



**Gulf Coast Center
of Excellence**

Session 07: Best Practices for Critical Equipment

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Opportunity Identification

What should be the objective of a “typical” assessment?

- **If the majority of the energy use is electrical**



- Objective: identify 10-15% energy savings

- **If the majority of the energy use is thermal (natural gas)**



- Objective: identify 20-25% energy savings

- **A typical one-day assessment identifies 10-12 projects**

- Projects with simple payback period less than 2 years
- Longer payback periods acceptable if external grants or rebates are a possibility

Principles of Energy Management

- **80% of the energy savings potential is in the largest 20% of the process**
- **Focus on energy intensive processes. Consider alternative technologies.**
- **Focus on support equipment. Adopt best practices.**
 - Motors and Drives
 - Air Compressors
 - Steam Systems
 - Process Heating
 - Process Cooling
 - Pumps and Fans

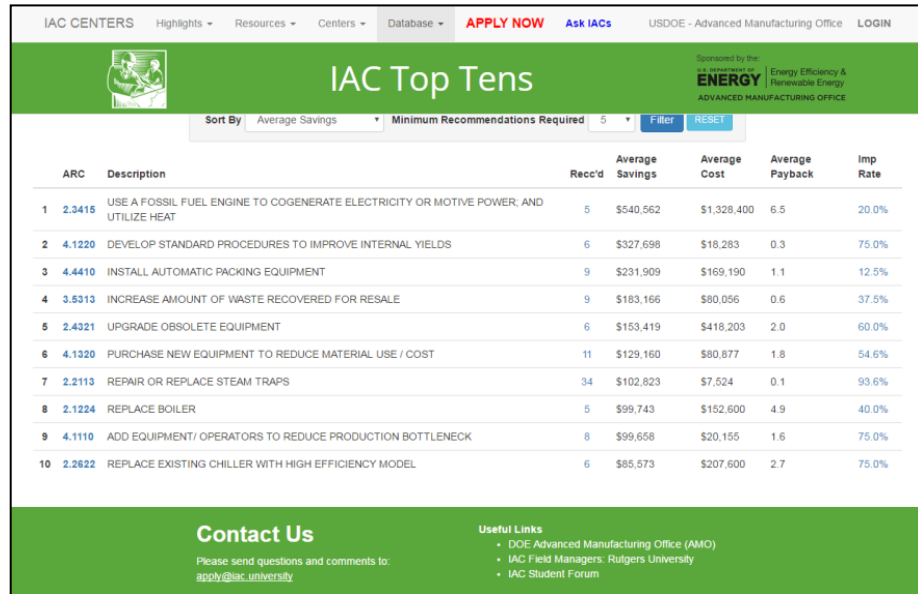
What are the most common recommendations?

- Data available the national IAC database:

<https://iac.university/topTens>

- Data is searchable based on:

- Largest savings
- Most recommended
- Most implemented
- Best payback
- Industry
- Geography, year, etc.



The screenshot shows the 'IAC Top Tens' webpage. At the top, there's a navigation bar with links like 'IAC CENTERS', 'Highlights', 'Resources', 'Centers', 'Database', 'APPLY NOW', 'Ask IACs', 'USDOE - Advanced Manufacturing Office', and 'LOGIN'. Below this is a green header with the 'IAC Top Tens' title and a logo. A search bar allows filtering by 'Sort By' (Average Savings), 'Minimum Recommendations Required' (5), and a 'Filter' button. The main content is a table with 10 rows of recommendations, each with an ARC number, description, and various metrics. At the bottom, there's a 'Contact Us' section and 'Useful Links'.

ARC	Description	Average Reccd	Average Savings	Average Cost	Average Payback	Imp Rate
1 2.3415	USE A FOSSIL FUEL ENGINE TO COGENERATE ELECTRICITY OR MOTIVE POWER, AND UTILIZE HEAT	5	\$540,562	\$1,328,400	6.5	20.0%
2 4.1220	DEVELOP STANDARD PROCEDURES TO IMPROVE INTERNAL YIELDS	6	\$327,698	\$18,283	0.3	75.0%
3 4.4410	INSTALL AUTOMATIC PACKING EQUIPMENT	9	\$231,909	\$169,190	1.1	12.5%
4 3.5313	INCREASE AMOUNT OF WASTE RECOVERED FOR RESALE	9	\$183,166	\$80,056	0.6	37.5%
5 2.4321	UPGRADE OBSOLETE EQUIPMENT	6	\$153,419	\$418,203	2.0	60.0%
6 4.1320	PURCHASE NEW EQUIPMENT TO REDUCE MATERIAL USE / COST	11	\$129,160	\$80,877	1.8	54.6%
7 2.2113	REPAIR OR REPLACE STEAM TRAPS	34	\$102,823	\$7,524	0.1	93.6%
8 2.1224	REPLACE BOILER	5	\$99,743	\$152,600	4.9	40.0%
9 4.1110	ADD EQUIPMENT/ OPERATORS TO REDUCE PRODUCTION BOTTLENECK	8	\$99,658	\$20,155	1.6	75.0%
10 2.2622	REPLACE EXISTING CHILLER WITH HIGH EFFICIENCY MODEL	6	\$85,573	\$207,600	2.7	75.0%

Contact Us
Please send questions and comments to:
apply@iac.university

Useful Links

- DOE Advanced Manufacturing Office (AMO)
- IAC Field Managers: Rutgers University
- IAC Student Forum

What are the most common recommendations?

- **Data available the national IAC database:**
<https://iac.university/topTens>
- **Top recommendations can generally be categorized as follows:**
 - Utilities
 - Compressed Air
 - Motors
 - Lights
 - Heating Systems, Steam Systems, etc.

What are the most common recommendations?

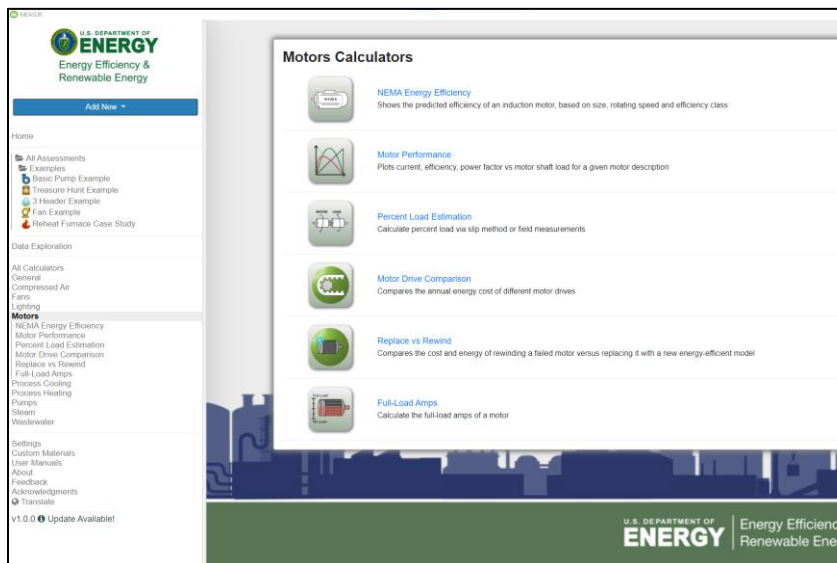
- Data available the national IAC database:

<https://iac.university/recommendationTypes>

TOP	ARC	Description	Recommendations	Recommended \$ Savings	Average Payback (yrs)	Implementation Rate
back	2.xxxx	ENERGY MANAGEMENT	143,170	\$2,029,254,418	1.8	51.0%
back	2.2xxx	Thermal Systems	19,968	\$424,396,232	3.0	41.8%
	2.21xx	STEAM	4,111	\$101,259,521	1.3	65.3%
open	2.211x	Traps	461	\$16,206,330	0.5	77.3%
open	2.212x	Condensate	864	\$28,391,338	1.2	53.6%
open	2.213x	Leaks and Insulation	2,470	\$46,482,473	1.5	69.6%
open	2.214x	Distillation	7	\$524,121	1.8	16.7%
open	2.215x	Maintenance	59	\$3,554,574	0.6	59.6%
open	2.216x	Operations	222	\$4,780,188	0.5	47.9%
open	2.219x	Miscellaneous	28	\$1,320,497	2.1	28.0%

Additional Resources: DOE “Treasure Hunts”

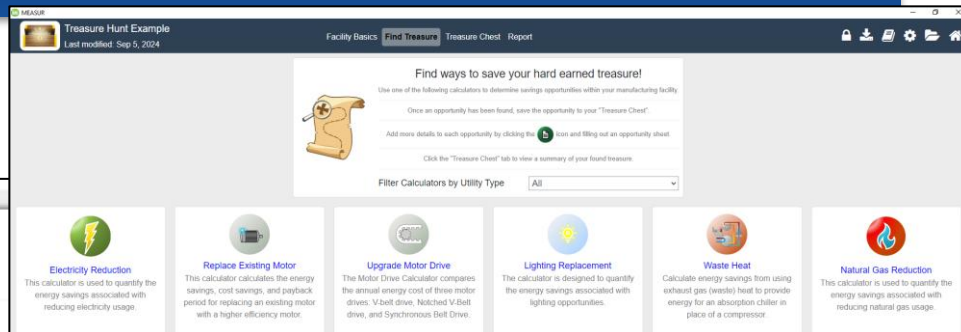
MEASUR Software



The MEASUR Software Home Page features the U.S. Department of Energy logo and a navigation menu. The main content area is titled "Motors Calculators" and lists several tools:

- NEMA Energy Efficiency:** Shows the predicted efficiency of an induction motor, based on size, rotating speed and efficiency class.
- Motor Performance:** Plots current, efficiency, power factor vs motor shaft load for a given motor description.
- Percent Load Estimation:** Calculate percent load via slip method or field measurements.
- Motor Drive Comparison:** Compares the annual energy cost of different motor drives.
- Replace vs Rewind:** Compares the cost and energy of rewinding a failed motor versus replacing it with a new energy-efficient model.
- Full-Load Amps:** Calculate the full-load amps of a motor.

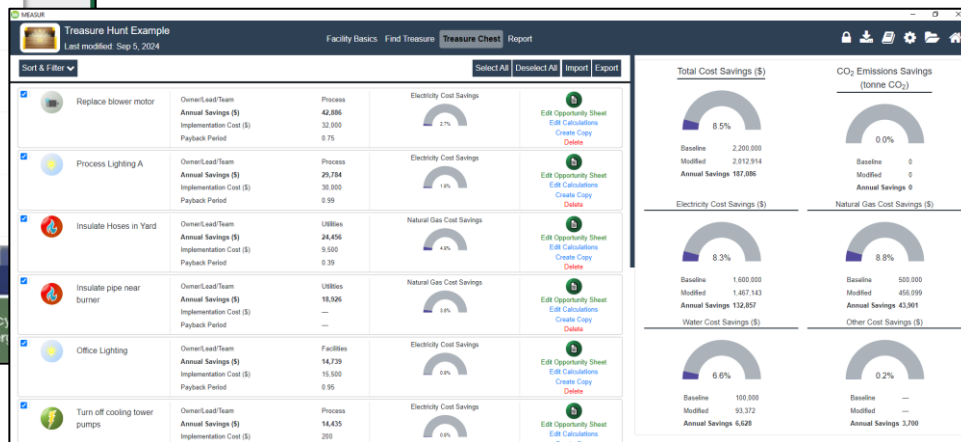
The footer includes the U.S. Department of Energy logo and the text "Energy Efficiency, Renewable Energy".



The "Find Treasure" screen in the MEASUR Treasure Hunt Example shows a treasure map icon and instructions: "Find ways to save your hard earned treasure! Use one of the following calculators to determine savings opportunities within your manufacturing facility. Once an opportunity has been found, save the opportunity to your 'Treasure Chest'." It also includes a "Filter Calculators by Utility Type" dropdown set to "All".

Below the instructions are six calculator tiles:

- Electricity Reduction:** This calculator is used to quantify the energy savings associated with reducing electricity usage.
- Replace Existing Motor:** This calculator calculates the energy savings, cost savings, and payback period for replacing an existing motor with a higher efficiency motor.
- Upgrade Motor Drive:** The Motor Drive Calculator compares the annual energy cost of three motor drives: V-belt drive, Notched V-Belt drive, and Synchronous Belt Drive.
- Lighting Replacement:** The calculator is designed to quantify the energy savings associated with lighting opportunities.
- Waste Heat:** Calculate energy savings from using exhaust gas (waste) heat to provide energy for an absorption chiller in place of a compressor.
- Natural Gas Reduction:** This calculator is used to quantify the energy savings associated with reducing natural gas usage.



The "Treasure Chest" screen in the MEASUR Treasure Hunt Example displays a table of found opportunities and summary charts.

Item	Owner/Lead Team	Annual Savings (\$)	Implementation Cost (\$)	Payback Period	Electricity Cost Savings	Natural Gas Cost Savings	Electricity Savings (\$)	Natural Gas Savings (\$)
1	Replace blower motor	42,896	2,000	0.75	17%	—	8.5%	—
2	Process Lighting A	25,714	35,000	0.99	1%	—	—	0.0%
3	Insulate Hoses in Yard	24,456	5,500	0.39	—	14%	8.3%	8.8%
4	Insulate pipe near burner	15,096	—	—	1%	—	—	—
5	Office Lighting	14,729	15,500	0.95	1%	—	6.0%	0.2%
6	Turn off cooling tower pumps	14,435	200	—	1%	—	—	—

Summary Charts:

- Total Cost Savings (\$):** Baseline 2,200,000, Modified 2,012,314, Annual Savings 187,686.
- CO₂ Emissions Savings (tonne CO₂):** Baseline 0, Modified 0, Annual Savings 0.
- Electricity Cost Savings (\$):** Baseline 1,600,000, Modified 1,487,143, Annual Savings 112,857.
- Natural Gas Cost Savings (\$):** Baseline 500,000, Modified 456,099, Annual Savings 43,901.
- Water Cost Savings (\$):** Baseline 100,000, Modified —, Annual Savings 6,628.
- Other Cost Savings (\$):** Baseline —, Modified —, Annual Savings 3,790.

Additional Resources: DOE Sourcebooks and Tip Sheets

US Dept. of Energy Publications





Best Practices for Specific Equipment

Best Practices for Motors and Drives

- Turn off equipment when not used!
- Synthetic lubricants
- Cogged or synchronized belts
- Power Factor Correction
- Preventative or Predictive Maintenance



Motor System Info Card

Top 5 Energy Conservation Measures

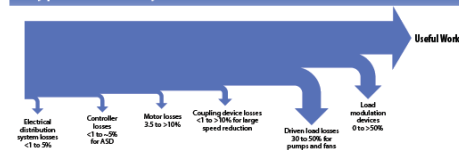
1. Turn off motors when not in use
2. Replace standard V-belts with notched or synchronous belt drives
3. Replace standard efficient motors with energy efficient/premium efficient motors
4. Mitigate voltage unbalance
5. Improve power factor

Annual Energy Savings for Premium vs Standard Efficiency Motors

Motor Horse-power	Standard Efficiency		Premium Efficiency		Annual Cost Savings
	Motor Efficiency	Annual Energy Cost	Motor Efficiency	Annual Energy Cost	
10	86.7	\$6,884	91.7	\$6,508	\$375
25	89.9	\$16,596	93.6	\$15,940	\$656
50	91.6	\$32,576	94.5	\$31,577	\$1,000
100	92.2	\$64,729	95.4	\$62,558	\$2,171
200	93.3	\$127,931	96.2	\$124,075	\$3,857

Note: Based on a 1,800 RPM TEFC motor in operation 8,000 hours per year (hrs/year) at 75% load at an electrical rate of \$0.1/kWh.

Typical Motor System Losses



Rules of Thumb: Replace Instead of Rewind If...

- Motors are standard and easy to purchase
- The process down time will be significantly reduced
- Motor power is less than 50 hp
- The cost of rewinding exceeds 60% of the price of a new motor

Best Practices for Compressed Air Systems

- Leak management
- Right-size compressor
- Lower pressure
- Eliminate inappropriate uses



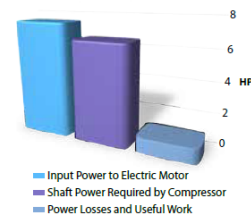
Compressed Air System *Info Card*

Top 5 Energy Conservation Measures

1. Eliminate inappropriate uses of compressed air
2. Stabilize system pressure
3. Lower pressure requirements of end uses
4. Minimize compressed air leaks
5. Provide compressed air of appropriate quality for manufacturing processes

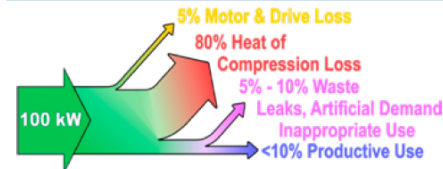
1 hp air motor = 7-8 hp of electrical power

- 30 scfm @ 90 psig is required by the air motor
- 7-8 hp electrical power required for this
- Annual energy cost \$1,164 (air motor) vs. \$194 (electric motor)



* 4,000 hrs/yr; \$0.05/kWh

Compressed Air System's Inefficiency



Rules of Thumb

- Lowering compressor pressure setpoints by 2 PSIG will result in ~1% savings
- Lowering compressor inlet air temperature by 10°F will result in ~2% savings.

Best Practices for Pumps and Fans

- VFDs
- Eliminate gear-boxes
- Trim pump impellers
- Motor best practices

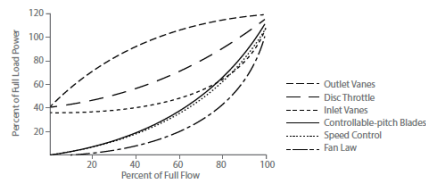


Fan System Info Card

Top 5 Energy Conservation Measures

1. Shut down fans when not needed by manufacturing processes
2. Use VFD instead of modulating dampers for air flow control
3. Use VFD instead of inlet guide vanes for air flow control
4. Replace standard V-belts with cogged V-belts
5. Operate close to Best Efficiency Point

Fan Capacity Control Options

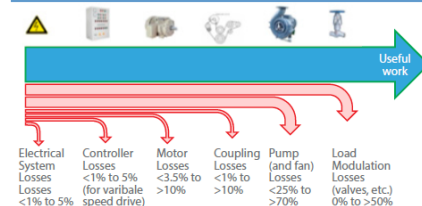


Pump System Info Card

Top 10 Energy Conservation Measures

1. Shut down pumps when not needed by manufacturing processes
2. Operate the minimum number of pumps that systems require
3. Use VFD instead of throttle valve for flow control
4. Trim or change pump impellers on oversized pumps
5. Reduce pipe and valve pressure losses
6. Re-tune pumping system when manufacturing process requirements change
7. Restore internal housing clearance
8. Replace worn throat bushings, wear rings, impellers, and pump bowls
9. Install new properly sized/selected pumps
10. Replace standard efficiency motors with NEMA premium motors

Pump System Energy Losses



Best Practices for Steam Systems

- Steam Traps



- Insulation



- Economizers



- Optimize blowdown

Steam System *Info Card*

Top 10 Energy Conservation Measures

1. Inspect and repair steam traps
2. Insulate steam distribution and condensate return lines and cover heated open vessels
3. Install condensing economizers
4. Use feedwater economizers for waste heat recovery
5. Minimize boiler blowdown
6. Recover heat from boiler blowdown
7. Replace pressure-reducing valves with backpressure turbogenerators
8. Use low-grade waste steam to power absorption chillers
9. Upgrade boilers with energy-efficient burners
10. Optimize the air-to-fuel ratio to improve combustion efficiency

Best Practices for Process Heating

- Combustion Efficiency
- Waste Heat Recovery
 - Preheating
 - Power generation
- Heat Containment
- Optimize batch processes

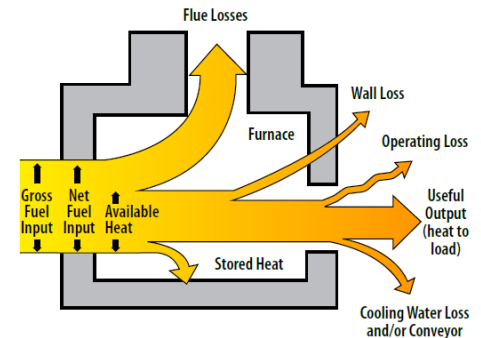


Process Heating System *Info Card*

Top 10 Energy Conservation Measures

1. Check and optimize burner air-to-fuel ratios
2. Consider oxygen-enriched combustion
3. Check and clean heat transfer surfaces
4. Reduce air infiltration in furnaces
5. Install furnace pressure controllers
6. Reduce radiation losses from heating equipment
7. Install waste heat recovery systems on fuel-fired furnaces
8. Preheat combustion air
9. Use flue gases to preheat loads
10. Use waste heat for external processes

Energy Loss Diagram in a Fuel-Based Process Heating System



Best Practices for Process Cooling

- VFDs on Chilled Water Pumps
- VFDs on Cooling Tower Fans
- Clean Cooling Tower HX
- Chiller bypass operation during cool ambient conditions



Process Cooling System *Info Card*

Top 5 Energy Conservation Measures

1. Convert chilled water systems from constant to variable flow by replacing 3-way with 2-way control valves and installing VFDs on distribution pumps
2. Convert condensing water systems from constant to variable flow by installing VFDs on condensing water pumps
3. Convert cooling tower fans from 1-speed or 2-speed to variable speed by installing VFDs
4. Reset chilled water supply temperature setpoints based on the process load
5. Reset condensing water entering temperature setpoints based on the ambient wet bulb temperature



Questions