Having Your Cake and Eating It, Too – Achieving OpEx Improvements and Energy Efficiency Simultaneously

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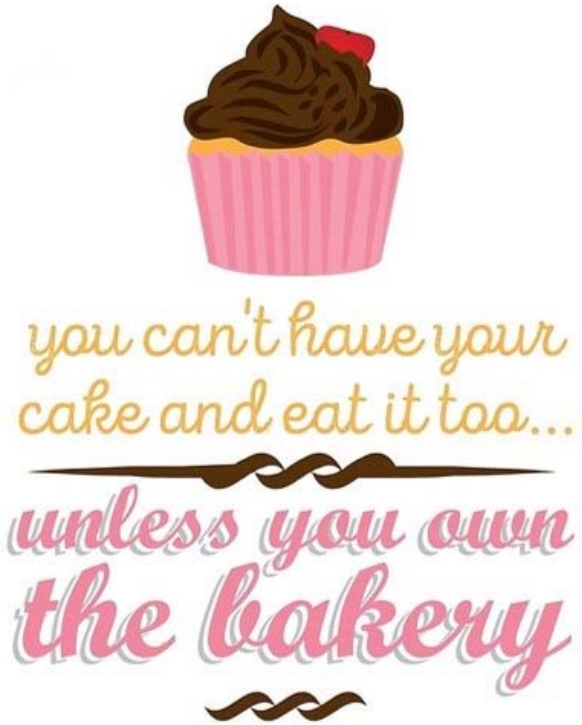
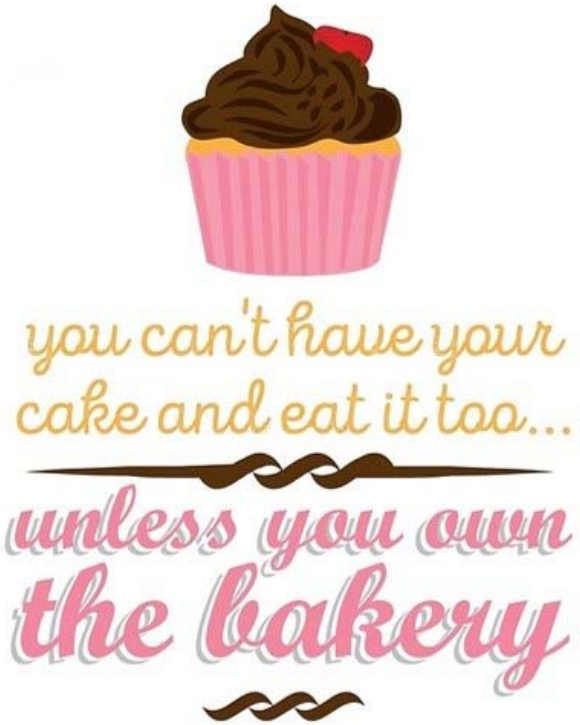
you can't have your cake and eat it too...

unless you own the bakery



You can have Operational Excellence and Energy Efficiency, too, because you own the bakery – But you have to use the right recipe!



The Cake:

- Energy Savings
- Equipment Capital & Maintenance Savings
- Higher OEE

Session Outline

- Operational Excellence and Plant Utilities Intro
- Linkage between OpEx and Utilities Efficiency
- Achieving OpEx & Utilities Efficiency Long-Term

Session Outline

- Operational Excellence and Plant Utilities Intro

What Is Operational Excellence?

Many definitions – buzzword of the decade candidate?

OpEx is a management philosophy that continuously improves an organization's processes, efficiency, and effectiveness.

Manufacturing OpEx includes many principles of Kaizen and Lean

Includes Vision, People, many other factors

Key Manufacturing OpEx Features

Mfg. OpEx stresses deterministic processes

- Repeatability / Consistency
- Efficiency
- Reliability
- Measurability
- Small / Incremental Testing & Improvements

Comprehensive *process control* is required – consistent inputs, known machine design, stable & repeatable process operations, etc.

Plant Utilities Energy Basics

Plant utilities support all other operations

- Lighting
- Compressed Air & Vacuum
- Process and Personnel Cooling
- Steam, Thermal Fluids, Exhaust Gas Oxidizers

Utilities ***Efficiency*** is frequently considered

Other OpEx–critical factors rarely recognized – if running, utilities mostly left to the plant engineers

Utilities Energy Efficiency

Plant utilities efficiency is realized through two, interrelated factors:

- System efficiency *potential*, combining
  - Equipment performance (nameplate and part-load)
  - System design to leverage equipment efficiency
- Efficient system *operation* via effective control

The most efficient equipment, in the most efficient system design, *performs inefficiently with poor control** (*relative to overall potential)

Chiller Technology Differences

Chiller technology choice bounds highest level of potential system efficiency

Chiller Type (Air-Cooled, Water-Cooled)	Size Range	Chiller Nominal kW/ton	Chiller Annual kW/ton	System Annual kW/ton*
Air-Cooled Screw†	150 - 500	1.225	0.875	1.250
Air-Cooled VFD Screw	150 - 500	1.195	0.750	1.125
W-C Screw (1 comp)	150 - 650	0.675	0.525	1.050
W-C VFD Screw	150 - 650	0.625	0.475	0.950
Centr. (1 comp)	250 - 1350	0.575	0.435	0.900
VFD Centr.	250 - 1350	0.550	0.350	0.750
Mag. Brg. VFD Cent.	125 - 750	0.525	0.325	0.675
Free Cooling	0 – 1500+	0.075	0.05	0.400

- Assumes system operated intentionally to leverage chiller efficiency, includes typical chilled water pumps, tower pumps, and tower fans (if applicable)
- † Smaller A-C systems may use scroll or other compressor technology for similar nominal efficiency, however system efficiencies typically worse

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OpEx and Utilities Energy Nexus

Plant utilities are foundational to the other operations and should be managed strategically

Must recognize long-term impact, multiple avenues of effect (energy, maintenance, OEE effects, etc.)

Performance held to same precision standard as process variables, e.g. melt temp., part weight, etc.

Sets stage for efficiency & OpEx – perfectly aligned with OpEx initiatives but insufficient alone

Utilities Energy Efficiency Requirements

Plant utilities efficiency is realized through two, interrelating factors:

- System efficiency potential, combining
  - Equipment performance (nameplate and part-load)
  - System design to leverage equipment efficiency
- System Control
  - Correct units being operated
  - Design concepts leveraged for performance & efficiency

Utilities Efficiency Practice

Utilities efficiency requires planning and execution

- Plant system evolution planning – where are we vs. where do we want to be?
- Component selection (retrofit or new) – not just very common like-for-like *[→evolution planning]*
- System design (new or retrofit) for low losses, leveraging of equipment efficiency
- Informed purchasing (meet specs, not low bid)
- Controls to fully utilize efficiency capabilities

Efficiency Potential ≠ OpEx

High efficiency equipment and system design does not guarantee either high efficiency operation or effective Operational Excellence performance

Plant utilities must be actually operated in efficient, stable, controllable manner to achieve goals of efficiency and OpEx success

Fortunately, capability in one supports the other!

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Practical Efficiency Program Steps

Utilities strategic design

- Corporate strategy decision & commitment (OpEx tie)
- Plant assessments, future plan (TBD execution timing)
- Tailored design at execution – available equipment, etc.

Effective system operation

- Operate for process optimization
- Efficiency follows from design and operation control
- Strict maintenance of system capabilities (N+1 upkeep)

Repeat and continue through plant evolutions

Strategic Design Highlights

Strategic competitive advantage decisions

- Intent to capture op'g & cap'l savings, OpEx benefits
- Enable with liberal "easy number" criteria* (not unlimited)
- Set time frame, priorities (expansions, high costs, etc.)

Execute program

- Review existing plant systems (or at least require no changes without examining in context of strategic goal)
- Develop plant-specific target plans per unique details
- Conduct upgrades with design tuning at project stage

* Easy numbers include energy savings, offset repair / replacement costs, rebate dollars, etc.

Design Decisions - Which Chiller?

Air-Cooled Options

Water-Cooled Options

Effective Operation Highlights

Operation activities

- Ensure initial system settings collaboration at start-up
- Plant acknowledgement of settings, limited recovery deviations (e.g., higher air pressure, cooler water temp)
- Operations and maintenance activities per plan
- Schedule for any repairs promptly during regular hours

System controls overall functions – not just on / off

- Controls configured for precise and efficient operation
- Linchpin to effective performance

Controls Criticality to Efficiency

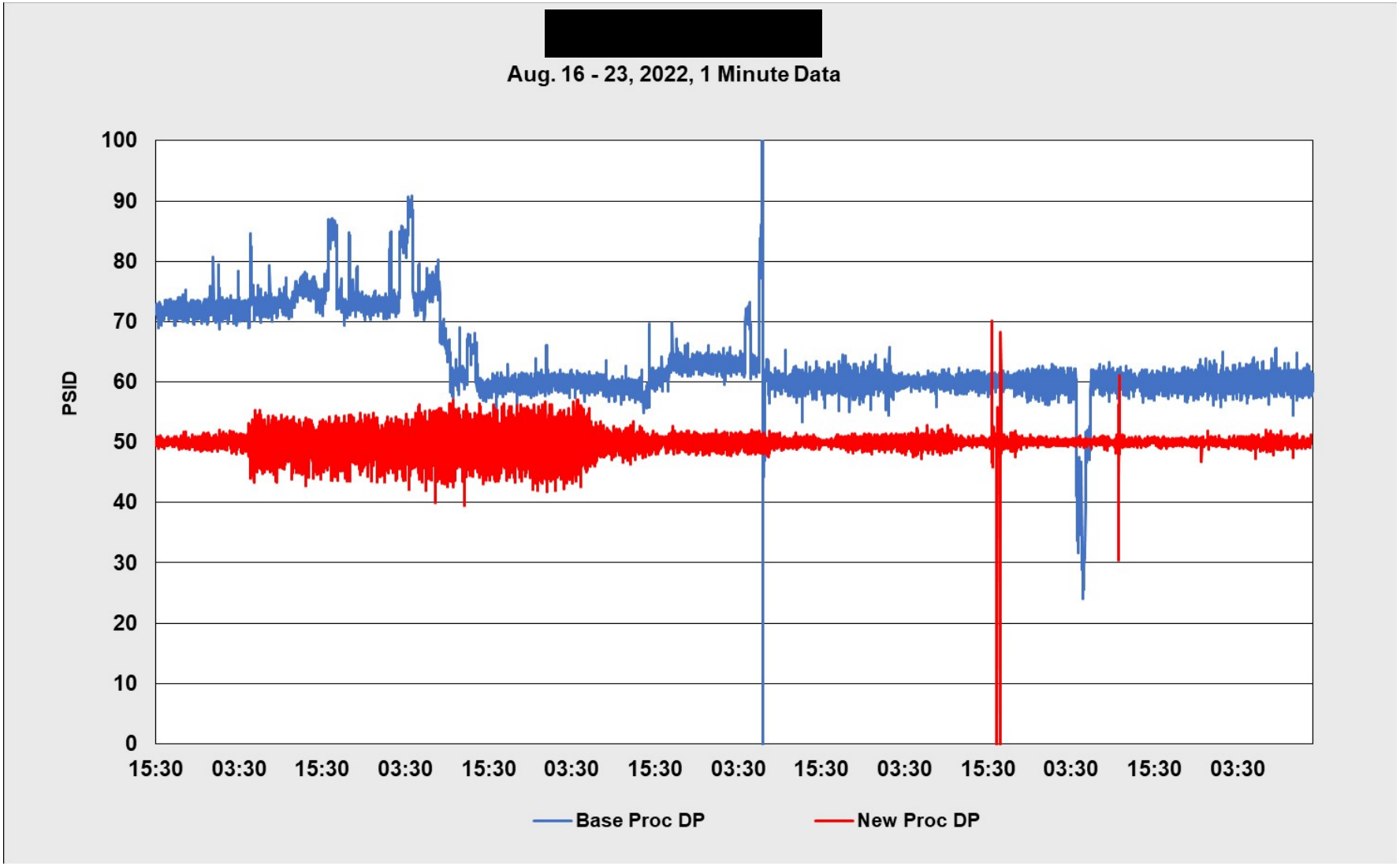
Key controls features & functions (includes VFDs)

- Significantly improved precision in pressure control*
- Pump and tower fan efficiency and maintenance savings from speed control with inverter drives
- Lead / lag rotations, fault response operation
- Programmed variation in variables for system efficiency

Efficient operation controls also provide OpEx benefits – stable inputs, trends, test support, etc.

* Cooling effect is a function of both temperature and flow, pressure control is key to controlling consistent flow

Effective Controls Illustration



Utilities System Controls Features

Typical On / Off ("Sequencing controls") is bare minimum – effective control for OpEx includes:

- Accurate control of plant floor variables (temperature, pressure, flow, etc.)
- Intelligent equipment operation
- Automatic fault response
- Operating data display & storage
- Effective control precision

Controls – OpEx Connections

Typical On / Off ("Sequencing controls") is bare minimum, effective control for OpEx includes:

- Accurate control of plant floor variables (temperature, pressure, flow, etc.) – [Repeatability]
- Intelligent equipment operation – [Efficiency]
- Automatic fault response – [Reliability]
- Operating data display & storage – [Measurability]
- Effective control precision – [Incremental improvability]

How Much Savings / Benefits?

"Easy Number" Benefits:

- Energy savings - ≈ 20 – 70% baseline
- Rebate payments - ≈ 30 – 100% energy savings
- Known maintenance / capital offsets - TBD

Difficult to quantify benefits (but clearly not zero):

- Increased profitability from increased OEE
- Lower M&R costs (fewer repair events)
- Reduced long-term capital costs

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Senior mgt. buy-in is mandatory for these programs to succeed due to hard-to-quantify benefits

Summary

- Brief intro to OpEx and utilities efficiency
- Utilities efficiency review
  - Potential strategic significance
  - Required elements – design, equipment
- Criticality of effective utility controls
- Linkage of utilities efficiency and OpEx
- OpEx benefits from efficiency integration

Q & A