SiteWatch Sample Report

Plastic Manufacturing

Summary

The purpose of this report is to present findings from an energy monitoring installation at a plastic manufacturing site, guiding them to issues identified through a regular review process. SiteWatch provides monitoring using Panoramic Power[1] for equipment serving production processes and reports findings to the customer through a regular review process.

This review covers monitored equipment and utility cost issues the customer specifically requested SiteWatch assistance with including air compressors, demand cost, off hour energy use, and insight to how equipment operates, including runtime and load factor. This report is part of a bi-annual review process requiring SiteWatch engagement with onsite personnel to identify issues with monitoring while focusing the review on key areas affecting the customer (specific equipment, demand costs, mechanical failures, etc.).

Key findings include low or no cost changes to equipment operations, which if enabled will lead to more than $100,000 in annual savings, equal to 30 times the cost of SiteWatch support:

- Fixing major, easily identified compressed air leaks - **$29,981** annual savings
- Shutting down unused compressors over weekends - **$10,291** annual savings
- Shifting recycle grinder operations to 3rd shift - **$32,089** annual savings
- Ensuring full shutdown rather than standby for production equipment on non-production weekends - **$33,000** annual savings

Air Compressor Sequencing and Off Hour Usage

Air compressor energy is related to industrial heating energy. Production requires heating, so heating energy usage is considered a parameter indicating when production takes place. When comparing heating and compressor usage, the compressor demand remains at nearly 50 kW even with no heating demand (i.e., no production). Compressor kW during this period is believed to keep the system pressurized with no useful load, only air leaks.

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[1] Panoramic Power and PowerRadar are registered trademarks of Panoramic Power Ltd in the United Kingdom and United States of America.

Figure 1: Compressed Air kW vs. Industrial Heating kW[2]

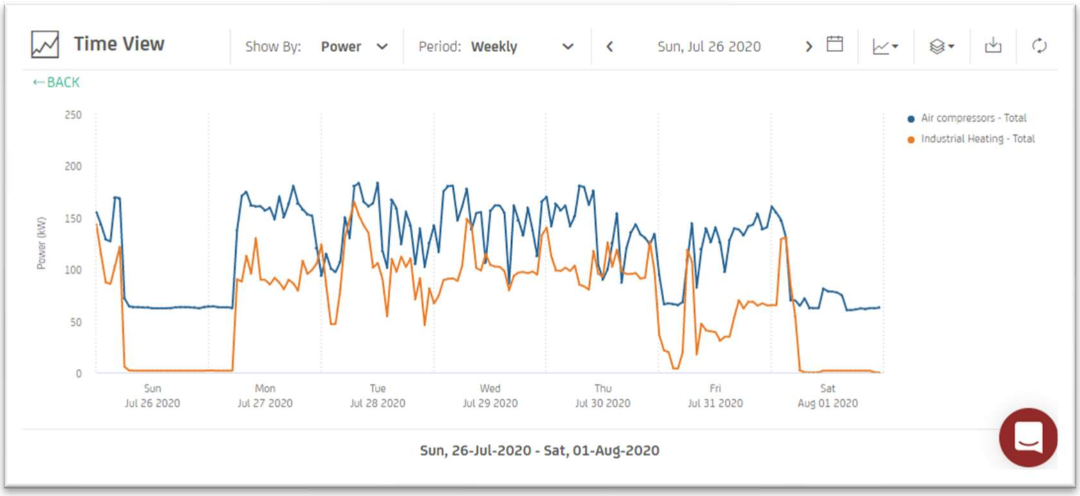

Table 1: Air Compressor Comparison

Production Air Compressor kW	139.91
Weekend Air Compressor kW (no production)	48.59
Annual Spending on Compressed Air	$99,630
Savings from Fixing Leaks (assume 25% leaks)	$29,981
Savings from Weekend Compressor Shutoff	$10,291

The site needs 2 of 3 compressors during production, with an average demand of 140 kW. There are two potential sources of savings: reducing weekend compressor energy use and fixing leaks, which would reduce compressor energy use during production periods:

Savings from Fixing Leaks = 139.91 kW (production period compressor demand) x 25% (assumed leak rate) x 50 operating weeks per year x 5 operating days per week x 24 hours per day x weighted $/kWh (including usage and demand charges) = $29,981

An air leak study and outside contractor assistance in repairing leaks would range in price between $5,000 and $15,000, depending on the depth of the study and number of leaks repaired (and how difficult they are to access). Leaks can cost-effectively be fixed during off hours by onsite staff or an outside contractor. The ROI for leak repair at this site would be between 3 months and 9 months, with savings continuing over a much longer period.

The site must review the need for compressed air over non-production weekends, and if any equipment does require air, what is the benefit of switching that equipment to a local compressor or changing the equipment to electrically-driven (e.g., pneumatic motors, actuators).

Savings from Weekend Compressor Shutoff = 48.59 kW (weekend compressor demand) x 50 operating weeks per year x 2 weekend days per week x 24 hours per day x weighted $/kWh (including usage charges) = $10,291

[2] View from Power Radar. Panoramic Power and PowerRadar are registered trademarks of Panoramic Power Ltd in the United Kingdom and United States of America.

This measure has no associated cost and would result in an immediate return on investment.

Impact of Demand on Utility Cost

The customer requested information on how demand charges impact overall energy spend, summarized by demand period (on or mid) and season (summer, spring/fall). The site electric utility tariff specifies demand and usage charge by periods, including seasons (summer, shoulder, and winter) and time of day (on-peak, mid-peak, and off-peak). Demand and usage rates vary by time of day. On Peak for the summer is between 2 PM and 6 PM, mid-peak is from noon to 2 PM and from 6 PM to 8 PM, and off peak is all other hours.

Table 2: Utility Tariff Schedule

Demand kW Cost	*May, June, October*	*July, August, September*	*Winter*
On-Peak	$19.62	$23.96	$15.55
Mid-Peak	$3.72	$3.72	$3.72
Off	$0.00	$0.00	$0.00

Usage kWh Cost	*May, June, October*	*July, August, September*	*Winter*
On-Peak	$0.0999	$0.1255	$0.0999
Mid-Peak	$0.0935	$0.1191	$0.0935
Off	$0.0839	$0.0970	$0.0839

By applying these rates to the monitored energy use (kW and kWh), SiteWatch quantified demand versus total charge by season and demand type (on, mid, off):

Table 3: Demand and Total (of Demand and Usage) Cost for Monitored Machines

Monthly Demand Cost by Period	*May, June, October*	*July, August, September*	*Winter*
On-Peak	$15,970	$19,732	$13,259
Mid-Peak	$2,969	$2,882	$2,904
Off	$0	$0	$0

Monthly Total Cost by Period	*May, June, October*	*July, August, September*	*Winter*
On-Peak	$26,328	$34,355	$27,022
Mid-Peak	$13,905	$18,554	$23,077
Off	$10,225	$13,526	$15,539

While usage charges are similar between periods, the customer was not aware that demand charges comprised more than 50% of electricity cost during summer and winter on-peak periods. Since movement from the on-peak period would affect costs year round, the customer was advised to move non-critical equipment operation, such as recycling grinders, to off-peak hours. This no-cost recommendation would result in more than $30,000 saved annual if only the recycling grinders, which run continuously, were operated only before noon and after 8 PM:

Table 4: Cost Savings from Moving Grinder Operations

Average Grinder kW	44.59
Existing Operating Hours	7,948
Off Peak Hours	2,978
Baseline Grinder Annual Operating Cost	$43,806
Annual Grinder Operating Cost during Off-Peak Hours Only	$11,716
Potential Savings	*$32,089*

Baseline Grinder Annual Operating Cost = 44.59 kW x 7,948 hours x Average Usage $/kWh + 44.59 kW x On Peak Demand Cost $/kW + 44.59 x Mid Peak Demand Cost $/kW

Annual Grinder Operating Cost during Off-Peak Hours Only = 44.59 kW x 2,978 hours x Average Usage $/kWh

Partial vs. Full Shutdown

Most weekends the site does not shut down fully; some equipment remains energized through the period, consuming a constant level of energy when the equipment is not actively used. The customer does occasionally shut down completely, allowing SiteWatch to compare energy use between weekends and quantify potential savings from enabling a full shutdown every weekend.

SiteWatch compared two similar weeks of operations, May 10-16, 2020, and June 14-20, 2020. During the June week, monitored machines showed energy use through the weekend while during the May week most monitored equipment shut down completely.

Figure 2: Partial vs. Full Shutdown Weeks

The orange week shows typical operation Monday-Saturday, and only a partial shutdown on Sunday. The blue week shows typical operation Monday-Saturday, and a full shutdown of machinery on Sunday. SiteWatch compared the cost (by equipment type) between a partial full shutdown weekend:

Table 5: Full vs. Partial Shutdown Weekend Cost

Machine Type	*Partial Shutdown Cost per Weekend*	*Full Shutdown Cost per Weekend*
Non-Production Equipment	$19.60	$16.56
Chillers	$180.19	$2.53
Industrial Heating	$0.00	$0.00
Air Compressors	$133.86	$0.00
Blowers	$0.55	$0.00
Motors	$188.32	$0.00
Miscellaneous	$137.99	$0.00
Total	$660.51	$19.09

The difference in energy use was primarily driven by equipment that only served production equipment, such as chillers, air compressors, motors, and miscellaneous equipment left on during the weekend. None of the equipment is required to operate during non-production periods, leading the customer to potentially $33,000 in annual energy savings.

Runtime Percent and Load Factor

Runtime percent and load factor indicate how often a machine runs and at what energy intensity. As production equipment, supporting machinery, and HVAC systems all may have different operating criteria, these variables should be reviewed by site personnel to confirm machines are operating at an accepted level for the expected amount of time. The SiteWatch team will check machinery included in this analysis as part of a regular review process.

Runtime % - Runtime percentage is expressed as a percent of the hours when each machine has a load versus overall hours in the monitoring period:

 # Hours with Any Load / # Total Period Hours = Runtime %

Average Load Factor – This parameter demonstrates what level of loading the machine sees across the monitoring period when the equipment is operating. The average load factor is calculated as follows:

Avg kW (or amps) When Running / Max kW (or amps) (measured or nameplate) = Avg Load Factor

Load factor is based on the measured maximum kW (or amps) or the machine's nameplate full load amps, if available.

An average load factor that is too high or low can indicate several issues with a machine or how it is operated. Likewise, runtime % can indicate to site personnel if equipment is being operated too often.

- A high average load factor (>90%) may indicate overloaded equipment. Equipment size should be reviewed when replacing. This also indicates equipment that may fail before the end of expected useful life.
- A low average load factor (<30%) may indicate improperly sized or improperly loaded equipment. Pumps and fans with a low average load factor are likely operating in an inefficient part of their

performance curve or are cycling ON/OFF frequently. Compressors with a low load factor may be oversized or may be operating when there is no load on the system.

- High runtime percentage (>75%) may be acceptable but may also indicate equipment inadvertently left running at the end of production.
- Low runtime percentage (<10%) indicates equipment that is not being used as part of typical site operations and can indicate to personnel that switching duty/standby machines is required.

Table 6: Runtime and Load Factor by Machine (July 2019 through July 2020)

Machine	*Machine Type*	*Runtime %*	*Average Load Factor*	*Max Measured kW*
Chiller 1	Chillers	71%	58%	58.24
Chiller 2	Chillers	91%	63%	90.80
Recycle Grinder 1	Chillers	64%	37%	34.49
Thermoformer 1	Industrial Heating	62%	41%	69.18
Thermoformer 2	Industrial Heating	60%	39%	63.44
Thermoformer 3	Industrial Heating	49%	38%	86.45
Thermoformer 4	Industrial Heating	46%	58%	64.88
Air Compressor 1	Air Compressors	19%	69%	92.11
Air Compressor 2	Air Compressors	71%	73%	95.39
Air Compressor 3	Air Compressors	79%	58%	94.04
Recycle Grinder 2	Blowers	72%	66%	36.94
Bus Duct A	Motors	65%	31%	13.95
Recycle Grinder 3	Motors	46%	11%	126.39
Recycle Grinder 4	Motors	63%	46%	36.15
Line Trim Press 1	Motors	48%	43%	22.15
Line Trim Press 2	Motors	66%	38%	13.24
Extruder 1	Motors	84%	78%	94.21
Extruder 1 Winder	Motors	84%	72%	20.19

Several issues were flagged during this review:

- Chiller 1 had a low load factor when operating leading the chiller to run at a lower efficiency than desired (less cooling produced per kW).
- Chiller 2 has an excessive runtime, primarily due to the chiller operating through the weekend.
- Recycle Grinders 1 and 3 have low load factors due to infrequent use while energized. Though the equipment is powered on, actual grinding only takes place during limited periods.
- Extruder 1 and the associated Winder have a runtime that does not align with other operations. More information was requested from the customer to ensure the runtime aligned with actual use.

Percent of Time by Load Factor

The table below shows the amount of time a machine is operated at each load factor. Zero percent indicates a machine is off, while 90-100% indicates a machine operating near fully loaded.

Each machine may be considered individually, or within a group of equipment serving a common system or production line.

Table 7: % of Monitoring Period by Load Factor Range by Machine (July 2019 through July 2020)

Machine	*Load Factor Range*					
	0%	*1-25%*	*26-50%*	*51-75%*	*76-90%*	*91-100%*
Chiller 1	30%	1%	11%	47%	7%	3%
Chiller 2	10%	9%	7%	46%	26%	3%
Recycle Grinder 1	37%	23%	16%	23%	1%	0%
Thermoformer 1	38%	18%	10%	33%	1%	0%
Thermoformer 2	41%	24%	4%	25%	6%	0%
Thermoformer 3	50%	20%	3%	26%	1%	0%
Thermoformer 4	55%	4%	5%	30%	6%	0%
Air Compressor 1	79%	2%	2%	5%	10%	2%
Air Compressor 2	31%	1%	2%	33%	28%	6%
Air Compressor 3	22%	19%	8%	17%	20%	14%
Recycle Grinder 2	28%	4%	5%	55%	8%	0%
Bus Duct A	36%	28%	27%	6%	2%	0%
Recycle Grinder 3	50%	45%	2%	1%	1%	0%
Recycle Grinder 4	38%	15%	5%	43%	0%	0%
Line Trim Press 1	54%	15%	11%	13%	7%	0%
Line Trim Press 2	36%	21%	19%	24%	1%	0%
Extruder 1	17%	1%	3%	13%	60%	5%
Extruder 1 Winder	17%	1%	1%	59%	22%	0%

While the nameplate full load amps are helpful for developing this table, Sitewatch can use the maximum measured amps assuming the equipment experiences loading near its rated capacity at some point.

- Ideal load factor from an energy efficiency standpoint is between 50-90%, and most operating hours should fall in this range.
- Equipment with significant hours between 1-25% indicates a machine may be oversized for its system.
- Equipment with significant hours >90% may indicate a machine is overloaded or undersized, leading to ongoing maintenance issues or decreased service life.

Several issues were flagged during this review:

- 3 of 4 thermoformers spent 20-25% of the monitored period at very low load, indicating the machinery was powered but not in production. The customer was advised on the impact for keeping these machines on standby versus shutting them down completely between production cycles
- Chillers 1 and 2 spent most operating hours between 25-75% loaded. Chillers operate less efficiently at part-load, so the customer was advised to operate only one chiller for most production periods unless

chilled water supply temperature cannot be maintained, at which point they should enable the second chiller.

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