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COMPRESSED AIR CHALLENGE

Confederation of Indian Industry

Business and Beyond

125 Years: 1895-2020

Save Energy And Money In Your Compressed Air System By Using Compressed Air Challenge's Systems Approach

About Your Presenter - Joe Ghislain

- **Ghislain Operational Efficiency**
- **Ford Motor Company 31+ years**
- **40 years' experience in**
  - Compressed Air Systems, Powerhouse Operations, Maintenance, Facilities, Manufacturing, Operational Efficiency Improvements and Energy/Energy Management
- **Compressed Air Challenge** –
  - L1 & L2 Instructor & Board Member
- **CAGI Certified Compressed Air System Specialist**
- **Several Energy Certifications including:**
  - Certified Energy Manager
  - 50001 Certified Practitioner in Energy Management Systems – Industrial
  - Certified EPI ISO 50001 Lead Auditor

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Webinar Description

In this webinar, you will learn how Compressed Air Challenge's training and using the Compressed Air Challenge's best-practice compressed air systems approach can increase the operating efficiency of your compressed Air System, leading to lower cost, improved energy efficiency and increased productivity.

Learning Objectives:

- Learn about the Compressed Air Challenge (CAC)
- How to improve your compressed air operation, using CAC best practices and a systems approach.
- Establish a Baseline- Understanding how to measure and manage compressed air usage.
- Supply Side with Demand Side Alignment and Controls
- Demand Side Strategy -Look beyond the air compressors for increased savings
- Learn how to establish a maintenance system to improve system efficiency.
- See how employee awareness and involvement is important in energy efficiency.
- Find out about Compressed Air Challenge Trainings and Compressed Air Gas Institute certifications.

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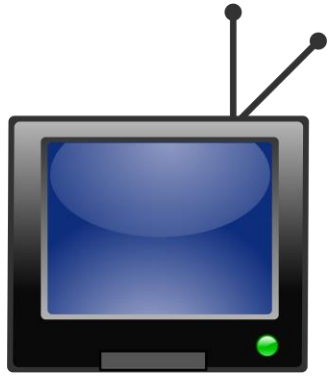
What is the Compressed Air Challenge (CAC)?

Its not a race

Don’t worry … Its not a test

Its not even a TV Game Show



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What is the Compressed Air Challenge (CAC)?

CAC is a non-profit organization, based in the USA and a voluntary collaboration of:

- Industrial end-users,
- Manufacturers and their associations
- Distributors and their associations
- Facility operating personnel
- Consultants
- Energy research and development agencies
- Energy efficiency organizations
- United States Department of Energy
- Utilities

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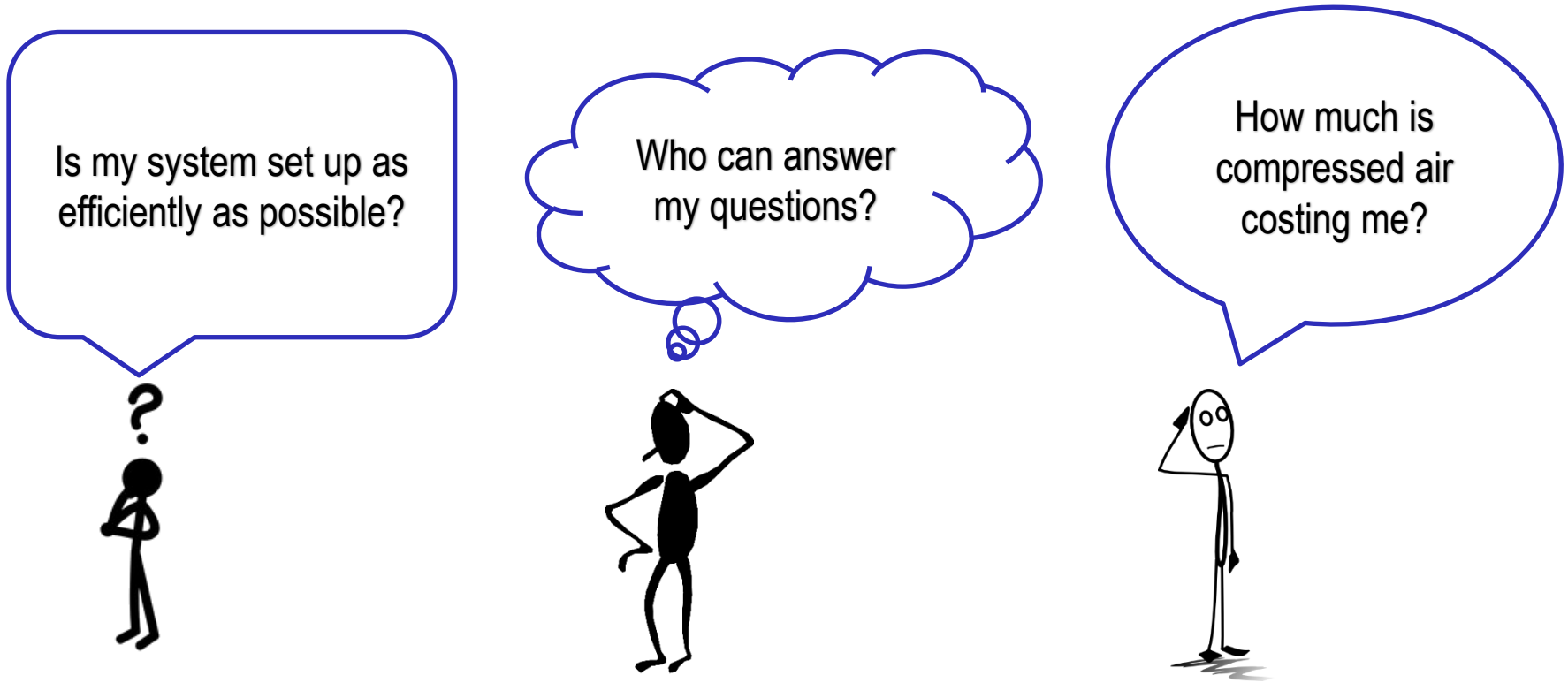
What is the CAC?

The CAC is about meeting the Challenge of Educating and Training End Users



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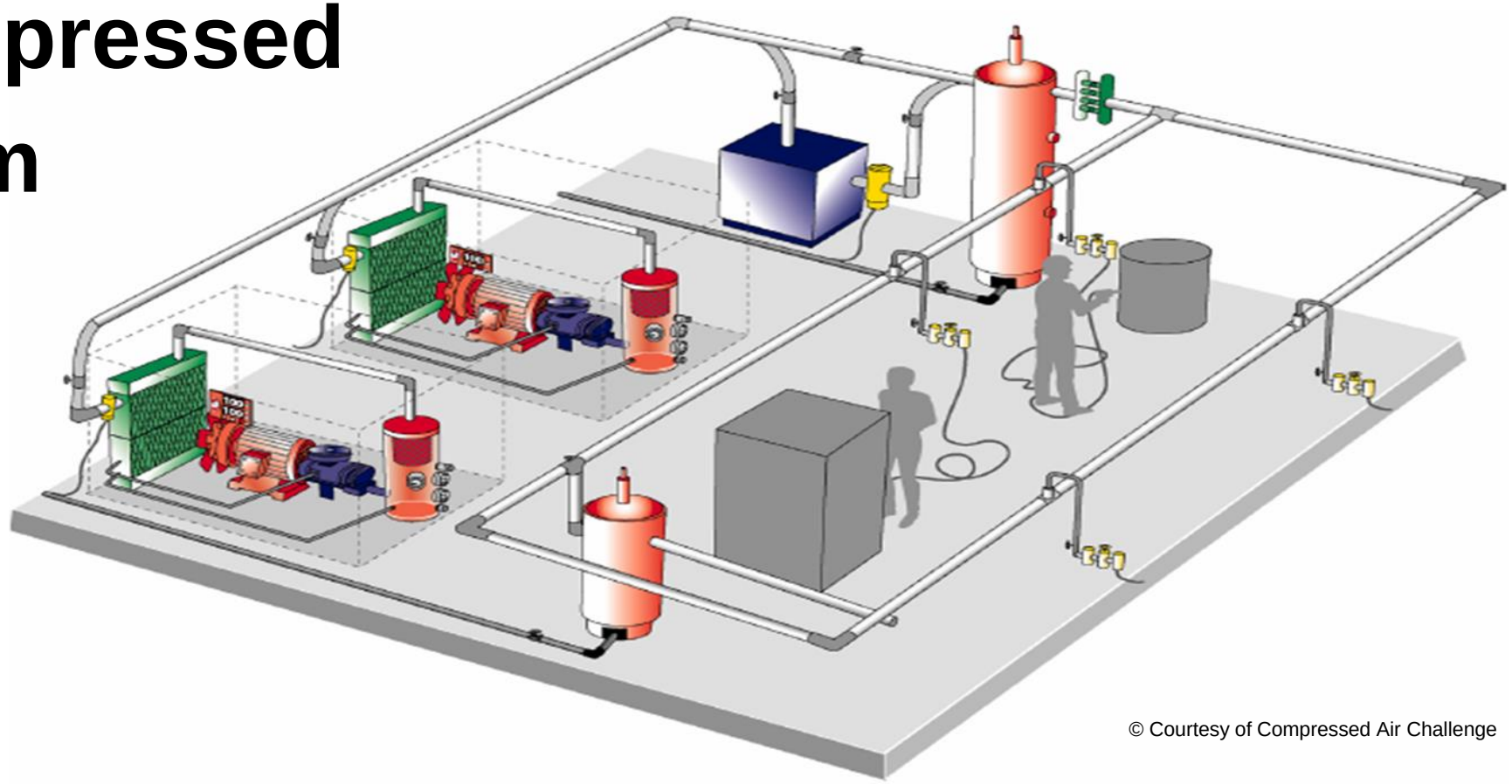
CAC Has One Purpose …

Help end-users improve the efficiency of their compressed air system



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The Beginning

Established in October of 1997 with the Founding Goals

- Increase the reliability and quality of industrial production processes
- Reduce plant operating costs
- Expand the market for high quality compressed air services
- Save energy – 10% over current, about 2.7 billion kWh nationwide (1998)

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CAC Today

"The **mission** is to promote energy and operational efficiency in compressed air systems for industry through information and training, leading end users to adopt efficient practices and technologies while leveraging collaborative cooperation among key stakeholders.

The **vision** is to be the **global leader** in developing and disseminating innovative product-neutral information and educational materials to help industries generate and use compressed air at maximum sustainable efficiency.

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Training: Solve Problems and Save Energy

CAC's portfolio of product-neutral trainings have proven results.

- DOE study showed that 76% of end-user attendees reported making significant efficiency improvements to their compressed air
- Achieving high levels of energy savings, averaging 149 megawatt hours per year, or roughly 7.5% of pre-project system energy usage
- CAC's training program is highly cost-effective, yielding a cost benefit ratio of $82 in energy savings for each training dollar spent

Source: DOE - Evaluation of the Compressed Air Challenge Training Program

The Compressed Air Challenge has trained over 20,000 compressed air users since 1999!

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Why the CAC training is so effective?

It Takes a Systems Approach & Applies Best Practices!

- Awareness Training on Systems Approach
- Establish a Baseline
- Calculate the Cost and Relate it Back to Production
- Controls
- Align Supply Side with Demand Side
- Maintenance – Air Leaks
- Inappropriate Uses
- Reduce System Pressure by Addressing Point of Use Issues
  - Air Quality Requirements
  - High Pressure Applications
  - High Volume, Intermittent Applications
- Integrate into Current Processes
- Publish Savings $$ and Implement Continual Improvement

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Training and Education on Many Levels

Compressed Air, It's Not Free! Awareness Training

- Customer site (30min - 1 hour)

Fundamentals of Compressed Air Systems

- In person (one day/8 hours) or web-based (four 2-hour sessions)

Advanced Management of Compressed Air Systems

- In person (two day/16 hours)

AIRMaster+

- In person (three and a half days)

***Best Practices for Compressed Air Systems* manual - Second Edition**

Coming Soon: Strategies – Building your Project Justification

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Why CAC cares?…… And you should too

- In the United States, compressed air systems account for $5 billion per year in energy costs.
- Compressed Air represents about 10% of electricity use in North America.
- Accounts for 16% of all motor driven systems.

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Contrary to popular belief –

Compressed Air

Is Not Free !!!

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Compressed air is a costly energy source

- The total cost of 6.9 Bar compressed air ranges from 65¢ to $1.15 per 100 cubic meter.
- In the automobile industry, it is a significant part of the energy cost, ranging from 10% in component plants to up to 40% in stamping plants.
- Air Leaks can be 20% - 30% and even as high as 50%
- In Ford plants, the cost of compressed air can be any where from several hundred thousand dollars to millions of dollars per year.

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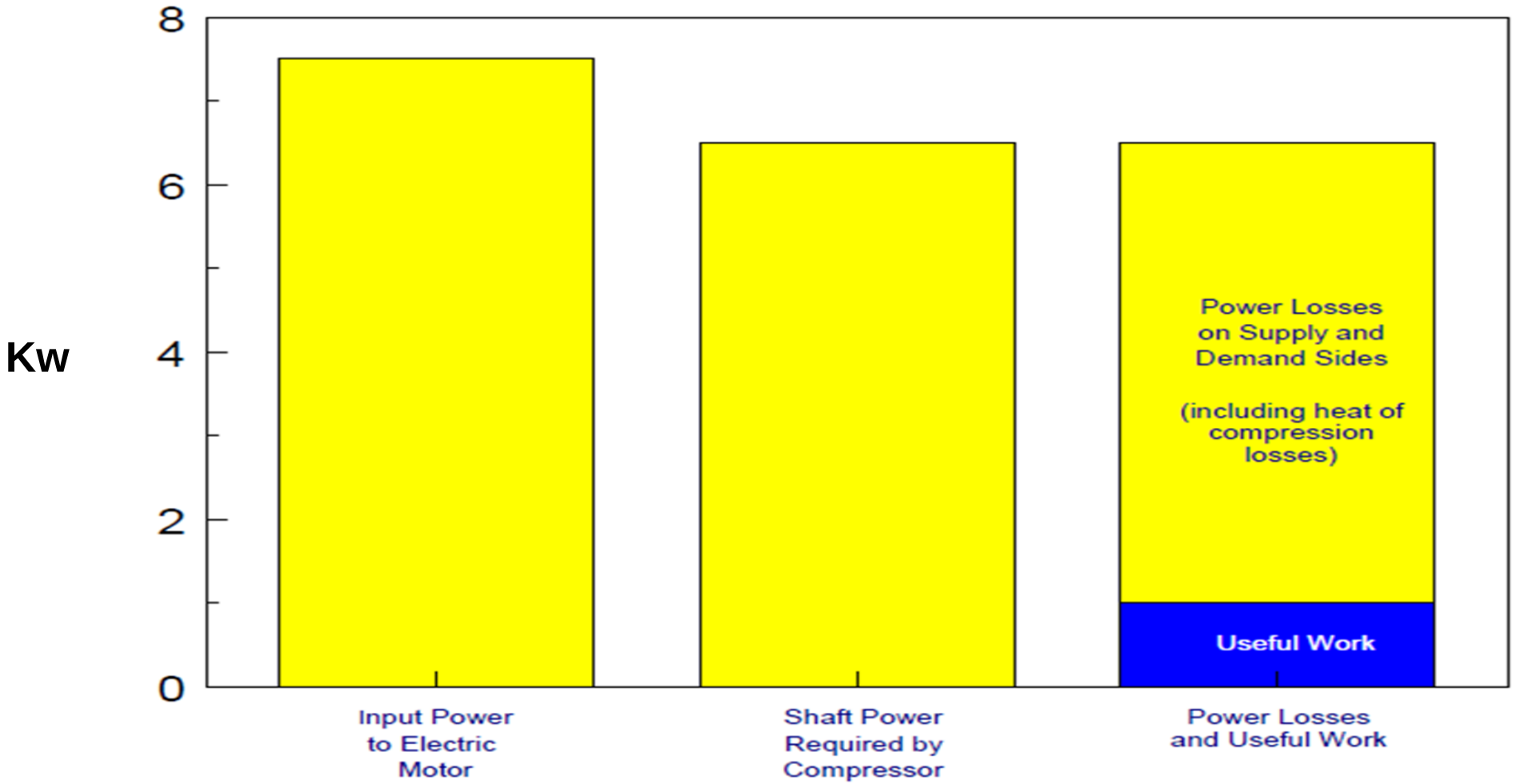
…..And not very Efficient



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To Save Money Apply CAC's Systems Approach

- Awareness Training on Systems Approach
- Establish a Baseline
- Calculate the Cost and Relate it Back to Production
- Controls
- Align Supply Side with Demand Side
- Maintenance – Air Leaks
- Inappropriate Uses
- Reduce System Pressure by Addressing Point of Use Issues
  - Air Quality Requirements
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- Integrate into Current Processes
- Publish Savings $$ and Implement Continual Improvement

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Baselining

If you can't measure it, you can't manage it

- Establish a Base line using flow ($m^{3/}$minute) and power consumption (kW)
- Develop a pressure profile for System dynamics
- Convert compressed air usage into dollars $$
- $/widget (Cost per unit) is very powerful!

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Align Supply Side with Demand Side

- The system demands drive the supply requirements!
- The operation of the compressors (number, duration, pressure, and flow) is all driven by the end uses and the system's dynamics.
- This relationship requires the monitoring and controlling of not only the air compressors but also the end uses.

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Purpose of Compressor Controls

- Optimize by using the right mix of compressors
- Minimize the number compressors running.
- Shut off unnecessary compressors
- Delay bringing compressors on.
- Safety

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System Control

Controls have to operate the right type of compressors under the right condition.

- Rotary compressors with modulating capacity control should not be run below 40%-50%.
- Variable speed machines should only be used for trim.
- Centrifugal Compressors are efficient base load machines but have limited modulation.
- Double Acting Reciprocating Compressors have very efficient part load operation.

System Control

Using Storage to Control Demand

- Air receivers (Storage) store compressed air to meet demand events.
- Primary storage is located close to the air compressors and reacts to system events.
- Secondary storage is located at the end use and minimizes the affect of high volume, low duration occurrences.
- Pressure/Flow controllers can be used with storage for systems/ applications that require a tight pressure band.

What is the Most Efficient Compressor ?

The one that is

Shut off!!

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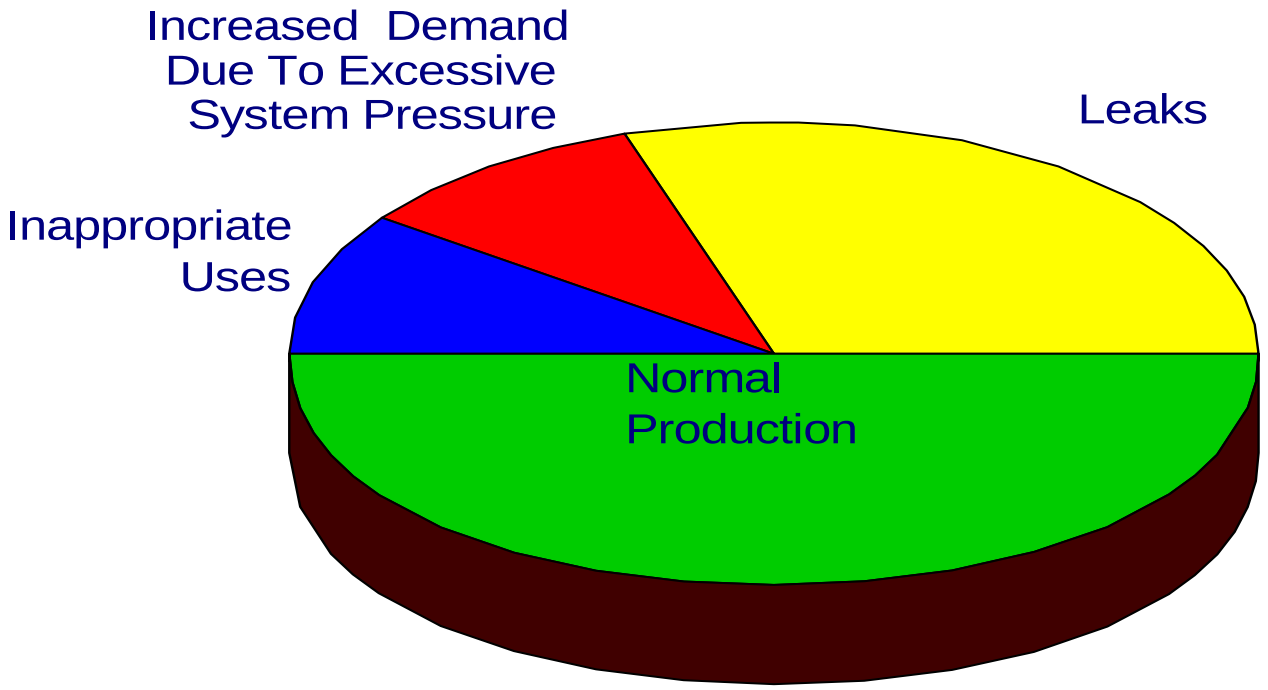
Typical Components of Demand



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Demand Side Strategy

If you want to cut costs, reduce unproductive demands:

- ✓ Inappropriate Uses
- ✓ Artificial Demand
- ✓ Excessive/High System Pressure
- ✓ Leaks

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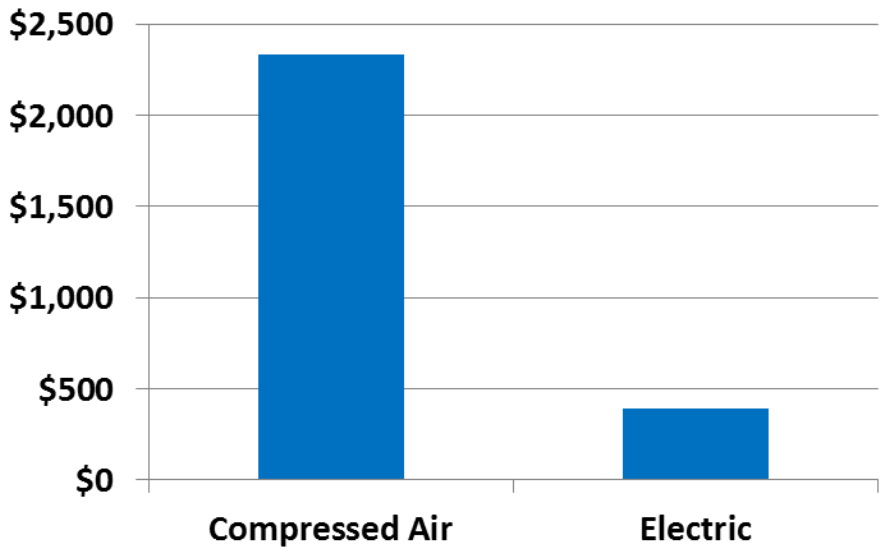
Inappropriate Uses & Electric Conversion

The overall efficiency of a typical compressed air system can be as low as 10-15%

Annual energy costs for a .75 kw air motor versus a .75 kw electric motor, 5 day per week, 2 shift operation, $0.10/kWh

$ 2,330 (compressed air)
$ 390 (electric)



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Potentially Inappropriate Uses

- Open Blowing
- Sparging
- Aspirating
- Atomizing
- Padding
- Dilute Phase Transport
- Dense Phase
- Vacuum Generation
- Personal Cooling
- Handheld blow guns or lances
- Diaphragm Pumps
- Cabinet Cooling
- Air Motors & Pneumatic Cylinders

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Inappropriate Uses & Electric Conversion

Examples of inappropriate uses/ electric conversions:

- Pneumatic Paint mixers – convert to electric motors
- Pneumatic tools - DC tools– Energy saved & increased quality
- Air blowing in paint shop and parts drying in component plants
  - High efficiency nozzles.
  - Low pressure electric blower
- Personnel cooling and cabinet cooling (Vortex Coolers) replaced with fans and A/C units for cabinets.
- Vacuum generation and vacuum venturis are replaced with high efficiency vortex cups or “Smart Pump” vacuum systems.

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Artificial Demand

What is it?

Increased demand due to excessive system pressure

What Causes it?

Running at higher pressure due to :

- Unregulated air leaks
- Assumed High Pressure Requirements

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System Pressure Reduction

- For every .14 barg decrease = 1% efficiency increase
- At 10¢ /kWh, a .75 kw compressor running at 5.5 barg rather than 6.9 barg would save

$6,500 per year

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System Pressure Reduction

To Reduce System Pressure you often have to address End Use Requirements:

- Air Quality Requirements
- High Pressure Applications
- High Volume, Intermittent Applications

The CAC End-Use Audit Checklist along with the CAC End-Use Solution Finder are tools designed to aid in your analysis.

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Biggest Maintenance Loss/Cost:

Air Leaks

- Compressed air leaks cause system pressure drops requiring:
  - Elevated system pressures
  - Increased compressor operation
  - Higher Energy usage/costs
  - Increased maintenance
  - Unnecessary purchasing of additional compressors
- The leak itself is very costly
  - The leak itself -At 10¢ per kWh, a 6 mm air leak will cost almost $16,000 per year.

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Air Leaks

- **Department of Energy study showed that a "tight" system will still have a 10% leak rate.**
- **Common to find 20% to 30% leakage rate**

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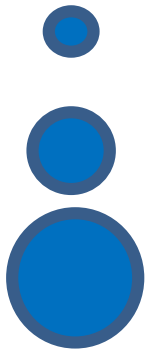
Cost of Air Leaks



Size (mm)	Air Flow (m^3/min)	Cost per year
1.6 mm	0.18	$1,050
3.2 mm	0.74	$4,190
6.4 mm	2.95	$16,760

Costs calculated using electricity rate of $0.10 per kWh, assuming constant operation, 6.9 barg and a typical compressor.

Note: These values assume a perfect orifice.

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How to Reduce Air Leaks?

Implement Aggressive Air Leak Program that Identifies and Fixes Air Leaks

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Leak Tag Program

- Establish Air Leak Reduction/ Leak Tag program as an Ongoing Process
- Use Ultrasonic Leak Detection to find leaks
- Estimate the Cost of Air Leaks
- Most Important thing – **FIX THE LEAKS**
- Publish Savings Results to Management
- Include (or Establish) Compressed Air Costs as Part of Your Energy Awareness

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Case Study

Woodhaven Stamping Plant in Michigan

Actions taken:

- Air leak detection correction team was formed
- Leaking seals on stamping press dies repaired
- Pressure drop reduced at various points in the system
- Orifice plate meters replaced
- High pressure assumptions tested
- Header pressure reduced
- Satellite compressors & dryers removed

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Case Study

Woodhaven Stamping Plant in Michigan

Results:

- Air use reduced by approximately 18%
- One 600 kW compressor shut down and controls adjusted so remaining compressors used less energy
- Six small (~ 22 kW each) compressors shut down
- Reduced system pressure by .34 barg
- Electricity savings of 7,900,000 kWh with savings of $400,000 per year

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Maintenance

- Proper maintenance of both the supply side and demand side is critical to efficient operation.
- Often considered a "necessary evil"
- One of the first places that budgets get cut
- Often is PENNY wise and DOLLAR foolish

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Maintenance Losses

- Pressure drops across dryers and filters
  - **.14 barg equal to 1% efficiency**
- Increased temperatures and moisture
  - Increases dryer loading
  - Reduces air quality
  - Shortens equipment life
- Inlet air filters
  - Dirty inlet filters reduce air compressor capacity
  - **For every 102 mm of water pressure drop across the inlet air filters you lose 1% efficiency.**
- #1 is Production Downtime! (CHSP)

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System Design – Total Cost

70%-90% Of The Operational Costs Are Determined By The System Design And The Equipment Purchased

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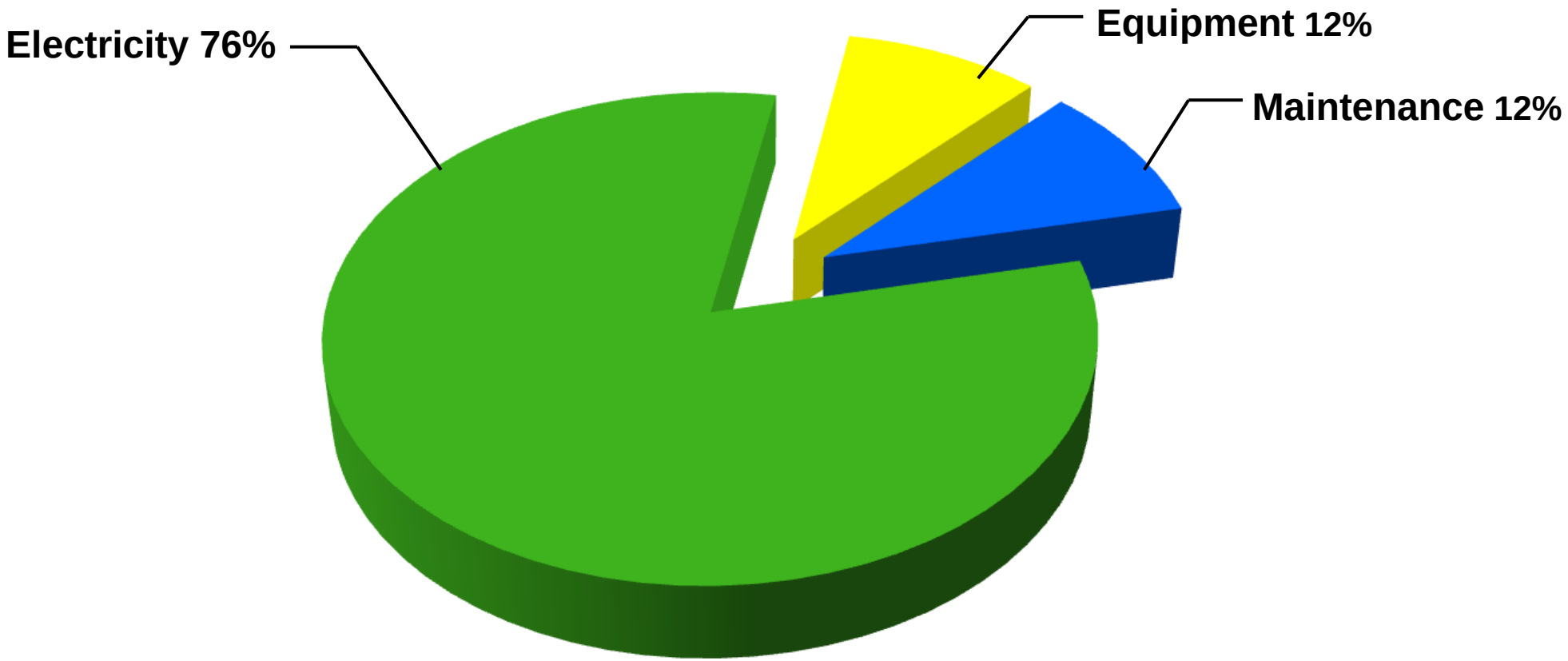
Compressed Air Costs

Relative Cost Over 10 Years



Based on electricity cost of $0.10 per kWh

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System Design – Total Cost

- Implement “Low Cost” actions before spending capital.
- Total cost: cost and benefits must be weighted and the most cost effect option taken (including end uses).
- Don’t forget to use utility rebates.
- Air compressors – right type and mix for demand .(e.g. Centrifugal - base load, VSD (for variable load).
- Specify end uses to operate at the lowest possible pressure.
- Consider Pressure drops
  - Designing equipment and systems.
  - Across dryers, filters or even piping systems (CHSP).
  - Incremental cost of increasing the size to reduce the pressure drop may be small compared to the ongoing energy cost.
- Design in heat recovery whenever it is cost effective and appropriate.

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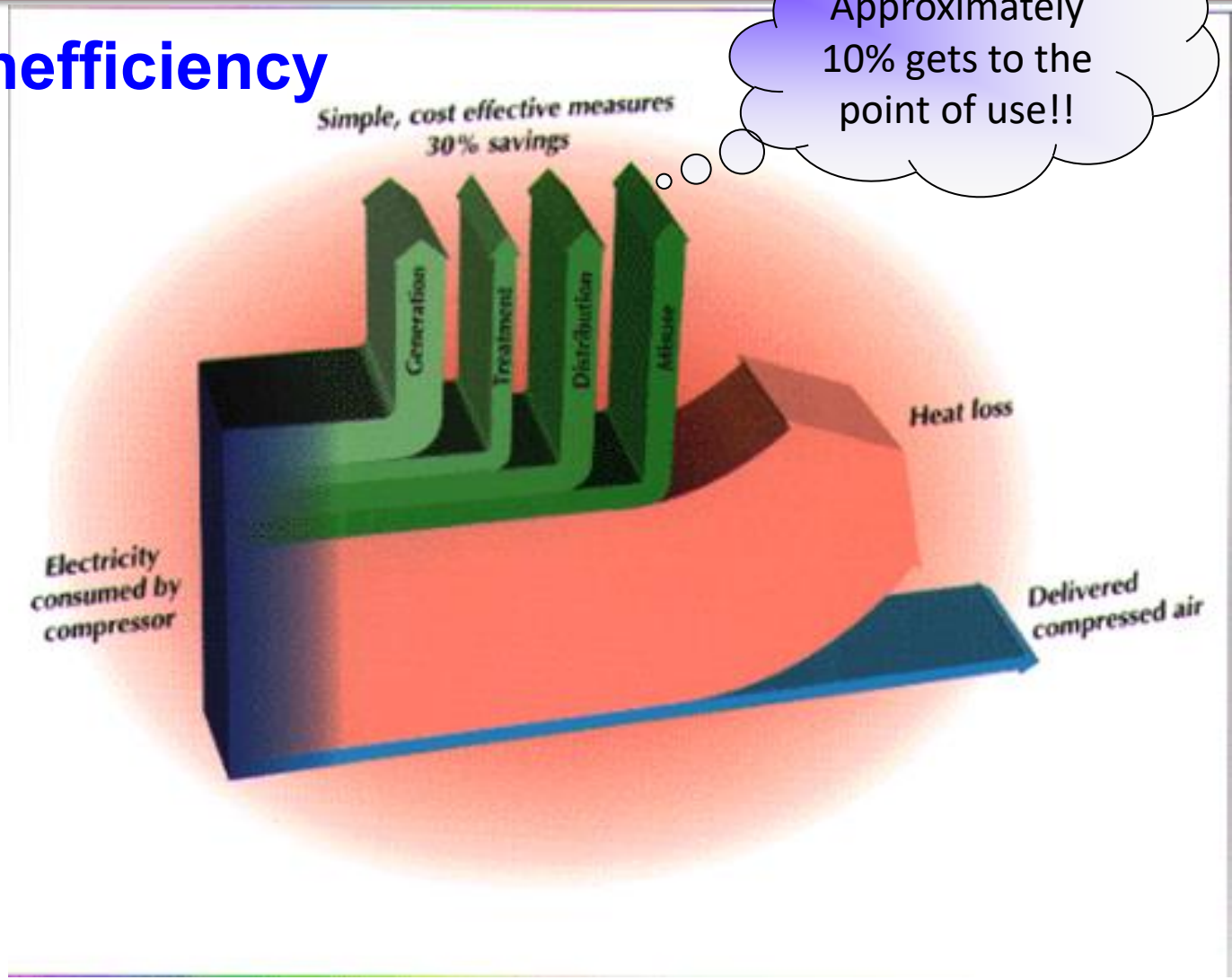
Heat Recovery

Compressed Air's Inefficiency

- **60 to 80% of the input power is converted into an unusable form of energy (HEAT)**
- And to a lesser extent, into friction, misuse and noise



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Heat Recovery Sources

Air-cooled rotary screw compressors

- Adding ductwork with auxiliary fans to compressor package
- Recover to space or reject outdoors with thermostatic controls

Water-cooled compressors

- Install heat exchangers to recover to space or reject outdoors
- Produce non-potable (gray) or potable hot water
- Compressors using water-cooled motors offer further opportunity

Engine driven compressors

- Heat can be recovered from engine jackets and exhaust stream

Gas turbine driven compressors

- Heat can be recovered from exhaust stream to make hot water or steam

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Heat Recovery Opportunities

- Supplemental space heating (applicable only in cold weather)
- Industrial process heating
- Water heating
- Makeup air heating
- Boiler makeup water preheating
- Drying compressed air

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Final System Design Tip

All Compressed Air Systems are Originally Engineered ….

Then They Grow

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Awareness Program

People Use the Compressed Air So Get Them Involved!

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If I told you that you could reduce compressed air usage and energy by buying jackets, hats, key chains and pizza would you buy it?

Well that is exactly what Ford Monroe Stamping Plant Did!

Ford

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Case Study

Monroe Stamping Plant in Michigan

Actions taken:

- Hourly Energy Team, (in their red jackets so they would stand out) implemented an aggressive energy awareness and air leak repair program.
- Gave away buttons, key chains, hats and tee shirts for reporting and getting air leaks fixed and a pizza lunch for passing the ”Red Coats” energy audit
- Posted “Leak Boards” through out the plant to track progress.
- Used Ford Communication Network to broadcast messages on energy costs throughout the plant.

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Case Study

Monroe Stamping Plant in Michigan

Results:

- Air use reduced from.49 million cubic meters per day to .25 million cubic meters per day.
- Nonproduction usage reduced from 5,400 cfm to less than 600 cfm.
- Electricity savings of over $2,000 per day
- Most importantly, created a cultural change in the plant for awareness of energy cost, usage and waste.

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Key Components of Compressed Air Awareness

- Target operators/end-users with the training
- Use site specific examples
- Overview of a compressed air system
- Understanding of demands, i.e. leaks, inappropriate uses
- Compressed air is inefficient and very expensive
- **They are the key to using it wisely to save energy and money**

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CAC Example: Compressed Air, It's Not Free!

Operator Awareness Training

- Includes all of the Key elements
- Training customized to the site/facility
- Delivered 30-45 min depending on content
- Perfect for team meetings /toolbox talks
- Flexible delivery options:
  - Delivery and presentation modified by plant/facility person(s).
  - Delivery by plant/facility person(s) and presentation modification assisted by CAC instructor
  - Delivery and presentation modification by CAC instructor with assistance from plant/facility person(s).

Operator Awareness Training

Compressed Air, It's Not Free!

Doug Woodward
D & G Design, Inc.

Joe Ghislain
Ghislain Operational Efficiency

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Key Message:

Three Things to Remember

1. Cost of compressed air is very expensive
2. End uses of compressed air

   Appropriate, inappropriate or air leak?
3. You (end user) are key to the wise use of an expensive utility

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Additional Messages include:

- Rules of Engagement
- Compressed Air Definition
- Cost for Compressed Air
- Plant C.A. Supply System
- Plant C.A. Demands
- Air Leaks and Inappropriate Uses
- They are the key to Compressed Air Savings
- Who to Contact for Help

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Final Point

For Lasting Energy Efficiency

Make It Part Of What You Do

Not Additional To What You Do

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Process Integration

- ISO 50001(SEM)/ISO 14001
- Sustainability Initiatives – Sustainability Annual Report
- Lean Manufacturing/Continuous Improvement System - FPS - EnMOS
- Plant/Facility Goals and Objectives – Plant Manager's Scorecard

Implemented at : Ford

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AND …..

Always Publish Results ($ Saved)

And Work On

Continual Improvement

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Remember

For Maximum Compressed Air Efficiency..

Take a Systems Approach!

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Compressed Air Gas Institute (CAGI) Certifications

CAGI has developed two personnel certifications and CAC trainings are a key resource to prepare for the exams!

Certified Compressed Air System Specialist (CCASS)

This Certification is based of the knowledge contained in:

- CAC Fundamentals and Advanced Courses
- CAC Best Practices for Compressed Air Systems
- CAGI Handbook

Certified Compressed Air System Assessor (CCASA)

This CAC will be developing a new course based of the body of knowledge for this certification

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Fundamentals of Compressed Air Systems

This is a one-day introductory course designed to teach facility engineers, operators and maintenance staff how to achieve 15-25% cost savings through more effective production and use of compressed air. Participants will learn how to:

- Calculate the energy cost
- Improve compressed air system efficiency and reliability;
- Identify inappropriate uses of compressed air;
- Establish a baseline
- Match system supply to demand;
- Find and fix leaks;
- Establish a leak prevention program, and
- Better control compressed air to improve productivity and profitability.

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Advanced Management of Compressed Air Systems

This is an intensive two-day training that provides in-depth technical information on troubleshooting and making improvements to industrial compressed air systems. This training is designed to help end users as well as industry solution providers learn how to:

- Collect and use data and tools to assess the efficiency and cost-effectiveness of a compressed air system;
- Develop and use a system profile;
- Implement a system maintenance program;
- Address air quality, highest pressure requirements and high-volume intermittent applications;
- Understand complex control system strategies;
- Align the supply side to demand side operation;
- Explain the value of heat recovery; and
- Successfully sell compressed air improvement projects to management.

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For More Information...

Visit the CAC at:

www.CompressedAirChallenge.org

Training

- Fundamentals of Compressed Air Systems
- Advanced Management of Compressed Air Systems
- Compressed Air, It' s Not Free- Operator Awareness Training
- System Specialists Training - Qualified AIRMaster+ Specialist

Best Practices Manual

Resources - Case Studies, Articles, Fact Sheets, DOE/CAC Source Book etc.

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COMPRESSED AIR CHALLENGE

Thank you!!

Questions?

Presenter contact info:

Joe Ghislain

Principal/Owner, Ghislain Operational Efficiency (GOE)

6-Sigma Black Belt, CEM, REM, CSDP, CP EnMS- Industrial, SEP Performance Verifier, 50001 EnMS Qualified Instructor, EPI ISO 50001 Lead Auditor, Certified Compressed Air System Specialist

e-mail - JoeG@GOE-LLC.com