focus on energy℠

Partnering with Wisconsin utilities

Energy Savings Using Variable Speed Drives

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Energy Savings Dollars And Sense

A dollar not spent on energy is a dollar of NET PROFIT:

- A company generating 5% return on net assets (RONA) has to sell $_____ in products to generate $50,000 in profit?

  $1,000,000.00

- If your solution saves $10,000.00 in energy costs, how much is that really worth?

  $200,000.00 in top line revenue

  $ savings x 1/(RONA % provided by management)

- Energy costs are rising.
- Motors are the largest consumers of energy in North America.

Basic Electrical Costs

- Demand
- Power factor
- Kilowatt hours consumed

Demand Charge – Hard To Justify

Demand charge – 15 minute average peak usage

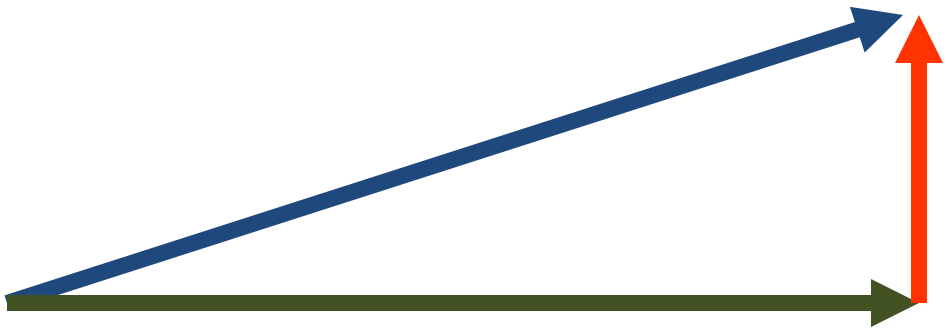
- Staggered starts
- Soft starts
- Variable speed drives

Power Factor – Easier To Justify

Power factor – charge or credits (depending on the power factor)

- Decreases efficiency if power factor is below 85%
- May be credited if power factor is above 95%

Power Factor As A Cost



Lagging PF

+20%

+10%

Standard

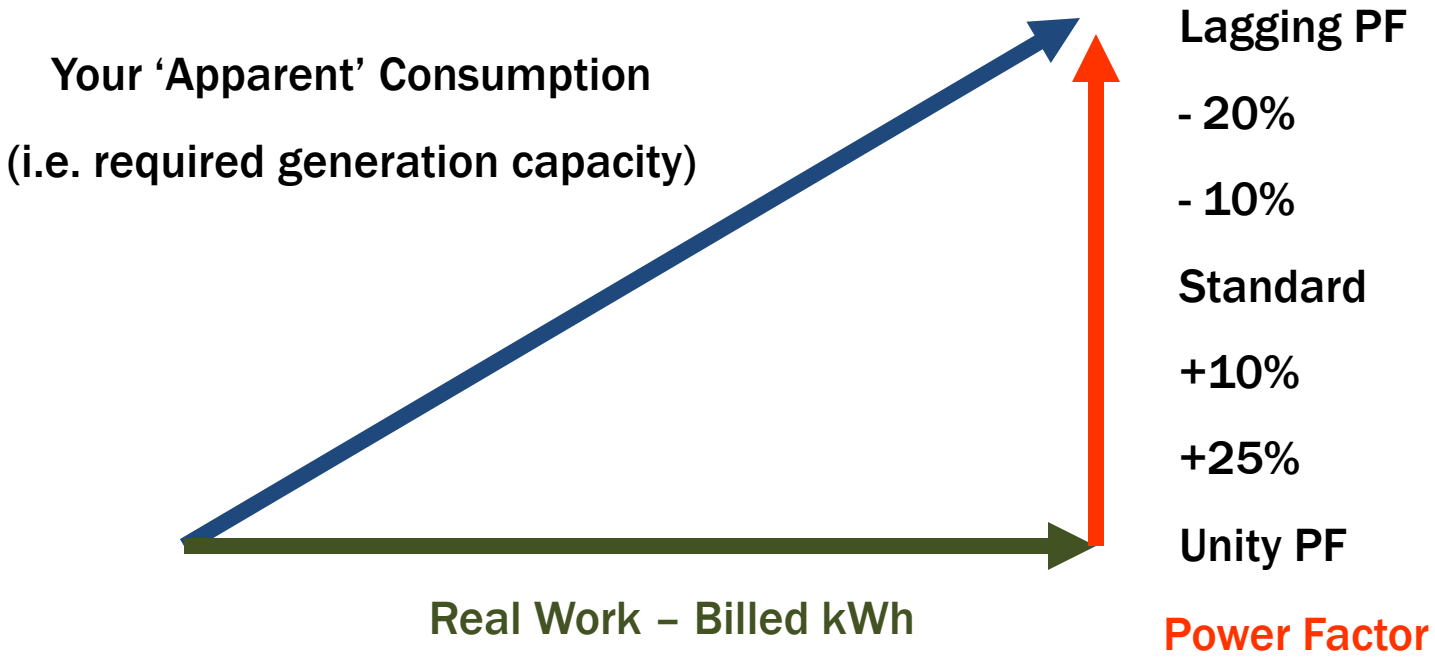
-10%

-25%

Unity PF

Power Factor

Power Factor As A Cost



Power Factor As A Cost

Your ‘Apparent’ Consumption

(i.e. required generation capacity)

Real Work – Billed kWh

Lagging PF

+20%

+10%

Standard

-10%

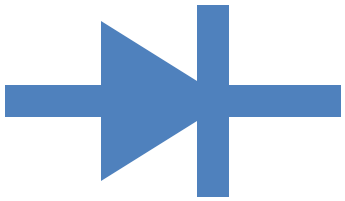
-25%

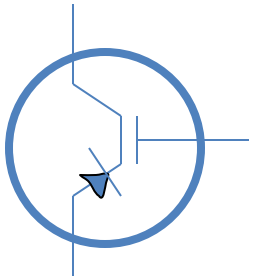
Unity PF

Power Factor

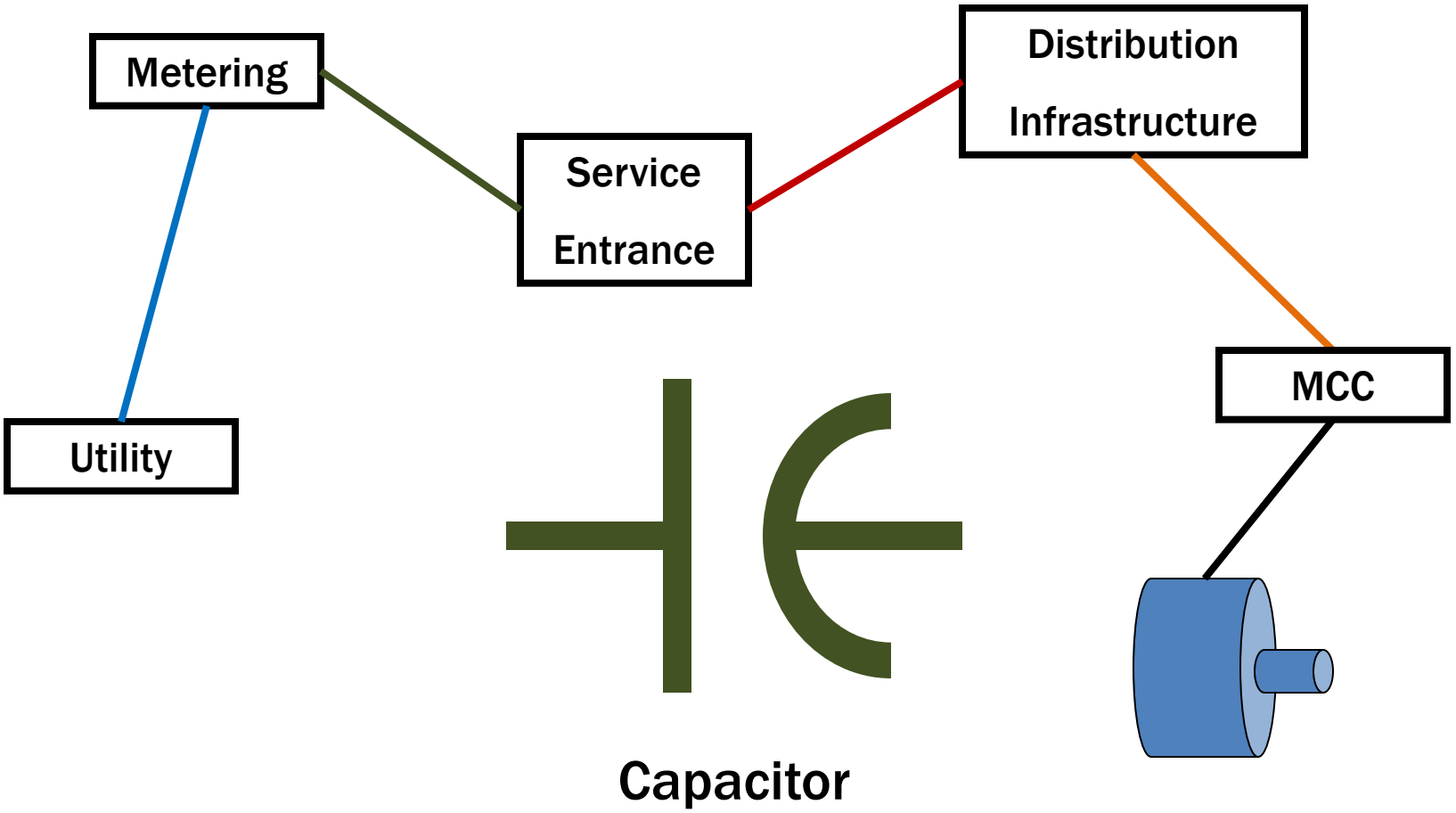
Variable Speed Drives

Electrically located at motor – looks like a power factor correction capacitor to distribution system





Capacitor Location?



Reducing True Consumption Benefits

Reducing consumed kW

- Provides quickest paybacks
- Easiest to justify
- Tools eliminate guess work

VSD – Big Payoff

Exponential reduction in consumed kW:

- Variable torque – fans, pumps
- Variable load characteristics – systems that cycle, i.e. injection molders
- Throttled loads – restricted flows, i.e. dampers, control valves, recirculation

Affinity Laws

Affinity laws apply to all centrifugal devices.

Flow (Q) Changes Linearly with Speed (N)

$$\frac{Q_2}{Q_1} = \frac{N_2}{N_1}$$

Pressure (P) is Proportional to the Square of Speed (N) or Flow (Q)

$$\frac{P_2}{P_1} = \left(\frac{N_2}{N_1}\right)^2$$

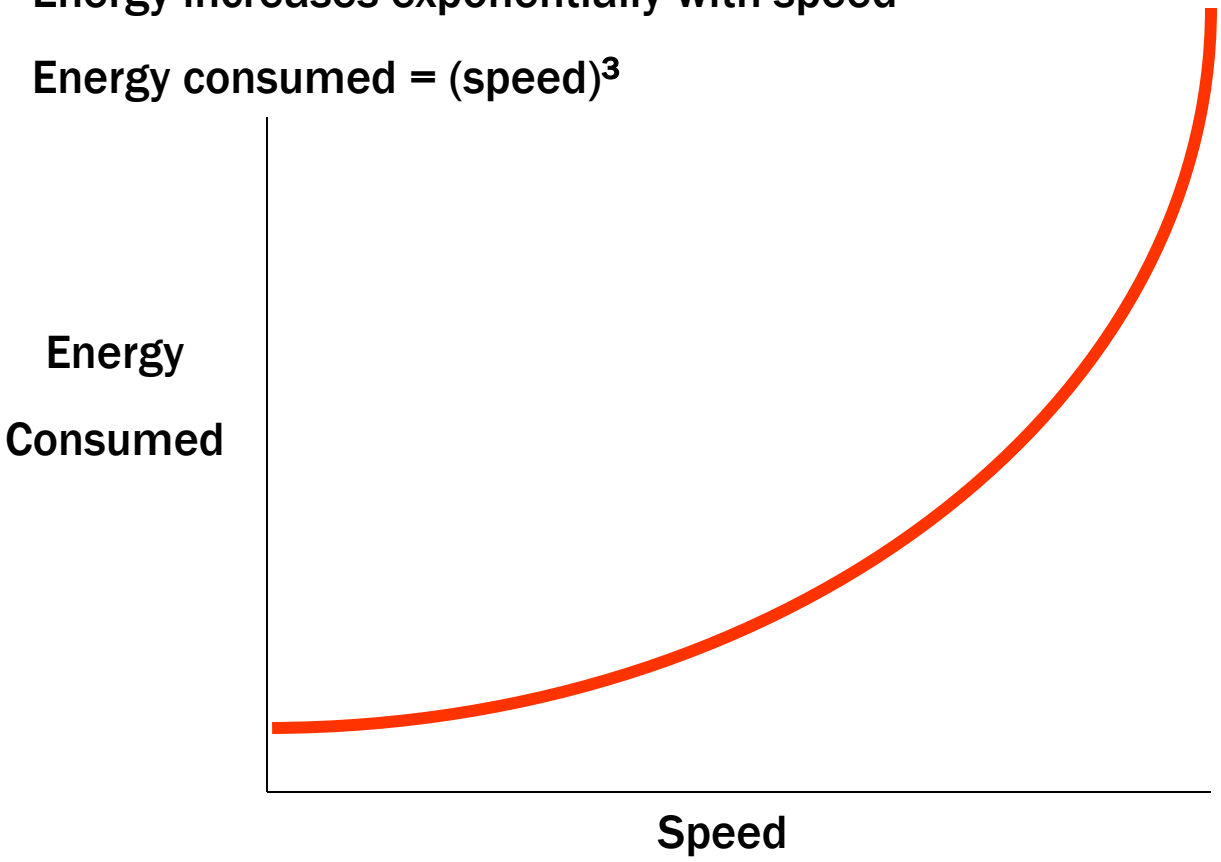
Power (HP) is Proportional to the Cube of Speed (N) or Flow (Q)

$$\frac{HP_2}{HP_1} = \left(\frac{N_2}{N_1}\right)^3$$

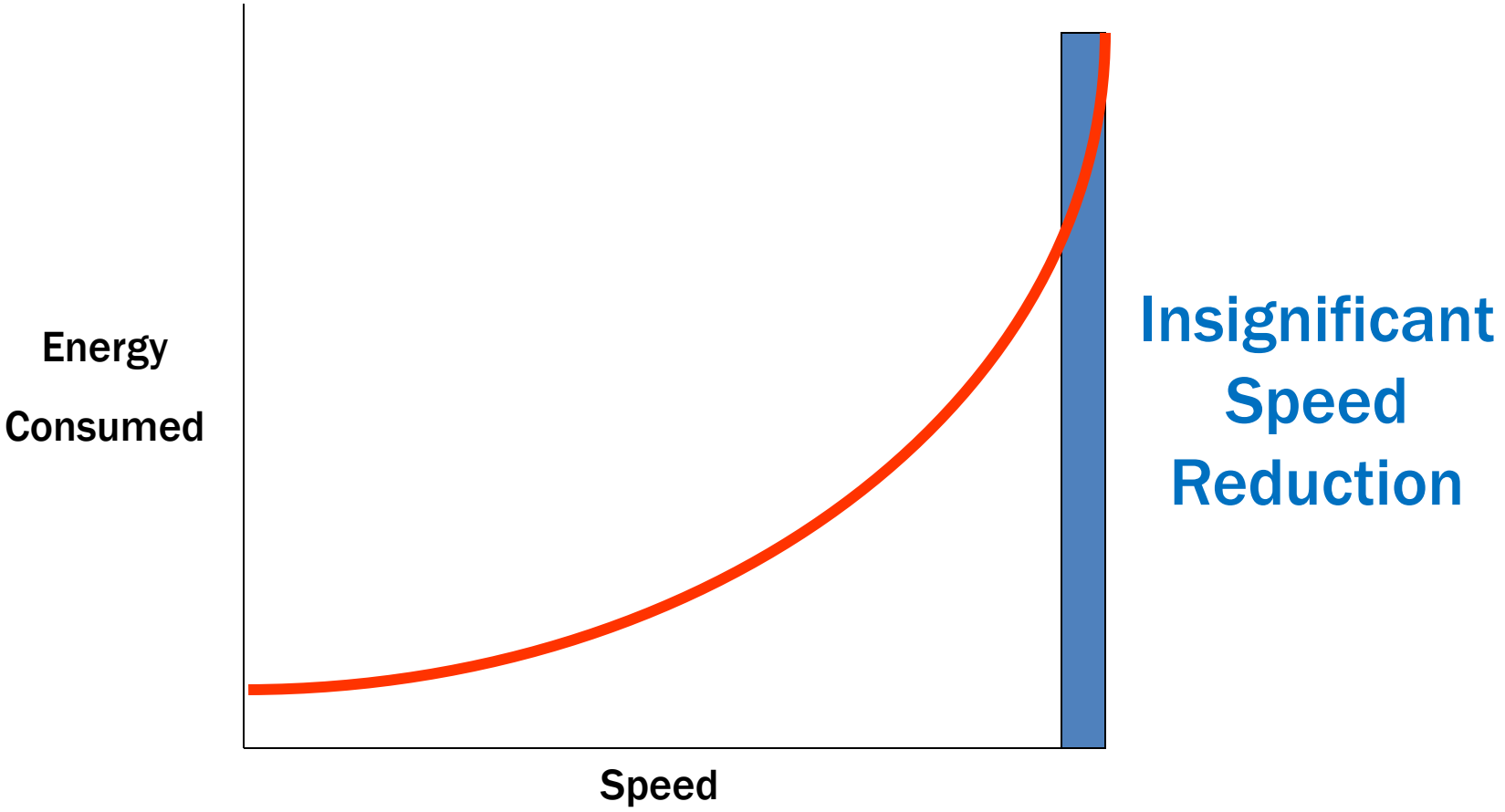
Affinity Law In Action

Variable torque 'ideal' loads:

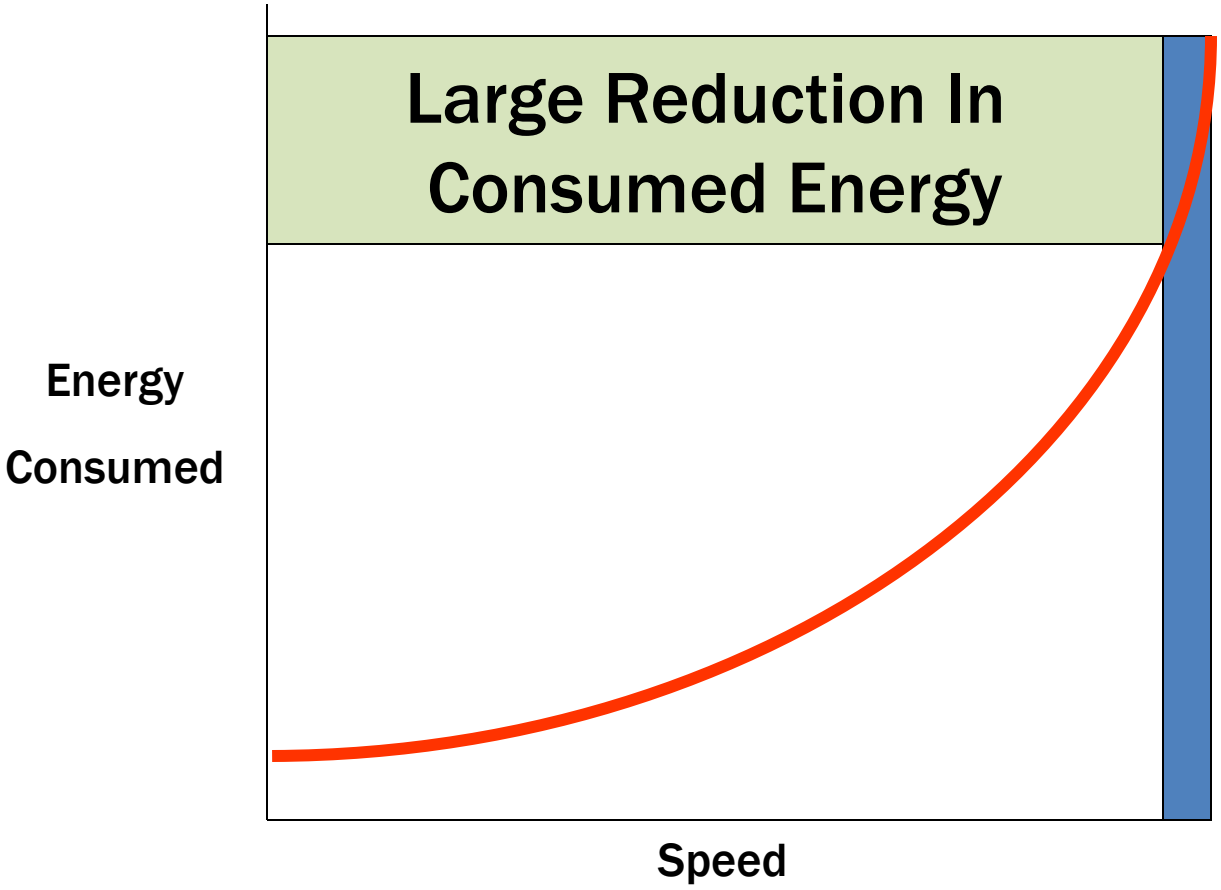
- Energy increases exponentially with speed
- Energy consumed = $(\text{speed})^3$



Affinity Law In Action (continued)

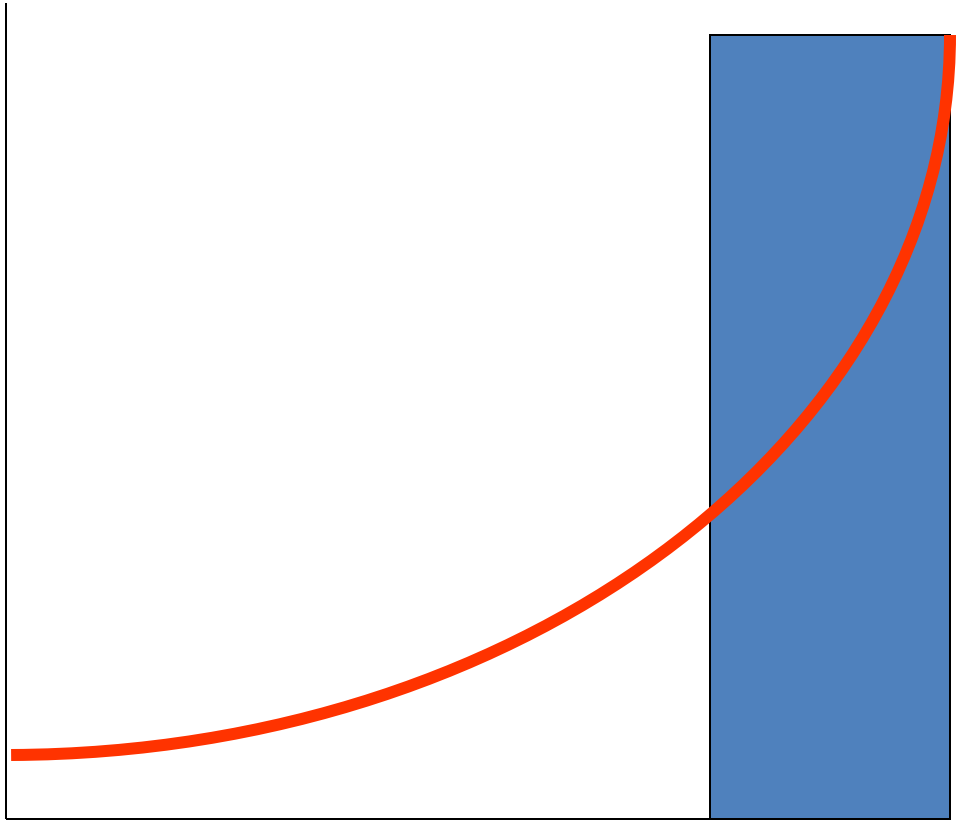


Affinity Law In Action (continued)



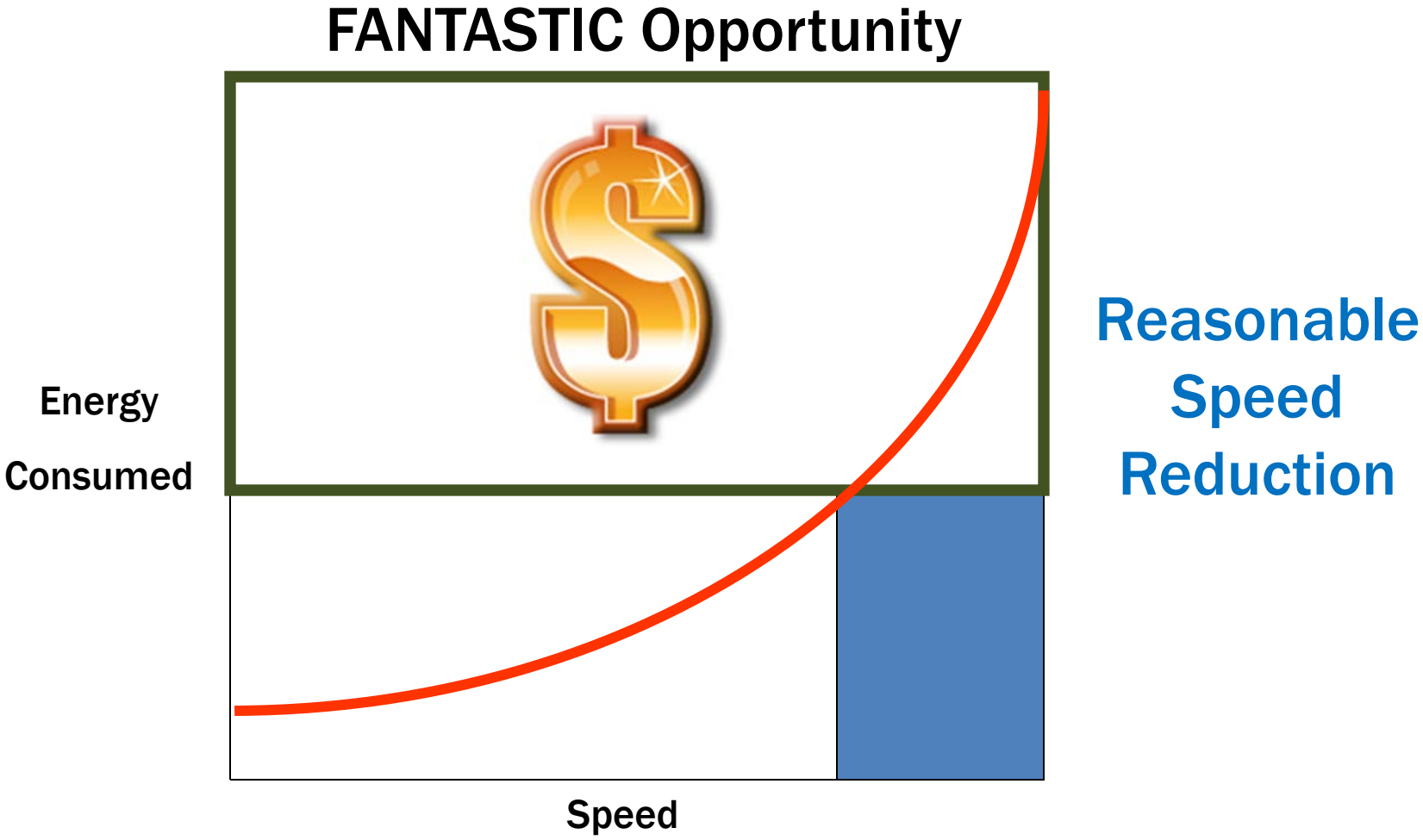
Insignificant Speed Reduction

Affinity Law In Action (continued)



Reasonable Speed Reduction

Affinity Law In Action (continued)



Motor Example

$$\text{Consumption}_{\text{reduction}} = (\text{Speed}_{\text{reduction}})^3$$

100 kW motor @ 50% speed – what does it cost?

$$E_r = (1/2)^3$$

12.5 kW

Pump Example

Pumps may have limited speed ranges due to system constraints.

100 HP motor @ 85% speed – how much HP are you using?

$$HP_{used} = (\text{Motor HP}) \times (\% \text{ Speed})^3$$

$$HP_{used} = (100 \text{ HP}) \times (.85)^3$$

61 HP

Fan Example

What if a fan worked at 45 Hz?

% Speed = Operating speed/full speed
= 45 Hz/60 Hz
= 75

$HP_{required}$ = (Motor HP) x $(\%\ Speed)^3$

$HP_{required}$ = (100 HP) x $(.75)^3$

42 HP

Financial Justification

- Need basic data to calculate savings – multiple tools available
- Value exceeds kWh cost – what is this worth to top line revenue?
- Does system performance justifies VSD regardless of savings?
    - Example – water authority pumping just 4 hours/day – fire main pressure, no broken mains, better aquifer management

Energy Saving Calculation Example

- 25 HP fan moves air three shifts/day, 5 days/week, for a year.
- Cost of fan running at full speed entire year:

25HP x 0.746 kW/HP x 6240 hrs x 0.075 kWh = $8,728.00

Assuming fan does not have to run constantly at full speed:

- 20% time at 100% speed
- 60% at 80% speed
- 20% at 60% speed

Cost of running fan with a variable speed drive:

25 HP x 0.746 kW/hp x 1248 hrs x 0.075/kWh x $(1.00)^3$ = $1,746

25 HP x 0.746 kW/hp x 3744 hrs x 0.075/kWh x $(0.80)^3$ = $2,681

25 HP x 0.746 kW/hp x 1248 hrs x 0.075/kWh x $(0.60)^3$ = $377

Total = $4,804

Potential annual savings = $8,728 – $4,804 = $3,924

ROI Calculators And Engineering Aids

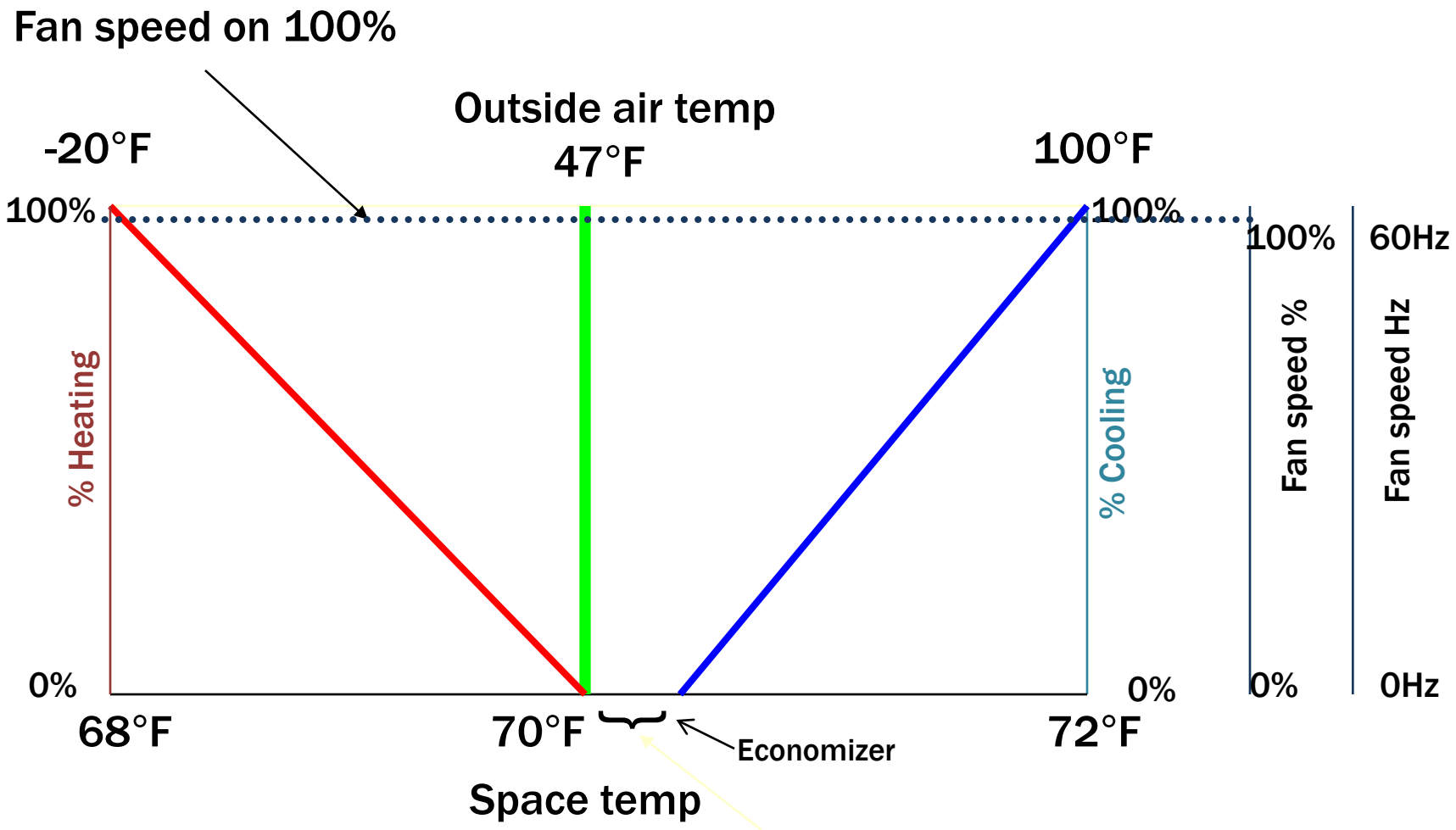
- Projects typically authorized based on return on investment.
- Project viability determined by facts rather than feelings.
- Focus on hard costs.
- Eliminate subjective content.
- *Your goal is to build a bullet proof justification that stands on its own!*

Fastest Payback?

Common traits

- Long hours of operation
- Load isn't constant
- Load may be throttled
- Significant downtime cost

Design Parameters – Constant Volume System



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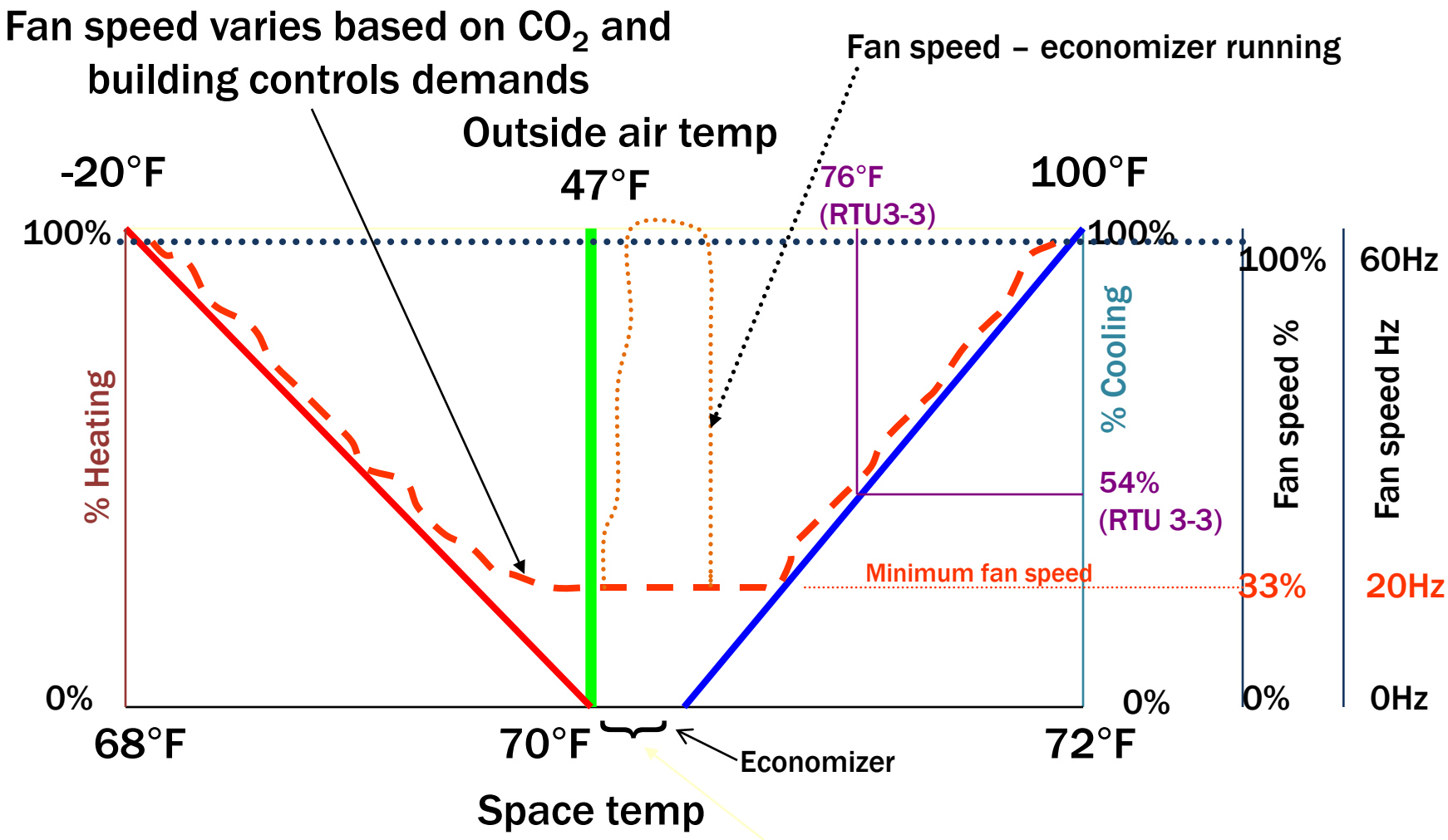
Constant Volume System With VSD



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Focus on Energy VSD Incentives

- Standard incentives
  - $60/ horsepower up to 30% of invoiced cost
- Custom incentives
  - 1.5 to 4 year energy payback
- Contact your Energy Advisor or call 800.762.7077

Resources

1. http://www.ab.com/drives/energy_savings/index.html
2. http://www.angelfire.com/pa/baconbacon/page2.html
3. http://www.pupman.com/listarchives/2001/June/msg00679.html
4. http://www.energysafe.com.au/products.html
5. http://www.iserv.net/~alexx/lib/general.htm
6. http://www.myronzuckerinc.com/docs/Specification%20-%20Trap%20Filter.pdf
7. http://www.transcoil.com/
8. http://www.trane.com/
9. http://www.et-sales.com/K_Factor.html
10. http://www.ab.com/drives/energy_savings/index.html

Thank You!

For additional information or questions:

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