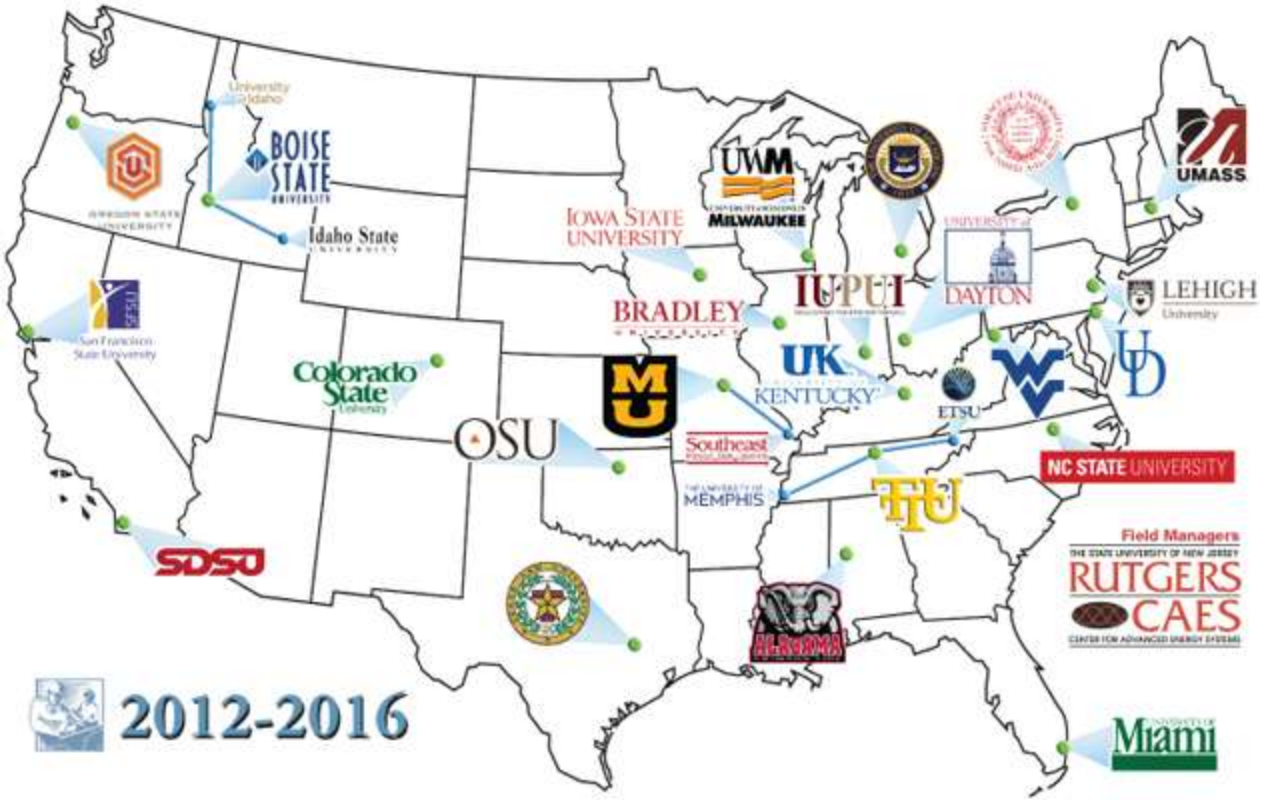
ENERGY MANAGEMENT PRACTICES BY SME

Bhaskaran Gopalakrishnan, Ph.D., P.E., C.E.M
Professor and Director of the Industrial Assessment Center
West Virginia University
Morgantown, West Virginia, USA
Email: bgopalak@mail.wvu.edu
Phone: (304) 293 9434
Fax: (304) 293 4970
Website: http://www2.cemr.wvu.edu/~gopal/

MY BACKGROUND

- Professor, West Virginia University (WVU), USA
- Director, Industrial Assessment Center at WVU
- President, Pro-Plus Engineering, PLLC
- Qualifications
  - PhD in Industrial Engineering (Virginia Tech)
  - MS in Operations Research (SMU)
  - B.E. (Honors) in Production Engineering (University of Madras, India)
  - Registered Professional Engineer in WV
  - Certified Energy Manager (Assoc of Energy Engineers)
  - US DOE Qualified Specialist in Steam, Process Heating, Compressed Air, and Fans
  - Conducted over 250 energy assessments for SME and large manufacturing facilities

Industrial Assessment Centers (IAC) Program, Advanced Manufacturing Office (AMO), US Department of Energy (DOE)



Source: US DOE

SME Focused IAC Energy Assessment Program

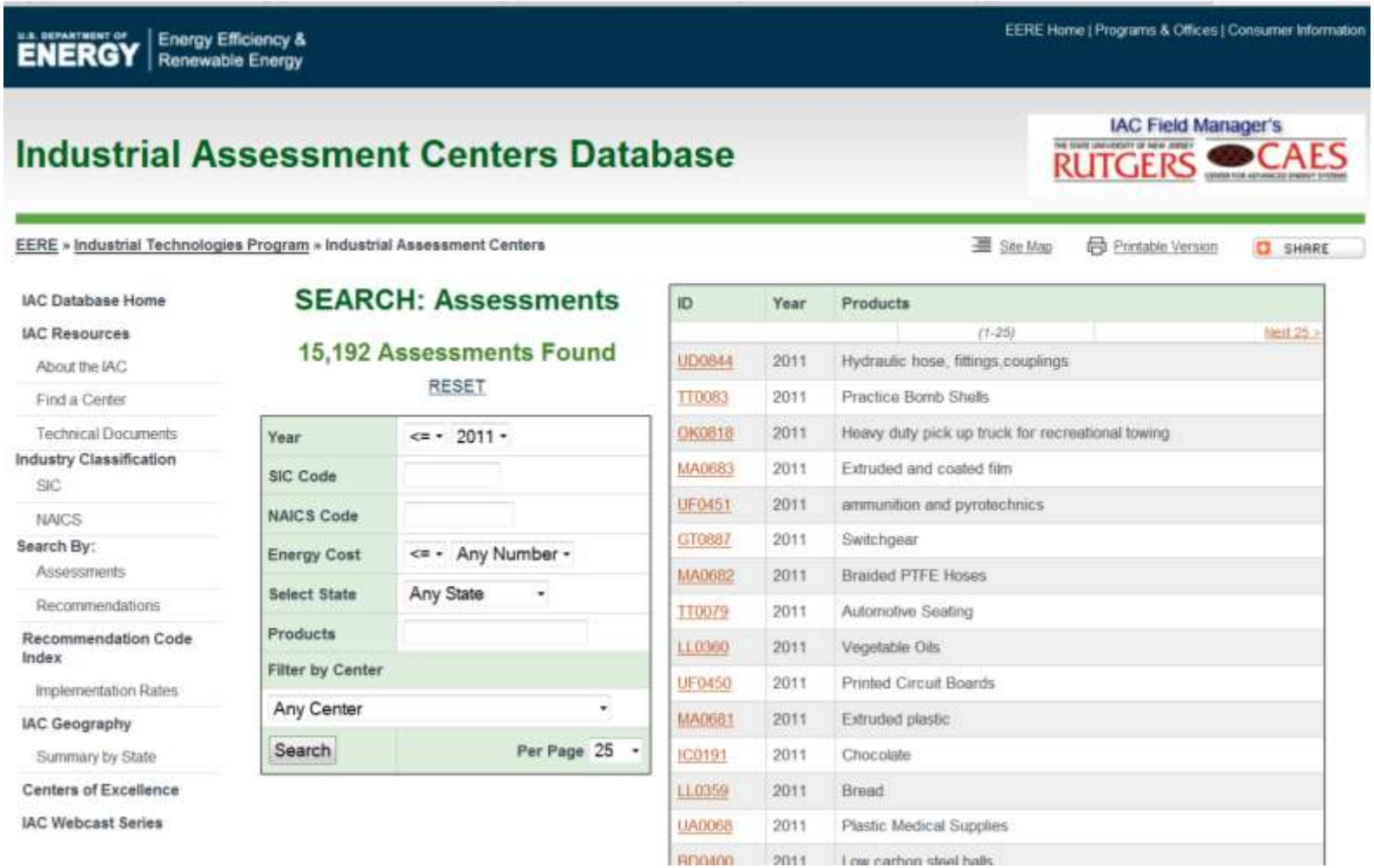
- Qualifying Manufacturing Plants
  - Within Standard Industrial Classification (SIC) 20-39 or North American Industry Classification System (NAICS) 31-33
  - Within 150 miles of a host campus
  - Gross annual sales below $100 million
  - Fewer than 500 employees at the plant site
  - Annual energy bills more than $100,000 and less than $2 million
  - No professional in-house staff to perform the assessment

IAC Database Summary

- Since 1981, 50 assessment centers have entered approximately:
  - 15,200 Assessments
  - 115,000 Recommendations
  - Excellent resource for SME to identify and analyze energy efficiency recommendations

http://iac.rutgers.edu/database/

Industrial Assessment Centers Database



US MANUFACTURING SECTOR

SME in US Manufacturing Sector NAICS 311 - 339

- Aluminum
- Brewing
- Cement
- Chemical
- Corn Refining
- Food Processing
- Forest Products
- Glass
- Metal Casting
- Automotive and Vehicle Manufacturing
- Petrochemical
- Petroleum Refining
- Pharmaceuticals
- Pulp & Paper
- Steel & Iron
- Textiles

Source: Energy Intensive Industries, US DOE

Small – Medium Sized Manufacturing Establishments – US

2007 NAICS code	Meaning of Employment size of establishments code	Number of establishments
31-33	All establishments	332,536
31-33	Establishments with 0 to 4 employees	133,805
31-33	Establishments with 5 to 9 employees	49,218
31-33	Establishments with 10 to 19 employees	46,814
31-33	Establishments with 20 to 49 employees	48,768
31-33	Establishments with 50 to 99 employees	25,019
31-33	Establishments with 100 to 249 employees	19,334
31-33	Establishments with 250 to 499 employees	6,154
31-33	Establishments with 500 to 999 employees	2,410
31-33	Establishments with 1,000 to 2,499 employees	822
31-33	Establishments with 2,500 employees or more	192

Total 99,275

Source: 2007 Economic Census, Census.gov

US Establishments with Employees 20 - 499

NAICS	NAICS Description	All Establishments	SME Establishments (employees 20 - 499)	%
311	Food manufacturing	24731	7941	32%
312	Beverage and tobacco product manufacturing	4222	1084	26%
313	Textile mills	2679	929	35%
314	Textile product mills	6557	986	15%
315	Apparel manufacturing	7688	1299	17%
316	Leather and allied product manufacturing	1246	240	19%
321	Wood product manufacturing	15142	4428	29%
322	Paper manufacturing	4706	2880	61%
323	Printing and related support activities	30526	5391	18%
324	Petroleum and coal products manufacturing	2281	546	24%
325	Chemical manufacturing	13138	5285	40%
326	Plastics and rubber products manufacturing	13351	6340	47%
327	Nonmetallic mineral product manufacturing	16319	4397	27%
331	Primary metal manufacturing	4753	2353	50%
332	Fabricated metal product manufacturing	57762	15864	27%
333	Machinery manufacturing	24926	8380	34%
334	Computer and electronic product manufacturing	13544	5004	37%
335	Electrical equipment, appliance, and component manufacturing	5960	2458	41%
336	Transportation equipment manufacturing	12091	4683	39%
337	Furniture and related product manufacturing	18572	3344	18%
339	Miscellaneous manufacturing	28740	4805	17%
		308,934	88,637	29%

Source: 2009 Business Patterns, Census.gov

Small and Medium Enterprises in USA

- More than 80% of manufacturing businesses have less than 250 employees
- SME (Manufacturing) with 500 or less employees consume 50% of industrial energy
- Manufacturing businesses with 250 or lesser employees constitute 25% of industrial energy use

Source: ACEEE, 2001

Energy Intensity in US Manufacturing Sector

NAICS	Description	Establishments	1 to 19 emp	20 to 99 emp.	Value of shipments ($1,000)	Energy Use Tbtu	Industrial Energy Intensity
311	Food Manufacturing	19,162	11,394	5,368	587,040,074	1,186	2,020.31
312	Beverage and Tobacco Product Manufacturing	3,491	2,494	739	127,625,182	107	838.39
313	Textile Mills	2,798	1,670	664	35,816,220	178	4,969.82
314	Textile Product Mills	6,471	5,274	944	28,684,971	72	2,510.03
315	Apparel Manufacturing	7,968	6,484	1,294	24,299,632	14	576.14
316	Leather and Allied Product Manufacturing	1,260	977	216	5,698,278	3	526.47
321	Wood Product Manufacturing	16,668	10,925	4,371	102,001,662	451	4,421.50
322	Paper Manufacturing	4,984	1,806	1,861	176,018,245	2,354	13,373.61
323	Printing and Related Support Activities	32,199	26,090	5,114	103,216,535	85	823.51
324	Petroleum and Coal Products Manufacturing	2,294	1,656	417	606,004,340	6,864	11,326.65
325	Chemical Manufacturing	13,079	7,614	3,939	722,493,722	5,149	7,126.71
326	Plastics and Rubber Products Manufacturing	12,534	6,118	4,872	211,531,165	337	1,593.15
327	Nonmetallic Mineral Product Manufacturing	16,649	11,127	4,608	127,239,663	1,114	8,755.13
331	Primary Metal Manufacturing	4,328	1,878	1,572	257,851,365	1,736	6,732.56
332	Fabricated Metal Product Manufacturing	60,284	42,539	14,540	345,104,298	396	1,147.48
333	Machinery Manufacturing	22,752	14,295	6,905	347,930,344	204	586.32
334	Computer and Electronic Product Manufacturing	13,806	8,475	3,710	395,409,844	142	359.12
335	Electrical Equipment, Appliance, and Component Manufacturi	4,952	2,712	1,690	129,270,659	103	796.78
336	Transportation Equipment Manufacturing	12,691	6,863	2,944	734,244,498	477	649.65
337	Furniture and Related Product Manufacturing	21,734	17,385	3,339	84,989,575	61	717.74
339	Miscellaneous Manufacturing	31,809	26,410	4,265	145,839,426	66	452.55
Grand Total		**311,913**	**214,186**	**73,372**	**5,298,309,698**	**21,099**	**3,982**

Intensity expressed in Btu/USD (sales)

Sources:
1. Census.gov, County Business Patterns
2. Manufacturing Energy Consumption Survey (MECS), 2006

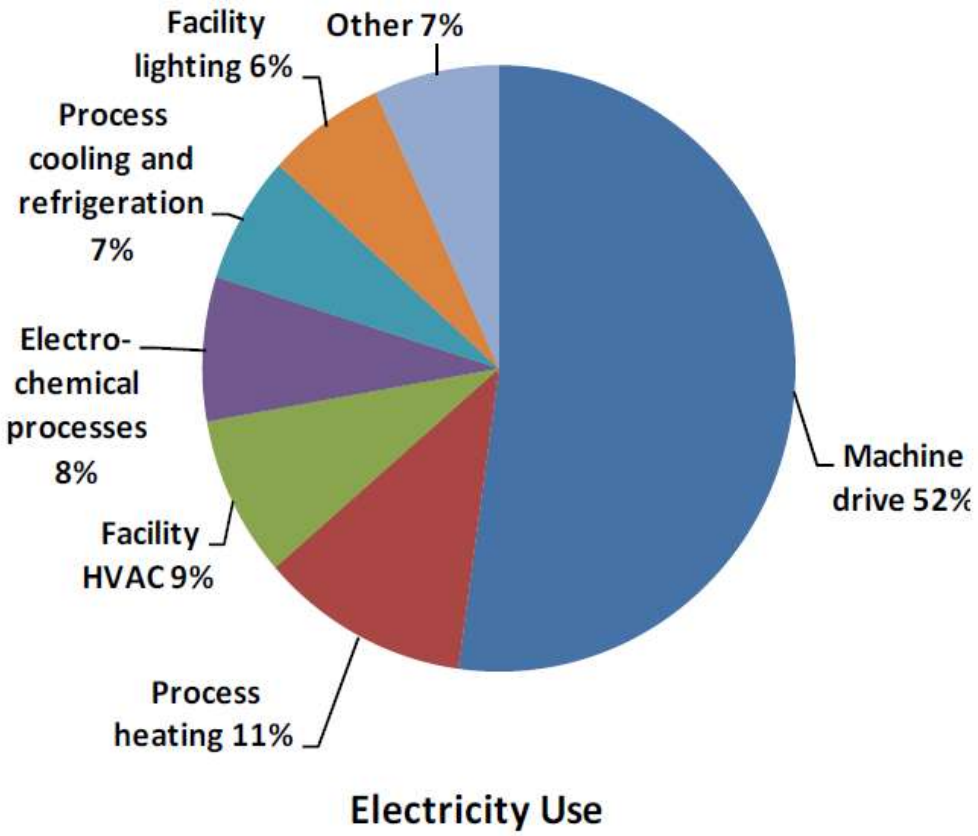
Energy Intensities in US –SME (IAC Database) Btu/Sales Dollar (Nominal)

NAICS	Description	Nominal Sales Dollars	Production Units Reported	Total Energy Purchased	Total Energy Cost	BTU/Nominal Sales $	BTU/Unit of Production
311	Food Manufacturing	37,625,260,296	34,874,188,787	138,256,990.16	560,515,618.39	3,674.58	3,964.45
312	Beverage and Tobacco Product Manufacturing	11,610,259,999	8,357,509,944	8,512,936.03	93,467,920.28	733.23	1,018.60
313	Textile Mills	2,725,333,471	1,899,856,596	8,145,708.98	69,592,001.47	2,988.89	4,287.54
314	Textile Product Mills	2,040,105,475	736,701,988	4,978,095.71	32,687,040.34	2,440.12	6,757.27
315	Apparel Manufacturing	520,800,000	421,164,000	922,788.76	11,549,666.00	1,771.87	2,191.04
316	Leather and Allied Product Manufacturing	57,500,000	1,055,700	90,322.96	1,230,410.73	1,570.83	85,557.41
321	Wood Product Manufacturing	11,922,336,860	3,816,391,274	38,891,253.53	159,509,821.73	3,262.05	10,190.58
322*	Paper Manufacturing	11,036,500,371	37,518,058,541	10,369,474,206.03	421,376,542.38	939,561.80	276,386.22
323	Printing and Related Support Activities	4,530,448,508	176,725,226,969	5,295,776.63	64,114,266.12	1,168.93	29.97
324	Petroleum and Coal Products Manufacturing	13,848,494,098	1,944,342,441	41,666,359.45	270,195,563.74	3,008.73	21,429.54
325	Chemical Manufacturing	30,397,965,819	38,404,007,749	143,385,722.43	633,573,369.37	4,716.95	3,733.61
326	Plastics and Rubber Products Manufacturing	13,827,694,635	51,969,607,784	24,677,849.21	309,371,642.69	1,784.67	474.85
327	Nonmetallic Mineral Product Manufacturing	5,515,358,865	8,832,479,323	41,052,601.72	267,082,051.31	7,443.32	4,647.91
331	Primary Metal Manufacturing	23,161,375,291	8,475,306,791	56,557,648.67	450,044,093.64	2,441.90	6,673.23
332	Fabricated Metal Product Manufacturing	19,300,855,534	38,252,283,051	27,659,884.61	320,500,659.53	1,433.09	723.09
333	Machinery Manufacturing	29,419,489,923	2,551,821,514	16,906,009.39	162,720,926.18	574.65	6,625.08
334	Computer and Electronic Product Manufacturing	37,386,850,000	4,539,337,610	8,017,526.64	123,722,558.44	214.45	1,766.23
335	Electrical Equipment, Appliance, and Component Manufacturing	10,325,570,396	2,955,583,897	8,481,845.33	93,827,903.00	821.44	2,869.77
336	Transportation Equipment Manufacturing	31,661,449,451	4,550,092,654	19,809,948.52	219,734,332.41	625.68	4,353.75
337	Furniture and Related Product Manufacturing	4,870,991,483	232,661,355	3,953,010.33	44,967,381.60	811.54	16,990.40
339	Miscellaneous Manufacturing	7,640,711,001	14,289,032,924	4,978,951.04	71,679,112.93	651.63	348.45
Grand Total		309,425,351,476	441,346,710,892	10,971,715,436.12	4,381,462,882.28	2,018.31	1,491.33

* Excluded from intensity calculation

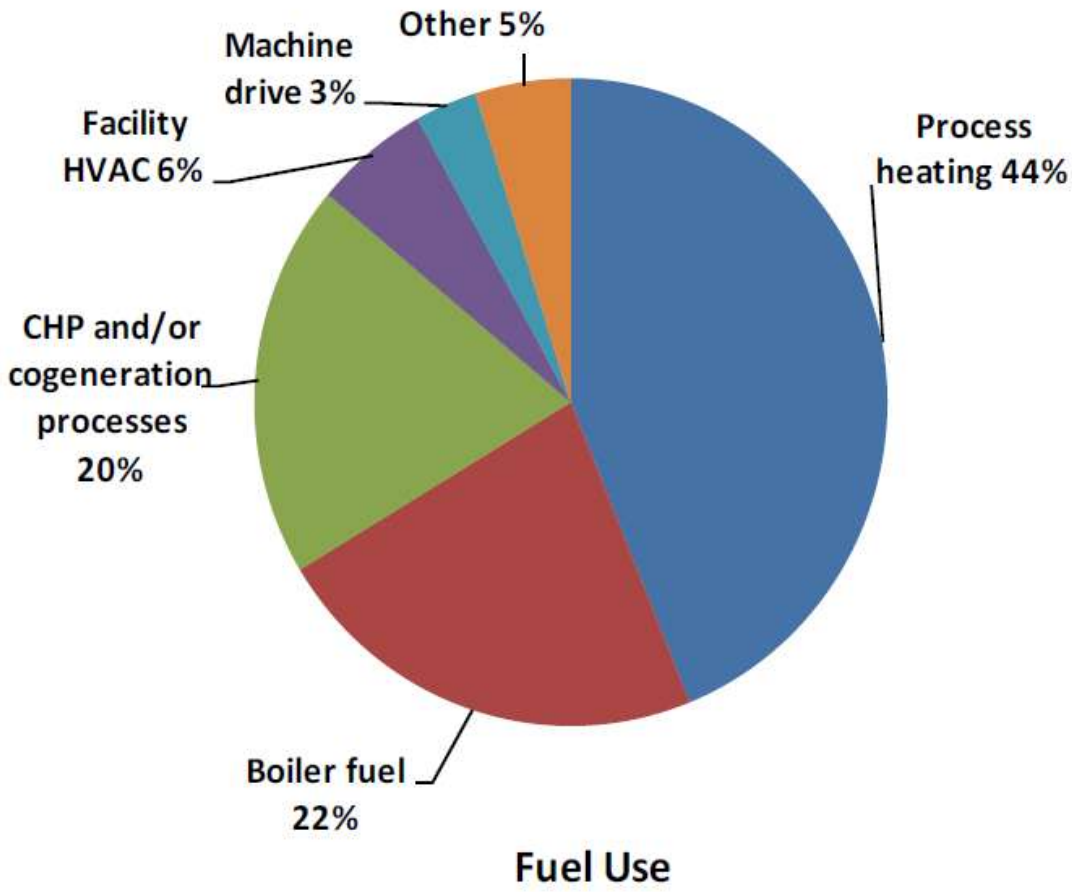
Source: IAC Database

Manufacturers' Electricity Distribution in US



Source: U.S. DOE 2010

Manufacturers' Fuel Use Distribution in US



Source: US DOE, 2010

Fuel Use and Distribution in US Manufacturing Industry

NAICS	Sector	Fuel (TBtu)	Boiler	Process Heating	Cooling	Drives	Building HVAC	Other	Not reported
311	Food	887	53%	24%	0%	2%	4%	0%	17%
312	Beverage & Tobacco	77	62%	9%	0%	0%	5%	1%	22%
313	Textile	119	50%	20%	0%	3%	0%	1%	27%
314	Textile Products	32	31%	41%	0%	0%	0%	0%	28%
315	Apparel	17	24%	12%	0%	0%	12%	12%	41%
321	Wood	303	6%	9%	0%	1%	2%	3%	79%
322	Pulp & Paper	2137	28%	7%	0%	1%	1%	1%	62%
323	Printing	48	0%	40%	0%	2%	31%	2%	25%
324	Petroleum	3075	10%	18%	0%	0%	0%	1%	70%
325	Chemicals	3243	38%	19%	1%	1%	1%	0%	39%
326	Plastic & Rubber	145	39%	27%	1%	1%	17%	3%	13%
327	Non-Metallic Minerals	911	1%	40%	0%	1%	2%	1%	54%
331	Primary Metals	1630	5%	35%	0%	0%	3%	1%	57%
3315	Foundries	103	3%	50%	0%	0%	16%	2%	29%
332	Products	219	0%	59%	0%	1%	20%	1%	18%
333	Machinery	91	16%	33%	0%	2%	33%	1%	14%
334	Computer & Electronics	69	42%	13%	0%	0%	29%	3%	13%
335	Appliances	56	11%	48%	0%	0%	27%	2%	13%
336	Equipment	252	23%	25%	1%	1%	25%	2%	23%
337	Furniture	39	5%	28%	0%	0%	31%	0%	36%
339	Miscelleaneous	35	29%	23%	0%	0%	29%	0%	20%

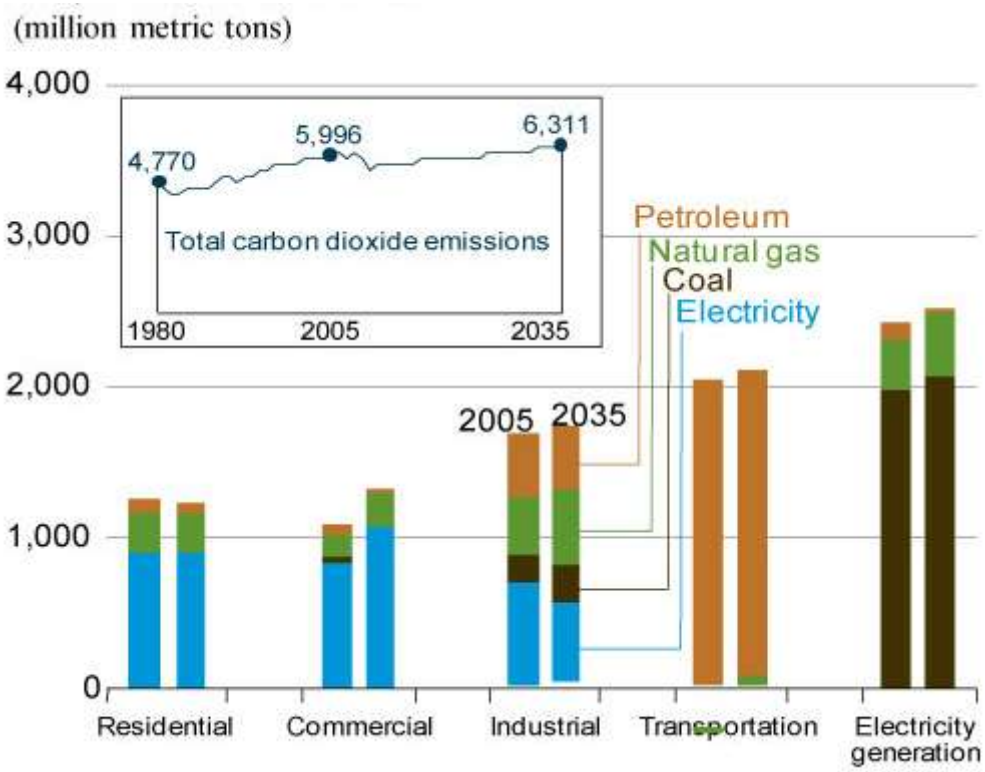
Source: Energy Information Administration, 2002 Manufacturing Energy Consumption Survey

Electricity Use and Distribution in US Manufacturing Industry

NAICS	Sector	Electricity (10^9 kWh)	Process Heat	Cooling	Drives	Electro-chemical Process	Building HVAC	Lighting	Other	Not reported
311	Food	67.4	3%	27%	48%	0%	7%	7%	2%	7%
312	Beverage & Tobacco	7.6	4%	31%	42%	0%	12%	8%	0%	4%
313	Textile	25.2	9%	8%	56%	0%	0%	0%	0%	27%
314	Textile Products	5.0	6%	6%	53%	0%	0%	0%	0%	35%
315	Apparel	3.5	0%	0%	33%	0%	25%	17%	0%	25%
321	Wood	21.1	6%	0%	69%	0%	7%	7%	0%	11%
322	Pulp & Paper	65.4	2%	2%	83%	2%	4%	4%	1%	2%
323	Printing	14.7	2%	4%	50%	0%	18%	12%	2%	12%
324	Petroleum	37.2	8%	4%	81%	0%	3%	2%	0%	2%
325	Chemicals	153.0	4%	9%	57%	14%	7%	5%	1%	3%
326	Plastic & Rubber	49.8	15%	8%	54%	1%	10%	8%	2%	1%
327	Non-Metallic Minerals	41.6	20%	4%	58%	0%	6%	5%	1%	5%
331	Primary Metals	144.5	29%	1%	30%	29%	4%	3%	1%	4%
3315	Foundries	15.8	44%	2%	33%	0%	9%	6%	2%	4%
332	Fabricated Metal Products	47.2	23%	4%	44%	1%	10%	9%	2%	7%
333	Machinery	24.6	7%	4%	49%	2%	18%	13%	2%	5%
334	Computer & Electronics	38.4	11%	9%	23%	3%	28%	13%	7%	5%
335	Appliances	13.8	19%	4%	36%	4%	17%	13%	2%	4%
336	Transportation Equipment	50.4	9%	5%	43%	2%	19%	15%	4%	3%
337	Furniture	7.0	4%	0%	50%	0%	0%	17%	0%	29%
339	Miscelleaneous	10.3	9%	6%	37%	0%	20%	14%	3%	11%

Source: Energy Information Administration, 2002 Manufacturing Energy Consumption Survey

Energy Use and Emissions are Related



Source: Energy Information Administration, Short Term Annual Energy Outlook, 2011

Energy Efficiency Opportunity in US

The manufacturing sector offers *significant* opportunities for *cost-effective* savings through increased energy efficiency.

Sector	Primary energy & cost savings (in 2020)	Investment Required* (2009 $)	Savings Achieved (2009 $)	Scope of Potential Opportunity
Manufacturing and Other Industrial	5,030 TBtu/yr $47 billion/yr	$113 billion	$442 billion	330,000 establishments
Commercial, Private**	1,840 TBtu/yr $11 billion/yr	$73 billion	$104 billion	57 billion sq ft
Commercial, State & Local**	860 TBtu/yr $5 billion/yr	$26 billion	$49 billion	18.2 billion sq ft
CHP	1,470 TBtu/yr $7.8 billion/yr	$56 billion	$77 billion	50 GW of additional power

Employees <500 = 320,000 establishments

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Employees < 5 135,000 establishments

Sources: *Energy Efficiency in the U.S. Economy*, McKinsey & Company, July 2009.

Notes: Savings achieved are net present value (NPV) positive for the 10-year period of 2010-2020.

* Not incremental; does not include maintenance costs

** Includes existing buildings and excludes new construction

1 TBtu = 36,000 tce

ENERGY EFFICIENCY AND MANAGEMENT APPROACH IN SME

Energy Management Approach in SME

- STEP 1: Make Commitment
- STEP 2: Assess Performance
- STEP 3: Set Goals
- STEP 4: Create Action Plan
- STEP 5: Implement Action Plan
- STEP 6: Evaluate Progress
- STEP 7: Recognize Achievements

Source: EPA, Energy Star Program

Major Energy Systems in SME

- Motors
- Process heating
- Steam
- Pumps
- HVAC
- Lighting
- Compressed air

Energy Management Personnel in SME Focus Factors

- Training in energy efficiency and management principles
- Dedicated energy management efforts
- Value added per employee for large enterprises is almost twice that for smaller enterprises
- Understanding of energy system operations
- Recognizing the importance of sub metering of utilities
- Ability to quantify energy efficiency measures
- Ability to integrate energy efficiency into the energy management plan
- Preventive maintenance procedures and understanding of overall equipment effectiveness

ENERGY MANAGEMENT PRACTICES
FOCUS ON ENERGY EFFICIENCY

Energy Efficiency Measures (EEM) With Near Term Return on Investment

No.	Description	Times Imp	Total Occur.	% Imp	kWh Saved	NG Saved (MMBtu/yr)	kW Reduced
1	ELIMINATE LEAKS IN INERT GAS AND COMPRESSED AIR LINES/ VALVES	4,137	5,142	80%	74,019.85	-	142.49
2	REDUCE THE PRESSURE OF COMPRESSED AIR TO THE MINIMUM REQUIRED	1,401	2,905	48%	47,256.07	-	133.24
3	UTILIZE HIGHER EFFICIENCY LAMPS AND/OR BALLASTS	1,520	2,443	62%	24,317.93	-	32.12
4	UTILIZE ENERGY-EFFICIENT BELTS AND OTHER IMPROVED MECHANISMS	1,309	2,191	60%	25,535.96	-	38.67
5	INSTALL COMPRESSOR AIR INTAKES IN COOLEST LOCATIONS	1,042	2,157	48%	33,383.65	-	66.12
6	INSULATE BARE EQUIPMENT	687	1,394	49%	46,102.76	614.37	27.46
7	ANALYZE FLUE GAS FOR PROPER AIR/FUEL RATIO	958	1,362	70%	1,194.36	1,986.58	0.21
8	REDUCE ILLUMINATION TO MINIMUM NECESSARY LEVELS	636	1,244	51%	55,814.03	-	85.19
9	TURN OFF EQUIPMENT WHEN NOT IN USE	629	1,049	60%	140,109.80	189.10	64.66
10	INSTALL TIMERS AND/OR THERMOSTATS	559	996	56%	15,639.03	862.71	1.47

1 MMBtu = 1.06 GJ

Source: IAC Database, 2011

Energy Efficiency Measures (EEM) With Medium Term Return on Investment

No.	Description	Times Imp	Total Occur.	% Imp	kWh Saved	NG Saved (MMBtu/yr)	kW Reduced
1	INSTALL OCCUPANCY SENSORS	535	1621	33%	25,383.57	-	55.67
2	USE MORE EFFICIENT LIGHT SOURCE	752	1402	54%	43,760.79	-	48.78
3	OPTIMIZE PLANT POWER FACTOR	283	719	39%	1,586.59	-	686.11
4	INSTALL TIMERS AND/OR THERMOSTATS	356	700	51%	8,633.49	320.46	
5	USE MULTIPLE SPEED MOTORS OR AFD FOR VARIABLE PUMP, BLOWER AND COMPRESSOR LOADS	199	678	29%	240,297.30	-	128.46
6	ANALYZE FLUE GAS FOR PROPER AIR/FUEL RATIO	403	634	64%	225.20	590.53	-
7	RECOVER HEAT FROM AIR COMPRESSOR	181	606	30%	2,129.29	379.38	-
8	INSULATE STEAM / HOT WATER LINES	322	551	58%	4,693.27	499.29	-
9	USE WASTE HEAT FROM HOT FLUE GASES TO PREHEAT COMBUSTION AIR	89	464	19%	4,490.02	3,813.92	-
10	USE POWER FACTOR CONTROLLERS	38	142	27%	15,678.92	-	131.29

1 MMBtu = 1.06 GJ

Source: IAC Database, 2011

Energy Efficiency Measures (EEM) With Far Term Return on Investment

No.	Description	Times Imp	Total Occur.	% Imp	kWh Saved	NG Saved (MMBtu/yr)	kW Reduced
1	USE MOST EFFICIENT TYPE OF ELECTRIC MOTORS	1223	2058	59%	56,479.39	117.17	-
2	USE OR REPLACE WITH ENERGY EFFICIENT SUBSTITUTES	89	216	41%	85,758.71	206.23	1,568.74
3	IMPROVE AIR CIRCULATION WITH DESTRATIFICATION FANS / OTHER METHODS	53	205	26%	10,095.38	-	634.10
4	REPLACE EXISTING HVAC UNIT WITH HIGH EFFICIENCY MODEL	69	183	38%	146,932.87	296.80	87.85
5	INSTALL SKYLIGHTS	26	174	15%	67,545.13	86.72	-
6	RECOVER WASTE HEAT FROM EQUIPMENT	37	169	22%	969,341.64	3.23	583.98
7	USE PROPER THICKNESS OF INSULATION ON BUILDING ENVELOPE	68	168	40%	2,125.52	3.87	1,110.27
8	USE FLUE GAS HEAT TO PREHEAT BOILER FEEDWATER	29	155	19%	-	-	1,055.06
9	USE RADIANT HEATER FOR SPOT HEATING	38	152	25%	1,662.57	4.70	1,278.53
10	USE A FOSSIL FUEL ENGINE TO COGENERATE ELECTRICITY OR MOTIVE POWER; AND UTILIZE HEAT	10	132	8%	5,598,223.44	7,853.71	-49,630.90

1 MMBtu = 1.06 GJ

Source: IAC Database, 2011

SME Energy Savings

Description	Times Recommended	Average Savings	Average Payback (Years)	Implementation %
Combustion Systems	6,434	$25,783	1.3	48.03%
Thermal Systems	14,810	$20,473	3.5	42.73%
Electrical Power	4,759	$42,936	1.5	37.15%
Motor Systems	32,369	$7,021	1.8	57.63%
Industrial Design	420	$41,694	1.6	35.84%
Operations	5,108	$6,921	0.6	55.24%
Building and Grounds	32,590	$6,105	2	49.54%
Ancillary Costs	2,282	$20,595	1.4	51.49%
Alternative Energy Usage	199	$103,640	14.3	6.16%

Source: IAC Database, 2011

TECHNOLOGIES THAT SUPPORT ENERGY EFFICIENCY AND MANAGEMENT

Technologies

Modular equipment that enables more flexible operations while achieving enormous energy savings

Isothermal Melting (ITM) Process

- Continuous flow system with immersion heaters that convert electricity to melting energy with 98% efficiency
  - 50% less energy consumption than traditional furnace
  - Zero in-plant emissions
  - April 2006 ribbon-cutting ceremony highlighted scale-up demonstration at a General Motors facility

SuperBoiler

- Gas-fired package boiler incorporating innovative concepts in combustion, heat transfer, heat recovery, and control components
  - Capable of achieving energy efficiencies $\geq$94%
  - Field evaluation of firetube boiler initiated in 2006

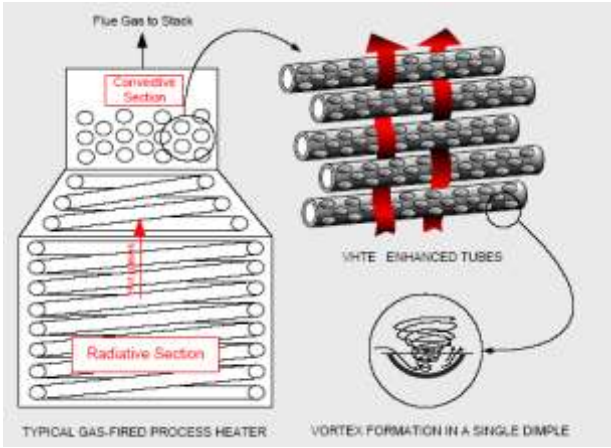
Source: US DOE

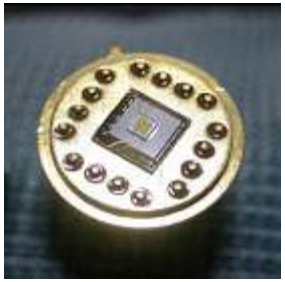
Technologies

- **Dimple-Tube Heat Exchangers**
  - GTI has identified an approach-Vortex Heat Transfer Enhancement (VHTE)-that increases heat transfer without any significant increase in pressure drop.

- **Distributed Wireless Multisensors**
  - Sensors are often used to monitor the efficiency of motors used in Industrial applications to reduce plant power consumption.
  - Distributed wireless technology offers continuous monitoring to both smaller and less critical motors through low-cost, distributed, multi-measure, wireless sensors.

Dimpled Tubes



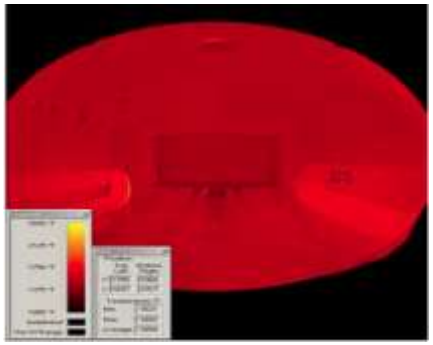


Source: US DOE

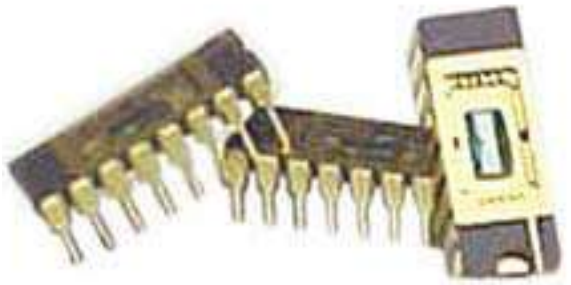
Technologies

- Thermal Imaging Control of High Temperature Furnace
  - The near-infrared thermal imaging system fine-tunes the main furnace controller for improved combustion performance.

Bench-Scale Thermal Imaging System Hardware



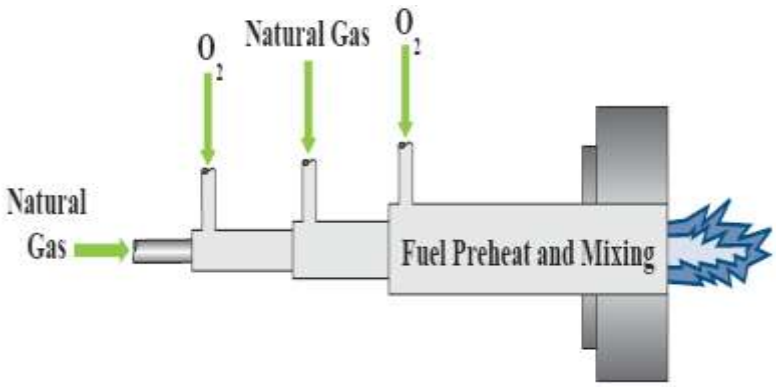
- Solid State Sensors for Monitoring Hydrogen
  - Hydrogen-specific sensing systems that can detect hydrogen against virtually any background gases. These hydrogen-sensing devices can detect hydrogen in 1 to 10 seconds, thus allowing the devices to be used in control systems.



Source: US DOE

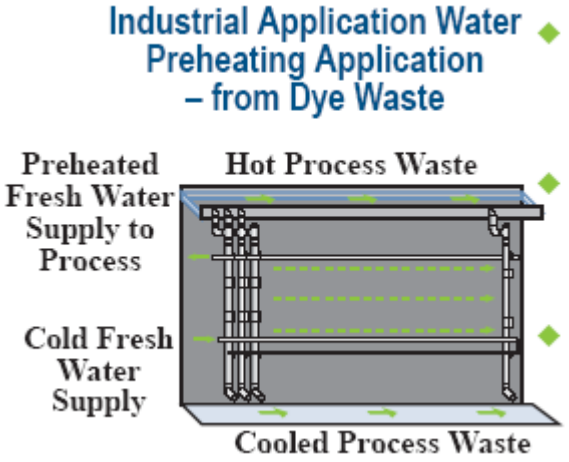
Technologies

- High Efficiency, Low NOx Burners



High Luminosity, Low-NO_X Burner Design

- Waste Fluid Heat Recovery System
  - A common industrial application is to cool effluent to meet environmental or waste treatment regulations.



Source: US DOE

STRUCTURED ENERGY MANAGEMENT PROTOCOL

Energy Management – ISO 50001

ISO 50001 energy management standard will establish a framework for industrial and commercial facilities and organizations to manage energy.

Potential impacts:

- Could influence up to 60% of the world's energy use across many economic sectors

Uptake of ISO 50001 will be driven by companies seeking an internationally recognized response to:

- Corporate sustainability programs
- Energy cost reduction initiatives
- Demand created along the manufacturing supply chain
- Future national cap and trade programs; carbon or energy taxes; increasing market value of "green manufacturing" / reduced carbon footprint
- International climate agreements

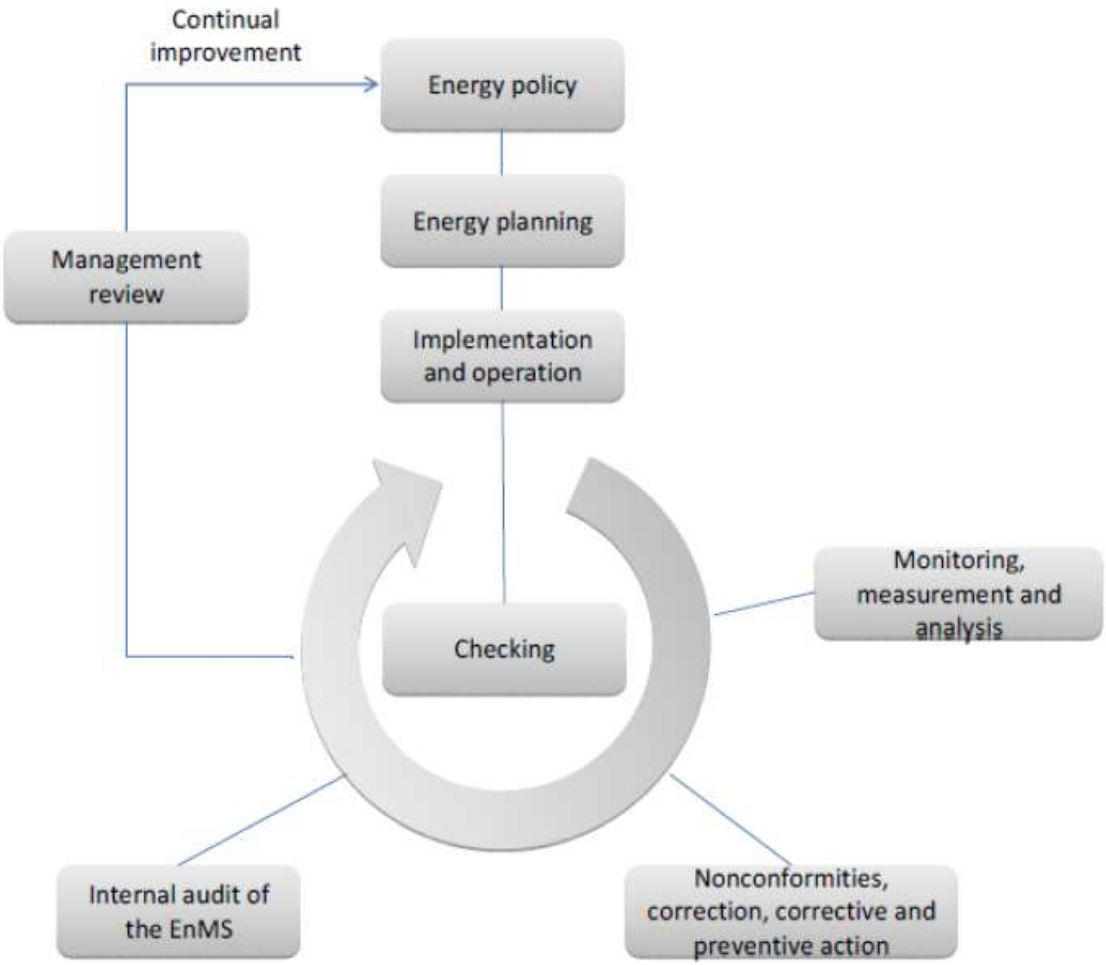
ISO International Organization for Standardization

Status of ISO 50001

- Developed by ISO Project Committee 242; United States and Brazil lead effort with United Kingdom and China
- 56 countries participating, 13 of which are observing
- Published June 15,2011
- ISO PC 242 transitioned to TC 242, developing standards and guidance related to implementation of ISO 50001

Source: WEEC, 2011

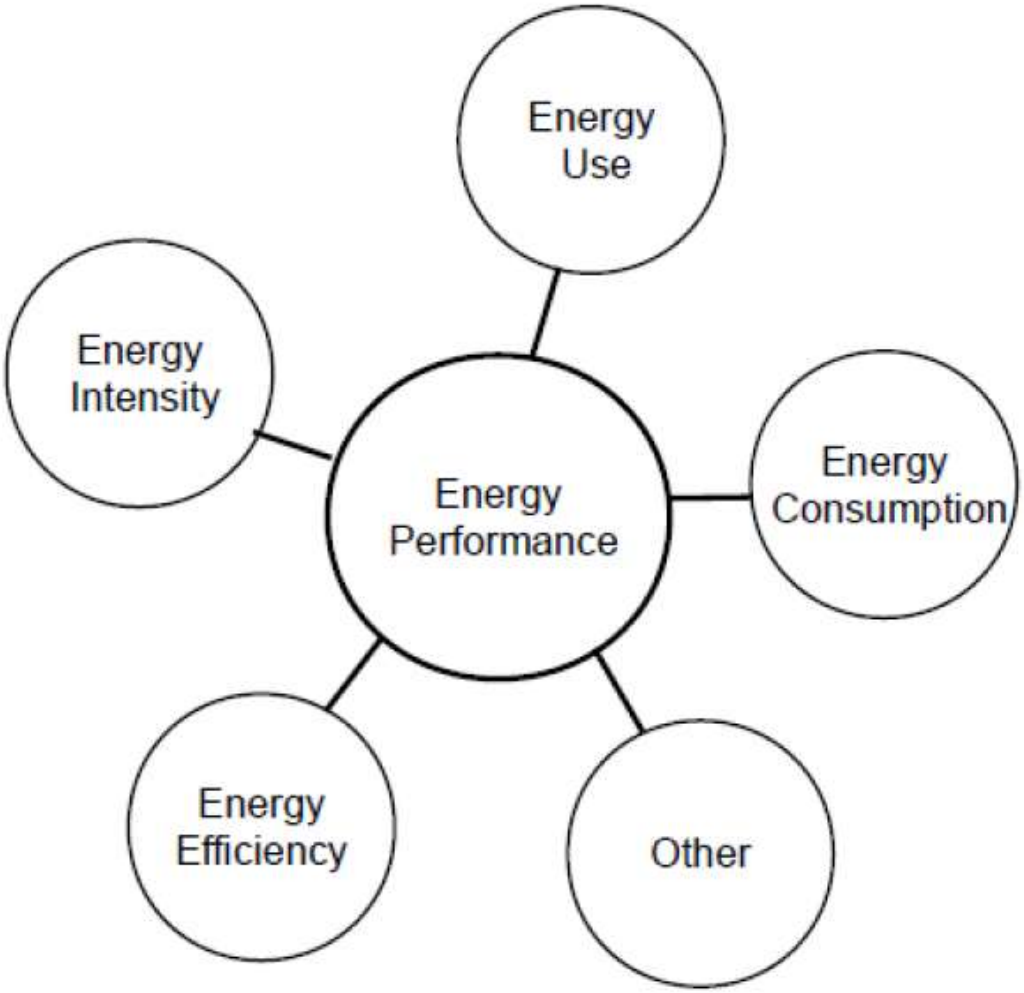
ISO 50001: Model



Source: WEEC, 2011

Energy Performance

It's all about improving energy performance!



Source: WEEC, 2011

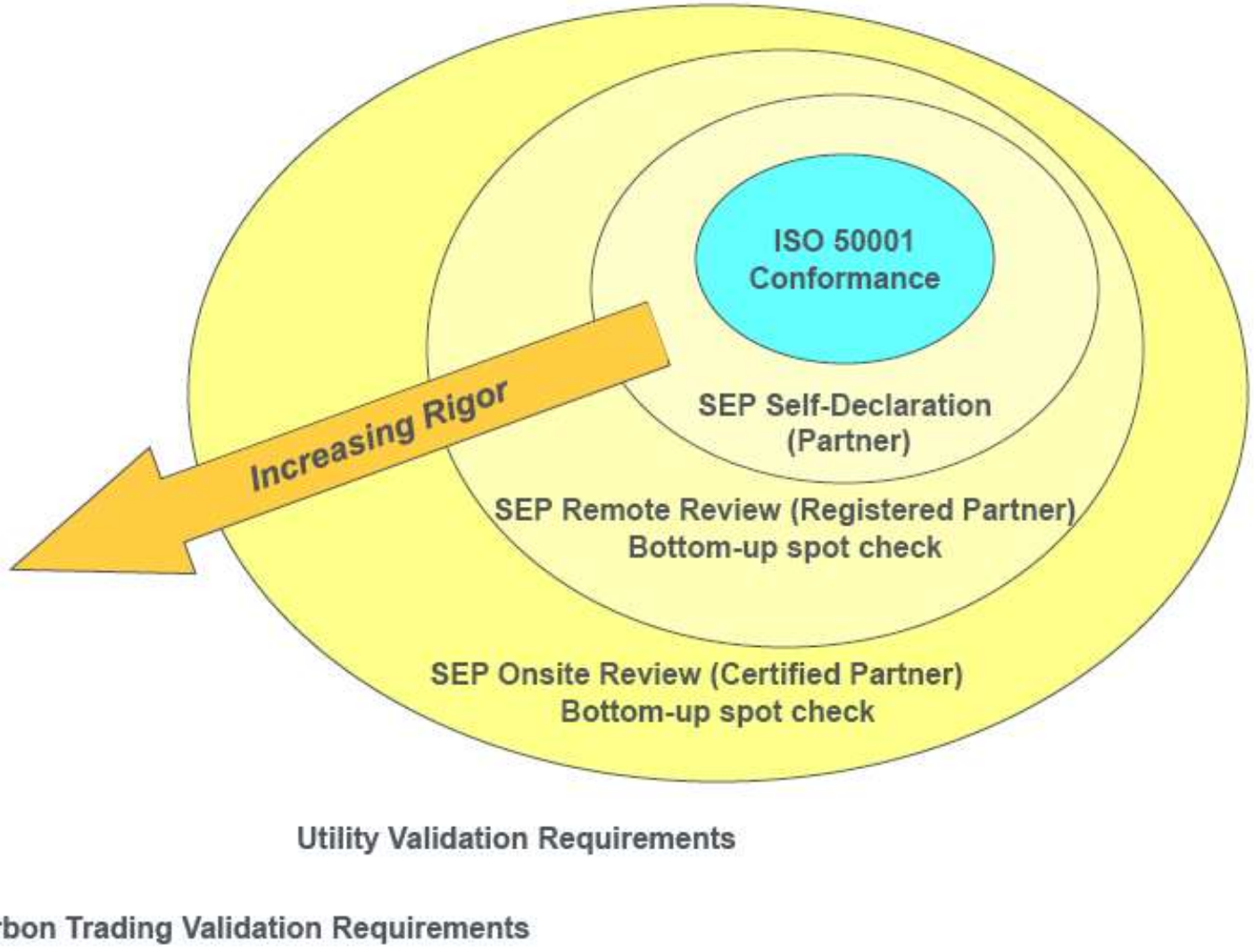
P-D-C-A to ISO 50001

Source: Georgia Tech, ISO 50001 Training

Superior Energy Performance

Source: Georgia Tech, ISO 50001 Training

Proposed M&V Rigor of SEP

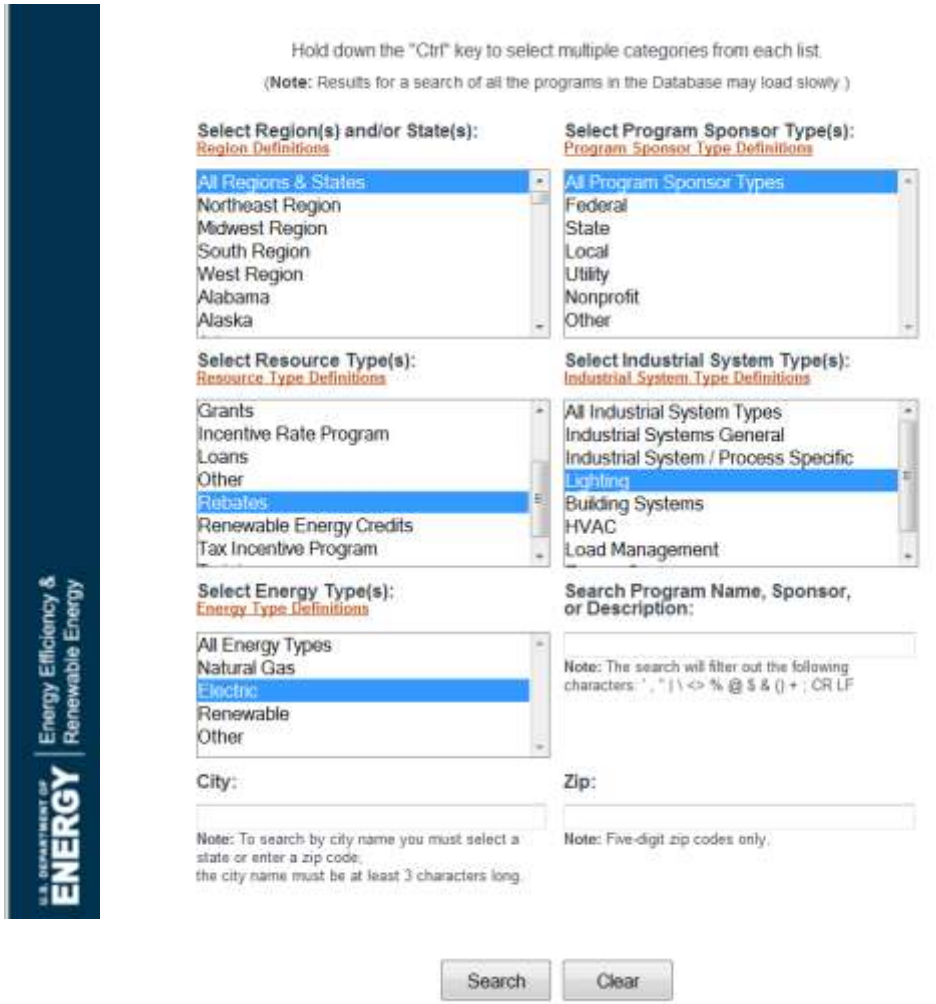


Source: Georgia Tech, ISO 50001 Training

I

INCENTIVES AND REBATES FOR ENERGY EFFICIENCY AND MANAGEMENT

Federal Resource Database for Energy Efficiency



http://www.eere.energy.gov/industry/states/state_activities/incentive_search.aspx

Federal Resources: Example

- **Energy Efficiency Improvements Loan**
  Loans are available for the purchase of renewable energy generating systems by small rural businesses or agricultural producers.
  Program Sponsor: U.S. Department of Agriculture
- **Business and Industry Guaranteed Loans**
  Loans of up to $10 million are available to rural industrial manufacturers to improve the economic and environmental climate in their communities.
  Program Sponsor: U.S. Department of Agriculture
- **Renewable Energy Production Incentive (REPI)**
  REPI provides financial incentives of $0.015/kWh of electricity generated from renewable sources. This incentive is issued for the first decade of operation.
  Program Sponsor: U.S. Department of Energy
- **ENERGY STAR® for Industry**
  The ENERGY STAR® program is a joint initiative of the U.S. Department of Energy and Environmental Protection Agency which seeks to increase implementation of energy efficient equipment and techniques.
  Program Sponsor: U.S. Environmental Protection Agency

Source: US DOE

Federal Resources: Example

- **Combined Heat and Power (CHP)**
  A 10% investment tax credit for CHP property, applicable to only the first 15MW of CHP property.
  Program Sponsor: Internal Revenue Service

- **Fuel Cells and Microturbines Tax Incentive**
  Tax credits of up to $3,000 per kWh are available for the purchase of fuel cells, while tax credits of up to $200 per kWh are available for microturbines.
  Program Sponsor: Internal Revenue Service

- **Production Tax Credit (PTC)**
  Through the 2009 American Recovery and Reinvestment Act, Congress acted to provide a three-year extension of the PTC through December 31, 2012. Additionally, wind project developers can choose to receive a 30% investment tax credit (ITC) in place of the PTC for facilities placed in service in 2009 and 2010, and also for facilities placed in service before 2013 if construction begins before the end of 2010. The ITC then qualifies to be converted to a grant from the Department of Treasury. The Treasury Department must pay the grant within 60 days of an application being submitted.
  Program Sponsor: U.S. Department of the Treasury

Source: US DOE

State Incentives Database

http://www.dsireusa.org/

State and Utility Resources: Example

Ohio Job Stimulus Plan (Advanced Energy Program)

Last DSIRE Review: 12/06/2010

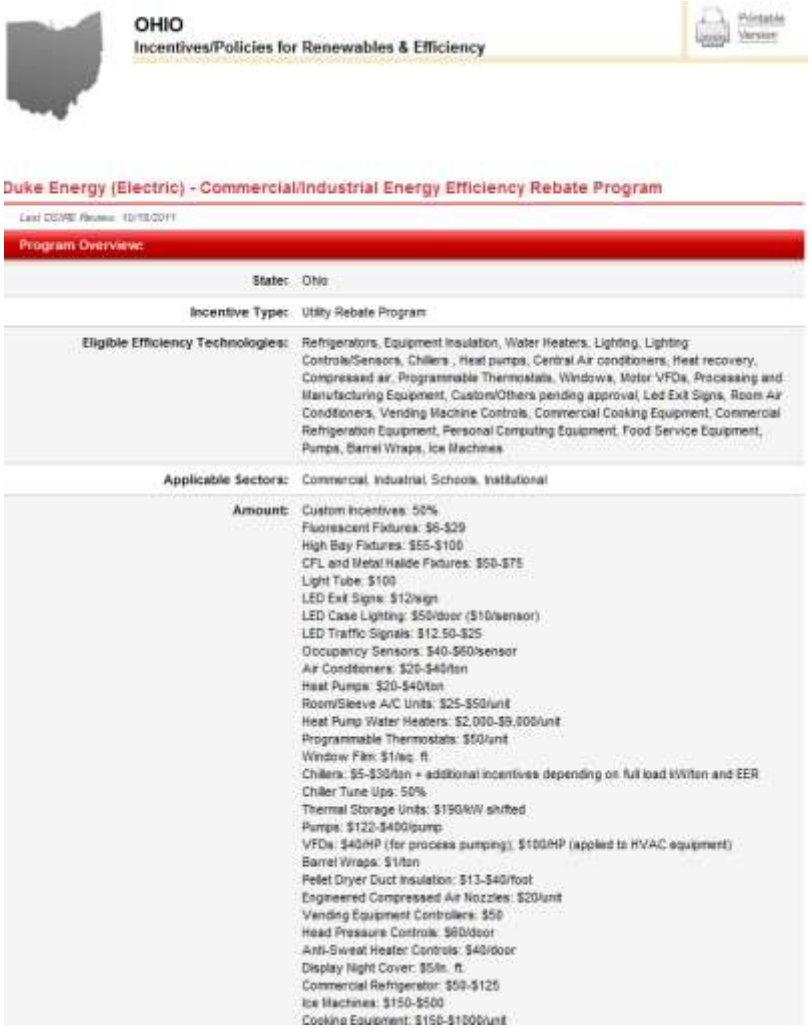
Program Overview:

State:	Ohio
Incentive Type:	Industry Recruitment/Support
Eligible Efficiency Technologies:	See the website for details
Eligible Renewable/Other Technologies:	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, CHP/Cogeneration, Advanced Solid Waste, Electricity Storage, Advanced Nuclear, Anaerobic Digestion, Fuel Cells using Renewable Fuels
Applicable Sectors:	Commercial, Industrial, Nonprofit, Local Government, State Government, Tribal Government, Fed. Government, Institutional
Amount:	$50,000 to $2 million
Start Date:	06/12/2008
Web Site:	http://www.ohioairquality.org/advanced_energy_program/
Authority 1: **Date Enacted:** **Date Effective:**	ORC § 3706.25 et seq 06/12/2008 06/12/2008

Summary:

Source: dsireusa.org

State and Utility Resources: Example



OHIO
Incentives/Policies for Renewables & Efficiency

Printable Version

Duke Energy (Electric) - Commercial/Industrial Energy Efficiency Rebate Program

Last DSIRE Review: 10/18/2011

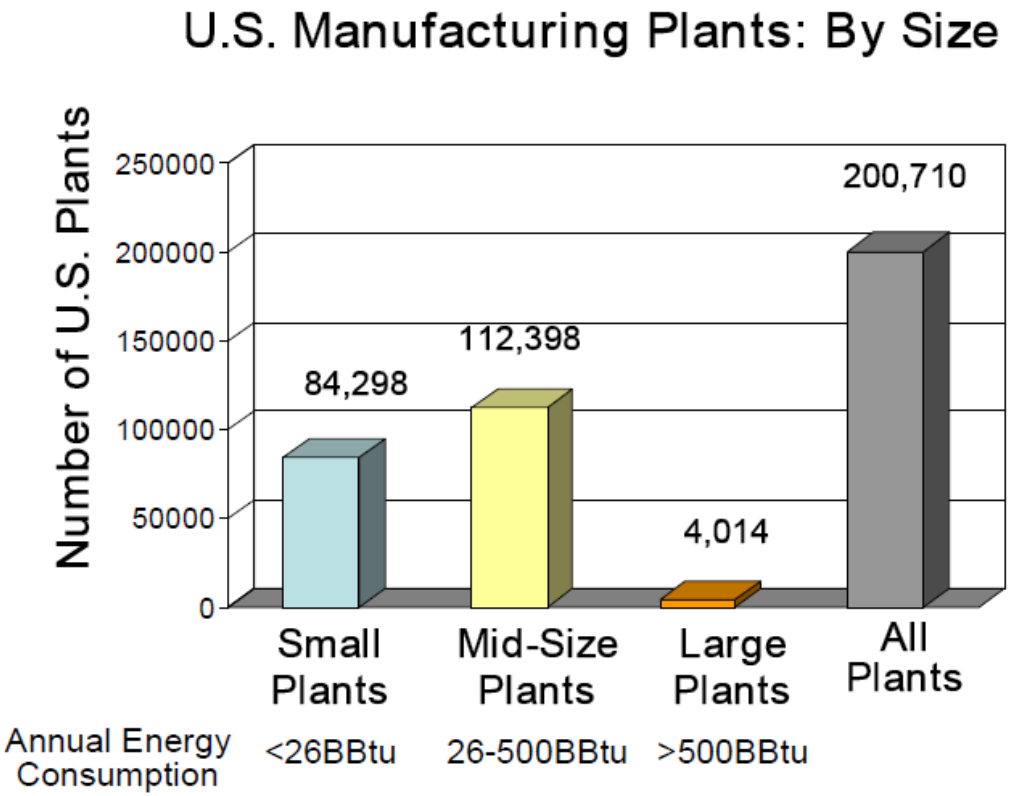
Program Overview:

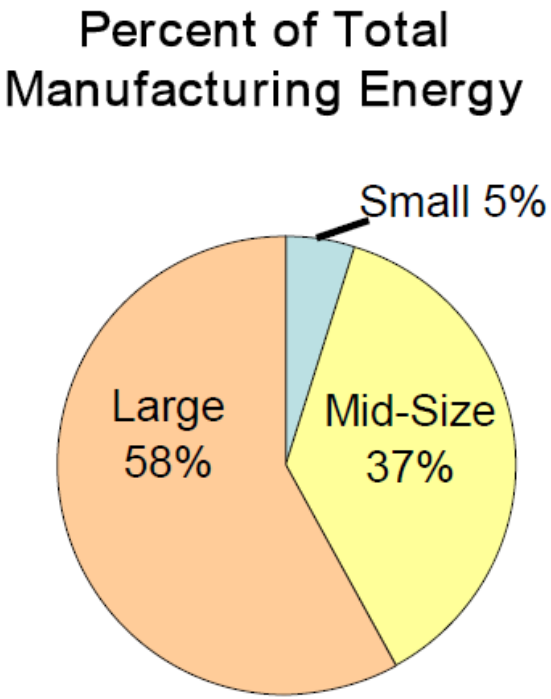
State:	Ohio
Incentive Type:	Utility Rebate Program
Eligible Efficiency Technologies:	Refrigerators, Equipment Insulation, Water Heaters, Lighting, Lighting Controls/Sensors, Chillers , Heat pumps, Central Air conditioners, Heat recovery, Compressed air, Programmable Thermostats, Windows, Motor VFDs, Processing and Manufacturing Equipment, Custom/Others pending approval, Led Exit Signs, Room Air Conditioners, Vending Machine Controls, Commercial Cooking Equipment, Commercial Refrigeration Equipment, Personal Computing Equipment, Food Service Equipment, Pumps, Barrel Wraps, Ice Machines
Applicable Sectors:	Commercial, Industrial, Schools, Institutional
Amount:	Custom Incentives: 50% Fluorescent Fixtures: $6-$29 High Bay Fixtures: $55-$100 CFL and Metal Halide Fixtures: $50-$75 Light Tube: $100 LED Exit Signs: $12/sign LED Case Lighting: $50/door ($10/sensor) LED Traffic Signals: $12.50-$25 Occupancy Sensors: $40-$60/sensor Air Conditioners: $20-$40/ton Heat Pumps: $20-$40/ton Room/Sleeve A/C Units: $25-$50/unit Heat Pump Water Heaters: $2,000-$9,000/unit Programmable Thermostats: $50/unit Window Film: $1/sq. ft. Chillers: $5-$30/ton + additional incentives depending on full load kW/ton and EER Chiller Tune Ups: 50% Thermal Storage Units: $190/kW shifted Pumps: $122-$400/pump VFDs: $40/HP (for process pumping); $100/HP (applied to HVAC equipment) Barrel Wraps: $1/ton Pellet Dryer Duct Insulation: $13-$40/foot Engineered Compressed Air Nozzles: $20/unit Vending Equipment Controllers: $50 Head Pressure Controls: $60/door Anti-Sweat Heater Controls: $40/door Display Night Cover: $5/ln. ft. Commercial Refrigerator: $50-$125 Ice Machines: $150-$500 Cooking Equipment: $150-$1000/unit

Source: dsireusa.org

GOVERNMENT ASSISTANCE FOR ENERGY EFFICIENCY AND MANAGEMENT

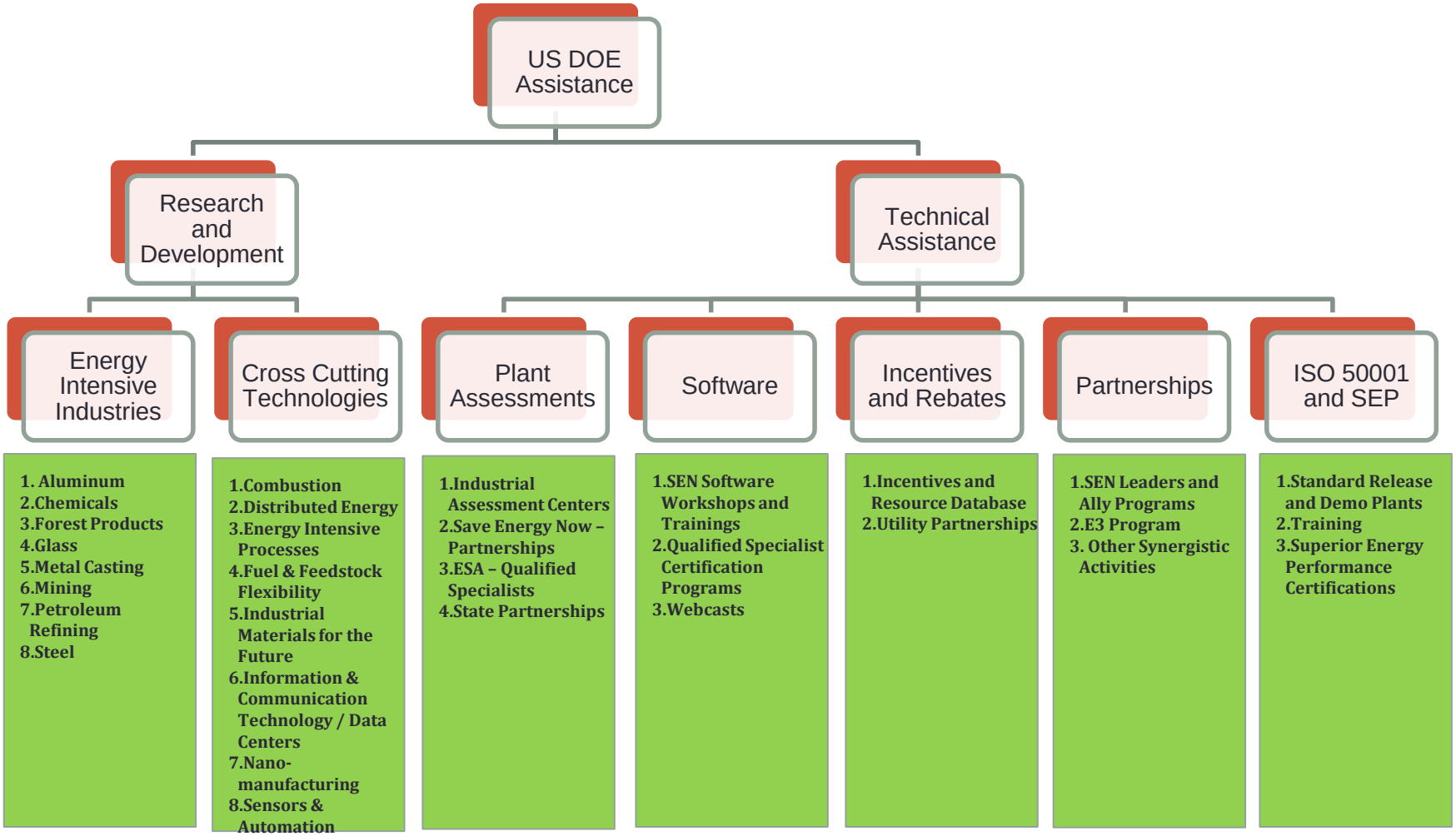
Energy Efficiency and Management Assistance for SME





Source: US DOE

US DOE Assistance for SME



Source: US DOE

Advanced Manufacturing Office (AMO) Delivers Solutions

Delivering technology solutions to make American industry the global leader in high-impact, clean, efficient, energy technologies and practices.

Partnerships

Collaborative R&D

- Energy-intensive Process Technologies
- Crosscutting Technologies

Technology Delivery

- Assessments
- Training & Tools
- Technology Demonstrations

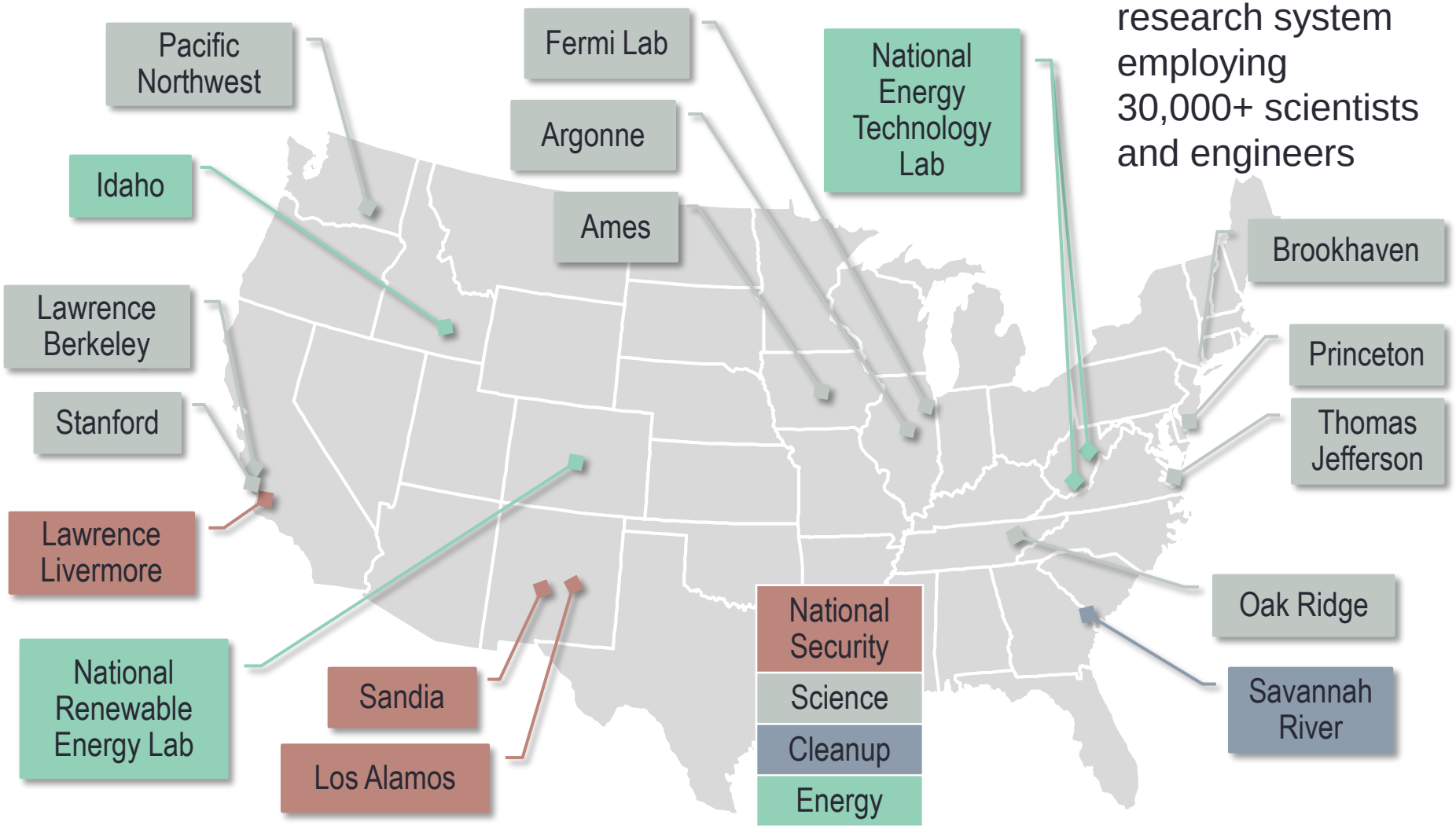
Source: US DOE

US DOE AMO Mobilized Capabilities and Services

- Suite of respected software tools for assessing plant systems
- Established training programs
- Cadre of Qualified Specialists in various assessment tools/systems
- Network of university-based Industrial Assessment Centers (IACs)
- In-depth experience in conducting plant energy assessments
- Strong partnerships and high credibility with influential companies in the manufacturing sector

US DOE Lab Initiatives

A comprehensive research system employing 30,000+ scientists and engineers



Source: ORNL, 2010

International Activities

International Industrial Energy Efficiency Training and Deployment Project in China, Lawrence Berkeley National Laboratory (LBNL) with the Institute for Sustainable Communities and Oakridge National Laboratory (ORNL)

http://www.iscchina.org/what_we_do/Industrial_Energy_Efficiency

Process heating and steam system energy assessment workshops in China and India from ORNL and LBNL

Development of the Industrial Assessment Center model for China and India by ORNL

Best Practices software tools for improving energy systems in Chinese

Technology R&D: Focus on Energy Efficiency

Industrial Reaction & Separation

Develop technologies for efficient reaction and separation processes

High-Temperature Processing

Develop energy-efficient, high-temperature process technologies for producing metals and non-metallic minerals

Energy Conversion Systems

Develop high-efficiency steam generation and combustion technologies and improved energy recovery technologies

Fabrication & Infrastructure

Develop energy-efficient technologies for making near net-shape finished products from basic materials

Source: US DOE

Energy Assessments Available to SME

- Energy assessments help SME save energy and train the next generation of energy engineers
- Focus on all energy systems
- Energy management
- Advanced energy analysis and diagnostics instrumentation

Source: US DOE

Identified Energy Savings Through Energy Assessments

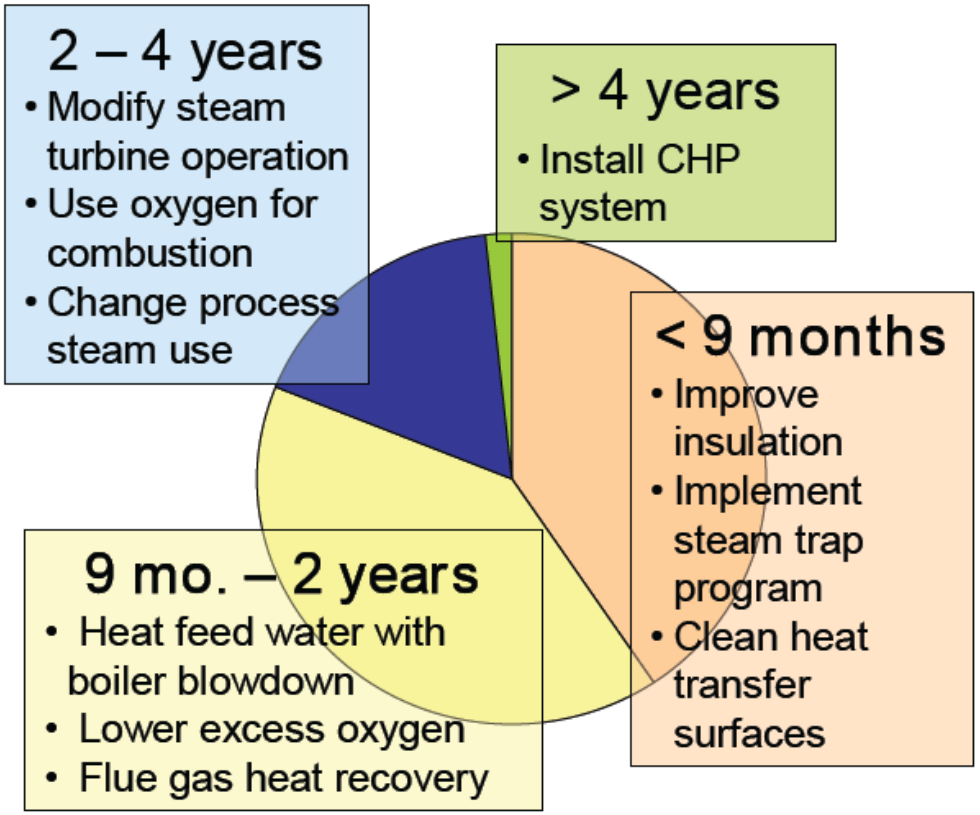
U.S. Energy Savings Results

The table below shows the overall potential annual savings identified in *Save Energy Now* energy audits.*

Average Savings Amount Identified Per Audit	Large Enterprises (annual source energy consumption > 0.5 trillion Btu** or 18,000 tce)	Small or Medium Enterprises (annual source energy consumption < 0.5 trillion Btu or 18,000 tce)
Cost Savings	$1.4 million USD	$165,000 USD
Energy (source)	190 billion Btu (6.5%) (6,840 tce)	23 billion Btu (8%) (830 tce)
Natural Gas	128 billion Btu (4,600 tce)	8.7 billion Btu (313 tce)
Carbon Dioxide (CO_2)	12,000 metric tons	1,400 metric tons

*Annual savings numbers based on small, medium, and large plant assessments as of September 2010.
**BTU (British Thermal Unit). 1 billion Btu = 36 tce.

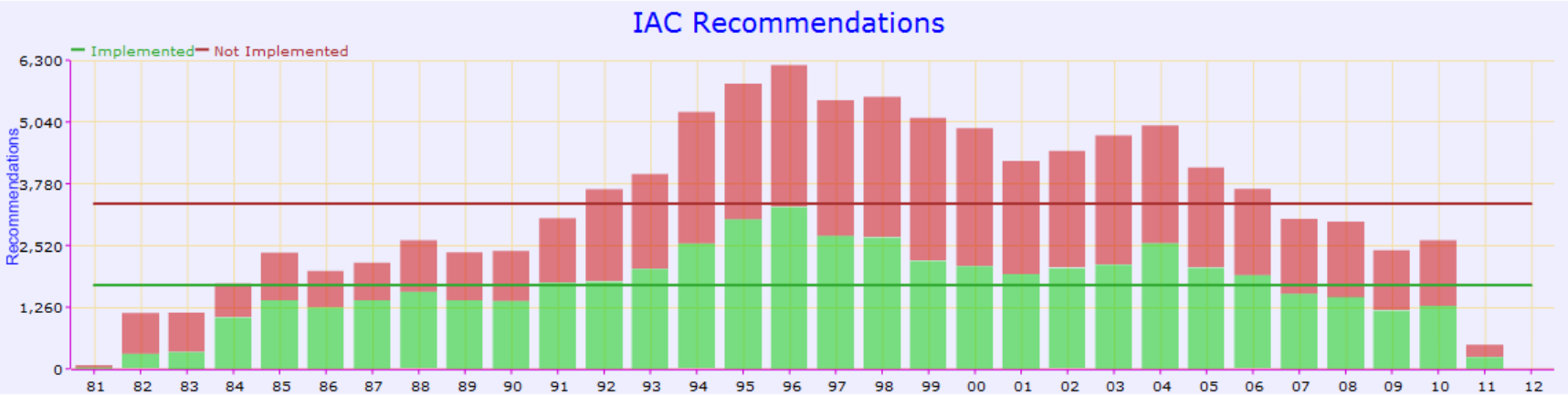
Energy Savings Assessments Success



Estimated Payback Periods for Recommended Actions

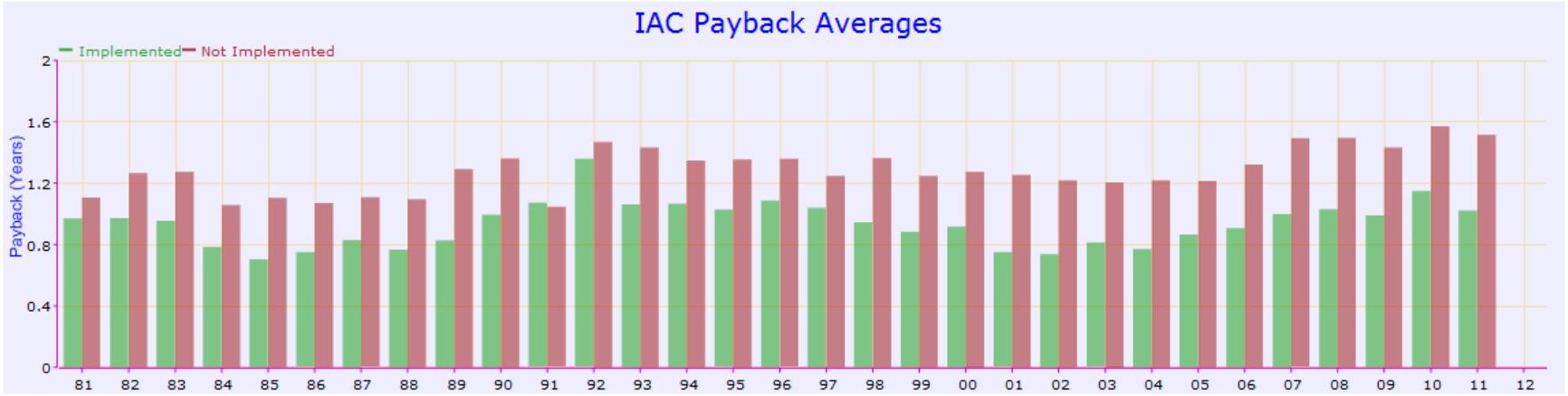
Source: US DOE

IAC Energy Efficiency Recommendations



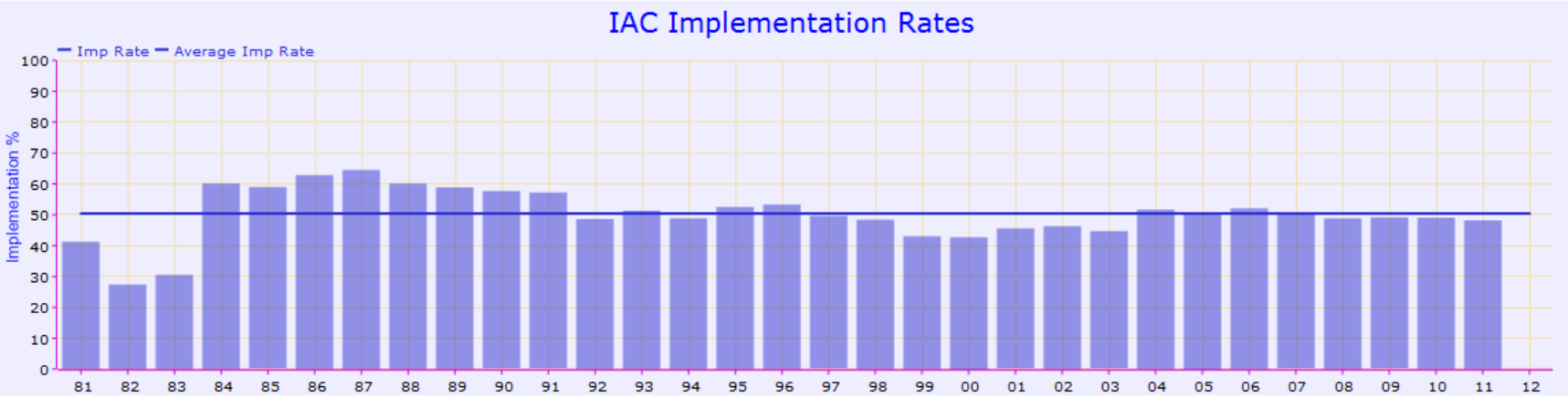
Source: IAC Database, 2011

Average Estimated Payback on Investment on IAC Recommendations



Source: IAC Database, 2011

Implementation Rates on IAC Recommendations



Source: IAC Database, 2011

Tools Available through DOE – AMO Website

- **Steam System Assessment Tool** Assesses potential benefits of specific steam system improvements.
- **Process Heating Assessment and Survey Tool** Models energy use and ways to improve performance
- **Steam System Scoping Tool** Profiles and grades large steam system operations and management to find opportunities.
- **International Motor Master** Assists in energy-efficient motor selection and management.
- **Pumping System Assessment Tool** Helps assess the efficiency of pumping system operations.

- **Air Master+** Provides comprehensive information on assessing compressed air systems.
- **3EPlus Insulation Assessment Tool** Calculates most economical insulation thickness under various operating conditions.
- **Fan System Assessment Tool** Assesses efficiency of fan system operations and quantifies benefits of system optimization.
- **Plant Energy Profiler** Helps plants assess plant-wide operation to identify savings and efficiency opportunities.

Source: US DOE

Plant Energy Profiler Tool: ePEP

INPUTS

- Plant description
- Utility supply data – electricity, fuel & steam
- Energy consuming system information
- Scorecard responses

OUTPUTS

- Overall picture of plant energy use
- Summary of energy cost distributions
- Preliminary assessment & comparison
- Areas or energy efficiency improvement

Source: US DOE

Industrial Energy Savings Recognition From DOE

- Energy efficiency awards were presented to manufacturing facilities in two categories:
  - Energy Champion Plant—More than 250,000 MMBtu total energy savings or more than 15% total energy savings.
  - Energy Saver—More than 75,000 MMBtu total energy savings or more than 7.5% total energy savings.

Source: US DOE

CASE STUDIES FROM ENERGY ASSESSMENTS FOR SME

Case Study – Miba Bearings US, LLC

- Metal fabrication plant in McConnelsville, OH
- Area 136,635 sq. ft.
- Use 100,000 MMBtu of energy annually
- $1.1 Million in annual energy costs

Case Study – Industry (Contd.)

- Energy efficiency recommendations in
  - Boilers
  - Process
  - Compressed air
  - Lighting
  - HVAC
- 9,174 MMBtu/year Implemented energy Savings
- $142,502/year Cost savings
- Investment capital of $124,553
- Payback on investment of less than a year

Power Factor Correction Installation – Cost Savings

- Connected a capacitor bank that was already present in the plant to reduce the excess KVA demand charges.
- Calculation of excess kVA

$$\frac{\text{Billed KW}}{\text{PFavg}} - 1.15 \times \text{Billed KW}$$

- Excess kVA savings of 5,066 kVA
- Cost savings of $20,264/year
- Installation Cost was low – since company had already one purchased
- 3 Months payback on investment

Control Cost	= $3,000
Engineering Cost	= $1,000
Labor Cost = 10 labor hrs x $49/hr	= $ 490
Total	= $4,490

Adjust Air to Fuel Ratio on Boiler Combustion

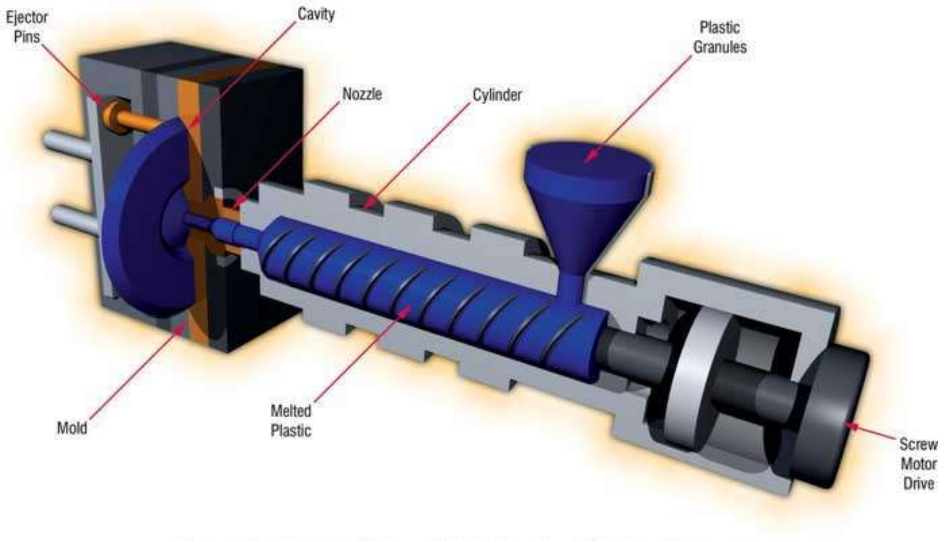
- Boiler combustion tuned to have ideal oxygen level in stack gas
- Implemented energy saving, 1,487 MMBtu/year
- Implemented cost saving, $ 15,167 per year
- Payback on investment, 2 months

Superfos Packaging Energy Assessment

- Plastics packaging plant located in Cumberland, MD
- Annual energy cost, $762,000/year
- Recommended energy savings 2.5 million kWh/year, $ 179,959/year
- Implemented cost savings, $ 98,542/year
- Average payback on investment, less than 2 years
- Major implemented recommendation: Insulate mold barrels

Superfos Packaging Energy Assessment

- Insulate mold barrels recommendation
- Implemented energy savings 1.6 million kWh/year
- Implemented cost savings $76,401/year
- Implementation cost, $ 2,253
- Payback on investment, 2 months



Source: machinerylubrication.com

ENERGY MANAGEMENT CHALLENGES FOR SME

SME Energy Management Challenges

- SME pay more energy cost per production unit as compared to large enterprises
- Lack of in-house technical skills to identify, investigate, and implement energy efficiency opportunities
- Lack of capital

SME Energy Management Challenges

- SME have very high stakes in committing investments
- High energy costs and slim profit margins
- Energy paradox exists
- Often do not use life cycle cost analysis: use payback analysis
- Risk significantly higher compared to larger counterparts: great barrier
- Due to economy of scale paybacks on investment can be higher on similar energy efficiency opportunities

SME Energy Management Challenges

- No dedicated staff for energy management
- Low investment capital for sub-metering
- Rewards for energy efficiency lower compared to other production related issues
- Lack of energy efficiency awareness
- Uncertainty about future cash flows and changes in product, process, and system parameters
- Primary motivation to continue production and increase value to shareholders, sometimes prevents effective analysis of energy efficient alternatives

Future Directions for EMAK

- Foster synergistic partnerships and support for SME efforts in energy management
- Enable effective energy management training possibilities for SME personnel
- Support output based emissions regulations that promote energy efficiency
- Widespread dissemination of successful energy management case studies
- Support the availability of incentives and rebates for energy efficiency

Thank you! Questions ?