Before we get started…

What pump or fan energy-saving projects are you planning?

Go to **menti.com** and enter:
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OCTOBER 31, 2023

Save on Energy webinar
Estimating Project Savings – Pumps and Fans

Nick Dalziel, Energy coach
Vern Martin, Fans expert

Download or print your participant workbook!

Download from:

- Calendar invitation, or
- Chat window

SAVE ON ENERGY | DELIVERY PARTNER

ESTIMATING PUMP & FAN PROJECT SAVINGS

PARTICIPANT HANDOUT

How do you know if an energy-saving opportunity is worth pursuing? After identifying an opportunity, you'll likely want to estimate the savings to evaluate if it's worth putting more effort and resources into.

Understanding how to develop a reasonable estimate of energy savings with limited information can be very useful, but it's important to understand what tools or calculations to use, what assumptions are going into those estimates, and under what conditions they're valid.

IN THIS WORKSHOP, PARTICIPANTS WILL:

- Learn how to estimate energy savings from pumps and fans projects, including what tools or calculators can be used.
- Understand when to apply different estimation approaches depending on applicability and available data.
- Have questions about estimating savings answered by Vern Martin.

This workshop will be hosted over Teams.

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Save on Energy Retrofit Program Update

There are some important recent changes to the Retrofit program:

- Prescriptive incentives for most **non-lighting** have increased as of October 30, 2023
- Most incentives have doubled and some have increased three- or fourfold, including air source heat pumps
- The last day to apply for **lighting** projects (prescriptive or custom) in the Retrofit program is **December 17, 2023**
- The **Instant Discounts Program** for lighting launches **December 18, 2023**
- In this program, incentives will be paid directly to distributors, enabling them to offer instant point-of-sale discounts on energy-efficient lighting to customers

Visit the Retrofit program website for the updated measures and incentives.

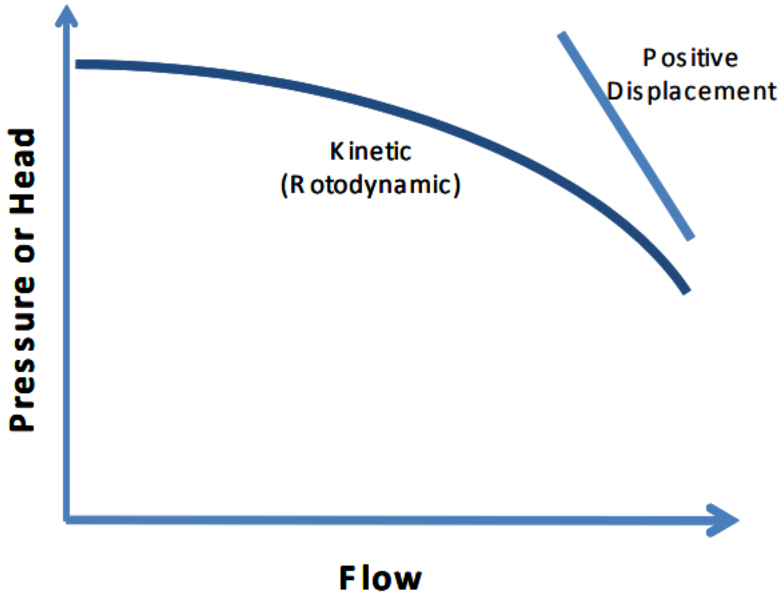
Pathway to Estimating Project Savings

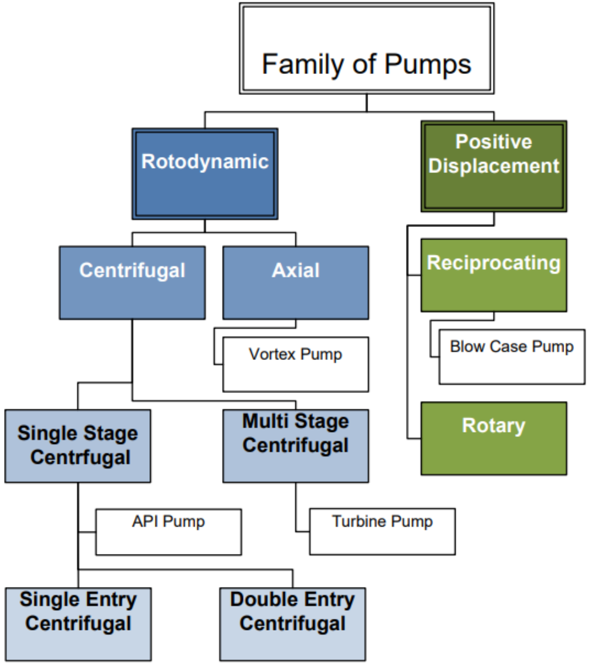
1.Pump and Fan Fundamentals

2. Establishing Pump and Fan Energy Baselines

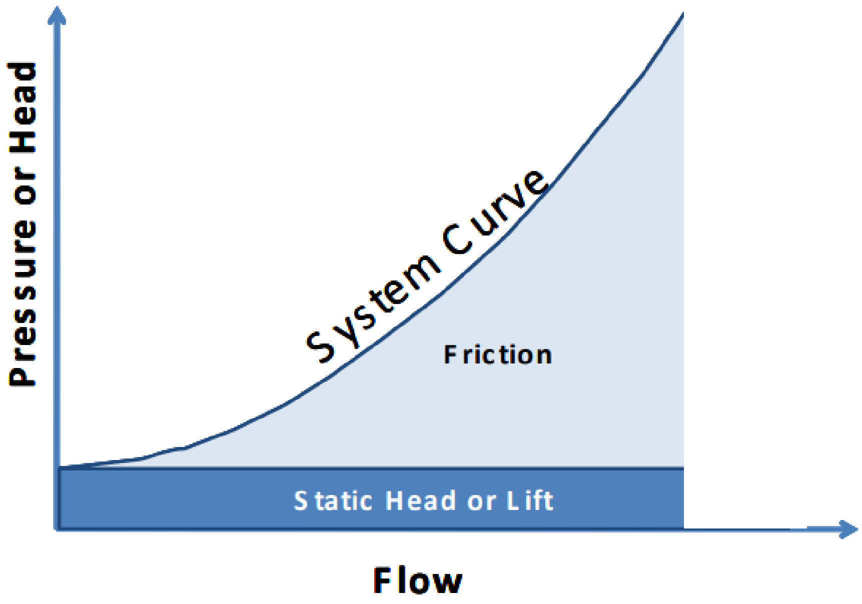
3. Estimating Pump and Fan Project Savings

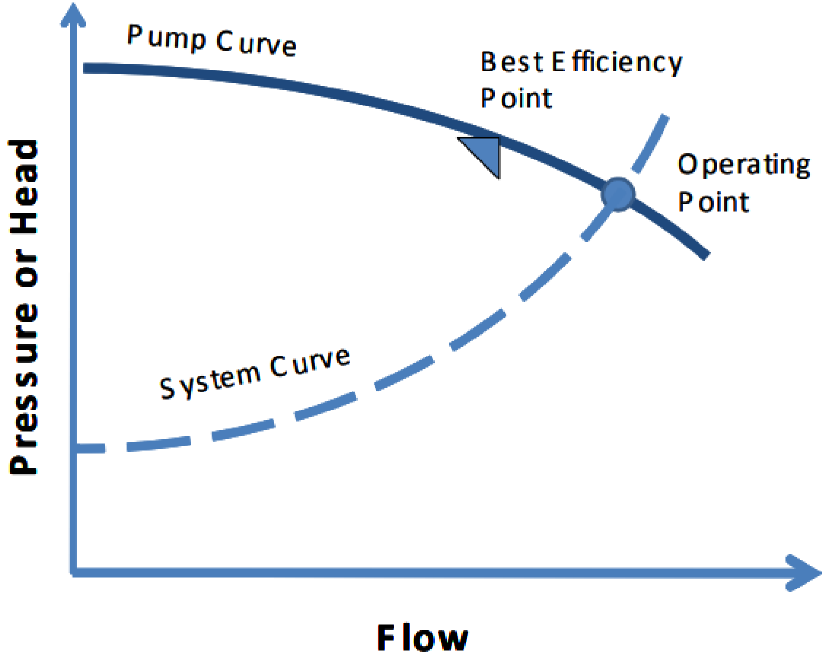
What type of pump system do you have?





Understanding Pump and Fan Systems





Note: All constants defined assuming fluid handled is water

Pump Power

Metric

$$P_m = \frac{\rho \times g \times Q \times H \times 10^{-3}}{\eta}$$

Where:

P_m = Mechanical power requirement for pump [kW]

ρ = Density of fluid handled, [1000 kg/m^3]

g = Gravitational constant, [9.81 m/s^2]

Q = Flow rate of the pump [m^3/s]

H = Head of the pump [m]

η = Pump efficiency [%]

Imperial

$$P_m = \frac{G \times Q \times H}{3960 \times \eta} \times 0.7457$$

Where:

P_m = Mechanical power requirement for pump [kW]

G = Specific gravity of fluid handled, [1]

Q = Flow rate of the pump [gpm]

H = Head of the pump [ft]

η = Pump efficiency [%]

Note: All constants defined assuming fluid handled is water

Pump Power – Simplified

Metric

$$P_m = \frac{9.81 \times Q \times H}{\eta}$$

Where:

P_m = Mechanical power requirement for pump [kW]

g = Gravitational constant, [9.81 m/s^2]

Q = Flow rate of the pump [m^3/s]

H = Head of the pump [m]

η = Pump efficiency [%]

Imperial

$$P_m = \frac{Q \times H}{3960 \times \eta} \times 0.7457$$

Where:

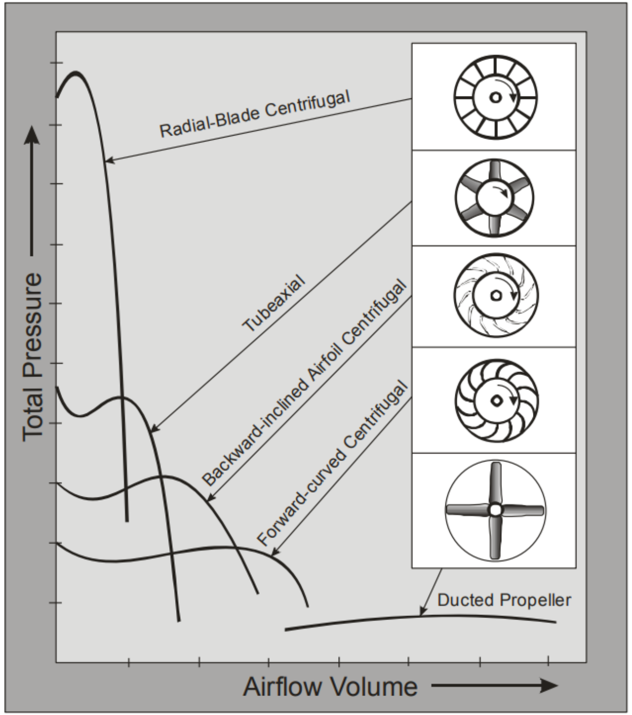
P_m = Mechanical power requirement for pump [kW]

Q = Flow rate of the pump [gpm]

H = Head of the pump [ft]

η = Pump efficiency [%]

What type of fan system do you have?



Fan Power

Metric

$$P_m = \frac{V \times \Delta p}{\eta}$$

Where:

P_m = Mechanical power of fan [kW]

V = Quantity of gas delivered [m^3/s]

Δp = Total increase of pressure of fan [kPa]

η = Fan efficiency [%]

Imperial

$$P_m = \frac{V \times \Delta p \times 0.7457}{229 \times \eta}$$

Where:

P_m = Mechanical power of fan [kW]

V = Quantity of gas delivered [cfm]

Δp = Total increase of pressure of fan [psi]

η = Fan efficiency [%]

Affinity or Fan Laws

$$\frac{BHP_1}{BHP_2} = \left[\frac{n_1}{n_2}\right]^3$$

Where:

BHP_1 = Brake horsepower at initial speed

BHP_2 = Brake horsepower at new speed

n_1 = Initial pump speed [RPM]

n_2 = New pump speed [RPM]

Estimating Power and Energy Consumption

If you've got nothing but the motor nameplate…

$$P_e = hp_{nameplate} \times 0.746\ [kW/hp] \times LF$$

$$\text{Energy Baseline} = \left(hp_{nameplate} \times 0.746\right) \times \text{Annual Hours}$$

Where:

- Energy Baseline is in kWh
- LF (Load Factor) is between 0% - 100%

Three-phase Power

$$P_e = \frac{V \times I \times PF \times \sqrt{3}}{1000}$$

Where:
P_e = Three-phase electric power [kW]
V = RMS voltage, mean line-to-line of 3 phases [V]
I = RMS current, mean of 3 phases [A]
PF = Power factor as a decimal

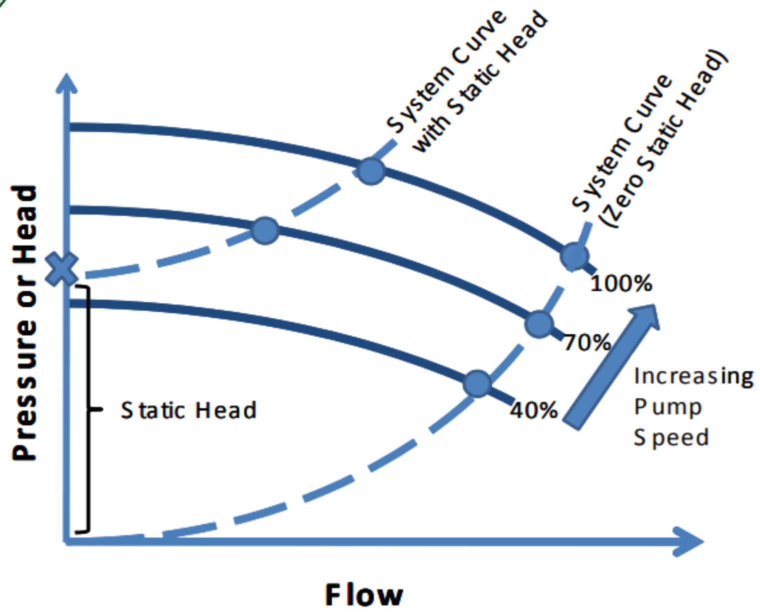
Calculating Project Baselines

Energy = Power x Time

Pump and Fan System Savings

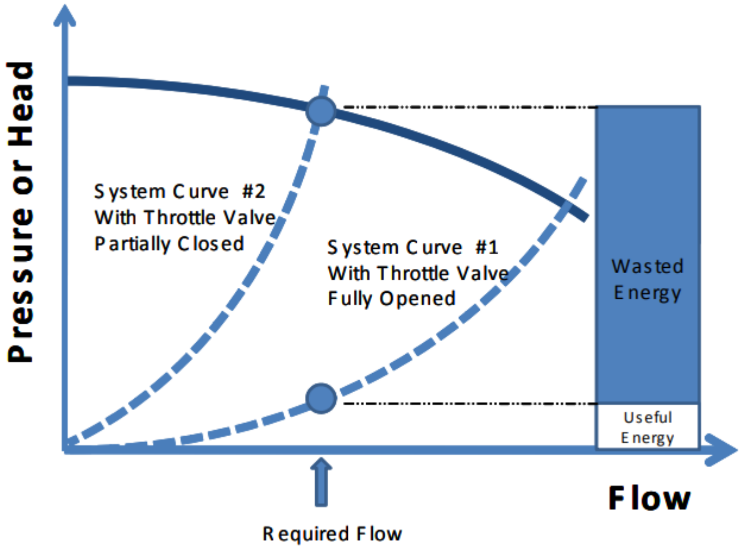
- **Reduce Flow**
- **Reduce Pressure**
- **Increase Efficiency**

Reduce Flow



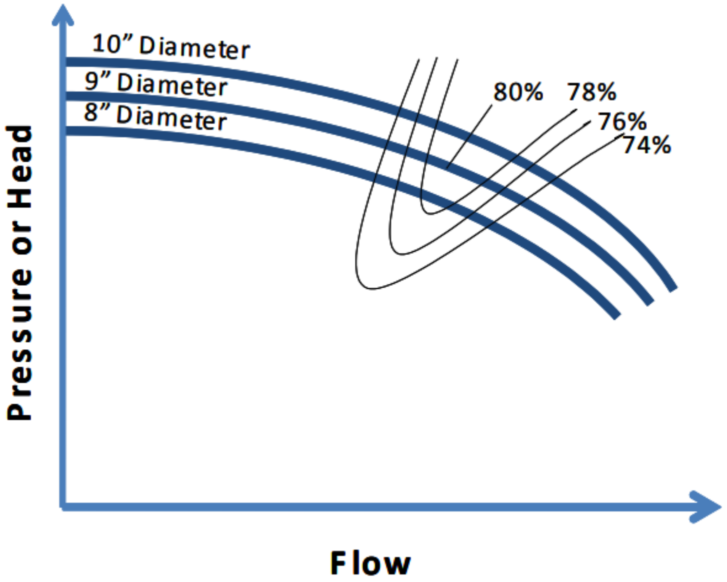
- **Savings mechanisms**: Move less volume, including turning pumps/fans down or off when not needed
- **Solutions**: Eliminate bypass or excess flow by right-sizing or by VFD; on/off controls; fix leaks
- **Calculation pitfalls**: Ignoring static pressure/head; applying design conditions

Reduce Pressure



- **Savings mechanisms:** Reduce restrictions, reduce head/height differentials in open systems
- **Solutions:** Control with VFD to eliminate dampers/throttling valves; increase pipe/duct diameter; improve maintenance
- **Calculation pitfalls:** Ignoring static pressure/head; applying design conditions

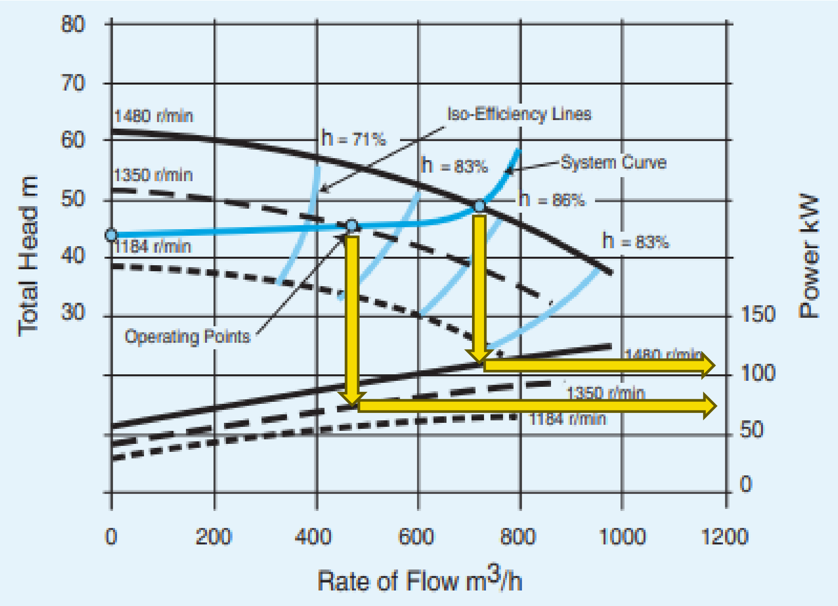
Increase Efficiency



- **Savings mechanisms:** Mechanisms: Operate at the Best Efficiency Point (BEP), or install higher efficiency equipment
- **Solutions:** Recommissioning; right-sizing
- **Calculation Pitfalls:** Ignoring static pressure/head; applying design conditions

Project Savings Example

Flow change via VFD in a pump system with high static head



Baseline P_m

$$= \frac{1000\ \frac{kg}{m^3} \times 9.81\ \frac{m}{s^2} \times 660\ \frac{m^3}{h} \times 50\ m}{3.6\times10^6 \times 85\%} = 105.8\ kW$$

$$P_{e\ baseline} = \frac{105.8\ kW}{94\%} = 112.5\ kW$$

Project P_m

$$= \frac{1000\ \frac{kg}{m^3} \times 9.81\ \frac{m}{s^2} \times 440\ \frac{m^3}{h} \times 46\ m}{3.6\times10^6 \times 78\%} = 70.7\ kW$$

$$P_{e\ project} = \frac{70.7\ kW}{93\%} = 76\ kW$$

Savings $= P_{e\ baseline} - P_{e\ project} = 36.5\ kW$

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SAVE ON ENERGY POWER WHAT'S NEXT

Source: Variable Speed Pumping, A Guide to Successful Applications, Hydraulic Institute, 2004

Estimating Savings Wrap-up

Methods

- Combine calculation approaches to establish baseline power estimates
- Assess the duty cycle when developing the energy baseline
- Start from your baseline when estimating savings

Tools

- Make sure you understand your system first
- Consider doing your own calculations, at least as a check of tool results
- Be cautious of calculations/tools using the fan/affinity laws

Questions and Answers with Vern Martin

Please give us feedback!

SCAN ME

Let us know what you think!

We practice continuous improvement, and your feedback will help us ensure you get the programming you value.

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POWER WHAT'S NEXT

One last question…

What's one tip from today you'll use when estimating savings?

Go to **menti.com** and enter:
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