS				Adjusted Baseline (kWh)	Energy Avoided	Enerygy Savings Percentage
					No of Class Day	No of Working Days Sensitivity	CDD Sensitivity	Intercept			
					$7,450.81x_1$	$9,667.68x_2$	$1,256.42x_3$	-194,076			
Jan-21	0	19	294.5	317,258	0.00	183,685.92	370,015.69	-194,076.00	359,625.61	42,367.61	12%
Feb-21	0	19	293.5	266,178	0.00	183,685.92	368,759.27	-194,076.00	358,369.19	92,191.19	26%
Mar-21	22	22	354	426,006	163,917.82	212,688.96	444,772.68	-194,076.00	627,303.46	201,297.46	32%
Apr-21	21	21	328	449,636	156,467.01	203,021.28	412,105.76	-194,076.00	577,518.05	127,882.05	22%
May-21	7	18	346	331,402	52,155.67	174,018.24	434,721.32	-194,076.00	466,819.23	135,417.23	29%
Jun-21	0	0	306	182,250	0.00	0.00	384,464.52	-194,076.00	190,388.52	8,138.52	4%
Jul-21	0	0	325	269,543	0.00	0.00	408,336.50	-194,076.00	214,260.50	-55,282.50	-26%
Aug-21	0	17	298	269,035	0.00	164,350.56	374,413.16	-194,076.00	344,687.72	75,652.72	22%
Sep-21	0	21	296.5	146,434	0.00	203,021.28	372,528.53	-194,076.00	381,473.81	235,039.81	62%
Oct-21	0	20	318.5	291,114	0.00	193,353.60	400,169.77	-194,076.00	399,447.37	108,333.37	27%
Nov-21	21	21	284	448,681	156,467.01	203,021.28	356,823.28	-194,076.00	522,235.57	73,554.57	14%
Dec-21	23	23	291	492,672	171,368.63	222,356.64	365,618.22	-194,076.00	565,267.49	72,595.49	13%
Average Monthly Saving on Current Year - 2021										**93,098.96**	**20%**

Month	No of Class Day (day)	No of Working Day	CDD	Consumptions (kWh)	FACTORS				Adjusted Baseline (kWh)	Energy Avoided	Energy Savings Percentage
					No of Class Day Sensitivity	No of Working Days Sensitivity	CDD Sensitivity	Intercept			
					$7,450.81x_1$	$9,667.68x_2$	$1,256.42x_3$	-194,076			
Jan-22	20	20	314	445,566	149,016.20	193,353.60	394,515.88	-194,076.00	542,809.68	97,243.68	18%
Feb-22	1	20	285	253,071	7,450.81	193,353.60	358,079.70	-194,076.00	364,808.11	111,737.11	31%
Mar-22	22	22	334.5	494,173	163,917.82	212,688.96	420,272.49	-194,076.00	602,803.27	108,630.27	18%
Apr-22	21	21	324	399,323	156,467.01	203,021.28	407,080.08	-194,076.00	572,492.37	173,169.37	30%
May-22	17	19	335	417,032	126,663.77	183,685.92	420,900.70	-194,076.00	537,174.39	120,142.39	22%
Jun-22	21	21	302.5	501,907	156,467.01	203,021.28	380,067.05	-194,076.00	545,479.34	43,572.34	8%
Jul-22	20	20	323	335,583	149,016.20	193,353.60	405,823.66	-194,076.00	554,117.46	218,534.46	39%
Aug-22	22	22	308.5	410,055	163,917.82	212,688.96	387,605.57	-194,076.00	570,136.35	160,081.35	28%
Sep-22	21	21	294	482,781	156,467.01	203,021.28	369,387.48	-194,076.00	534,799.77	52,018.77	10%
Oct-22	20	20	304	440,690	149,016.20	193,353.60	381,951.68	-194,076.00	530,245.48	89,555.48	17%
Nov-22	21	21	294.5	489,696	156,467.01	203,021.28	370,015.69	-194,076.00	535,427.98	45,731.98	9%
Dec-22	21	21	274.5	407,257	156,467.01	203,021.28	344,887.29	-194,076.00	510,299.58	103,042.58	20%
Average Monthly Saving on Current Year - 2022										**110,288.32**	**21%**

POST-RETROFIT /REPORTING PERIOD DATA					ADJUSTED BASELINE DATA					AVOIDED ENERGY	
Month	No of Class Day (day)	No of Working Day	CDD	Consumptions (kWh)	FACTORS				Adjusted Baseline (kWh)	Energy Avoided	Energy Savings Percentage
					No of Class Day Sensitivity	No of Working Days Sensitivity	CDD Sensitivity	Intercept			
					$7,450.81x_1$	$9,667.68x_2$	$1,256.42x_3$	-194,076			
Jan-23	2	20	288.5	301,060	14,901.62	193,353.60	362,477.17	-194,076.00	376,656.39	75,596.39	20%
Feb-23	20	20	288	418,042	149,016.20	193,353.60	361,848.96	-194,076.00	510,142.76	92,100.76	18%
Mar-23	23	23	334.5	463,039	171,368.63	222,356.64	420,272.49	-194,076.00	619,921.76	156,882.76	25%
Apr-23	14	14	326	373,349	104,311.34	135,347.52	409,592.92	-194,076.00	455,175.78	81,826.78	18%
May-23	21	21	345.5	508,964	156,467.01	203,021.28	434,093.11	-194,076.00	599,505.40	90,541.40	15%
Jun-23	19	21	327	405,459	141,565.39	203,021.28	410,849.34	-194,076.00	561,360.01	155,901.01	28%
Jul-23					0.00	0.00	0.00	-194,076.00	-194,076.00	-194,076.00	
Aug-23					0.00	0.00	0.00	-194,076.00	-194,076.00	-194,076.00	
Sep-23					0.00	0.00	0.00	-194,076.00	-194,076.00	-194,076.00	
Oct-23					0.00	0.00	0.00	-194,076.00	-194,076.00	-194,076.00	
Nov-23					0.00	0.00	0.00	-194,076.00	-194,076.00	-194,076.00	
Dec-23					0.00	0.00	0.00	-194,076.00	-194,076.00	-194,076.00	
Average Monthly Saving on Current Year - 2023										**-42,633.91**	**21%**

Referring to above table, it is shows that there is **21% energy saving in** year 2023. This is not including of maximum demand saving.

Based on the M&V report, it is agreed that:

1) The baseline period is 12 months which is from Nov 2014 until Oct 2015. Baseline data include energy consumption and independent variables i.e., number of class days in a month (academic calendar), number of working days in a month, and cooling degree days (CDDs). Energy savings in reporting period i.e., August 2016 till December 2016 is calculated using the Energy Avoidance technique.
2) The baseline energy data is obtained from the utility bill. The baseline temperature and the number of class-days data are from Malaysia Meteorological Department and academic calendar year respectively.
3) During the M&V period too, the baseline energy is adjusted based on three non-routine factors: 1) breakdown chiller of number 3 in November and December 2016, 2) the number of occupancies of Dewan Harum Manis, and 3) the malfunctioned of one phase of TNB meter in week four of December 2016.
4) The baseline model for PTSS is given in the equation below. The R-Square of the mathematical problem is 0.82 (>0.75) and 0.00259 (<0.05) respectively. These values show that the regression model has an acceptable relationship. According to IPMVP, mathematical model with R-Square > 0.75 and F-test value < 0.05 imply a good relationship correlation. The correlation analysis measures the strength of the relation between two or more variables.

$$Y=-194{,}076+7{,}450.81x1+9{,}667.68+1{,}256.42x3$$

where,

Y : Electricity consumption (kWh)

x_1 : No of class-days

x_2 : No of working days

x_3 : CDDs

3. List of Energy Saving Measure (ESM) Installation

Energy Saving Measure (ESM) listed below was implemented in PTSS under Energy Performance Contract (EPC) between PTSS and Taiace Engineering Sdn. Bhd. (TESB). Both parties signed a contract with a guaranteed saving of 10% with reference to one-year baseline before implementation. Any saving between 10 to declared percentage will be shared between PTSS and TESB at ration 20:80.

List of energy-saving measures implemented as below:

1) 36W T8 Fluorescent replaced with 18W TTUBE fluorescent type.
2) 18W T8 Fluorescent Light Bulb replacement with 10W TTube fluorescent type.
3) High-efficiency split unit air conditioner installation for server rooms
4) Hydrocarbon Gas Migration
5) Optimization cooling system-Variable frequency drive.
6) Comprehensive cleaning to all chiller
7) Online web dashboard energy monitoring

4. Measurement and Verification Methodology

Measurement & Verification **Option C** - Whole Facility from the International Performance Measurement and Verification (IPMVP) of energy savings is used because the saving project involved installing multiple ECMs and it was expected that the energy savings from these implementations are more than 10%.

M&V Option	How Savings Are Calculated	Typical Applications
C. Whole Facility Savings are determined by measuring energy use at the whole facility level. Short-term or continuous measurements are taken throughout the post-retrofit period.	Analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis.	Multifaceted energy management program affecting many systems in a building. Energy use is measured by the gas and electric utility meters for a twelve-month base year period and throughout the post-retrofit period.

Summary of Measurement & Verification methods.

5. Total Baseline Energy Consumption (kWh) background

PTSS baseline for 12 consecutive month energy consumption before the implementation of SEMS & ESM is shown below:

i) Electricity consumption baseline:

BASELINE DATA				
MONTH	**No of Class Day**	**No of Working days**	**CDD-18**	**CONSUMPTONS (kWh)**
Nov-14	**6**	**20**	**299.0**	**419,152**
Dec-14	**17**	**22**	**289.0**	**503,234**
Jan-15	**22**	**22**	**292**	**526,085**
Feb-15	**13**	**18**	**291**	**405,540**
Mar-15	**22**	**22**	**361**	**629,844**
Apr-15	**18**	**22**	**339**	**542,252**
May-15	**0**	**19**	**343**	**421,647**
Jun-15	**8**	**22**	**316**	**497,304**
Jul-15	**16**	**21**	**308**	**521,819**
Aug-15	**20**	**20**	**306**	**612,385**
Sep-15	**20**	**20**	**306**	**513,038**
Oct-15	**21**	**21**	**322**	**588,766**

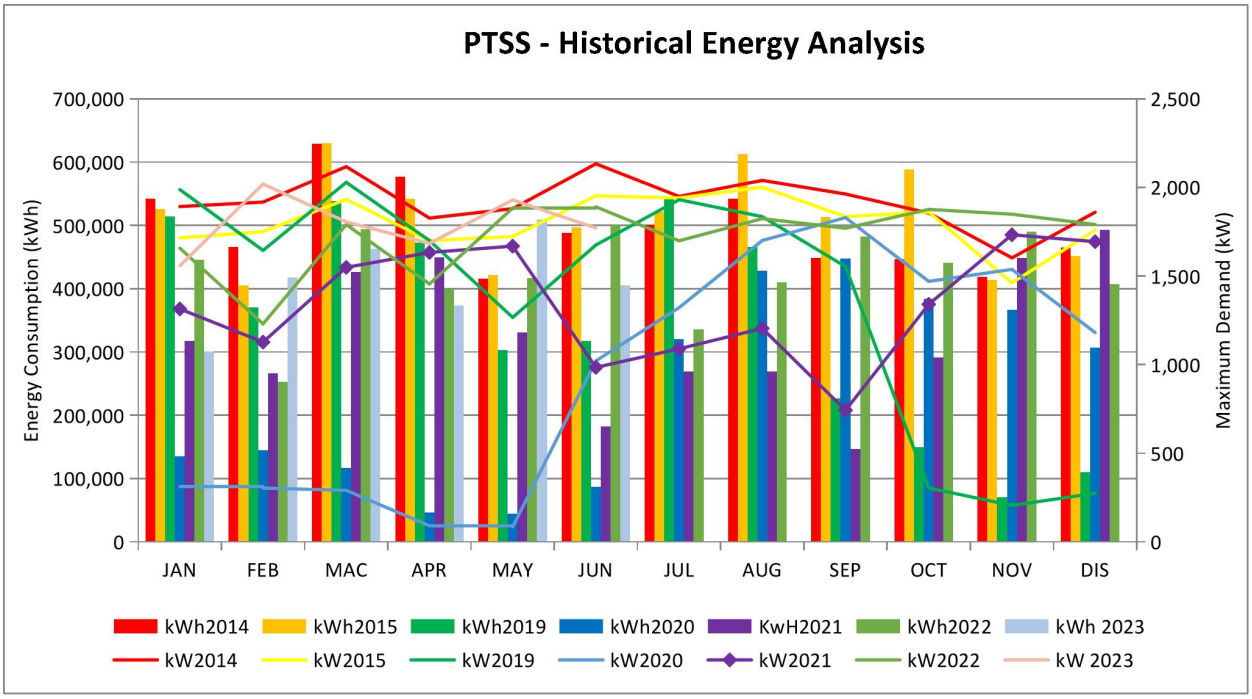
PTSS Baseline data for energy consumption, no of the class day, no of working day, and CDD's.

The ESM implementation started in Jan 2015 by phase until July 2016, therefore data from 2014 were taken to represent a baseline for Jan to December 2014.

6. Monthly Energy Consumption

MONTH	2014		2015		2019		2020		2021		2022		2023	
	ENERGY CONSUMPTION	MAX. DEMAND	ENERGY CONSUMPTION	MAX. DEMAND	ENERGY CONSUMPTION	MAX. DEMAND	ENERGY CONSUMPTION	MAX. DEMAND	ENERGY CONSUMPTION	MAX. DEMAND	ENERGY CONSUMPTION	MAX. DEMAND	ENERGY CONSUMPTION	MAX. DEMAND
	[kWh]	[kW]	[kWh]	[kW]	[kWh]	[kW]	[kWh]	[kW]	[kWh]	[kW]	[kWh]	[kW]	[kWh]	[kW]
JAN	541,799.00	1,892.83	526,085.00	1,715.67	513,980	1,988.73	134,909	312.53	317,258	1,314.91	445,566	1,657.97	301,060	1,558.48
FEB	465,913.00	1,918.00	405,540.00	1,751.44	370,530	1,645.23	144,963	303.96	266,178	1,127.86	253,071	1,230.56	418,042	2,020.19
MAC	629,322.00	2,118.00	629,844.00	1,933.31	538,500	2,029.57	116,323	290.89	426,006	1,549.59	494,173	1,791.09	463,039	1,806.35
APR	577,078.00	1,827.82	542,252.00	1,700.21	472,841	1,700.94	46,311	90.86	449,636	1,633.79	399,323	1,455.69	373,349	1,684.84
MAY	415,987.00	1,880.90	421,647.00	1,724.17	303,400	1,267.02	44,037	84.43	331,402	1,669.42	417,032	1,884.24	508,964	1,930.44
JUN	487,931.00	2,134.12	497,304.00	1,953.12	317,233	1,676.00	86,912	1,021.90	182,250	985.29	501,907	1,891.32	405,459	1,771.50
JUL	501,124.00	1,950.05	521,819.00	1,941.47	540,988	1,931.63	319,958	1,322.27	269,543	1,089.82	335,583	1,699.62		
AUG	541,868.00	2,040.44	612,385.00	2,002.26	465,750	1,835.84	428,325	1,701.41	269,035	1,205.12	410,055	1,824.53		
SEP	448,858.00	1,963.46	513,038.00	1,835.93	226,864	1,554.02	447,437	1,830.26	146,434	743.00	482,781	1,770.62		
OCT	446,918.00	1,856.34	588,766.00	1,862.40	149,808	304.64	384,284	1,470.59	291,114	1,340.95	440,690	1,876.86		
NOV	419,152.00	1,603.15	414,142.00	1,462.23	70,019	206.00	366,825	1,538.27	448,681	1,733.63	489,696	1,849.64		
DIS	465,449.00	1,860.82	451,050.00	1,759.86	109,942	273.84	306,519	1,181.49	492,672	1,694.57	407,257	1,791.65		
AVG	495,116.58	1,920.49	510,322.67	1,803.51	339,987.92	1,367.79	235,566.92	929.07	324,184.08	1,340.66	423,094.50	1,726.98	411,652.17	1,795.30

Current PTSS electricity consumption compared to baseline energy year 2014 and 2015



Current PTSS electricity consumption pattern until June ,2023.

END OF REPORT