ENVIRO-STEWARDS

# Finding Energy Savings in Production Processes

TUR Conference, April 9, 2024

# Agenda.

## Purpose:

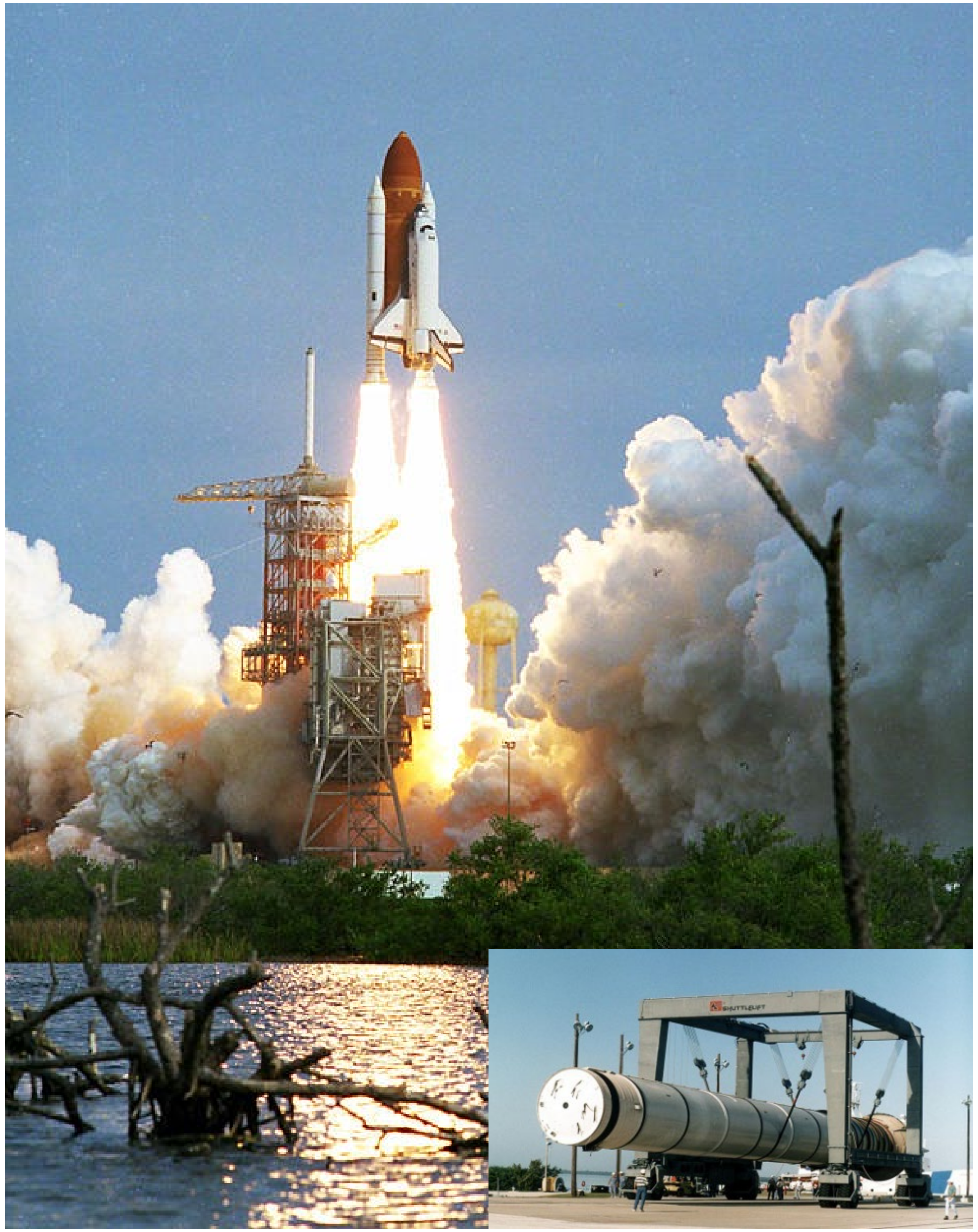
- Identifying practical, affordable measures to conserve energy

## Process:

- Holistic project approach
- Relevant case studies
- Questions & answers

## Payoff:

- Higher margins, smaller footprints, and Brand stewardship



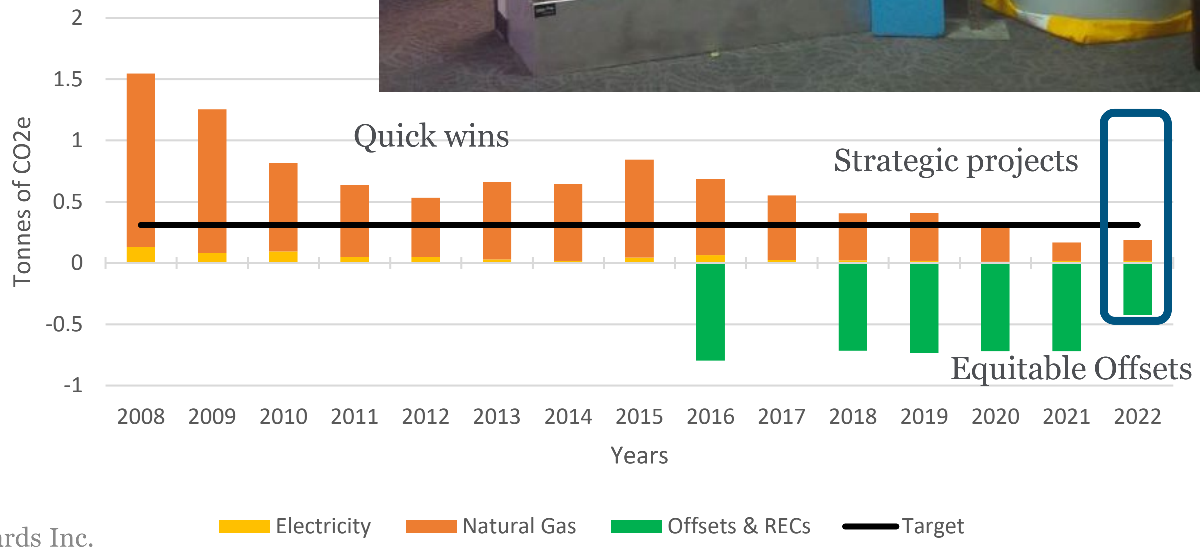
# “Walk the walk.”

Footprint: operations (scope 1&2 GHGs) and supply chain (scope 3 GHGs)

- 97% less outside air required
- **88%** reduction in GHGs/employee
- 0 L/year tap water for living wall for 5 years
- May 2021 added affordable smart blue roof

Handprint:

The impact (+ve or –ve) of your product or service (scope 4)



# GHG emissions.

## Three main types

**Scope 1:** Direct emissions produced on-site from burning fuels, leaking refrigerants or production processes.

**Scope 2:** Indirect emissions produced off-site from purchased electricity or other energy used on site.

**Scope 3:** Indirect emissions that are embedded in the purchased ingredients used in products (supply chain).

## Poll.

What volume is a tonne of $CO_2$?

a) 5 L
b) 500 L
c) 5 $m^3$
d) 500 $m^3$

Note:
1 gallon = 3.79 litres
1,000 L = 1 $m^3$
1,000 $m^3$ = 1 tonne

# Case study: large corporation.

## Maple Leaf Foods.

- Enviro-Stewards completed energy, water, and pollution prevention assessments at 35 facilities
- MLF reports 572 of the 1,300+ projects identified have been implemented (saving over $17 million to date)
- **World's First Major Carbon Neutral Food Company** (while generating a net increase in profitability)

2021 Clean50
exceptional contributors to the clean economy
TOP PROJECT


MAPLE LEAF

MAPLE LEAF FOODS

World's First Major Carbon Neutral Food Company

### MAPLE LEAF FOODS & ENVIRO-STEWARDS

#### LEADING BRANDS ARE COMMITTING TO CARBON NEUTRALITY SOMETIME IN THE FUTURE, *BUT WHY WAIT?*

There is simply no more time to waste. The urgency of the climate crisis requires us to act now. That is why in 2019, Maple Leaf Foods became the first major food company in the world to become carbon neutral and is on a journey to become the most sustainable protein company on earth.

Even more impressive, they **achieved carbon neutrality while generating a net increase in profitability**.

#### HOW DID MAPLE LEAF FOODS BECOME CARBON NEUTRAL?

By aggressively avoiding and reducing its greenhouse gas emissions across its operations and supply chain and by investing in high-impact environmental projects across North America to offset the remaining, unavoidable emissions.

MLF's sustainability team retained Enviro-Stewards to find practical viable measures to reduce its environmental footprint at each of 35 MLF facilities across North America.

Thus far, the conservation measures have resulted in the following savings*:

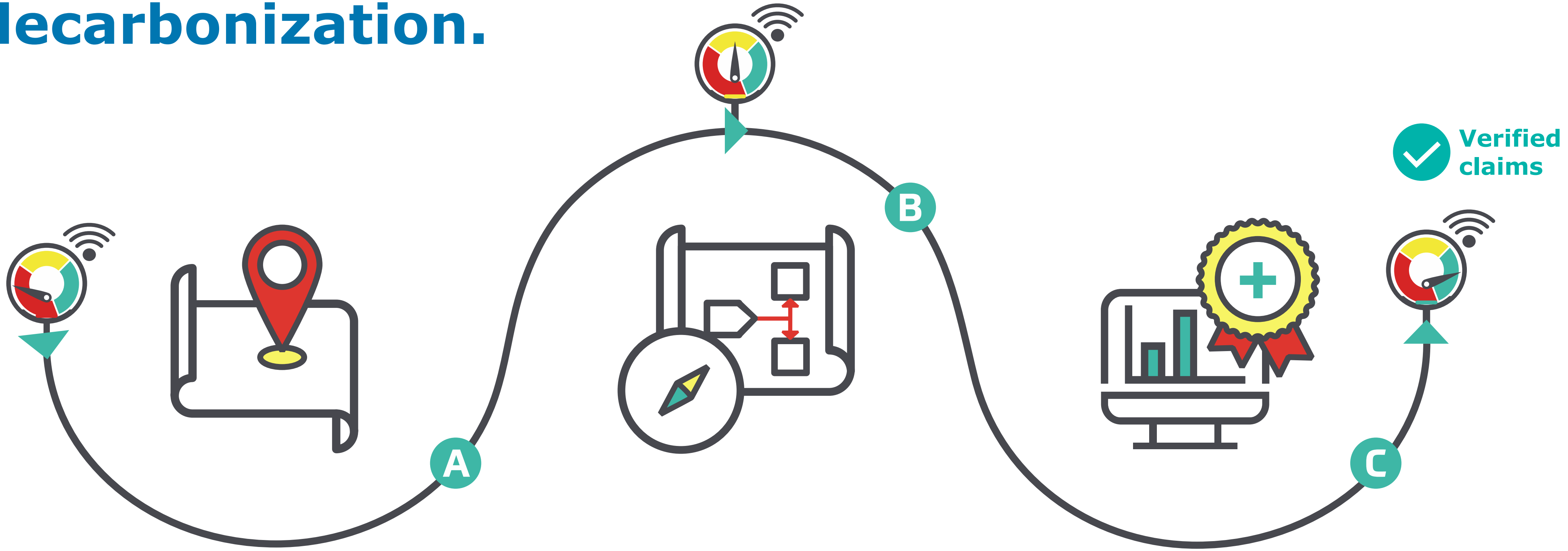
- 1.77% absolute reduction in SBT Scope 1 & 2 GHG emissions
- 19.5% reduction in natural gas intensity
- 25.9% reduction in electricity intensity
- 21.6% reduction in water intensity, and
- 12.1% reduction in solid waste intensity (91.6% diversion rate)

All of the above savings have a **payback period of one year on average!**

ENVIRO-STEWARDS
engineering change

*Note: Performance measured from 2014 baseline with the exception of solid waste, which is a 2015 baseline and SBTs (Scope 1 and 2), which is a 2018 baseline.

# Energy conservation's role in decarbonization.




## A Baseline

Establish Starting points & targets

- Operations (Scope 1 & 2)
- Supply Chain (Scope 3)

## B Conserve

- Implement quick wins & deep retrofits
- Decarbonize supply chain

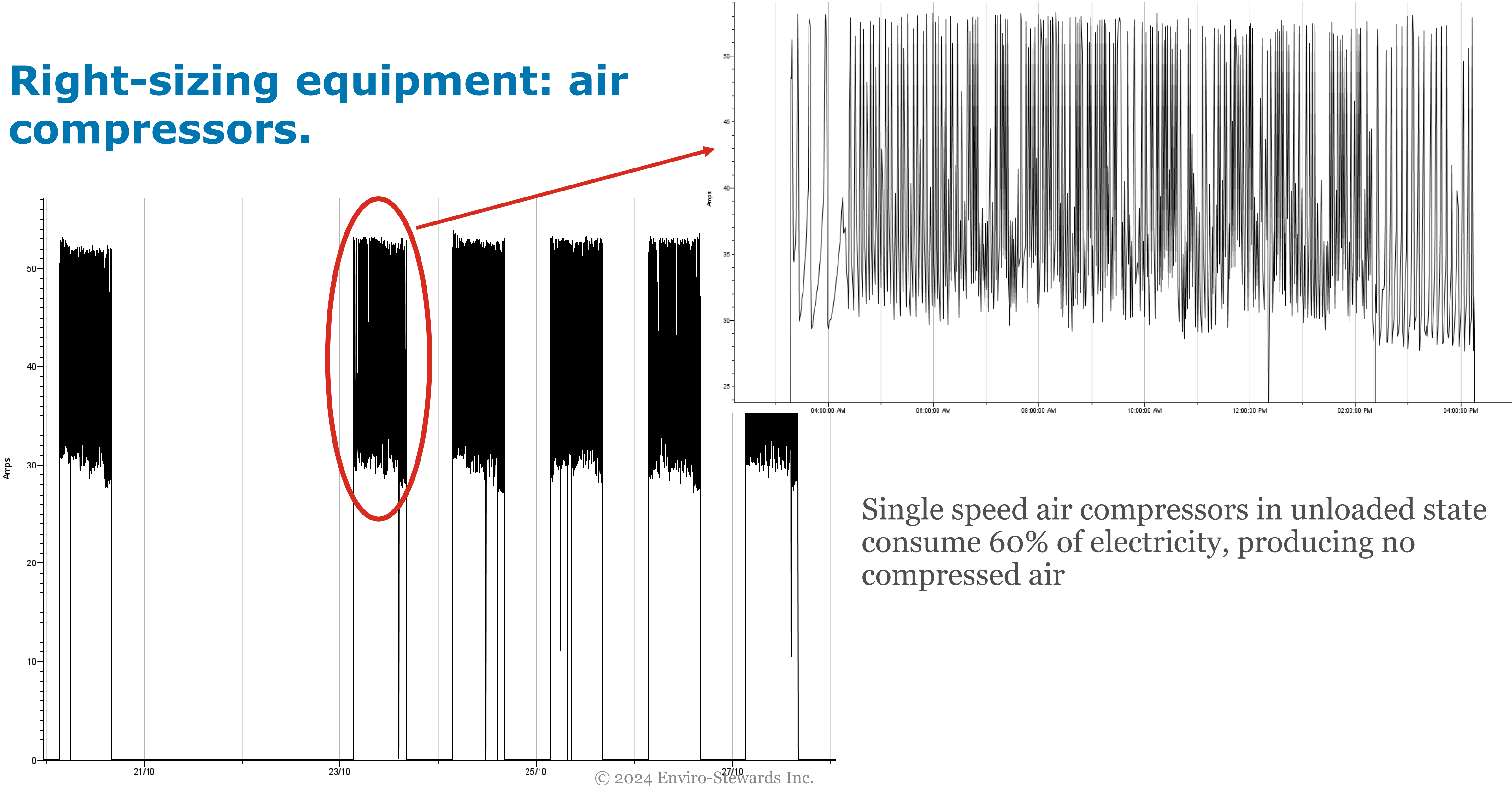
## C Replace

- Credibly replace remaining consumption/emissions
- Select SDG-rich project(s)

# Typical avenues explored in industrial energy conservation.

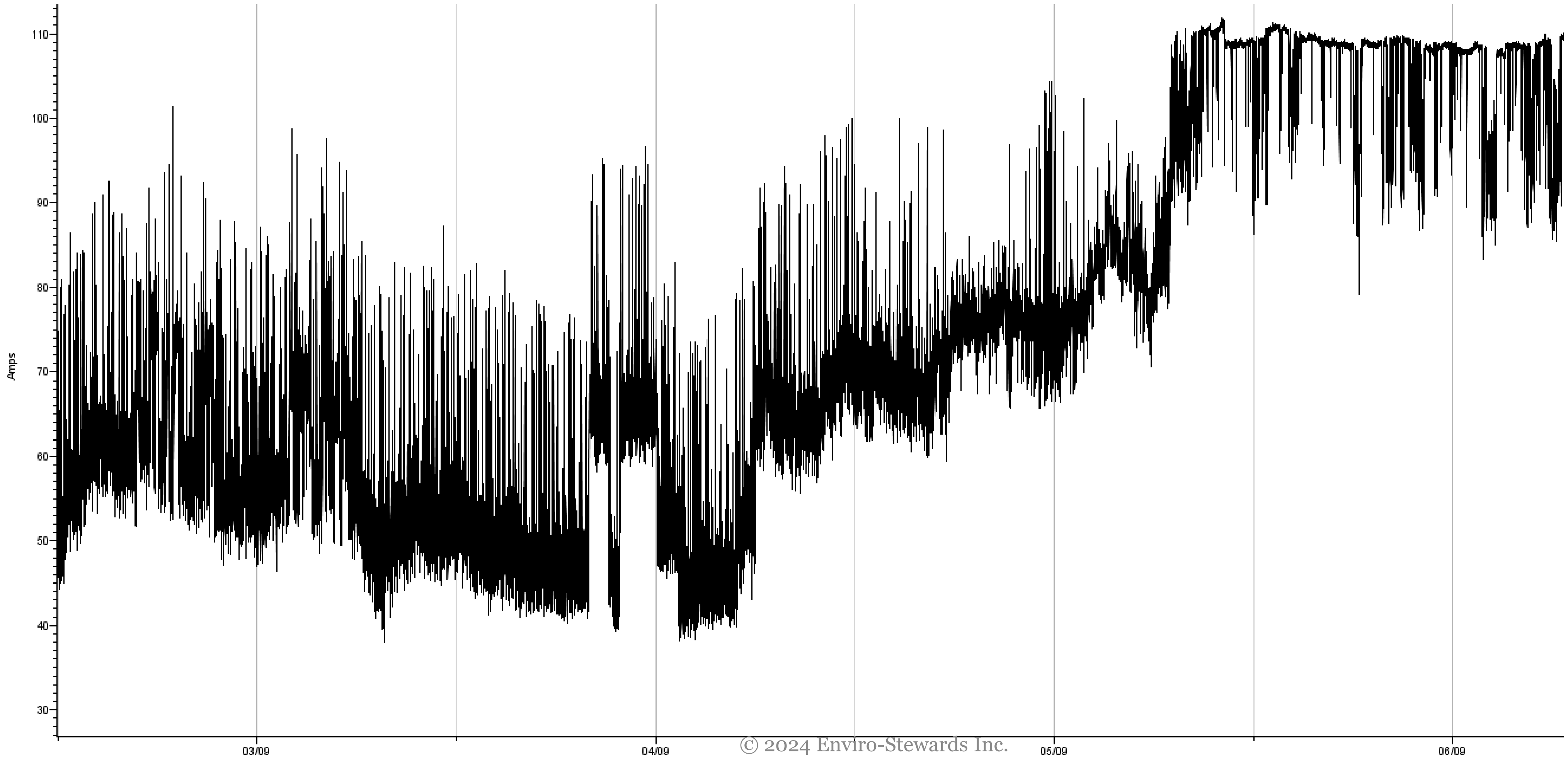
- **Lighting** (LED, occupancy, etc.)
- **HVAC** (air balancing, heat recovery, dehumidification, etc.)
- **Compressed air** (variable speed drives, leaks, heat reuse, etc.)
- **Refrigeration** (floating head pressure, free cooling, heat reuse, etc.)
- **CIP** (Clean-In-Place) **& hot water** (reuse tanks, nozzle selection, preheating, etc.)

# Right-sizing equipment: air compressors.




Single speed air compressors in unloaded state consume 60% of electricity, producing no compressed air

# Right-sizing equipment: air compressors.



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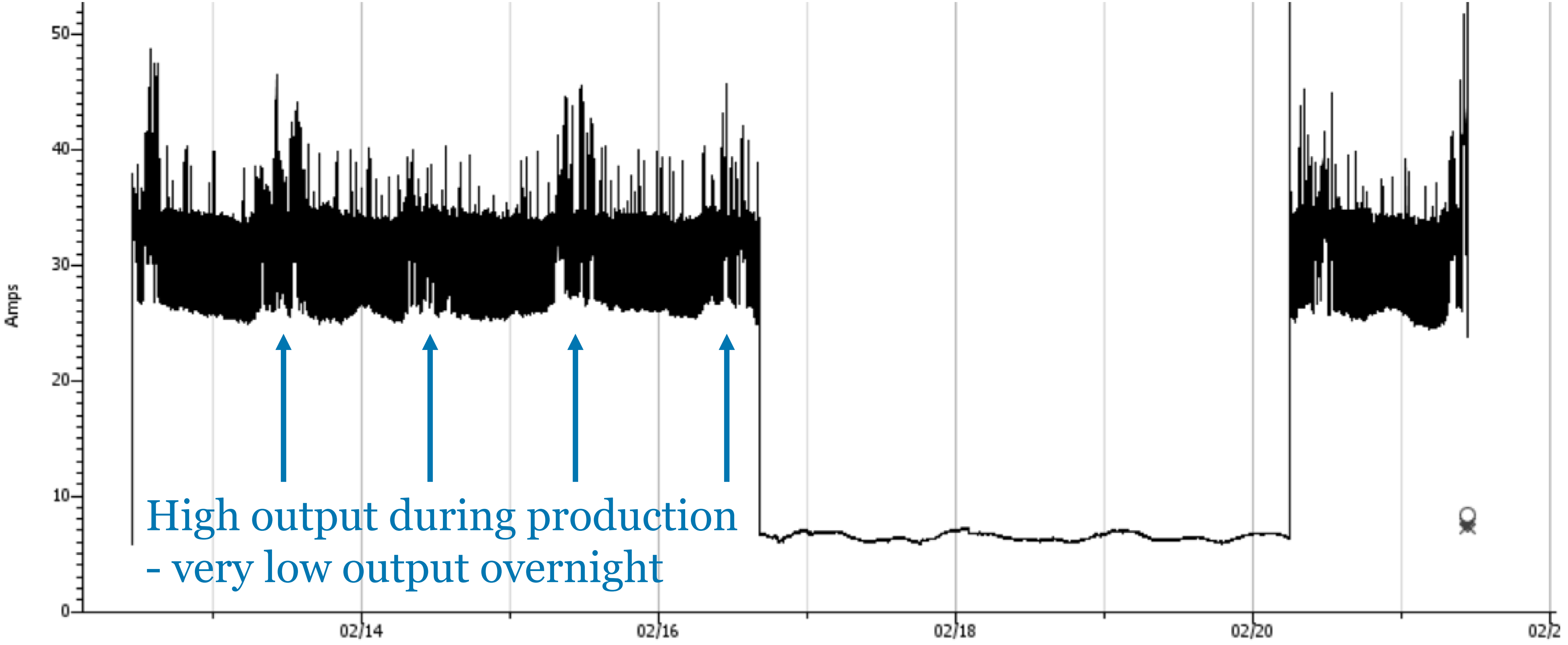

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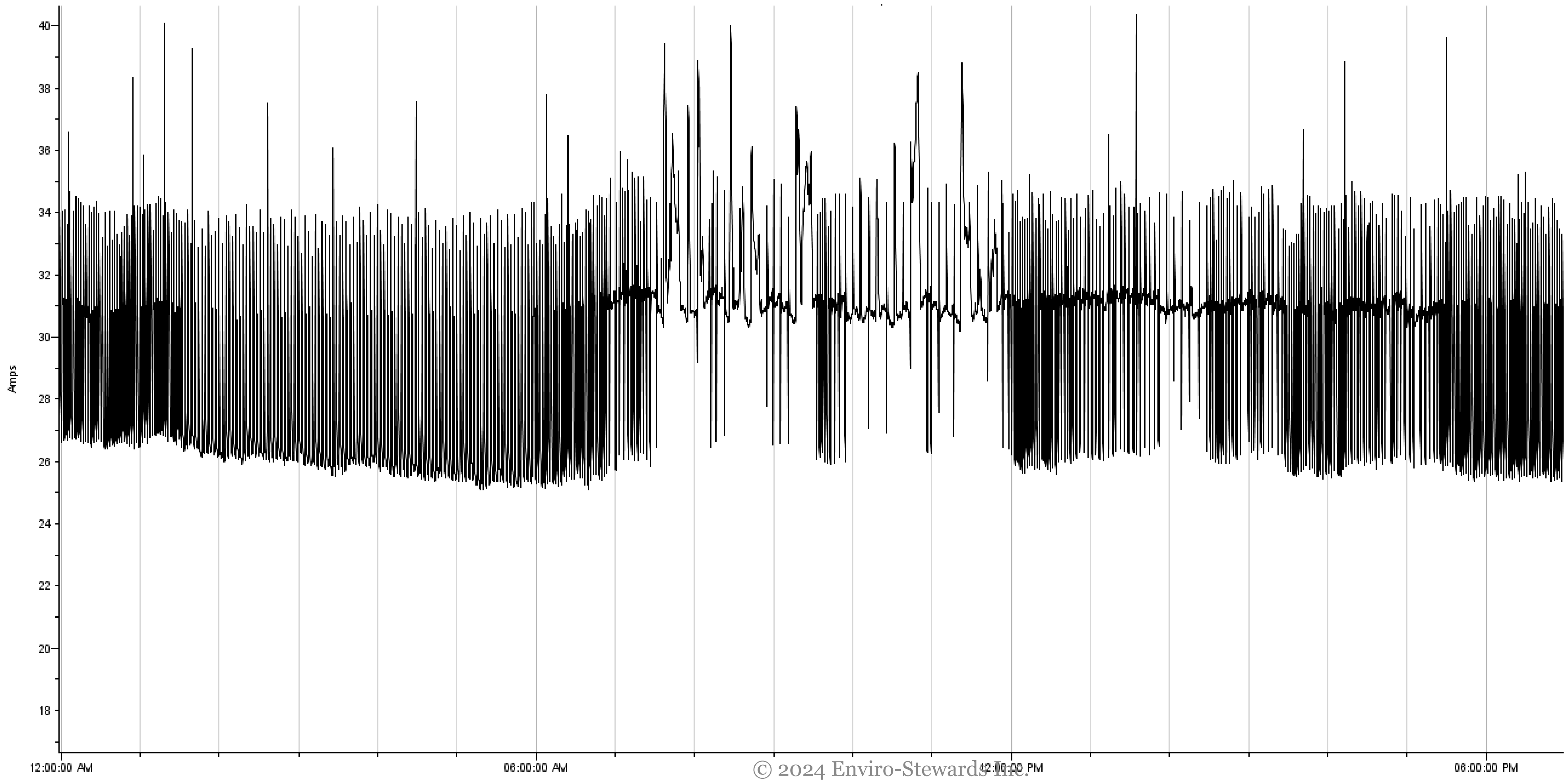


# Heat reuse.

- 100% of the electricity you buy eventually turns into heat
- Many facilities pay to get rid of that heat (while they purchase heat somewhere else)
- Cooling towers: use electricity, water, and chemicals to get rid of heat from refrigeration systems
- Direct contact water heater is 97% efficient
- Pre-heat that water with refrigeration waste heat: 2/3 less energy!


## Approach.

Assessment flow

- Kick-off
- Baseline assessment
- Data analysis & root cause analysis
- Opportunities & progress meeting
- Report (business case)
- Implementation & tracking

# Kickoff meeting.

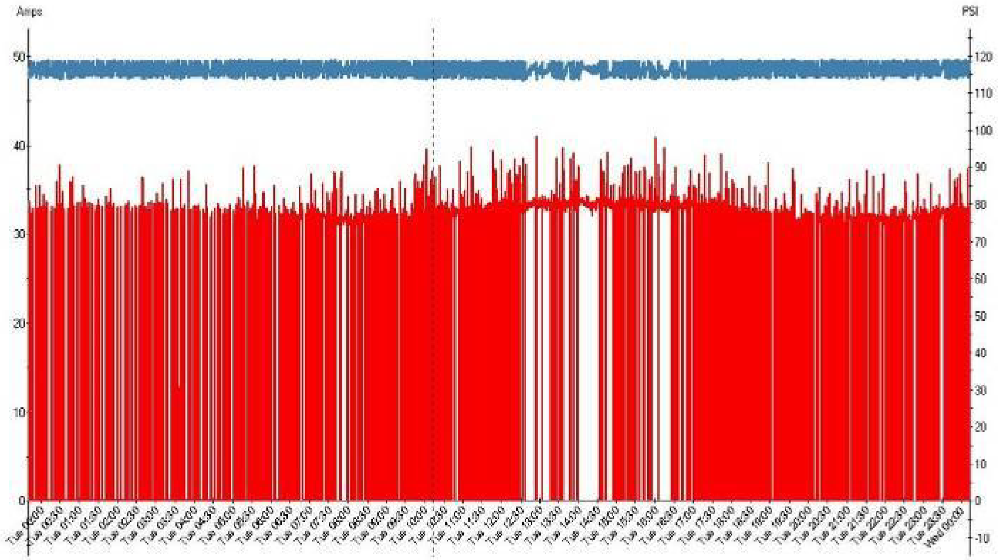
Gaining buy-in

- To facilitate change, a multi-disciplinary team participates in kick-off and progress meetings
- Stakeholders include management, engineering, maintenance, operations, QA/QC, purchasing

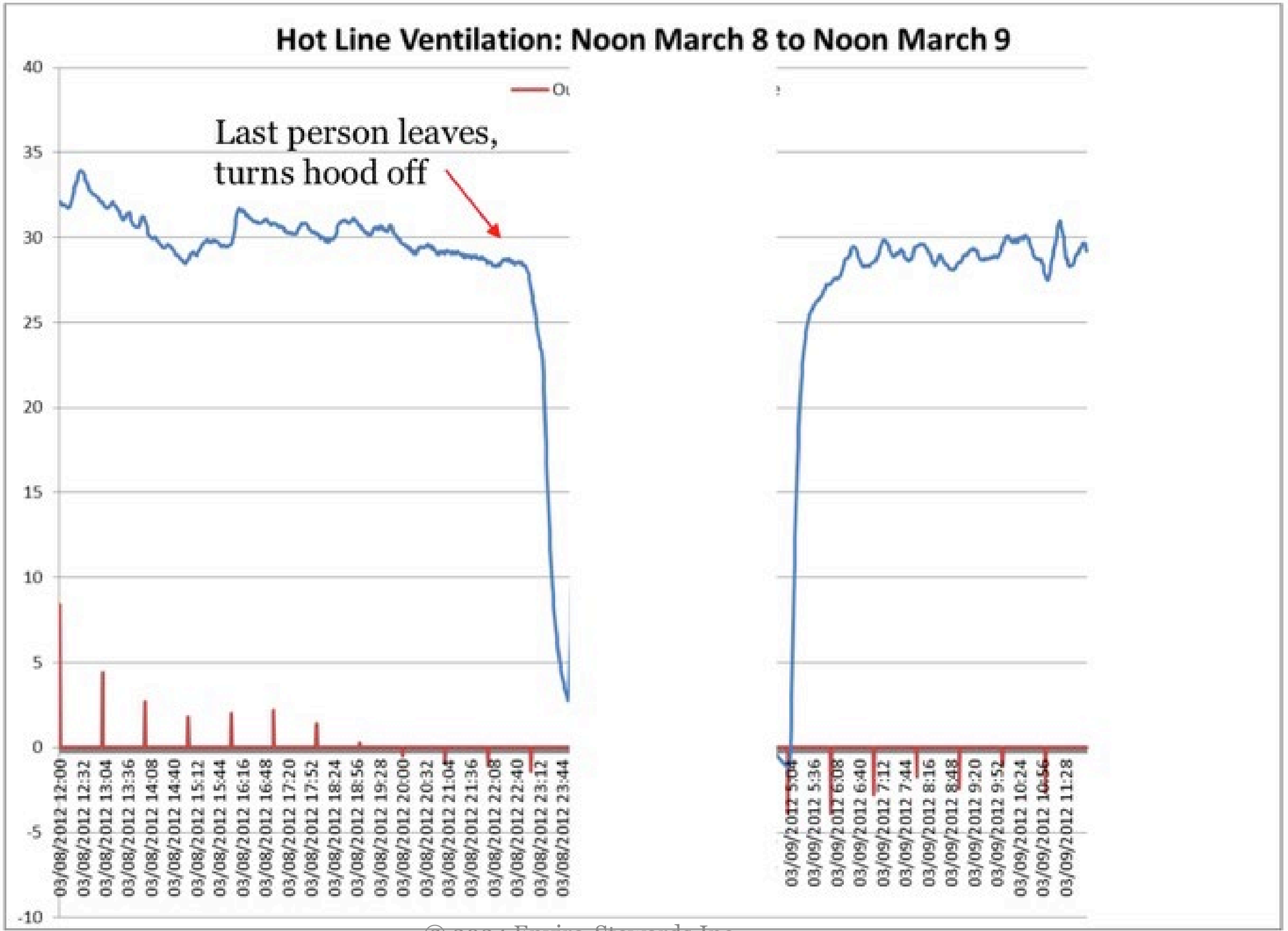
# Baseline assessment.

Collecting reliable data

- A detailed and systematic assessment of utility consumption and waste generation
- Logging, measuring, observing, utility data review, etc.

# What logging reveals.



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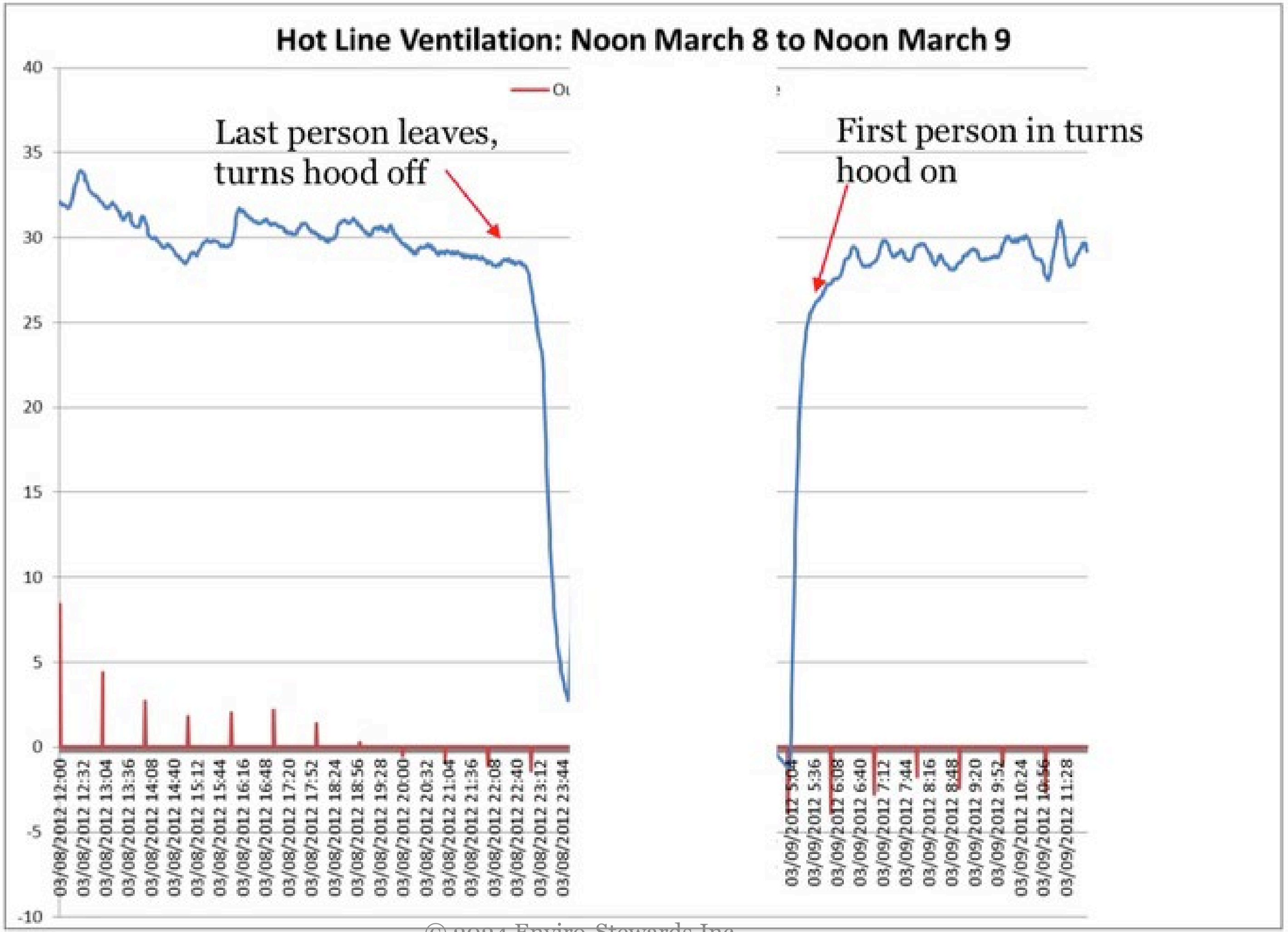

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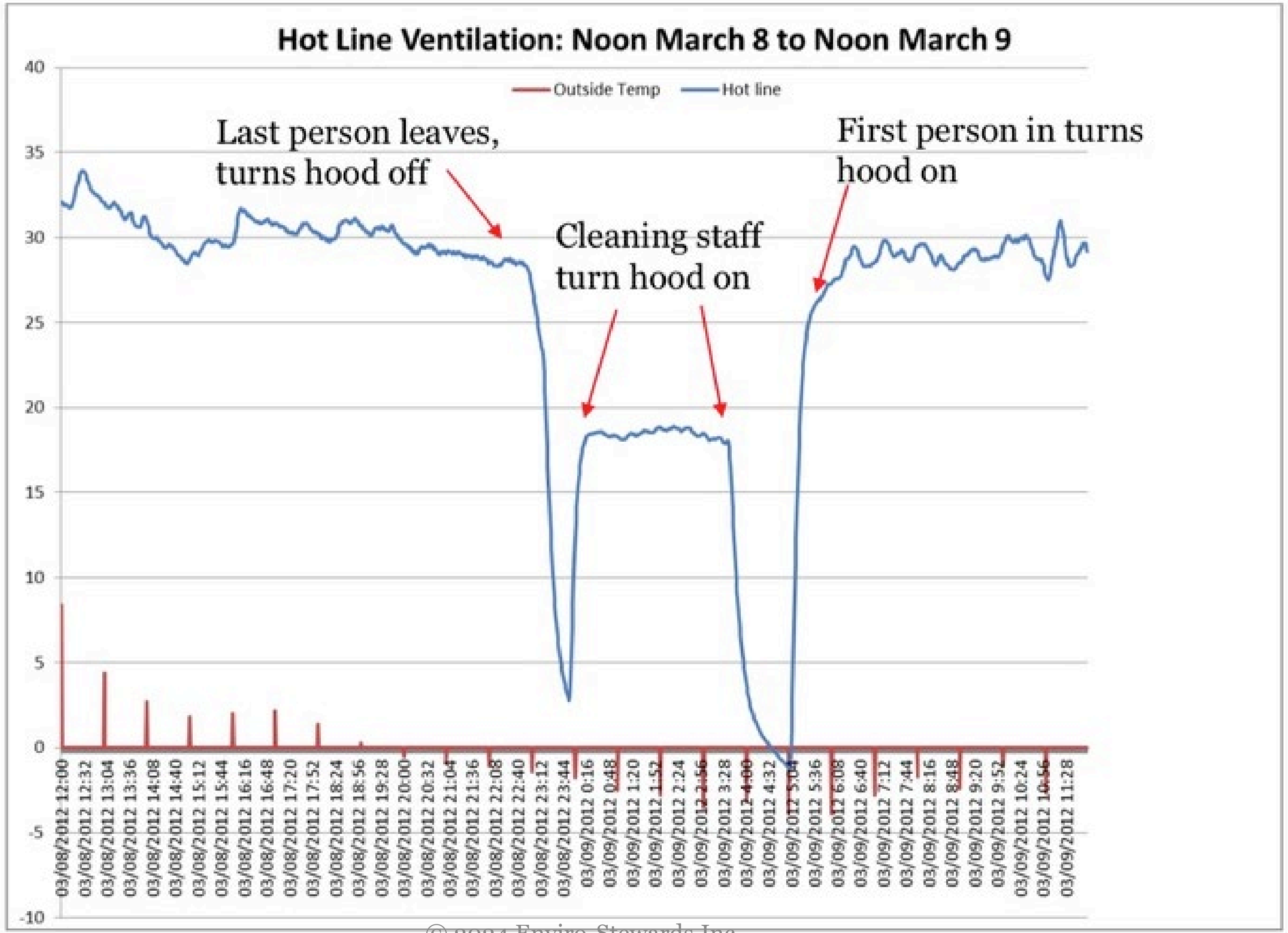
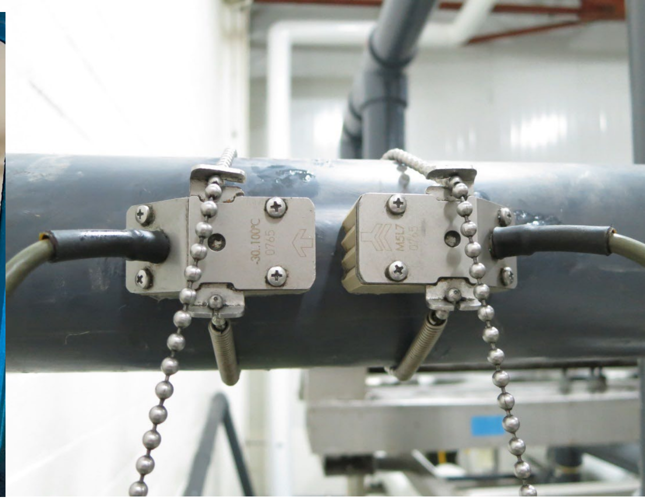
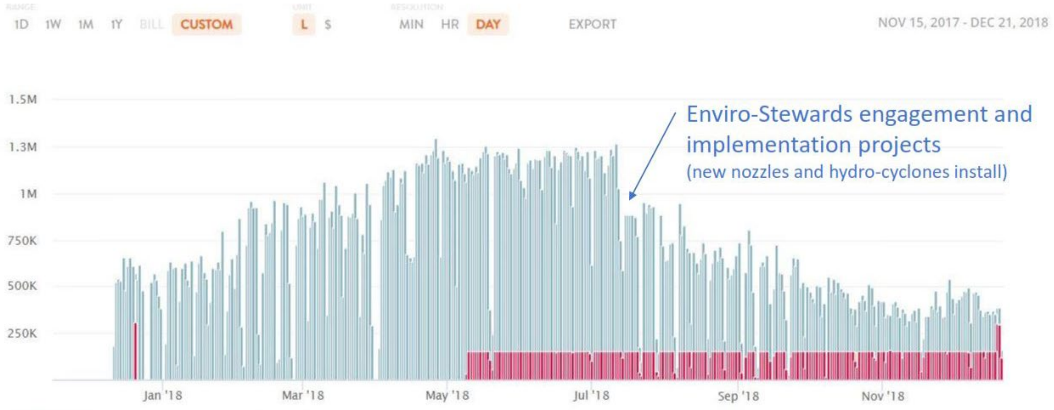


# Data collection.

## Useful tools

# Baseline assessment.

Analyze & prioritize

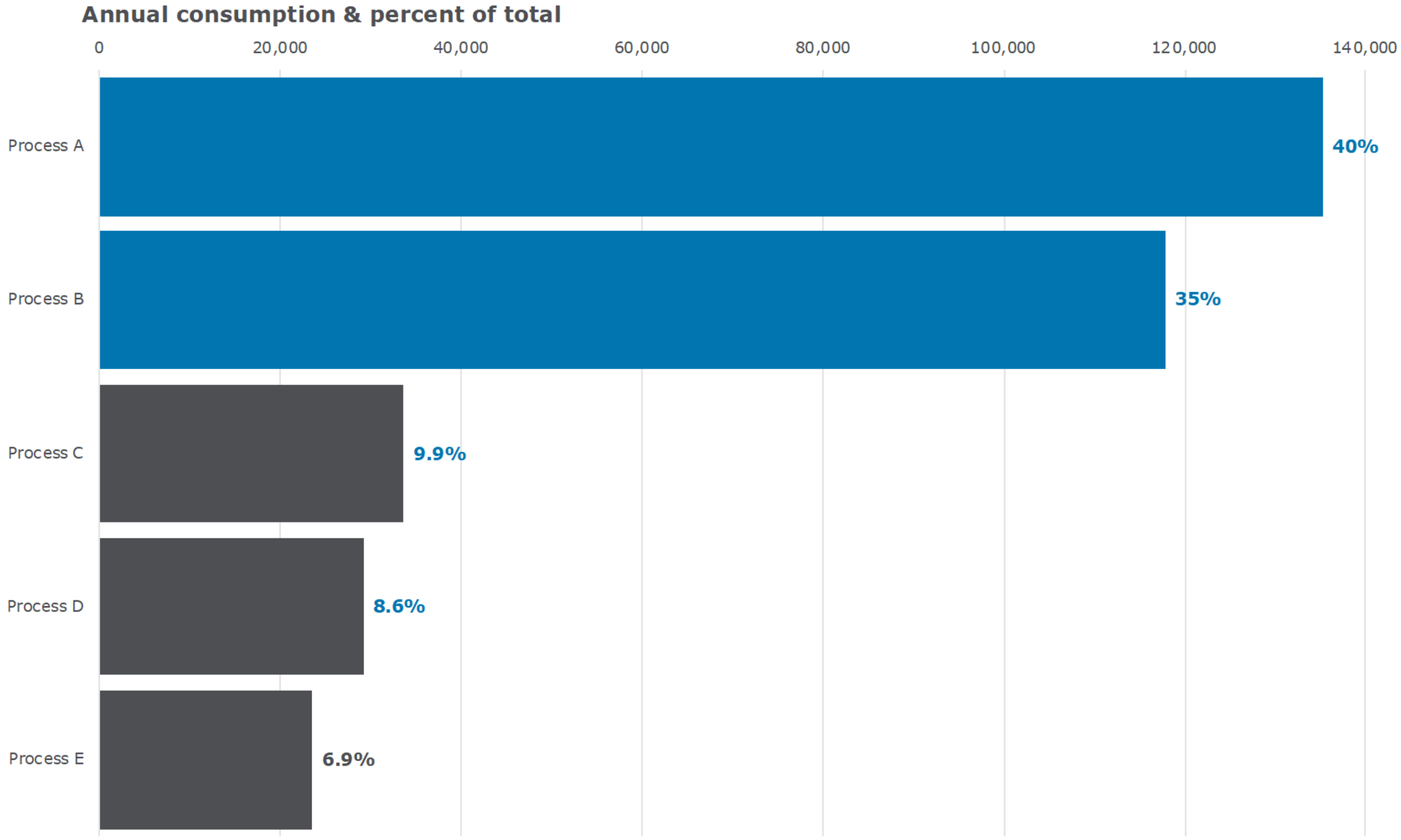
- The Pareto principle:

**80%** of the contribution is frequently generated by **20%** of the population

# The 80/20 Rule

# Baseline assessment.

Analyze & prioritize



# Energy calculations.

## Basic formulas, tips & tricks

Calculating **electricity consumption**:

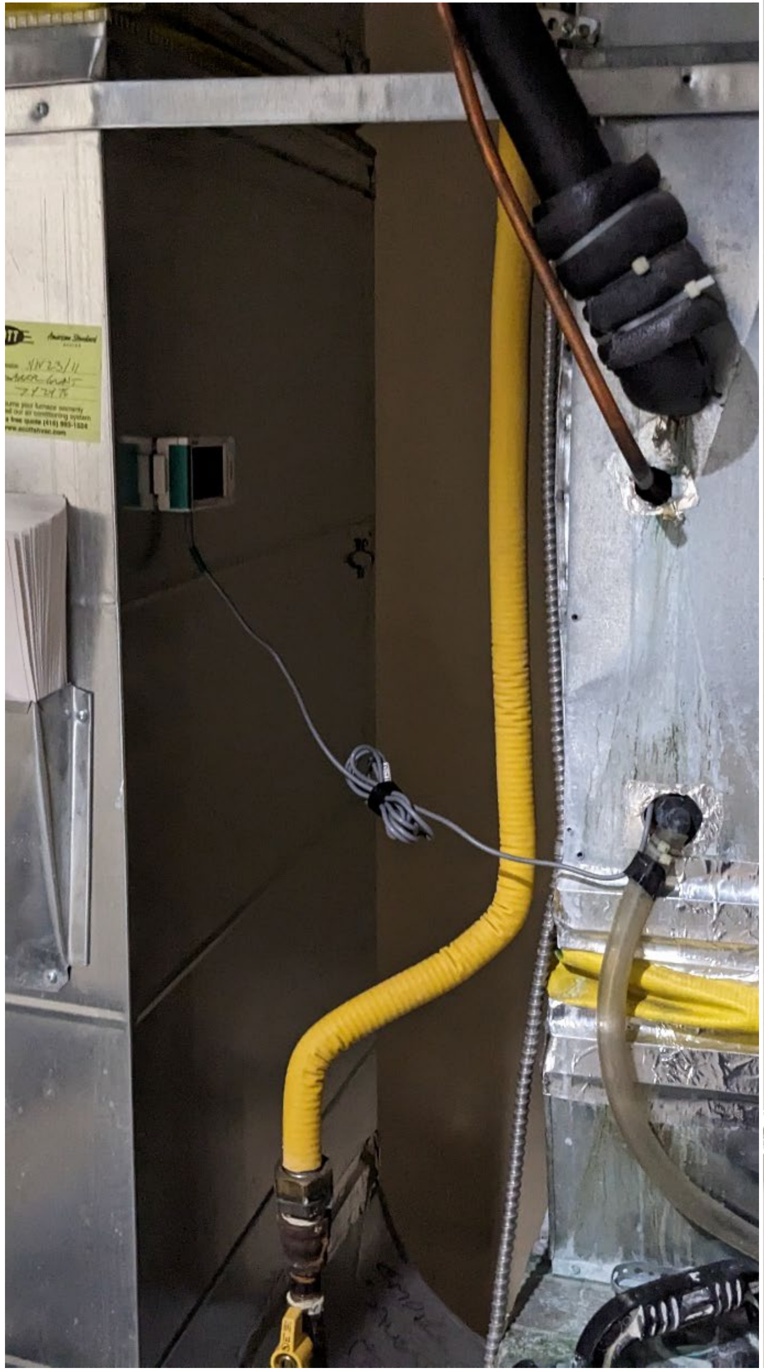
- Measure (log) the **average current** ($A_{avg}$) over a representative period (typically one week to include weekend downtime)
- Can get a general ballpark using equipment nameplates and estimated run times if you can't get logging data
- 20 kWh/CFM/year to cool a space to 46°F (8°C) in Ontario
- Identify the **voltage** (V), **power factor** (PF), number of phases (√3 for three phase)
- **Power = $A_{avg}$ * V * PF * √3 / 1,000**
  (kW) = (A) * (V) * ( - ) * ( - ) / (W / kW)
- **Energy = Power * runtime**
  (kWh/yr) = (kW) * (hrs/yr)

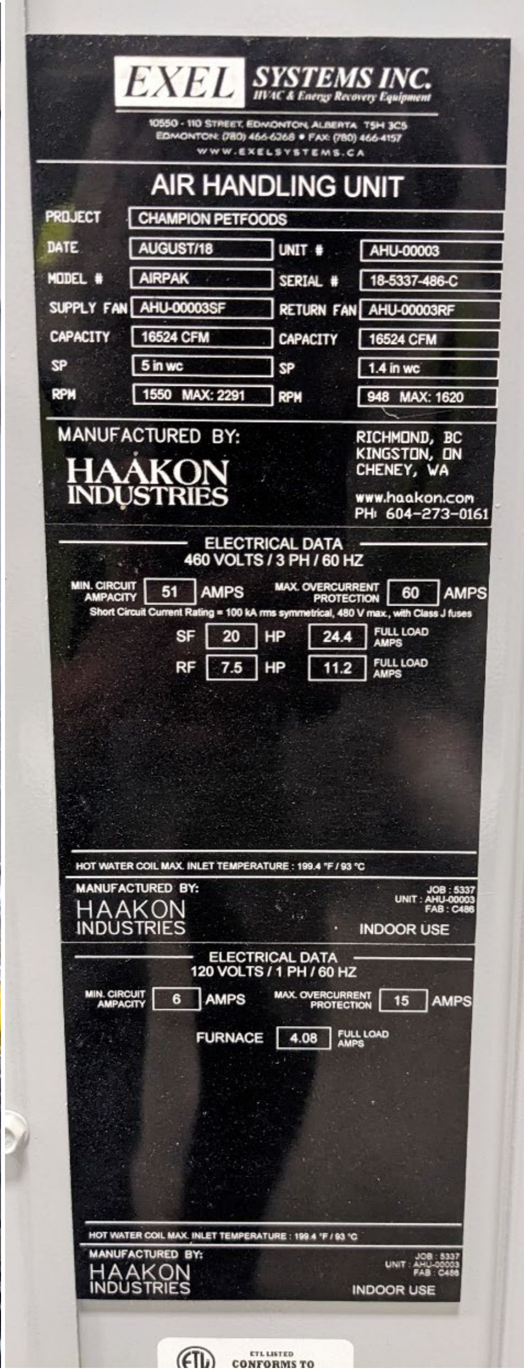
# Energy calculations.

## Basic formulas, tips & tricks

Calculating **natural gas consumption**:

- Difficult to measure directly unless there are submeters on various processes (e.g., ovens, boilers)
- Can measure indirectly using flow meters and thermocouples on boilers, hot water heaters
- Use CFM ratings of fresh air makeup HVAC units, determine runtime and temperatures using thermocouples





# Energy calculations.

## Basic formulas, tips & tricks

Calculating **natural gas consumption**:

- Measure the **flow rate** ($V_{avg}$) of cold water makeup to a boiler or hot water heater over a representative period (typically one week to include weekend downtime)
- Measure the increase in temperature
- **Sensible heat** – heat to raise water by X degrees (1 BTU/lb°F)
- **Latent heat** – heat to evaporate water (1,000 BTU/lb)
- **Heat Flow = $V_{avg}$ * 2.2 * (sensible + latent heat)**
  (BTU / hr) = (LPM) * (lb / L) * (BTU/lb) * (60 min/hr)
- **Energy = Heat Flow / 35,500 / Efficiency**
  ($m^3$ NG / yr) = (BTU/hr) / (BTU/$m^3$ NG) / %
- Efficiency of hot water heaters varies so look for nameplate, boiler efficiency typically 80%, with economizer 84%, with condensing economizer over 90%

# Energy calculations.

## Basic formulas, tips & tricks

Calculating **natural gas consumption**:

- Identify the **flow rate** ($V_{avg}$) of makeup air over a representative period (typically one week to include weekend downtime)
- Assume on average 5 $m^3$ / year of natural gas is needed to heat makeup air to ambient temperature in Ontario
- **Energy** = $\mathbf{V_{avg}}$ * **5**

  ($m^3$ NG / yr) = (CFM) * ($m^3$ NG / CFM/yr)

# Energy calculations.

## Basic formulas, tips & tricks

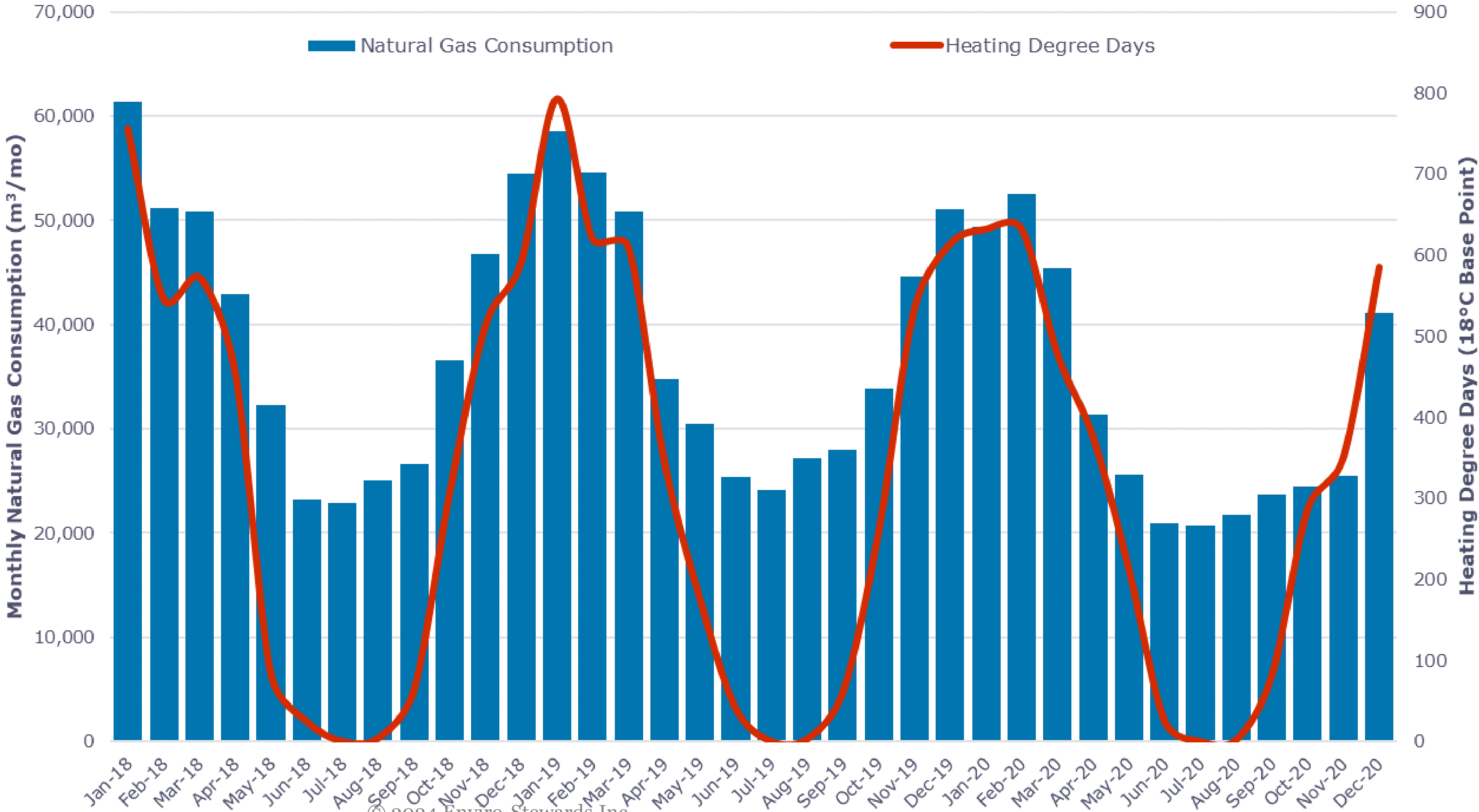
Other methods of quantification:

- Submeters
- Demand profiles from utility
- Analyzing amperage profiles
- Seasonal differences
- Remainders
- Creative reasoning

# Seasonal heating.

Determine the natural gas baseline

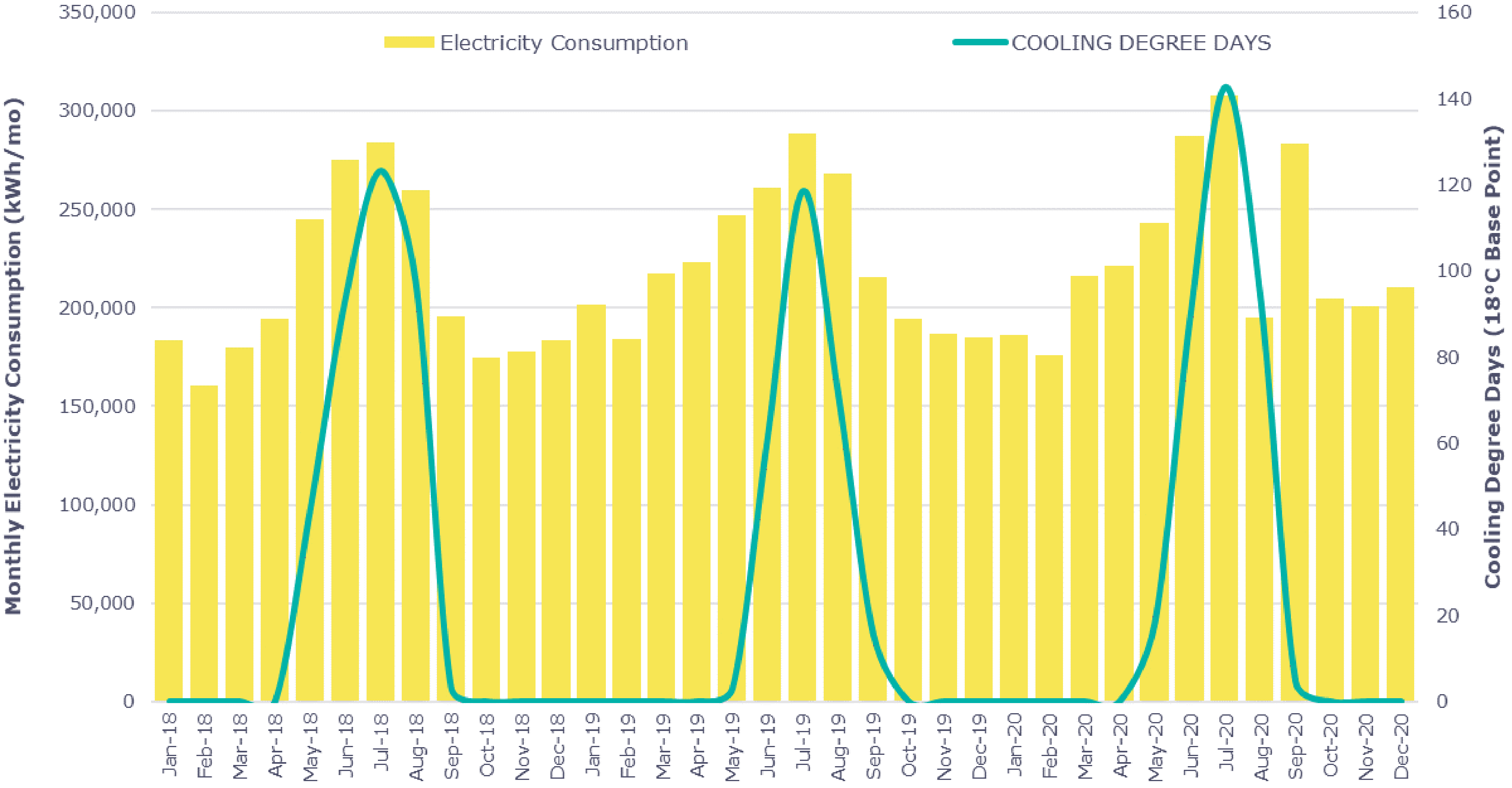
a. 22,000 m³/yr
b. 61,000 m³/yr
c. 264,000 m³/yr
d. 732,000 m³/yr



# Seasonal cooling.

Determine the electricity baseline

a. 180,000 kWh/yr
b. 310,000 kWh/yr
c. 2,160,000 kWh/yr
d. 3,720,000 kWh/yr



# Electricity consumption.

## Annual consumption of this motor?

You suspect in runs full out for 8 hours, 5 days per week.

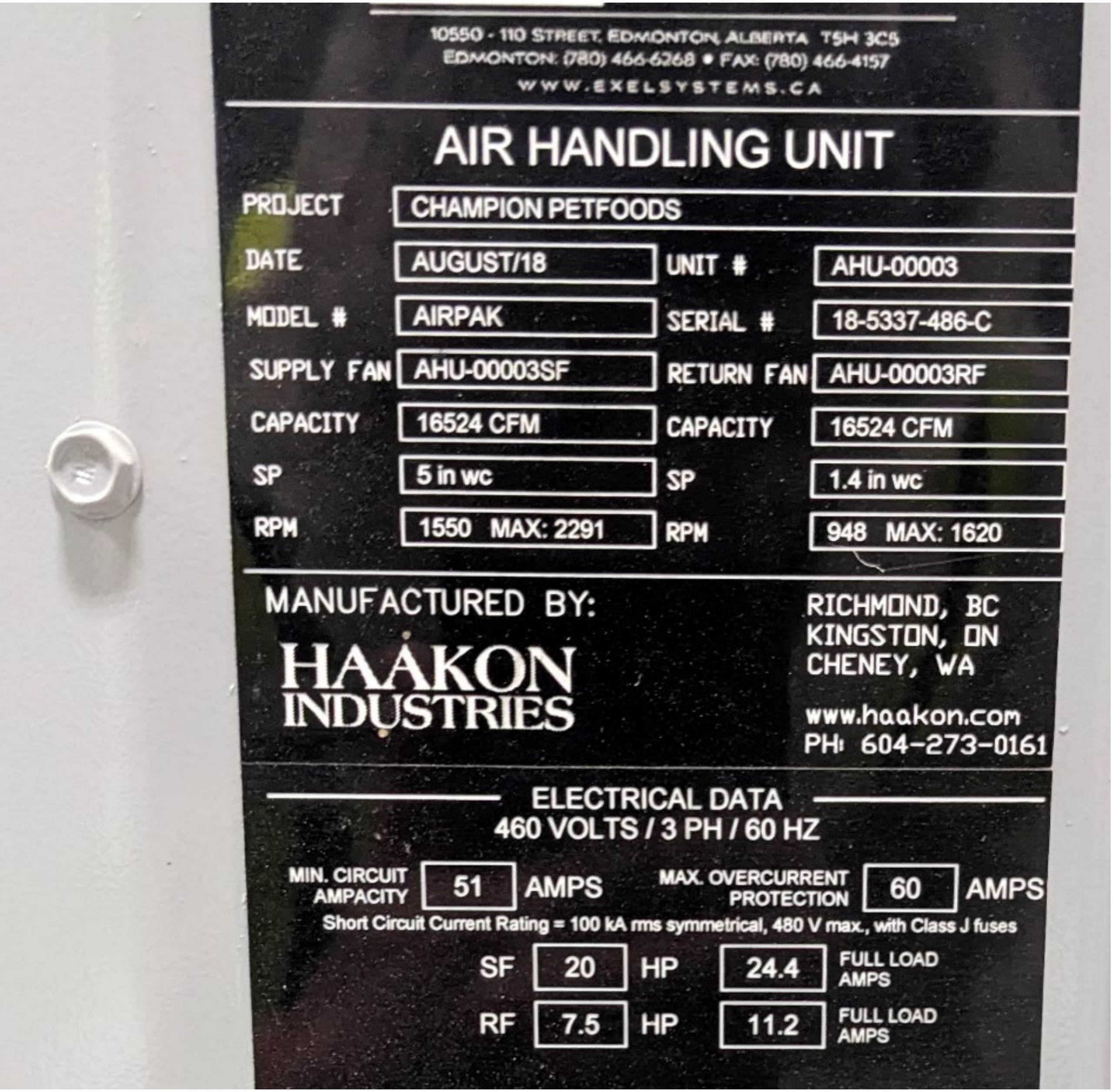
a) 15,000 kWh / year
b) 31,200 kWh / year
c) 41,600 kWh / year
d) 131,400 kWh / year

# Natural gas consumption.

Annual consumption of this MAU?

It runs at max capacity for 24 hours, 5 days per week.

a) 11,800 $m^3$ NG / year
b) 16,500 $m^3$ NG / year
c) 59,000 $m^3$ NG / year
d) 82,600 $m^3$ NG / year



# Root cause analysis.

Example:

- Hot water (22 litres/min) was being discharged to the drain
- The hot water was used to prevent clogging of the drain by lard discharged by the centrifuge

## Solution.

- Rework lard saving:
  - 1,200 litres/day of lard (and the electricity to process lard)
  - 22 litres/min of water
  - Gas to heat the water
  - Effluent chemicals & sludge disposal

# Root cause analysis.

Purpose: Seal

Purpose: Cleaning


Purpose: Cooling

Cold city water

$88,000

Hot city water

$46,000

Cold city water


$29,000

# Root cause analysis.




**$163,000/yr**

Cold city water

Reuse


Reuse

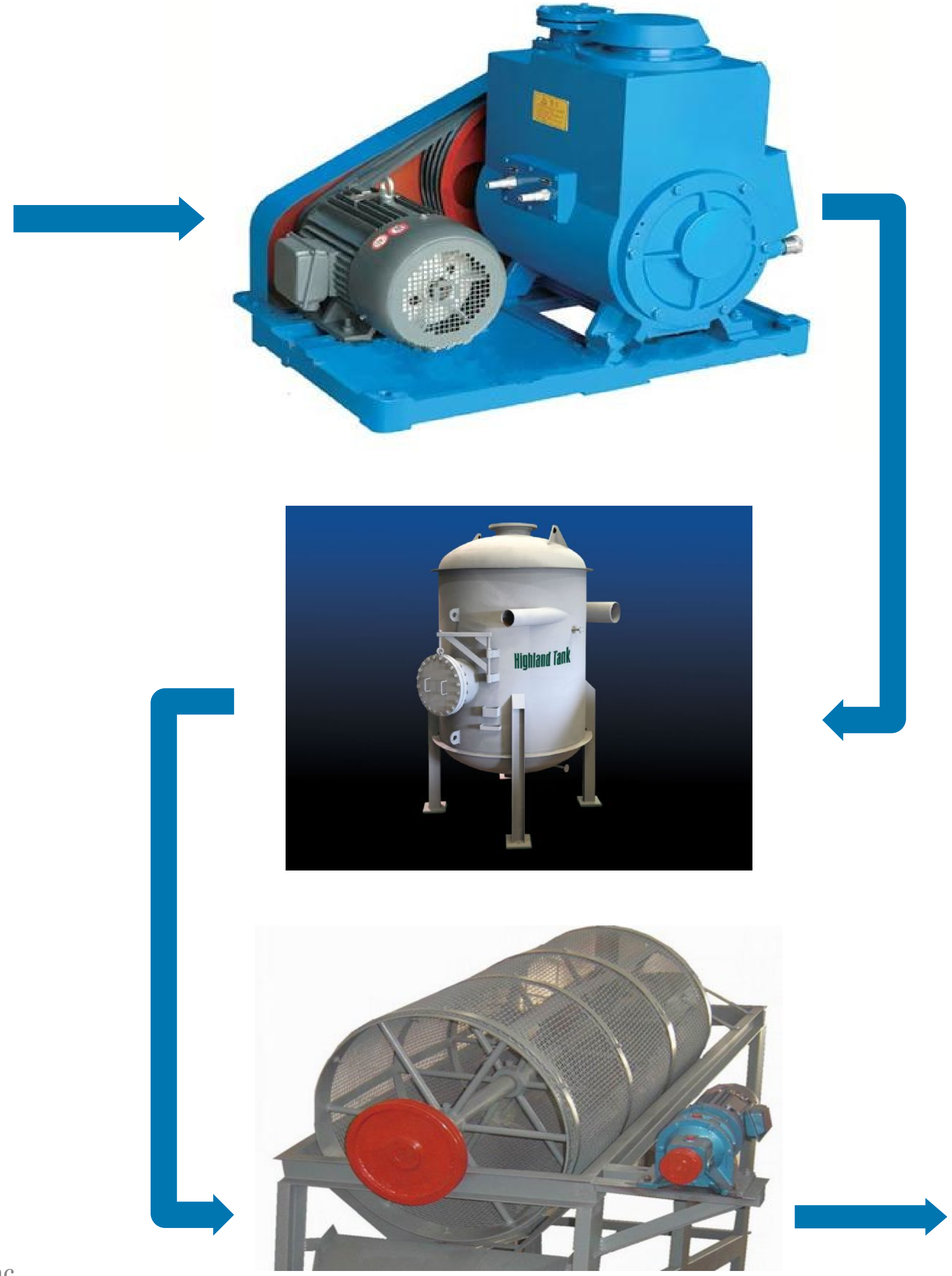
To drain

## Opportunities.

Identify & quantify

# Reuse savings.

# $110,000/yr



# Progress meeting.
## Opportunities & savings

- Same team as kick-off team
- Review findings & opportunities
- Agreement on technical feasibility

# Report.

Creating a business case

- Business cases are developed in the language of facility's capital approval process

**$748,656 NPV**

**1.3 years payback**

**77% ROI**

# Report.

## Opportunities & action plan

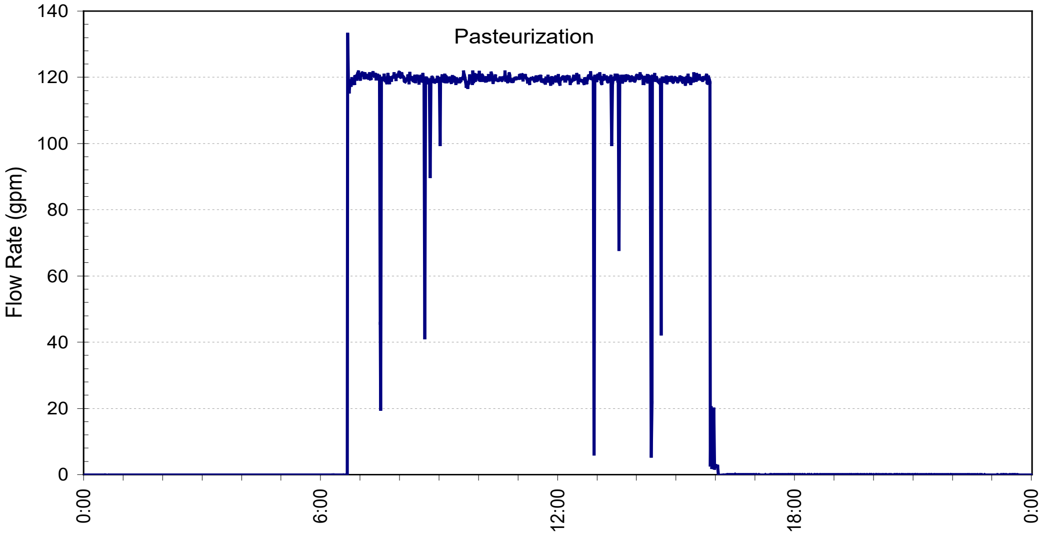
| Recommended Opportunities | | RESOURCE SAVINGS qty/yr | % | $/yr | TOTAL SAVINGS $/yr | GHG ($CO_2eq$) tonnes/yr | ESTIMATED PROJECT COST $ | PAYBACK Years |
|---|---|---|---|---|---|---|---|---|
| **1.0** | **Process/area of focus** | | | | | | | |
| 1.1 | Opportunity 1 | 9,360 | 2% | $1,872 | $24,552 | 95 | $5,000 | 0.2 |
| 1.2 | Opportunity 2 | 9,360 | 2% | $1,872 | $36,672 | 145 | $1,000 | 0.03 |
| 1.3 | Opportunity 3 | 8,410 | 1.6% | $1,682 | $36,082 | 144 | $5,000 | 0.1 |
| 1.4 | Opportunity 4 | 312 | 0.1% | $62 | $1,206 | 5 | $1,000 | 0.8 |
| 1.5 | Opportunity 5 | 14,893 | 2.8% | $2,979 | $2,979 | - | - | 0.0 |
| | **TOTAL** | **42,335** | **8%** | **$8,467** | **$101,491** | **388** | **$12,000** | **0.1** |

## **Implementation.**

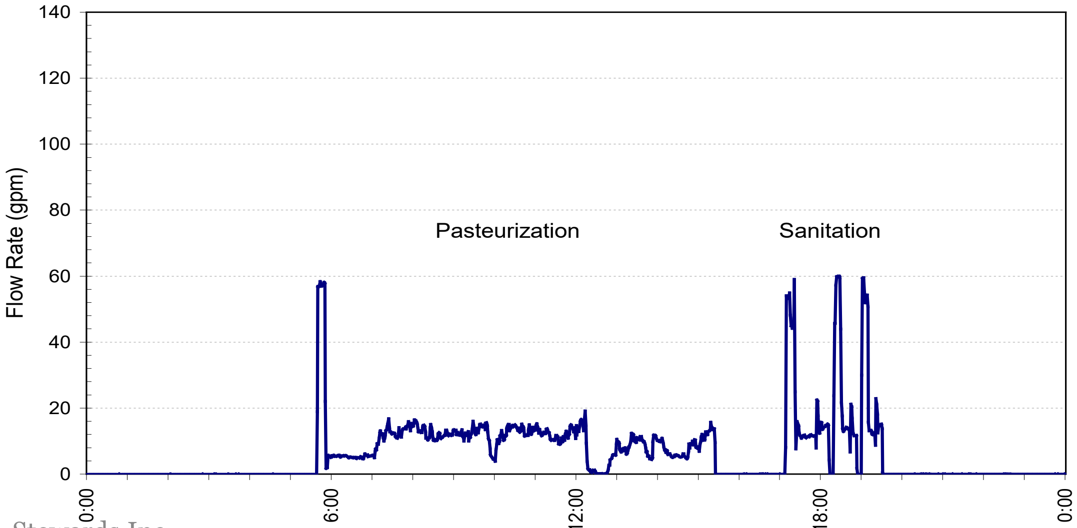
Implementation & tracking

- Project management
- Engineering design
- Funding applications
- Commissioning
- Verification logging
- Reporting

Before




After



## Bandwidth.

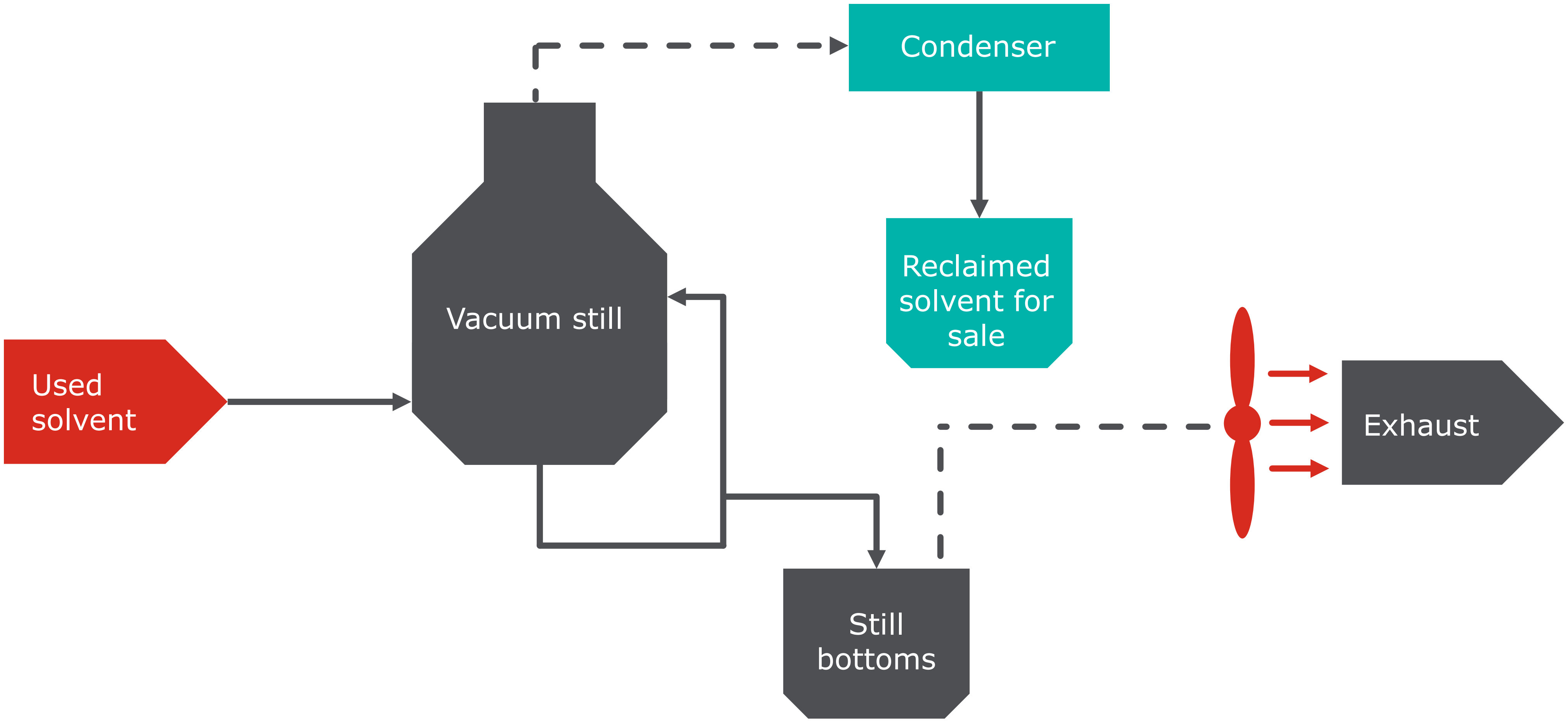
Who here has maintenance (or other) staff with capacity to take on this kind of work?

# P2

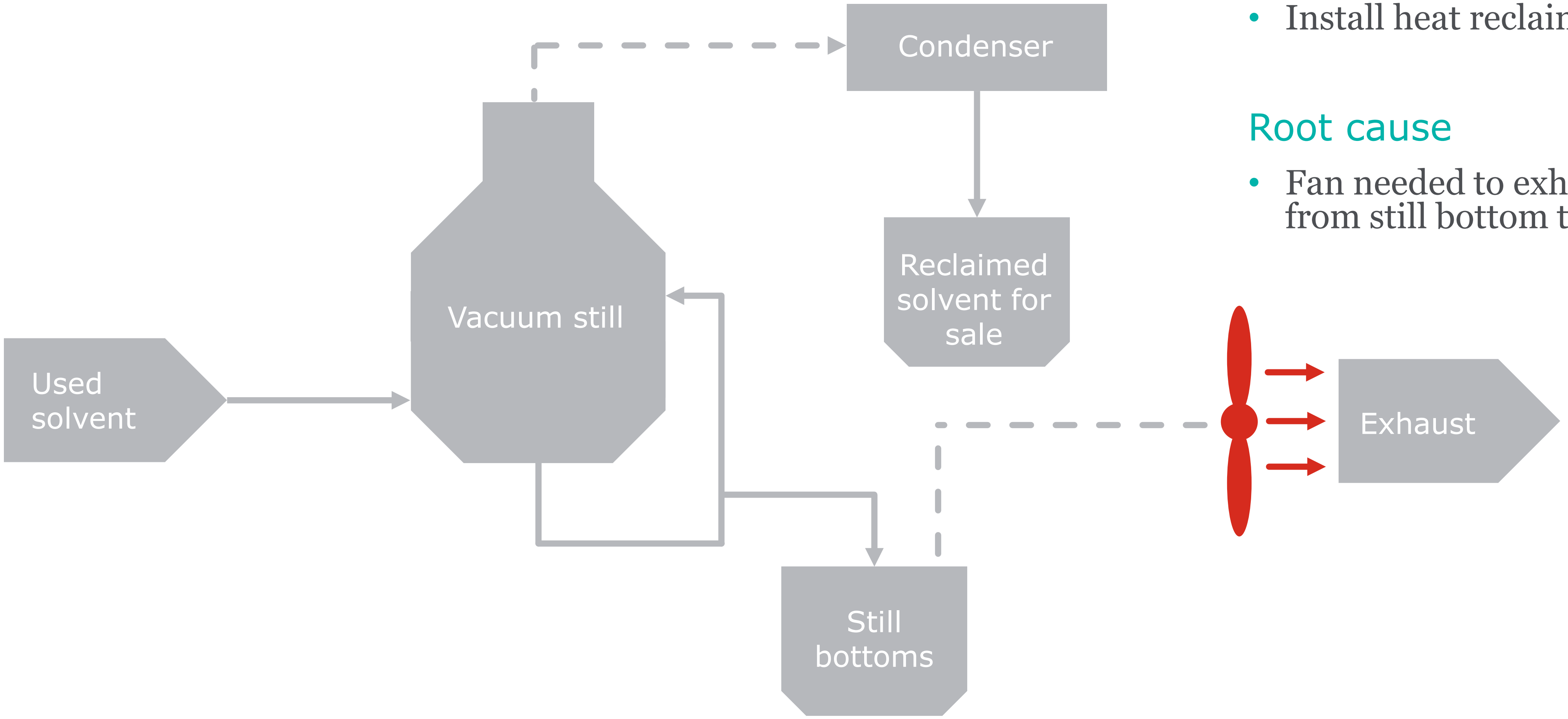
- Addresses root causes, not symptoms
- Preventative approach (prevents problems before they happen)
- Repeatable methodology
- Forces systems thinking

If you study any system, you can only learn 60% of it (systems design theory).
If you want to learn the other 40%, you need to understand the systems it interacts with.

# Integrated approach example.



# Integrated approach example.




## Electricity viewpoint

- More efficient fan

## Natural gas viewpoint

- Install heat reclaim system

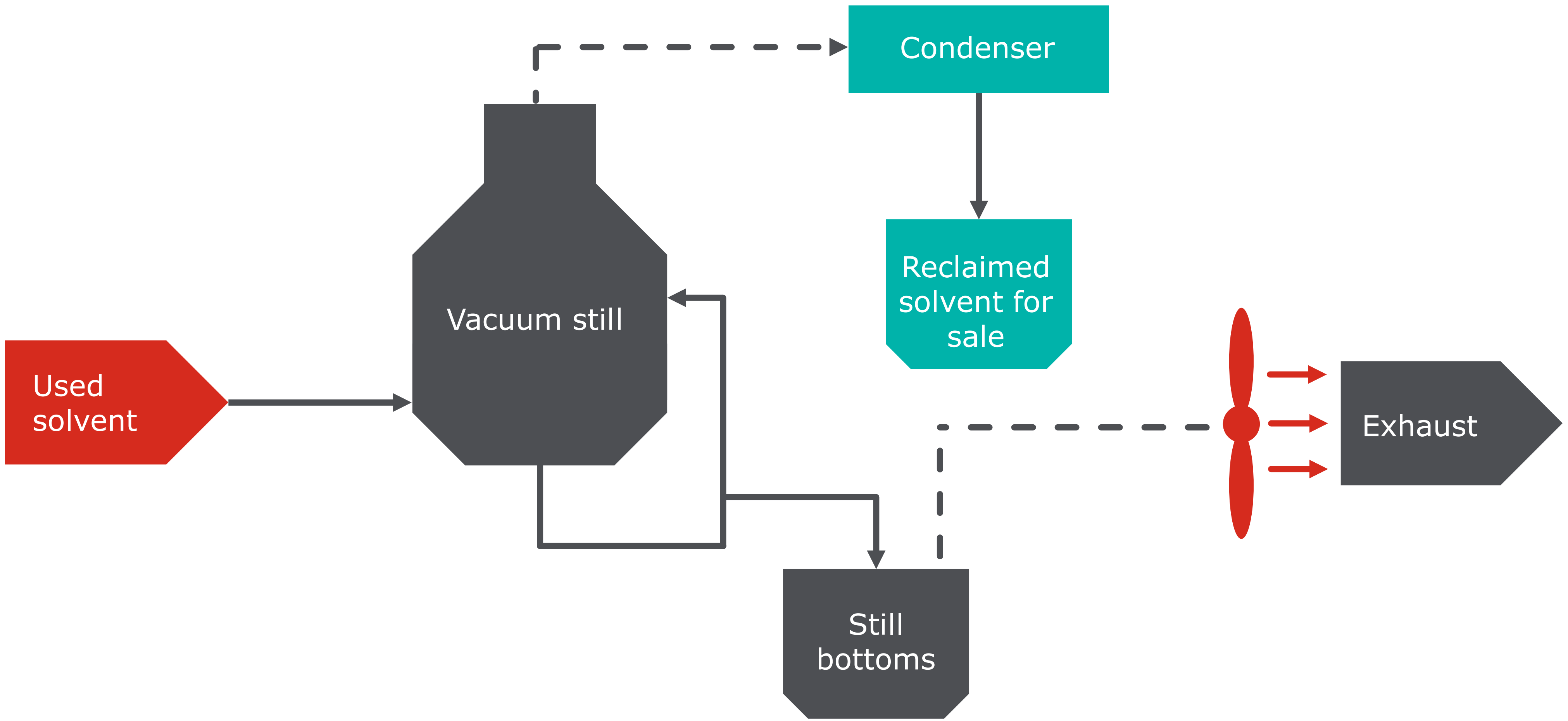
## Root cause

- Fan needed to exhaust fumes from still bottom tank

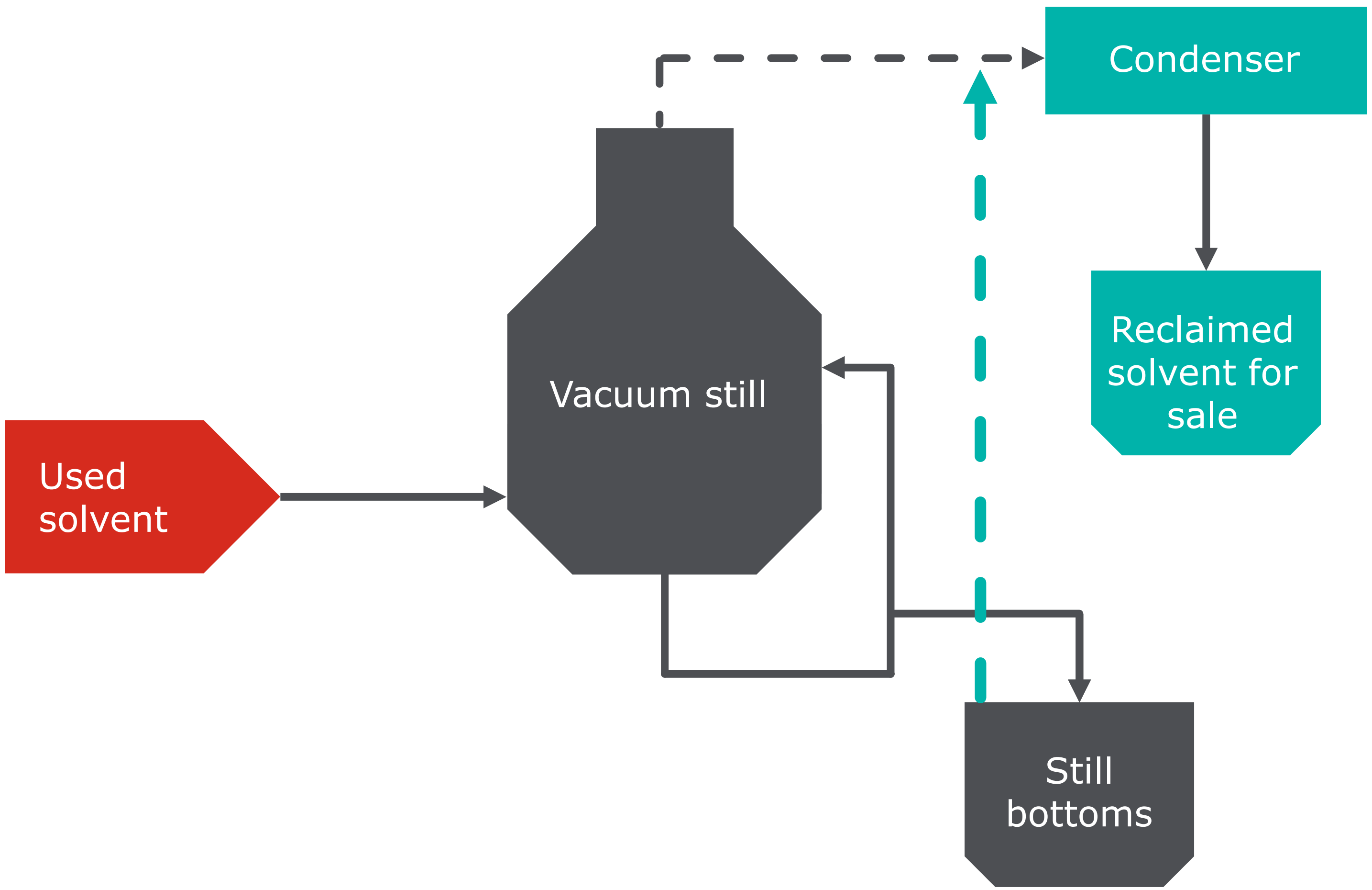
# Integrated approach example.

## P2 solution

- Systems approach

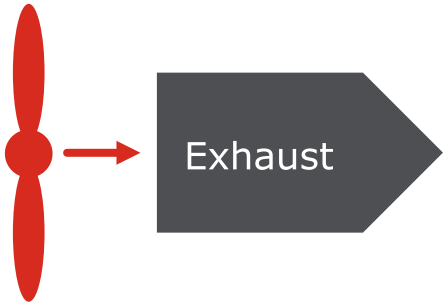


# Integrated approach example.




## P2 solution

- Put lid on still bottom tank & remove fan
- Route still bottom tank to condenser
- Condense vapors and sell reclaimed solvent
- A toxics use assessment was a better approach than an energy assessment



# Case study: deeper assessment.

Southbrook Vineyards

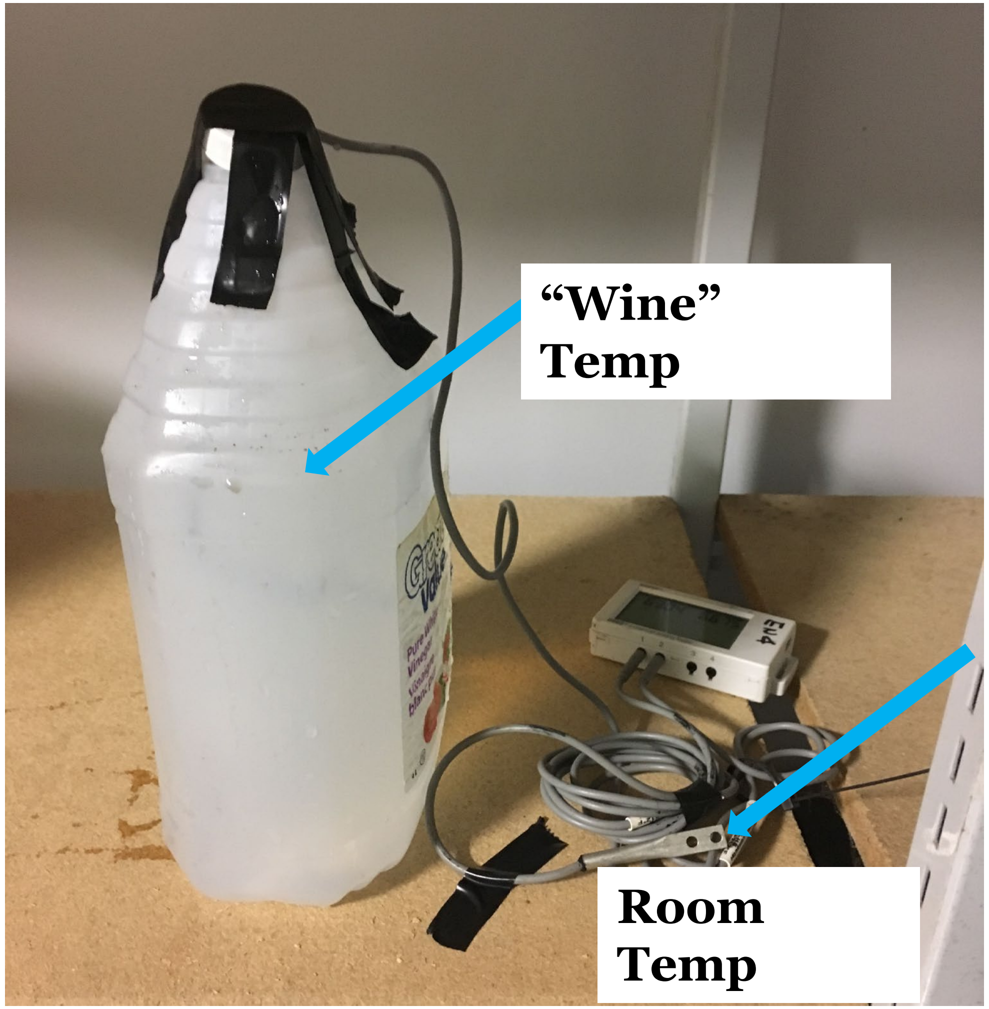
- Already LEED gold certified
- Previous audit identified 5% savings with a 20-year payback
- Our assessment identified & implemented **40% savings** with a **4-month payback**

# Setpoint selection.

## Southbrook Vineyards

How tight does a setpoint need to be?

- wine temp vs room temp
- Allowing for the thermal storage capacity of wine, the cellar can be overcooled in the evening while preserving the wine aging setpoint
- Allowed a 70% turndown of ventilation system

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# Hold your breath?

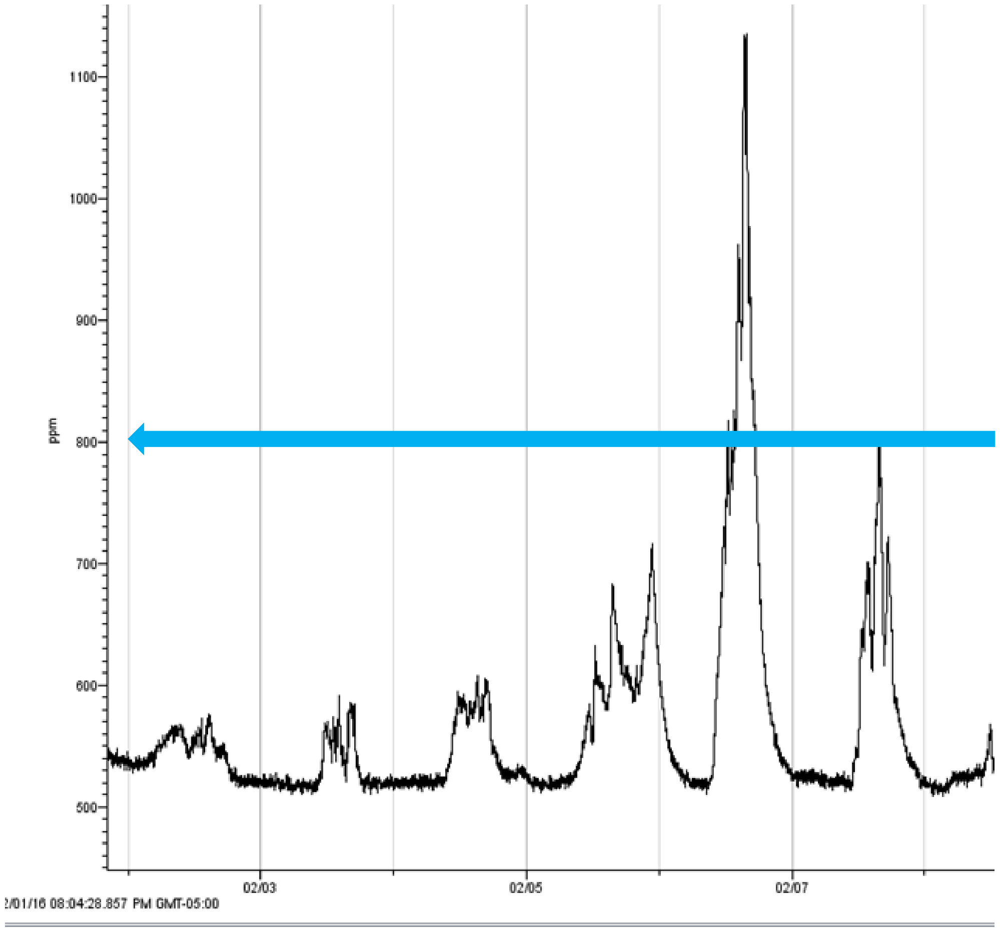
## Southbrook Vineyards

Buildings typically take in 10% outside air to dilute carbon dioxide.

- Add carbon dioxide controls in pavilion

Projected Savings:

- $6,000/yr
- 15,700 $m^3$ gas
- 3,000 kwh electricity



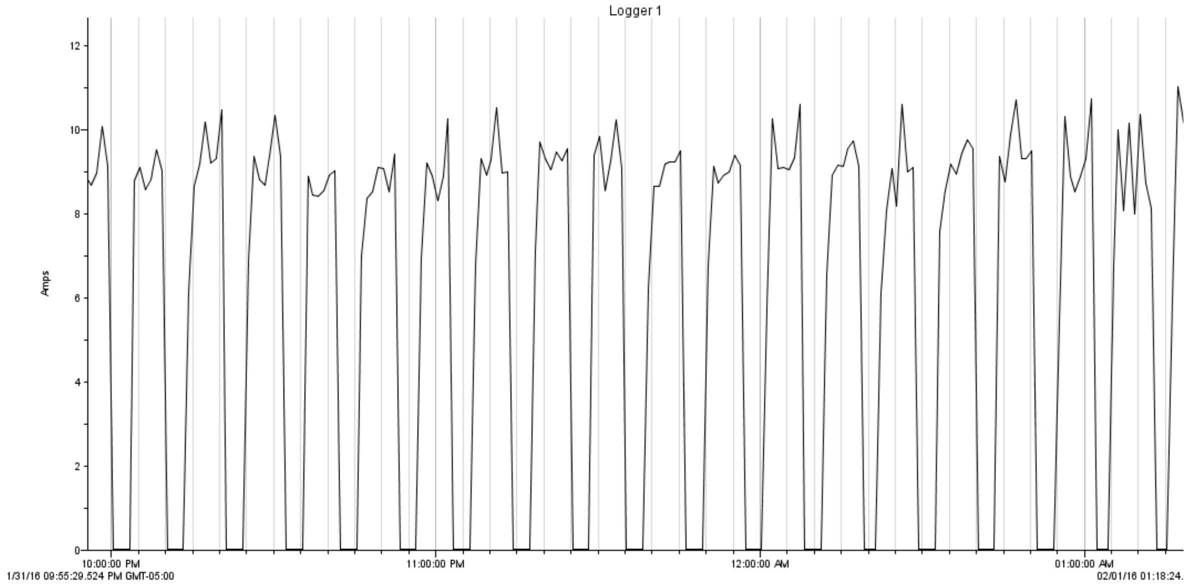

Carbon Dioxide in Pavilion

# Recommissioning.

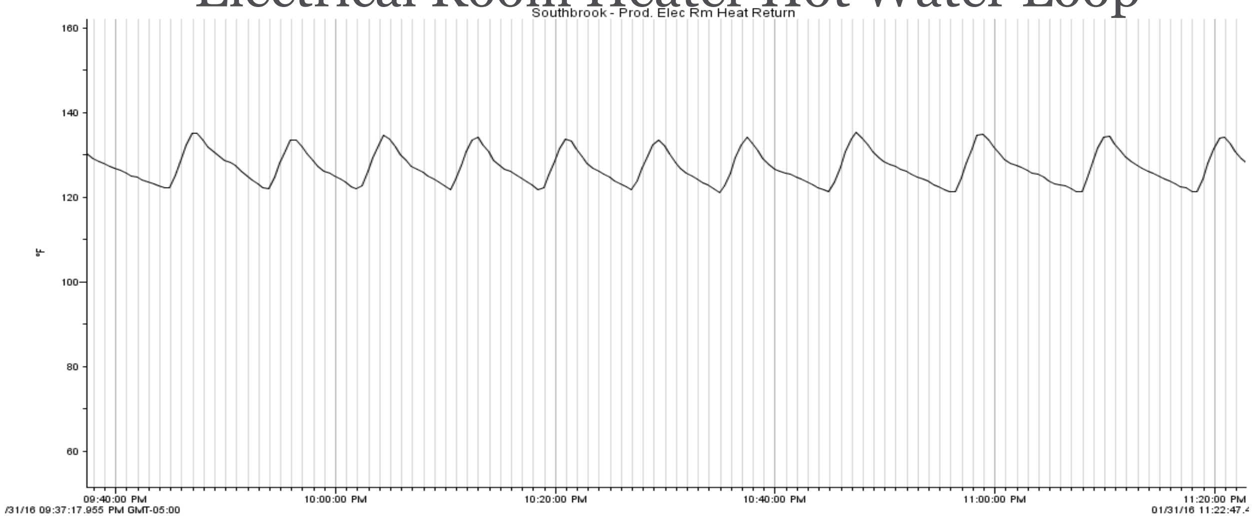
## Southbrook Vineyards

- Unit heater and A/C unit fighting each other 24/7/365 (in a LEED certified building)

Electrical Room A/C Amperage




Electrical Room Heater Hot Water Loop

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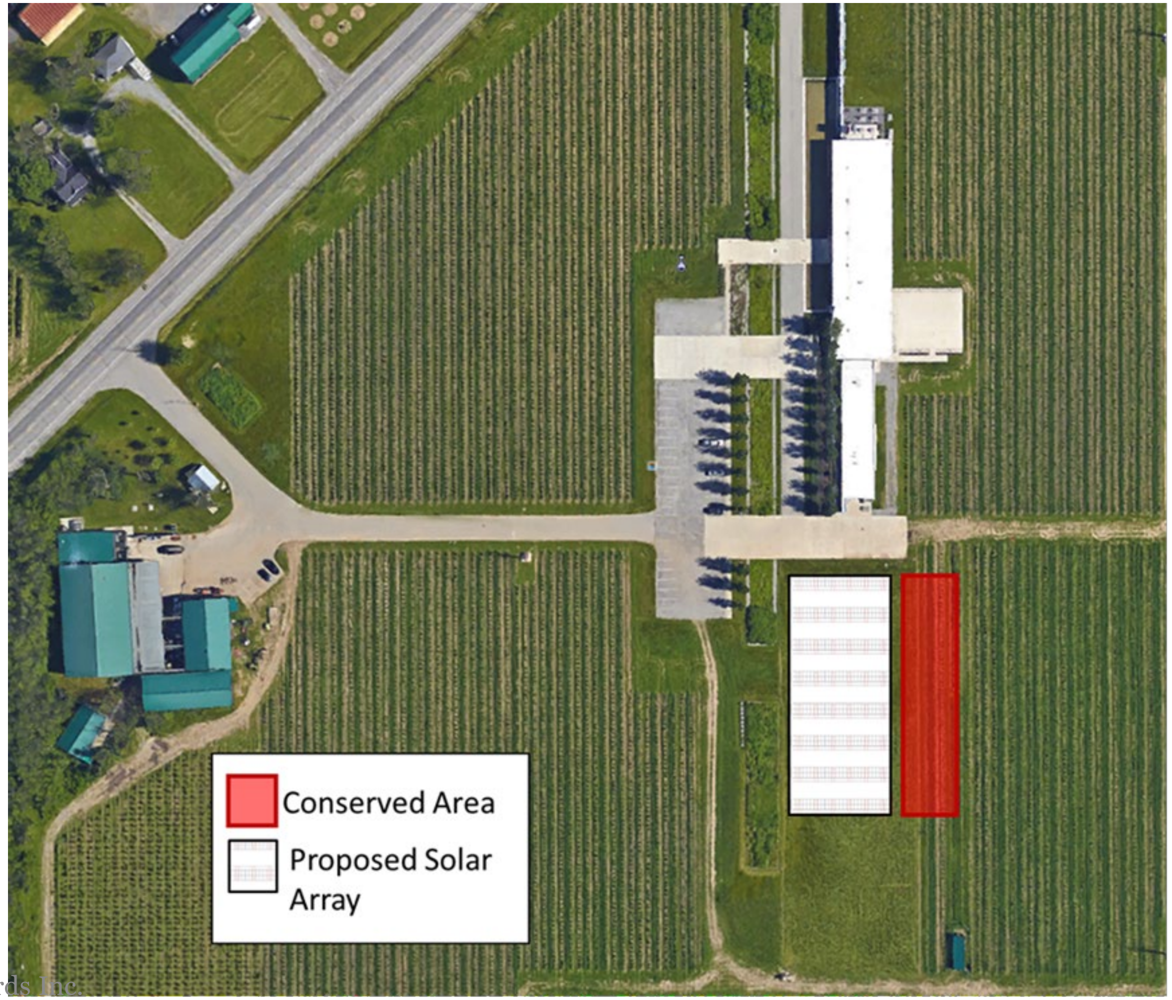
# Negawatts vs renewable.

Southbrook Vineyards

- 7-year payback for solar
- 0.3 year payback for conservation

- Avoided ½ acre of panels
- 50 cases/yr of “preserved reserve”

*“Don’t use renewables to waste your energy more efficiently!”*



# What is the why in this picture?

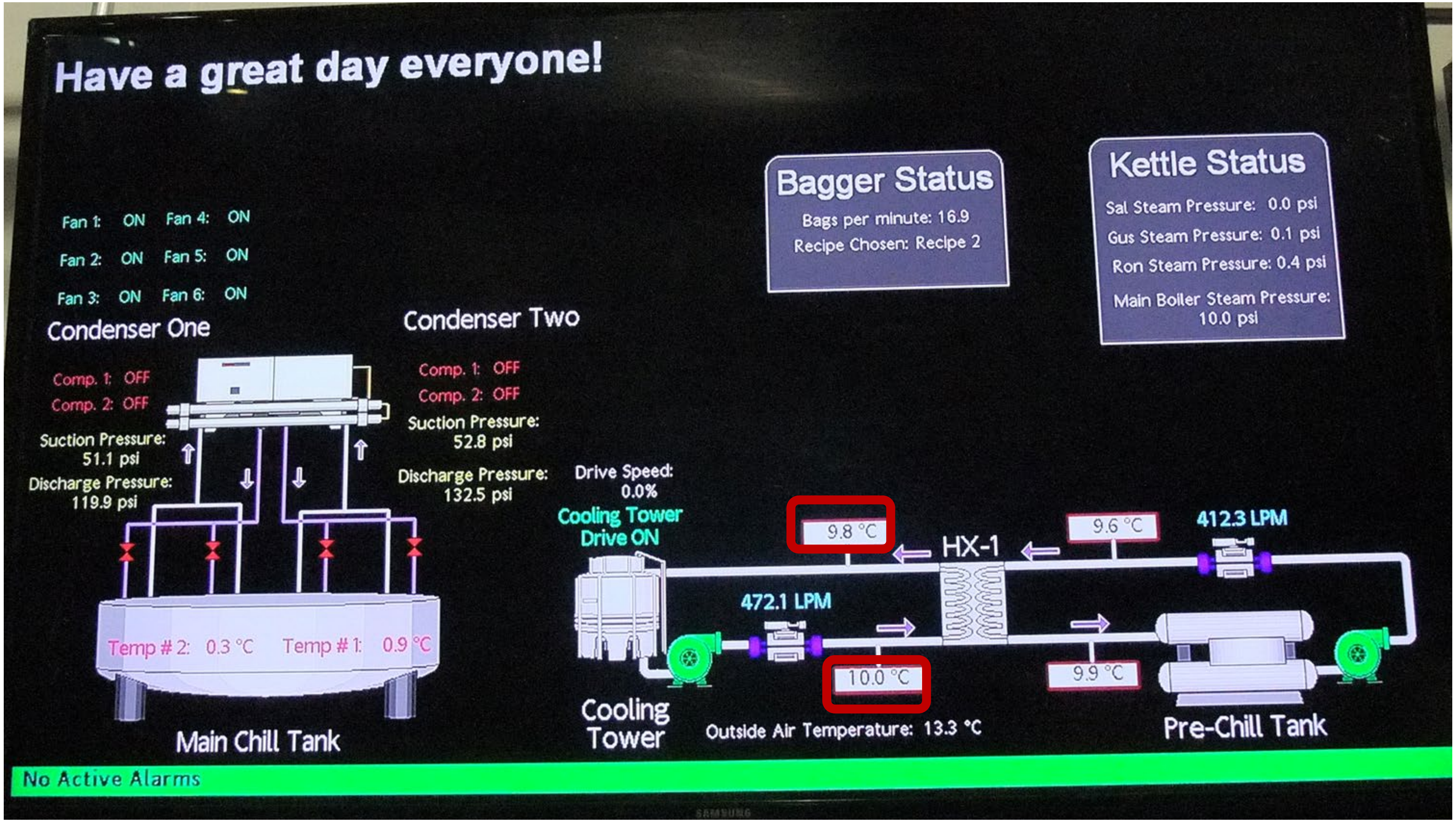
Blower mixed chilled water tank

- Air from blowers (104°F) enters 41°F chilled water tank (40,000 BTU/hr)
- Added humidity removed by refrigerant evaporators (31,400 BTU/hr)

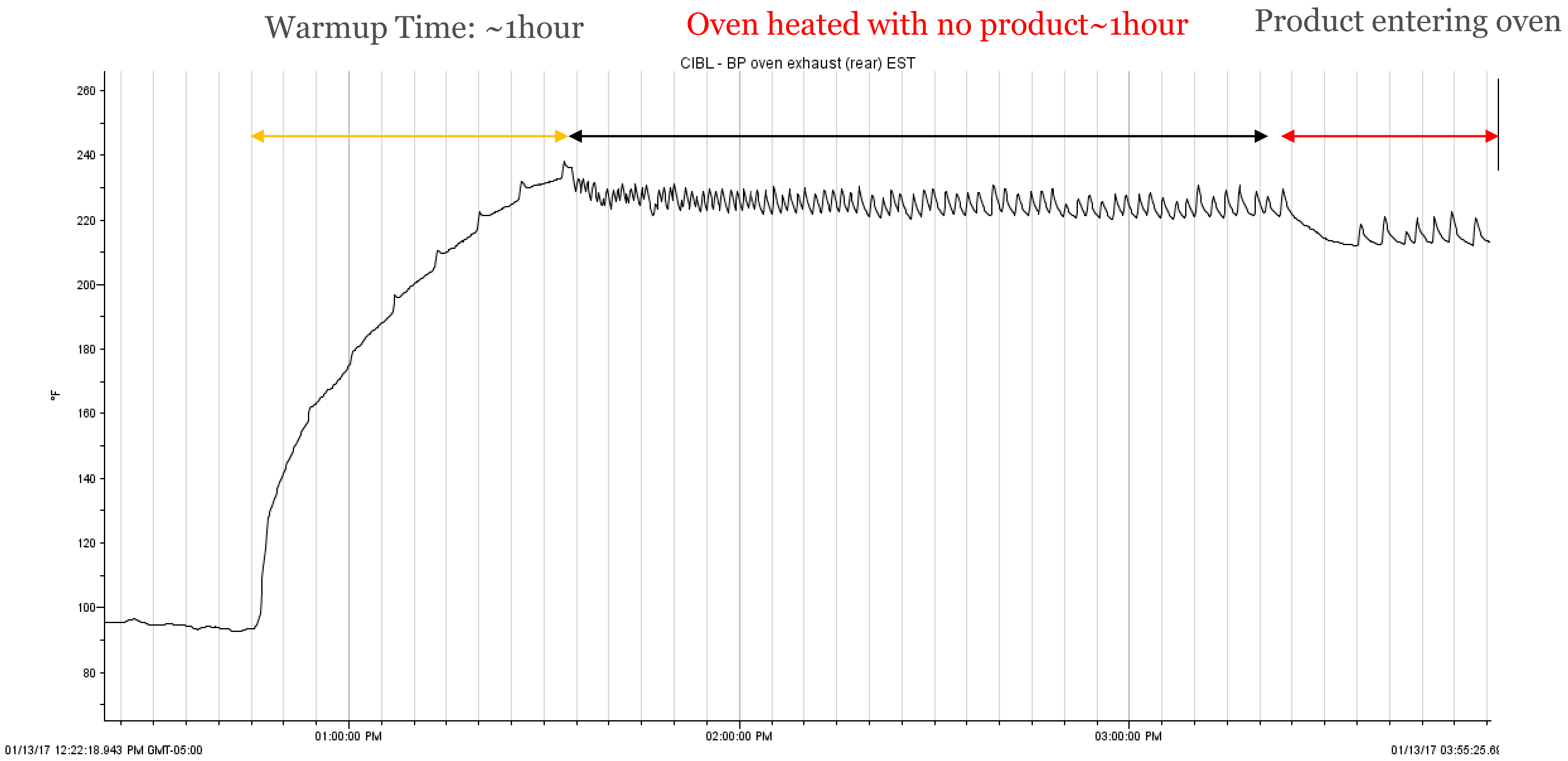
# What is the why in this picture?

LCD display in gowning area

- Cooling water temperature after it is cooled was warmer than before it is cooled!
- Cooling tower was unintentionally a warming tower



# Bakery energy, water & ingredient conservation.



# Heating processes.

Examples from your own facilities?

# Energy reuse.

Process integration

- Match heat sources & heat sinks
- Heat sources ('waste' heat):
  - Mechanical heat from equipment
  - Steam boiler exhaust
  - Heat exchangers
  - Can be expensive to 'get rid of'
- Heat sinks:
  - Building heating
  - Pre-heating boiler make-up water
  - Pre-heat process/product water

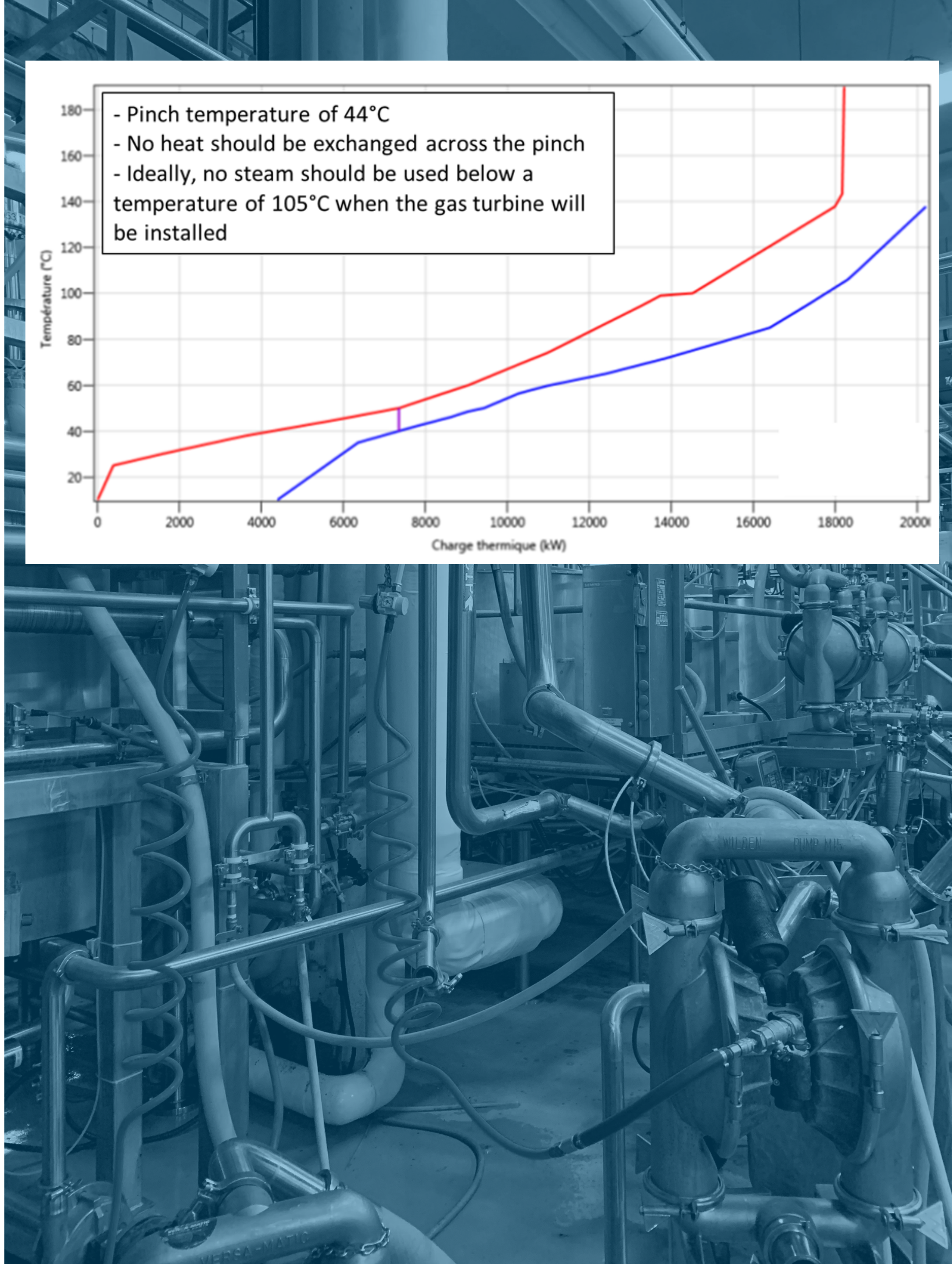
# Energy reuse.

Process integration

## Savings

- 3,233,000 kWh/yr
- 161,400 MCF of gas
- 32,493,162 USGAL water

**$1,645,000/yr** with a 2-year payback



## Food loss & waste prevention.

FLW assessment

### Problem

- Collateral (good product) loss from optical sorter

### Root Cause

- Processing rate results in air purge rejecting adjacent good product

### P2 solution

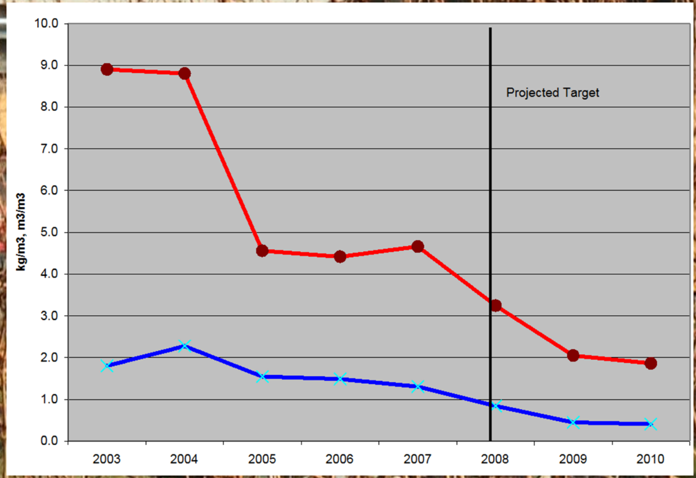
- Adjust rate and/or reprocess

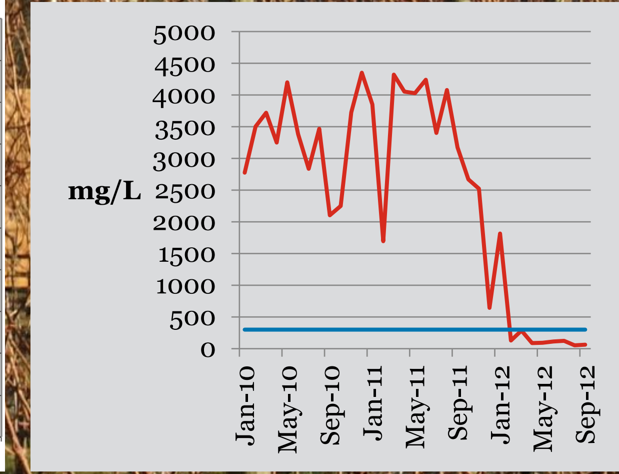
**$225,000/yr** savings

# **Effluent Treatment** (Prevention First)

## Jackson Triggs, Oliver BC

- $1.5 million capital cost savings
- Plus annual wine & water savings
- Plus avoided Electricity for Aeration

# Water conservation.
(Save Embedded Energy)

York Region

## 2019 OWWA Public Sector Award:

- High participation rate
- Integration of co-benefits (energy, climate adaptation, P2 & embedded water)
- Average **36% water savings/facility**
- Average payback of 1.5 years
- Plus electricity of chilled water etc.

## 2018 OWWA Private Sector Award:

**WATER SAVING:** >37,000 m³/year

**TOTAL OPERATIONAL SAVINGS:** $285,000

**Payback:** Less than 6 months

*Payback period includes water incentives, energy and operational savings.

# Food Loss Prevention (Save Embedded Energy)

- 50 facilities averaged $230k/yr with under 1-year payback
- Enough for a line of grocery bags from CN tower to London, Ont.




2020 Clean50
Outstanding Contributors to Clean Capitalism
TOP PROJECT

**Here's what Bimbo Canada learned from taking the leap and implementing strategies to prevent food loss: Factory food loss prevention could save the output of 200 hectares of agricultural land otherwise wasted...**

## Food loss prevention offers the opportunity to reduce environmental footprints while adding profit:

**5.5M**
meals that can be saved per year

**C$1.6M**
/year of food value that can be saved

**200**
hectares of agricultural output that can be saved (less land conversion favors biodiversity)

**2.2K**
tonnes of carbon emissions that can be avoided annually

**2.76B**
litres/year of water already saved (including food supply chain impacts)

**For full case study visit: cec.org/BimboCanada**

ENVIRO-STEWARDS

# Questions?

engineering
change

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