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Partnering with Wisconsin utilities

Efficient Compressed Air

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Focus on Energy

Efficient Compressed Air

One (1) horsepower of compressed air requires seven (7) horsepower of electricity.

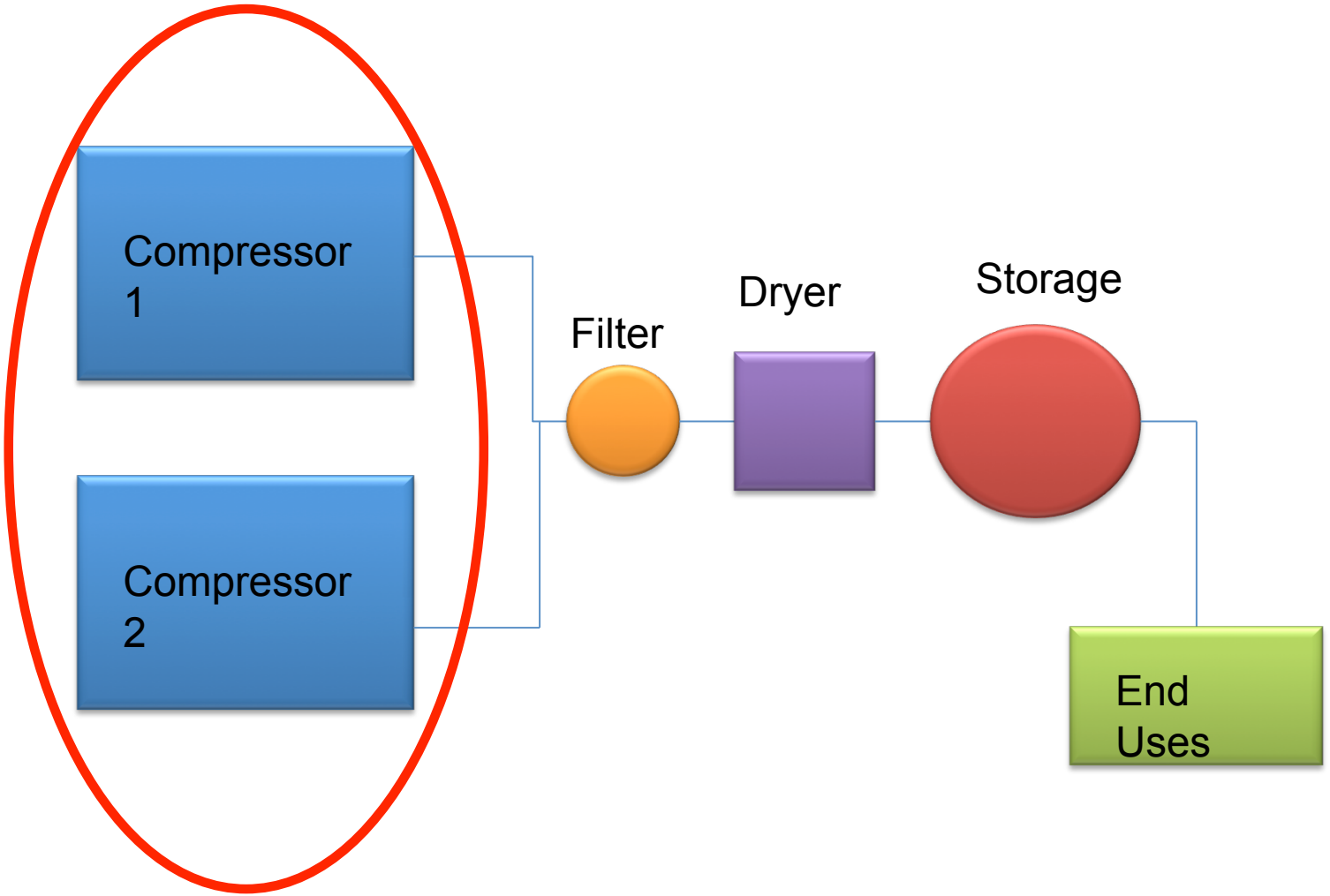
By replacing a compressed air use with an electric alternative you save 85% of the energy required for the task.

Broadly Applicable Compressed Air Principles*

- 4 to 5 cfm/hp at 100 psi
- Every 2 psi of pressure increases or decreases compressor power draw by 1%
- Every 10 degree change in inlet air temp affects efficiency by 1%
- Control air 1 gallon/cfm of compressor capacity
- Storage capacity 2-4 gallons/cfm of capacity
- Total pressure drop should not exceed 15 psi

* Not intended to be strictly accurate or reliable for every situation

Efficient Compressed Air

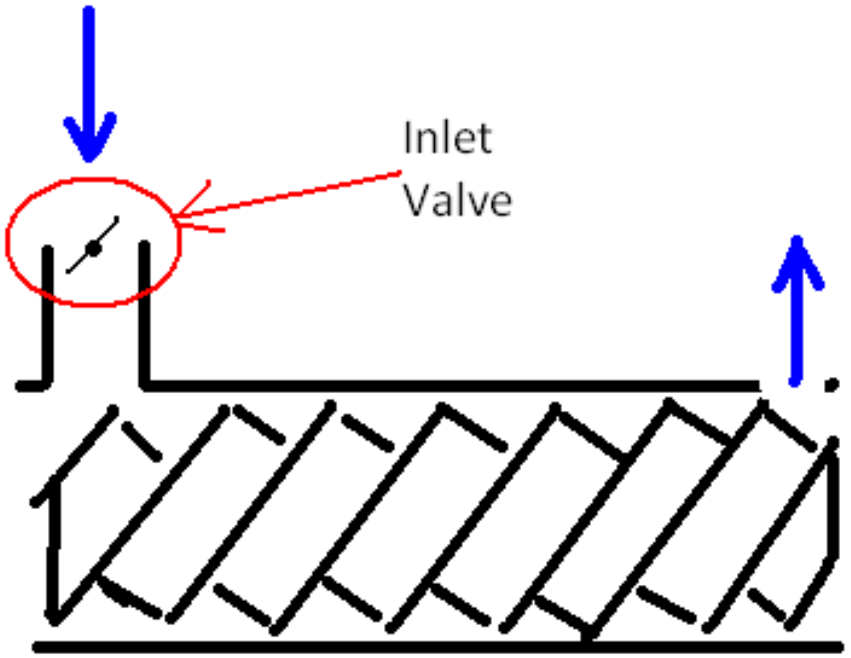


Capacity Control

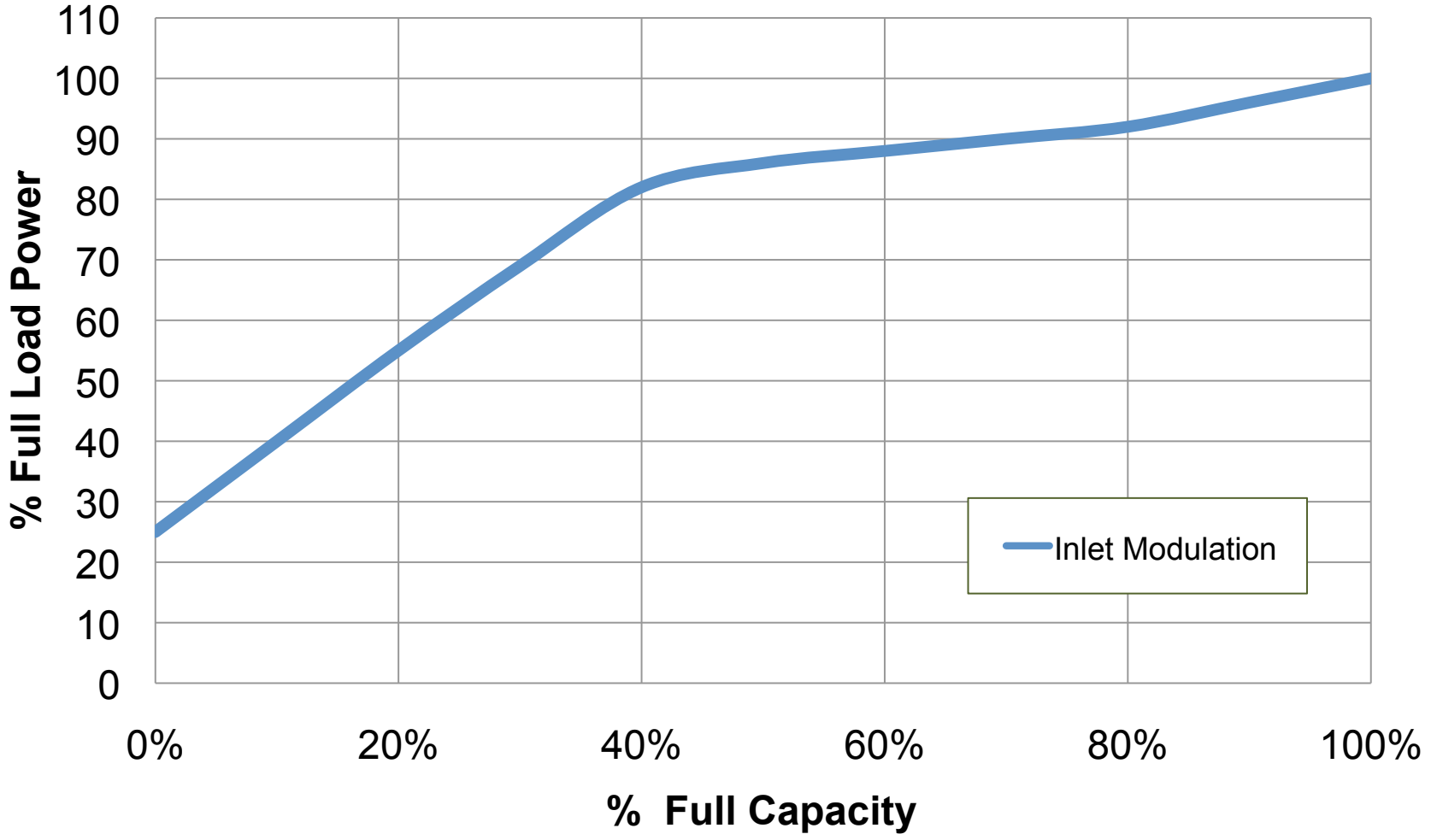
- Method used to allow compressor to deliver less than full output
- On/Off
  - Simplest
  - Starts, stops based on pre-set pressure
  - Storage essential to prevent motor burn out
  - Usually 30 hp or less
  - Only uses power when running = Good
  - Must pressurize to artificially high pressure = Bad
  - Not really a “capacity control” method

Inlet Modulation

- Used only on lubricant- injected rotary screw compressors
- Modulation of inlet valve in response to system pressure increase
- Control capacity until about 40% output then “unloaded”
- Unloading requires blowdown of 30 - 120 seconds



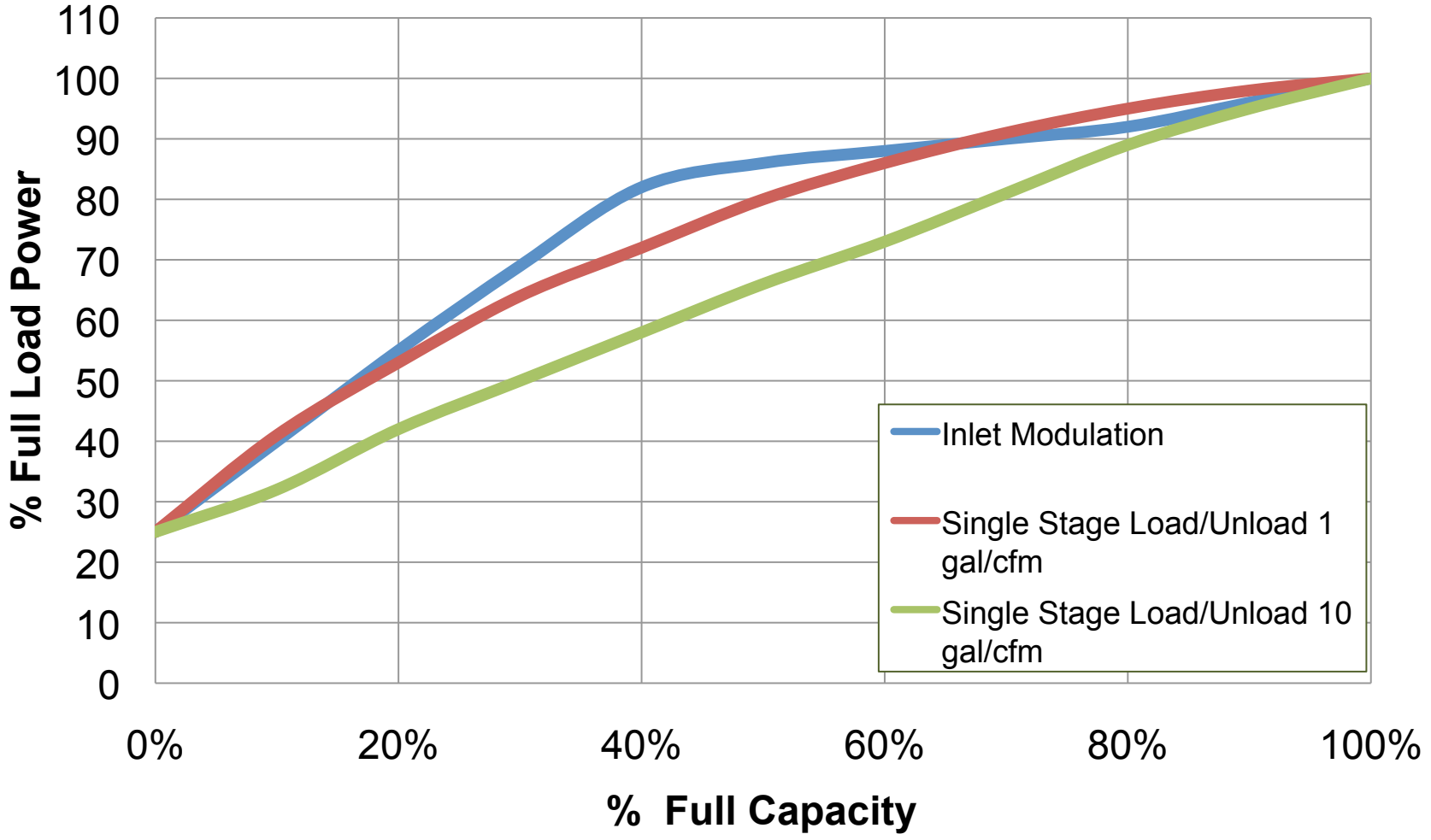
Inlet Modulation



Load/Unload Capacity Controls

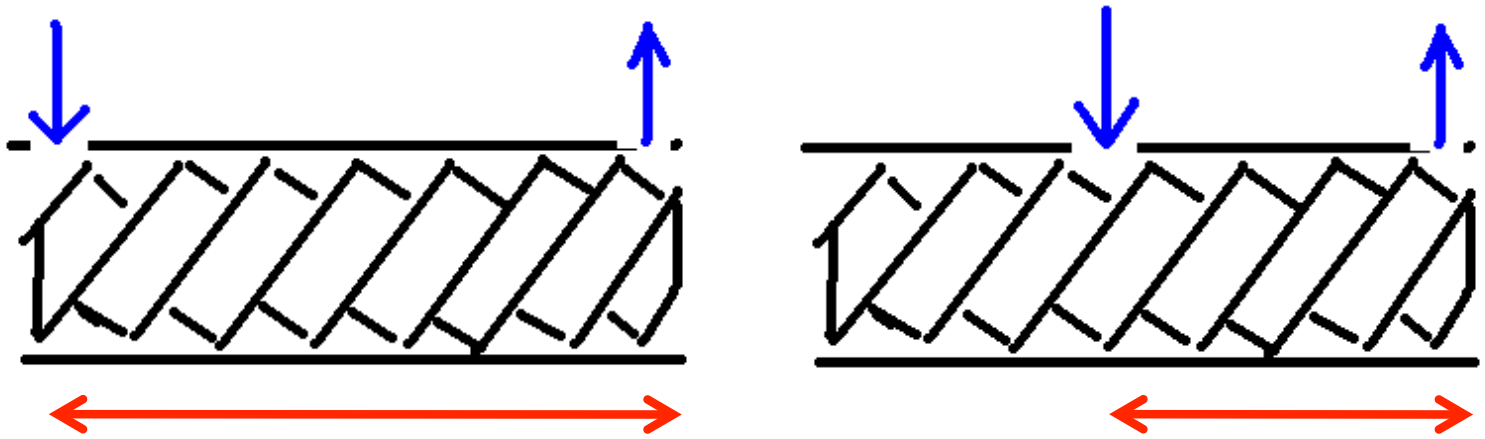
- Inlet valve held open on reciprocating compressors
- Inlet closed w/blowdown on lubricated rotary compressor
  - Blowdown is not instantaneous (takes 30 – 120 seconds)
- No blowdown on lubricant-free for instantaneous unloading
- Storage is still important to prevent short cycling

Load/Unload Capacity Control

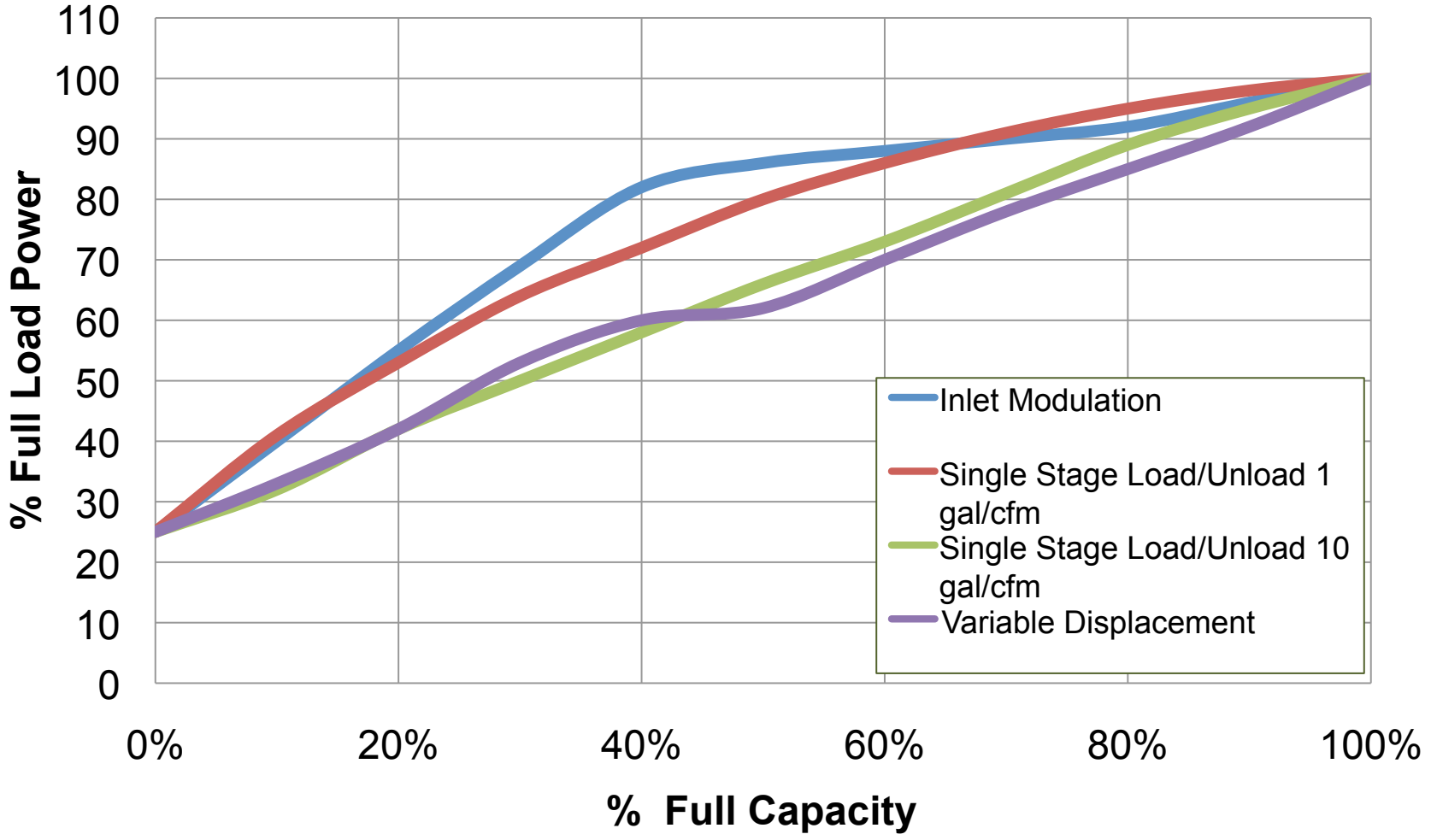


Variable Displacement

- Slide, spiral, turn valves
- Relatively efficient down to 50%
- <50% either modulated or unloaded
- More efficient because do not reduce inlet pressure



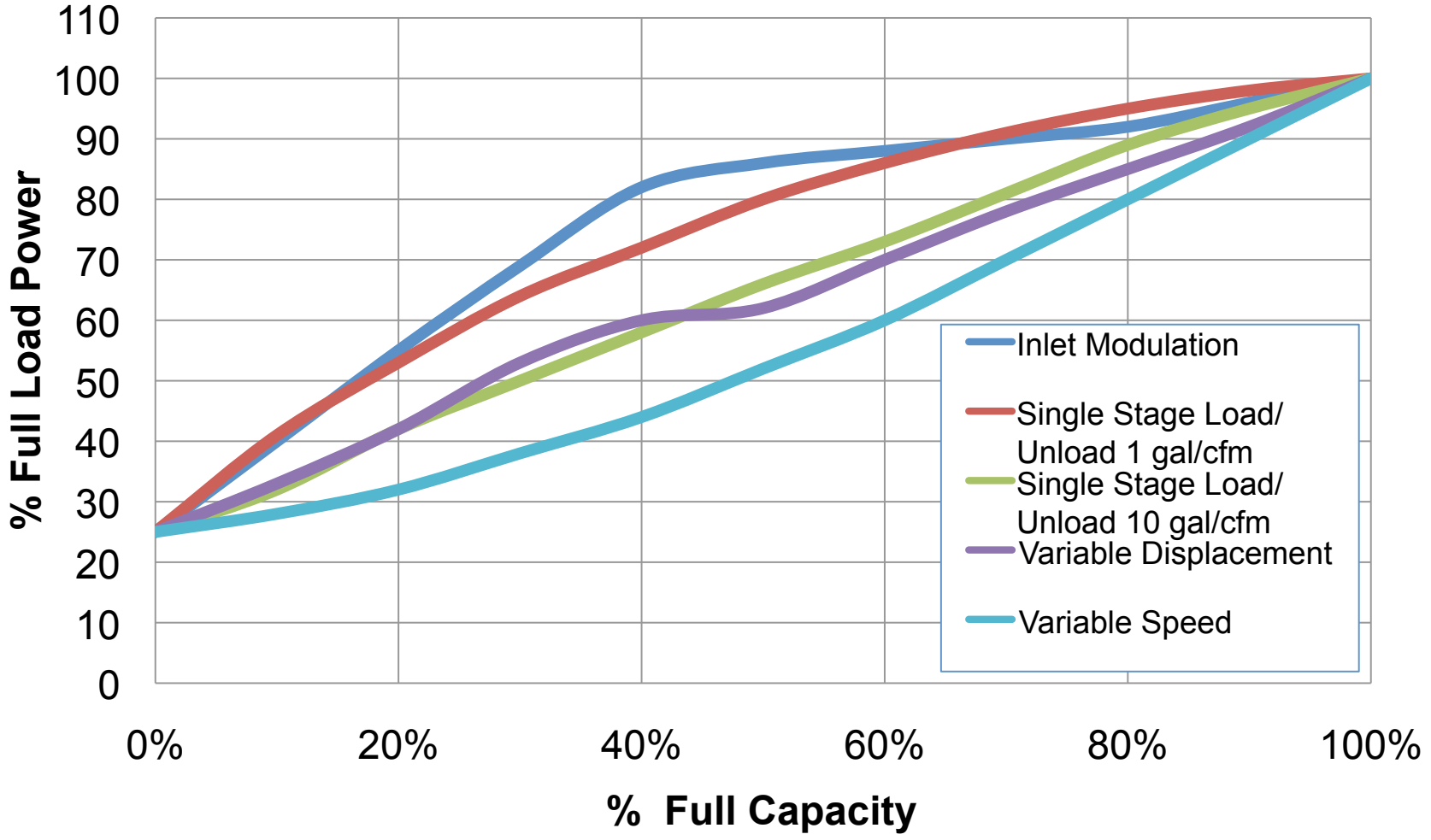
Variable Displacement



Variable Speed Control

- Slows down drive motor
- NOT as efficient at 100% speed as other compressors
- Best used when part load output is majority of compressor operating time

Variable Speed



Example Calculation

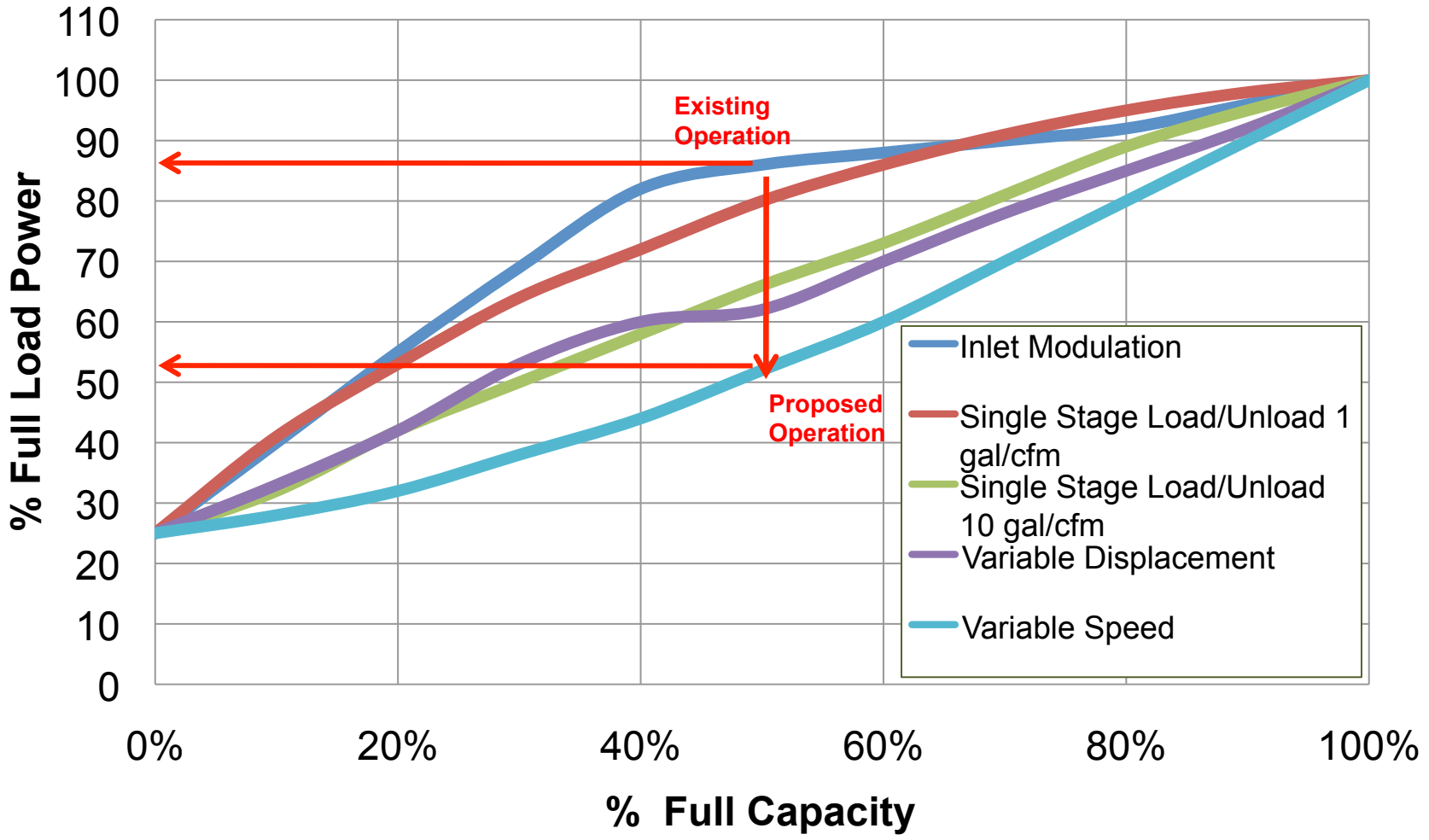
100 hp inlet modulation machine operating at 50% capacity replaced with VSD-controlled compressor:

- 50% capacity inlet mod = 85% rated power
  - 85 hp = 64 kW
- 70% capacity VSD control = 70% rated power
  - 51 hp= 38 kW

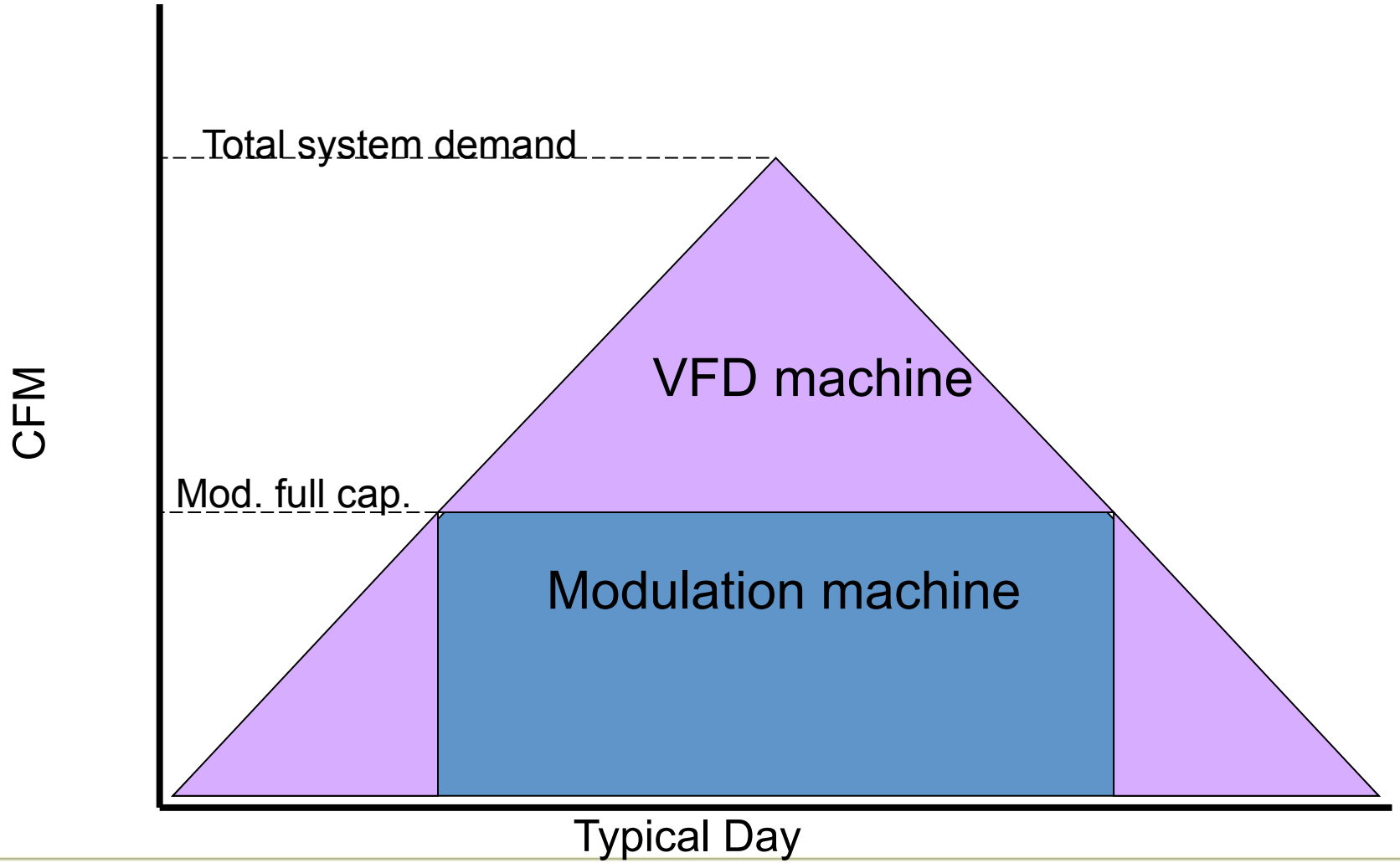
Assume 6000 hr/yr operation @ $0.1/kWh =
$17,160/year savings!

100 hp VSD ~$35,000
$55/hp Focus incentive

Variable Speed



Sequencing



Sequencing Case Study

- 9 compressors, 3700 cfm, 1000 hp capacity
- Project cost $81,000
- $48,800 energy savings per year
- (Focus grant ~ $8,000)

Compressor Heat Recovery

Compressors reject approximately 125,000 BTU/hr per 50 hp – about 120,000 is recoverable

Actual project:

- 450 hp compressed air system
- 450hp/50hp x 120 btu/hr x 4000 hrs/year = 43,000 therms
- $65,000 heat recovery project
- $24,000 annual savings

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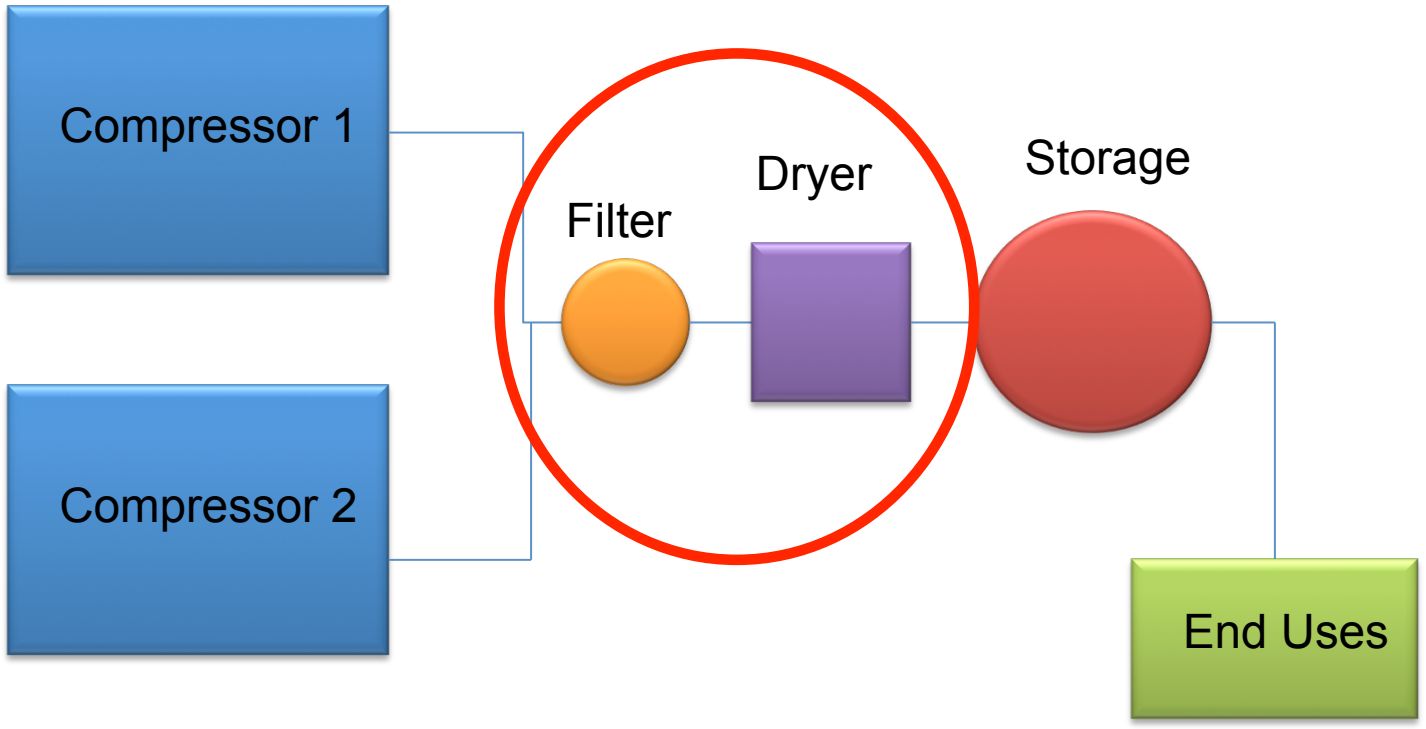


Treatment Opportunities

- Filters
  - Monitor pressure drop
  - Only filter to the level needed
  - Use point-of-use filtration when appropriate
- Dryers
  - Do not dry more than needed
  - Turn of freeze-protection dryers during summer
  - Purge air dryers require up to 15% of compressor capacity to dry desiccant

Refrigerated Dryer

- Dewpoint just above freezing
- Incoming air often precooled by outgoing dry air
- Cycling refrigerated dryers allows refrigeration to shut off during light loads – air is dried with thermal mass

Regenerative Desiccant Type Dryer

- Uses two towers – one dries compressed air while other is being ‘regenerated’
- Either timed or ‘on-demand’
- Heatless regeneration requires purge air – 10 to 18% of total dryer rated flow
- Heated regeneration saves air but requires electric heat
  - Purge air can be reduced to 5 to 8%
  - Blower can eliminate purge air

Example Calculation

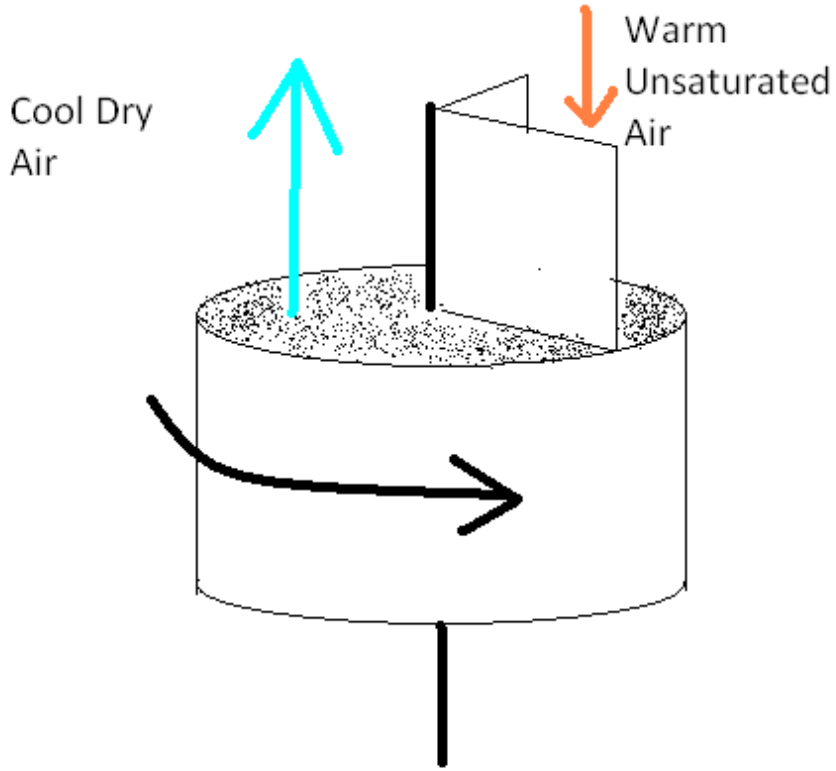
Replace a regenerative dryer with heat of compression dryer:

- 100 hp air compressor
- 10-18% of capacity used for regeneration
- 10 hp = 7.46 kW
- 7.46 kW x 6000 hrs/yr = 44,760 kWh
- @ $0.06/kWh = $2,600/yr

Dryer = $5,500 project cost (770 cfm dryer replacement)

Heat Of Compression Dryers

- Only for lubricant-free, centrifugal compressors
- Very little electrical consumption



Deliquescent Dryers

- Chemical absorbent ‘used-up’ as it absorbs moisture
- No electricity needed
- No moving parts
- Must replace deliquescent throughout year

Transmission Losses

- Improperly sized piping can create significant pressure loss
- For every 2 psig of pressure reduction, achieve 1% reduction in compressor power draw

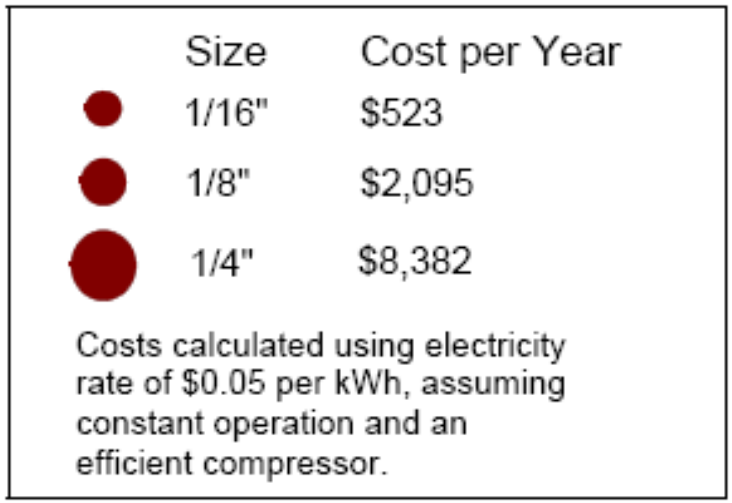
Pressure Drop Due to Friction
(in psi in 1,000 ft. of pipe, 100 psig initial pressure)[1]

Equivalent Cubic Feet Compressed Air/Min.	Pipe Diameter *(Inches)* 1	2	3	4	6	8	10
1.28	0.28						
6.41	9.96	0.19					
12.82	27.9	0.77					
32.04		4.78	0.58				
64.28		19.2	2.34	0.55			
96.13		43.3	5.23	1.24			
128.2		76.9	9.3	2.21			

Transmission Opportunities

Compressed air leaks

- 20-30% of system capacity in leaks!
- Survey can be had for $1000/day
- Paid for by fixing three 1/16” leaks!!
- Need to use detection equipment



End Uses

The greatest opportunity for reducing energy costs associated with compressed air is to stop using compressed air whenever possible!

- Open blowing to nozzles
- Air motors to electric motors
- Air cylinders to electric actuators
- Automatic condensate drains
- Dedicated compressors
  - High pressure uses
  - Small “after-hour” uses

Case Study

- Open blowing used to correct for custom equipment design flaw in material handling
- 51 nozzles installed – reducing air flow at each open tube by 50%
- Cost to purchase nozzles was $1,245
- Reduction in cfm will save customer ~$33,000/yr in energy costs

Focus on Energy

- $4/hp compressed air audit incentive (up to $7,500)
- $55/hp variable speed compressor incentive
- Compressed Air ESA through DOE
  - 400 hp + ~ $10k value no cost to customer

Custom incentives – special incentives to help implement projects that otherwise wouldn't happen – up to 30% of project cost

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