House keeping

- Today's event is being recorded
- The final presentation will be available in a few days at www.pumpsandsystems.com
- Use the chat feature to the left to submit questions for the presenter

The presenter

Nicole George is the Product Manager for pumping variable frequency drives at Eaton. She has over eight years of experience with Eaton in various roles in operations, sales, engineering, and marketing. Nicole is responsible for Eaton's pumping strategy including new product development and sales execution. Nicole holds a bachelor's degree in mechanical engineering from the University of Tennessee and an MBA from the University of Florida.

Modern Pumping Technology

Integrated VFD software applications & algorithms

Nicole George - Product Manager, Pumping Variable Frequency Drives

Agenda

- Energy savings technologies
- Methods for maximizing uptime
- Technologies that protect your pumping system
- The IIoT advantage

Pumping industry challenges

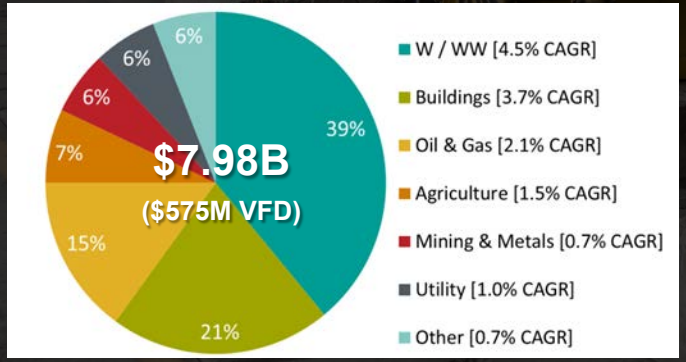
High energy costs

Aging infrastructure

Protect equipment

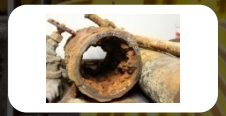
Industry drivers

2017 US pumping market



Market trends

- **High energy costs –** Water facilities account for up to 40% of a city's energy usage



- **Aging infrastructure –** The American Society of Civil Engineers (ASCE) identified aging infrastructure as one of the nation's top water priorities

- **Preventative maintenance –** To maximize uptime, critical system components require proactive maintenance, such as impeller inspections and pipe cleaning

- **Water quality regulations –** The EPA actively enforces Clean Water Act regulations on emerging contaminants

Energy savings technologies

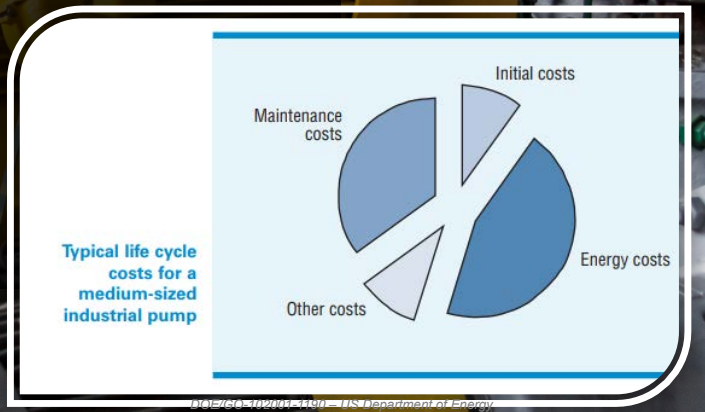
According to a Department of Energy (DOE) study, how much of the energy consumed by pump systems could be saved through equipment or control system changes?

a. 10% - 20%
b. 30% - 50%
c. 60% - 80%

b. 30% - 50%

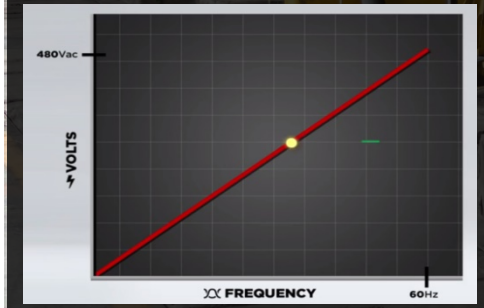
Industry challenge

- High energy costs – Water facilities can account for 30–40% of a city's energy usage and the aeration process uses approximately 50%

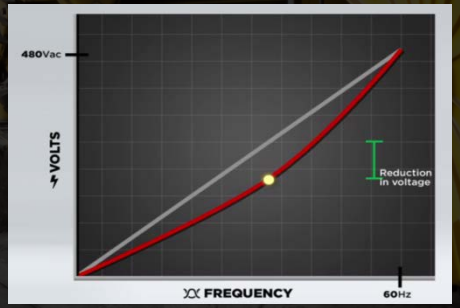


Energy optimization algorithm

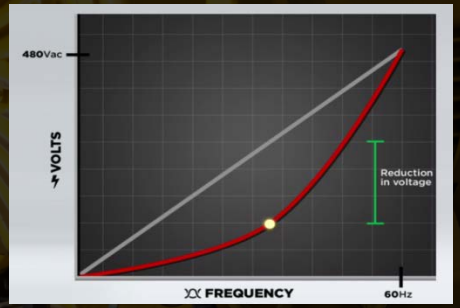
Energy optimization algorithms are used to achieve energy savings on variable torque loads by reducing the output power while maintaining the speed.



The VFD starts the motor and ramps it up to the desired speed. At this point the VFD is following the typical V/Hz curve.



After 50 seconds, the VFD reduces the motor voltage by 5 volts while monitoring the output frequency for any change in speed.



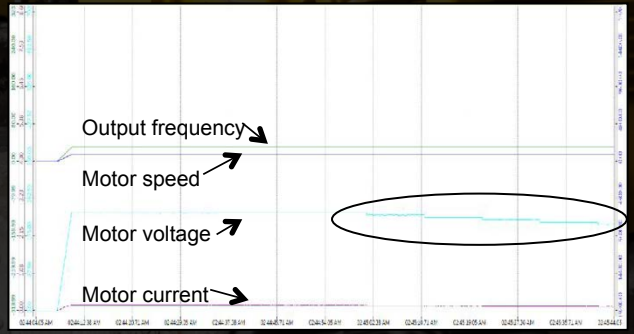
The VFD continues to step down the motor voltage by 5 volts every second until it detects the motor speed has slowed. The VFD then increases the motor voltage by 5 volts and remains at this voltage.

Energy optimization algorithm

As the motor voltage decreases, the motor current also decreases in proportion to the voltage. The end result is an optimized state in which both voltage and current are at the lowest possible values to maintain the required speed.

Actual test data using an unloaded 0.16A motor

	Motor Start up	Final values	Savings
Output frequency	30.00 Hz	30.00 Hz	No change
Motor speed	885 RPM	885 RPM	No change
Motor current	0.16 A	0.05 A	-0.11A (-69%)
Motor voltage	229.9 V	96.6 V	-133.3V (-58%)



Assume there are 20 motors (230V, 0.16A) that operate at 30 Hz for the majority of the run time. If the motors run 8 hours a day, 5 days a week for 50 weeks out of the year, you can save approximately $3,450 annually.

Methods for maximizing uptime

According to the ASCE, how long is the useful life of the electrical components in treatment plants?

a. 15 – 25 years
b. 30 – 40 years
c. 60 – 70 years

a. 15 – 25 years

TABLE 5 ★ The Useful Lives of Wastewater System Components

COMPONENT	USEFUL LIFE (YEARS)
Collections	80–100
Treatment plants—concrete structures	50
Treatment plants—mechanical and electrical	15–25
Force mains	25
Pumping stations—concrete structures	50
Pumping stations-mechanical and electrical	15
Interceptors	90–100

SOURCE EPA (2002, table 2-1).

Failure to Act: The Economic Impact of Current Investment Trends in Water and Wastewater Treatment Infrastructure, American Society of Civil Engineers

Industry challenge

- Aging infrastructure – The ASCE identified aging infrastructure as one of the nation's top water priorities

What is the multi-pump function?

Used in process applications where multiple pumps or fans are used to maintain pressure or flow.

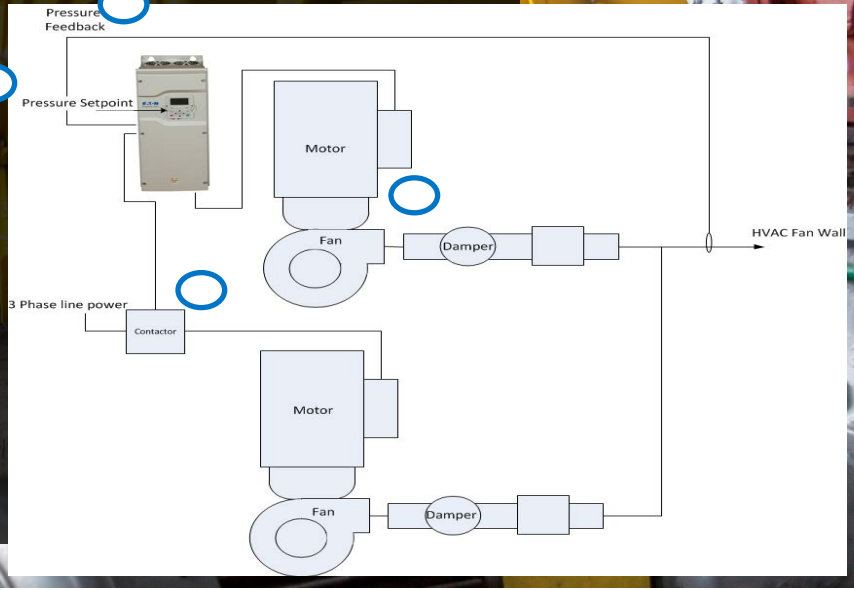
- A single proportional–integral–derivative (PID) loop in the variable frequency drive is used to maintain a process setpoint
- If a single pump or fan is not able to meet the demand, additional fans or pumps are used to boost the system
- 2 types of multi-pump controls
  - Single drive – One VFD is used with one motor, the other motors run across the line
  - Multi-drive – Each motor has a VFD

Example

What is the multi-pump function?

1. External control system provides cubic feet per minute (CFM) setpoint to VFD
2. Pressure feedback measures the air flow
3. VFD adjusts the speed of the fan motor to maintain desired CFM
4. If single motor can't maintain a relay output enables contactor to start/stop 2nd Motor across the line

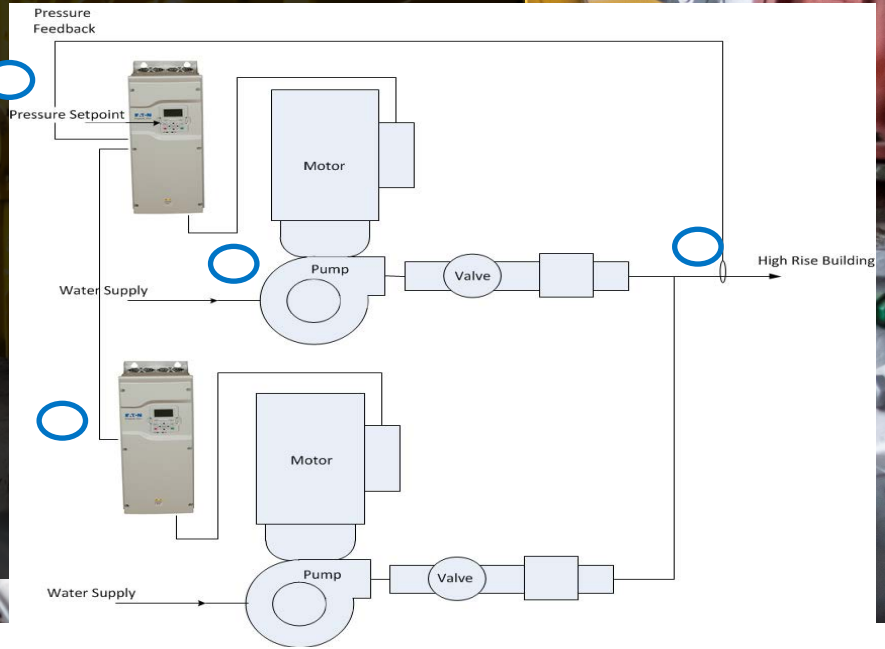
Booster Fan – Single Drive



What is the multi-pump function?

1. External control system provides pressure set point to VFD
2. Pressure feedback measures the water pressure
3. VFD adjusts the speed of the fan motor in the cooling tower to cool water
4. If master can't maintain, it sends command to next VFD to start and share speed

Multi drive – Booster pump application



Technologies that protect your pumping system

What is your biggest opportunity for improvement in regards to your pumping system?

a. Achieve energy savings
b. Reduce maintenance & repair cost
c. Simplify complex systems
d. Collect relevant data

Increasing the intelligence of the motor and VFD can help in all of these areas.

Industry challenge

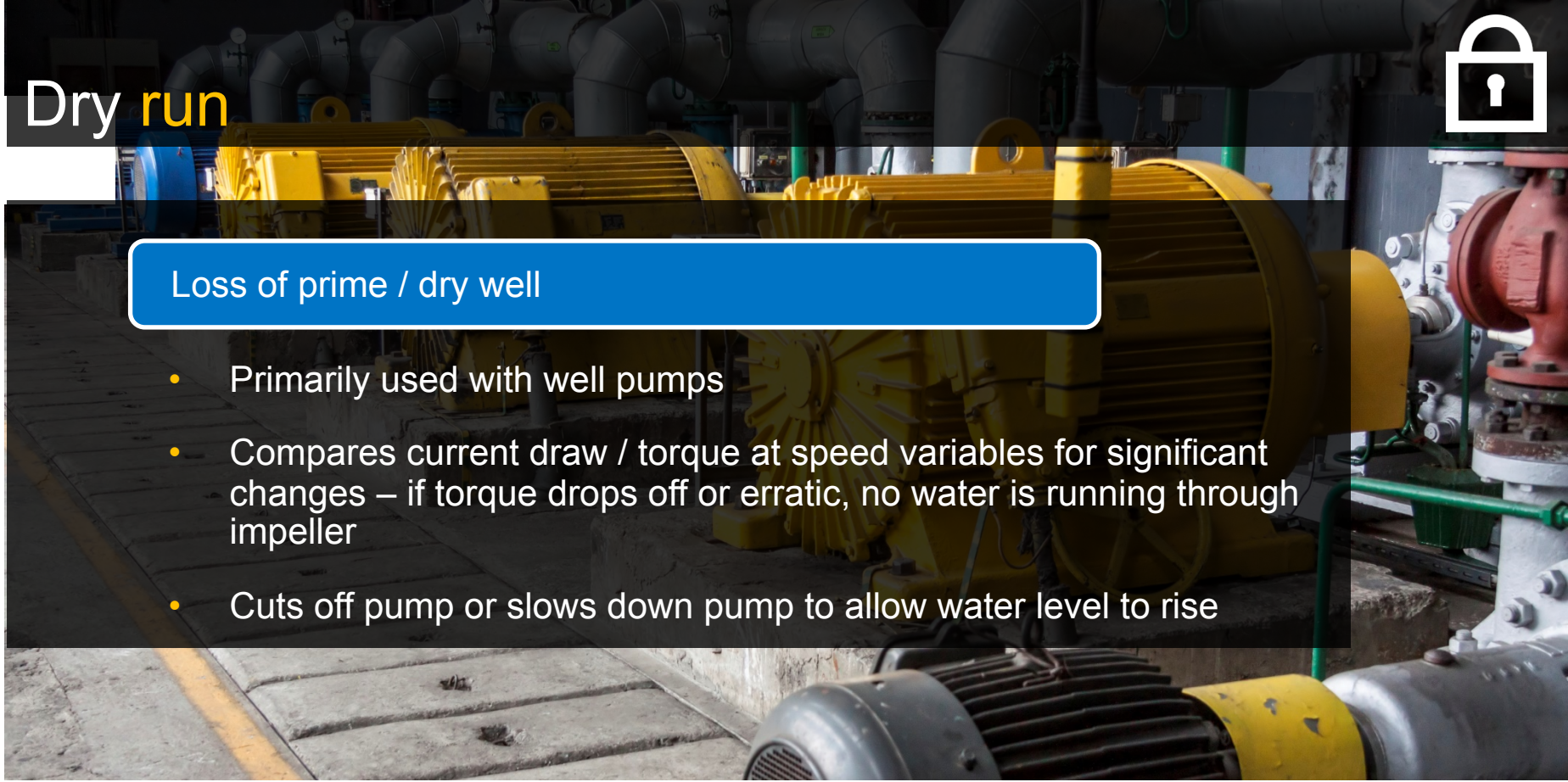
- Preventative maintenance – To maximize uptime and protect equipment, critical system components require proactive maintenance, such as impeller inspections and pipe cleaning

Deadhead

Deadhead / no flow protection

- “Deadhead” is a condition where system pressure (“head”) exceeds the pressure the pump is able to produce
- Water is unable to leave pump, circulating inside impeller – generating heat and damaging pump
- VFD detects without sensors and shuts down pump for inspection

Dry run



Loss of prime / dry well

- Primarily used with well pumps
- Compares current draw / torque at speed variables for significant changes – if torque drops off or erratic, no water is running through impeller
- Cuts off pump or slows down pump to allow water level to rise

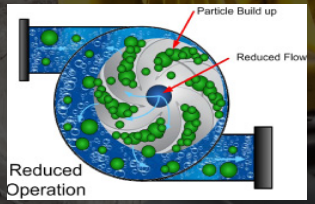
Other VFD pumping controls & protections

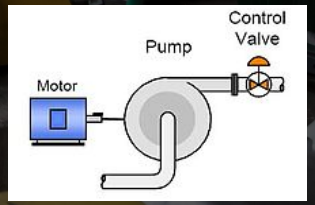
Pump control

- Alternating leads
- Jockey pump
- Anti-Jam
- Skip frequencies
- Damper control
- Pipe fill

Pump protection

- Cavitation
- Deragging
- Feedback loss





IIoT as a competitive advantage

How can the Industrial Internet of Things (IIoT) improve your bottom line?

a. Eliminate process waste
b. Prolong equipment life
c. Eliminate downtime due to failures
d. Onboard new employees faster
e. All of the above

e. All of the above!

IIoT as a competitive advantage

What if we could achieve…?

- Uninterrupted uptime
- Proactive failure detection and prevention
- Automated troubleshooting
- Automatic deployment of repair parts and labor
- Seamless knowledge transfer between human resources
- Unrealized cost savings as a result of process efficiency

IIoT as a competitive advantage

As organizations work to develop sustainable competitive advantages through the integration of IIoT, an increased appreciation of the realities of implementation shapes the landscape of a connected future.

Eaton solutions !

Eaton solutions

PowerXL® VFD family

- Active Energy Control®
- Single-phase applications
- Multi-pump control
- Flying start
- Built-in communications
- Dual PID control
- Expandable I/O

Advancing your pumping system

The PowerXL™ drives family is engineered to provide a complete solution for your demanding pumping applications. The PowerXL DE1, DC1, DA1 and DG1 provide the reliable performance you need while also generating the energy savings you want. With advanced yet easy-to-use features, precise system control and dedicated product support, the PowerXL drives are designed to optimize your pumping systems.

Eaton solutions

CPX9000 Clean Power VFD

- 40 - 800HP @ 480V 50 / 60hz
- 18 pulse low harmonics VFD
- 0.1 - 400HZ frequency range
- Smallest footprint in the industry
- Guarantees IEEE 519 compliance < 5%THD
- Customizable power and control options

Key takeaways

Energy savings

- Energy optimization algorithms built into VFDs
- Reduces the power output while maintaining speed

Multiple pump control

- Single drive uses 1 VFD to control multiple motors with across the line starters
- Multi-drive uses multiple VFDs to control multiple motors

Protect pumping systems

- VFD can protect the pump with deadhead and dry run protection
- Protect the fan motor with broken belt protection
- Protect the contents and people in a building with fire mode

The IIoT advantage

- Benefits of implementing connectivity can be a sustainable competitive advantage
- Understanding the realities of implementation are critical to success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