OKLAHOMA STATE UNIVERSITY
Industrial Assessment Center
U.S. DEPARTMENT OF ENERGY

OPTIMIZING INDUSTRIAL EFFICIENCY: INSIGHTS FROM OKLAHOMA STATE'S INDUSTRIAL ASSESSMENT CENTER

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NATIONAL PRESENCE

Industrial Assessment Center
U.S. DEPARTMENT OF ENERGY

Ref: https://iac.university/

- The OSU IAC is one of the 37 IACs serving the small and mid-sized enterprises (SMEs)
- The OSU IAC is home to one of the oldest IAC in the nation continuously operational since 1982 and the first to reach the 1,100th assessments milestone.
- **We are located at Oklahoma State University in Stillwater, Oklahoma, with affiliates (satellite location) at the Wichita State University.**
- Fulfilling the land-grant mission of our university.

Ref: https://iac.university/center/OK

MISSION - VISION - VALUES

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1. **No-cost energy assessments/audits** that will help reduce energy and waste and increase productivity.

2. **Educating and training** the next generation of energy professionals.

3. **Focuses on all forms of energy and more…** electricity, natural gas, propane, water, solid waste, productivity, cybersecurity, and safety issues.

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

OBJECTIVE

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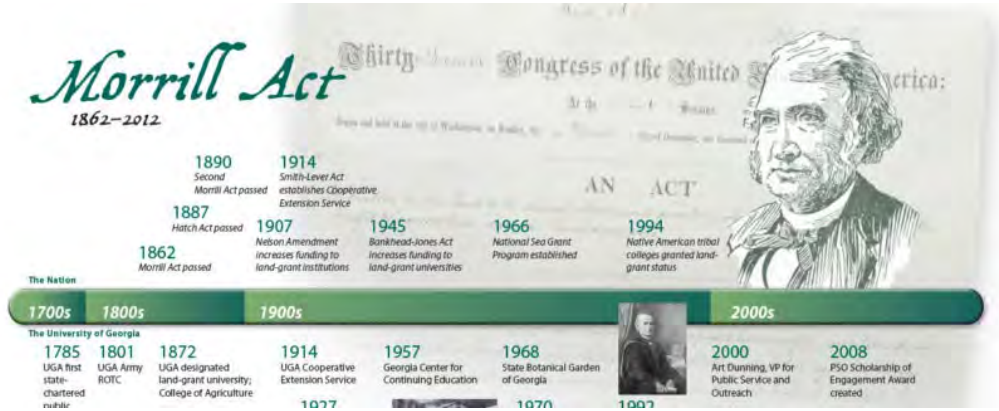
- The **Industrial Assessment Center** is an integral part of Oklahoma State University since 1982 and plays an important role in **improving economic growth** and **developing the clean energy workforce** to benefit the community.
- Its values and mission align with that of the university as it is an epitome of the benefits of the Morrill Land-Grant Acts of 1862 and 1890.
- Industrial Assessment Center at Oklahoma State University aligns with the traditional values of a Land Grant university by participating in its cause and upholding its mission.



- **3-pronged land-grant mission - Instruction, Research and Extension**

OVERVIEW OF THE IAC PROGRAM:

- Funded by DOE - Manufacturing and Efficiency Supply Chain (MESC)
- IACs provide extensive energy-efficiency services to small and medium-sized enterprises (SMEs) in the United States.
- Our IAC strategically meet the critical need for energy conservation, efficiency improvements, and sustainable development within our communities.
- Our IAC's dynamic and impactful research program commitment to these principles has been unwavering since its inception 40 years ago, **with a strong focus on public impact and community engagement.**
- Spanning a four-state territory encompassing Oklahoma, Kansas, Arkansas, and northern Texas, our IAC has **provided invaluable no-cost energy assessments to small and medium-sized manufacturing companies, commercial buildings, water treatment plants, as well as rural businesses and agricultural producers**.
- Our center is committed to advancing energy conservation, efficiency, and sustainability within the industrial/commercial sector while actively collaborating with local industries, community leaders, and academic experts in developing clean energy workforce.

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ENERGY EFFICIENCY & COST SAVINGS

- Energy audit is a method where professional team surveys, inspects and analyze energy flow inside the industrial/commercial facility.
- This is done to determine the best course of action for energy conservation and improving energy efficiency and productivity.
- It includes various things from reducing the amount of energy input, energy cost and carbon footprint.
- The process of energy audit includes:
  1. Data Collection
  2. On-site Visit and Inspection
  3. Analyzing the Information
  4. Energy Saving Plan

ENERGY ASSESSMENTS

- Reasons why energy audits are so important:
  - Improve Energy Efficiency
  - Reduce Energy Costs
  - Reduce environmental damage and pollution
  - Increase Safety and Efficiency of the Workplace
  - Create a Better Image
- The Bottom-line
  - Energy audit is very important for industries today.
    - energy efficient, safe and cost-effective.
  - Audits help find out the areas where the consumption is high and how it can be addressed.
  - Industries need it more than ever as new challenges come up.
  - Through the energy audit, industries can meet those challenge without affecting their efficiency or profit.

Energy audits are done by our experienced personnel who specialize in helping industries become more energy efficient.

WHAT DO WE COVER?

- We are in IDEA Business
  - WE perform energy assessment and provide recommendation through our comprehensive assessment report
- We assess everything in your plant that consume energy
  - Electricity,
  - Natural Gas
  - Water
  - Waste
  - Other fuels
- We provide unbiased evaluation of your plant
- We work with utility companies and other agencies to help you implement our recommendations
  - Grant
  - Rebates
  - Loans
- **Our goal is to have more than 50% implementation rate**

INTENDED FOCUS

1. Energy Management

- **Combustion System**
  - Furnace, Boilers, Fuel Switching
- **Thermal System**
  - Steam, Heating, Heat Recovery, Heat Containment, Cooling, Drying
- **Electric Power**
  - Demand Management, Power Factor, Onsite power generation, Cogeneration, Transmission
- **Motor systems**
  - Motor, Air Compressors, VFDs
- **Industrial Design**
  - Thermal, Mechanical
- **Operations**
  - Maintenance, Equipment Control, Automation, Load Reduction, Scheduling, Use Reduction
- **Building and Grounds**
  - Lighting, Space Conditioning, Ventilation, Building Envelope
- **Alternative Energy**
  - Solar, Wind Power, Hydrogen, Biofuels

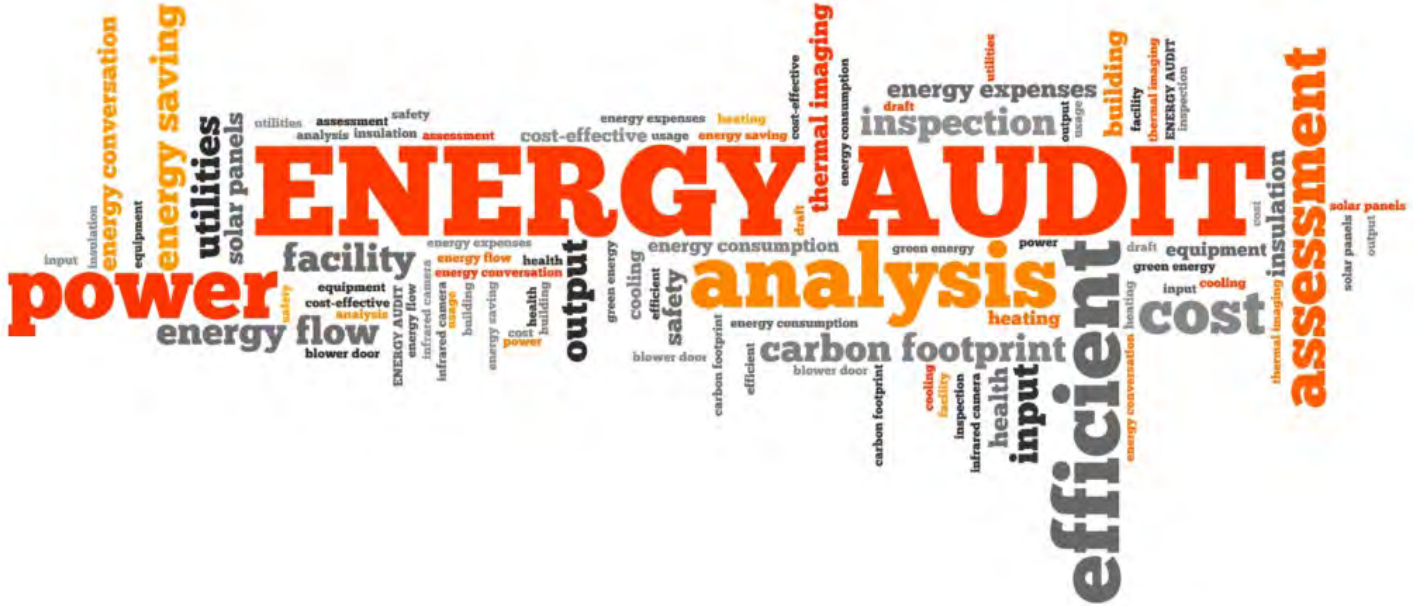
2. Waste Minimization / Pollution Prevention

- Operations
- Equipments
- Post Generation Treatment/minimization
- Water Use
- Recycling
- Waste Disposal
- Maintenance
- Raw Materials

3. Productivity Improvements

- Manufacturing Enhancement
- Purchasing
- Inventory
- Labor Optimization
- Space Utilization
- Downtime Reduction
- Management Practices
- Other Admin Savings

PROGRAM BENEFITS



- **Clean, green, productive, and energy efficient with cost savings.**
- The service is provided at **no charge**.
- Making Oklahoma manufacturing more competitive.

AUDIT PROCESS:

Potential savings fall into five categories:

1. Energy Savings
2. Water Savings
3. Waste Savings
4. Productivity Gains
5. Greenhouse Gas Emission Reductions

What you get:

- Free Service
- ASHRAE Level 2 Audits
- Report ~60 days
- Follow-up Action
- **Confidentiality**
- Latest Technologies
- Best Practices

Preliminary Information

- By telephone or email

Billing Information

- 12 months of all electricity, natural gas, & water bills
- Equipment list
- Preaudit Virtual Meeting

Plant Visit

- Requires one day (2-days for large site)
- Team of 6 IAC members

Assessment Report

- Within 60 days of site visit

Implementation Survey

- Performed approximately one year following the site visit

REPORT

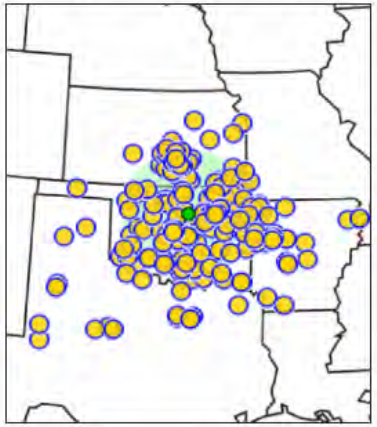
- IAC team spends time researching, evaluating, and developing the recommendations.
- The most cost-effective assessment recommendations (ARs) are combined in a final assessment report
  - First, sent and received approval from DOE field manager
  - Approved report sent to Client (~60 days from the site visit)
- **Report quantifies**
  - Current energy and waste management costs
  - Recommends specific opportunities for energy conservation, waste prevention, and productivity improvement
  - Savings calculations
  - Estimated implementation cost estimates
  - Simple payback periods for the recommended actions
  - Estimated savings associated with greenhouse gases

ASSESSMENT CONDUCTED SO FAR….

from 1982 through 2023

State	Assessments	Recommendations	Recommended Savings	Implemented Recommen-dations	Implemented Savings	Imple-mentation Rate
AR	100	687	$14,455,160	330	$4,484,205	50.4%
KS	125	975	$15,770,172	399	$4,330,208	43.5%
MO	5	40	$1,612,693	24	$1,449,120	60.0%
OK	821	5,598	$96,689,106	2,574	$23,058,706	48.0%
TX	26	257	$5,603,886	103	$937,278	40.1%

The Oklahoma State University Industrial Assessment Center (OK-IAC) provides **free energy, productivity, and waste assessments** to small and medium-sized industrial facilities through funding provided by the US Department of Energy.



1,084 Assessments

7,587 Recommendations

14.50 Tbtu Energy Saving*

$134.94 million Cost Savings*

246 Students Trained

*Recommended Savings

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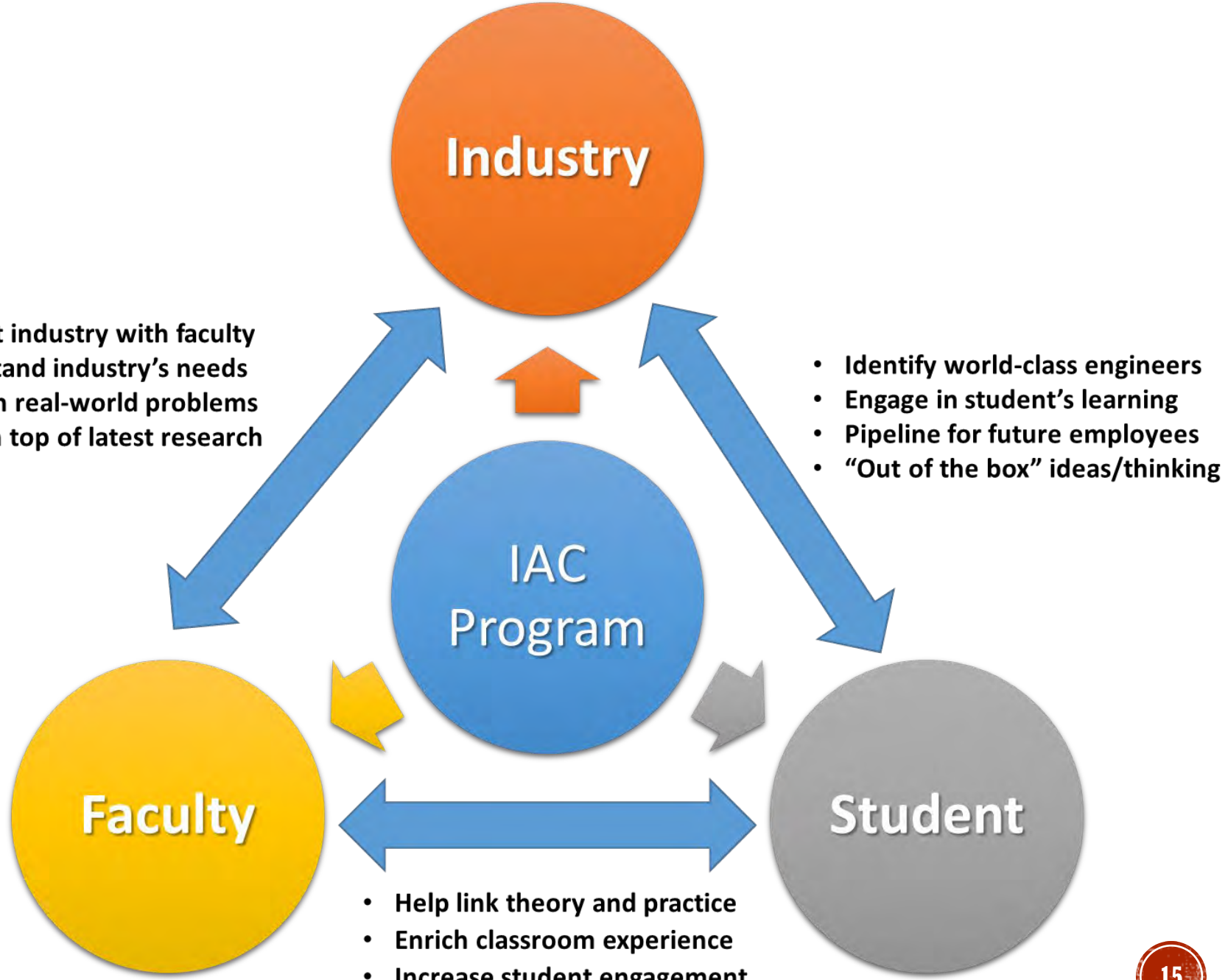
TOP 10 RECOMMENDATIONS FROM OSU IAC

Top ten energy saving recommendations	Frequency	Average savings	Average payback	Implementation rate
Condition smallest space necessary	5	$3,956	1.3	100%
Increase amount of waste recovered for resale	11	$5,077	0.5	100%
Pay bills on time to avoid late fees	12	$3,694	0	88.9%
Pay utility bills on time	8	$4,729	0	85.7%
Adjust burners for efficient operation	5	$37,735	0.3	80%
Repair furnaces and oven doors so that they seal efficiently	5	$2,684	0.4	80%
Eliminate leaks in inert gas and compressed air lines/valves	496	$3,941	0.4	79.5%
Repair and eliminate steam leaks	38	$14,941	0.3	79%
Clean and maintain refrigeration condensers and towers	77	$3,429	0.7	76.4%
Establish burner maintenance schedule for boilers	12	$31,981	0.9	72.7%

HOW TO MEASURE IAC SUCCESS

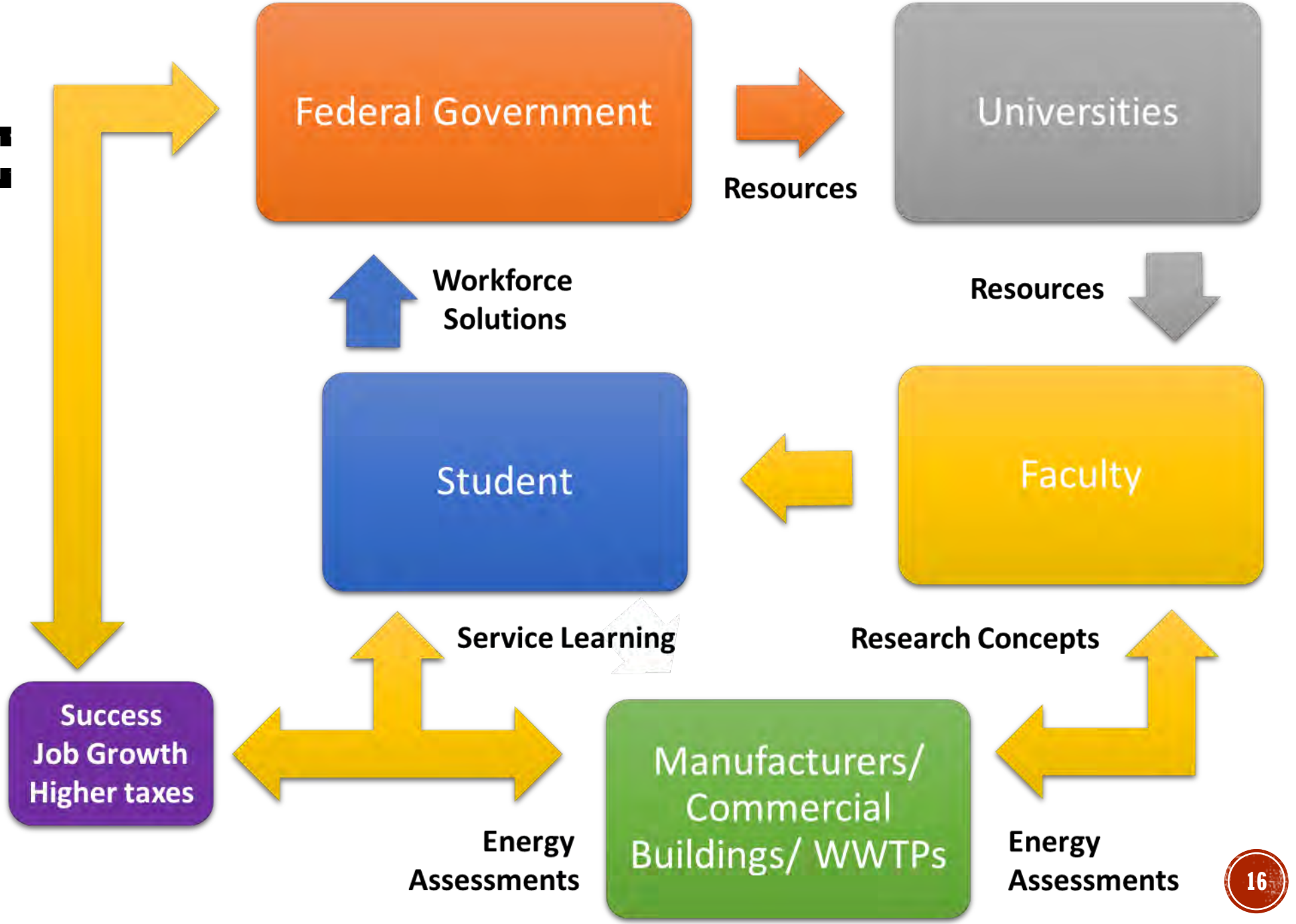


- Connect industry with faculty
- Understand industry's needs
- Work on real-world problems
- Keep on top of latest research

- Identify world-class engineers
- Engage in student's learning
- Pipeline for future employees
- "Out of the box" ideas/thinking

- Help link theory and practice
- Enrich classroom experience
- Increase student engagement

HOW TO MEASURE IAC SUCCESS



MILESTONES

- Established in 1982 (40+ years in OSU)
- Our center has conducted **over 1,100 audits/assessments** **(>7,572 recommendations)**
- **Energy savings of $ 134.94 millions or 14.50 Tbtu**
  - **Reduction of CO_2 emission of 2.02 million metric tons**
  - **(DOE Database: https://iac.university/center/OK)**
- An average of 50% implementation rate for our recommendations
- **Trained 246 students**, 96 with IAC Certificate, 31 active students
- Satellite Location: Wichita State University, Kansas
- Partners:
  - Federal offices and partnerships, DOE – MESC, EERE,
  - National Laboratories – ONL, NREL, PNNL, LBNL
  - Manufacturing USA Network, Department of Commerce, NIST MEPs – Oklahoma Manufacturing Alliance
  - State, Tribal, and local entities – OSEE, OCAST, ODOC, etc.
  - Utilities and energy service providers – PSO, OGE, GRDA, CREC, Co-ops, etc.
  - Educational Institutes – NOC, CareerTech, etc.
  - Non-profit professional societies - AEE, AEEOK, SPEER, MEEA, etc.
  - Industries, ESCOs, Etc.

(Data last updated in Oct 2022)

REAL IAC PROGRAM BENEFITS

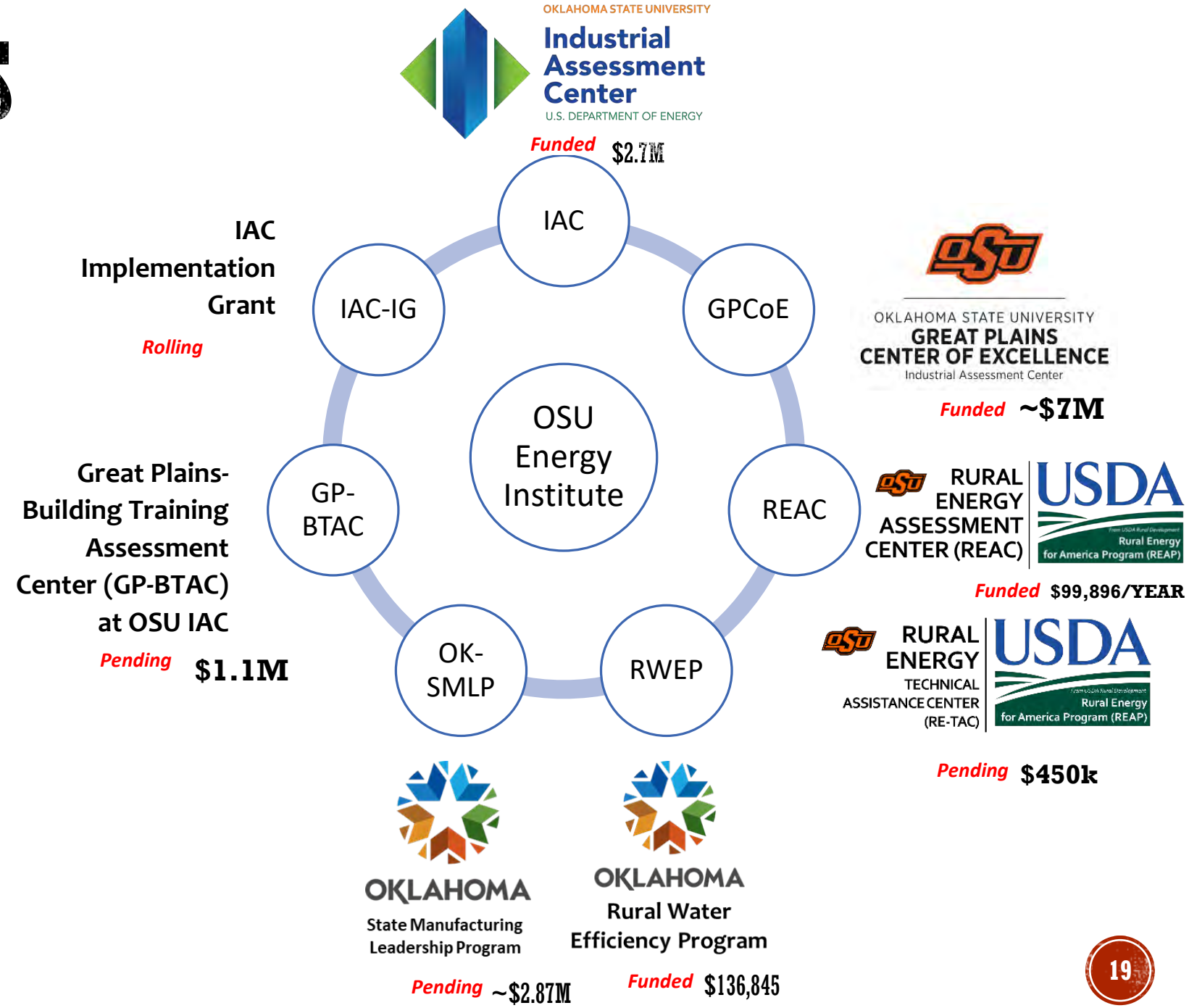
- **The program actually pays for itself—**it is not a burden on the taxpayer.
- The program offers a valuable service to industry at **no direct cost to participants**.
- The **tax generated by the increased profits is greater than the DOE program funding**.
- **Funding received: 8 cycles X ~$1.5M/cycle=~$12M.**
- **We already saved $134.81M**
  - **11.23 times more than federal funding itself.**
- This shows a tremendous ROI and impact.
- The program also provides energy education, and trains engineering students to become the next generation of energy managers.
- **Win, win, win!**

ON-GOING GRANTS

Through strategic engagement with local stakeholders and industries, our IAC fosters public impact by providing innovative solutions to energy challenges.

At the core of our IAC lies a fundamental mission ***to enhance citizens' lives, foster economic growth, and facilitate workforce development.***

- Portfolio of 18 projects >$12.5M.
- Leadership roles in 13 projects as a Principal Investigator collectively ~$11.6M.
- Submitted 3 additional proposals ~$4.4M in the pipeline



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TOTAL $2.7M

Topic Area 1: Manufacturing Technical Assistance and Energy Engineering Workforce Development

- Conduct **20** energy assessments per year for small and medium sized manufacturers, water and wastewater treatment plants.
- Timeline - Oct 2021 to Sept 2026.

IAC (2021-2026)

Topic Area 2: Commercial Building Efficiency Workforce Development Pilot Project

- Conduct **10** energy assessments per year for small and medium sized commercial buildings.
- Timeline - Oct 2022 to Sept 2026.

Qualification Criteria

For Manufacturing Plants:

- Standard Industrial Classification (SIC) Codes: 20 - 39
- North American Industry Classification System (NAICS) Codes: 31 – 33
- Annual energy costs*: $100,000 to $2.5 Million
- Annual gross sales: less than $100 Million

For Water and Wastewater treatment plants:

- North American Industry Classification System (NAICS) Codes: 22
- Size limit: 3-10 million gal/day

For Commercial Buildings:

- Size limit: less than 100,000 sq. ft.
- Annual energy costs*: Minimum $50,000

** Energy cost includes electricity, natural gas, water, waste, etc.*

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GREAT PLAINS CENTER OF EXCELLENCE
Industrial Assessment Center

On April 7, 2023

U.S. Secretary of Energy Jennifer M. Granholm and 2nd Gentleman Douglas Emhoff visited Oklahoma State University to announce the ~$7M award to create the Great Plains Center of Excellence (GPCoE) at the Industrial Assessment Center of Oklahoma State University.

Oklahoma Gov. Kevin Stitt, Sen. Tom Duggar, Rep. Trish Ranson were also on hand to celebrate the momentous announcement.

Video: http://www.kaltura.com/tiny/b7p0b

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EMPOWERING INDUSTRY ACROSS THE REGION

U.S. SECRETARY OF ENERGY ANNOUNCES CREATION OF GREAT PLAINS CENTER OF EXCELLENCE AT OSU

U.S. Secretary of Energy Jennifer M. Granholm visits the ENDEAVOR Lab to celebrate the launch of the Great Plains Center of Excellence at OSU.

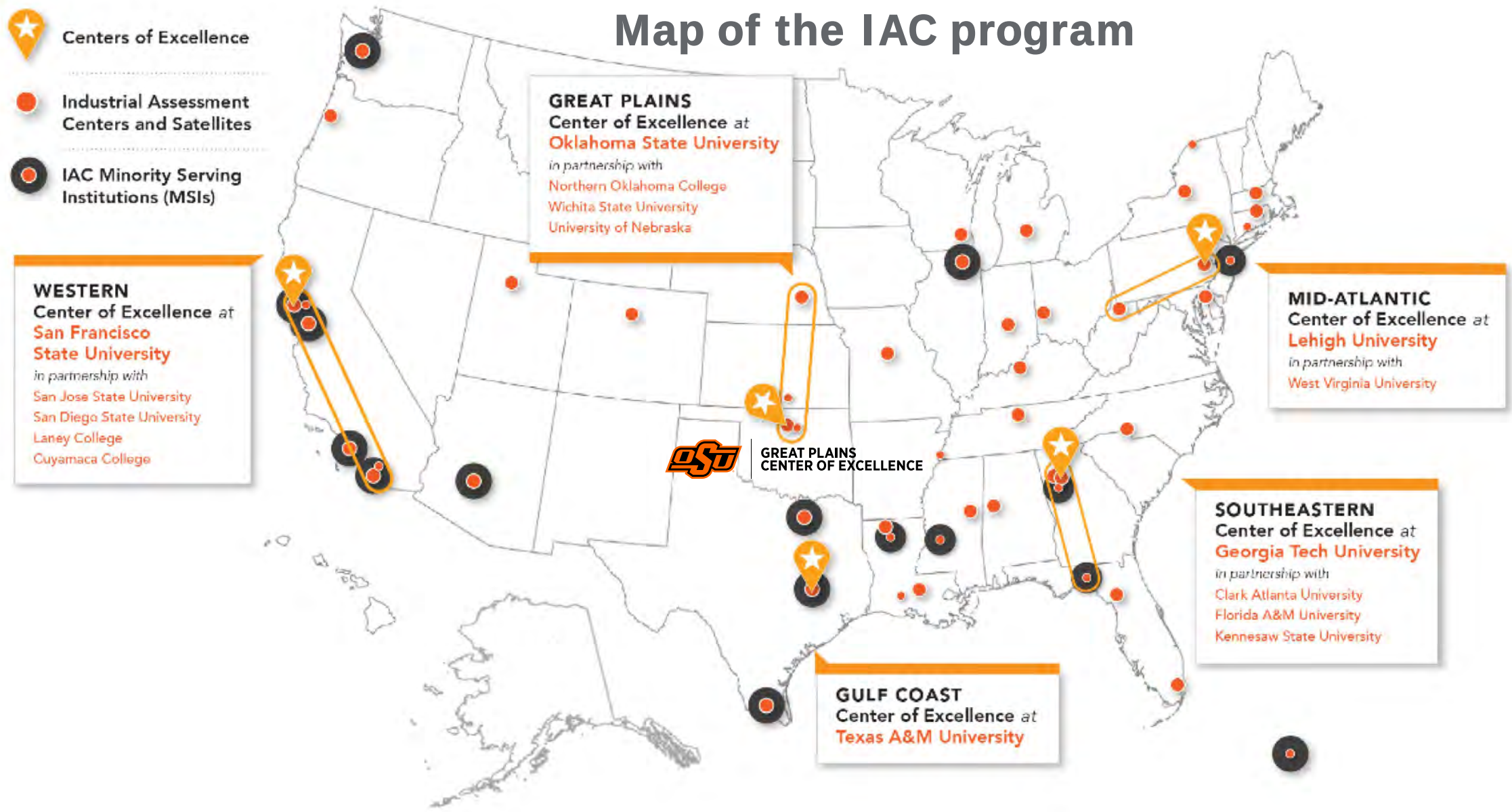
Oklahoma State University's Industrial Assessment Center (IAC) has helped manufacturers reimagine their operations for more than four decades, identifying a combined $132 million in potential cost savings and educating hundreds of renowned energy engineers.

This spring, an OSU campus visit from U.S. Secretary of Energy Jennifer M. Granholm and Second Gentleman Douglas Emhoff trumpeted the creation of a new entity that will expand OSU's footprint across the region, amplifying its institutions to serve as centers of excellence for the Department of Energy's Industrial Assessment Centers Program.

"[OSU's IAC] is one of 37 Industrial Assessment Centers that we have through funding with the Department of Energy," Granholm said as she addressed a crowd during an April 7 news conference at OSU's ENDEAVOR lab. "And the thing that is so important is that it does give students this hands-on ability to see technology in action to see how to reduce the carbon emissions price of energy, reduce energy

PHIL SHOCKLEY

Great Plains Center of Excellence (GPCoE)



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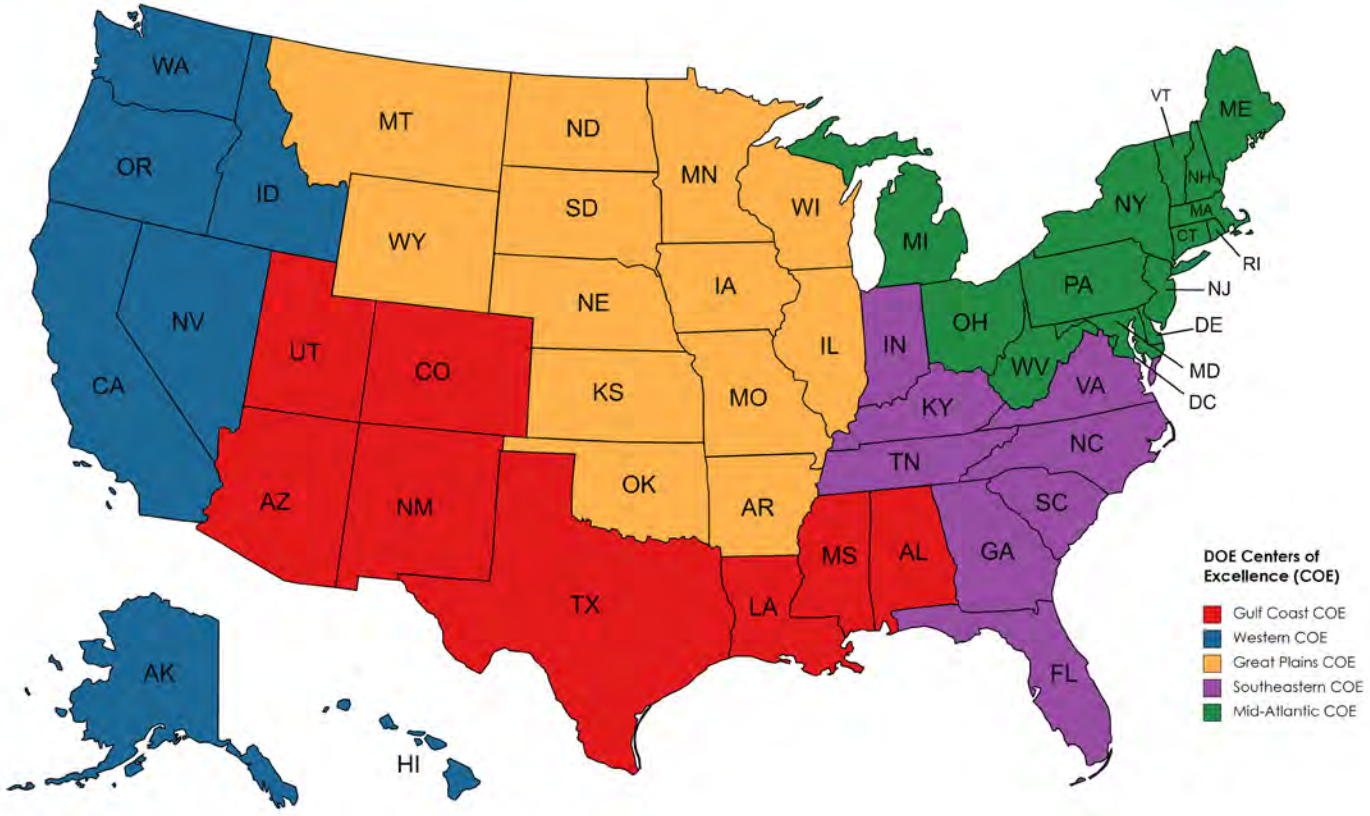
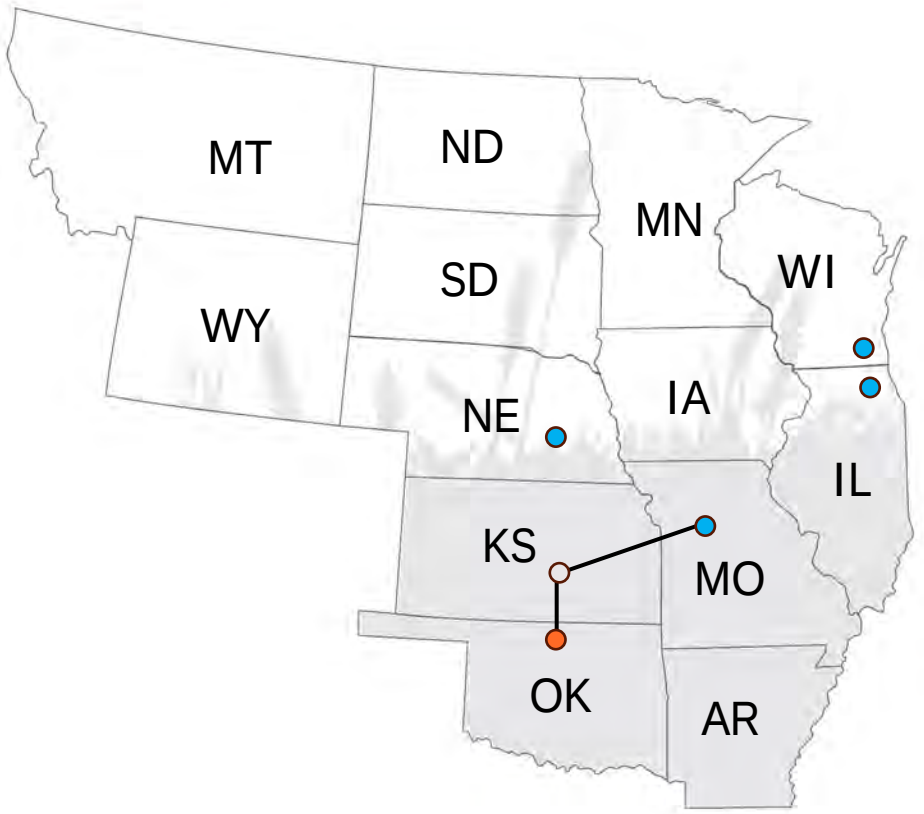
Map of the IAC program





GPCoE will serve 13 Great Plains States as a regional hub for the DOE and its strategic partners:

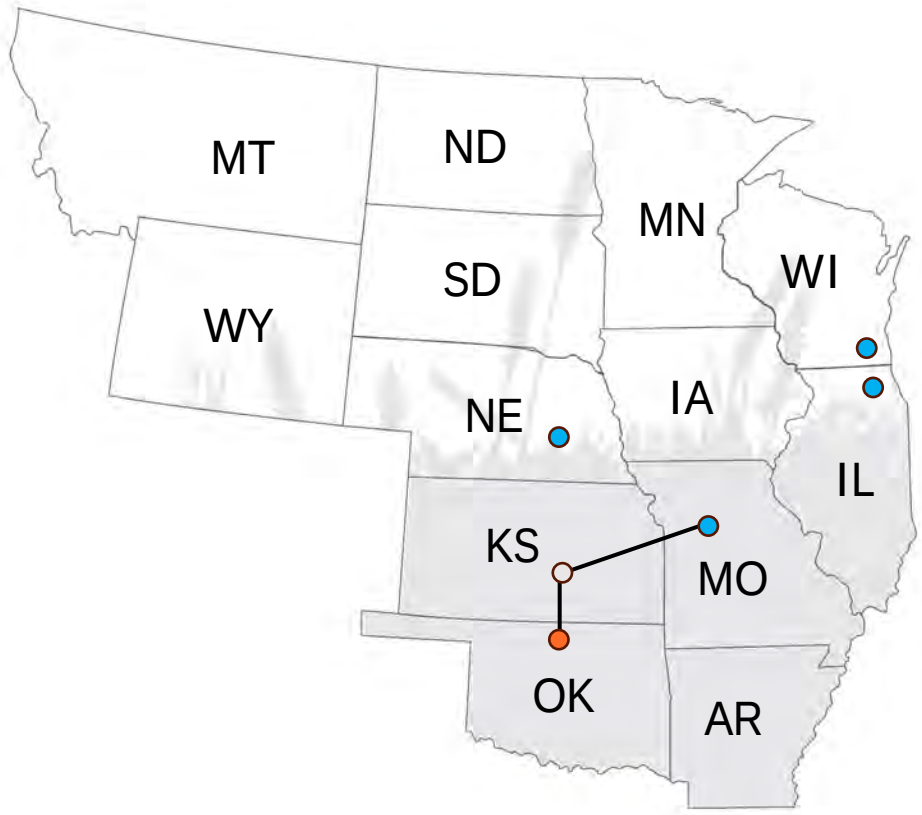
- **6 IAC states**: Oklahoma, Kansas, Missouri, Nebraska, Illinois, Wisconsin.
- **7 non-IAC states**: Arkansas, Iowa, Minnesota, North Dakota, South Dakota, Wyoming, and Montana.

Build a collaborative center where all can participate, contribute, and prosper.

Great Plains Center of Excellence (GPCoE)

GOALS

- Support expansion of existing assessment practices and development of new tools.
- Coordinate efforts with national and regional stakeholders.
- Support the development of materials and resources for the National Clearinghouse.
- Coordinate regional outreach activities.
- Mentor all the IAC directors, staff, and students regionally.
- Develop and train on new methods of delivering IAC assessments.
- Support student-focused activities.
- Forge new relationships and articulation agreements.
- Support regional and national **clean-energy workforce development** activities.



GREAT PLAINS CENTER OF EXCELLENCE

Great Plains Center of Excellence (GPCoE)

- **Key Personnel/Organizations** *(50+ partners and supporters)*
  - OSU, Northern OK College, IACs at Wichita State, Nebraska, LA Tech, Missouri, Texas A&M, Colorado, North Texas, Hamm Institute of American Energy, Great Plains Institute, Tulsa CC, CareerTech, MeridianTech, New Mexico State University, ENTEGRITY, OSU-IT, Guernsey, AEE, AEEOK, SPEER, MEEA, AEP/PSO, Lubrication Univ, ORNL, OK-LSAMP, CHP-TAP, DEQ, SEE, ABSG, EGT, CREC
- **Key Milestones & Deliverables**
  - Develop smartphone App, remote/virtual assessment capabilities, curriculum development, host conferences, trainings, workshops, outreach events.
  - Submit resources to the National Clearinghouse.
  - Reach target DEI inclusivity index of 4.20 making significant outreach to disadvantaged populations.
- **Project Impact**
  - Support the National Clearinghouse's needs and equitably develop the clean energy workforce and form significant collaboration focused on improving our region's industrial competitiveness.

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PHIL SHOCKLEY

REMOTE/VIRTUAL ASSESSMENT

- The vision of OSU IAC COE is to create a "**Techanical Assistant Program (TAP) – Remote/Virtual Assessment**" to create a big impact on the mission of Dept. of Energy.

- Educational program - webinars, trainings, workshops, or short credential-based certificate program for us.

VIRTUAL ASSESSMENT/ TRAINING

- Virtual modules
  - for Manufacturing plant, Water and Wastewater treatment plants, commercial buildings
- Simulate 3D virtual tour
- Virtual observations and collect data/measurements
  - Take picture, read name plates, take readings, measure RPM, IR thermography, air pressure leaks, illumination level, combustion analysis, etc.
- Simulate predefined issues and ask students to identify opportunities
  - Air leaks, etc.
- Energy treasure hunt activity for all levels
- Incorporate this in online virtual trainings
- Benchmarking activities

RURAL ENERGY ASSESSMENT CENTER (REAC)

USDA From USDA Rural Development Rural Energy for America Program (REAP)

USAD REAP – Energy Audit Program

Small rural businesses and/or rural agricultural producers of Oklahoma

- **Conduct 10 energy assessments** per year for small rural businesses and/or rural agricultural producers that are located in rural towns of Oklahoma.
- Timeline – April 2023 to March 2024.

Qualification Criteria

MUST BE A RURAL AGRICULTURAL PRODUCERS OR A RURAL SMALL BUSINESSES

- Facility should be located in a rural area.
- Should be directly engaged in the production of agricultural products.
- Should be a small business that meets Small Business Administration's (SBA) definition of Small Business.
- No cap or requirements of minimum annual expenditure toward energy bills (including electricity, natural gas, water, and all other fuels).
- Client need to pay $500 as energy auditing fees.

OKLAHOMA
Rural Water
Efficiency Program

Rural Water Efficiency Program (RWEP) funded by Oklahoma Department of Commerce

- Conduct energy assessments per year for small rural water treatment plants (RWDs) that are located in rural towns of Oklahoma.
- Timeline - June 2023 to Aug 2023.

Qualification Criteria

MUST BE A RURAL OKLAHOMA WATER TREATMENT PLANT

- Applications are accepted on a rolling basis, and plants will be notified within 10 days if they are eligible for services.
- FREE to Public Water Treatment Plants and rural water districts within the State of Oklahoma.

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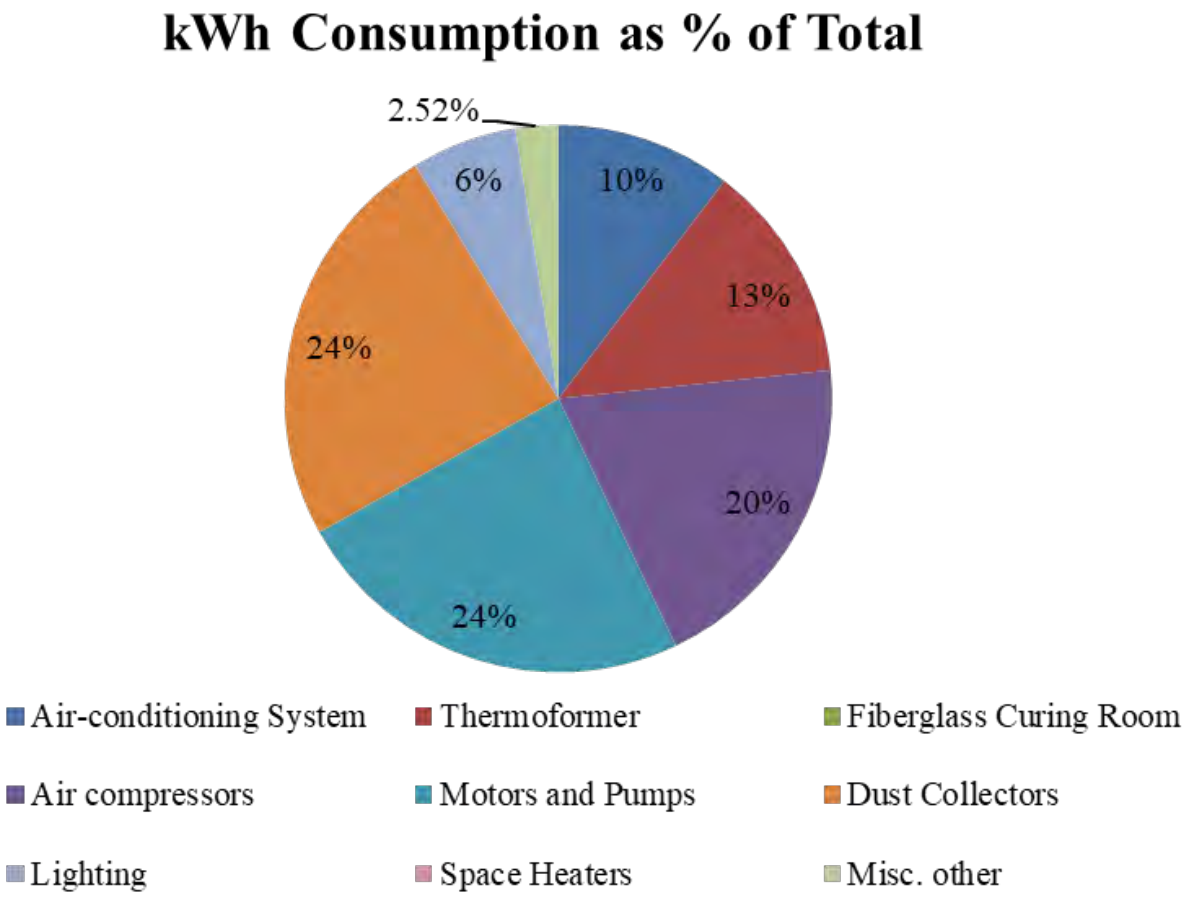
ENERGY EFFICIENCY MEASURES IN MANUFACTURING PLANTS

ESTIMATED ENERGY BALANCE BY SYSTEM

Example - Whirlpool Bathtubs Manufacturing Plant

System	Estimated electricity consumption (kWh)	% Annual bill	Estimated natural gas consumption (MMBtu)	% Annual bill
Air-conditioning System	98,754	10%	0	0%
Thermoformer	123,476	13%	0	0%
Fiberglass Curing Room	0	0%	3,050	65%
Air compressors	186,500	20%	0	0%
Motors and Pumps	226,430	24%	0	0%
Dust Collectors	231,890	24%	0	0%
Lighting	59,240	6%	0	0%
Space Heaters	0	0%	1,407	30%
Misc. other	23,980	3%	235	5%
Total	950,270	100%	4,692	100%



This info will not always be available – Which make it into one goal for the assessment!

CONVERT TO LED AND ADD CONTROLS

- 400W metal halide runs 24/7
- With 7.0cents/kWh
- Energy savings = 0.4 kW × 8,760 hours per year × $0.07/kWh

Current Cost = $245/year

Reduce kW and hours

- Convert to LED = 0.28 kW x 3,000 hours per year x $0.07/kWh

New Cost = $58/year

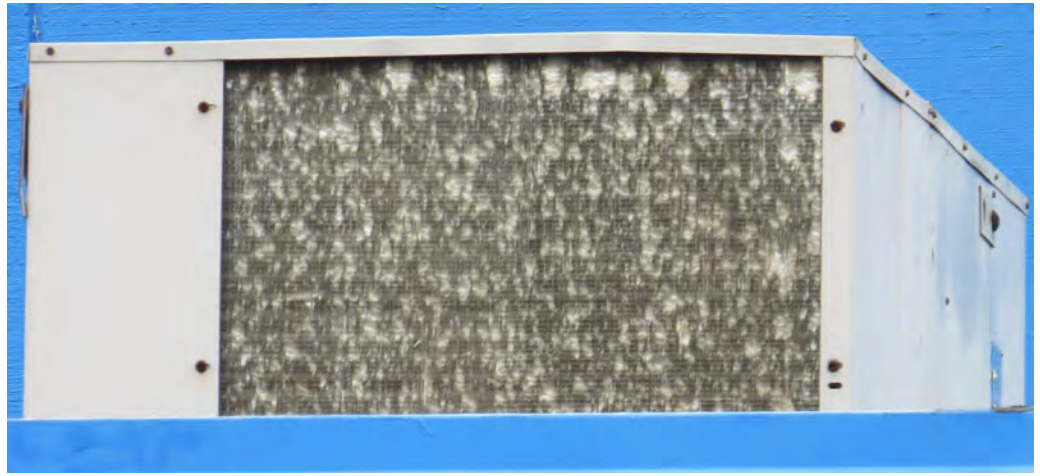
Check for rebates with utility providers

INCREASING TEMPERATURE FROM 60°F TO 72°F

- In cooling months, setting your temperature to 72°F for at least 8 hours a day will save 10% of your electricity bills
- That is approximately $83/year
- Key Takeaway: The smaller the difference between the indoor and outdoor temperatures, the lower your overall cooling bill will be.
- Source: https://www.energy.gov/energysaver/thermostats

Check for rebates with utility providers

CLEANING CONDENSER COIL



- Annual Energy saved (if office runs 8 hrs/day) = (8.7-7.8) × 2,080 hours = 1,872 kWh
- Dollar saved = 1,872 × 7 cents/kWh = $131/year

Rooftop package unit: 7.5 tons

- kW/ton (if maintained) = 12/11.4 = 1.05
- kW/ton (damaged condenser coil) = 12/10.26 = 1.16
- Electrical load if maintained = 7.5 ton × 1.05 kW/ton = 7.8 kW
- Electrical load for damaged condenser coil = 7.5 ton × 1.16 kW/ton = 8.7 kW

SIMILAR SITUATION

REMOVE PLANT AWAY FROM CONDENSER

Cooling capacity of the air conditioner drops by 25%-30%

- Split Unit Capacity = 5 tons each × 2
- kW/ton (if maintained) = 12/9.5 = 1.26
- kW/ton (damaged condenser coil) = 12/7.125 = 1.68
- Electrical load if maintained = 10 tons × 1.26 kW/ton = 12.6 kW
- Electrical load for damaged condenser coil = 10 tons ×1.68 kW/ton =16.8 kW
- Annual Energy saved (if office runs 8 hrs/day) = (16.8-12.6)×2,080 hours = 8,736 kWh savings
- Dollar saved = 8,736 × 7 cents/kWh = $611/year

SIMILAR SITUATION

WASTE HEAT RECOVERY

Assume 5,000 lbs/hr of condensate at 180°F

- Annual Fuel Savings

= (1 – Flash Steam Fraction) × (Condensate Load, lb/hr) × Annual Operating Hours × (Makeup Water Temperature Rise, °F) × (Fuel Cost, $/MMBtu) × (Heat Capacity of Makeup Water, Btu/lb-°F)/ (Boiler Efficiency × 10^6 Btu/MMBtu)

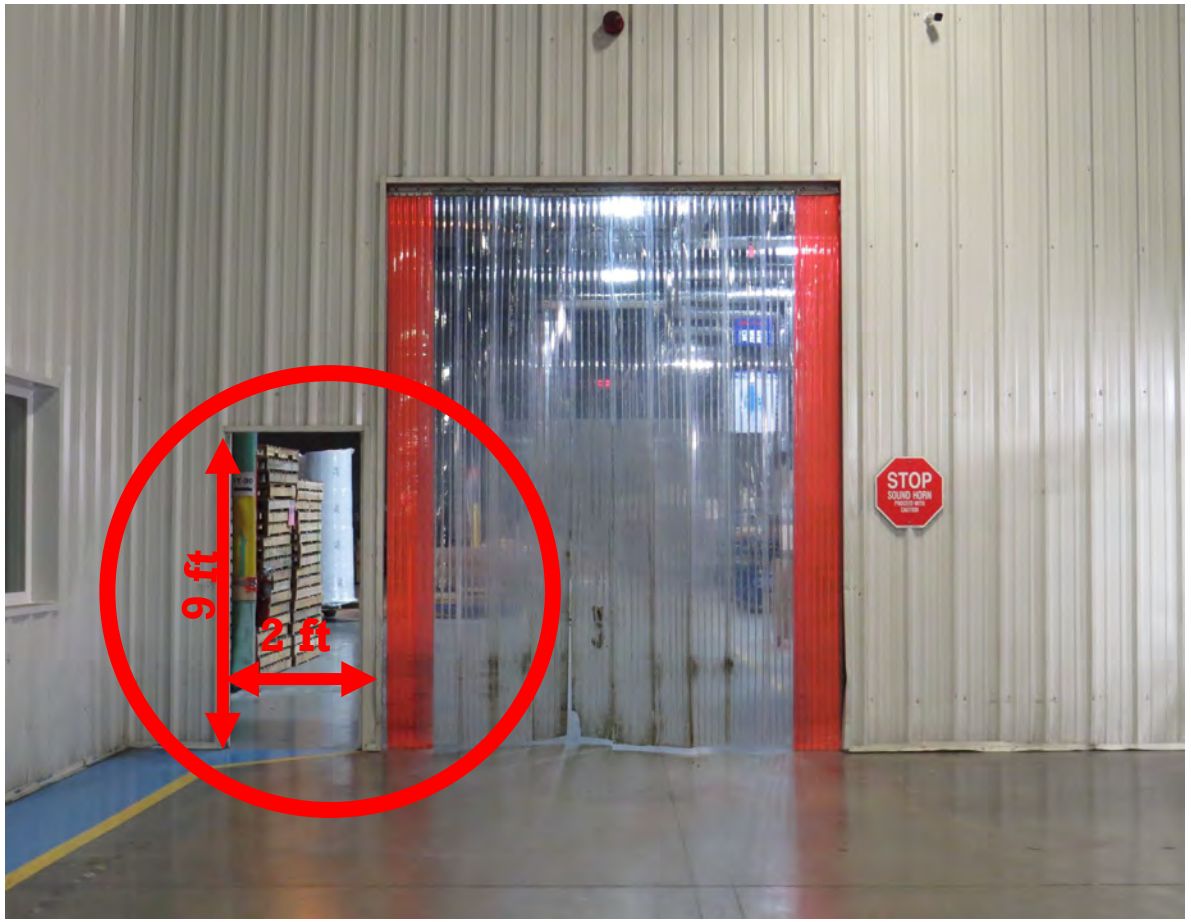
= (1 – 0.12) × 5,000 × 3,500 × (180 – 55 °F) × $8.00 × 1/(0.80 × 10^6) =

= $19,250

JOINT INSULATION

- Pipe insulation is easy but joint insulation is often neglected.
- Joint insulation can be done using jackets or sprays.

SAVINGS USING STRIP CURTAINS



- Facility runs 12 hrs/day
- Total air flow due to temperature difference = 96 ft^3/s
- Heat loss due to air flow in winter($\Delta T=10$) = 66 MMBTU/year
- Heat loss due to air flow in summer (($\Delta T=5$) = 9,717 kWh/year
- Total dollar saved = 66 MMBTU/year × 8 + 9,717 kWh/year × $0.07/kWh

= $1,208/yr

Check for rebates with utility providers

FORKLIFT – SWITCH TO ELECTRIC

Check for rebates with utility providers

Energy savings
= (Existing energy use) – (Electric forklift energy use)
= 1,408 MMBtu/year - 468 MMBtu/yr = 940 MMBtu/yr

Energy cost savings
= (Existing annual cost of propane) – (Electric forklift energy cost)
= ($29,037/yr) – ($6,257/yr) = $22,780/yr

Electric forklift lease cost
= (Additional monthly lease cost)(Number of forklifts)(conversion factor)
= ($100/month)(11 forklifts)(12 months/yr) = $13,200/yr

Annual savings
= (Energy cost savings) – (Electric forklift lease cost)
= ($22,780/yr) – ($13,200/yr) = $9,580/yr

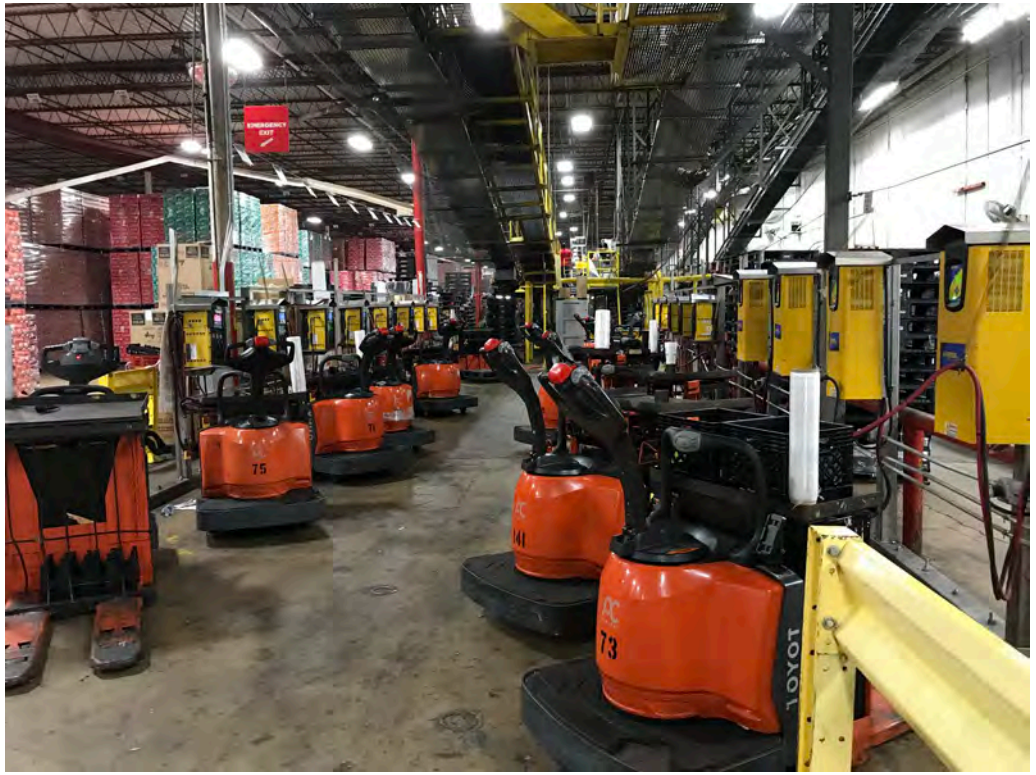
Cost estimated by current forklift lease vendor as additional cost per month for 11 electric forklifts with 9 hour batteries and 11 high-efficiency programmable chargers.

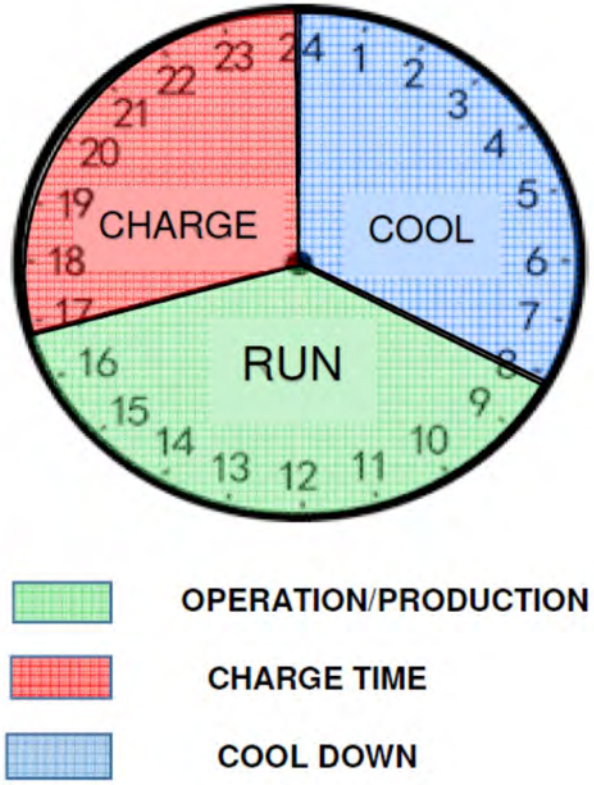
Implementation Cost
= (Battery charger installation time)(Number of battery chargers)(Maintenance cost)
= (2 hours/battery charger)(11 Battery chargers)($35/hr) = $770

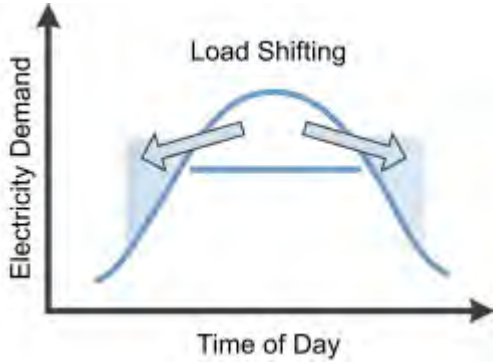
Simple Payback Period
= (Implementation Cost) / (Cost Savings)
= $770 / $9,580/yr = **0.1 yrs**

Calculator: https://et.epri.com/Calculators_LiftTruckComparison_with_cap2.html

FORKLIFT – CHARGE BATTERIES ON OFF-PEAK HOURS







- Charged the battery on the off-peak hours for additional savings
  - Rates are low at the night
  - Put the hard timer lock so operator accidently don't charge on peak hours
  - Use High Frequency Battery Chargers

OPTIMIZE FORKLIFT USE

- Facility uses 24 forklifts with utilization rate of 53%
- For optimal use of forklift, utilization rate should be between 60-70%
- For 65% utilization rate, optimal number of forklift

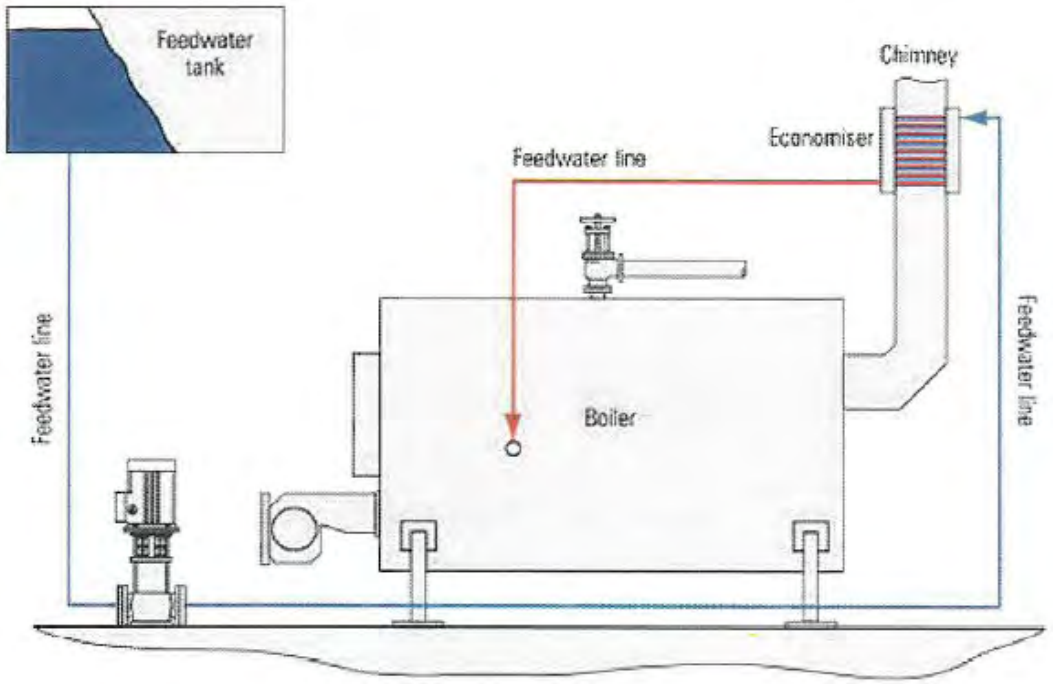
= (Storage or Retrieval request) / (Optimal Utilization rate) (service rate)

= 3.2 / (0.65) (0.25) = 20

- Reducing the use of 4 forklift trucks will save 11,646 kWh (if one forklift works 8 hours/day) and 90 kW demand reduction
- Total dollar savings = $1,628/year

USE ECONOMIZERS TO PREHEAT WATER

Industrial Boilers

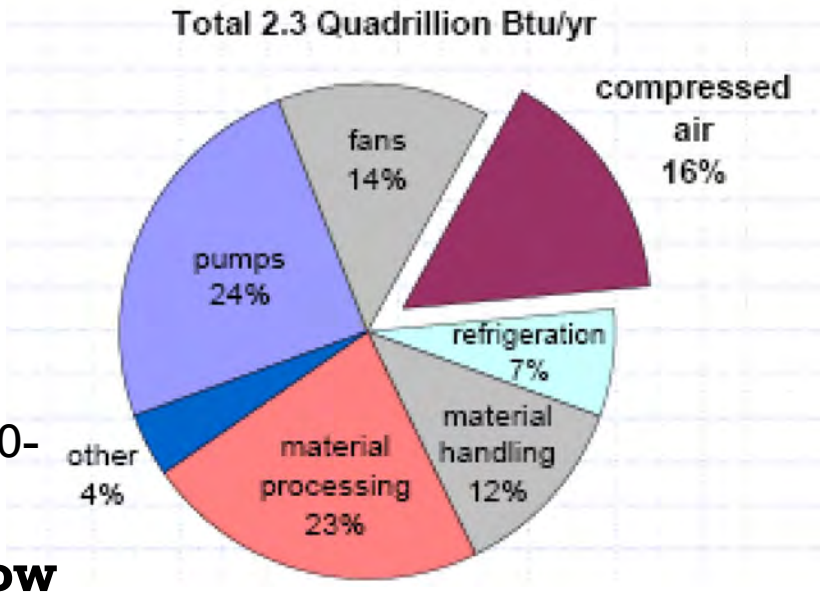


Schematic Diagram of Boiler with Economizer

- Heat content in the flue gas of the combustion in boiler can be used to preheat water.
- Economizers are used to preheat the incoming water and by doing so it helps to save significant amount of fuel.
- Savings can be determined by the heat content in flue gas (temperature of flue gas). A general rule of thumb is annual savings of fuel by use of economizer can be around 10%.

COMPRESSED AIR - *WHY FOCUS ON IT?*

- **Consumes 5-20% of a plant electricity**
- **It is an expensive industrial utility – it accounts for $1,500,000,000 in energy bills every year!!**
- **People tend to underestimate its importance – Air is "cheap"**
- **Often used poorly**
  - Improvements to air system can reduce energy consumption by 20-50%
- **Both workers and management often fail to understand how expensive compressed air is**
- **Typical plant**
  - Plant Demand:……400 CFM
  - Loss due to Air Leaks ……20%
  - Annual Operation……8000 Hours
  - Typical Compressor:
  - 4 CFM per 1 HP (0.912 KW)
  - 1 CFM = 0.228 kW
  - Electrical Cost: $0.06/kWh
  - **1 CFM = $0.0137/Hour**



Example:

- Plant Demand (CFM)…… 400
- 20% Air Leaks (CFM)…… 80
- Total Demand(CFM)……480

400CFM x 8000Hrs X .0137/Hr=	**$43,840**
80CFM x 8000Hrs X .0137/Hr=	**$8,768**
TOTAL COST =	**$52,608**

A new 100 hp compressor costs ~$30k!

REPAIR LEAKS IN BLOWER LINES AND VALVES

Ultrasonic Air Leak Detection

- Recommendation – Perform Air Leak Maintenance
- In the blower line and valves, our audit found significant number of leaks.
- These leaks result in blower working for more time to suffice the requirement and repairing these leaks can save significant amount of energy consumed by blower.
- By repairing these leaks, the plant could save 243,703 kWh of energy or $18,521 per year

REDUCE COMPRESSED AIR PRESSURE

Kaeser Air Compressor

- Most of the air compressors are run at higher pressure than required for industry courtesy of losses during transfer of compressed air.
- A general rule of thumb is air pressure should be at most 15 psig more than operating pressure. Suppose the operating pressure is 90 psig then it is desired the pressure is kept at 105 psig.
- Any set pressure more than that puts heavy work load on compressor resulting in larger energy consumption.

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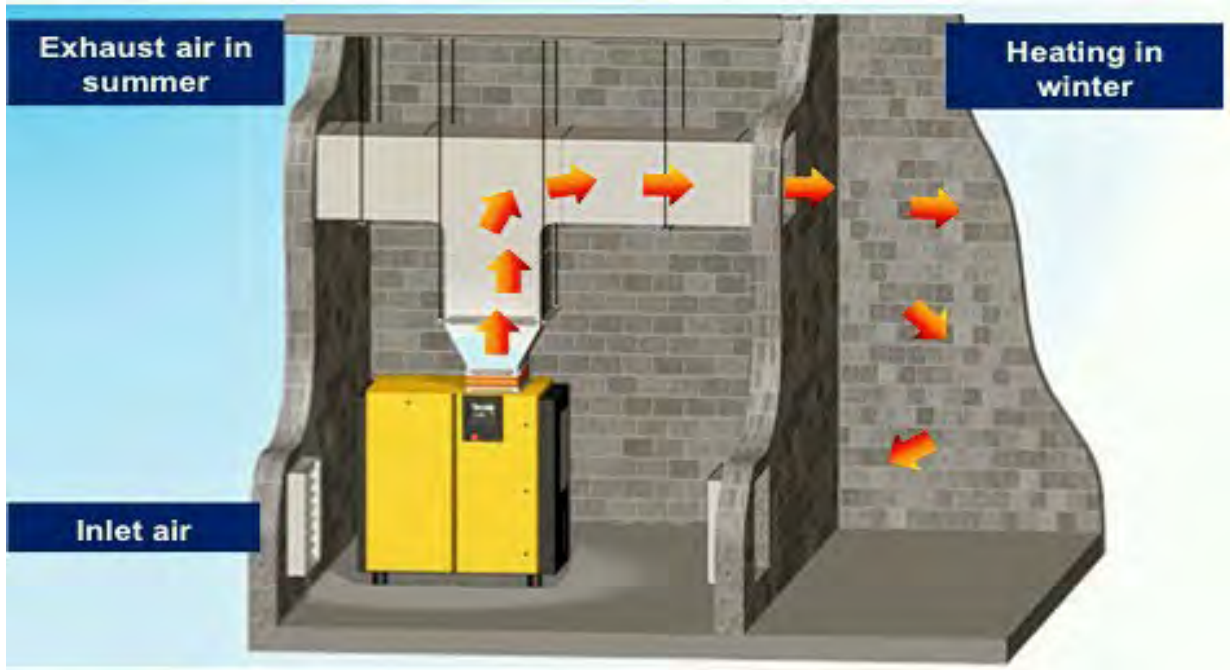
RECOVER WASTE HEAT FROM AIR COMPRESSOR FOR PLANT HEATING



Example duct work to recover waste heat from air compressor

- Compressor doing work results in heat which needs to be dissipated.
- This heat energy can be recovered for plant heating during winter months by proper ducting.
- It is more suitable for the location near to the compressor room as ducting cost would be substantially less and not much heat would be lost in transfer.

INSTALL VFD

- Install VFD on 125 HP blower motor The plant has five 125 HP blower without variable frequency drives (VFDs), out of which two of them run all the time.

- By installing VFDs on blowers, the plant could save 81,665 kWh or $6,207 per year.

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RECOMMENDATIONS FOR MOTORS

Example of Variable Frequency Drive (VFD)

- **Install variable frequency drive (VFD) on motor which operates at different speed**
- Industrial motors run at variable speed depending upon nature of operation.
- If it is operated at its highest capacity, it draws a lot of energy to perform less work.
- Hence, it is desired to install a variable frequency drive which only performs work at desired speed resulting in massive saving of electrical energy.
- The use of a data logger on the motor to measure the pattern of energy consumption determines the feasibility on installing a VFD.

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THANK YOU

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