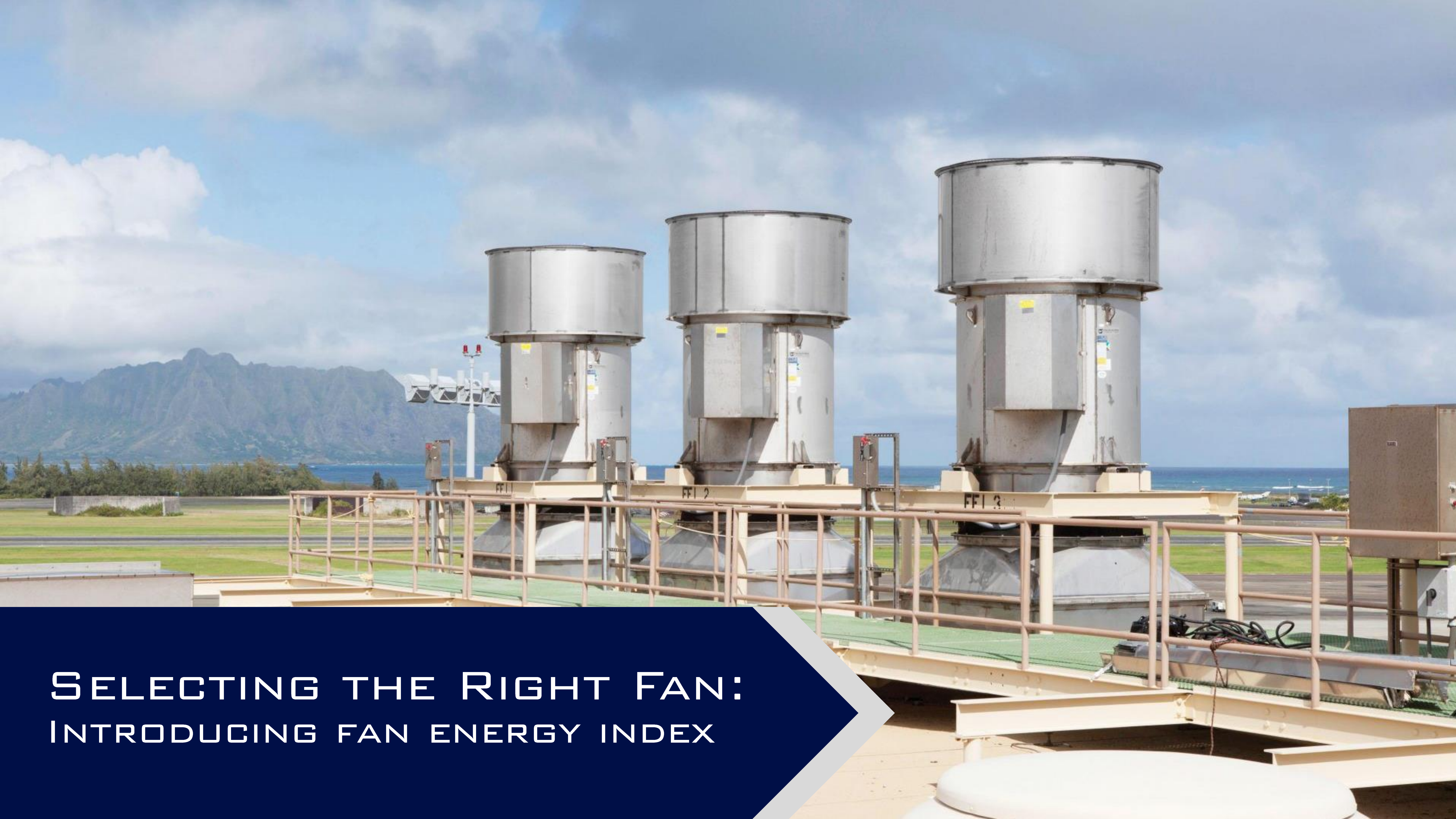


Selecting the Right Fan:

Introducing fan energy index

Three Takeaways

1. We have a choice -
   – Increasing safety requirements
   – Energy efficiency is more important than ever
2. Regulations are here and more are coming.
3. Every system is different and important.
   Rely on the experts with your questions.

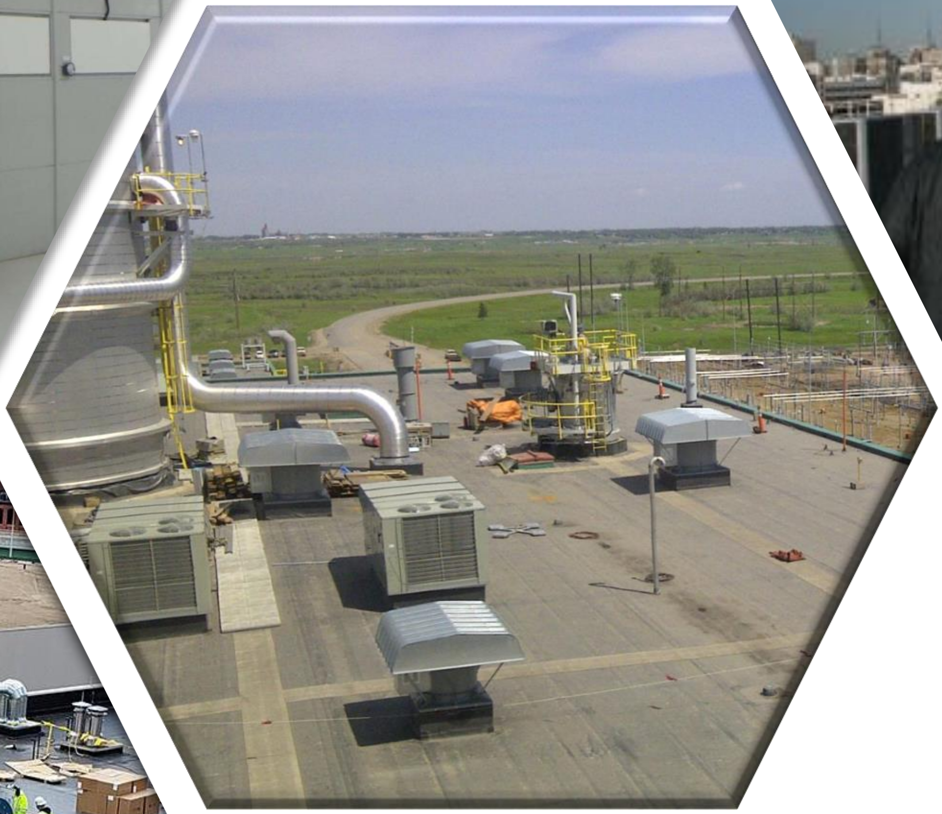
Learning Outcomes

The Case for Change

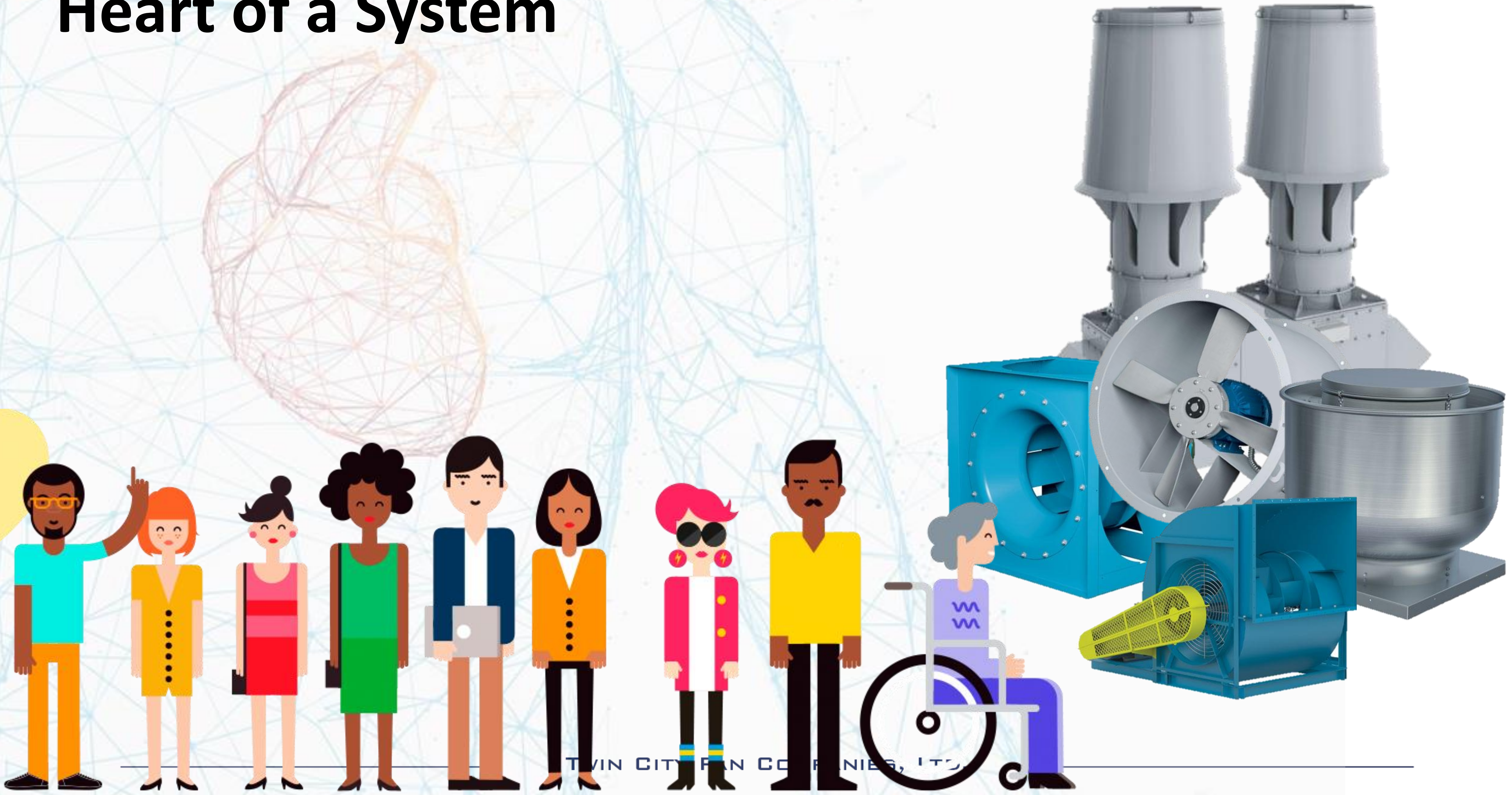
Fan Regulation

Best Practices

Where Are Fans?

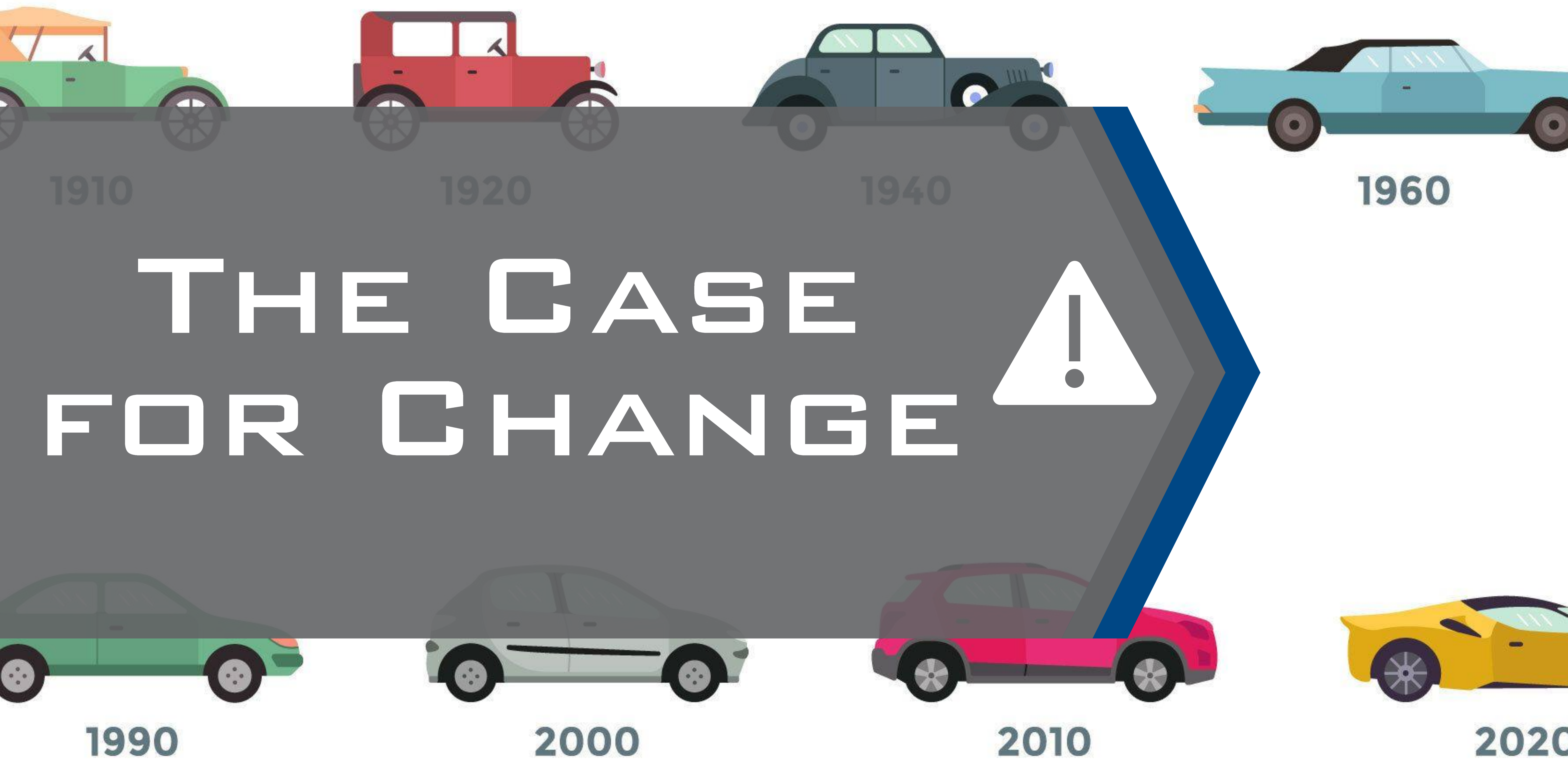


Heart of a System

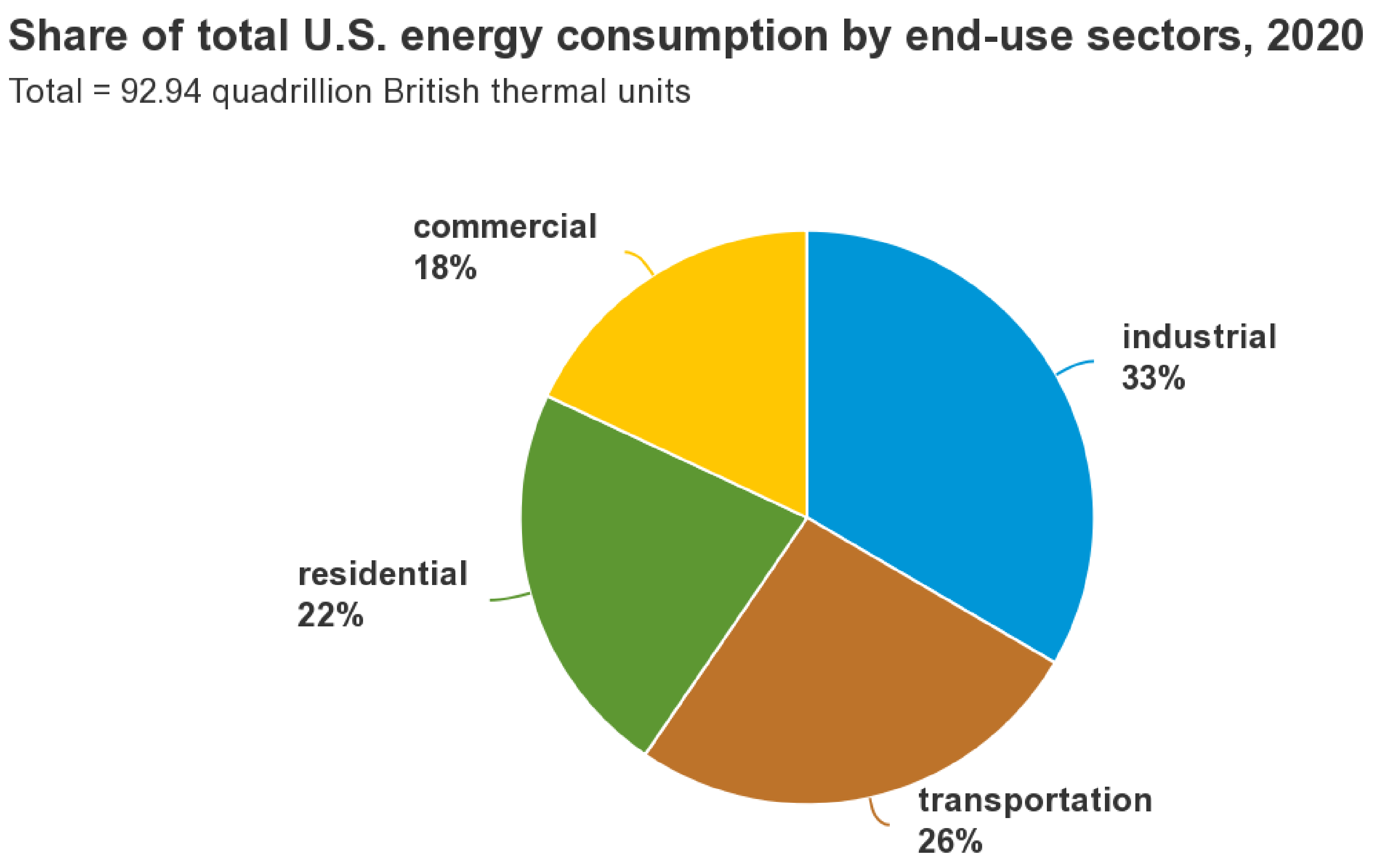


System

The Case for Change



Energy Consumption

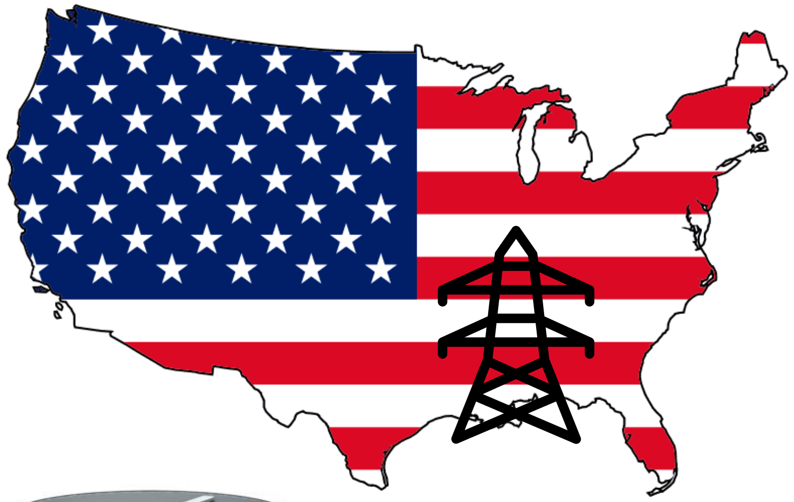


"Commercial and Industrial buildings account for approximately 51% of total U.S. energy use."

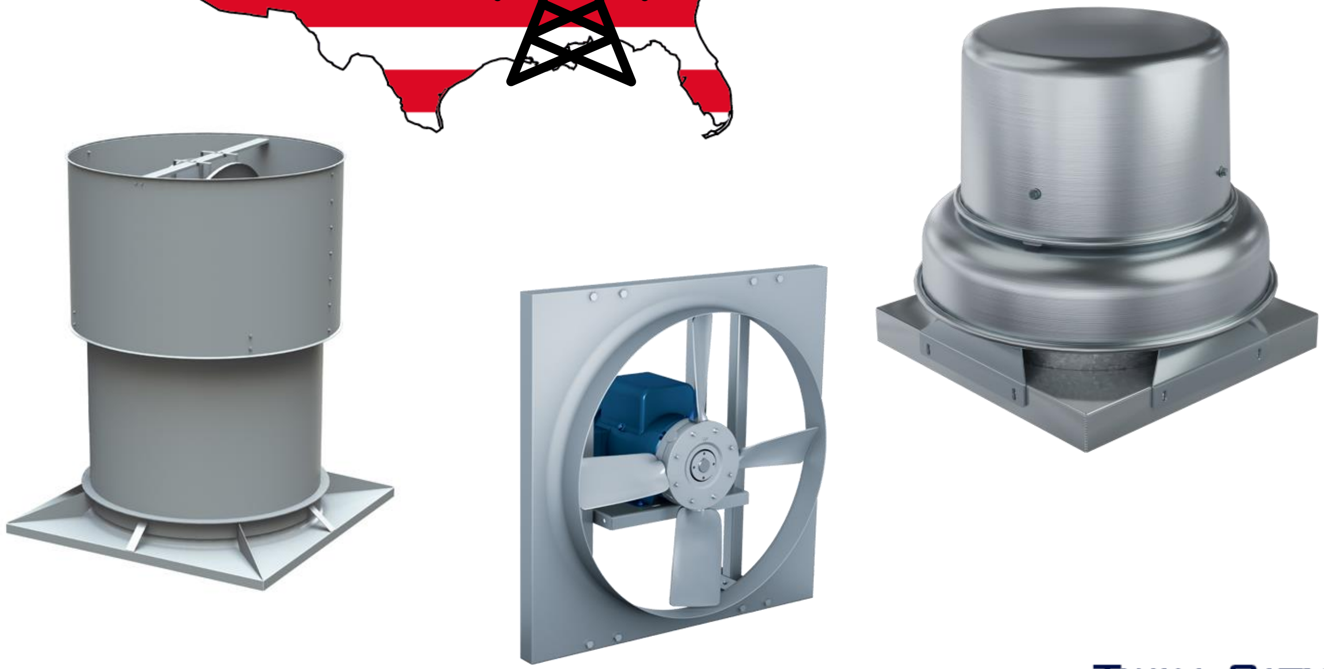
- U.S. Energy Information Administration, April 2021

Energy Consumption

The yearly consumption of Commercial and Industrial fans



7.6%



2020 US Energy Consumption
27,238,916,784,001 kWh

What we can do - 1% Reduction

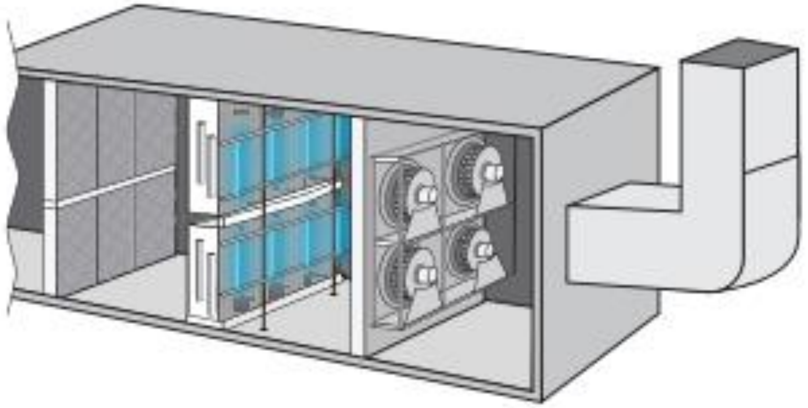
Extra households to power
25.6M Households
- Based on average household consumption of 10,649 kWh / year

Savings
$34.2 Billion
- Based on average US Electricity Rate of 12.55 cents / kWh

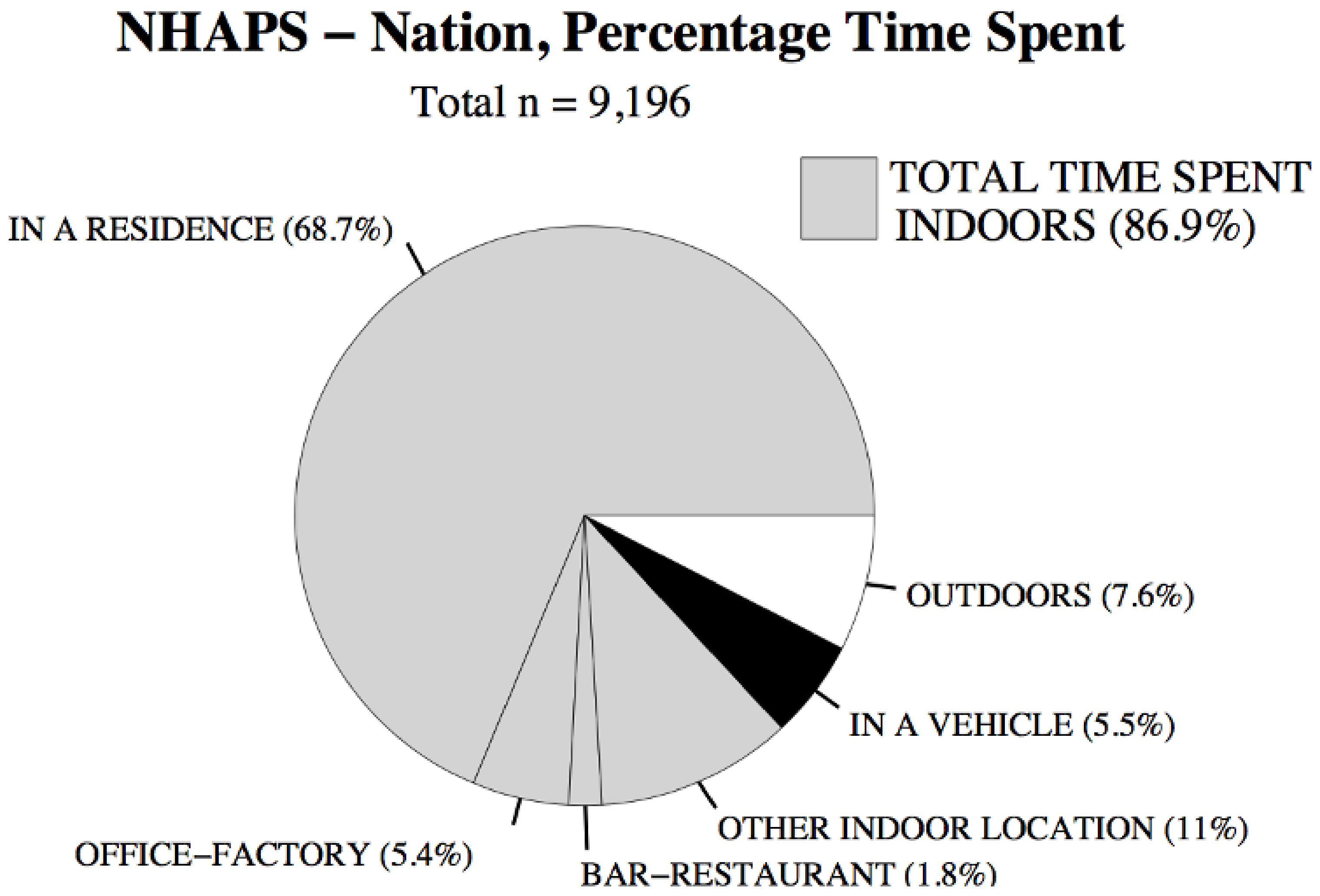
Safety – Pandemic

ASHRAE Recommendations for COVID-19

24/7 operation - ASHRAE 62.1 Airflow Recommendations
MERV 13 Filtration
Ultraviolet Germicidal Disinfection
Portable Room Cleaners with HEPA Filter
Increase Outside Air



Safety



National Human Activity Pattern Survey

-Funded by EPA (Environmental Protection Agency)

Indoor Air Quality

- Estimated percentage of buildings with complaints related to indoor air quality

Real Consequences

U.S. indirect costs, including missed work and lost productivity

Asthma: $5 Billion / Year

Allergic Rhinitis: $9.7 Billion / Year

- Asthma & Allergy Foundation of America, 2021

Environmental Litigation

Dangerous indoor air quality and sick building syndrome are a **growing** area of law for lawyers in the areas of personal injury, real estate, construction, homeowner associations and business.

The Case for Change

Fan Regulation

Historical Regulation

AMCA

OSHA

NFPA

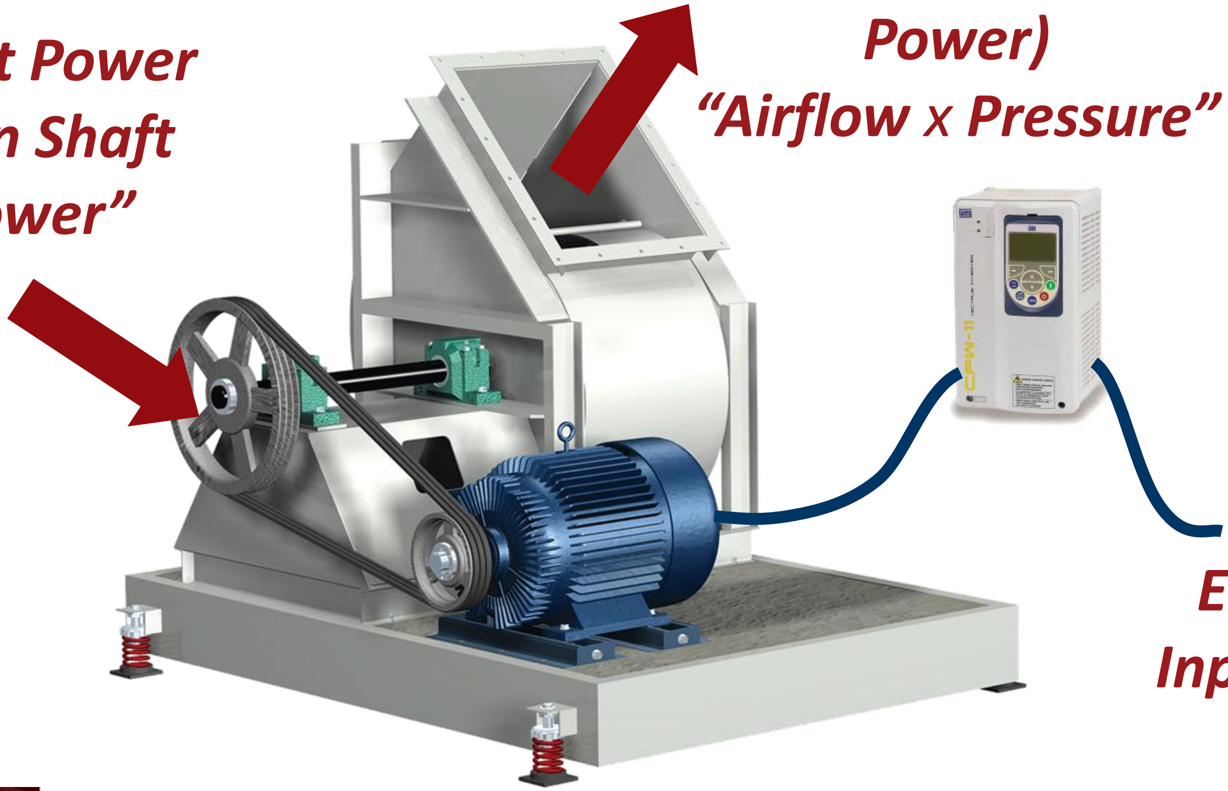
Miami-Dade Regulation

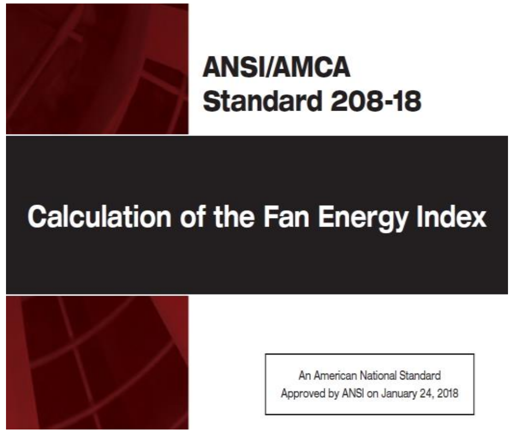
OSHPD Regulation

FEG

FEI vs. FEG

Wire-to-Air Metric





Fan Energy Index (FEI)

True 'application-based metric'

Not a 'product-based metric' like FEG.

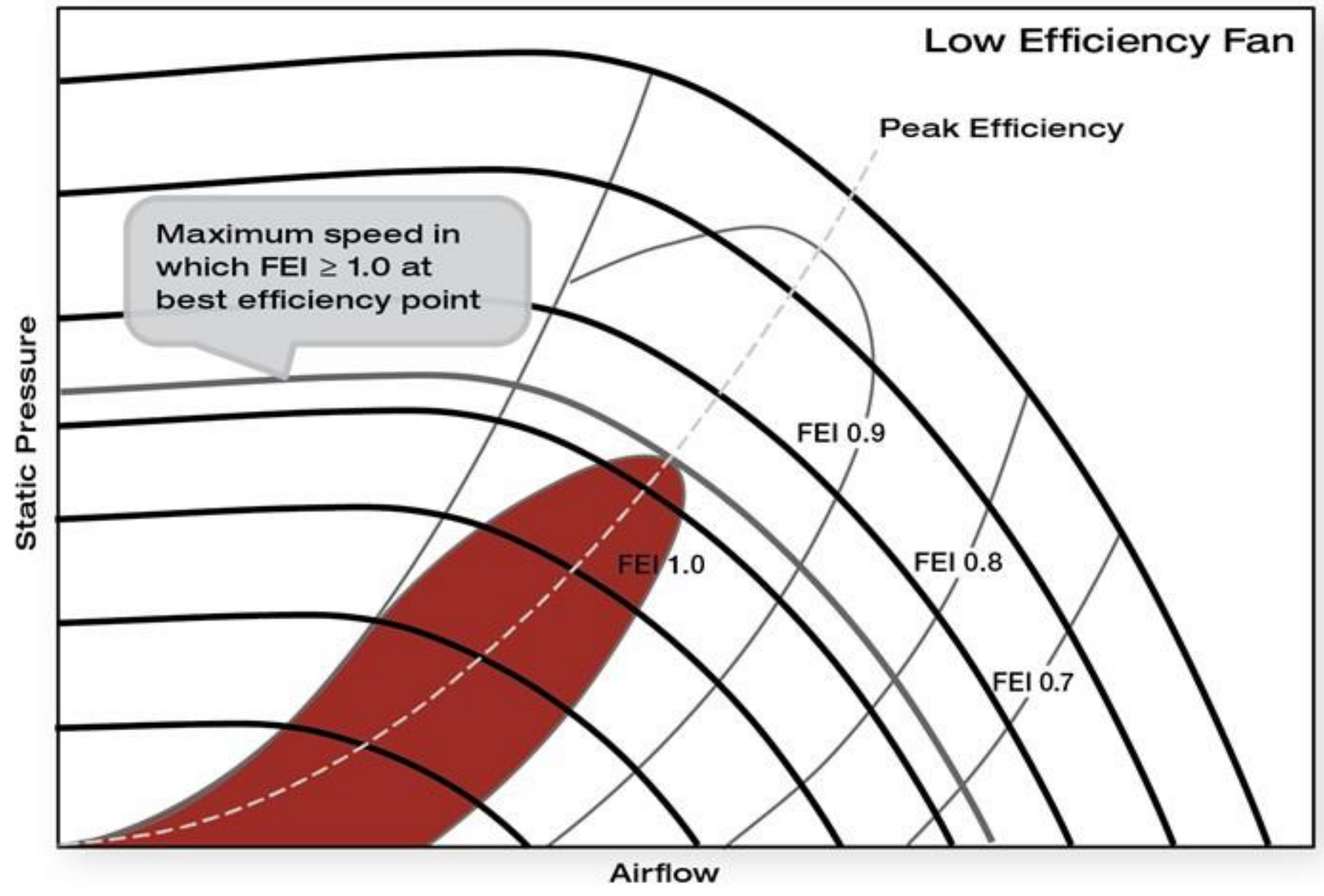
It optimizes system design with proper fan selection

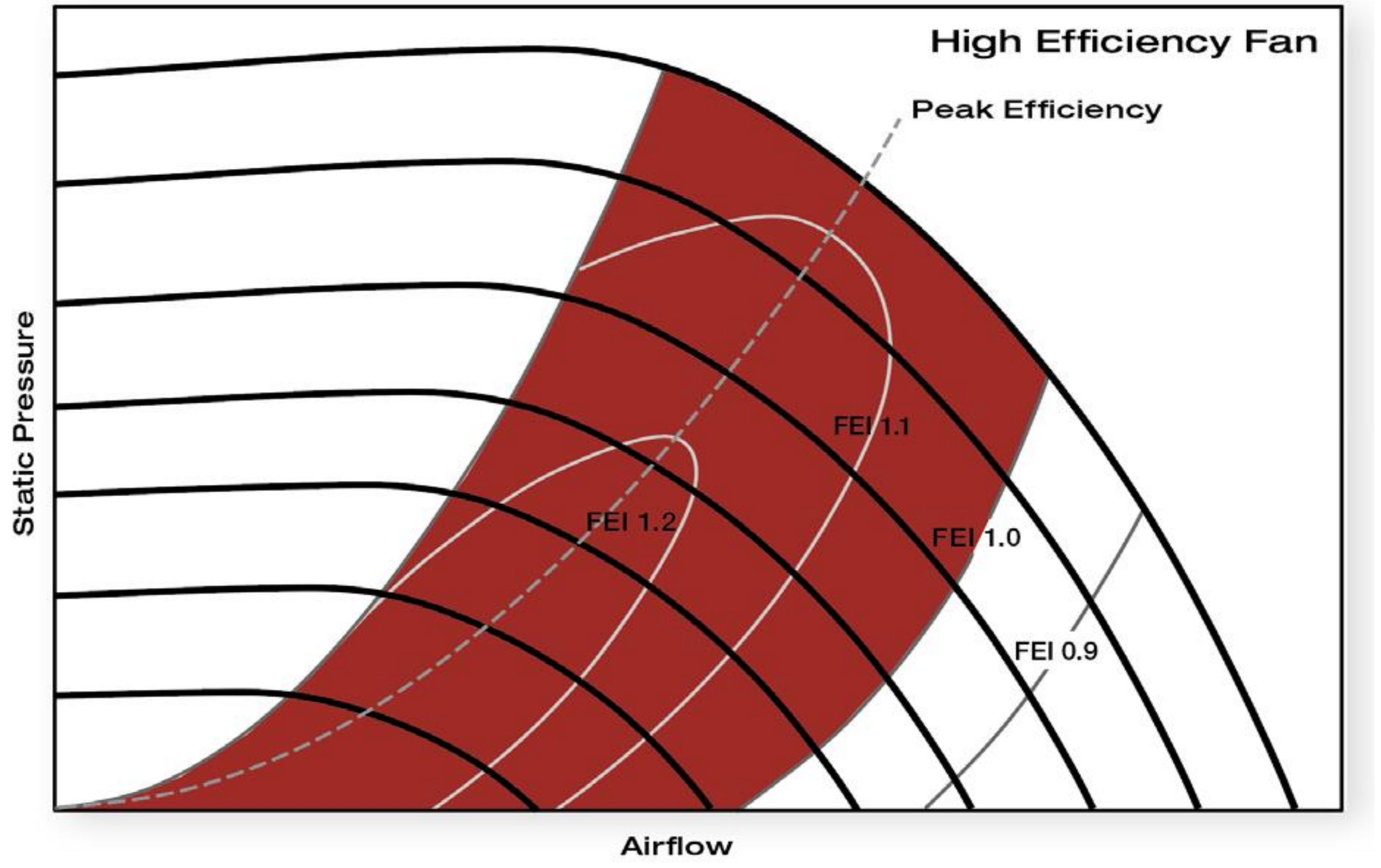
- FEI is a relative measure of power required to satisfy a given duty point – relative to the *Reference Fan*
- Reference Fan Power is a 'Virtual Fan Power' and also a function of duty point (Flow*Pressure)
- Forces system designers to minimize Pressure

Total Pressure, Pt ~ H (Power) / Q (flow rate)

$$\text{FEI} = \frac{\text{Reference Fan Electrical Input Power}}{\text{Rated Fan Electrical Input Power}}$$

Low Efficiency vs. High Efficiency





Fans Out of Scope

- Safety fans as defined in Section 1602(d) of this Article;
- Ceiling fans;
- Circulating fans;
- Induced flow fans;
- Jet fans;
- Cross-flow fans;
- Embedded fans as defined in ANSI/AMCA 214-21;, including embedded fans sold exclusively for replacement of another embedded fan;
- Fans mounted in or on motor vehicles or other mobile equipment;
- Fans that create a vacuum of 30 in. water gauge or greater;
- Air curtains unit as defined in Section 1602(d) of this Article.
- Fans that are designed and marketed to operate at or above 482° F (250° C)

FEI in Codes, Standards & Regulations

Publication	Publication Type	Edition	Status	Expected Completion	Effective Enforcement Date
US DOE	Test Procedure NOPR	2023	Draft 2023(~AMCA 214)	Late 2023	~~November 2023~~ Pushed to April 2024
US DOE	Energy Standard NOPR	2024	Draft 2023	Final Early 2024	Final + 5 years = ~Early 2029
California Energy Commission (CEC Title 20)	FEI >=1 Product compliance	2022	Complete	Published	~~November 2023~~ Pushed to April 2024
ASHRAE 90.1	Model Standard	2019	Complete	Published	Published, but needs to be enforced to have effect
ASHRAE 189.1	Model Standard	2020	Complete	Published	Published, but needs to be enforced to have effect
IGCC (International Green Construction Code)	Model Code	2021	Complete	Published	Published, but needs to be enforced to have effect
IECC (International Energy Conservation Code)	Model Code	2021	Complete	Published	Published, but needs to be enforced to have effect
Oregon Energy Efficiency Specialty Code	State Code	2020	Took Effect	Complete	
Florida Building Code	State Code	2020	Took Effect	Complete	
California Energy Commission (CEC Title 24)	State Code	2022	Under review by CA Bldg. Stds Commission	Aug 2022	January 1, 2023

Best Practices

Roof Ventilation

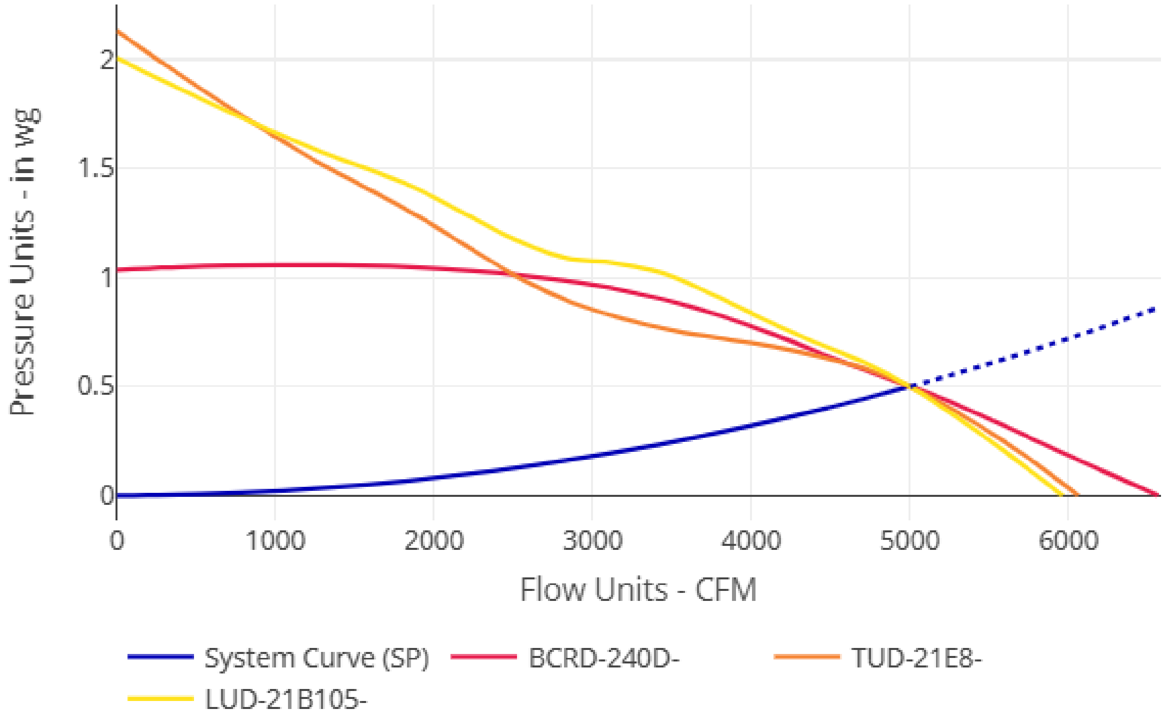
Roof Ventilation

5,000 CFM at .5” w.c. Static Pressure

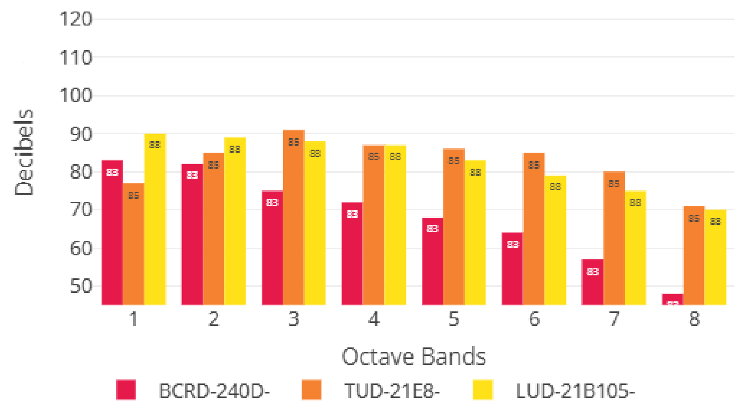
Roof Ventilation

Fan Product Comparison

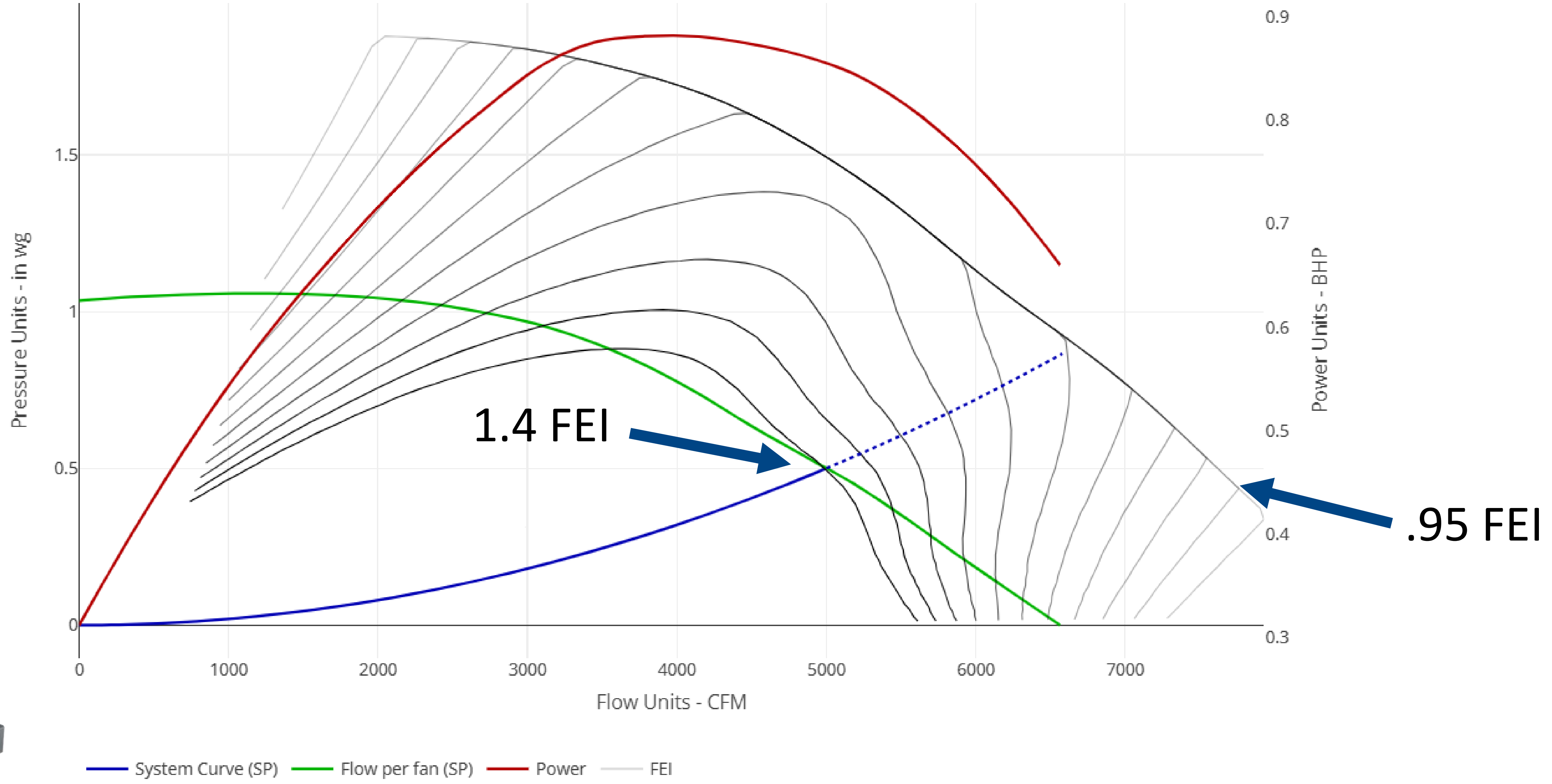
	BCRD-240D	TUD-21E8	LUD-21B105
Performance			
Volumetric Flow (CFM)	5000	5000	5000
Static Pressure (in wg)	0.500	0.500	0.500
Total Pressure (in wg)	0.550	0.756	0.756
Operating Power (BHP)	0.86	1.41	1.08
RPM	652	1701	1694
Static Efficiency %	46.0	27.9	36.5
% of Peak Static Pressure	47.3	70.1	46.7
Fan Energy Index (FEI)	1.40	0.97	1.24
Sound			
Inlet LwA	74	91	88
Inlet Sones	12.6	31	28
Pricing			
Budget Price Index	2.0	3.1	1.7



Sound Graph



Roof Ventilation



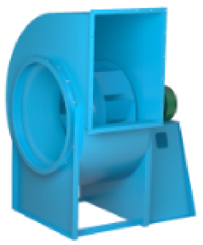
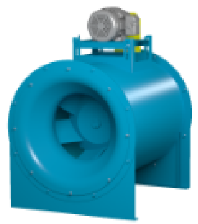
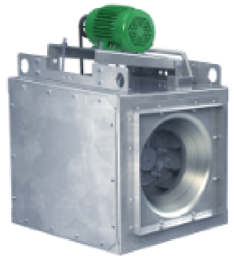
Mid-Run Ducted Fan

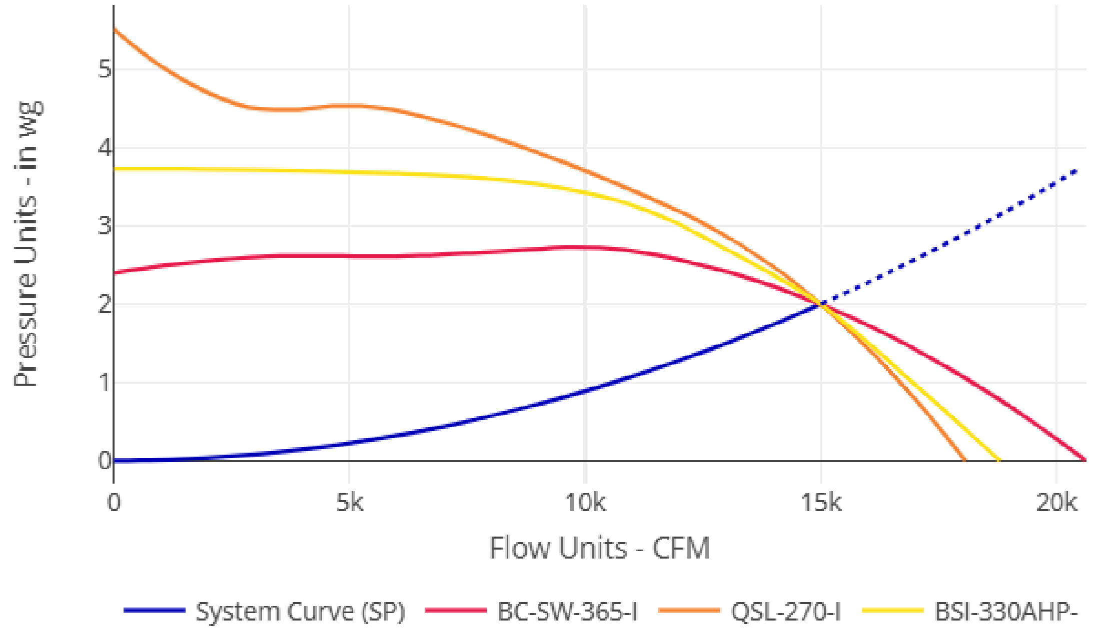
Mid-Run Ducted Fan

15,000 CFM at 2” w.c. Static Pressure

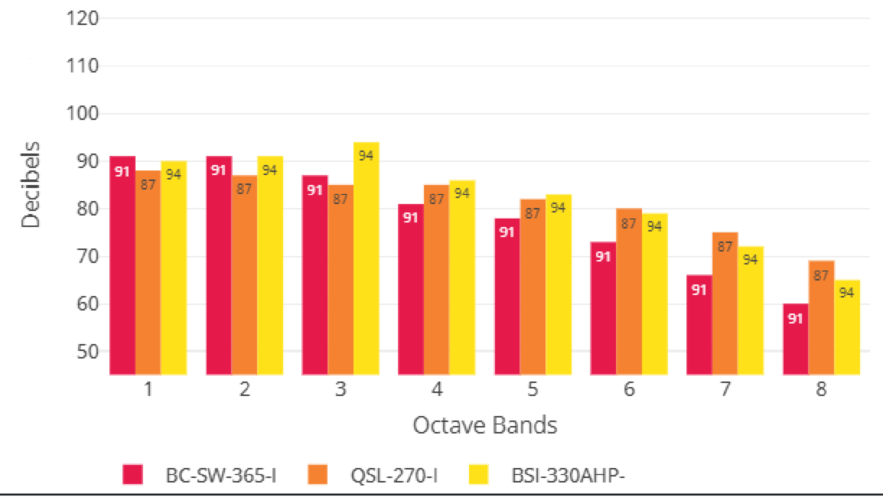
Mid-Run Ducted Fan

Fan Product Comparison

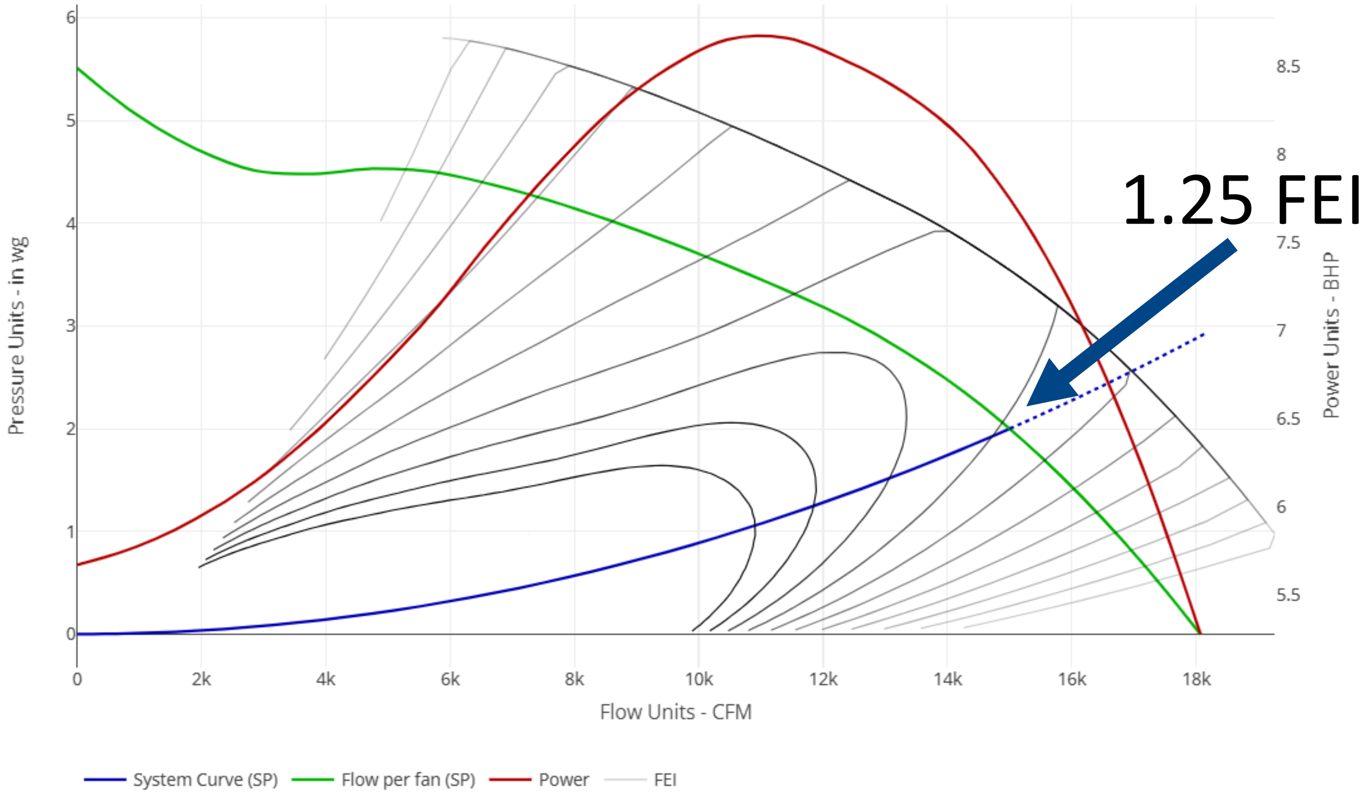
	 BC-SW-365-I	 QSL-270-I	 BSI-330AHP
Performance			
Volumetric Flow (CFM)	15000	15000	15000
Static Pressure (in wg)	2.000	2.000	2.000
Total Pressure (in wg)	2.239	2.264	2.052
Operating Power (BHP)	6.87	7.75	10.26
RPM	710	1331	939
Static Efficiency %	68.7	60.9	46.0
% of Peak Static Pressure	73.3	44.1	53.6
Fan Energy Index (FEI)	1.38	1.24	0.87
Sound			
Inlet LwA	84	87	90
Inlet Sones	23	26	30

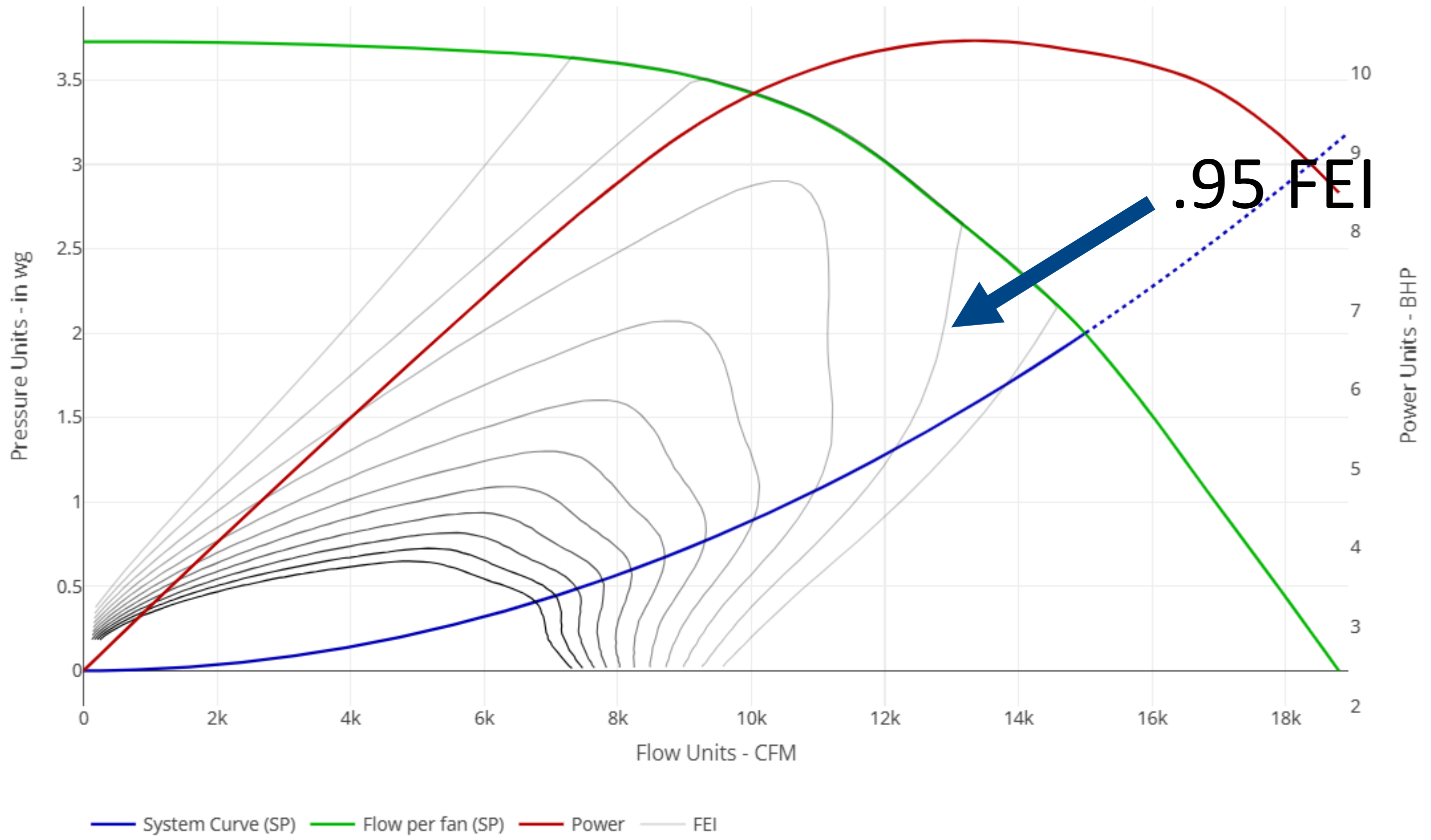


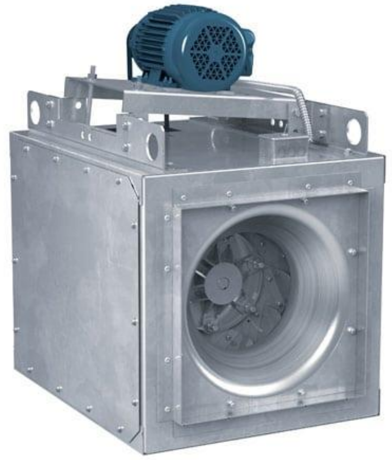
Sound Graph



Mid-Run Ducted Fan







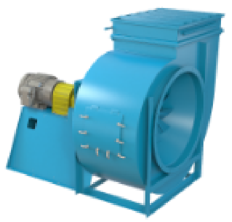
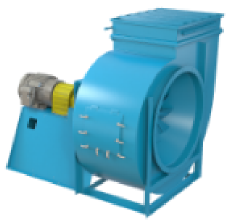
Dust Collection

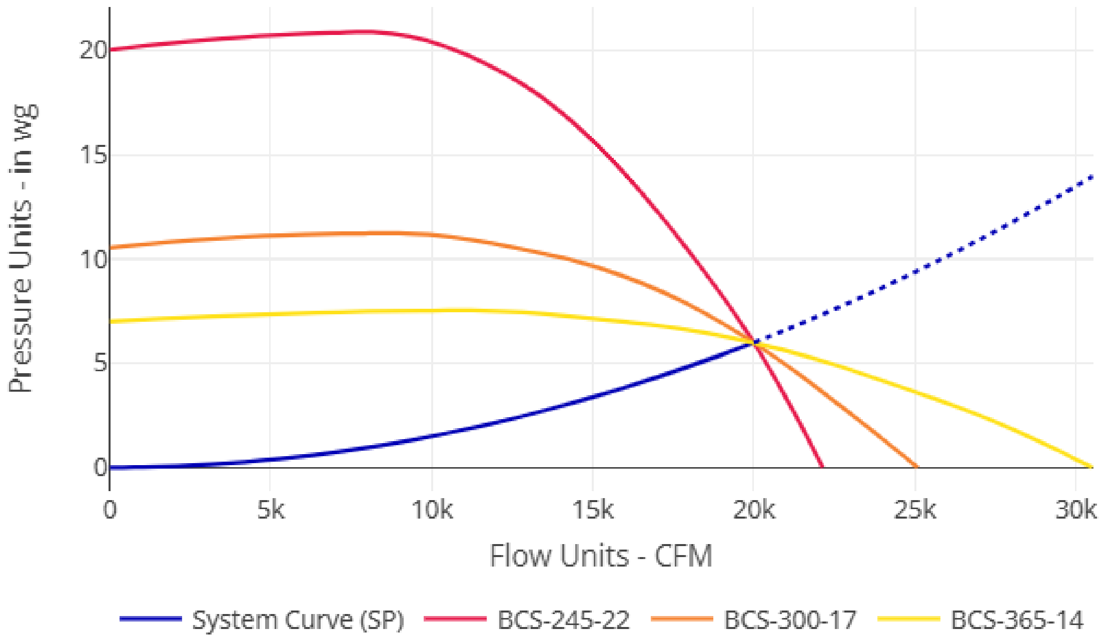
Dust Collection

20,000 CFM at 6” w.c. Static Pressure

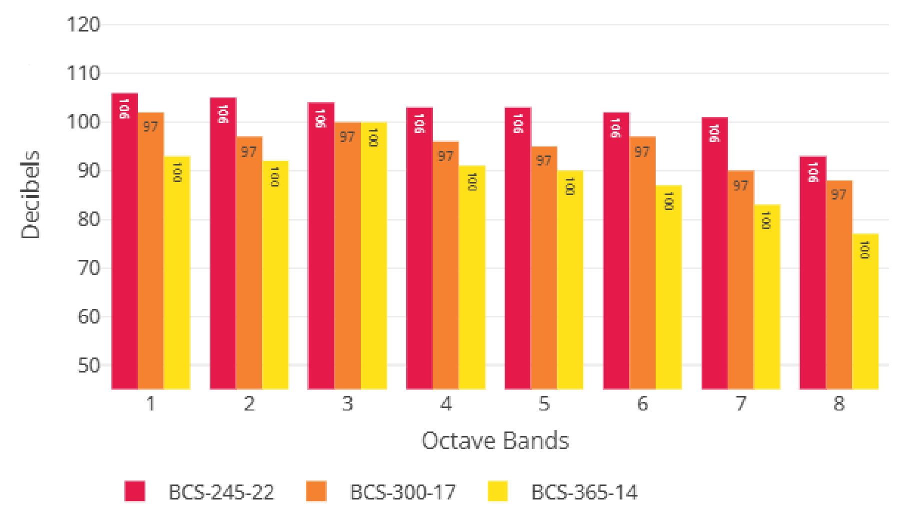
Dust Collection

Fan Product Comparison

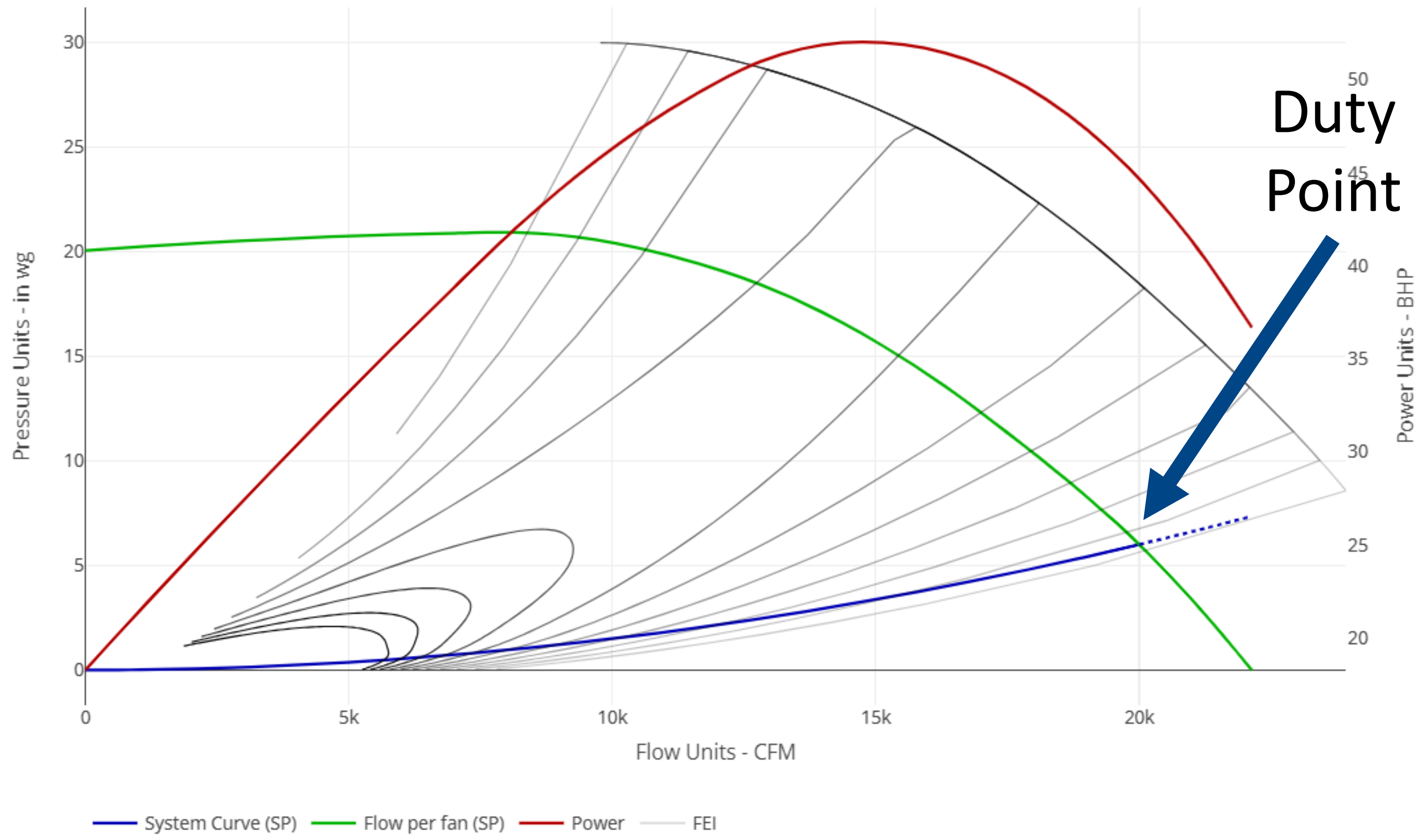
	 BCS-245-22	 BCS-300-17	 BCS-365-14
Performance			
Volumetric Flow (CFM)	20000	20000	20000
Static Pressure (in wg)	6.000	6.000	6.000
Total Pressure (in wg)	8.091	6.931	6.424
Operating Power (BHP)	44.67	30.21	25.14
RPM	2982	1796	1202
Static Efficiency %	42.1	62.3	74.9
% of Peak Static Pressure	28.7	53.4	79.6
Fan Energy Index (FEI)	0.92	1.22	1.30
Sound			
Inlet LwA	109	102	96
Inlet Sones	113	69	45

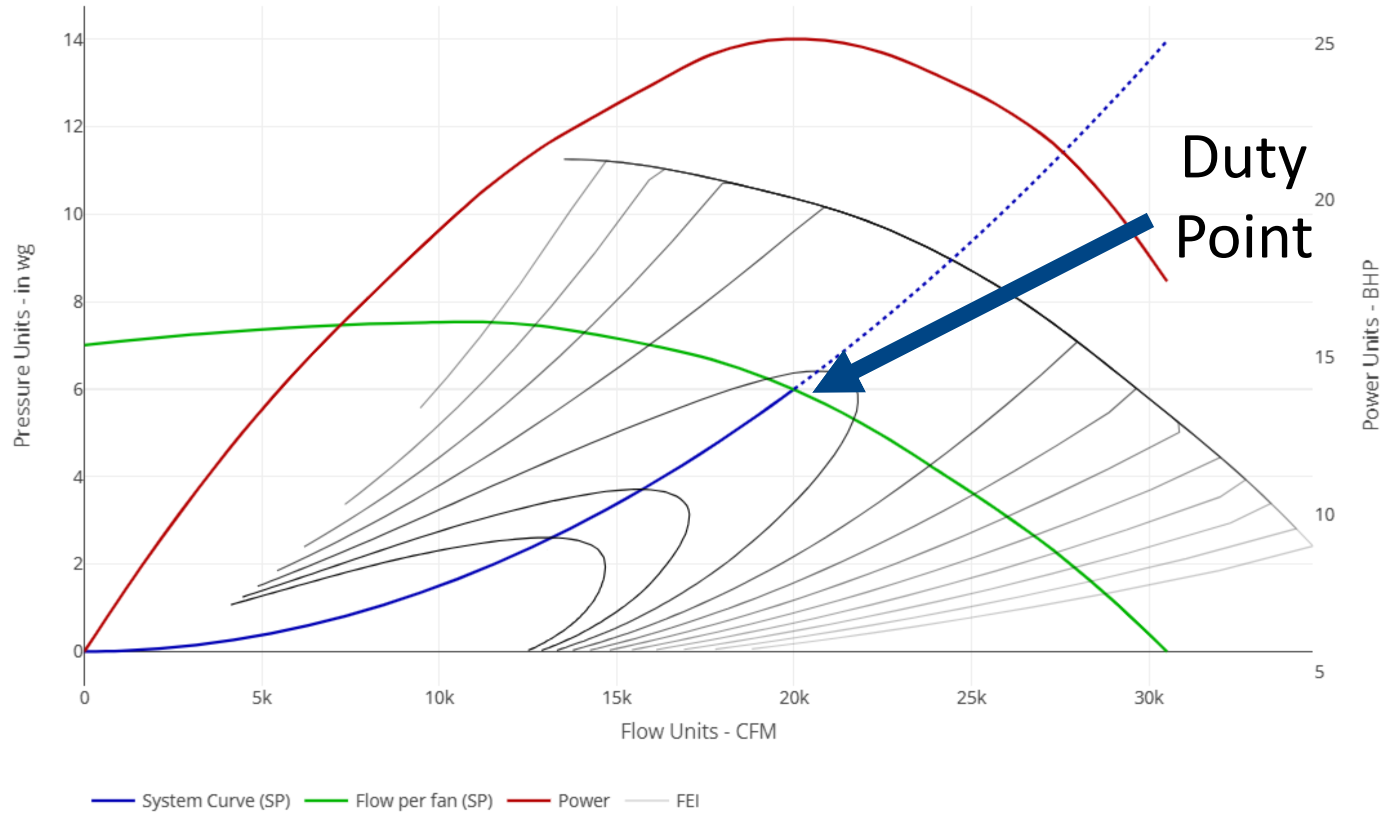


Sound Graph



Dust Collection



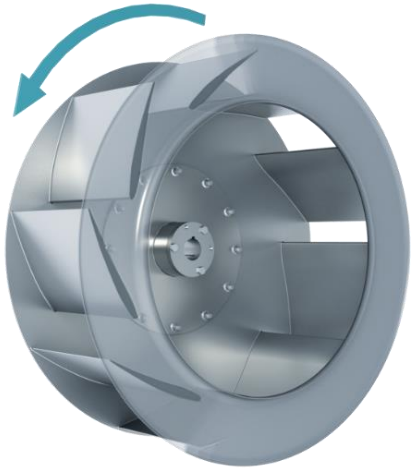


Size 245
FEI = .92
BHP = 44.67

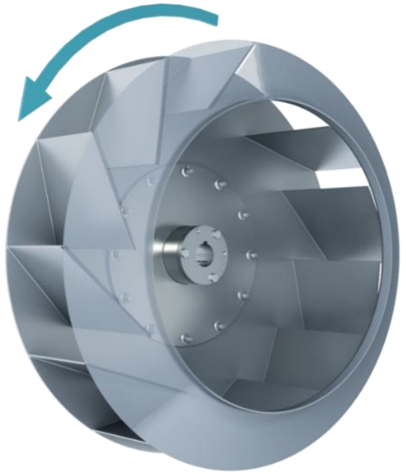
Size 365
FEI = 1.3
BHP = 25.14

Variable Air Volume

Max design flow rate: 18,000 CFM at 5.4” w.c. Static Pressure

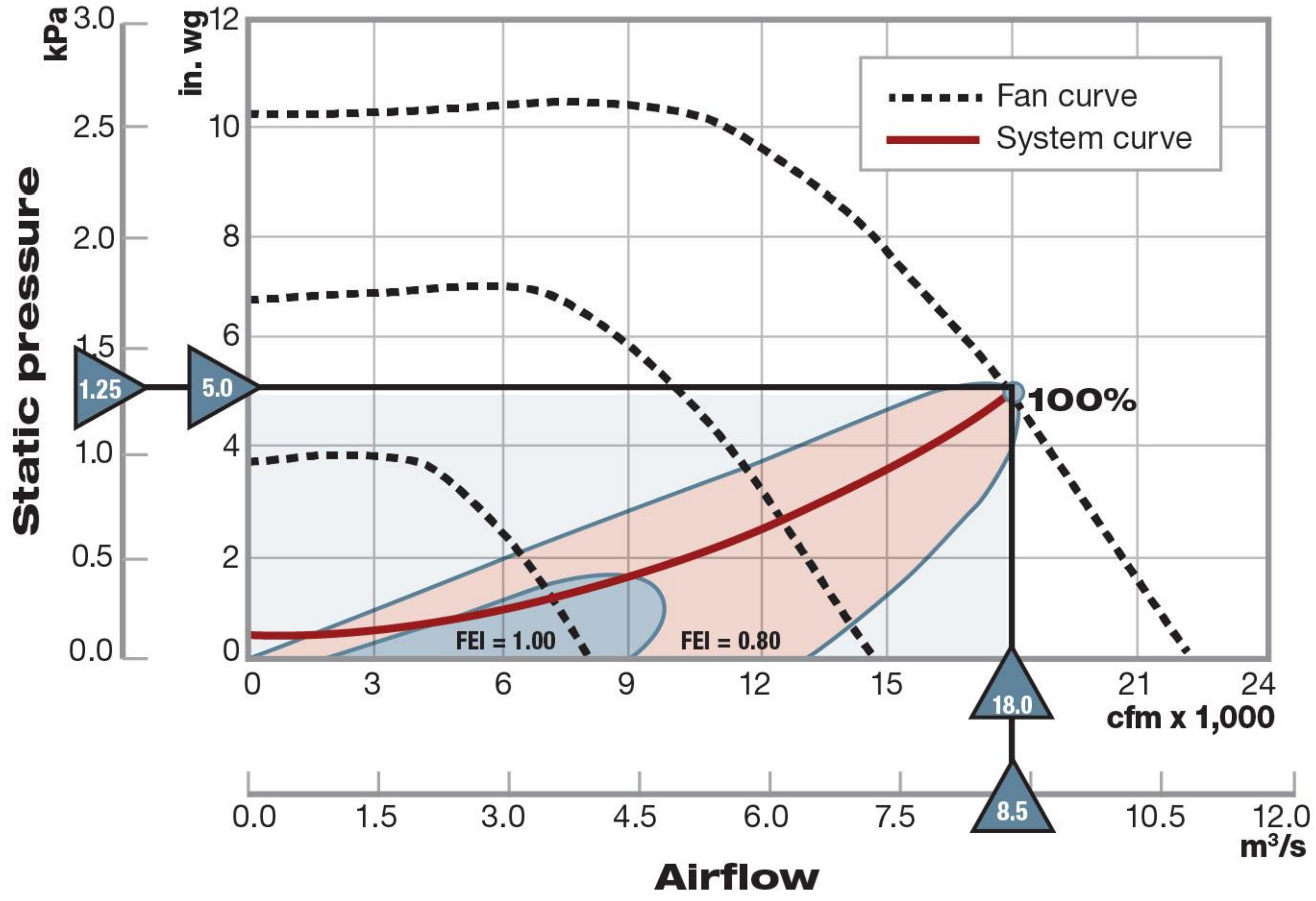


Fan Size	Fan Type	FEI 40% Flow (7200 CFM)	FEI 70% Flow (12,800 CFM)	FEI 100% Flow (18,00 CFM)
18	Airfoil	1.05	0.89	0.9
20	Airfoil	1.17	1.06	1.05
22	Airfoil	1.21	1.15	1.13
24	Airfoil	1.24	1.25	1.23
27	Airfoil	1.2	1.23	1.21

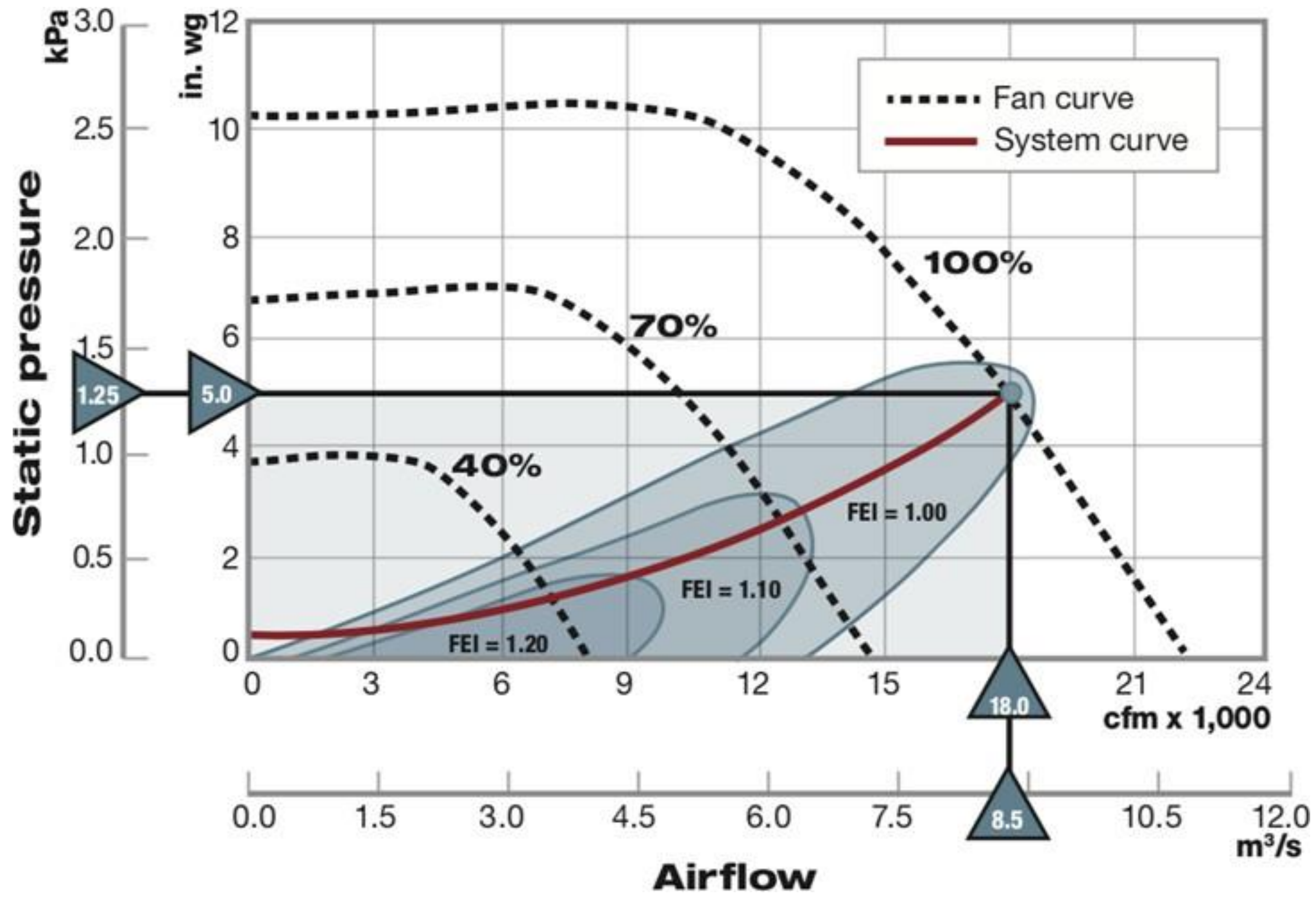


Fan Size	Fan Type	FEI 40% Flow (7200 CFM)	FEI 70% Flow (12,800 CFM)	FEI 100% Flow (18,00 CFM)
16	Backward Inclined	1.05	0.83	OVERSPEED
18	Backward Inclined	1.02	0.9	0.82
20	Backward Inclined	1.11	0.94	0.93
22	Backward Inclined	1.21	1.12	1.05
24	Backward Inclined	1.22	1.18	1.16
27	Backward Inclined	1.19	1.2	1.17

Variable Air Volume



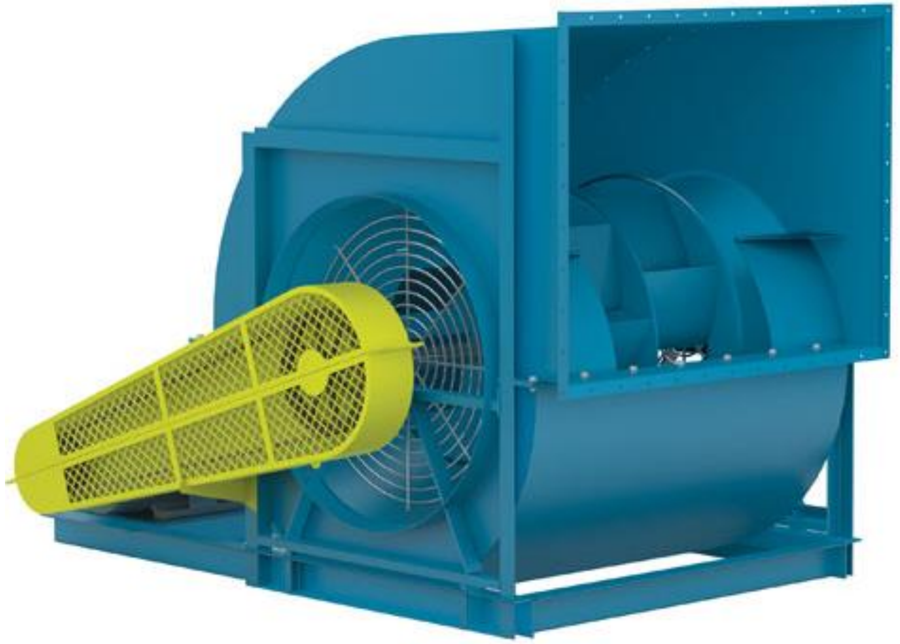
Backward Inclined
Size 182



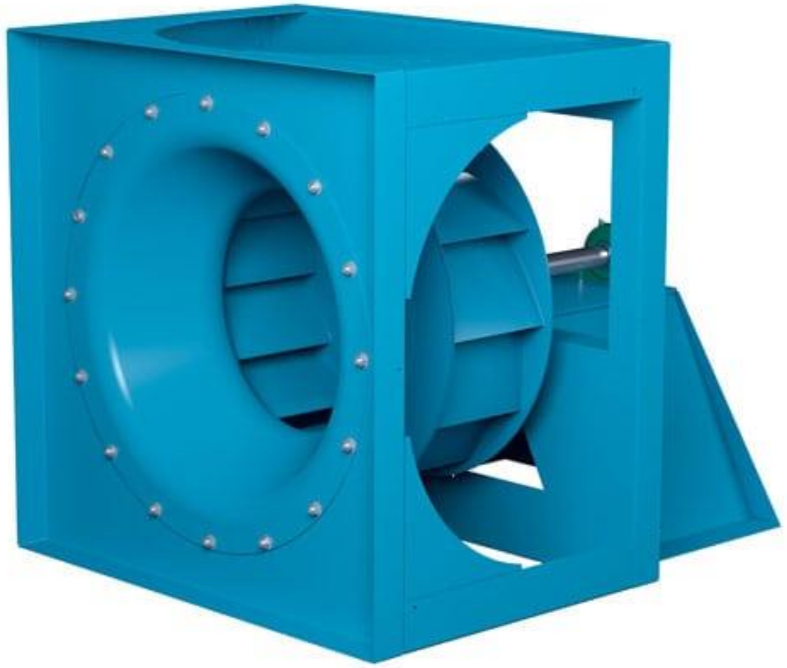
Backward Inclined
Size 222

Air Handling Units – Supply Fans

Double Wide



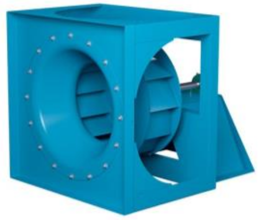
Plenum Fan



Plenum Fan Array

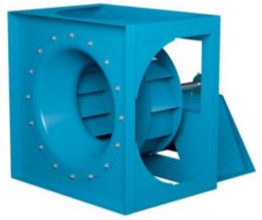
40,000 CFM at 6.5” w.c. Static Pressure

Air Handling Units – Fan Compare



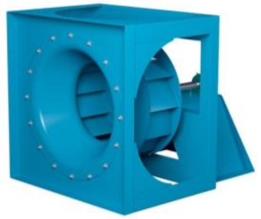
Metric	Double Wide	Single Plenum	4 Fan Array	16 Fan Array
Fan BHP				
System BHP				
Static Efficiency				
Total System FEI				
Individual Fan FEI*				
System FEP (KW)				
System LwA (db)				
EQ FLH				
KWH				
Elec Rate				
Operating Cost				
Delta				
System Cost				

Air Handling Units – Fan Compare

Metric	Double Wide	Single Plenum	4 Fan Array	16 Fan Array
Fan BHP	51.68	55.43	14.69	3.77
System BHP	53.75	55.43	58.76	60.32
Static Efficiency	79.3%	74.0%	69.8%	68.0%
Total System FEI	1.27	1.27	1.25	1.22
Individual Fan FEI*	1.27*	1.27*	1.28*	1.34*
System FEP (KW)	44.04	45.41	46.13	47.35
System LwA (db)	103	96	96	99
EQ FLH	6000	6000	6000	6000
KWH	240,585	248,104	263,009	269,992
Elec Rate	.12	.12	.12	.12
Operating Cost	$28,870	$29,772	$31,561	$32,399
Delta	Base	$902	$2691	$3529
System Cost	1.15	1.0	1.58	3.23

Air Handling Units – Fan Compare

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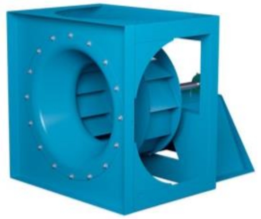

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Trends

Trends

What to expect: Fans and equipment in systems are going to get bigger.

Benefits:

- Slower Speeds
- Energy Efficiency
- Decreased Sound Levels
- Increased Bearing / Motor Life
- Decreased Vibration Potential

Trends

What to expect: Heavy focus on system design. Reducing pressure drop.

- Mitigating selection safety factors
- Education on system effect
- Inefficient products will be penalized
- Contractors need to prioritize duct work over other trades

Three Takeaways

1. We have a choice -
   – Increasing safety requirements
   – Energy efficiency is more important than ever
2. Regulations are here and more are coming.
3. Every system is different and important.
   Rely on the experts with your questions.