Energy Cost Reduction Opportunities in Indiana Manufacturing

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Agenda

- **Indiana utilities market and policy fundamentals and energy challenges facing Indiana manufacturing**
- **Snapshot of Indiana manufacturing sector energy profile**
- **Manufacturing facilities energy case studies**
- **Corporate energy efficiency program**
- **Summary**

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Industry in Transition

Traditional Business Model

Renewable Energy and DERs

Major Investment in Capacity and T&D

New Rate Offerings (load management)

Customer Electric Generation

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Industry in Transition

New Procurement Options

Energy Services

Customer Power Sales

Carbon Reduction

New Product Offerings

New Business Model

Legal and Regulatory

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Opportunities

Reduced Energy Costs

Greater Operating Flexibility

Increased Productivity

Improved Security

Improved Reliability

New Sources of Revenue

Enhanced resiliency

Sustainability Commitments

"You need a Strategy and Action Plan"

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Industry Challenges

Higher Electric Prices

Grid Integration of Renewables/DERs

New Resource Mix

New Technologies (IoT)

Capital Investments and Economics

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Industry Challenges

Standby Rates

Utility Cost Recovery

Utility Provider Relations

Leveraging Lower Natural Gas Prices

Competitiveness Gap

Cyber Concerns

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Hoosier State

Electric Prices	Renewables
Growth	EE Plans
Resource Mix	Net Metering
T&D	Opt-out

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The How to.....

C-suite Interest

Team

Business Objectives

Expertise

EE Machines, Equipment, Processes

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The How to .....

Rates and Programs

Legal and Regulatory

Long-term Strategy

Energy Management Plan

Utility Provider Relations

"You need a Strategy and Action Plan"

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Snapshot of Indiana manufacturing sector

- The Indiana manufacturing sector has the highest share of gross state product (GSP) in the US (National Association of Manufacturers, 2017)
  - Indiana 28.6%
  - Oregon 20.0%
  - Louisiana 19.7%
  - Michigan 19.1%
  - North Carolina 19.0%
- Indiana had 7460 manufacturing facilities in 2016
- Share of total number of facilities by employees per facility (National Survey of Entrepreneurs, 2016)
  - More than 500 employees 9.8% major
  - 100 – 500 9.8% SMEs
  - 10 – 100 33.9% SMEs
  - Less than 10 employees 46.5% SMEs

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12 Indiana manufacturing sectors dominate manufacturing contribution to state economy (2016 Annual Survey of Manufacturers)

NAICS	Sector	Energy intensive	Number of employees	Value added ($ billions)	Value added share, %	Top 12 manufacturing sectors share, %
31 - 33	All Manufacturing			102.353		
336	Transportation equipment manufacturing		121,265	26.766	26.15%	
331	Primary metal manufacturing	*	40,518	12.295	12.01%	
325	Chemical manufacturing	*	20,697	10.669	10.42%	
311	Food manufacturing		34,649	9.349	9.13%	
332	Fabricated metal product manufacturing		56,740	8.636	8.44%	
333	Machinery manufacturing		33,357	5.724	5.59%	
326	Plastics and rubber products manufacturing		38,981	5.002	4.89%	
324	Petroleum and coal products manufacturing	*	3,953	3.473	3.39%	
334	Computer and electronic product manufacturing		13,421	3.147	3.07%	
327	Nonmetallic mineral product manufacturing	*	14,310	2.490	2.43%	
322	Paper manufacturing	*	9,824	1.803	1.76%	
321	Wood product manufacturing	*	15,031	1.539	1.50%	88.80%
323	Printing and related support activities		13,082	1.451	1.42%	
312	Beverage and tobacco product manufacturing		2,521	1.224	1.20%	
335	Electrical equipment, appliance, and component manufacturing		6,404	1.015	0.99%	
314	Textile product mills		2,109	0.150	0.15%	
315	Apparel manufacturing		809	0.058	0.06%	
313	Textile mills		350	0.056	0.05%	
316	Leather and allied product manufacturing		189	0.018	0.02%	
	other			7.488		

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Energy efficiency policies and impact on Manufacturing energy use

- US manufacturing energy intensity (1000 Btu/$) decreased: 3.016 (2010) to 2.882 (2014)
- US energy intensive manufacturing energy intensity increased by 4.6 %: 2010 - 2014
- US energy un-intensive manufacturing energy intensity decreased by 8.5%: 2010 – 2014

State	ACEEE rank	Energy Intensity (Thousand Btu / Dollar)	Total Energy Consumption (Trillion Btu)	Real Gross Domestic Product (GDP)
California	2	3.4	7,830.3	2317.5
Michigan	11	6.4	2,751.6	430.4
Illinois	12	5.6	3,907.1	697.1
Pennsylvania	18	5.8	3,755.3	651.9
Texas	25	8.9	13,183.5	1481.9
North Carolina	26	5.7	2,553.8	448.9
Ohio	29	6.7	3,684.8	551.1
Wisconsin	29	6.4	1,781.1	277.5
Kentucky	29	9.9	1,702.4	171.8
Georgia	38	6.1	2,838.9	466.6
Indiana	40	9.2	2,802.3	303.3
Louisiana	46	20.2	4,205.3	208.3
United States		5.8	97,314.7	16716.2

(source: 2014 manufacturing Energy Consumption Survey, 2016 US Energy Information Administration, The American Council for an Energy-Efficient Economy (ACEEE))

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Manufacturers energy efficiency targets (Alliance for Industrial Efficiency, 2018)

Ranking for Number of Facilities with Energy Efficiency Targets	State	Number of Facilities	Ranking in the State Scorecard[37]
1	Texas	180	26
2	California	159	2
3	Ohio	114	31
4	Illinois	107	11
5	North Carolina	89	31
6	Georgia	81	38
7	Michigan	81	11
8	Indiana	77	40
9	Pennsylvania	72	19
10	Virginia	65	29

- 2100 facilities of major manufacturing companies in the U.S. interviewed
- 1025 or 48.8% had energy efficiency targets
- Indiana has 77 facilities with energy targets despite low ACEEE ranking.
- Indiana facilities with energy efficiency targets is 10.3% of all larger facilities registered in the state;

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Case study 1: benchmarking study - pharmaceutical industry

Distribution of energy end use in the pharmaceutical industry (LBNL 2005)

	Overall	Plug loads and processes	lighting	Heating ventilation and air conditioning (HVAC)
Total	100%	25%	10%	65%
R&D	30%	R&D equipment		Clean room ventilation and fume hoods 100% make-up air zones Chilled water Hot water and steam Refrigeration
Offices	10%	Office equipment		Space heating, cooling and ventilation
Manufacturing, etc.	60%	Sterilization Incubators Dryers Separation processes Mixers Motors		Clean room ventilation and fume hoods 100% make-up air zones Chilled water Hot water and steam Refrigeration Compressed air

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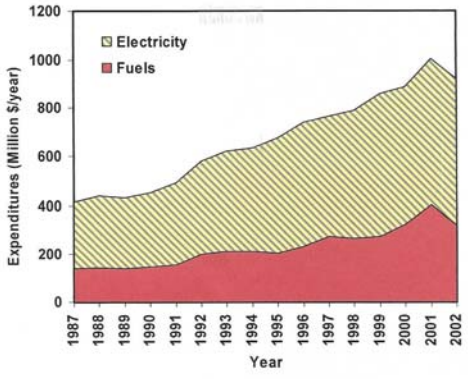
The pharmaceutical industry is a heavy user of both electricity and natural gas



Sources: U.S. Census (1990, 1993, 1995, 1996, 1998, 2003, 2005a).

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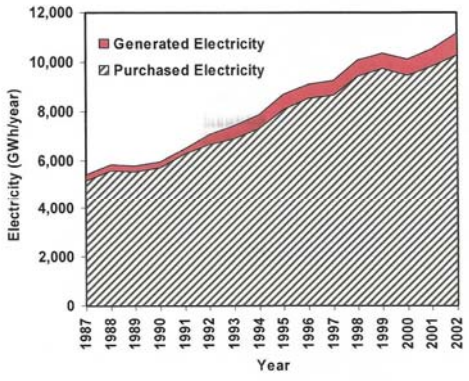
Onsite generation versus purchased electricity among in the U.S. pharmaceutical industry



Sources: U.S. Census (1990, 1993, 1995, 1996, 1998, 2003, 2005a).

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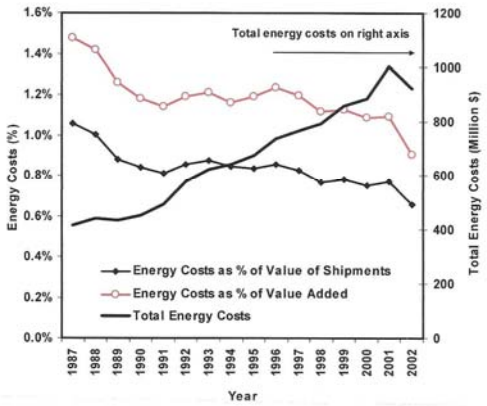
Energy profile of the pharmaceutical industry (LBNL and U.S. Census 1990, 1993, 1995, 1996, 1998, 2003, 2005).



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Indiana pharmaceutical industry

- The value of the pharmaceutical industry to Indiana's economy is $ 11 Billion annually equal to 11% of Indiana's state economy. (Annual Survey of Manufacturers, 2016)
- Pharmaceuticals adhere to good manufacturing practice (GMP). Emphasis is on:
  - meeting rigorous FDA regulations,
  - lowering emissions and
  - quality manufacturing.
- The key energy challenge to the pharmaceutical industry is
  - clean room standards
  - low level of environmental emissions
  - higher cost of electricity
  - energy review of facility expansion at project planning phase

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Case study 2: food manufacturing facility

- Utilities total annual cost $ 750 thousands:
  - Electricity 4.8 GWh/year
  - Natural gas 33 thousand SCF/year
  - Water / waste water 42 million gallons/year
- Less than 100 employees
- Limited management and engineering in-house resources
- No energy management plan, energy manager, or verification of utilities invoices
- No accountability at corporate or process unit level for energy cost and consumption
- Some tracking of facility energy cost year to year
- Over 30 years old HVAC system
- Efficient thermal storage to provide refrigeration
- Package boilers to provide steam; no steam management system
- No heat recovery
- Over concern with energy efficiency interfering with production schedules and causing downtime
- Lack of knowledge of state and federal energy efficiency guidelines and incentives
- Estimated utilities cost savings: 10 – 20%; procurement savings 15%

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Case study 3: methanol manufacturing facility

- Utilities total annual cost $ 23 million:
  - Electricity 113 GWh/year
  - Natural gas 12 billion SCF/year
  - Water 540 million gallons/year
- State of the art well designed facility
- Plant Information System (PI)
- Strong plant engineering resources
- No energy management plan or energy manager or verification of utilities invoices
- No accountability at corporate or process unit level for energy cost and consumption
- Package boilers to provide steam; no steam management system
- No heat recovery and no cogeneration
- Significant oversized motors, compressors
- Overreliance on seawater cooling
- Estimated utilities savings technical potential: electricity 15%, natural gas 40%, water 20%.
- Total elimination of power imports is possible with cogeneration

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Case study 4: A multi-facility oil and gas conglomerate: refineries, gas plants, pipelines, other

- Utilities total annual cost $ 300 million:
  - Electricity 7 TWh/year
  - Natural gas 85 billion SCF/year
- In excess of 25,000 employees
- State of the art well designed facilities; plant information system (PI)
- Significant plant and central engineering resources; no energy engineering resources
- No energy review of plant capacity expansion design
- No energy management plan; no energy manager;
- No multi-facility utilities procurement plan; supply side utilities planning; limited verification of utilities invoices
- No accountability at corporate or process unit level for energy cost and consumption
- Internally generated gas and syn gas not charged for; lack of knowledge of effective cost of energy
- Some tracking of facility energy cost year to year
- Package boilers to provide steam; no steam management system
- No recovery of exothermic process heat; no recovery of other heat sources
- Significant oversized motors, compressors, and process cooling
- Estimated utilities savings: 9 - 17% for measures of payback of 2 years or less.

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Key observations of weak energy efficiency practices in manufacturing – both major and S&M facilities:

- Lack of management involvement and commitment
- Weak or absence of corporate energy management system and programs
- Weak corporate utilities planning and procurement
- Lack of an integrated approach to energy efficiency improvement
- Lack of energy review of new facility design and manufacturing process selection.
- Lack of knowledge of peer competitors' energy efficiency benchmarks
- Lack of accountability for energy consumption
- Lack of knowledge of the effective cost of energy at the corporate, department, and process level

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Three necessary elements to an effective corporate energy efficiency program – both major and S&M facilities

- Corporate energy management system
- Corporate utilities planning and procurement
- Energy efficiency technologies and programs

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An effective energy management system is central to achieving energy efficiency targets (ENERGY STAR Energy Management Program Assessment Matrix)

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Energy Management Program Assessment Matrix

Energy Management Program Assessment Matrix				
	Little or no evidence	Some elements	Fully implemented	Next Steps
Make Commitment to Continuous Improvement				
Energy Director	No central corporate resource Decentralized management	Corporate or organizational resource not empowered	Empowered corporate leader with senior management support	
Energy Team	No company energy network	Informal organization	Active cross-functional team guiding energy program	
Energy Policy	No formal policy	Referenced in environmental or other policies	Formal stand-alone EE policy endorsed by senior mgmt.	
Assess Performance and Opportunities				
Gather and Track Data	Little metering/no tracking	Local or partial metering/tracking/ reporting	All facilities report for central consolidation/analysis	
Normalize	Not addressed	Some unit measures or weather adjustments	All meaningful adjustments for corporate analysis	
Establish baselines	No baselines	Various facility-established	Standardized corporate base year and metric established	
Benchmark	Not addressed or only same site historical comparisons	Some internal comparisons among company sites	Regular internal & external comparisons & analyses	
Analyze	Not addressed	Some attempt to identify and correct spikes	Profiles identifying trends, peaks, valleys & causes	
Technical assessments and audits	Not addressed	Internal facility reviews	Reviews by multi-functional team of professionals	
Set Performance Goals				
Determine scope	No quantifiable goals	Short term facility goals or nominal corporate goals	Short & long term facility and corporate goals	
Estimate potential for improvement	No process in place	Specific projects based on limited vendor projections	Facility & corporate defined based on experience	
Establish goals	Not addressed	Loosely defined or sporadically applied	Specific & quantifiable at various organizational levels	
Create Action Plan				
Define technical steps and targets	Not addressed	Facility-level consideration as opportunities occur	Detailed multi-level targets with timelines to close gaps	
Determine roles and resources	Not addressed or done on ad hoc basis	Informal interested person competes for funding	Internal/external roles defined & funding identified	

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Energy Management Program Assessment Matrix (cont'd)

	Little or no evidence	Some elements	Fully implemented	Next Steps
Implement Action Plan				
Create a communication plan	Not addressed	Tools targeted for some groups used occasionally	All stakeholders are addressed on regular basis	
Raise awareness	No promotion of energy efficiency	Periodic references to energy initiatives	All levels of organization support energy goals	
Build capacity	Indirect training only	Some training for key individuals	Broad training/certification in technology & best practices	
Motivate	No or occasional contact with energy users and staff	Threats for non-performance or periodic reminders	Recognition, financial & performance incentives	
Track and monitor	No system for monitoring progress	Annual reviews by facilities	Regular reviews & updates of centralized system	
Evaluate Progress				
Measure results	No reviews	Historical comparisons	Compare usage & costs vs. goals, plans, competitors	
Review action plan	No reviews	Informal check on progress	Revise plan based on results, feedback & business factors	
Recognize Achievements				
Provide internal recognition	Not addressed	Identify successful projects	Acknowledge contributions of individuals, teams, facilities	
Get external recognition	Not sought	Incidental or vendor acknowledgement	Government/third party highlighting achievements	

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Corporate utilities procurement plan needs to

- Identify, develop, and manage utilities procurement resources and portfolios
- integrate supply / demand planning of corporate utilities requirements at single and multi-facility, corporate and plant level
- account for utilities consumption at: corporate, central, and process units level
- review and execute utilities contract terms (rate schedules, metering, invoicing, supply terms, duration, load aggregation, sale of excess power, wheeling, provision of ancillary services, partnership with IOU/IPP)
- maintain knowledge of the effective cost of energy: corporate wide and by process
- ensure utility sections access to funding and decisions over utilities design and operation

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A manufacturing facility needs to develop a utilities procurement strategy

- The strategy requires evaluation of cost saving opportunities /trade offs that evolve in:
  - an effective energy, electricity, and water efficiency program,
  - secured long term power supply agreement and partnership with investor owned utilities or IPPs,
  - taking equity position in new generation capacities, and / or
  - development of onsite power generation
- The need is to Identify and develop the necessary energy procurement resources and portfolios to ensure:
  - minimum cost of satisfying electricity, water, steam, and energy,
  - availability and reliability of electricity requirements,
  - access to backup power and the grid, and
  - minimum risk due to market forces.

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Energy efficiency technologies and programs

- Energy optimization requires addressing all utilities simultaneously: all primary fuels, electricity, and water
- Energy optimization is a multidisciplinary function.
- Significant information is readily available on optimization of energy systems: motors, fired heaters, steam generation and distribution, lighting, refrigeration, compressed air systems, HVAC, HRSG, and others
- Detailed process simulation modelling of a facility is effective a tool to resolve:
  - competition between energy conservation measures and
  - possible interdependency among measures.
- Process integration and pinch analysis is an effective methodology to investigate heat recovery potential.
- Energy review of new facility plans and manufacturing process selection.
- Renewable energy is applicable in manufacturing.
- In-house energy engineering capability is advisable for major manufacturing facilities.

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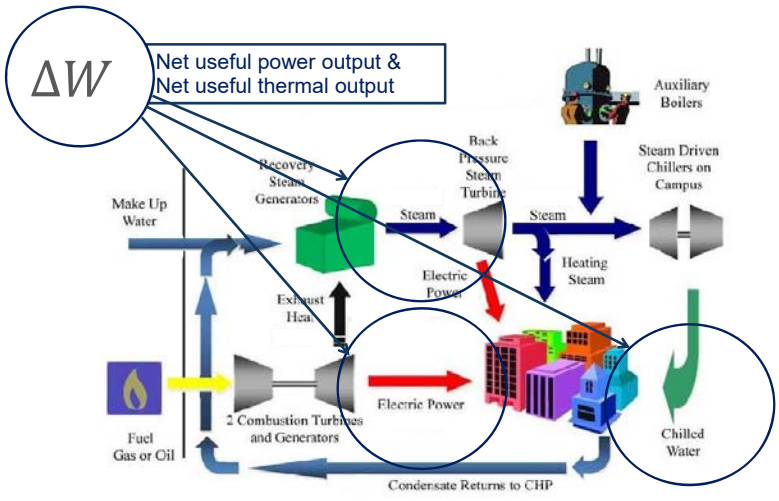
Trigeneration - cogeneration of heat and power in combination with absorption cooling and refrigeration



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Summary and recommendations

- Indiana manufacturing sector is of critical importance to Indiana's economy;
- Indiana manufacturing holds significant energy assets and resources (energy savings, captive power, reactive power, reserve margin);
- Limited effort is currently made by manufacturers to set energy savings targets, plan utilities requirements and act on energy efficiency;
- Major and SMEs manufacturers need to draft utilities procurement strategies and establish achievable energy efficiency targets and programs;
- State policies need to reach and assist manufacturers in meeting climate and energy targets through
  - support of energy efficiency programs and policies;
  - assessing the value of energy and energy efficiency to the health of the sector;
  - development of energy surveys and recommend energy performance indicators;
  - further development of standards and financial incentives for energy efficiency;
  - removal of barriers to industrial energy efficiency: industrial opt-out policies, standby rates, sale of excess power and services, wheeling;
  - improve dialogue and effective partnership between utilities and manufacturers;

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Summary and recommendations (cont'd)

- Utilities need to:
  - explore partnership with manufacturing facilities on: supply, provision of services, joint development of captive power
  - make further effort at integrating potential manufacturers DER in their integrated resources plans;
  - improve on their energy efficiency program offerings to major and SME facilities.

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Thank You

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