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# Industrial System Efficiency: Capturing and Sustaining Energy Savings

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# Industrial System Efficiency: Capturing and Sustaining Energy Savings

**Steam and motor-driven systems account for more than 50% of final manufacturing energy use worldwide**

**Energy savings potential from cost-effective optimization of these systems for energy efficiency is estimated at 10-12 EJ of primary energy<sup>1</sup>**

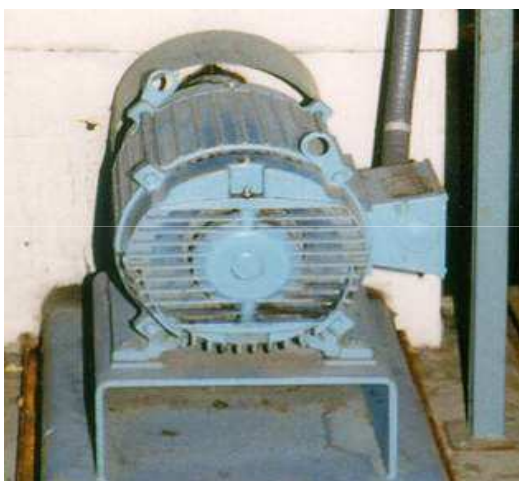
**A global effort to cost-optimize industrial systems for energy efficiency could achieve these energy savings through**

- the application of commercially available technologies
- in existing and new industrial facilities

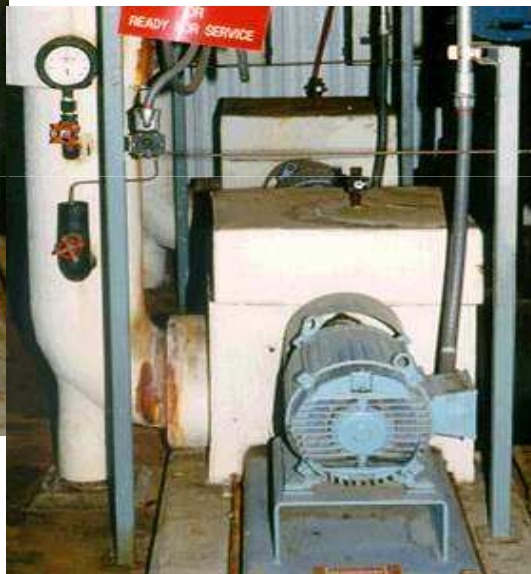
<sup>1</sup> 2007 IEA Statistics



# Industrial System Efficiency: Capturing and Sustaining Energy Savings



**15 kW motor  
efficiency = 91%**



**Combined motor &  
pump efficiency =  
59%**

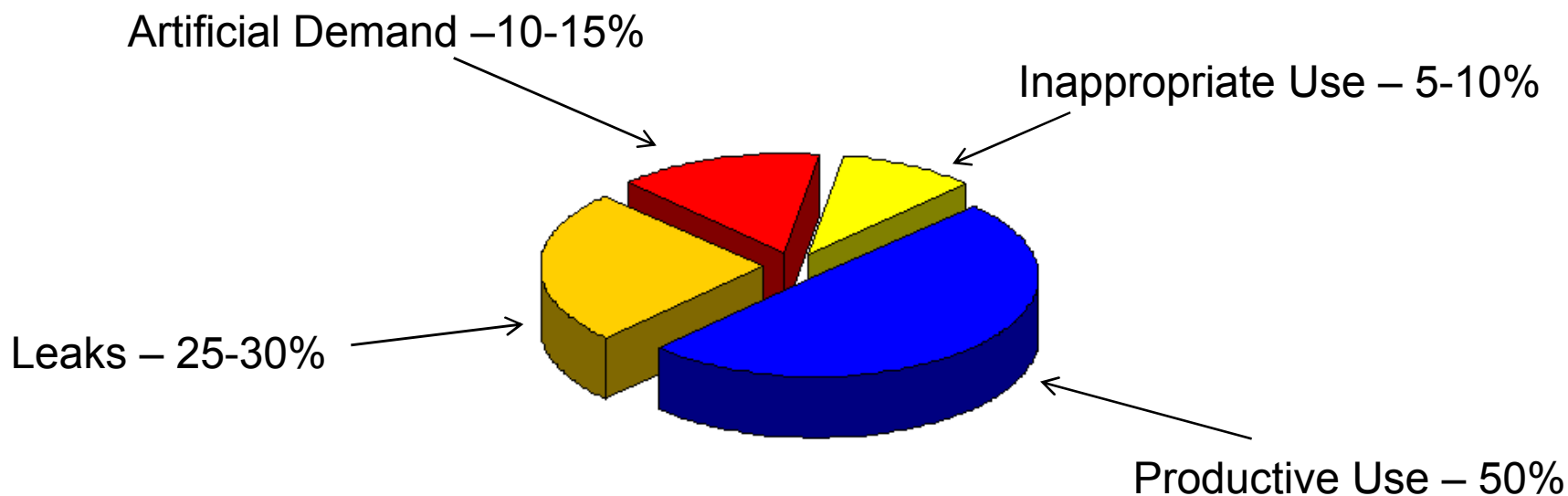


**System efficiency = 13%**



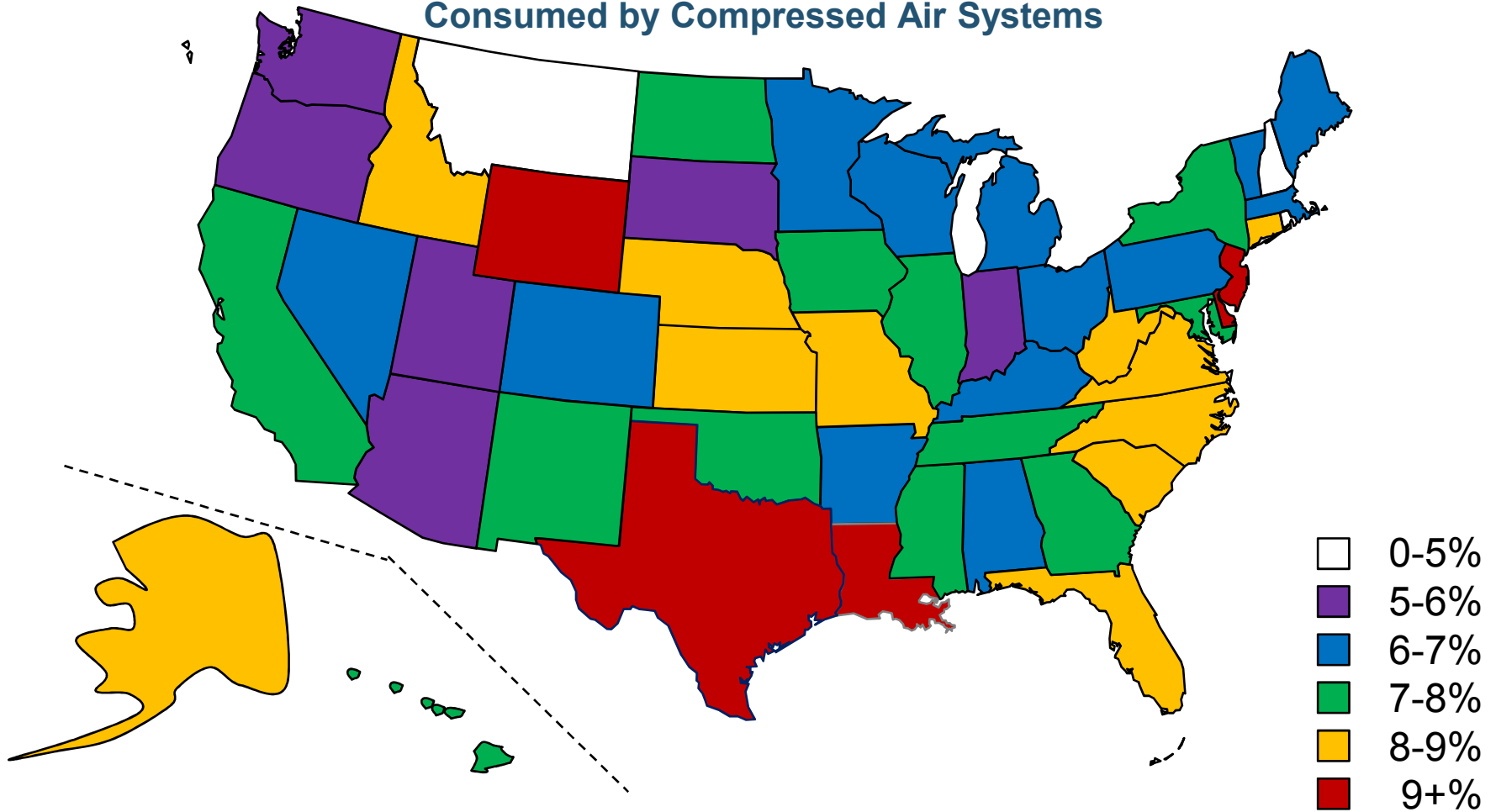
# Industrial System Efficiency: Capturing and Sustaining Energy Savings

**U. S. Department of Energy estimates that half of all compressed air is wasted.**



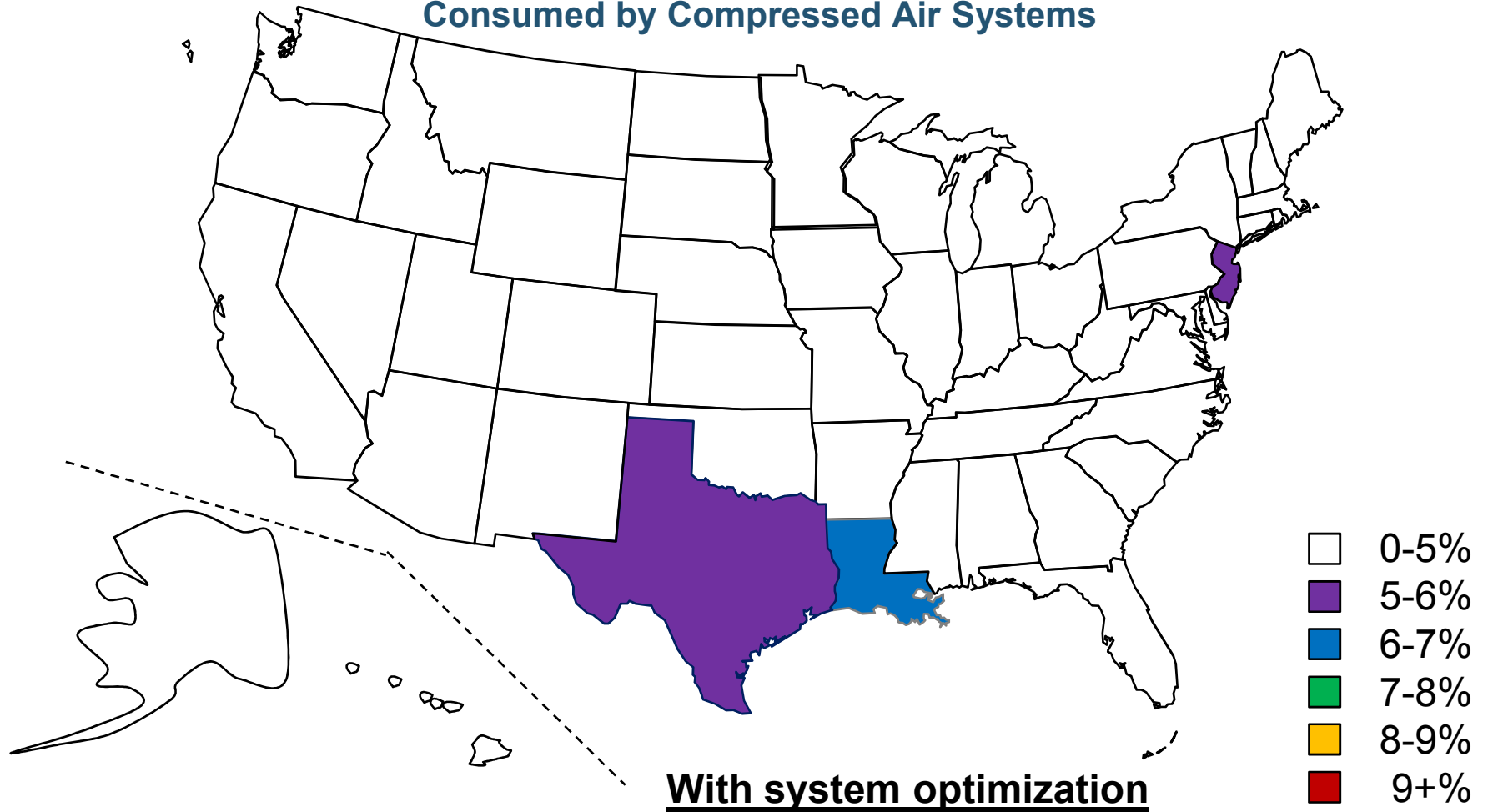


### Percent of Manufacturing Sector Electricity Consumed by Compressed Air Systems





### Percent of Manufacturing Sector Electricity Consumed by Compressed Air Systems





# Industrial System Efficiency: Capturing and Sustaining Energy Savings

*Capacity Building* for systems optimization

- **Evaluating energy requirements in factory.**
- **Matching system supply to these requirements**
- **Eliminating or reconfiguring inefficient uses and practices (throttling, open blowing, etc)**
- **Changing out or supplementing existing equipment (motors, fans, pumps, compressors) to better match work requirements and increase operating efficiency**





# Industrial System Efficiency: Capturing and Sustaining Energy Savings

## Systems improvements in China

<b>System / facility</b>	<b>Total Cost [\$US]</b>	<b>Energy savings [kWh/y]</b>	<b>Payback Period</b>
<b>Compressed air/forge plant</b>	18,600	150,000	1.5 years
<b>Compressed Air/machinery</b>	32,400	310,800	1.3 years
<b>Compressed air/tobacco</b>	23,900	150,000	2.0 years
<b>Pump system/ hospital</b>	18,600	77,000	2.0 years
<b>Pump system/ pharmaceuticals</b>	150,000	1.05M	1.8 years
<b>Motor systems/ petrochemicals</b>	393,000	14.1M	0.5 years



# Industrial System Efficiency: Capturing and Sustaining Energy Savings

- **Most motor-driven systems are initially designed with:**
  - The assumption that “more” is better, where supply is concerned
  - Little or no thought given to system efficiency
  - No plan for increases or decreases in system demand
  - A “lowest first cost” goal
- **Changes to existing systems face the same issues**



# Industrial System Efficiency: Capturing and Sustaining Energy Savings

- **The size of a system has little influence on the savings potential, as a percentage of current consumption**
- **Small, medium and large systems have similar savings potential**



# Industrial System Efficiency: Capturing and Sustaining Energy Savings

- **Lack of capital is the number one reason *given* by managers for not improving efficiency**
- **Lack of understanding of systems and their impact on a factory's profitability are the *actual* reasons why more improvements projects are not initiated**



# Industrial System Efficiency: Capturing and Sustaining Energy Savings

## **Case Study – Energy savings opportunities in a compressed air system in a Vietnamese footwear manufacturer.**



# Industrial System Efficiency: Capturing and Sustaining Energy Savings

- **The footwear factory is located outside Ho Chi Minh City and employs about 4500 workers.**
- **The cost of electricity to operate the compressed air system has been estimated to be about \$470,000 USD per year.**
- **There are 38 operating compressors driven by 37 kW motors.**



# Industrial System Efficiency: Capturing and Sustaining Energy Savings

- **A project team was established to study the compressed air system in order to optimize energy efficiency.**
- **One of the aspects of the study was to perform a leak survey.**



# Industrial System Efficiency: Capturing and Sustaining Energy Savings

**The study found that as much as 86% of the compressed air was lost to leakage!**





# Industrial System Efficiency: Capturing and Sustaining Energy Savings

**Through a combination of leak management, control optimization and compressor relocation, the factory estimates it will save about \$196,000 USD per year in electrical costs. The payback for the investment required to correct existing problems is, on average, less than 6 months.**



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# **Case Study – Improving Performance in a Small Compressed Air System at a Containerboard and Packaging Material Manufacturer**



# Improvements in a Compressed Air System

- **Original compressed air system used two 150 horsepower and one 125 horsepower compressors**
- **All three compressors operated with modulation controls at an average of 43% of full capacity**
- **There was no master controller**
- **Average monthly electrical expense for the compressors was \$9,486.00 USD**



## Improvements in a Compressed Air System

- **Optimization included four base-load compressors and one variable speed trim compressor**





## Improvements in a Compressed Air System

- **Supply piping was modified to minimize turbulence and pressure drops**





## Improvements in a Compressed Air System

- **Main header piping was oversized to reduce velocities and allow for future growth of supply**





## Improvements in a Compressed Air System

- **A master controller was added that both controls the compressors and has data collection and reporting functions**





# Improvements in a Compressed Air System

- **The results include:**
  - **46% reduction in energy consumption**
  - **Less than 2-year payback, not including heat recovery savings**
  - **\$4,000 to \$5,000 USD savings per month**

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**KAESER KOMPRESSOREN** SIGMA AIR CONTROL plus Contact / Service

Settings  
System status  
Event memory  
System data  
Current system pressure  
System pressure  
FAD  
Specific power requirement  
Compressor status  
On-load / Idle / overall power consumption  
Rate  
Graph of power costs  
Table of power costs  
Total costs  
Data retrieval

Table of power costs  
Currency / Work: \$ / kWh Friday, 2004-09-24, 12:50

Account period (max. one year)  
Date from: 07/01/04 Date to: 09/01/04 Update display Start of account: 04/05/03 12:00:10 pm

Compr.	Power Load [kW]	Power Idle [kW]	FAD [CFM]	Load [h]	Total [h]	Duty cycle [%]	FAD [cu.ft]
C1	90.90	9.00	489.01	582	582	100.0	9570729
C2	65.45	19.50	380.99	313	315	99.5	6780136
C3	65.45	19.50	380.99	340	341	99.6	7356032
C4	65.45	19.50	380.99	343	344	99.7	7432960
C5	65.45	19.50	380.99	351	351	99.9	7592131
C6	0.00	0.00	0.00	0	0	0.0	0
C7	0.00	0.00	0.00	0	0	0.0	0
C8	0.00	0.00	0.00	0	0	0.0	0
Sum:	352.80	87.00	1912.97	1928	1933	99.7	38731988

Compr.	Load [kWh]	Idle [kWh]	Total [kWh]	Load [\$]	Idle [\$]	Total [\$]	Spec. power [\$/WCFM]
C1	30119	1	30119	1355.33	0.09	1355.42	0.189
C2	20499	28	20517	922.02	1.28	923.30	0.182
C3	22232	23	22255	1000.33	1.08	1001.41	0.182
C4	22462	20	22482	1010.78	0.91	1011.69	0.181
C5	22946	6	22951	1032.44	0.24	1032.68	0.181
C6	0	0	0	0.00	0.00	0.00	0.000
C7	0	0	0	0.00	0.00	0.00	0.000
C8	0	0	0	0.00	0.00	0.00	0.000
Sum:	118246	78	118324	5320.90	3.60	5324.50	0.183

Ready

Applet com/kaeser/aircontrol/plus/3AcpPCT started



# Industrial System Efficiency: Capturing and Sustaining Energy Savings

- **Energy awareness must start at the corporate management level for large corporations**
- **Energy awareness must start with the owners of SME's**
- **Factories must measure:**
  - **Power to each system**
  - **Output from each system**
- **Operating culture must change and that change must be from the top down**
- **Changing company culture involves all employees**



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