Fan Efficiency Grade Classification for Fans

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Learning Objectives

1. Describe Fan Efficiency Grade (FEG).
2. Describe the use and application of FEG.
3. Explain FEG for selection of efficient fan.
4. Provide an overview of how FEG will be used in the fan industry in the very near future.
5. Explain how standard and regulatory authorities will utilize FEG for setting requirements.
6. Describe the impact of FEG on fan technologies.

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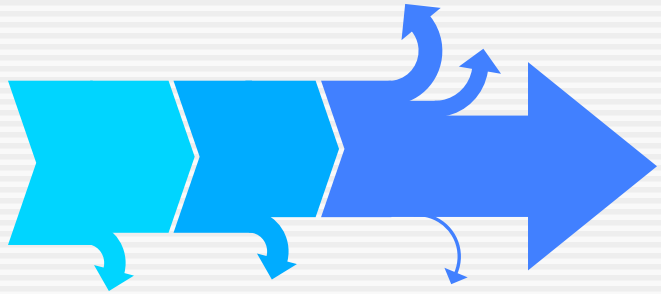
Outline

- Background
- Fan Energy Metrics
- Fan Efficiency
- **FEG** - Fan Efficiency Grade
- ASHRAE 90.1 and FEG



Energy Consumption

US Energy Consumption 2010* = 98 Quads (104 EJ)

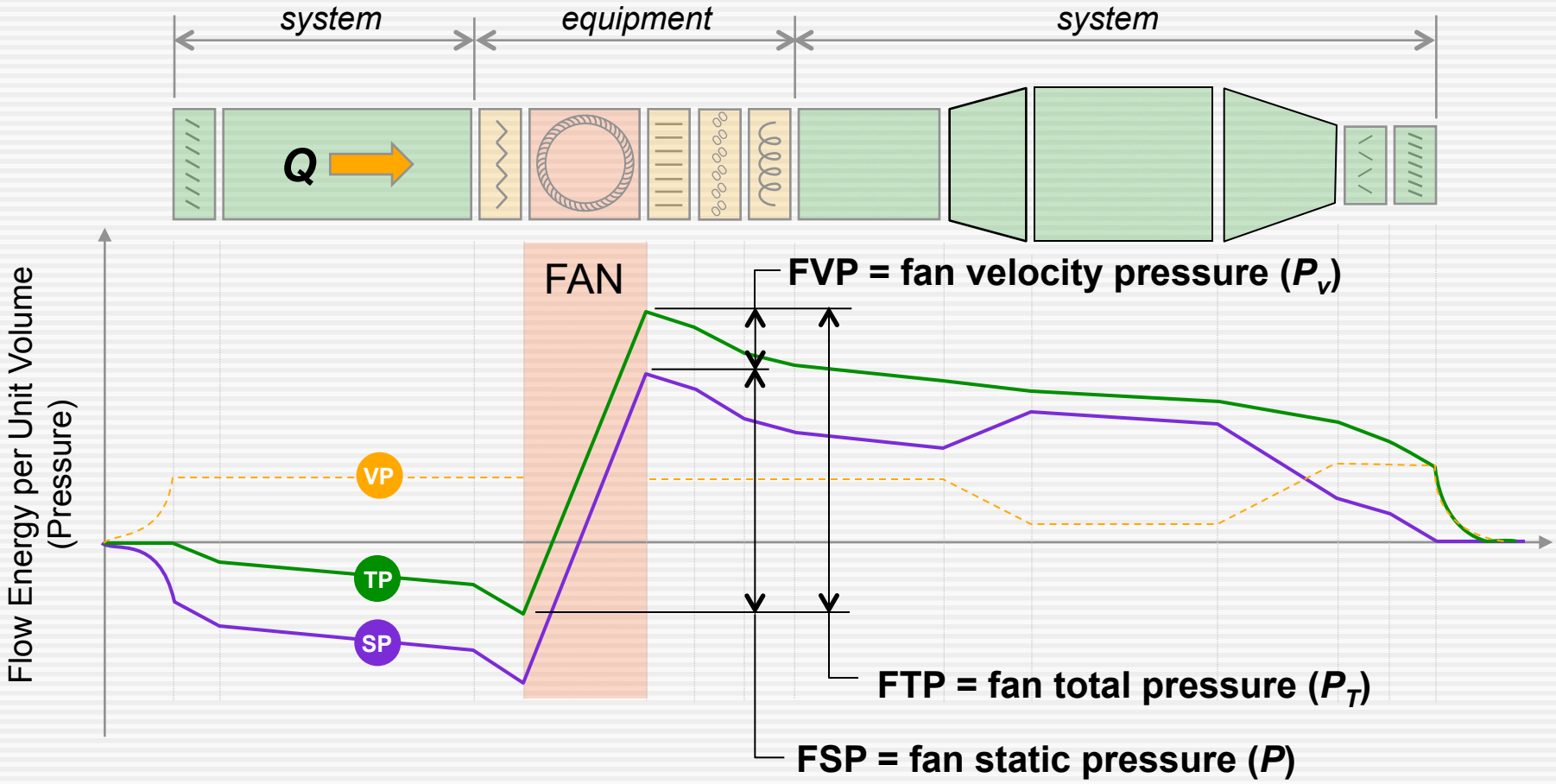
- Equivalent to **29 million million kWh**
- **37%** from petroleum → transportation
- **21%** from coal → electricity
- **25%** from natural gas → residential, commercial, industrial
- Over **half** of source energy **rejected** (heat)

FOCUS ON AIR DISTRIBUTION

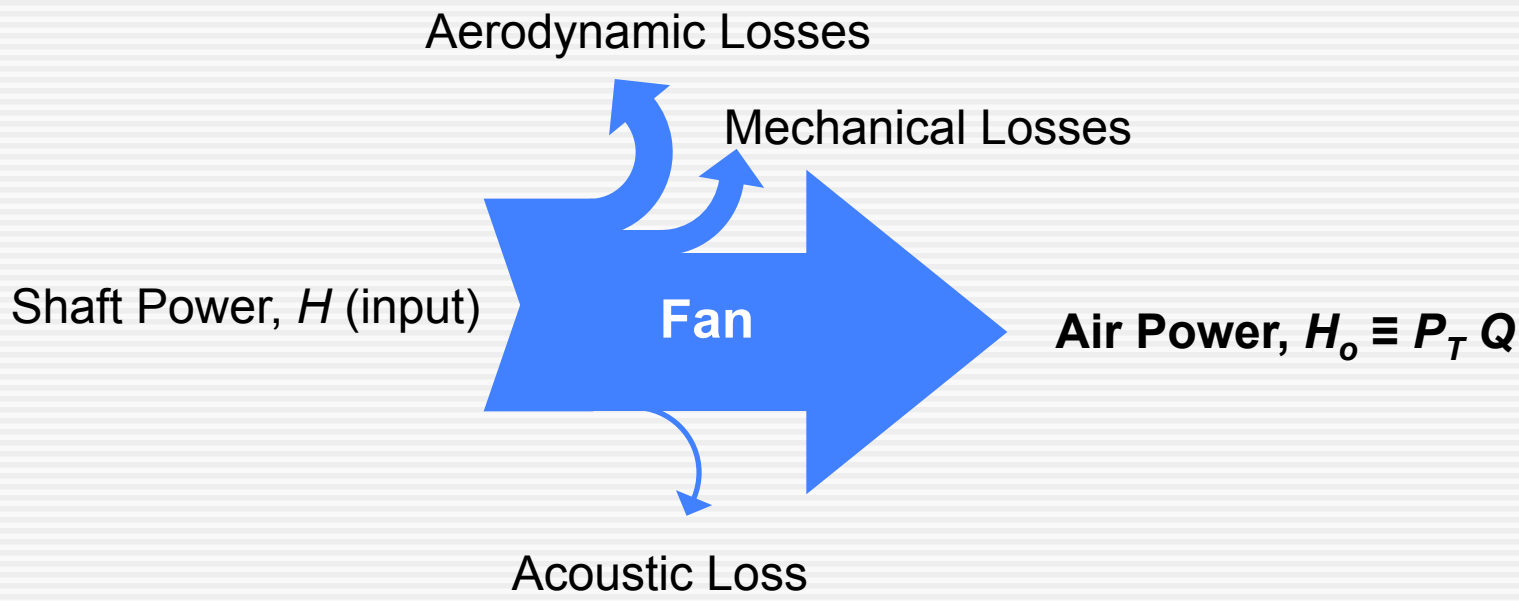
- **Estimated: DOE → ~230 billion kWh for commercial/industrial fans**
- **Estimated: ~20% commercial building energy budget**

*source LLNL

HVAC System


system
equipment
system
Q
FAN
FVP = fan velocity pressure (P_v)
Flow Energy per Unit Volume
(Pressure)
VP
TP
SP
FTP = fan total pressure (P_T)
FSP = fan static pressure (P)

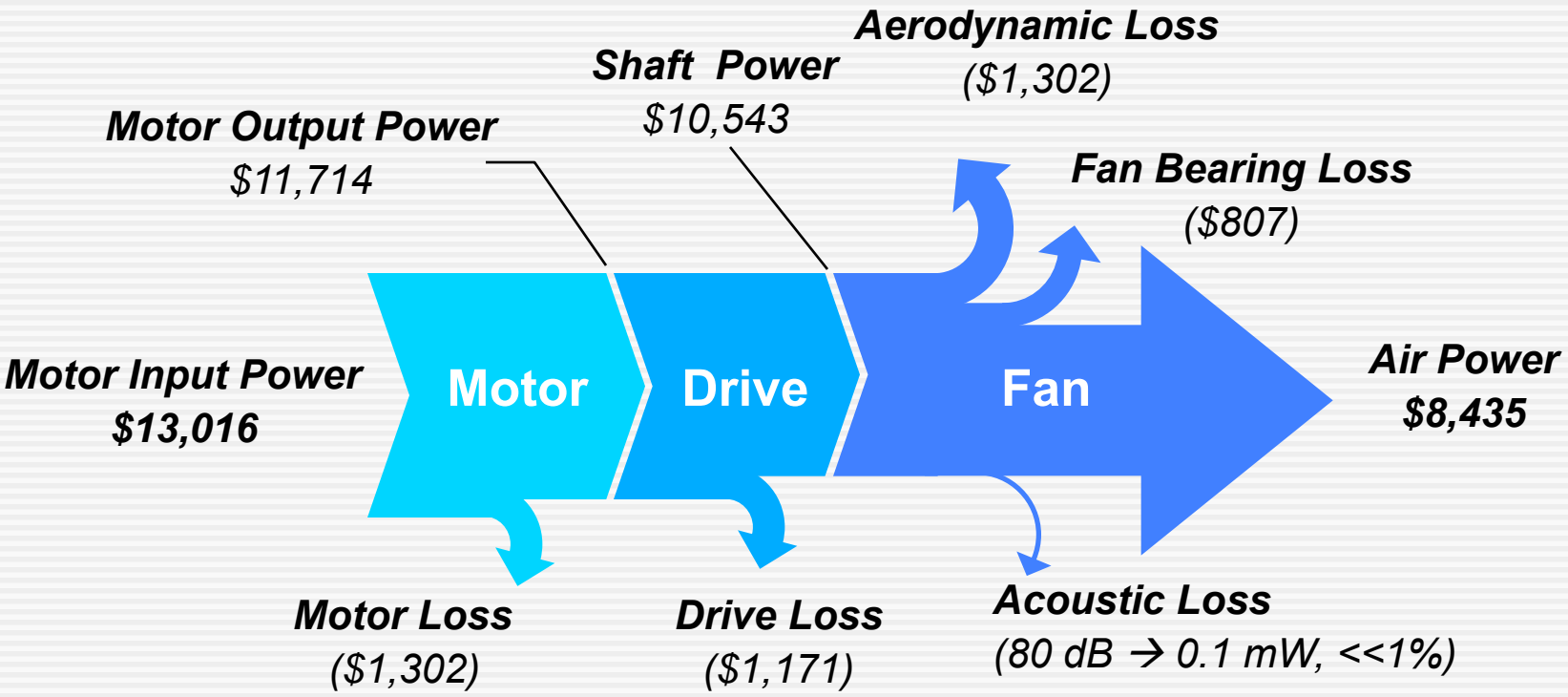
Fan Energy Consumption



$$\textbf{Energy Efficiency} \equiv \frac{H_o}{H} = \frac{P_T Q}{H}$$

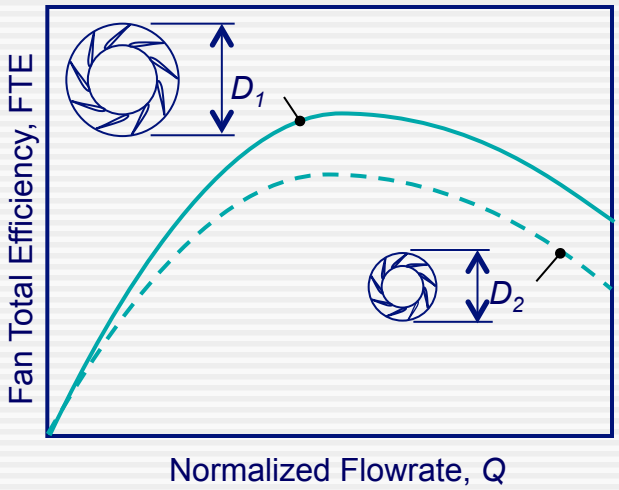
Fan Energy Consumption - Example

25” Belt Drive Airfoil DWDI Blower
Operating Point: 16,800 cfm @ 6.5 in-wg (total), 21.5 bhp, 80% FTE
Operating Conditions: 50% duty cycle, $0.15/kWh
Motor - 90% efficient, Drive - 90% efficient



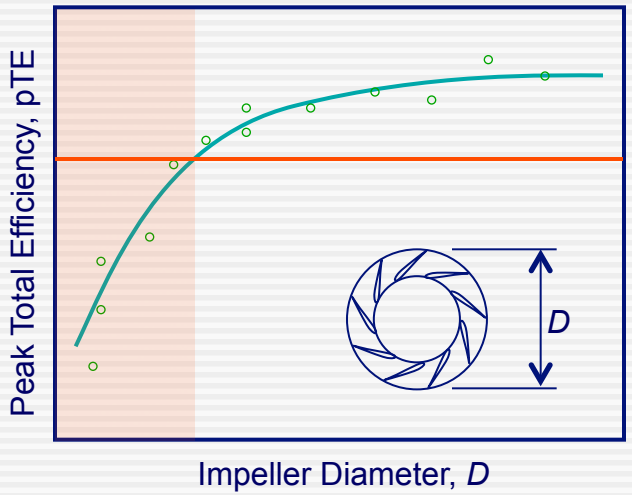
Annual Cost

Fan Energy Efficiency

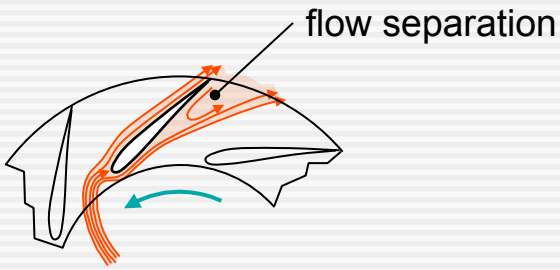


$$\eta = f(fan\ design, Q, D, N)$$

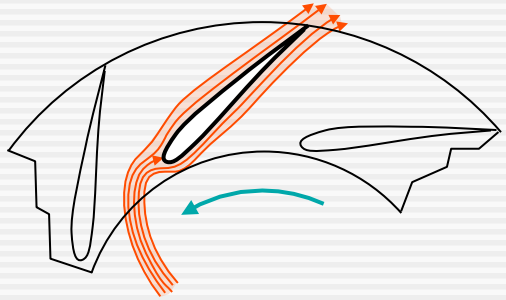
Minimum Fan Efficiency? → eliminate small fans



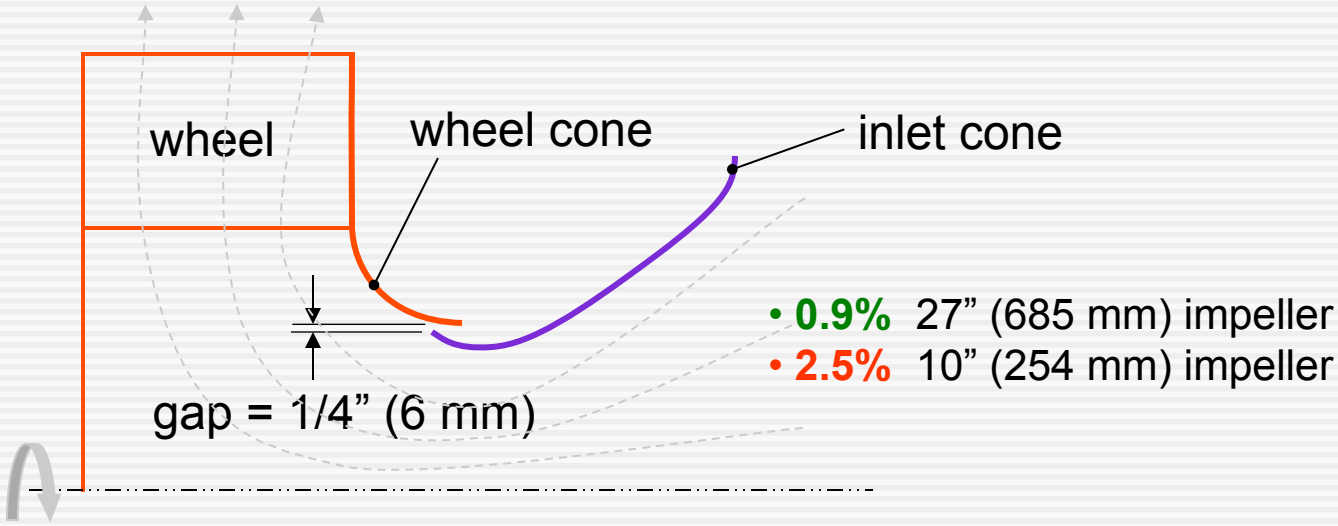
Fan Energy Efficiency



Small Diameter Impeller



Large Diameter Impeller



Effect of Manufacturing Tolerances

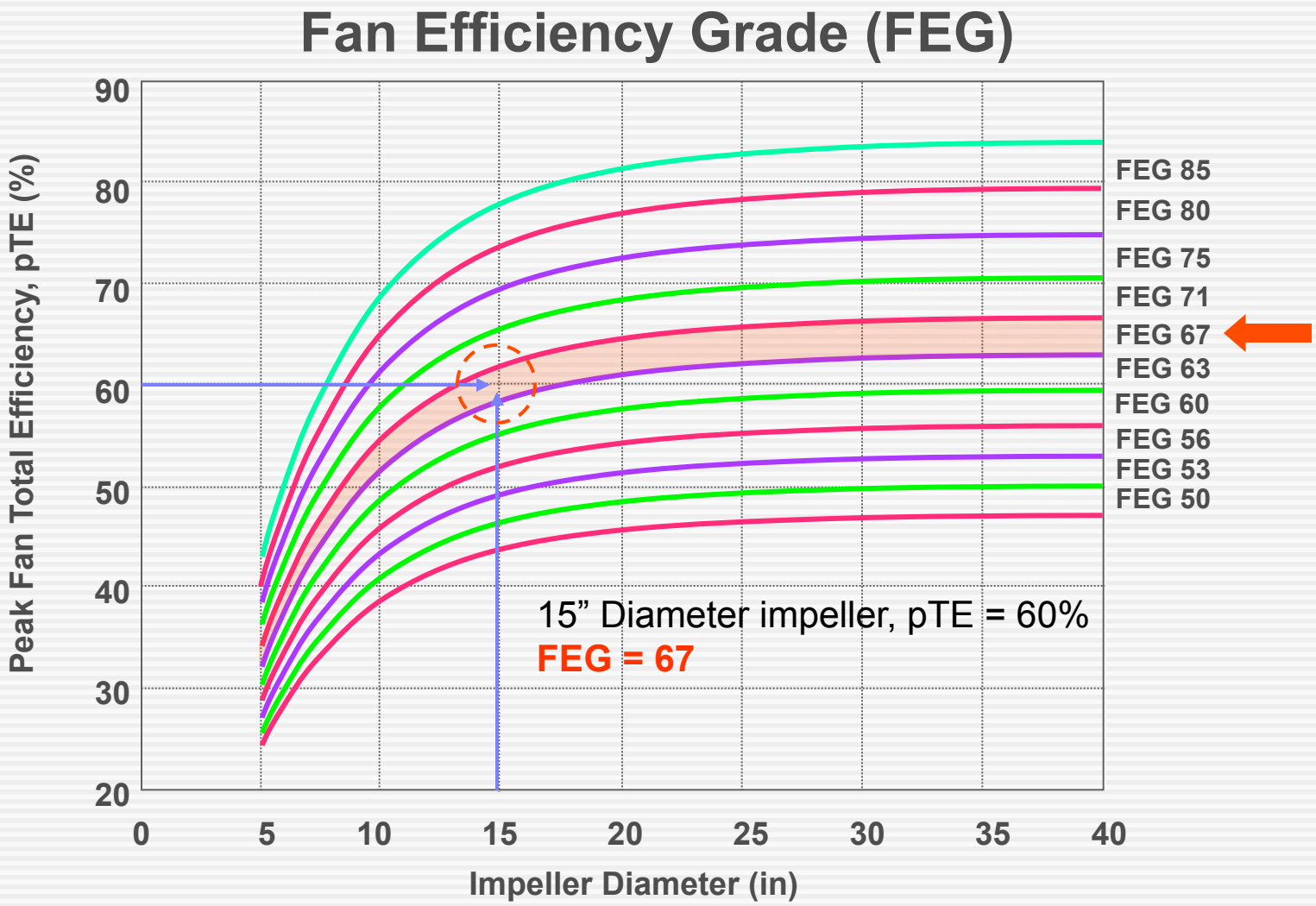
Fan Energy Efficiency

Grading Standards

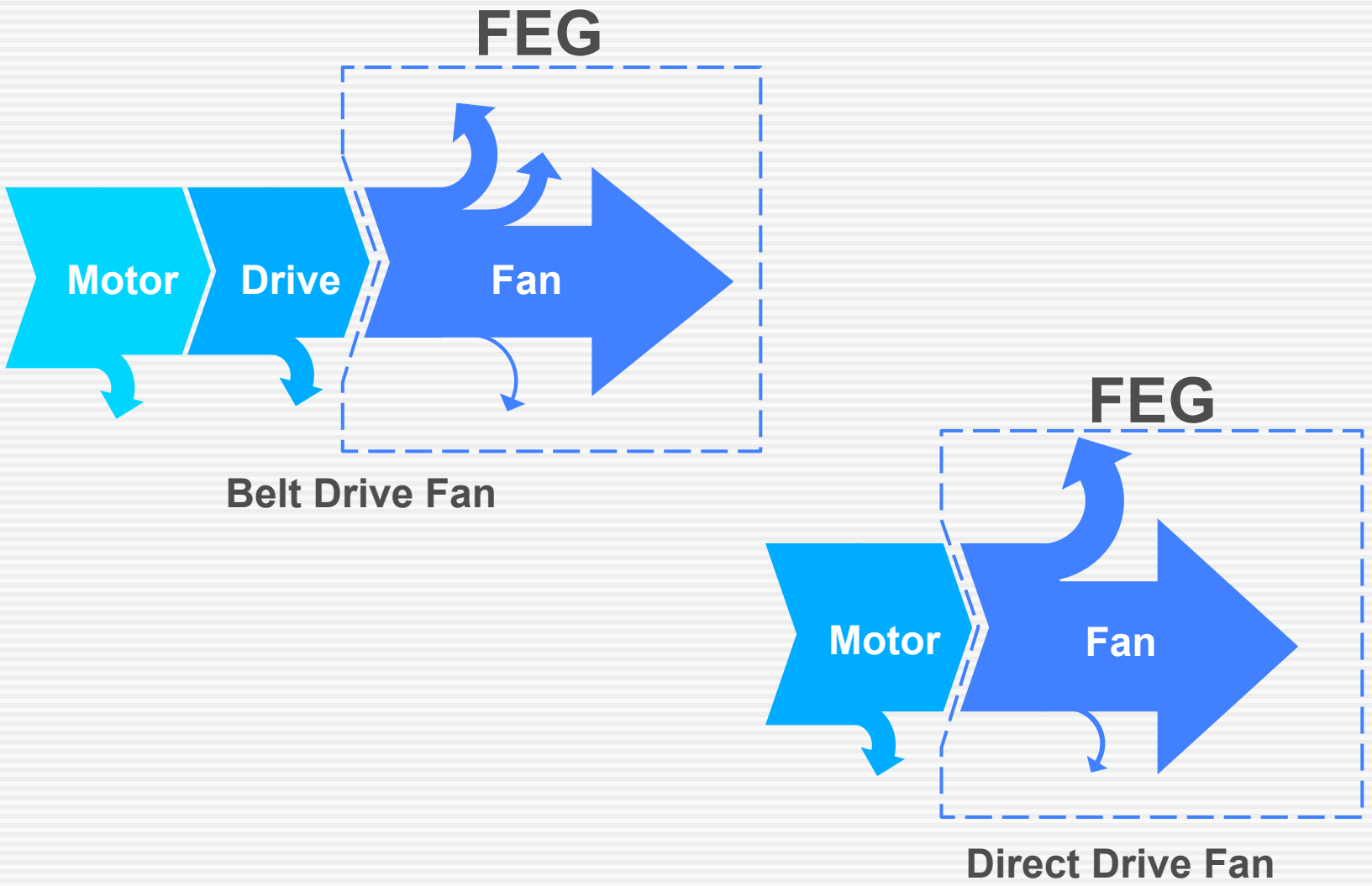
ISO I2759 Fans - Efficiency Classification for Fans

AMCA 205 Energy Efficiency Classification for Fans

Fan Efficiency Grade



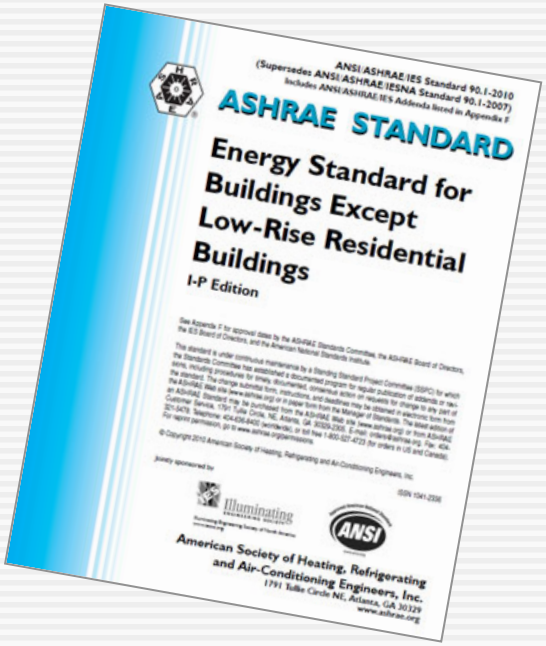
Fan Efficiency Grade



Fan Power Limitation

ASHRAE 90.1 – 2010: Fan Power Limitation (Tables 6.5.3.1.1A/B)

- Two Options → motor nameplate hp & bhp
- Two Systems → CV & VAV



$$\sum H \leq \alpha\, Q_s + A$$

α = coefficient (hp/cfm), e.g. 0.0013 for VAV systems
A = pressure drop adjustment (hp)
Q_s = max design supply air (cfm)
H = bhp

Fan Power Limitation

Based on **Specific Fan Power** (SFP) approach

$$SFP = \frac{\sum shaft\ \ power}{flowrate} = \frac{\sum H}{Q}$$

Single fan → $$SFP = \frac{shaft\ \ power}{flowrate} = \frac{H}{Q} = \frac{P}{\eta} = \frac{P_T}{\eta_T}$$

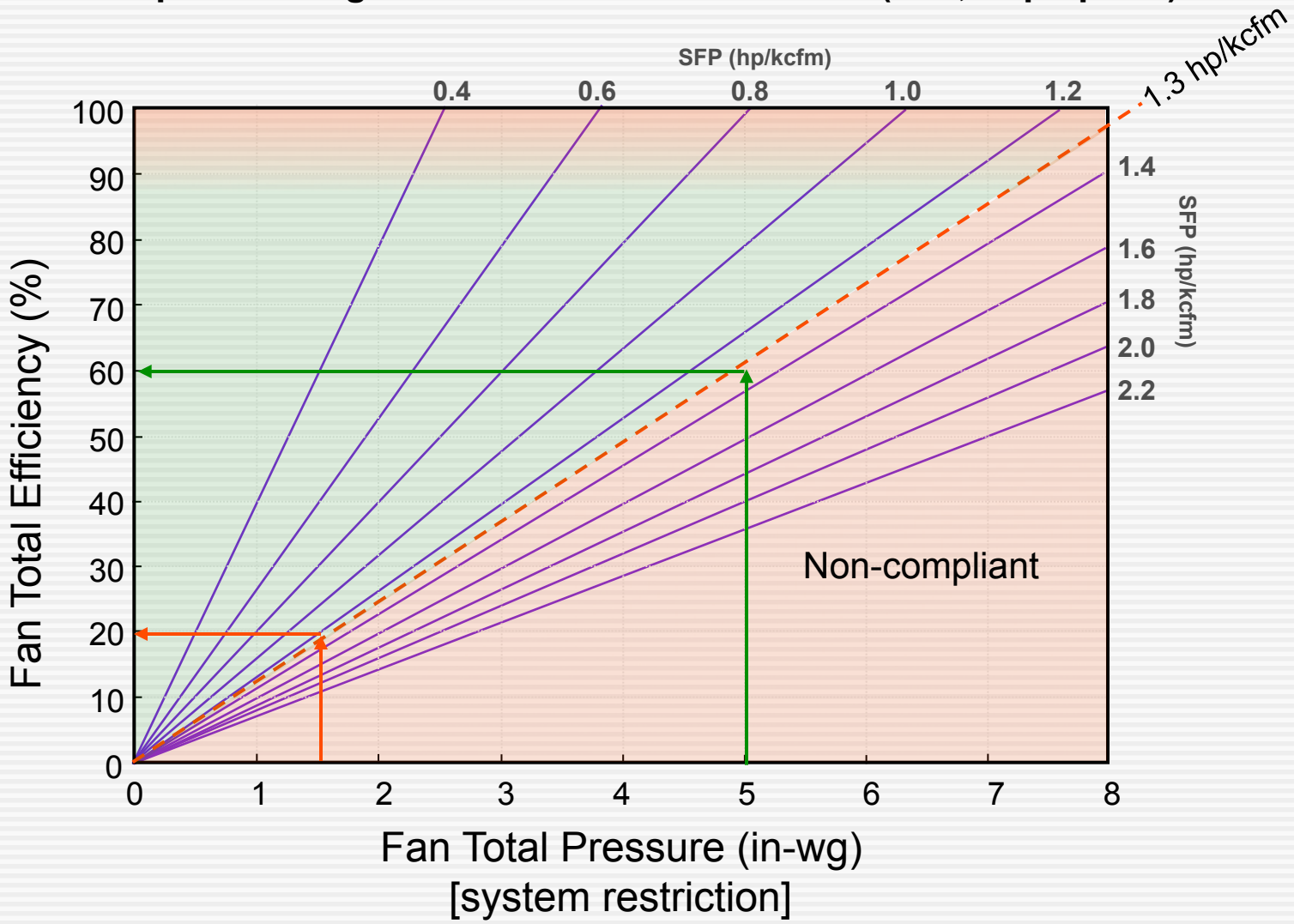
$$\frac{H}{Q_s} \le \alpha + B$$

α = limit, e.g. 0.0013 for VAV systems
$B = A/Q_s$
Q_s = max design supply air (cfm)
H = bhp

Encourages low pressure drop and/or high fan efficiency

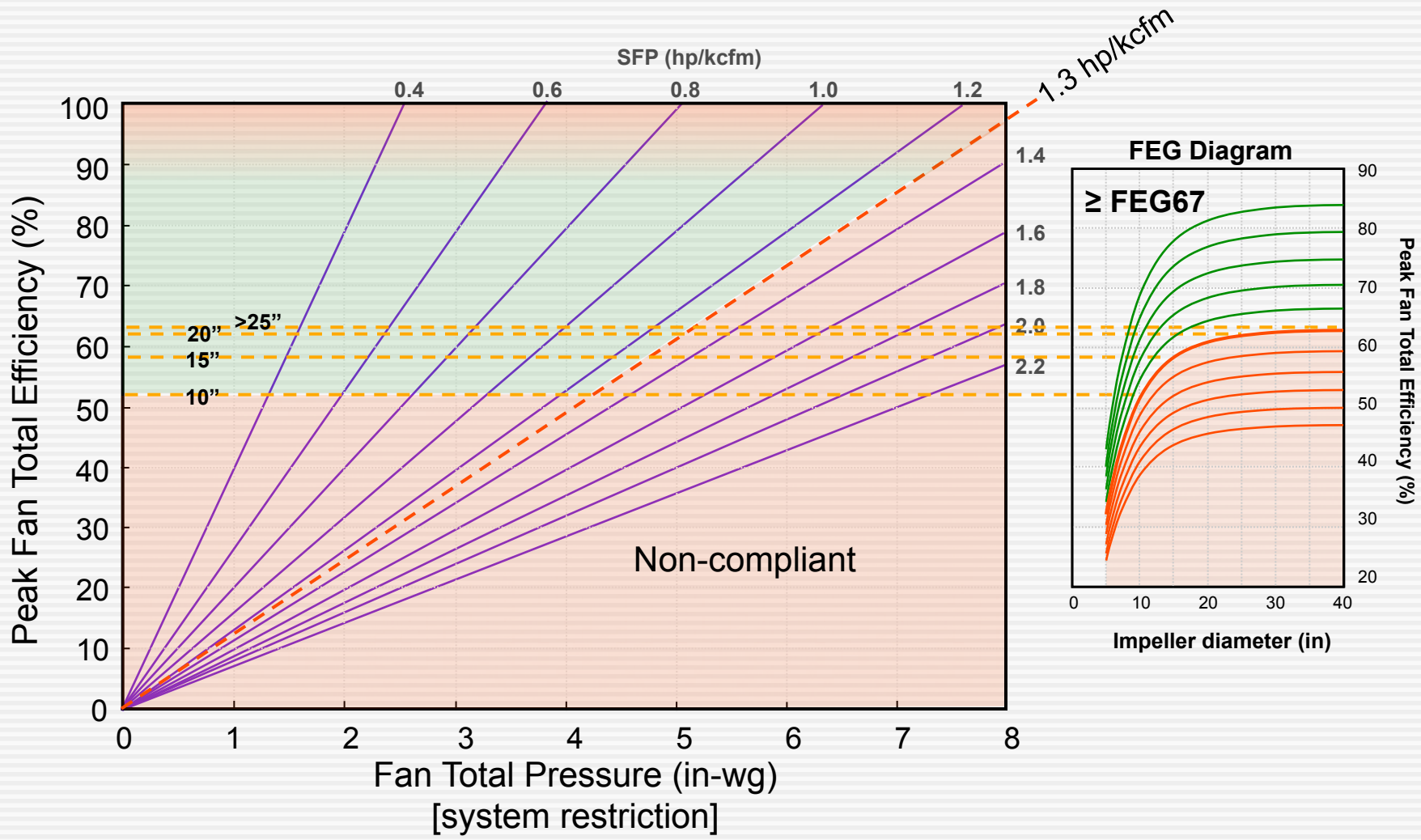
Fan Power Limitation

Single fan example: 5 in-wg TP → fan must be >60% FTE (VAV, bhp option)



Fan Power Limitation + FEG

Proposed minimum FEG67 + exclusions + 15pt selection condition + (> 5 hp motor)



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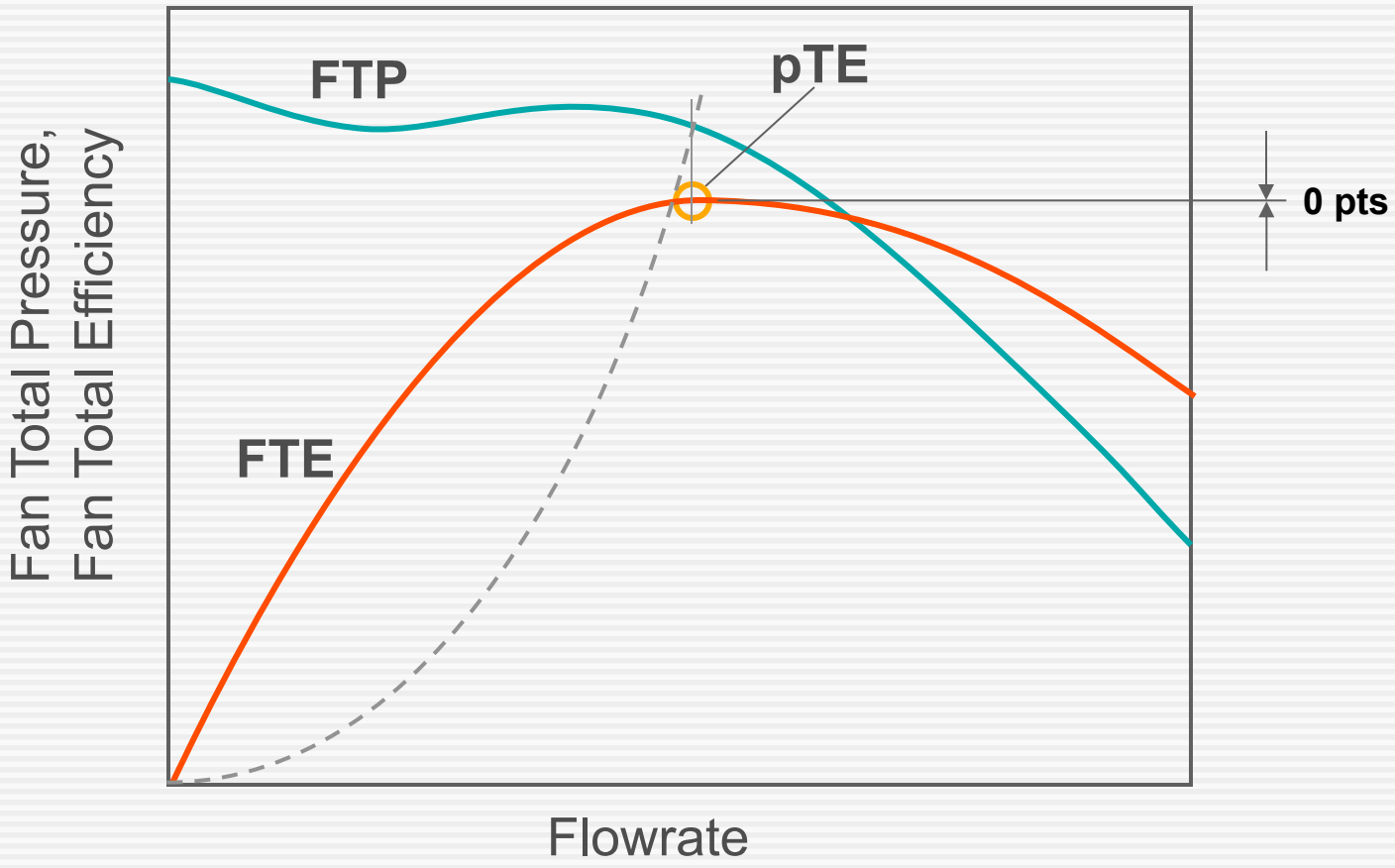
…design point of operation shall be within 15 pts of the maximum total efficiency of the fan.



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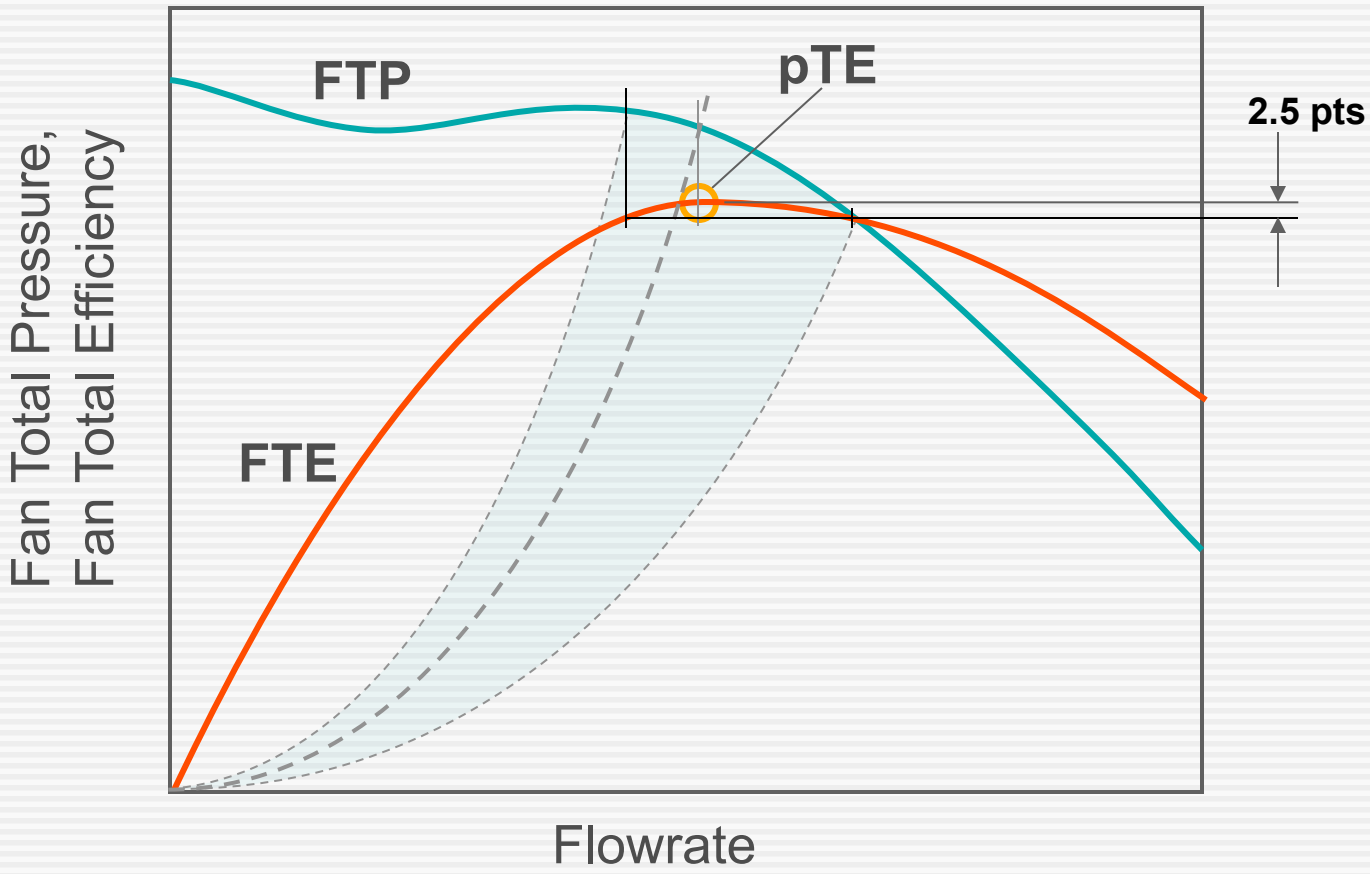

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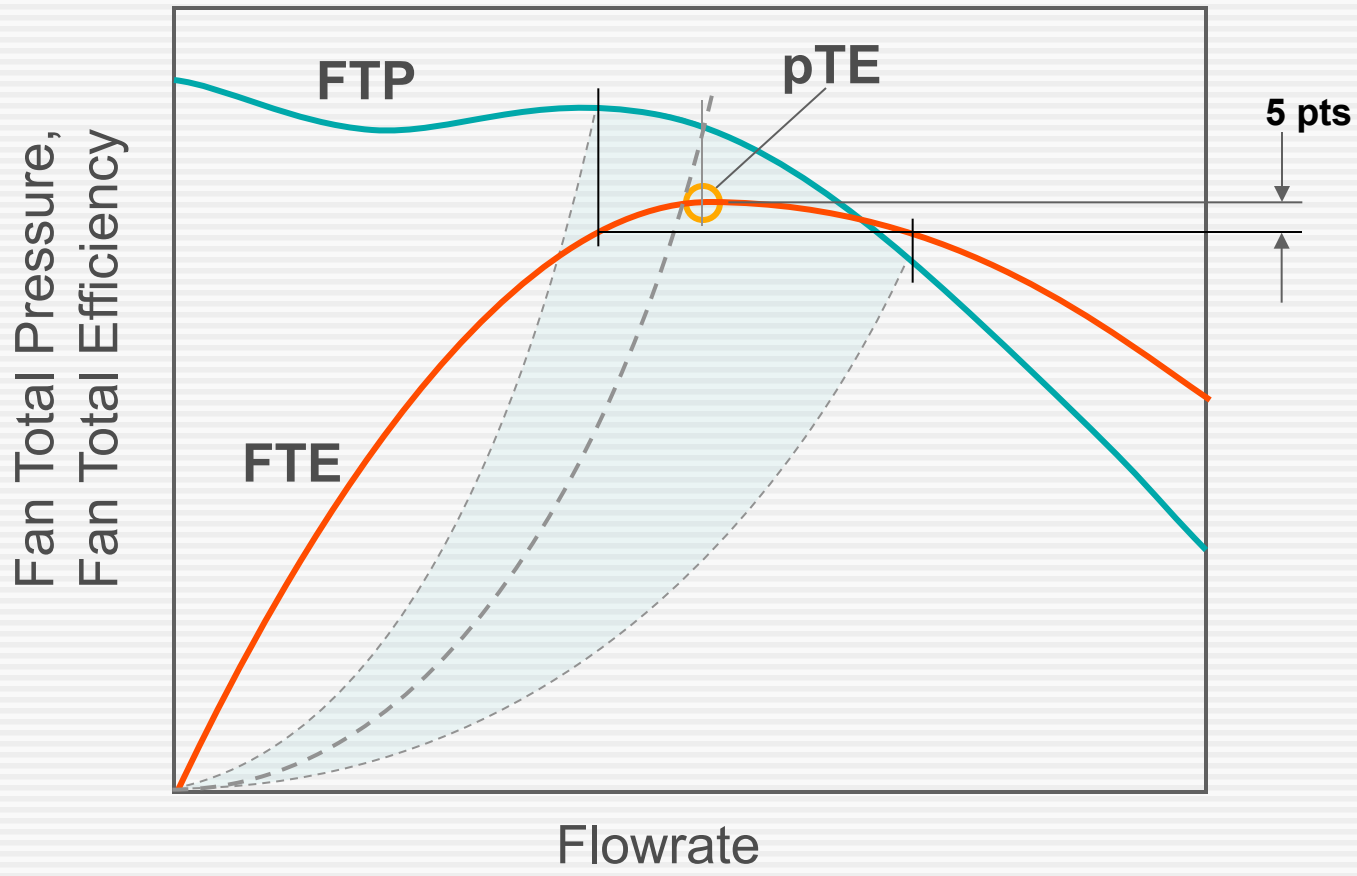

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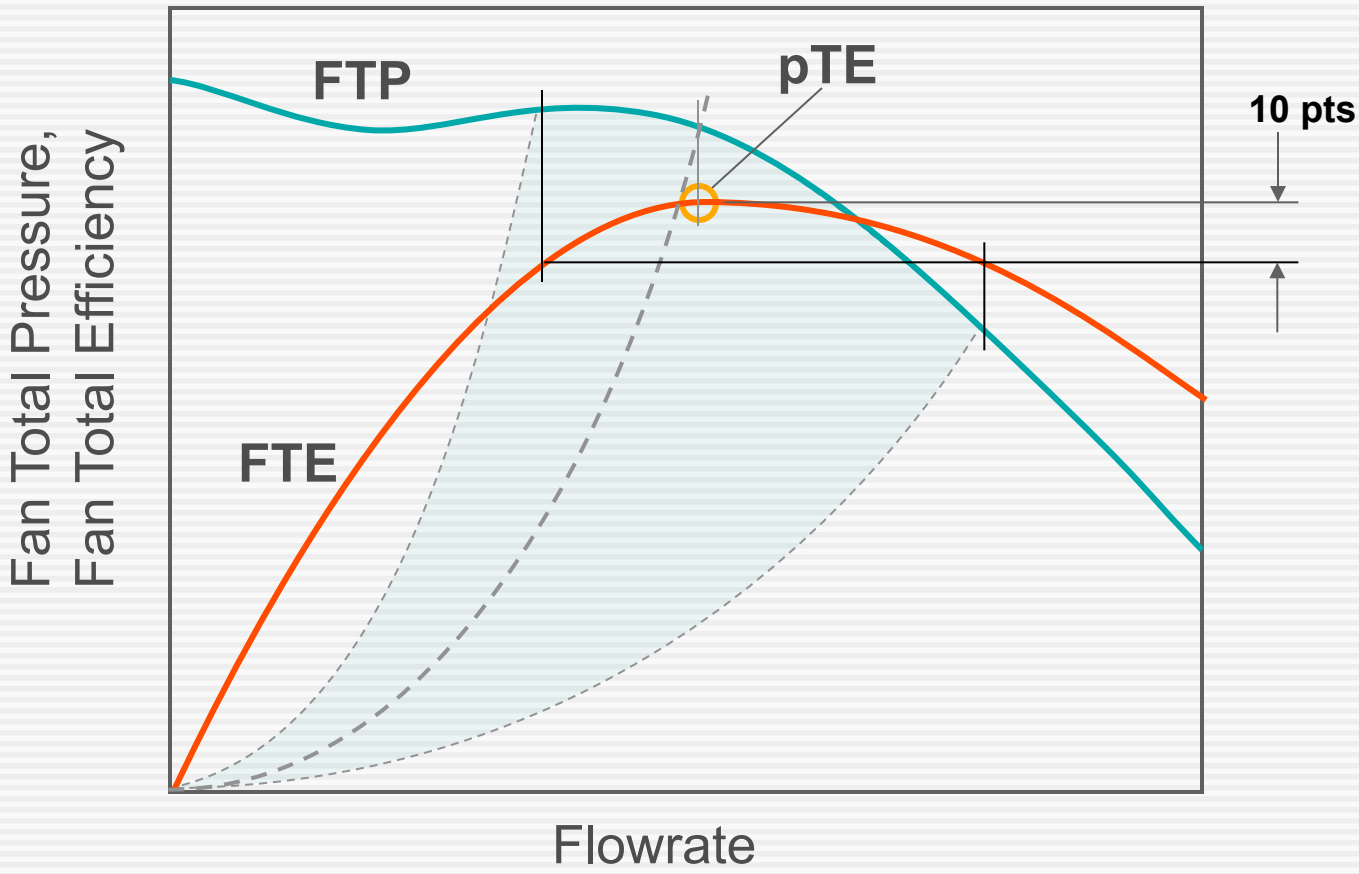

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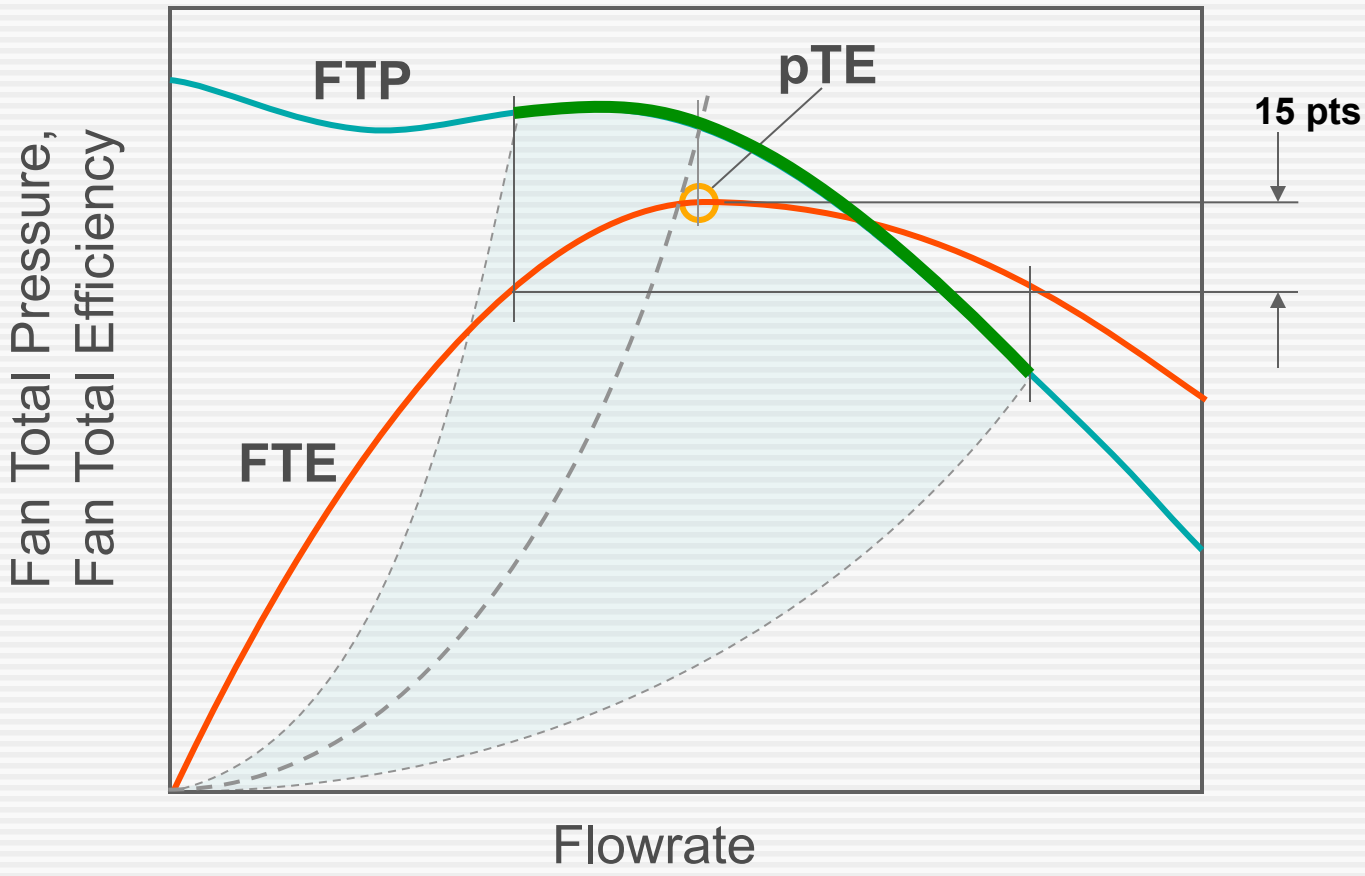

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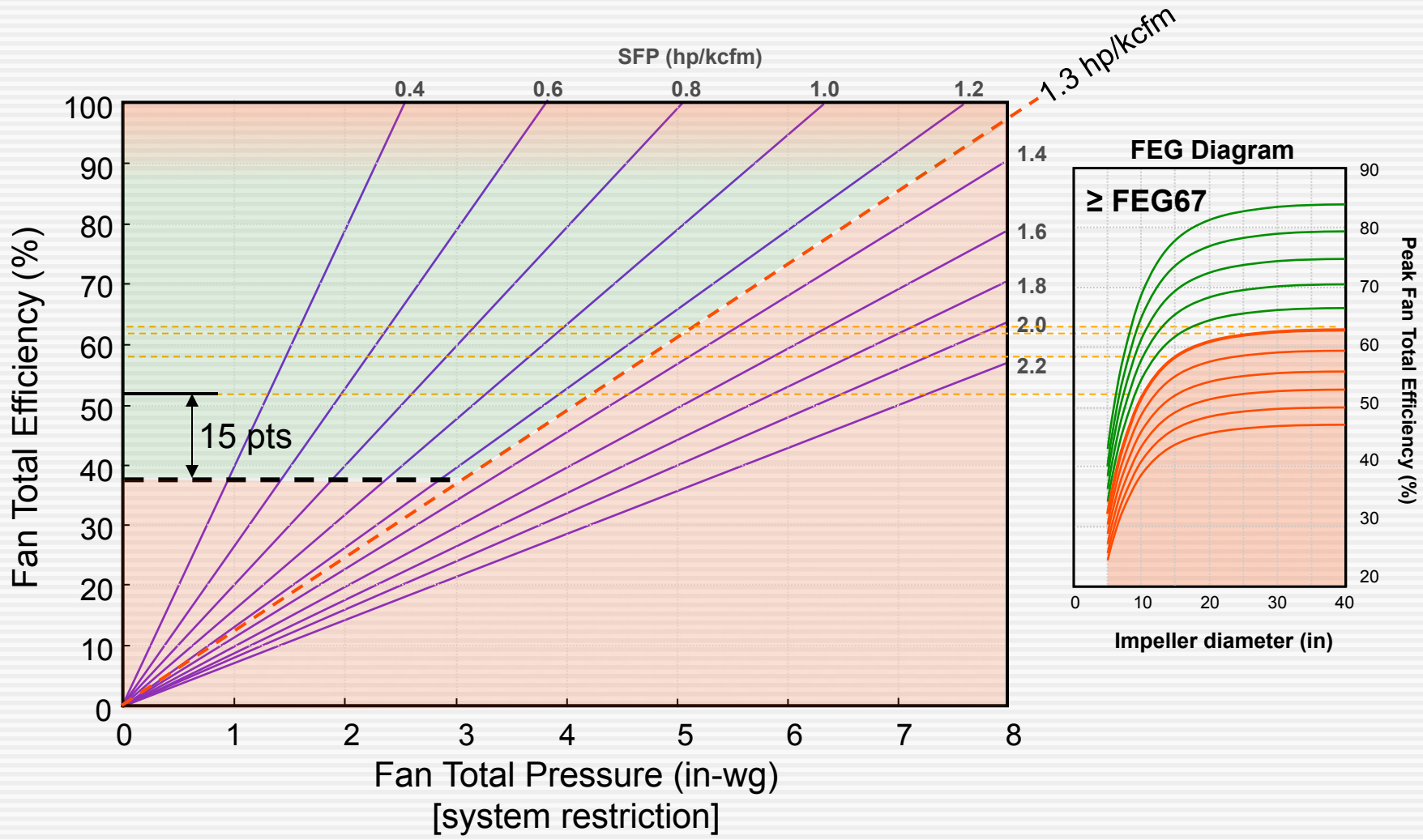
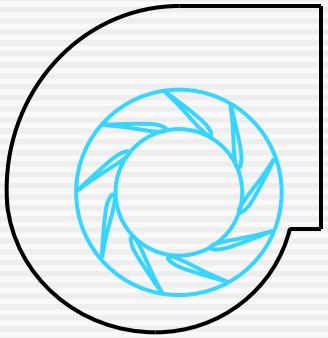


Summary

- Fan energy consumption – regulation on the horizon
- Fan Efficiency – only part of the story
- FEG – aerodynamic indicator, focus on fan performance
- ASHRAE 90.1 has implicit fan efficiency requirement
- ASHRAE 90.1 + FEG proposed
- ASHRAE 90.1 generous operating efficiency band



Questions