

Compressed Air Applications and Dominion Energy- VA Incentives

Nandini Mouli, Ph.D.

Consultant to TRC

Implementer of Dominion Energy Custom
Programs

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Overview - Compressed Air Systems

- **Why care about compressed air systems?**
 - Wide application
 - Very inefficient
- **Compressed air systems**
 - Compressors
 - Compressor controls
 - Dryers
- **Energy savings opportunities**
 - How to use less (demand side)
 - How to generate compressed air more efficiently (supply side)
 - Others
- **Dominion Energy VA utility incentives**



Source: Compressed Air Best Practices



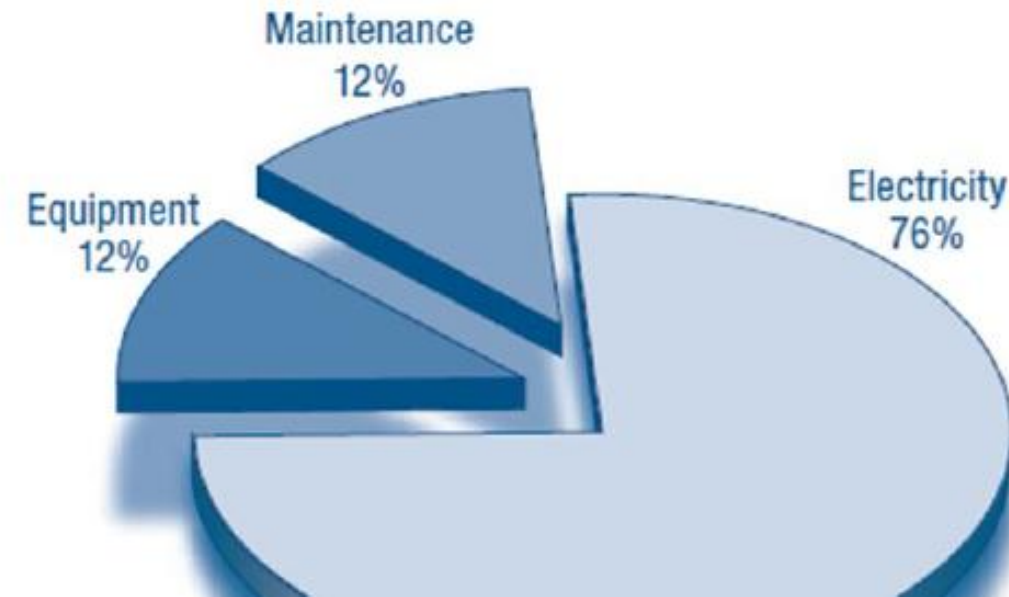
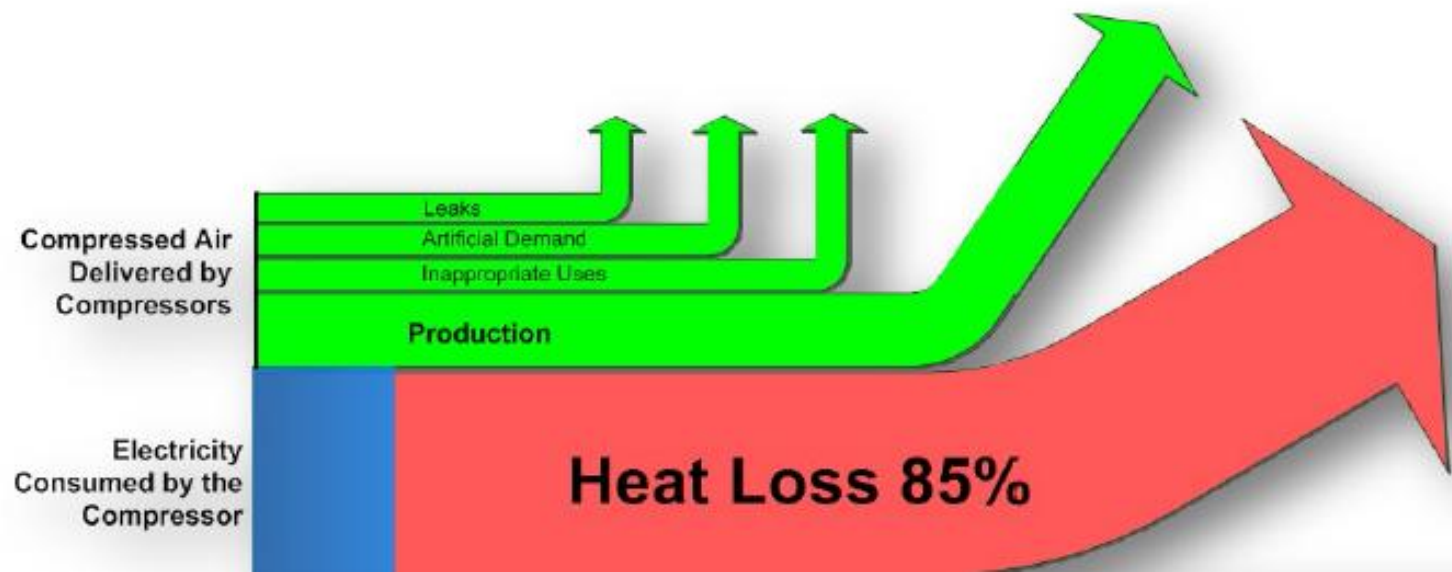
Why Care about Compressed Air Systems?

- **Wide applications (e.g.)**
 - Conveyers
 - Pneumatic tools
 - Machine actuators
 - Paint sprayers
 - Robotic arms
- Comparing to electrical
 - **Smoother power**
 - Variable speed and torque control
 - **No potential hazards of electric shock**



Why Care about Compressed Air Systems?

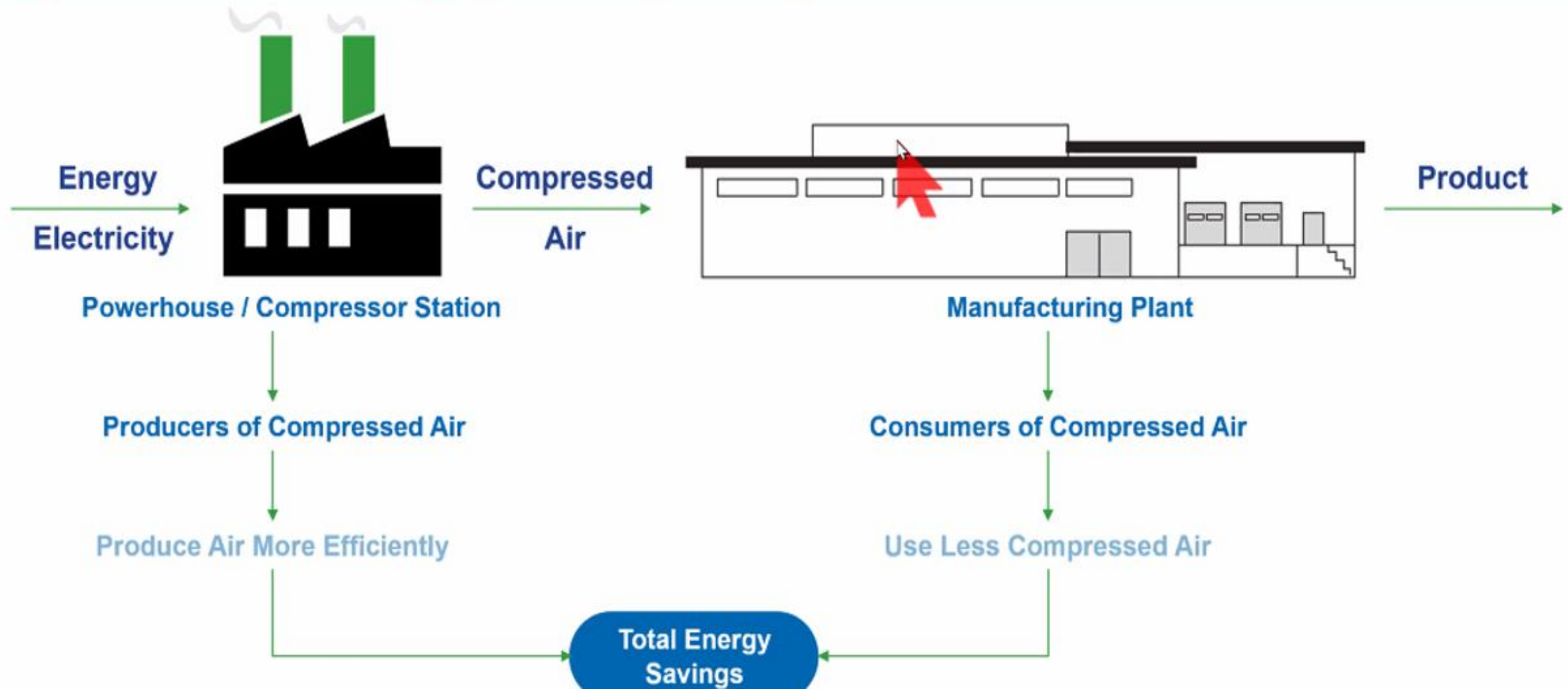
- Consumes **5-20% of a plant electricity**
- Very **inefficient**



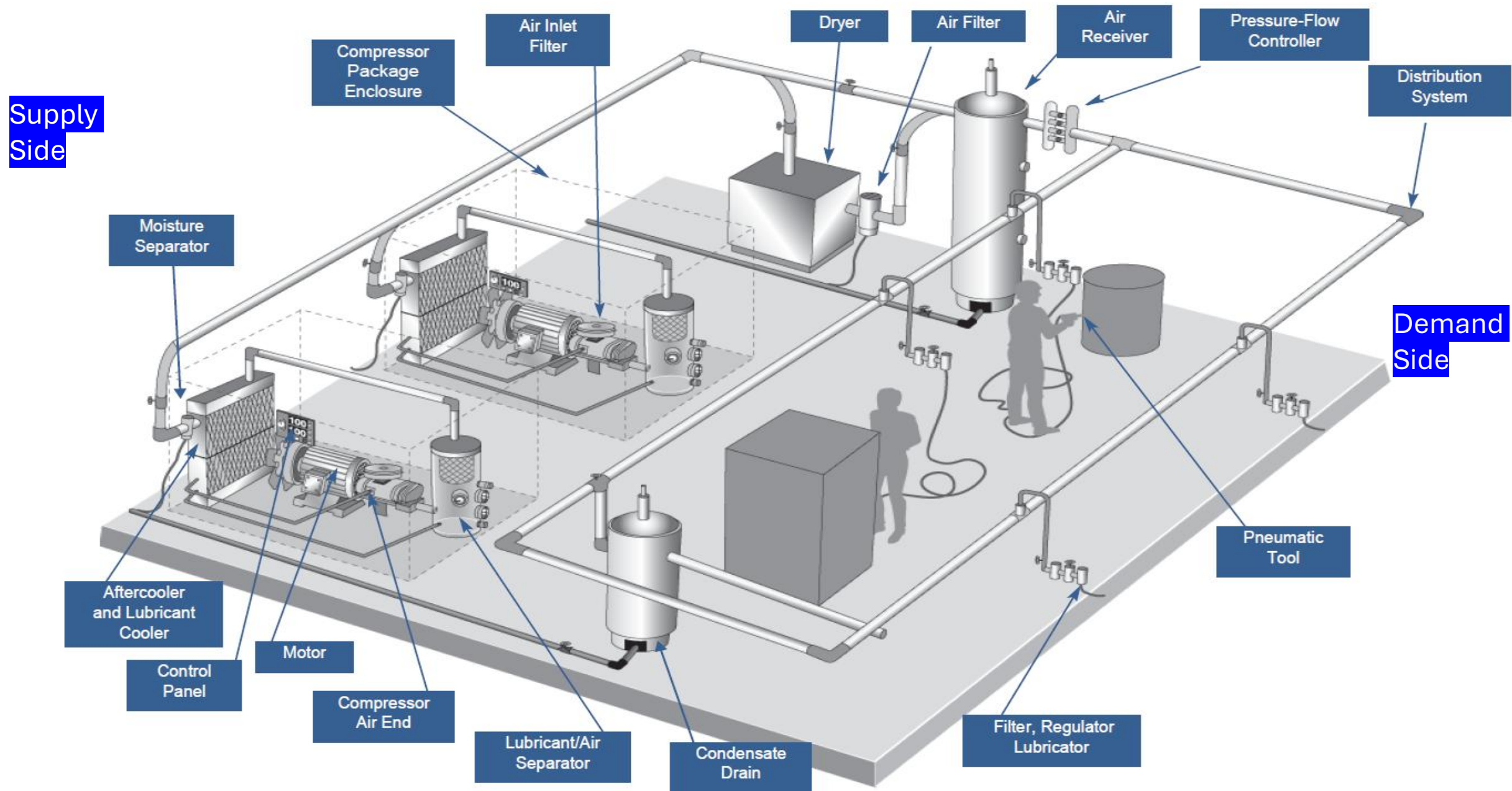
Compressed Air Systems Approach

plant efficiency: energy >> product

There are two basic ways to reduce the energy consumption of a compressed air system: produce compressed air more efficiently; and consume less compressed air.



Components Of An Industrial Compressor System



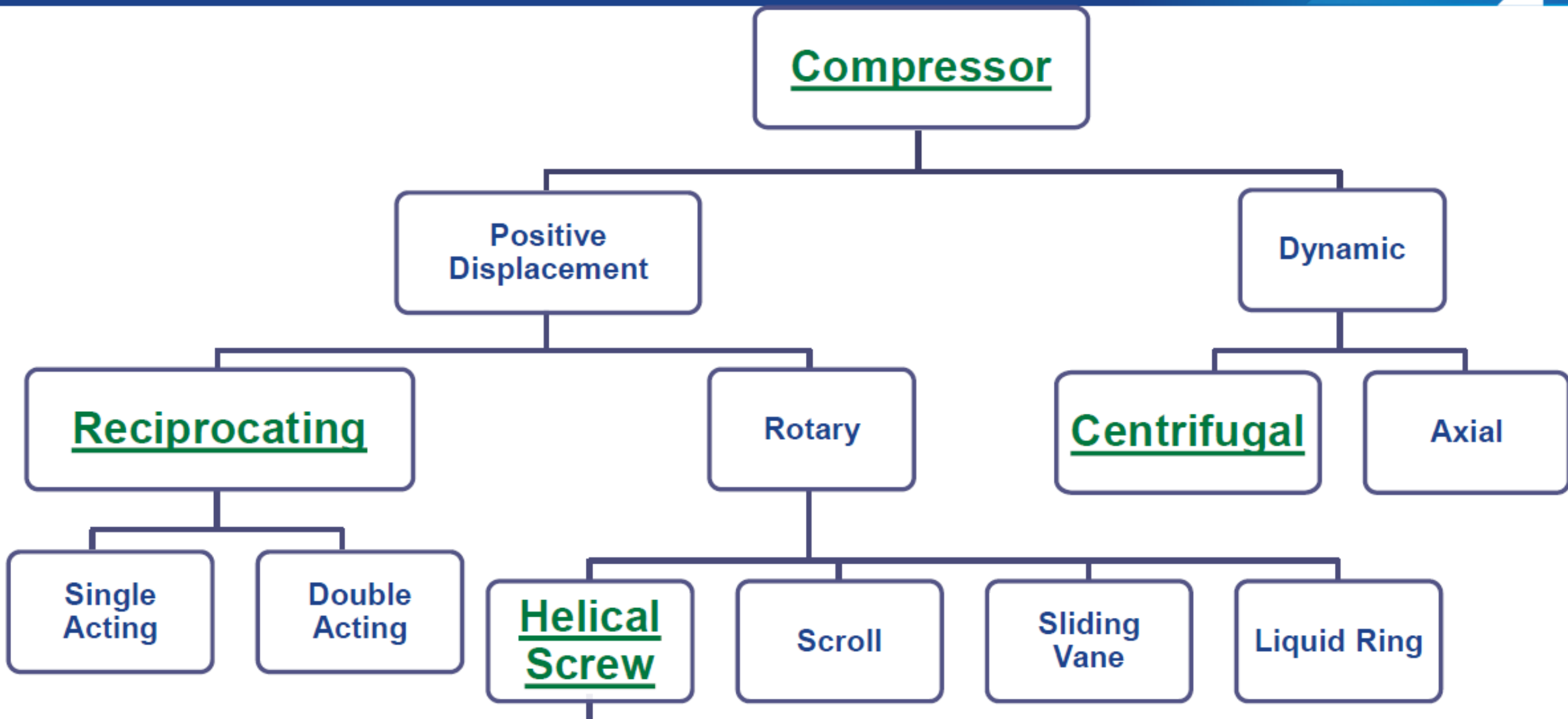


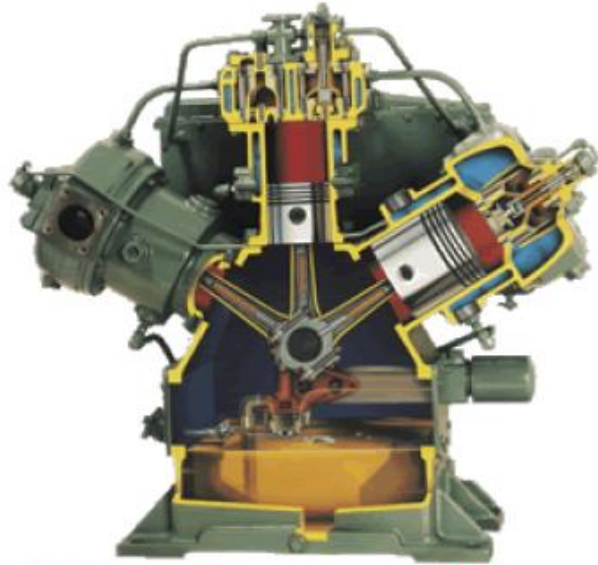
Compressed Air
Supply Side

1. Compressors

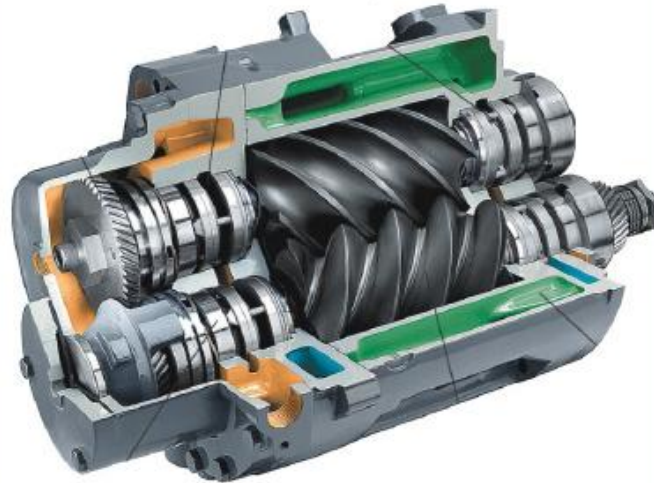
- Proper sizing - Air Capacity and Air Pressure are critical
 - Minimum, normal and maximum air demand should be considered
 - Minimum turndown of at least 20% and pressure rise of a min. of 10% to avoid blow-off and guarantee an optimal EE operation of the unit.
- Compressor type needs to be determined:
 - Reciprocating: Low-volume applications and intermittent; piston & common
 - Rotary Screw: Continuous duty cycles, high volume, high efficiency and low maintenance; often used in industrial settings
 - Centrifugal: Cost-effective for very high-volume applications.
 - Scroll: Quiet, high efficiency, low maintenance; best for clean and dry air end-uses

Types of Compressors





Reciprocating



Rotary Screw

For medium capacity



Centrifugal

2. Compressor Controls:

Main Function: Matching supply with demand thereby reducing energy waste

Goal of Control Strategies:

- Maximize energy efficiency
 - Run only compressors that are needed, when they are needed, only for as long as needed
 - Secondary benefit of reduced equipment run → less maintenance
- Minimize system pressure range
 - Minimize the total range of pressure control so that average pressure is reduced
 - Secondary benefit to process from less variation in pressure → Stable pressure at the lowest power use possible

Compressor Controls: Operation Mechanism

Modes of Control
Depend On the Type and
Uses of Compressors

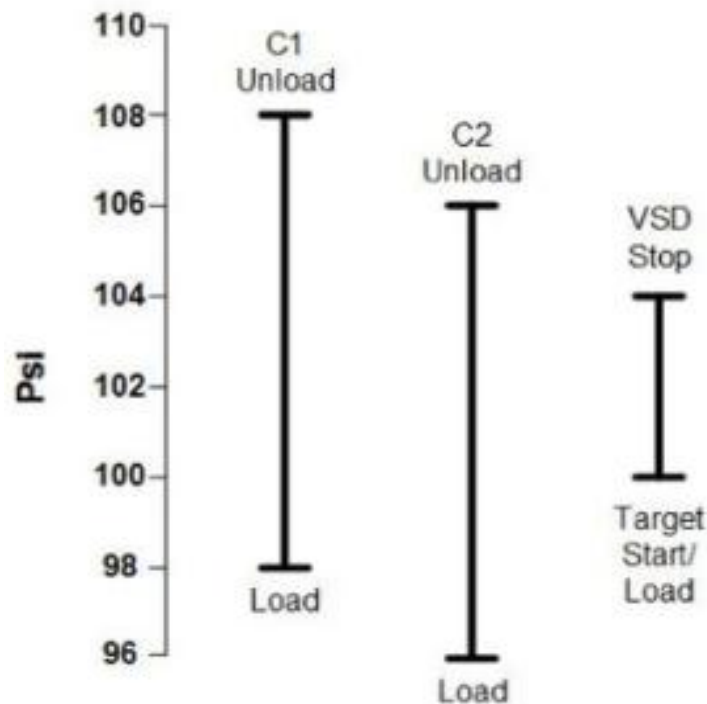
Compressor Controls

- **On/Off controls**
 - Turns on at low end of pressure range and turns off at the high end
 - Available on reciprocating or rotary compressors
 - Efficient if load is intermittent
- **Load and unload**
 - Unloads the compressor when discharge pressure is adequate.
 - Inefficient since ~50% power is drawn when compressor is unloaded
- **Inlet modulation**
 - Modulation of inlet valve in response to system pressure variation
- **Variable speed controls**
 - Can regulate capacity from **15% to 100%**
 - Provide a **soft start** and very **stable pressure band**
 - Operate in start/stop mode when it is below 15%

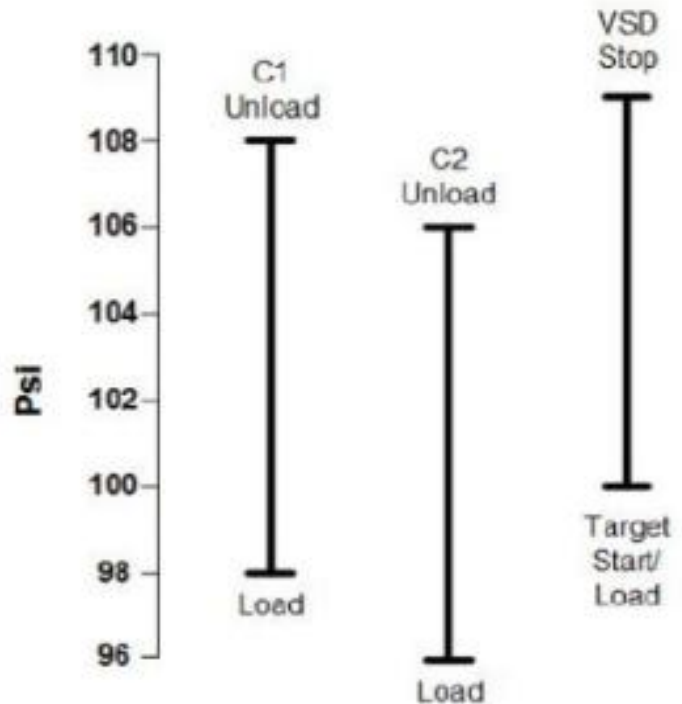
VSD as an example of Controls:

Two Ways to set up a VSD compressor with Fixed Speed Units

If VSD is equal in size to the base units

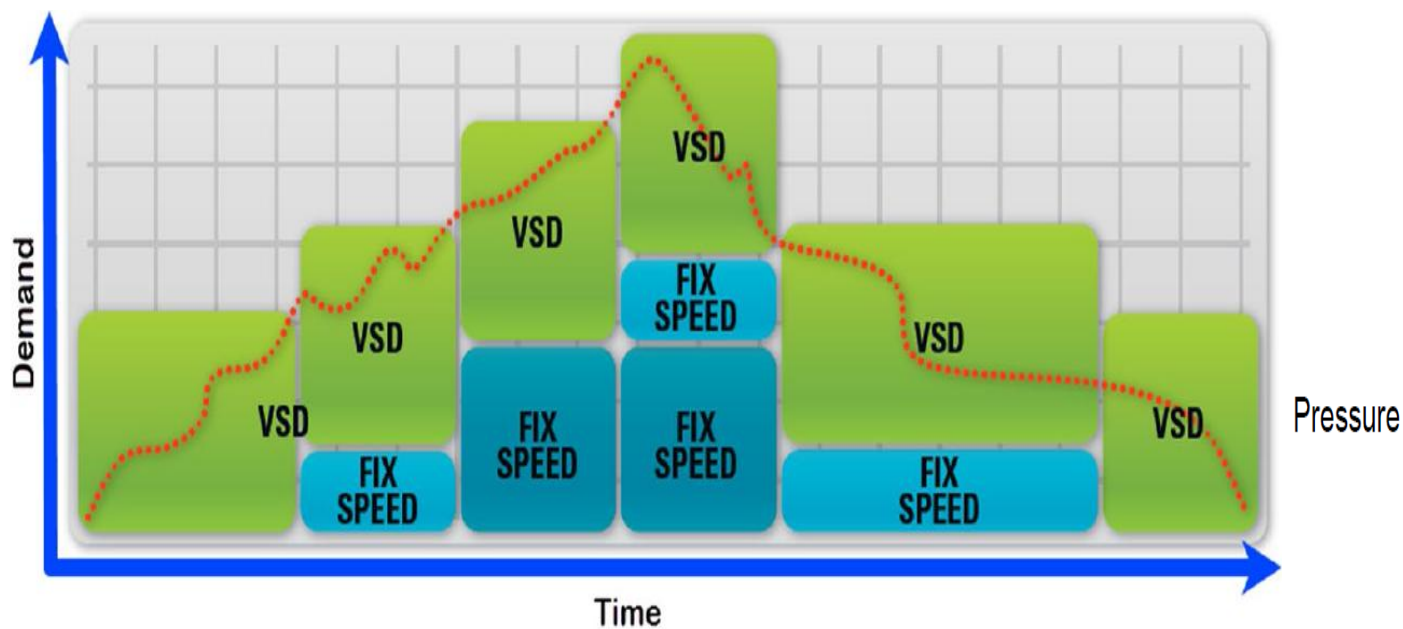


If VSD is bigger in size to the base units

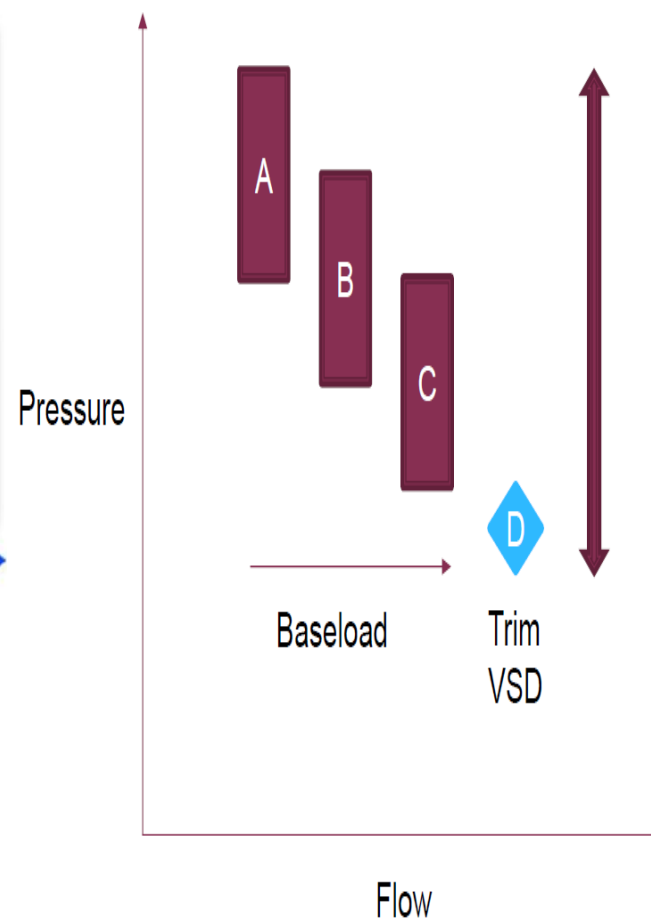


In both cases the VSD target pressure is nested with the bands of the two other compressors.
Assumption: That the load or start setting for the VSD is the same as the target pressure.

VSD as a Trim Compressor in a Multiple-Compressor Scenario



To provide efficient VSD regulation over the complete range of the air profile, the range of the VSD from min to max should be sized equal or greater than the load/no load machine.



- Less pressure band required with a VSD.
- VSD is last to run as flow increases

3. Air Dryers:

Work by removing moisture from the air stream, preventing condensation and ensuring the air remains dry and usable for various applications

- Methods of Drying:
 - Cooling
 - Adsorption
 - Membrane separation



Refrigerant-Type Dryers

- **Most common**
 - Low capital and operating costs
- **Cools air to 35-40°F, removes moisture and reheats the air**
 - Reheat should use hot incoming air
- **Almost always air cooled (no cooling tower)**
 - Condensing temperature can be very high



Source: GSA

Desiccant-Type Dryers

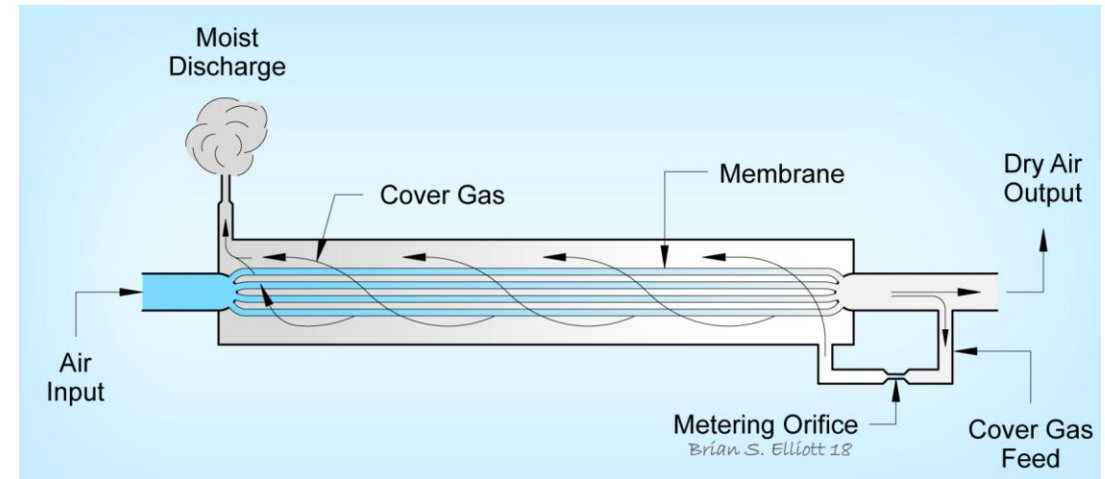
- Desiccant medium to absorb or adsorb moisture
- Most common design: **twin tower regenerative**
 - One is used while the other is regenerated
 - Uses large amount of compressed air to regenerate
 - **Lower dew points** (often to -40 F), but **More costly** than refrigeration type
- Heated regens are more efficient
 - Less purge air (5% vs 15% for unheated)



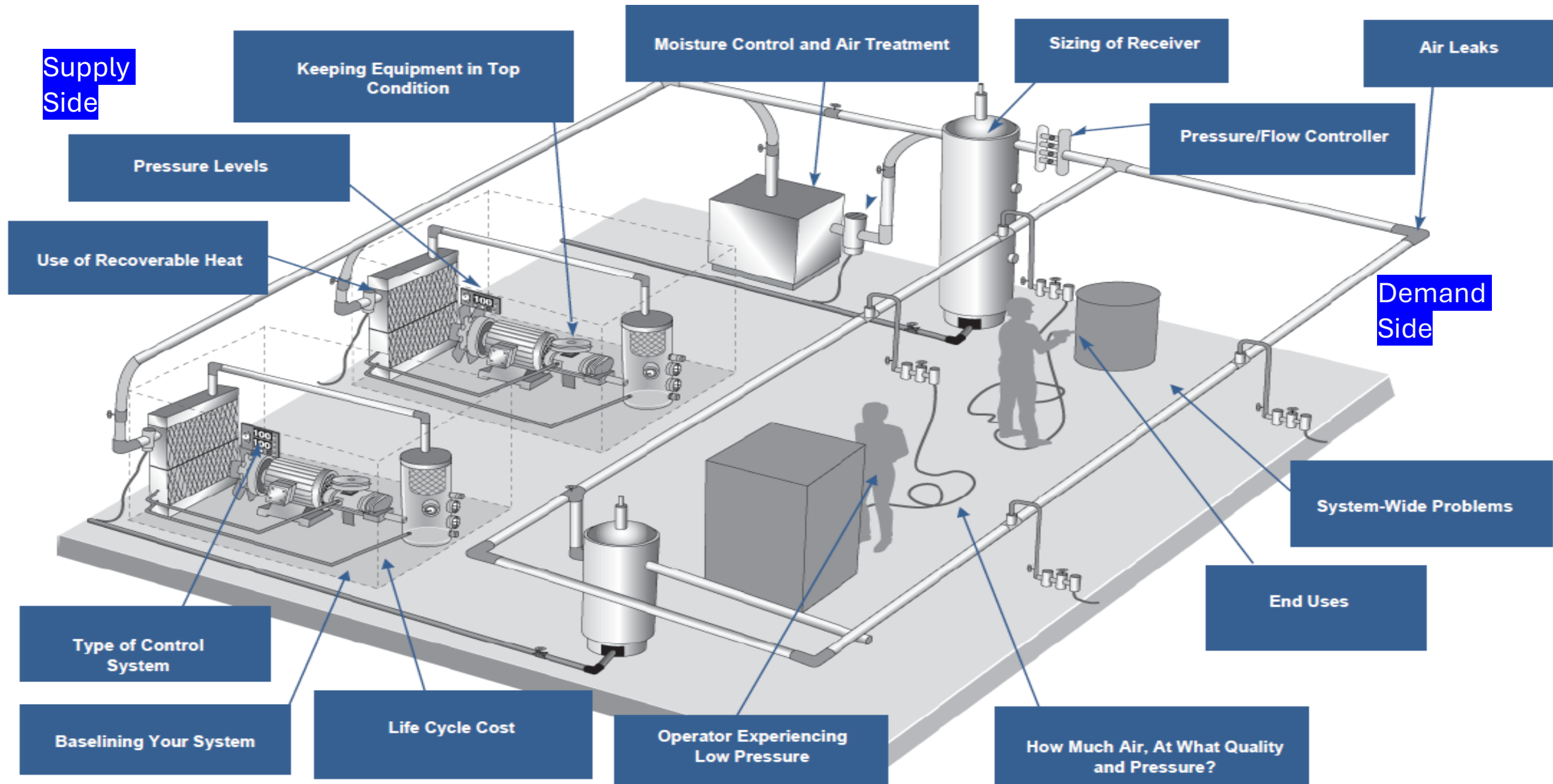
Source: Vortex

Membrane Air Dryers

- Utilize a semi-permeable membrane to allow water vapor to pass through, while compressed air continues to the point of use.
- **Energy-Efficient:** known for energy efficiency and quiet operation.
- **Applications:** food processing and other industries for smaller applications and single points-of-use.



Compressed Air System Performance Improvement Opportunities

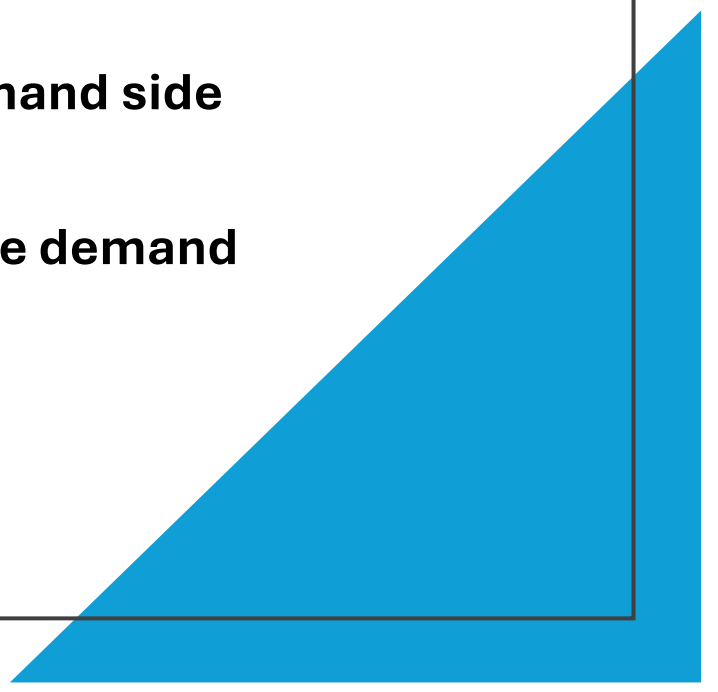


Compressed Air Performance Improvement

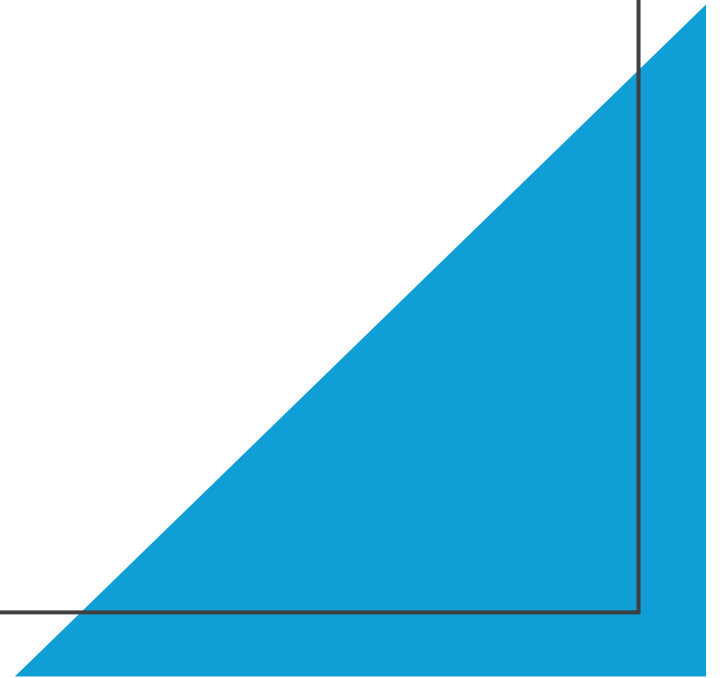
Produce More Efficiently → Supply side

- 1. Lower Pressure of the System**
- 2. Lower Inlet Temperature**
- 3. Improve compressor control**
- 4. Provide Appropriate Quality of Air – Do Not over dry**

Use Less Compressed air → Demand side

- 5. Remove Inappropriate demand**
 - 6. Reduce Leaks**
 - 7. Recover Heat**
- 

Supply Side



1) Lower Pressure Setpoints

- **Lower pressure reduce leakage and usage rates**
 - Every additional **2 psi** costs **1.5% to 2%** in energy
- **Things to check**
 - Check **pressure drops** through dryers, filters and piping systems
 - Applications that need higher pressure
- **Measures to lower compressed air pressure**
 - **Modify high pressure applications** to operate at lower pressure
 - Use an **amplifier or booster** to serve the single high-pressure point of need

2) Lower Compressor Inlet Air Temperature

- **Relocate compressor intake to cooler place**

- If plant is conditioned, intake air from inside in the summer and outside in the winter
- If plant is not conditioned, intake air from outside both in the summer and in the winter
- Exceptions are some rotary screw compressors that can be damaged by the exposure to moisture and extreme cold

**Because cooler air is more dense, compressors
do less work compressing the air**

Lowering inlet temperature by 10 °F saves energy by ~ 2%

Demand Side

A solid blue right-angled triangle is positioned in the bottom right corner of the slide, with its hypotenuse running diagonally from the bottom left towards the top right.

5) Remove Inappropriate Air Demands

- **Inappropriate Uses**

- Cabinet cooling
- Liquid agitation or stirring
- Vacuum generation
- Unregulated Open Blowing
- Air Motors
- Atomizing

- Many applications can be served more **efficiently** by:

- Low pressure air from a **fan** or **blower**
- A vacuum pump
- Electric motors



6: Reduce Leakage Losses; Account for > 20% of Total Compressed Air Consumption

Cost From Leakage

	Size	Flow Rate (cfm)	Cost per Year
●	1/16"	6.5	\$1,046
●	1/8"	26	\$4,190
●	1/4"	104	\$16,784

Costs calculated using electricity rate of \$0.10 per kilowatt-hour, assuming 8,760-hour operation, a perfect orifice at 100 psi, and an efficient compressor.

Discharge of air through an orifice (SCFM)

	1/64"	1/32"	1/16"	1/8"	1/4"	3/8"
70 psi	.300	1.20	4.79	19.2	76.7	173
80 psi	.335	1.34	5.36	21.4	85.7	193
90 psi	.370	1.48	5.92	23.8	94.8	213
100 psi	.406	1.62	6.49	26.0	104	234
125 psi	.494	1.98	7.90	31.6	126	284

Leaks are a function of the supply pressure in an uncontrolled system

Higher pressure = greater flow

Lower pressure = less leak flow

6) Identifying Leaks – Three Good Ways

- **Routinely** have **maintenance walk** the system looking for hissing noises
 - Ultrasonic probes can help
- Start an **employee tagging program** for air leaks
 - Reward workers where possible
- **Perform bleed down test on the compressed air system when plant is not operating**
 - Determine total leak rates with an estimate of system volume

7) Recover Waste Heat Recovery – Air Cooled

- Compressors can be ducted for waste heat recovery

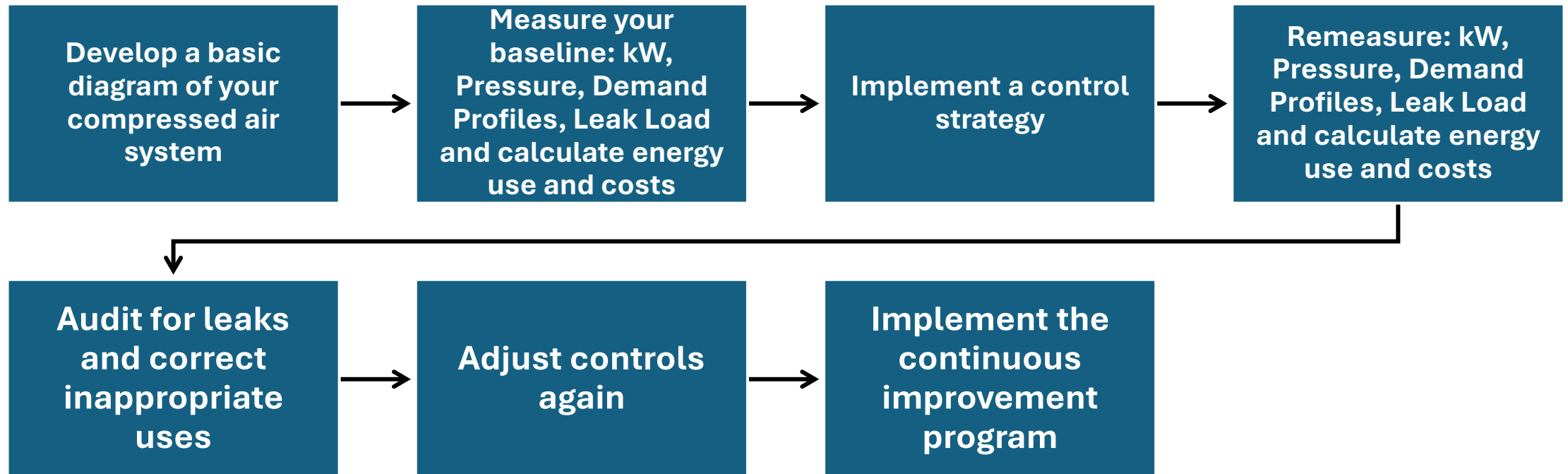


7) Recover Waste Heat – Water Cooled

- Up to 180F hot water
- Better year-round usage



General Action Plans to Improve Compressed Air System





Dominion Energy-VA Incentives for Compressed Air Custom Projects



Measures for Compressed Air Systems

Item	Measure Name	Minimum Requirements	Eligible for New Construction	Incentive*
1	Efficient Compressed Air Nozzles	<ul style="list-style-type: none"> • Must be a new installation or replace standard nozzles. • High efficiency nozzles must use less than or equal to the following ratings at 80psig: 1/8" 11 SCFM, 1/4" 29 SCFM, 5/16" 56 SCFM, 1/2" 140 SCFM. 	Yes	Incentives for All Measures are up to \$0.07 per kWh Savings
2	Compressed Air Leak Repair	<ul style="list-style-type: none"> • Only retrofit projects are eligible. • Leaks must be identified through an audit/study and repaired. 	No	
3	No-loss Condensate Drains	<ul style="list-style-type: none"> • New and retrofit projects are eligible. • Drains must not allow condensate to escape when purged. 	Yes	
4	Additional Compressed Air Storage	<ul style="list-style-type: none"> • Only retrofit projects are eligible. • Only compressors with load/no-load controls are eligible. • Must increase total system storage to at least 5 gal/cfm. 	No	
5	Compressor Pressure Setpoint Reduction	<ul style="list-style-type: none"> • Only retrofit projects are eligible. • Pressure setting on the compressor must be changed. 	No	
6	Low Pressure Drop Filter	<ul style="list-style-type: none"> • New and retrofit projects are eligible. • Pressure setting on the compressor must be changed to account for lower pressure drop. • New filter must have an initial pressure drop of 3 PSI or less. 	Yes	
7	Heat of Compression Dryer	<ul style="list-style-type: none"> • New and retrofit projects are eligible. 	Yes	
8	Cycling Refrigerated Dryer	<ul style="list-style-type: none"> • New projects are eligible. • Retrofit projects must be replacing existing non-cycling refrigerated air dryer. 	Yes	
9	Desiccant Dryer Dewpoint Controls	<ul style="list-style-type: none"> • New and retrofit projects are eligible. • Dewpoint controls must be installed on a desiccant dryer, overriding or replacing timer controls. 	Yes	
10	Efficient Air Compressor	<ul style="list-style-type: none"> • New and retrofit projects are eligible. • Retrofit projects must involve installing new compressors that have more efficient control schemes or operating profiles than the existing compressors. • One-for-one compressor replacements must involve a new compressor of lesser or equal horsepower than the existing compressor. Compressors of a larger horsepower will be treated as new construction projects. • For new construction projects, only VFD-controlled compressor installations are eligible, and the new compressor must not operate solely at full-load. 	Yes	
11	Custom	<ul style="list-style-type: none"> • Project must save energy versus existing system/equipment or baseline system/equipment. • Savings will be calculated by program staff. • Additional documentation may be required. 	Yes	

Contact

To discuss your compressed air projects you can reach out to:

Nandini Mouli, Ph.D.
Consultant to TRC
Dominion Energy Programs
Nandini@eSai.Technology
Phone: 443 691 7664



Hannah Aiken

Outreach Coordinator/Inspection Specialist
Hannah@eSai.Technology
Phone: (804) 944-4600



Kristian Cusimano

Outreach Coordinator/Inspection Specialist
Kristian@eSai.Technology
Phone: (240) 802-6967



Thanks for joining!

