Upgrading Pumping Systems

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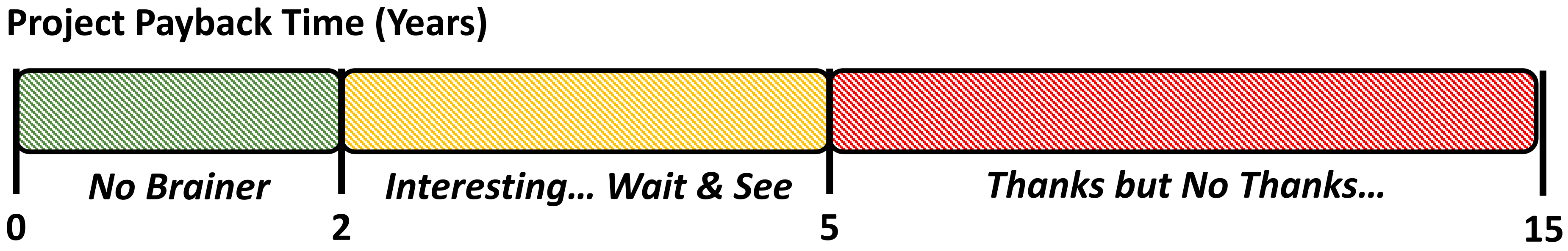
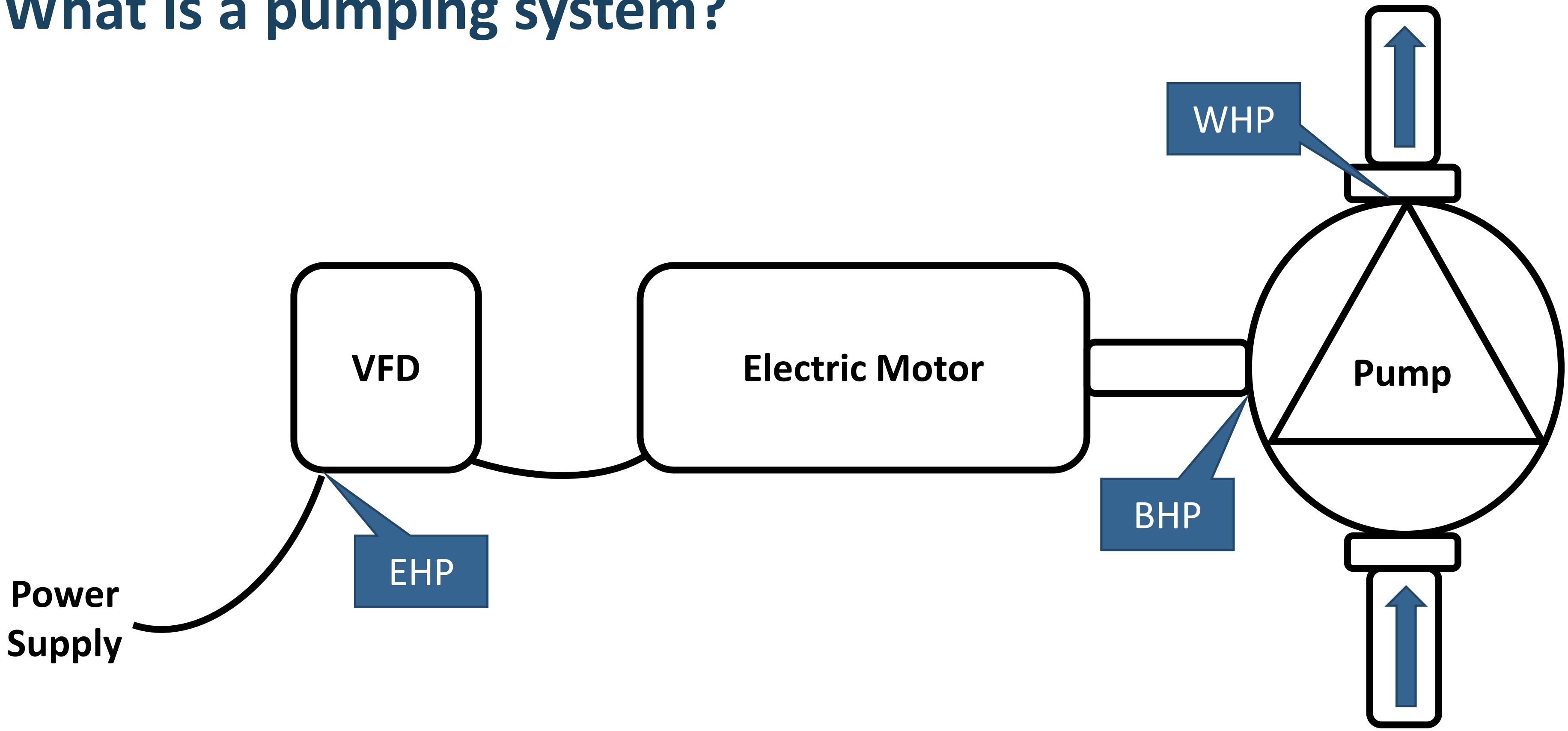
Upgrading Pumping Systems

- Why upgrade, is it cost effective?
- What is a pumping system?
- How do pumping systems consume energy?
- Fully integrated pumping systems
- **Case 1** St. John Fisher College
Hot Water Heating System
- **Case 2** Renaissance New York Times Square Hotel
Domestic Water System
- Wrap up

Define cost effective…



What is a pumping system?



Components:

A) **Pump** – Pressure is applied to pumped product
B) **Motor** – Force is applied to pump impeller
C) **VFD/ VSD** – Dictates rotational speed of motor, allows for variation (based on Hz)

Efficiency loss (“slip”) across each component in the system, **ETA % measures system efficiency**.

How is energy consumed?

Pump Theory for Static Condition

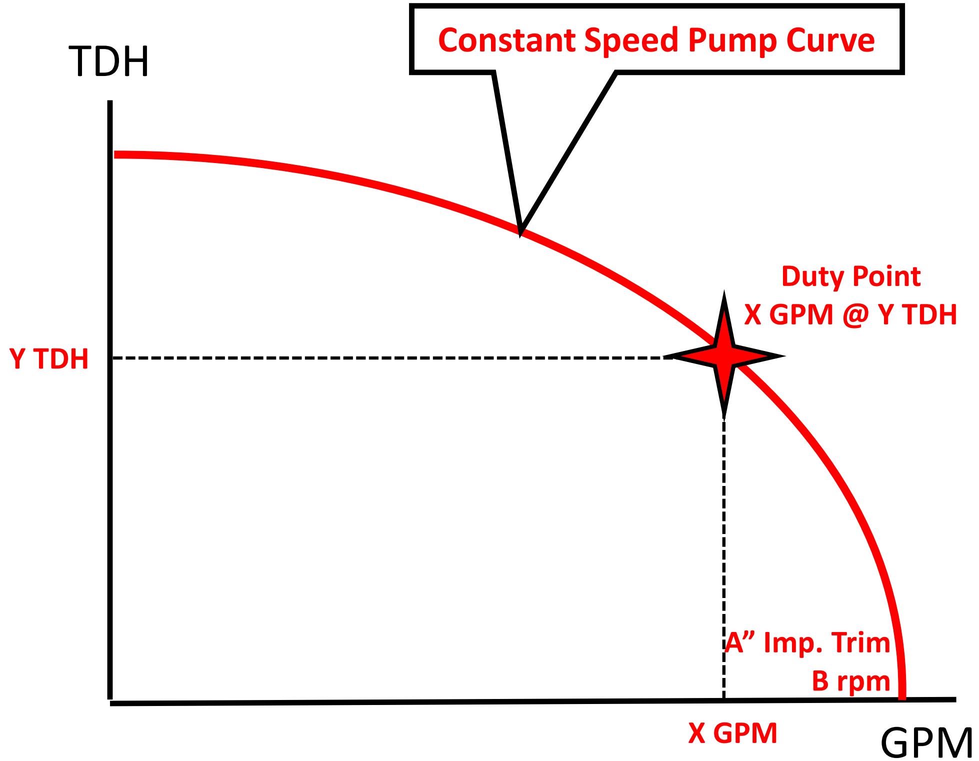
Power Consumption Formula

$$kW = \frac{(GPM \times TDH \times S.G.)}{(3960 \times ETA\ \%)} \times 0.7456$$

GPM: Gallons per minute (Flow)
TDH: Total Dynamic Head
S.G.: Specific Gravity (Water = 1.00)
ETA % = Pump $_{Efficiency}$ x Motor $_{Efficiency}$ x VFD $_{Efficiency}$

Energy Consumption Formula

kWh = kW x Running Hours per year



Example:

Given: X = 10 GPM and Y = 20 GPM, 5,000 Hours/ Year, ETA % = 65%, Pumping Water (S.G. = 1.00)
kW = [(10 x 20 x 1.00)/(3960 x 0.65)] x 0.7456 = 0.058 kW
kWh = 0.058 x 5,000 = 290 kWh/ Year (rounded)

How is energy consumed?

Pump Theory for Dynamic/Variable Load Condition

Power Consumption Formula

$$kW = \frac{(GPM \times TDH \times S.G.)}{(3960 \times ETA\ \%)} \times 0.7456$$

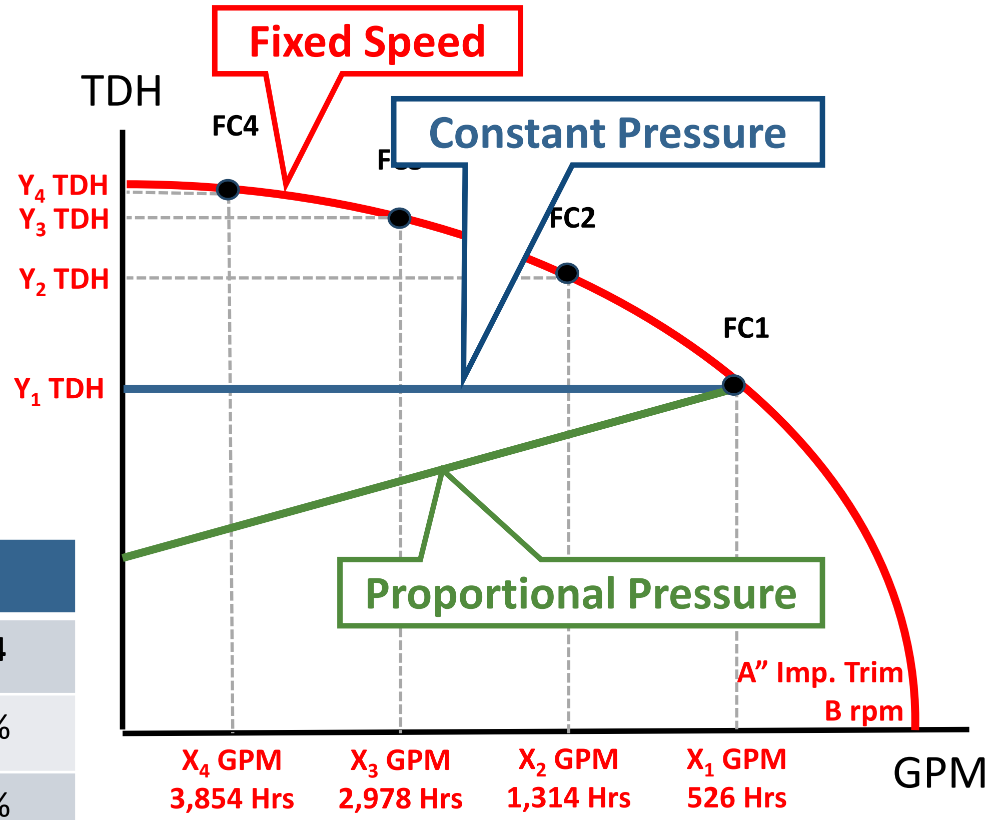
Energy Consumption Formula

kWh = kW x Running Hours per year

FOR EACH FLOW CLASS BASED ON LOAD PROFILE

Assumed: 8,760 Hours/ Year (100% Runtime)

Flow Classes				
	FC1	**FC2**	**FC3**	**FC4**
% Load	100%	75%	50%	25%
% Time	6%	15%	34%	44%
Hours/ Yr	526	1,314	2,978	3,854



Each Flow Class has its own ETA %

Here's the situation…

- Our facility has a pump sized to do 92 GPM @ 159 TDH, it runs 8,760 Hrs/ Yr, $0.148 Cost/ kWh
- It's nearing the end of its useful life, needs to be replaced
- Pressure coming from the top to cut costs where possible
- We have a VFD laying around that we could use if needed (or general recomdation for a vfd)
- Would like to hook the pump system up to our Building Automation System
- Limited capital expenditure budget

What do we do?

1. Just replace the old pump system on a "like-for-like" basis
2. Grab the VFD and hook it up to the newer version of the same pump
3. Look at a new integrated pump system

"Like-For-Like"

Grundfos CR 15-3
Cost: $5,966

Fixed Speed Pump
Premium Efficient Motor
VFD Capable
BAS Capable

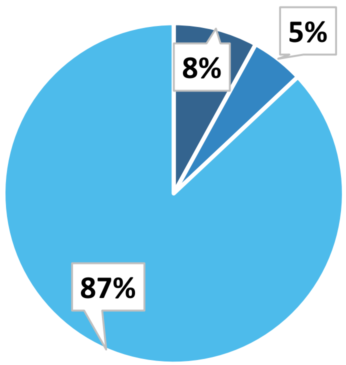
Integrated Pump System

Grundfos CRE 15-3
Cost: $8,785

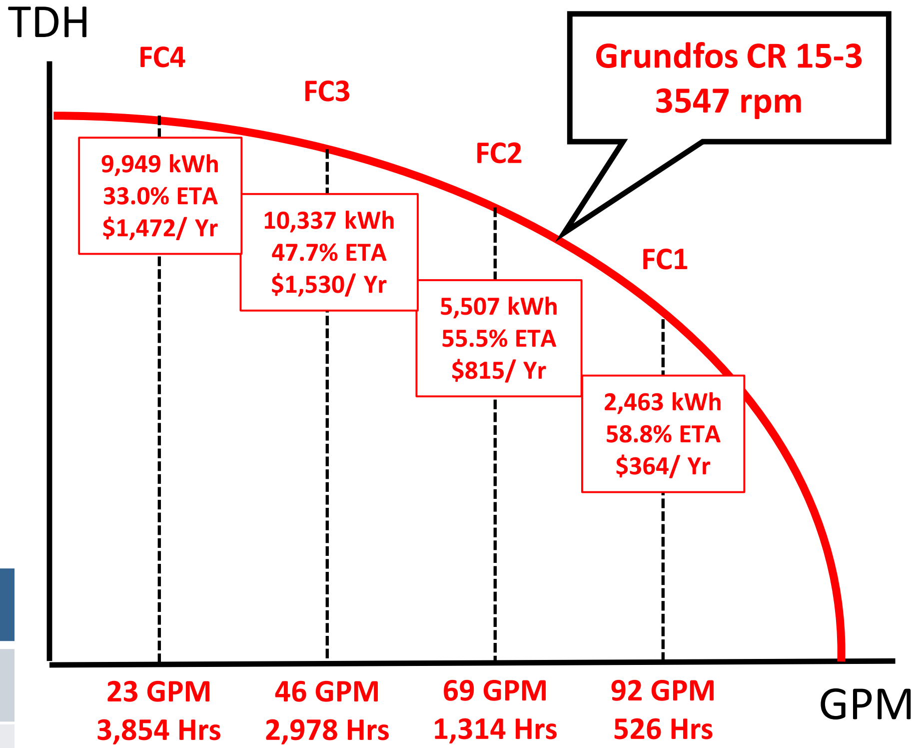
Variable Speed Pump
PMM/ECM Motor
Integrated VFD
BAS Capable

What is the LCC of the existing pump system?

Grundfos CR 15-3
92 GPM @ 159 TDH, 8,760 Hrs/ Yr
Cost/ kWh: $0.148
15 Year Life
kWh/ Yr: 28,256



Cost	Year 1	15 Yr LCC
Replacement	$5,966	$5,966 (8%)
Maintenance	$250	$3,750 (5%)
Energy	$4,182	$62,730 (87%)
TOTAL	**$13,148**	**$113,696**



Integrated System – Proportional Pressure

Duty Conditions:
92 GPM @ 159 TDH
8,760 Hrs/ Yr, Cost/ kWh: $0.148

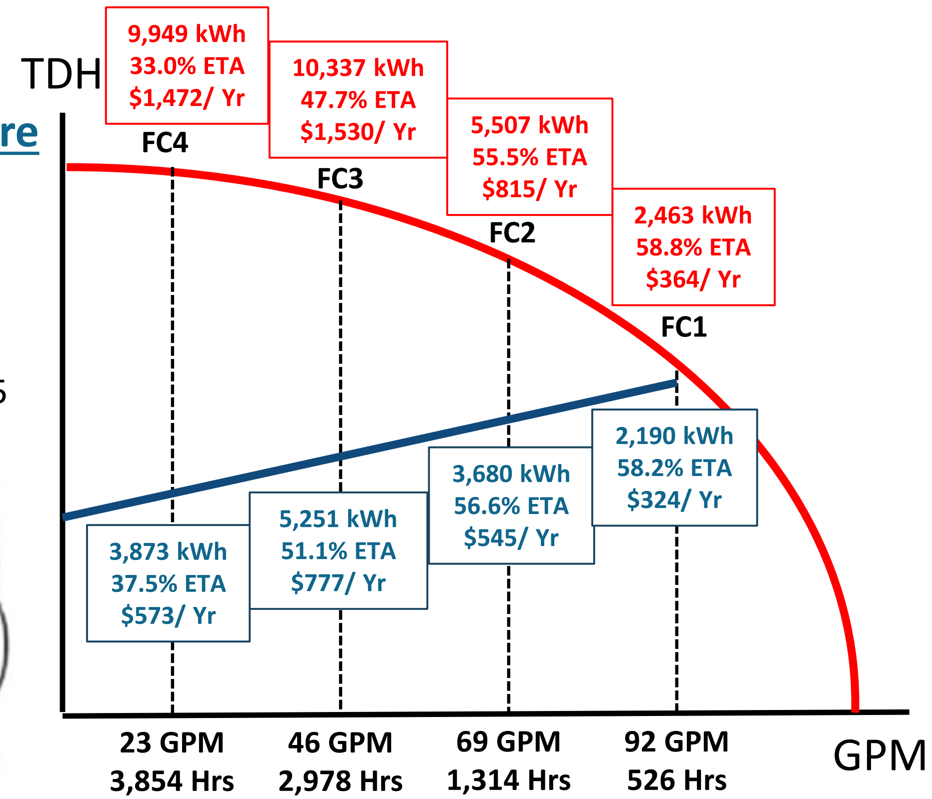
$$kW = \frac{(GPM \times TDH \times S.G.)}{(3960 \times ETA\ \%)} \times 0.7456$$

$$kWh = kW \times Hours/\ Year$$

Max Fixed Speed vs **Proportional Pressure**

Grundfos CR 15-3
kWh/ Yr: 28,256
Energy Cost/ Yr: $4,182
15 Yr Energy Cost: $62,730

Grundfos CRE 15-3
Set point: 140 TDH
kWh/ Yr: 14,994
Energy Cost/ Yr: $2,219
15 Yr Energy Cost: $33,285

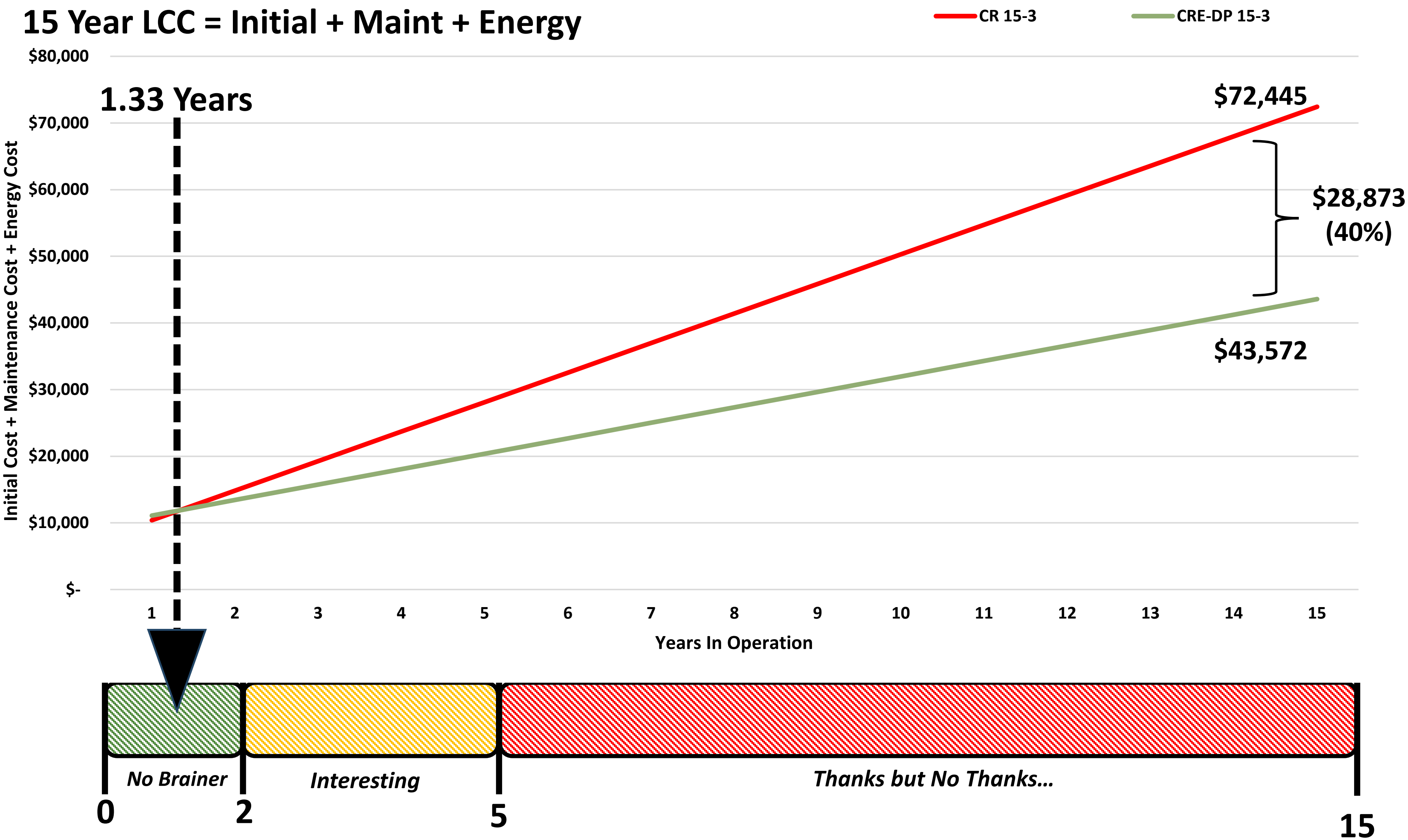


Savings Potential

Energy Savings/ Yr: $1,963
15 Yr Energy Savings: $29,445

Integrated System – Proportional Pressure

Cost Effectiveness?



Case 1 – St. John Fisher College

Hot Water Heating System

- Pumping system retrofit
- Variable volume system?
- 6 pumps total
  - 2 primary boiler pumps
  - 4 secondary zone pumps
- Pump audit revealed design conditions
  - Zone 1 – 41.5gpm at 20' tdh
  - Zone 2 – 24.1gpm at 21' tdh
  - Zone 3 – 23.7gpm at 21' tdh
  - Zone 4 – 17.4gpm at 21' tdh
- Like for Like replacement?
- Justifications for retrofit:
  - Improved system performance
  - Increased comfort
  - Less wear and tear on system
  - Reduced operating costs

Integrated pumping system

St. John's Pump Retrofit: Comfort in the Bitter Cold, with Less Head and Lower Energy Consumption							
SCIENCE CENTER BUILDING WING	OLD PUMPS			NEW MAGNA 3 CIRCULATORS			
	FLOW (GPM)	HEAD (FEET)	POWER CONSUMPTION (Watts)	FLOW (GPM)	HEAD (FEET)	POWER CONSUMPTION (Watts)	PCT. SAVINGS
North	41.5	20.0	400	39.6	14.8	166	58.5
East	23.7	21.0	350	21.1	8.5	56	84.0
South	24.1	21.0	350	25.5	9.2	68	80.6
West	17.4	21.0	150	12.8	7.2	30	80.0

Integrated pumping system

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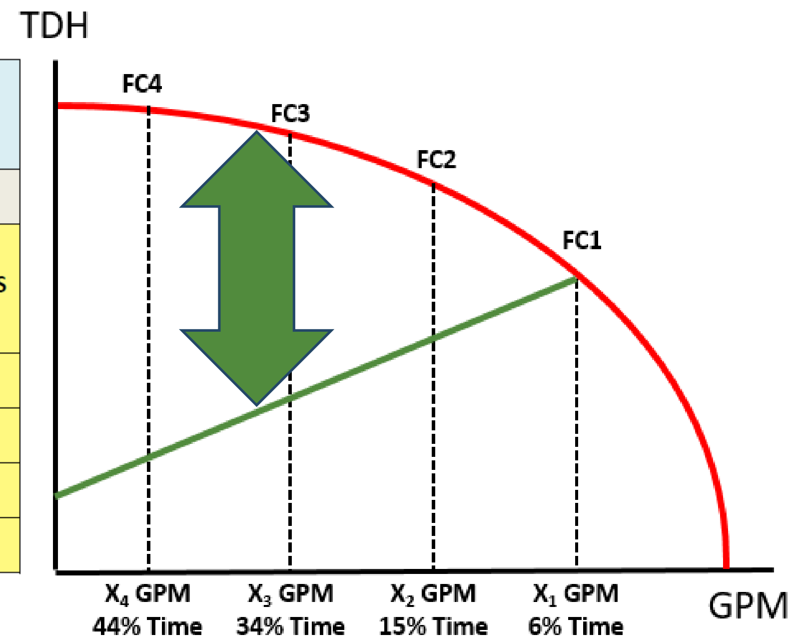


Case 2 - Renaissance New York Times Square Hotel

Domestic Water Booster System

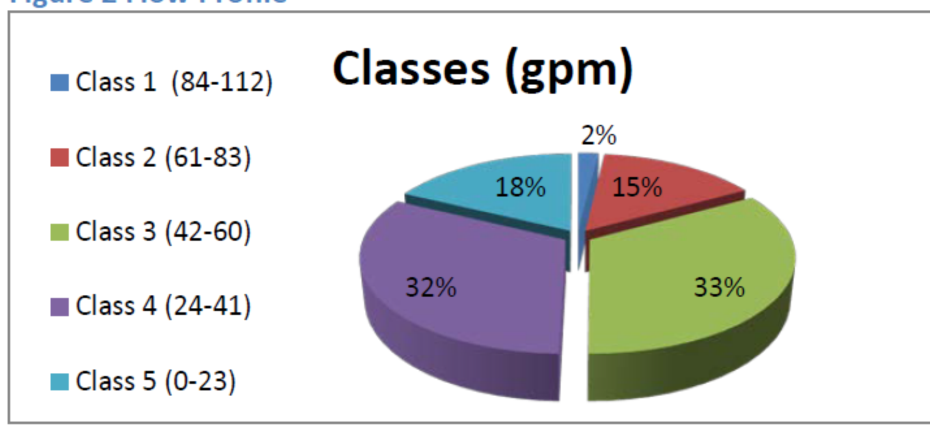
Table 2 Pressure Profile

Pressure	Units	Design	Gauges	Pump Audit	
				Min	Max
Suction	psi	30	41	38	48
Discharge	psi	158	155	133	165
Boost	psi	133	114	91	119

Table 3 Flow Statistics

Flow	Units	Design	Audit	Scaled
Max	GPM	375	90	112
Average	GPM	-	34	42
Min	GPM	-	0	0

Figure 2 Flow Profile



Case 2 - Renaissance New York Times Square Hotel

Domestic Water Booster System

Table 4 Operational Comparison

	Boost (FT)	Flow (GPM)			
		1 Pump	2 Pumps	3 Pumps	4 Pumps
Design	307	0-125	126-250	251-375	-
Hydro MPC-E 4CRE10-10 7.5HP 3x208V					
Proposed	274	0-61	62-104	105-148	149-264
Operational Time	-	60%	35%	5%	Stand-by

Table 5 Annual Energy Savings Potential

Grundfos Pump Audit				
	Unit	Existing	Proposed	Savings
System Water Volume	Cubic Feet	2,966,479	2,966,479	-
Energy Consumption	kWh	162,548	31,151	**131,397**
Energy Cost	USD	$34,135	$6,542	**$27,593**
Savings	%	-	-	**81 %**

Thank you!