



# Industrial Energy Efficiency May 2006

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ELECTROTECHNOLOGY APPLICATIONS CENTER  
Northampton Community College

***Industrial  
Energy  
Institute  
at  
Northampton Community  
College***



Energy Efficiency  
Training Program

# ***Northampton Community College, Bethlehem, PA***

- **NCC Student Enrollment**
  - 30,000 students per year
  - 11,000 in credit programs
  - 19,000 in workforce training
  - Serves 20% of local area HS graduates
- **Industrial Energy Institute is part of the Electrotechnology Applications Center (ETAC)**
- **Program manager**
  - Bill Clark, CEM
  - [clark@etctr.com](mailto:clark@etctr.com)



# ***Electrotechnology Applications Center (ETAC)***

- Established in 1994 to help manufacturing firms:
  - Improve existing processes
  - Develop new products & processes
  - Reduce costs and increase competitiveness
  - Address environmental and energy issues



# ***ETAC Services***

- Process audits & analysis
- Poll. prev. & energy efficiency assessments
- Process/materials research & develop.
- Laboratory demonstrations
- Prototype production work
- Materials & environmental testing
- Technical consulting
- Energy management education
- Hands-on training & technology courses



# ***Industrial Energy Institute Programs***

- Industrial Energy Assessments
- Energy Management Training
- Energy Technology Application
- Energy Management Curriculum
  - On Campus
  - Distance Learning



# Advisory Team



U.S. Department of Energy  
Energy Efficiency  
and Renewable Energy



PA Department of  
Environmental Protection



LEHIGH  
University



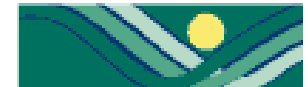
Bethlehem Area  
Vocational-Technical  
School



AEE  
Association of  
Energy Engineers



Great Basin  
College  
Higher Education  
in Northeastern Nevada



Lehigh Valley  
ECONOMIC  
DEVELOPMENT CORPORATION



Ben Franklin  
Technology PARTNERS  
Northeastern Pennsylvania





**Fundamentals of Industrial  
Process Heating**

1<sup>st</sup> Edition



***Next Course***

***Fundamentals of  
Industrial  
Process Heating  
(ETAC 0018)***

***June 15 - July 17***

# ETAC 0018 - Course Learning Outcomes

- Develop an understanding of the principals of combustion.
- Demonstrate a working knowledge of burners used in industrial process heating equipment.
- Understand how materials are heated in industrial applications.
- Perform heat balance and thermal efficiency calculations.



# ETAC 0018 - Course Learning Outcomes

- Perform heat balance and thermal efficiency calculations.
- Develop an understanding of the basic principles of heat transfer.
- Develop an understanding of furnace and oven design and operation.
- Understand the applications and principles of electric process heating.



# ***ETAC-0018 SCHEDULE***

- First Day – Monday, June 5<sup>th</sup>
- Last Day – Monday, July 17<sup>th</sup>
- Course Length – 6 Weeks
- CEUs – 1.6



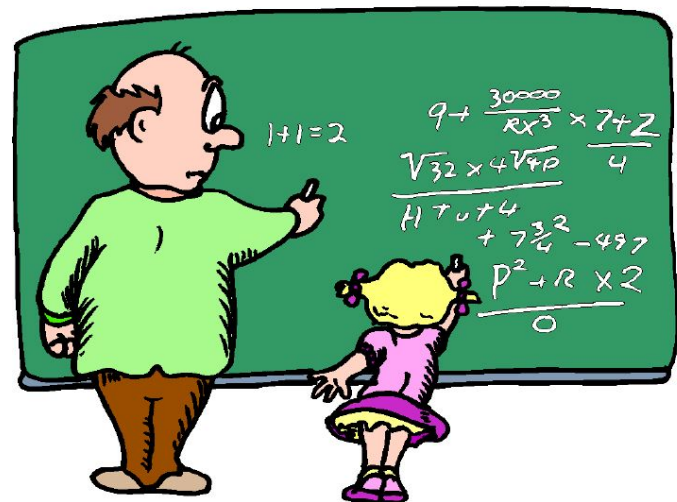
# ***ETAC 0018 - DESCRIPTION***

Provides an overview of the fundamentals of combustion, fuels, burners and control basics, and heat transfer in both combustion and electric furnaces. Students will gain a basic understanding of heat transfer principles, fuels and combustion equipment, electric heating, and instrumentation and control for efficient operation of furnaces and ovens in process heating.



# ***COURSE REQUIREMENTS***

- Success Requires Approximately 3-4 hours/week
- Weekly Homework/Quiz
- Weekly Reading Assignments
- 1 Project
- 4 Forum Questions
- Final Exam



# ***GRADING CRITERIA***

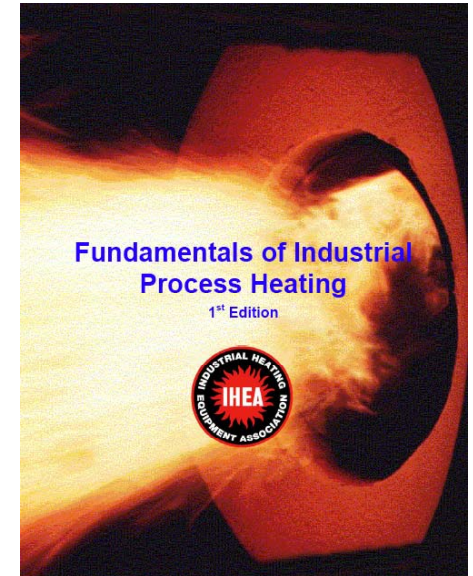
## ***PASS/FAIL GRADING (Passing is $\geq 70\%$ )***

- Weekly Quizzes 20%
- Discussion Forum 20%
- Project 20%
- Final Exam 40%



# ***COURSE MATERIALS***

- Text Book: Industrial Process Heating Fundamentals, Industrial Heating Equipment Association
- Weekly PowerPoint Presentations
- Supplemental Readings and Materials  
(Posted on Blackboard System)



QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.

# *Energy Management Strategies*

1. Do Nothing
2. Short-term Energy Management
  - Price-shop for lowest-cost fuel
  - Low-cost projects
  - Large asset investments
3. **SUSTAINED ENERGY MANAGEMENT**



# ***Reasons for Doing Nothing (or so I've heard)***

***Too Costly***

***Unsuitable ROI***

***Cash Flow Problems***

***"We've always done it that way"***

***No time to investigate***

***Not Worthwhile***

***Going out of business***



# ***Energy Management vs Energy Conservation***

*Conservation is the reduction of usage.*

*Management is the judicious and effective use of utilities to maximize profits (minimize costs) and enhance competitive positions.*



# ***Energy Management Benefits***

## Short-term Energy Management

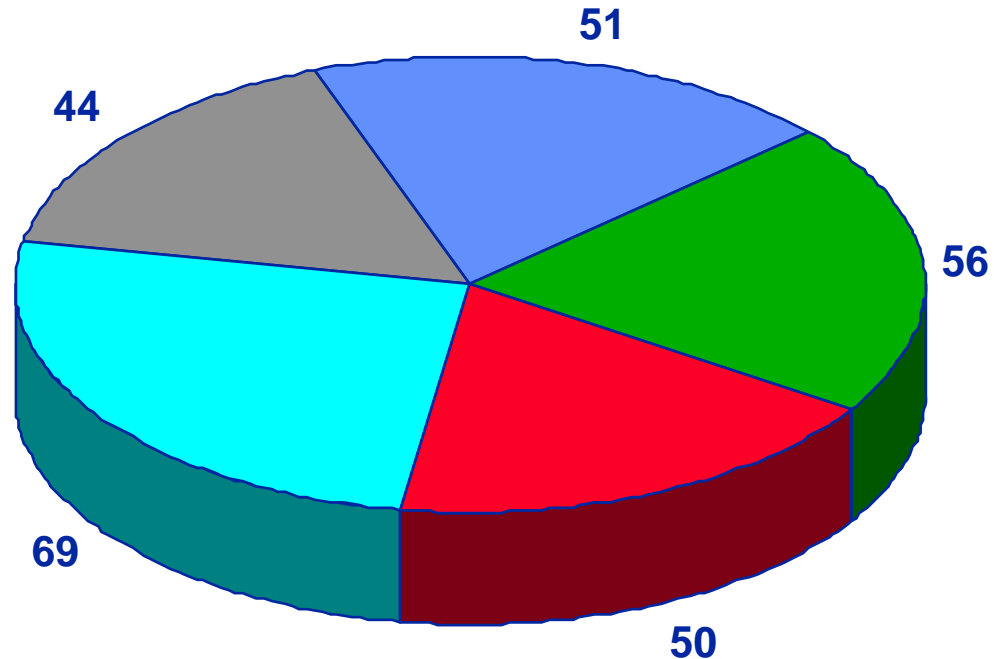
- 5-15% cost savings
- Little or no capital expenditure

## Sustained Energy Management

- 25% or higher cost savings
- Requires management commitment
- A never ending process



# Typical Results (AEE Survey)



■ 0-5%   ■ 6-10%   ■ 11-15%   ■ 16-25%   ■ >25%

Percent Reduction in Energy Bills

*270 EMs surveyed, 52 of the programs in first two years of implementation*



# ***Short-term Energy Management***

- Focus on COST not USAGE
- Pareto Principle
  - 20% of loads account for 80% of costs
  - Identify these 20% loads
- Control and meter these loads
- Report your savings - it is a big deal



# ***The Pareto Principle***



# ***Question #1***

*How would you determine the loads that account for 80% of your utility costs?*



## ***Question #2***

*What data is needed to determine the utility costs for these uses? Is additional metering necessary?*



## ***Question #3***

What opportunities exist to reduce the cost of these uses?

Don't know? Consider an assessment.



# *Types of Assessments*

## Walk-Through

- Aka: Simple, Preliminary, Screening, Scoping Assessment

## Site Assessment

- Aka: Mini, General, Complete Site , Investment Grade Assessment

## Comprehensive Assessment

- Aka: Maxi, Detailed, Technical Analysis Assessment



# ***1. Walk-Through Assessments***

- “Big Picture” survey
- No detailed measurements
- Determine if more detailed assessment is warranted

Who? Utilities, ESCOs, Govt. Agencies,  
Equipment Vendors, Energy  
Professionals, Engineers



## ***2. Site Assessments***

- Detailed data collection (utility bills, energy usage profile, metering, interviews)
- Measurements made to quantify EMOs
- Financial analysis for EMOs
- Sufficient detail to act on EMOs

Who? Engineers or energy professionals, IACs, ESCOs



### ***3. Comprehensive Assessments***

- All phases of energy purchase and use evaluated
- Dynamic energy model developed
- Extensive interviews and data collection
- Life cycle cost analysis

Who? Engineers or energy professionals



# ***Assessment Providers***

- In-house
- Utilities
- ESCOs (Performance Contracts)
- Engineers or Energy Service Professionals (e.g. CEM)
- Government Agencies (DOE IAC, EPA, State Energy Office)
- Equipment Vendors



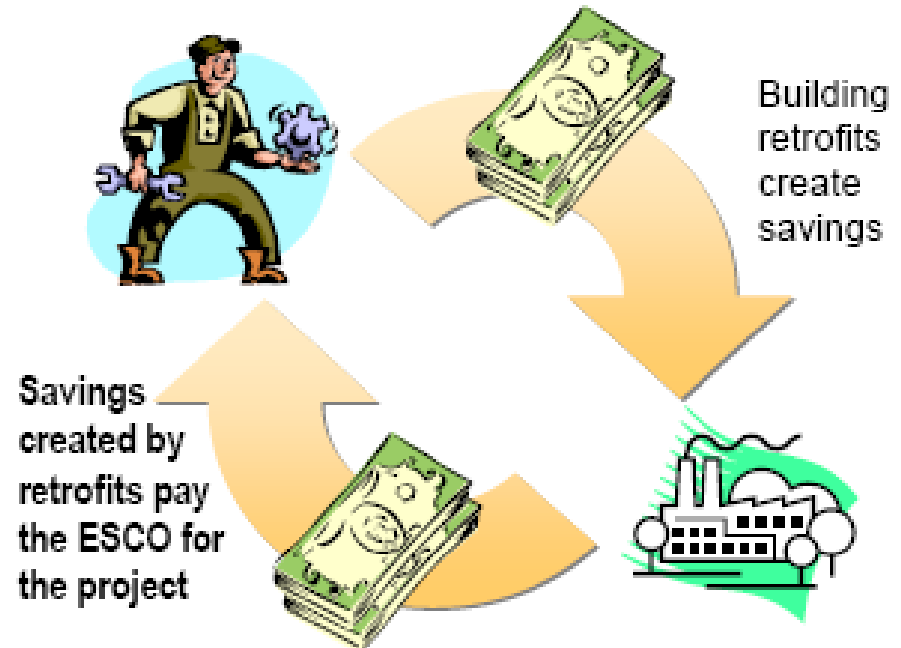
# Performance Contracts

## ESCO

- Pays development and implementation costs
- Guarantees a specific costs savings
- Measures and verifies cost savings

## Customer

- Pays ESCO project costs from the verified cost savings



# ***Sustained Energy Management***

- A PERMANENT energy cost control program.
- Energy cost control is a PROCESS, not a Project!
- It requires a PLAN - ***An Energy Action Plan***



# ***What is an Energy Action Plan?***

Cost control involves ALL of the following:

- Procurement
- Optimizing performance
- Behavior and procedural change
- Utilizing technology and informational resources



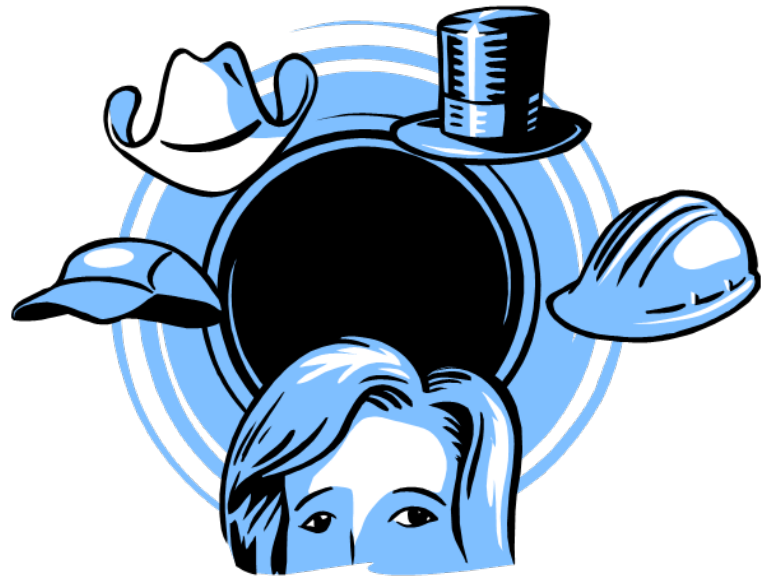
# ***Starting Your Energy Action Plan***

- Designate an Energy Management Coordinator
- Establish the Energy Management Team
- Evaluate cost saving opportunities
- Prioritize implementation
- Implement
- Evaluate success (e.g. benchmarking) and promote



# *Energy Management Coordinator*

- *A single person*
- *Dynamic*
- *Goal oriented*
- *Good manager*
- *Wears other hats*



# ***GOALS OF THE EMC***

- *Architect of the “Energy Action Plan”*
- *Provide effective energy reporting and analysis (energy accounting)*
- *Secure management commitment*
- *Establish “cost center” mentality*
- *Establish energy cost/usage standards*
- *Provide EM training*
- *Set EM objectives (defined goals)*



# ***EXAMPLE ENERGY MANAGEMENT GOALS***

- *Reduce electric cost per unit of production by 10% the first year and 5% in the second*
- *Within 2 years all tenants will be separately metered*
- *Facility will have a contingency plan for gas curtailment by end of first year*
- *All boilers will be examined for waste heat recovery potential the first year*



# ***ENERGY MANAGEMENT TEAM***

*Energy Management  
Coordinator*

*Technical Support*

*Steering Group*



# ***TECHNICAL SUPPORT***

- *Several people*
- *Part-time duty*
- *Strong technical background*
- *Able to provide technical support and update knowledge on new technologies*
- *May include consultants and vendors*



# ***STEERING GROUP***

- *Several people*
- *Part-time duty*
- *Guides activities*
- *Aids in communication*
- *From various departments*
  - *Personnel department*
  - *Production workers*



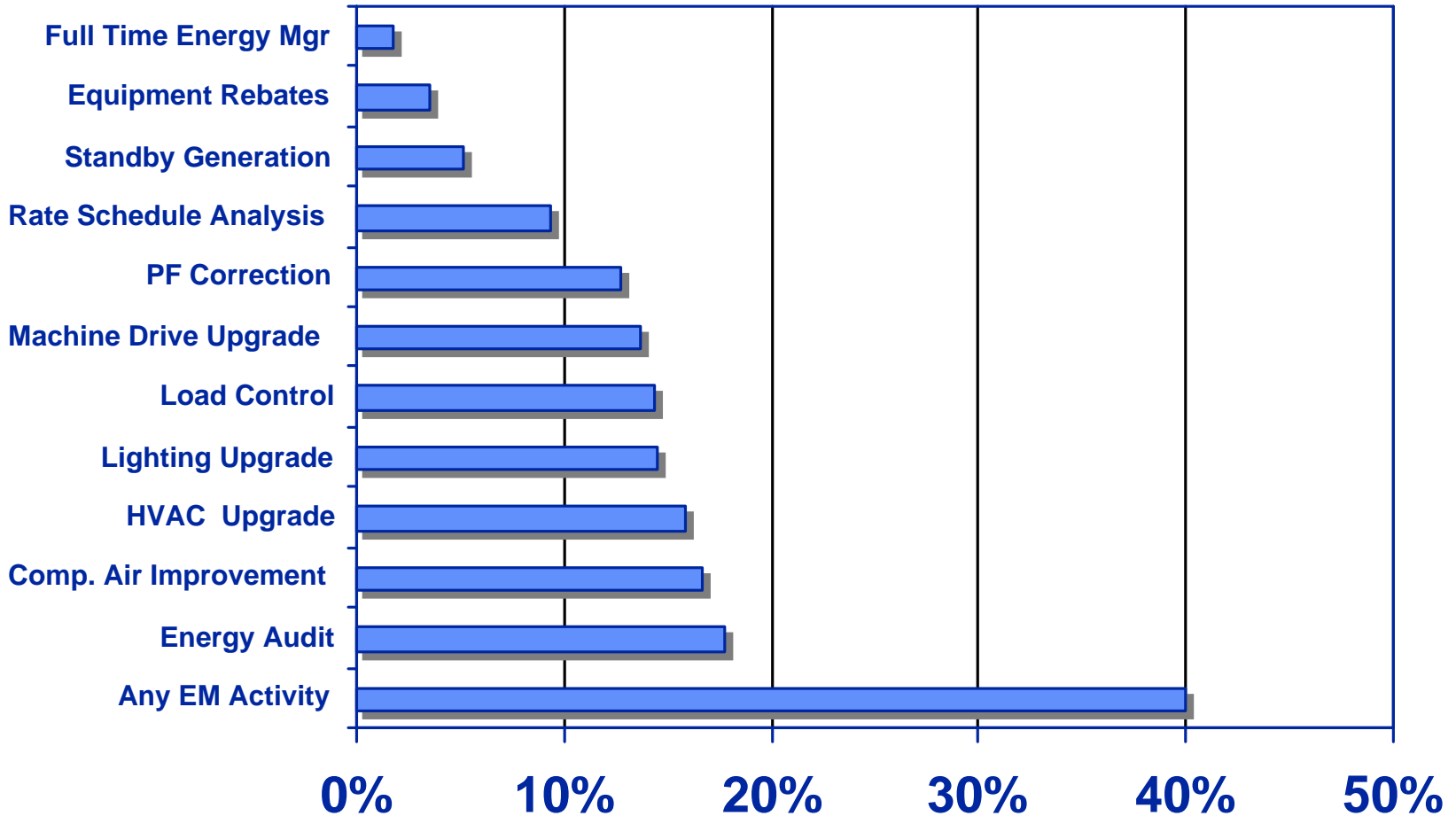
# ***IDENTIFYING EMOs***

- Analysis of utility bills
- Experience of assessment team
- Concerns of plant management
- Focus on major utility costs
- Identify wastes
- Common sense
- Ask why

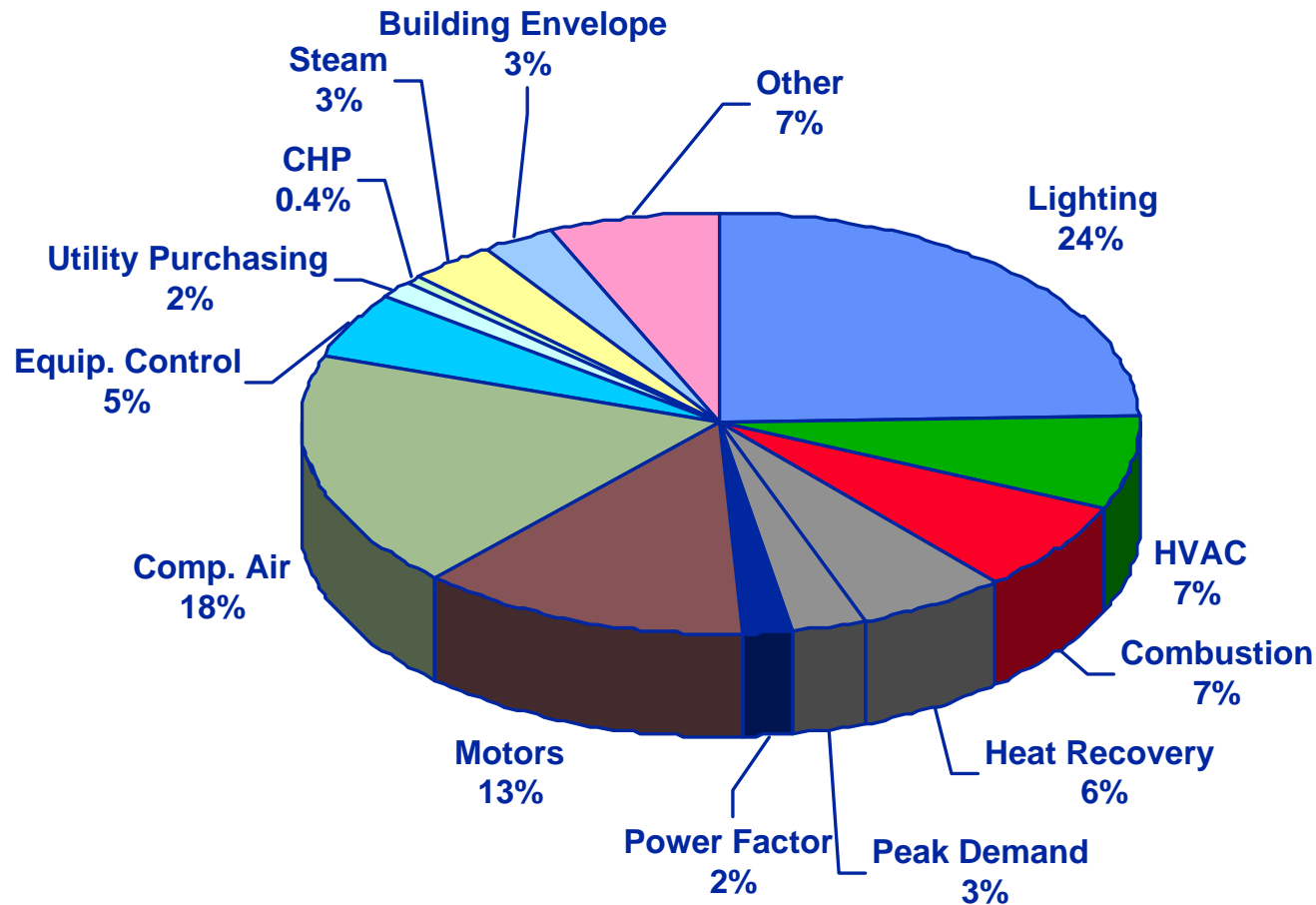


# *EM Practices by Type*

*(EIA 2002: 200,710 facilities)*



# Assessment Focus Areas (US DOE - IAC Database)



# *Carousel Brainstorming*

1. Compressed Air
2. Motor Systems
3. Utility Supply
4. Buildings and Grounds (Envelope, HVAC, Lighting)

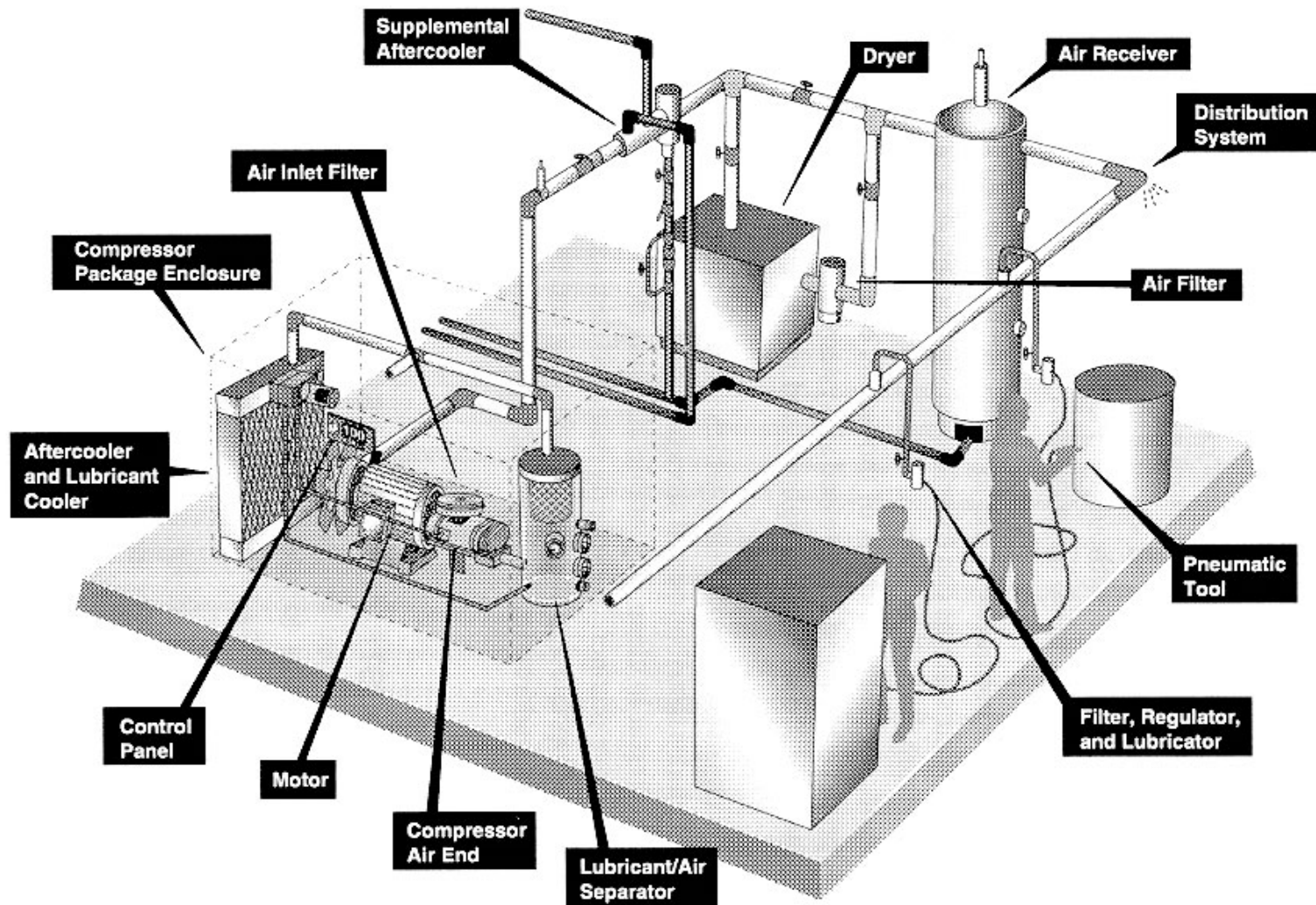


# Energy Management Focus Areas

- The building envelope
- Boiler and steam system
- HVAC
- Utility supply
- Lighting
- Hot water distribution
- Compressed air system
- Motors
- Manufacturing processes

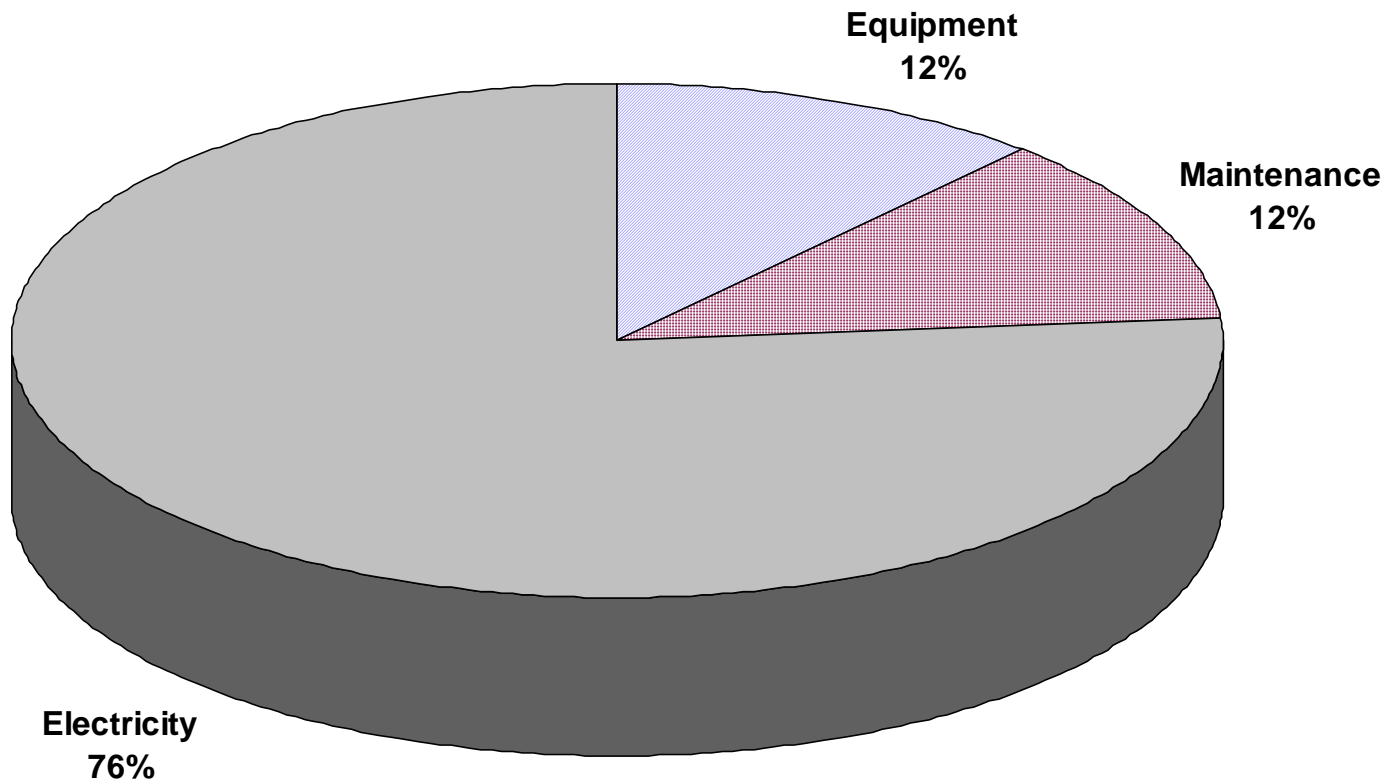


# Compressed Air Systems



# Compressed Air Costs

## Costs Over 10 Years



# Compressed Air is NOT Free

- 80% of the input energy consumed is converted to **HEAT**
- About **50%** of the air is used appropriately
- 1 hp air motor = 6-7 bhp at compressor



# Common Compressed Air EMOs

- Fix air leaks
- Reduce air intake temperature
- Reduce pressure
- Recover waste heat
- Treat air to level needed
- Eliminate unnecessary uses
- Provide adequate storage
- Upgrade compressor controls



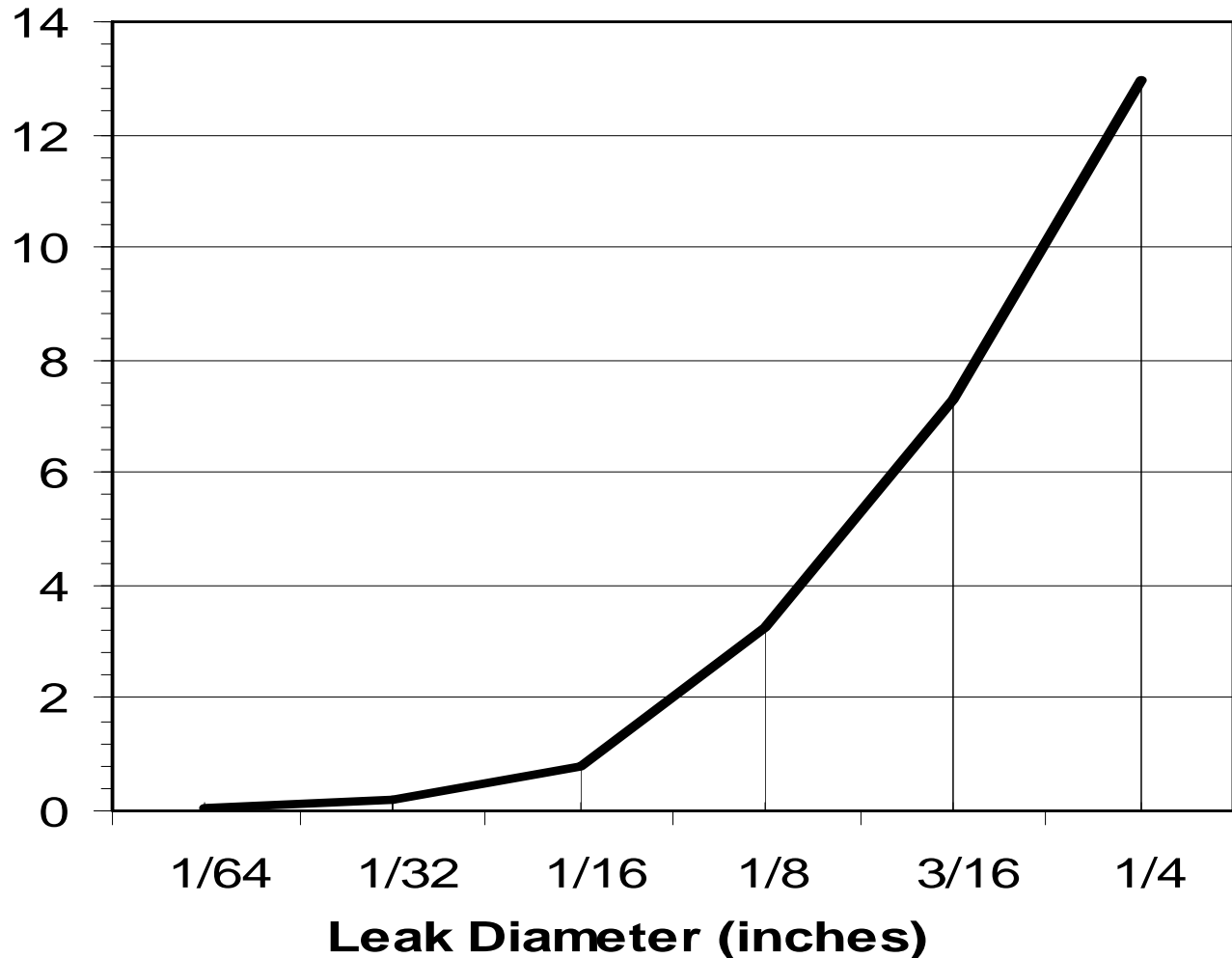
# Air Leaks - Background

- Commonly, 30% or more of total energy is lost to leaks
- Amount of lost air depends on:
  - line pressure
  - air temperature at leak
  - air temperature at compressor inlet
  - area of the leak
- Percentage lost to leakage should be less than 10% in a well-maintained system



# Air Leaks – Power Loss (kW)

Hole Diameter (inches)	Demand Loss (kW)
<b>1/64</b>	<b>0.05</b>
1/32	0.2
<b>1/16</b>	<b>0.8</b>
1/8	3.2
<b>3/16</b>	<b>7.1</b>
1/4	12.6



# Common Motor Recommendations

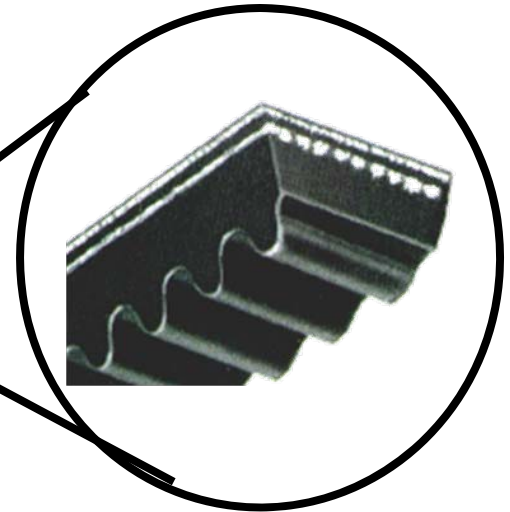
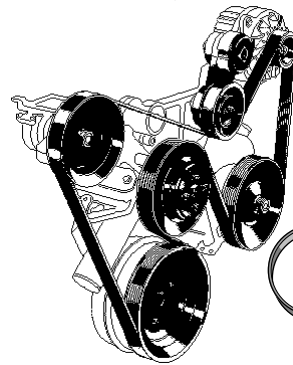
1. Replace motors with energy-efficient motors



**NEW HIGH EFFICIENCY MOTOR**

**MOTOR REWIND**

3. Use energy-efficient belts



2. Install variable frequency drive controls



4. Optimize motor size with load



# *Common Building Envelope Improvements*

- Closing doors and windows
- Repairing/Replacing broken windows and doors
- Sealing roof/wall openings and installing weather stripping
- Upgrading building insulation
- Installing door seals, plastic strip doors, or air curtains
- Using storm or double-glazed windows, or insulating windows



# Common Lighting ECOs

- T8 or T5 lamps
- High frequency electronic ballasts
- Compact fluorescent lamps
- LED sources
- High performance fixtures and lensing
- Maintain appropriate light levels
- Install proper controls



# *Common Steam System Improvements*

- Adjust air/fuel ratio
- Install/repair insulation
- Recover waste heat
- Repair steam leaks
- Replace faulty steam traps
- Increase condensate return
- Install deaerator
- Flash HP condensate to make LP steam
- Improve makeup water quality to decrease blowdown rate



# *Common Steam System Improvements*

- Minimize cycling losses (match demand to capacity)
- Use backpressure turbines to make LP steam
- Reduce boiler scale
- Cover heated tanks
- Optimize deaerator vent rate
- Install VFDs on fans
- Isolate unused steam lines
- Decrease feed pump discharge pressure



# ***DOE and IAC WEBSITES***

## US Department of Energy Sites

- DOE Main Page [www.energy.gov](http://www.energy.gov)
- Energy Efficiency and Renewable Energy [www.eere.energy.gov](http://www.eere.energy.gov)
- Industrial Technologies Program [www.eere.energy.gov/industry](http://www.eere.energy.gov/industry)
- Industrial Assessment Center Program Sites
  - Rutgers [www.caes.rutgers.edu](http://www.caes.rutgers.edu)
  - Colorado State Univ. [www.engr.colostate.edu/IAC//](http://www.engr.colostate.edu/IAC//)
  - U of Dayton [www.engr.udayton.edu/udiac/](http://www.engr.udayton.edu/udiac/)



# *Association Websites*

- Association of Energy Engineers  
[www.aeecenter.org](http://www.aeecenter.org)
  - Specialized books
  - CEM and other certifications
  - Workshops and teleconference courses
- Alliance to Save Energy [www.ase.org](http://www.ase.org)
- American Council for an Energy Efficient Economy [www.aceee.org](http://www.aceee.org)
- National Association of State Energy Offices [www.naseo.org](http://www.naseo.org)

