Intelligent Compressor Control for Reduced Energy Usage

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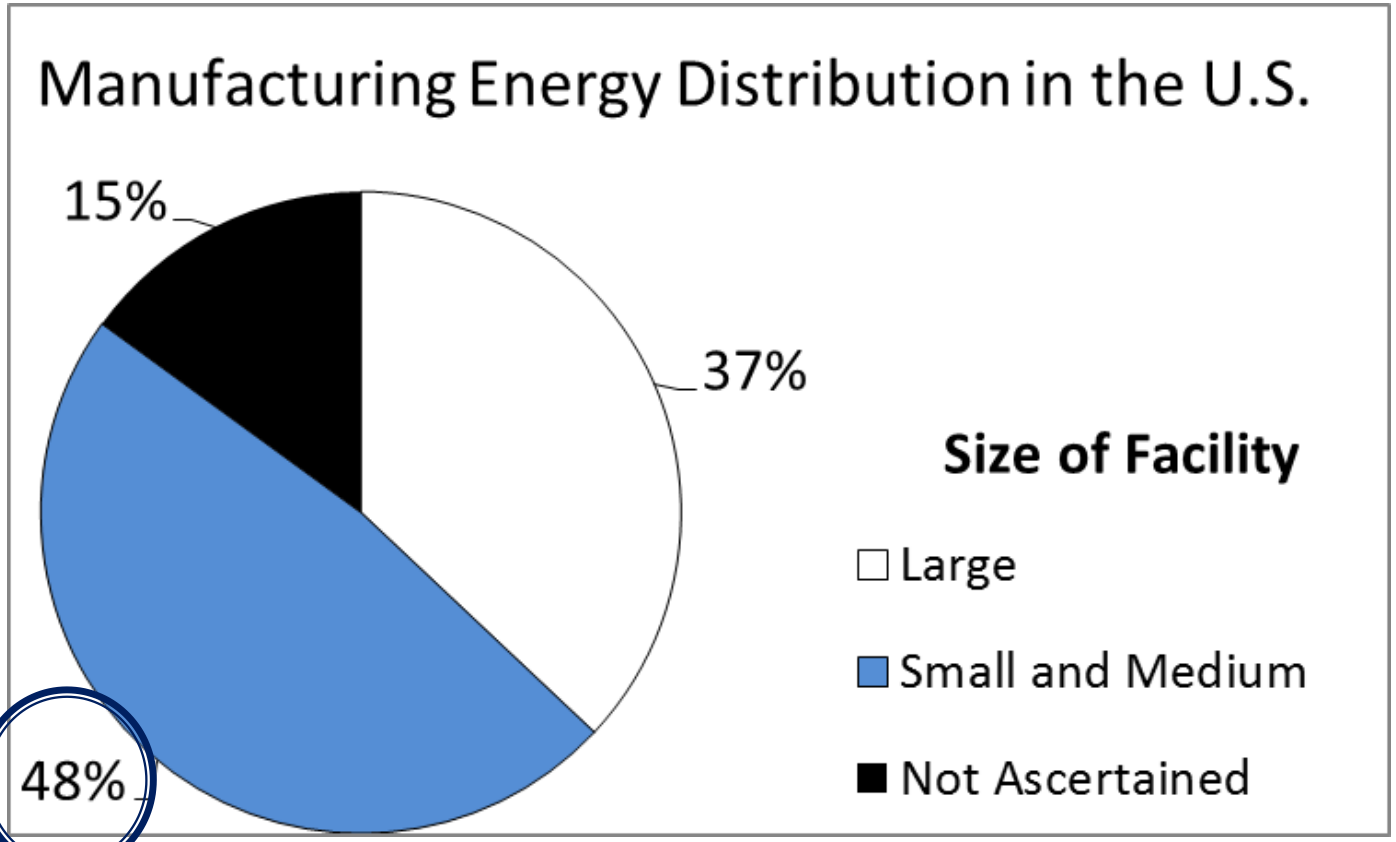
Outline:

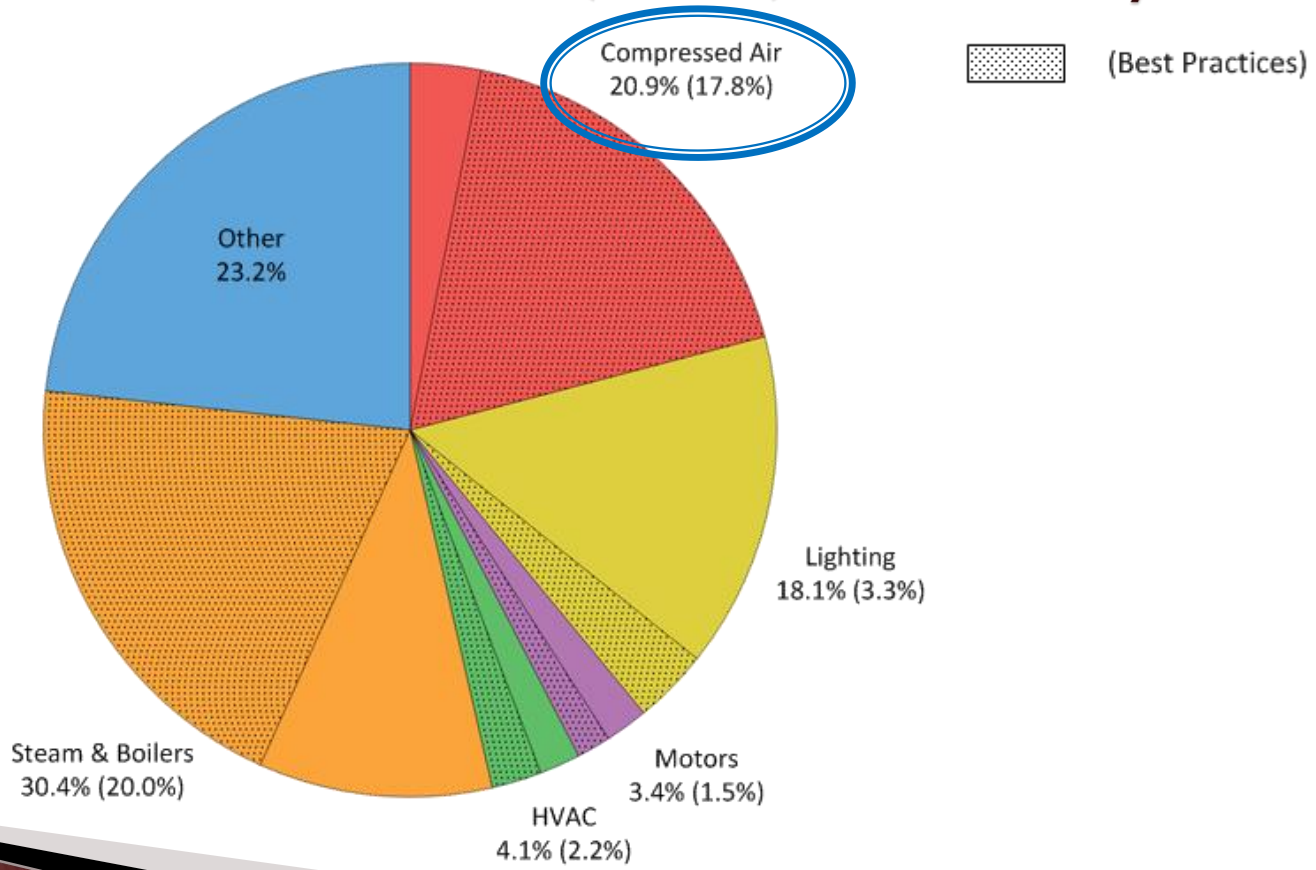
- Opportunities in the manufacturing industry
- Intelligent control of compressed air systems
- Simulation results and associated energy savings
- Ancillary benefits of data-rich manufacturing

- Texas A&M: One of 28 centers
- Small- to medium-sized manufacturers

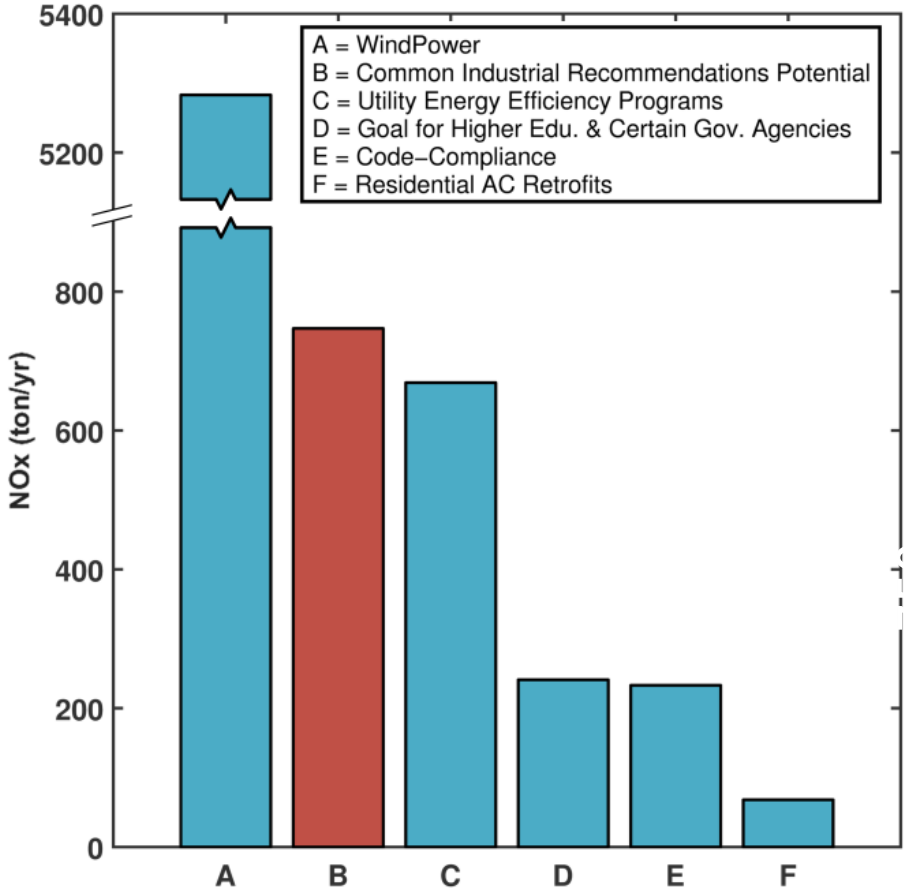
Manufacturing is a dominant energy user in the US



A large portion of savings in the IAC result from low cost energy conservation measures (ECMs) to basic systems



Widespread implementation of common ECMs have similar potential avoided emissions to other Texas programs

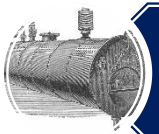


Data can enable the widespread adoption of common ECMs and unlock additional ECMs in manufacturing

Smaller manufacturers typically have limited energy management expertise

Motors

Compressed Air



Boilers

Lighting

Chillers

Compressed air systems are widespread in manufacturing and notorious for wasted energy

- Reliable (under maintained)
- Expensive "4th Utility"
- Built based on initial plant needs
- Varying pressure requirements

Common ECMs:

Repair air leaks

Reduce plant pressure

Two basic strategies are discussed for energy savings in this presentation

Turn off the compressed air system during non-production hours

Dynamically adjust the pressure setpoint during production to minimize energy usage

- Differing pressure requirements
- Pressure loss in piping resulting in virtual increases in pressure requirements

By using monitored data, compressors can be intelligently controlled and unlock additional energy savings

Modern compressors are equipped with remote operation capabilities

Using machine learning, the compressor pressure setpoints can be dynamically adjusted

Plant production remains the highest priority

Current and pressure sensors are used to monitor the system and provide data for control

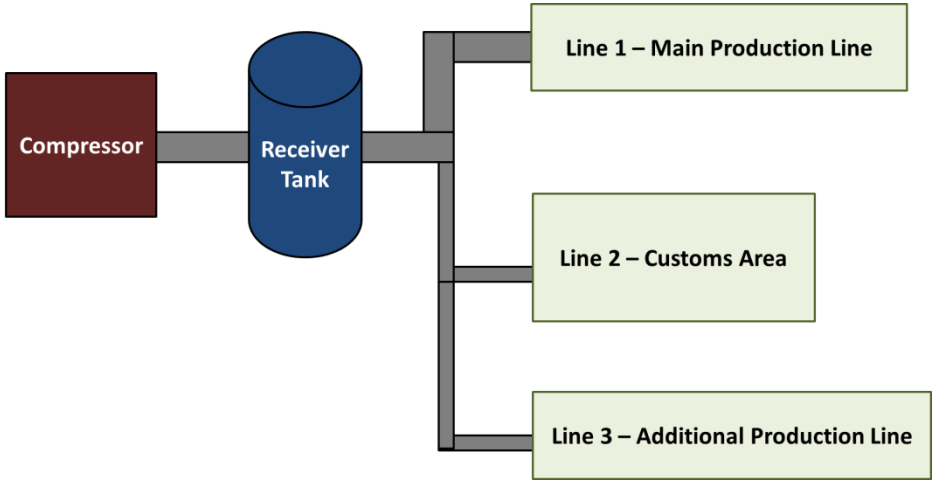
- Minimum of 1 pressure or current transformer for basic system control.

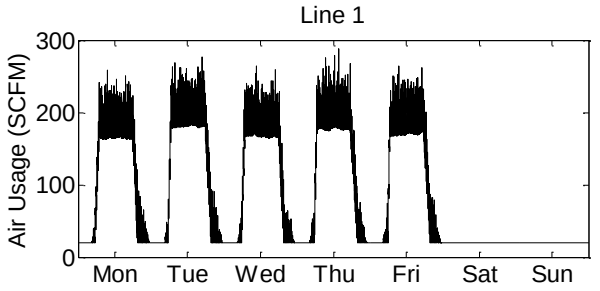
- Additional pressure sensors on major lines or equipment enable more complex control

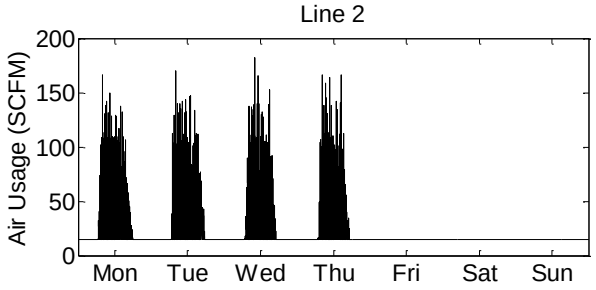
The simulation includes 3 operating lines with varying air usage and operating schedules

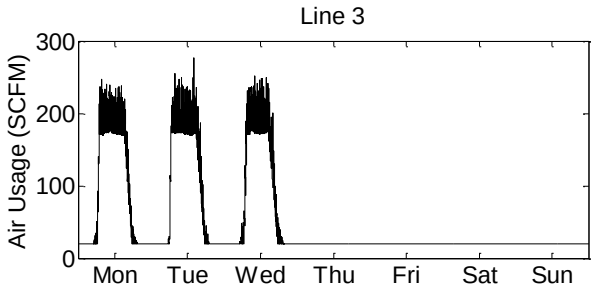
Production Lines

Customs Area

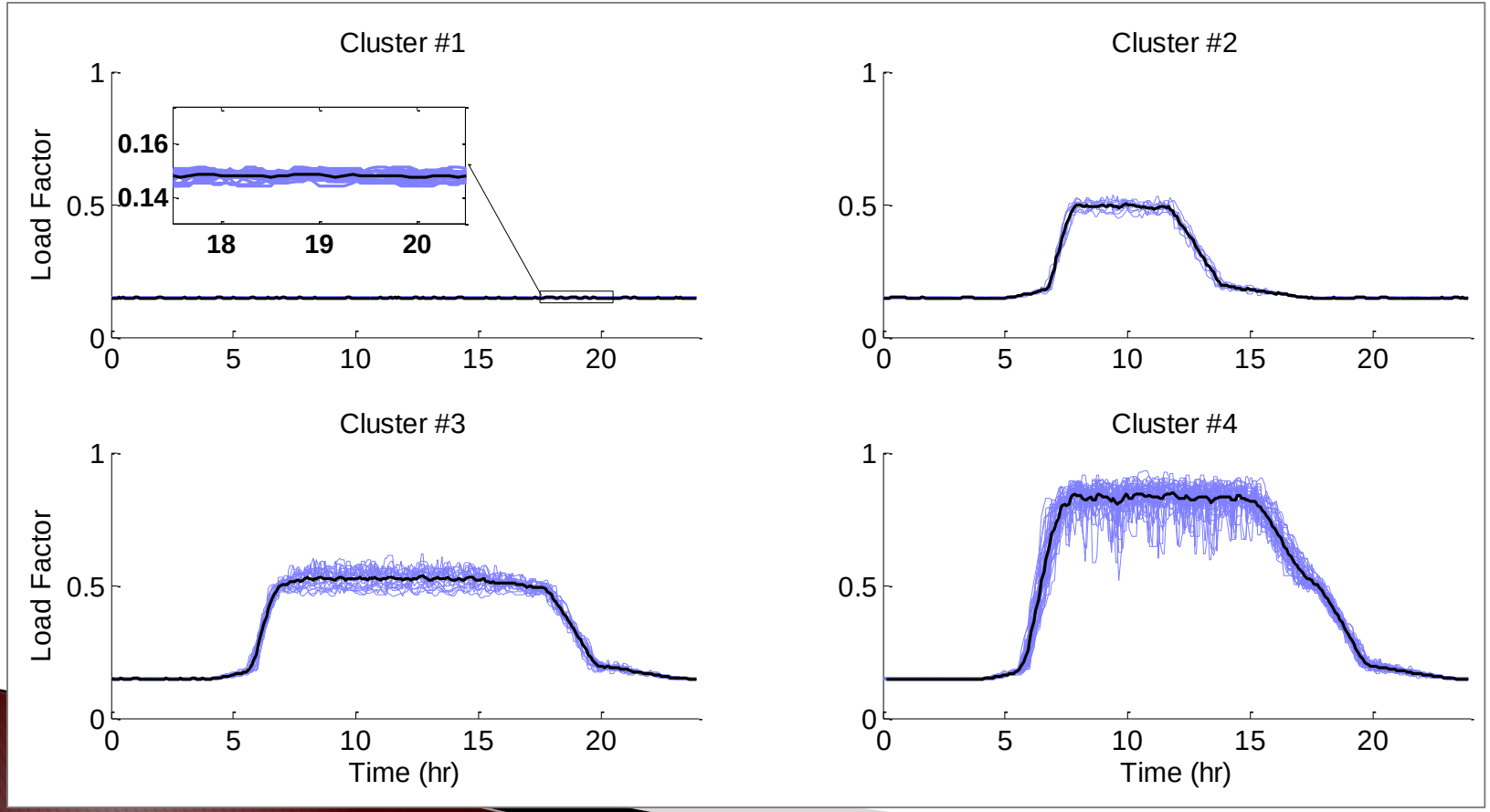




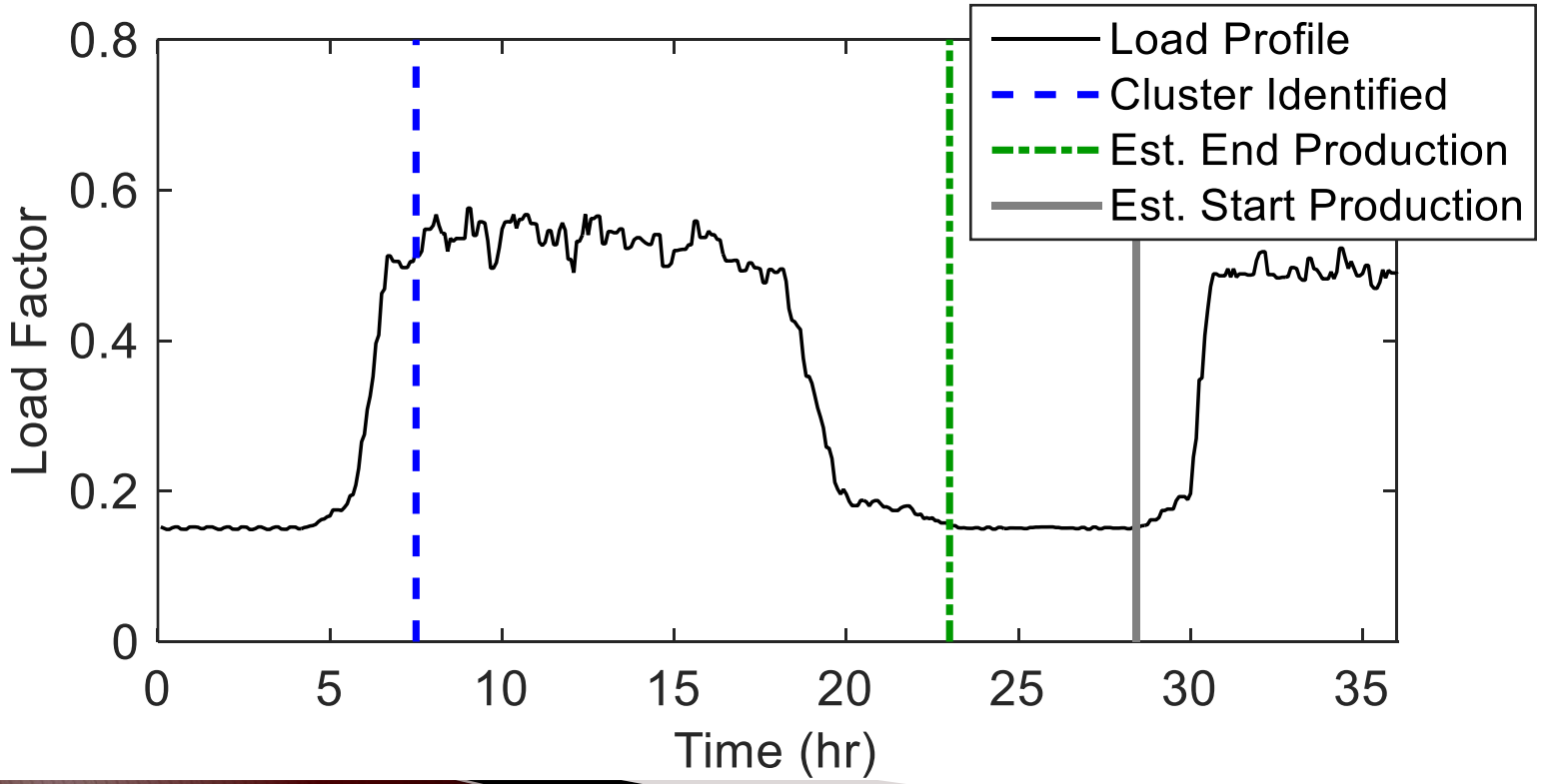




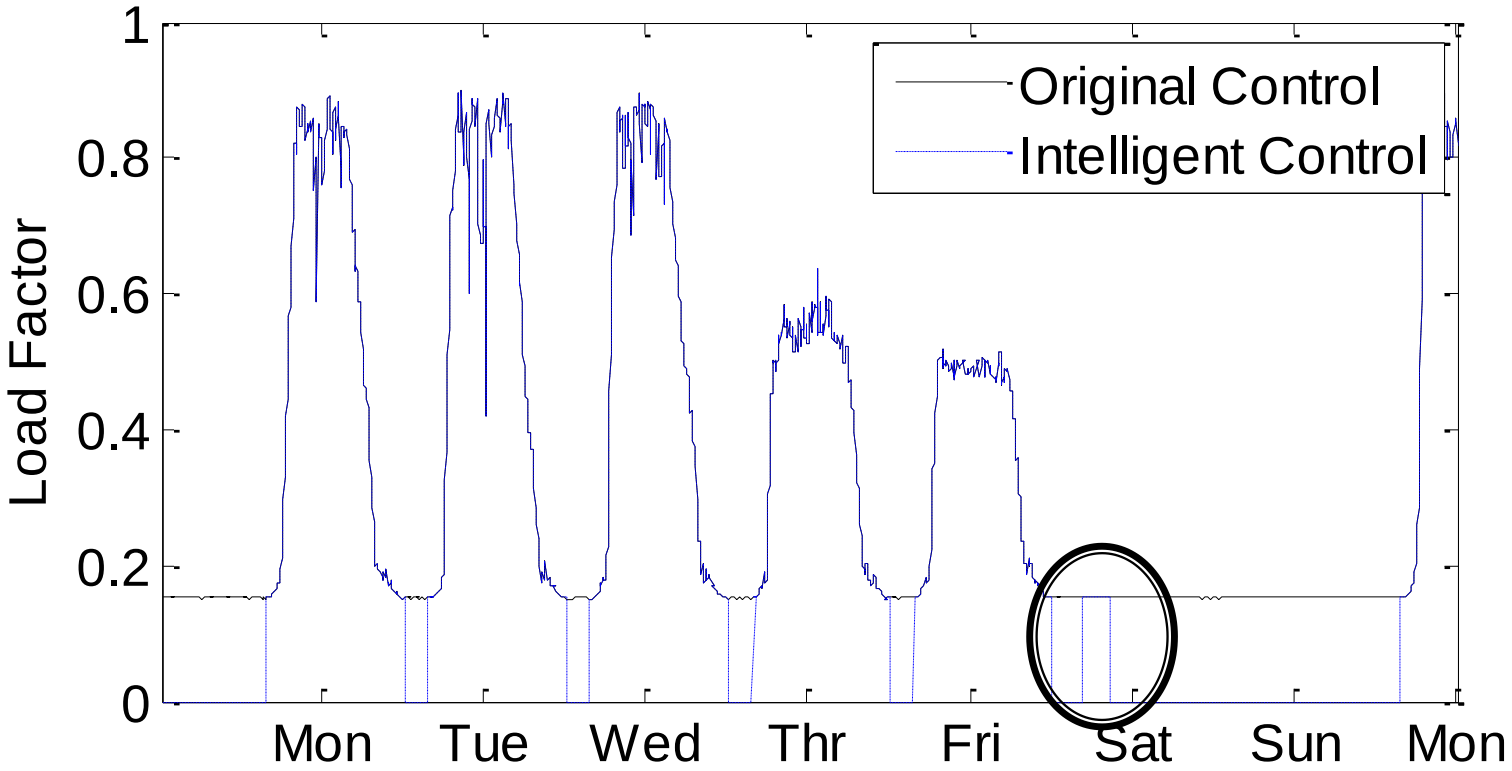
An adaptive k-means clustering algorithm is used to identify the operation of the compressor for each day



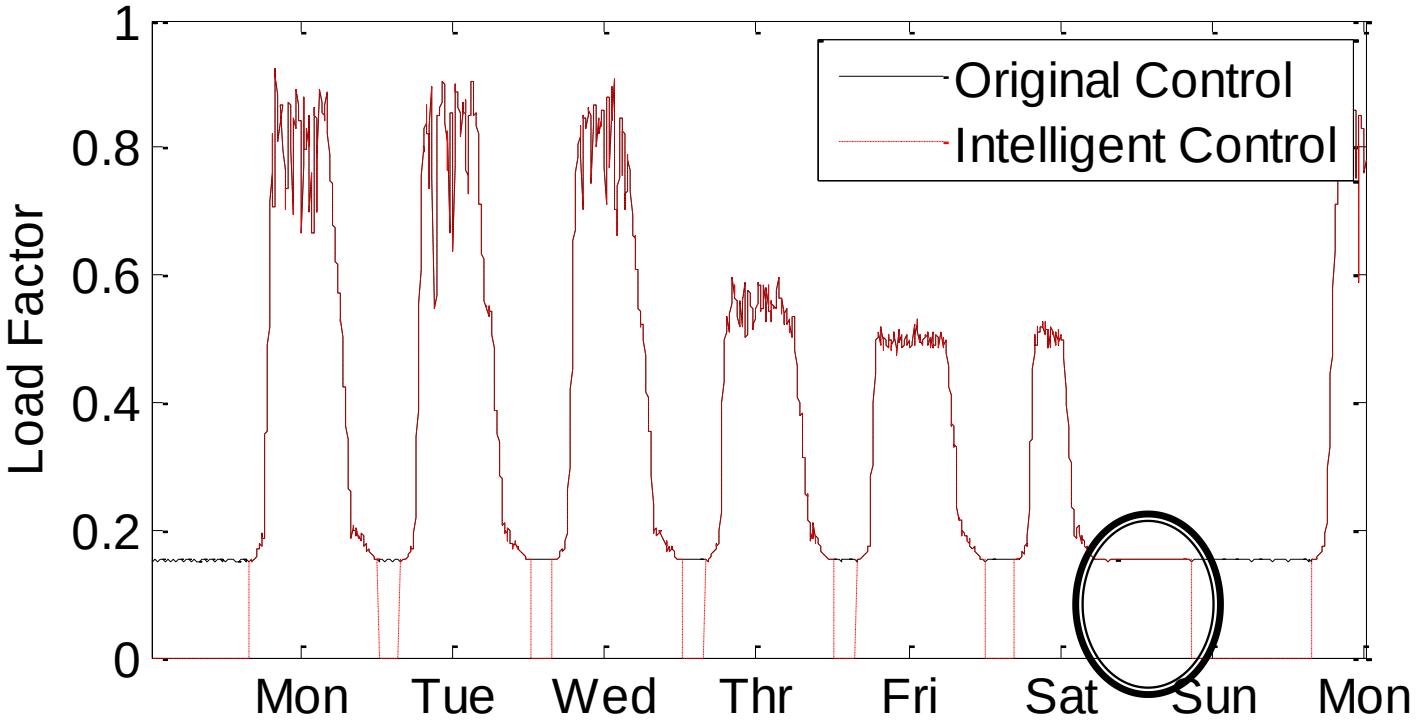
Each day is autonomously evaluated and assigned to a cluster, after which the end and start times of production are estimated



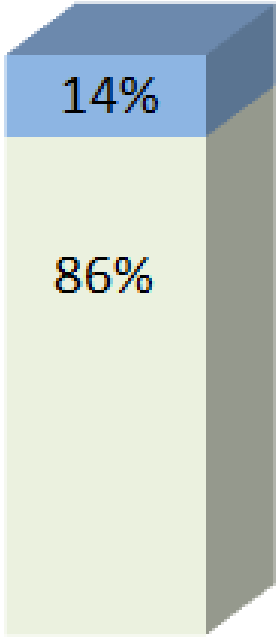
Results of System-Level Control



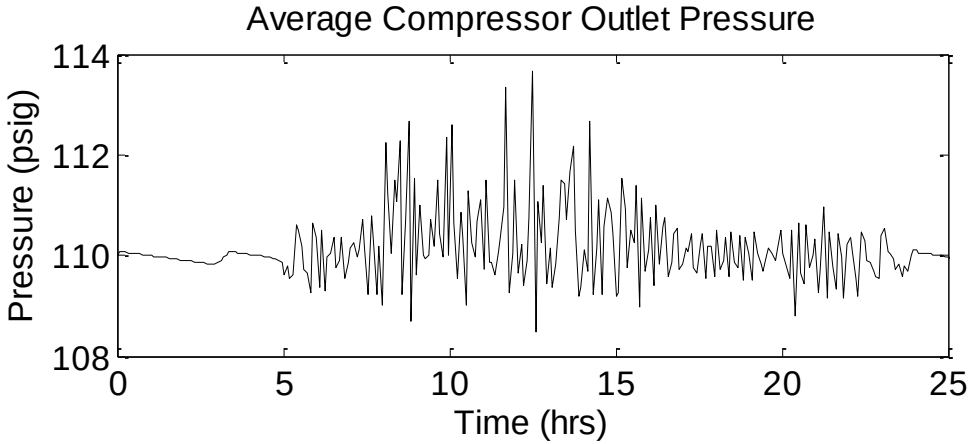
System Control Results

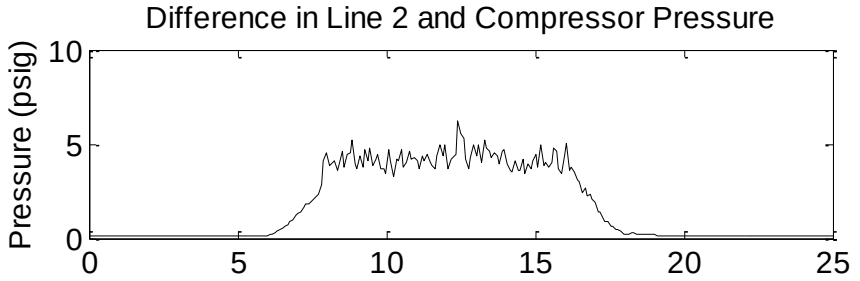


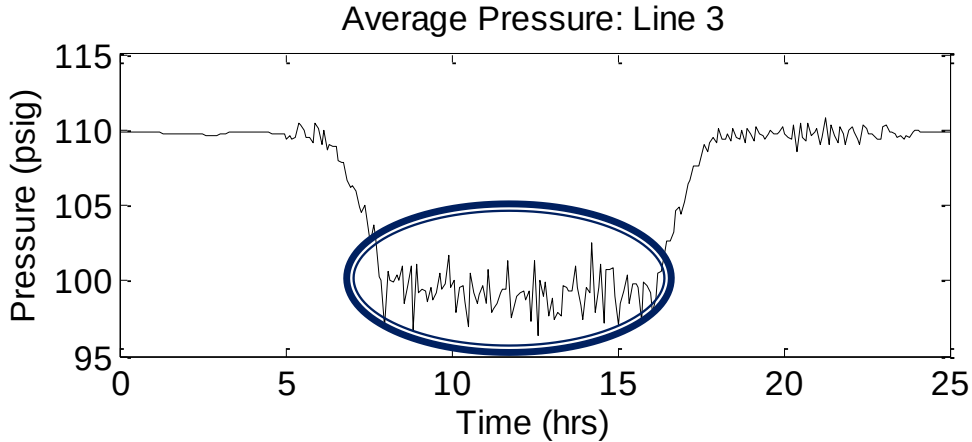
Energy Savings

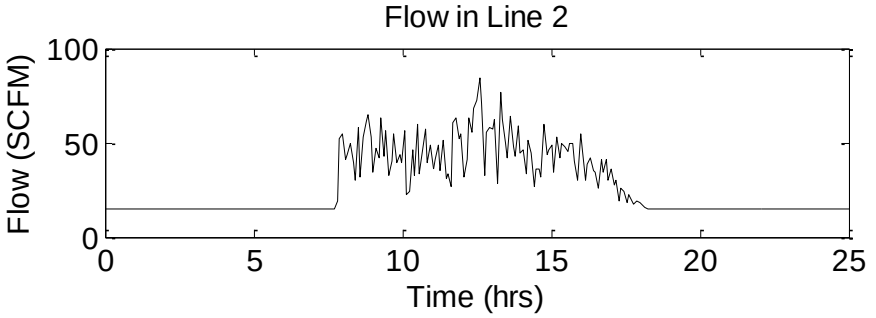


The difference in line pressure and compressor outlet pressure may be used to adjust compressor setpoints

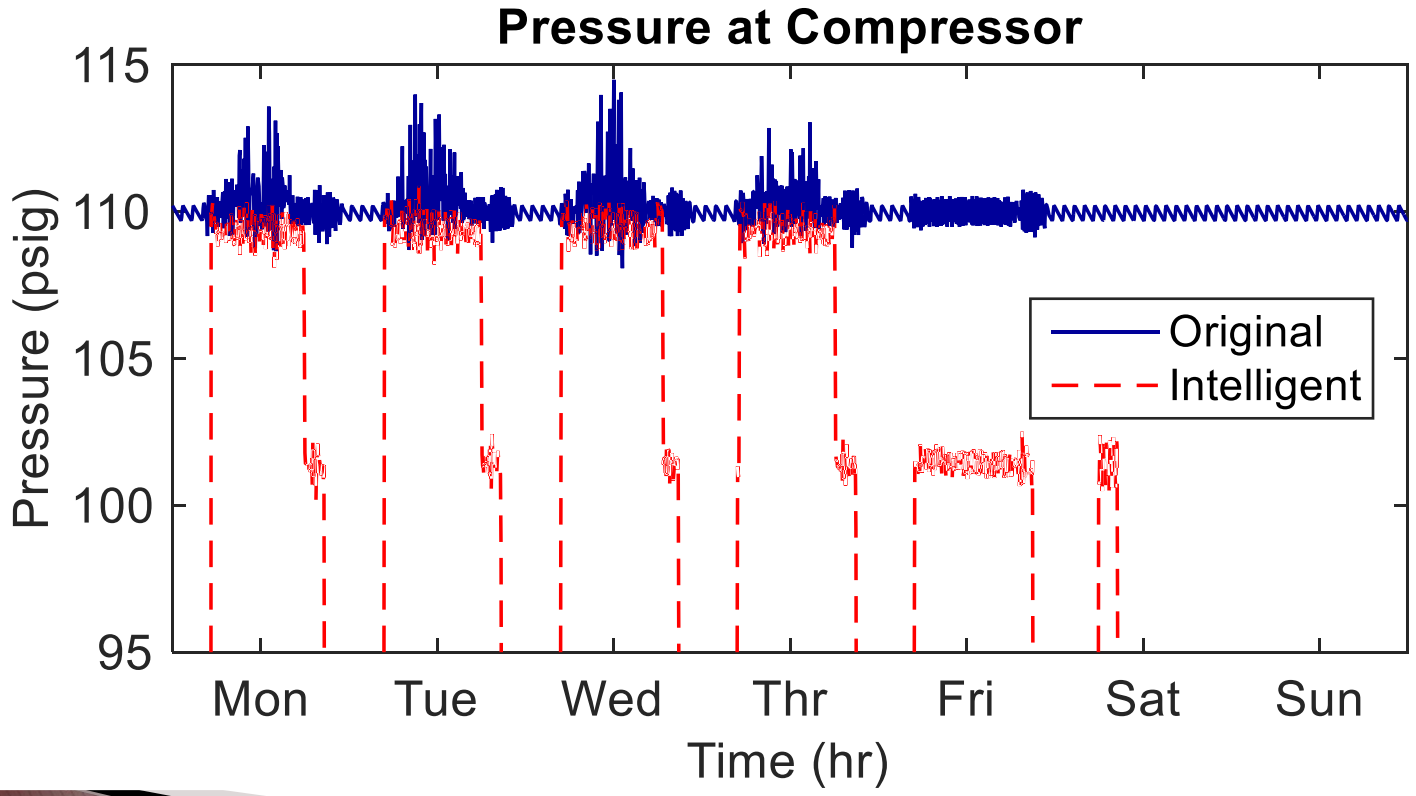








Simulation results on pressure reduction



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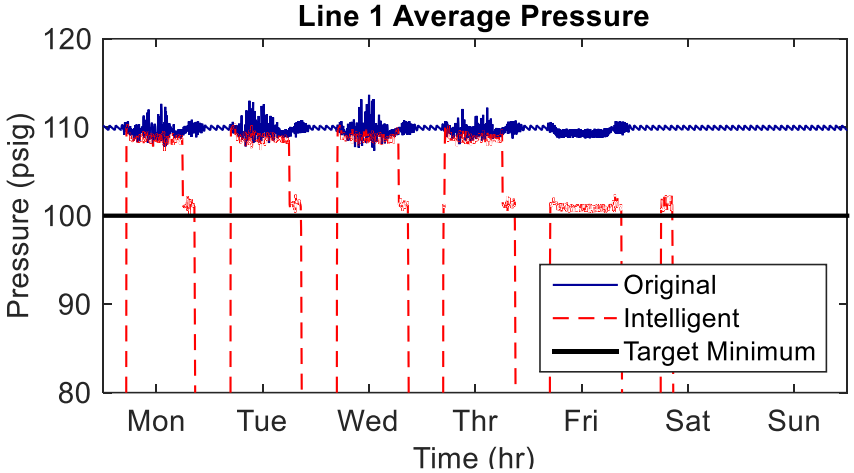
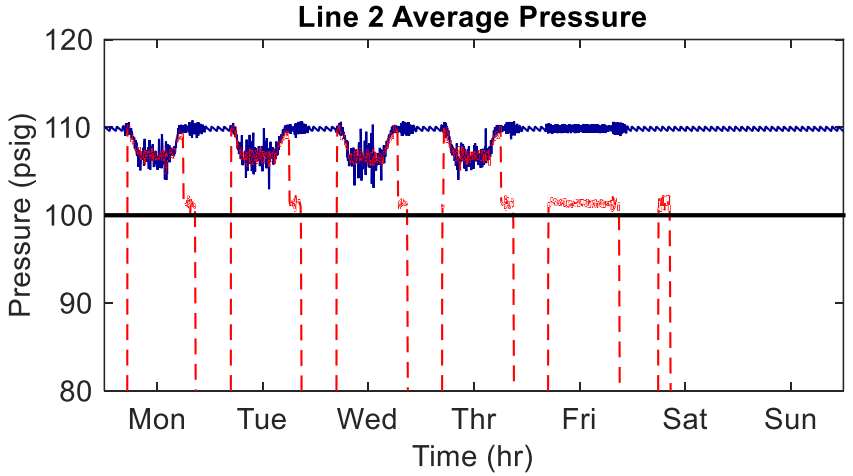
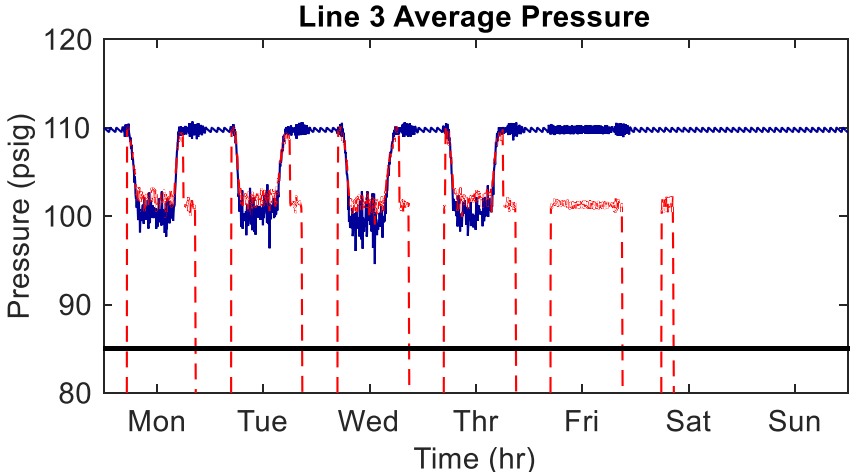
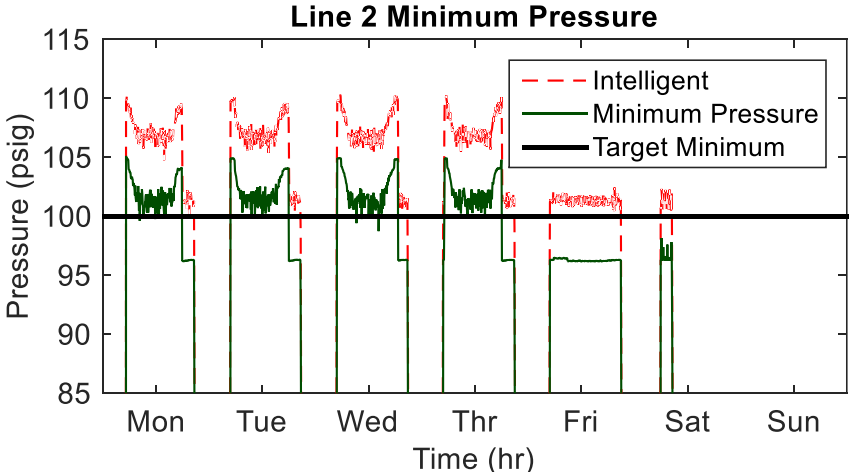
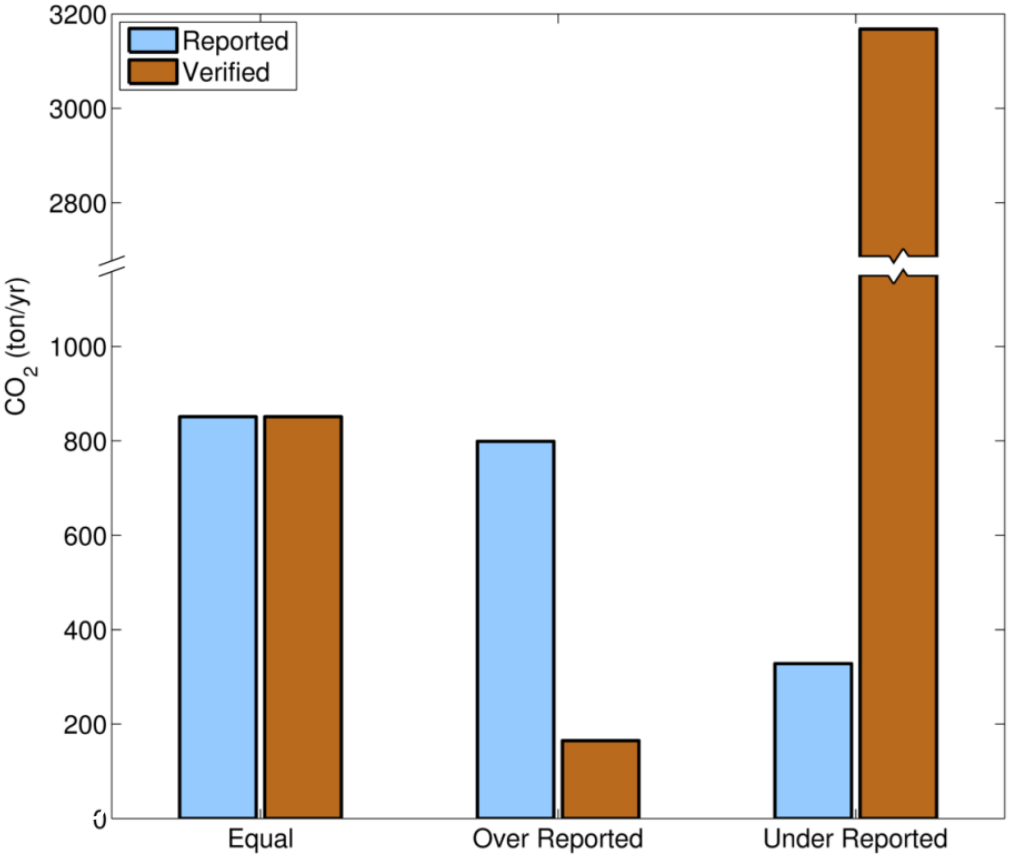








Ancillary Benefit 1: ECMs often have underreported savings that can be automatically verified with intelligent control



"Emissions Reductions Potential from Common Energy Efficiency Projects in Small to Medium-Sized Industries". South-central Partnership for an Energy Efficiency as a Resource (*SPEER*) and *DOE*, 2016.

Ancillary Benefit 2: Continuous monitoring allows tracking and verification for legislative emissions targets

SPEER
The South-central Partnership for Energy Efficiency as a Resource

Emissions Verification Database

TEXAS A&M UNIVERSITY

Client Breakdown

	#	%	Total Utilities
Small Manufacturers ($20,000 - $200,000)	23	31%	$ 2,689,151
Medium Manufacturers ($200,000 - $2,000,000)	41	55%	$ 26,788,717
Large Manufacturers ($2,000,000 - $20,000,000)	11	15%	$ 42,708,974
Exceptional Manufacturers ($20,000,000+)	0	0%	$ -
Total Clients	75	100%	$ 72,186,842
Eligible For 3PV Verification	50	66.7%	
Received Third Party Verification (3PV) Visit	7	14.0%	

Savings Breakdown

	Electricity (kWh/yr)	Demand (kW/yr)	Natural Gas (MMBtu/yr)	CO2 (ton/year)	NOx (kg/year)
Total Proposed Savings	71,762,257	139,365	270,521	47,299	47,765
Total Verified Savings	20,786,999	30,248	35,152	10,953	10,617
Captured Savings	29.0%	21.7%	13.0%	23.2%	22.2%

Total Proposed PAR Savings	35,658,215	48,404	41,623	19,149	20,749
Total Verified PAR Savings	17,493,629	23,708	10,446	7,897	7,247
Captured Savings	49.1%	49.0%	25.1%	41.2%	34.9%

Implementation Rates

Overall Implementation Rate	42.8%
Non-PAR Cimplementation Rate	36.0%
PAR Implementation Rate	47.1%

PAR Verification Breakdown

Self Reported	228
Self Verified	0
Third Part Verified (3PV)	40
Unverified	128
Total	396

Conclusions

- Industrial energy systems have potential low cost opportunities using data rich solutions
- Compressed air systems typically have significant potential for improvement
- Using pressure sensors or power meters, production schedules can be estimated on compressed air systems to generate energy savings
- Ancillary benefits of intelligent control include verification of efficiency retrofits and legislative emissions targets