It's All About Energy!

DOE Sensors & Automation—2006 Annual Portfolio Review

Eaton Wireless Sensor Network for Advanced Energy Management Solutions Phase 2—Advanced Pervasive Wireless Energy Sensing

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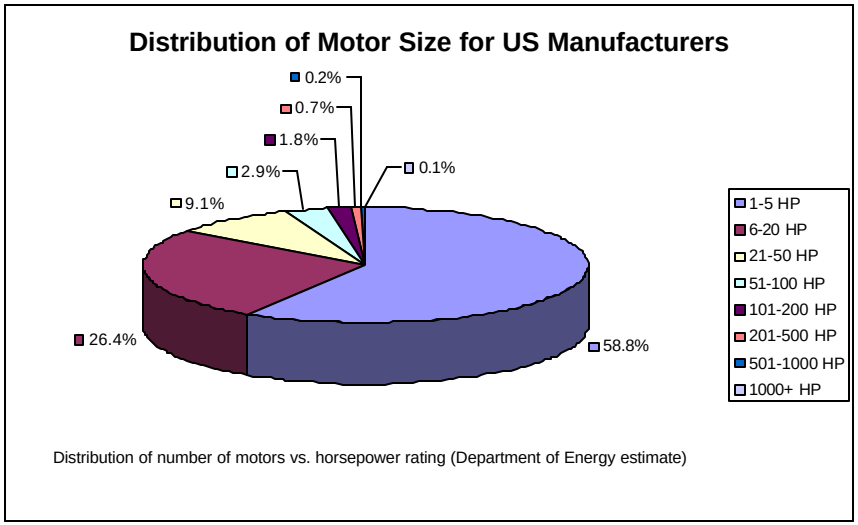
Project Description

Need—Increase energy savings in industrial electric motors across IoF



Distribution of number of motors vs. horsepower rating (Department of Energy estimate)

To achieve improvements on a broad scale, energy management solutions will need to be extended widely across the energy distribution systems within the process plant

Electric Motor Driven Process in U.S.

- Accounts for 23% of all U.S. electricity sold
- 98% of motors are <200 hp
- Consumes 71% of electrical energy used in industrial process plants

Weyerhaeuser Quotes

"If this product had been in my plant, a recent pump failure *(caused by a unnoticed cavitation condition)* would not have caused a full day shutdown. The plant restart included costly rework and a substantial increased in energy usage."

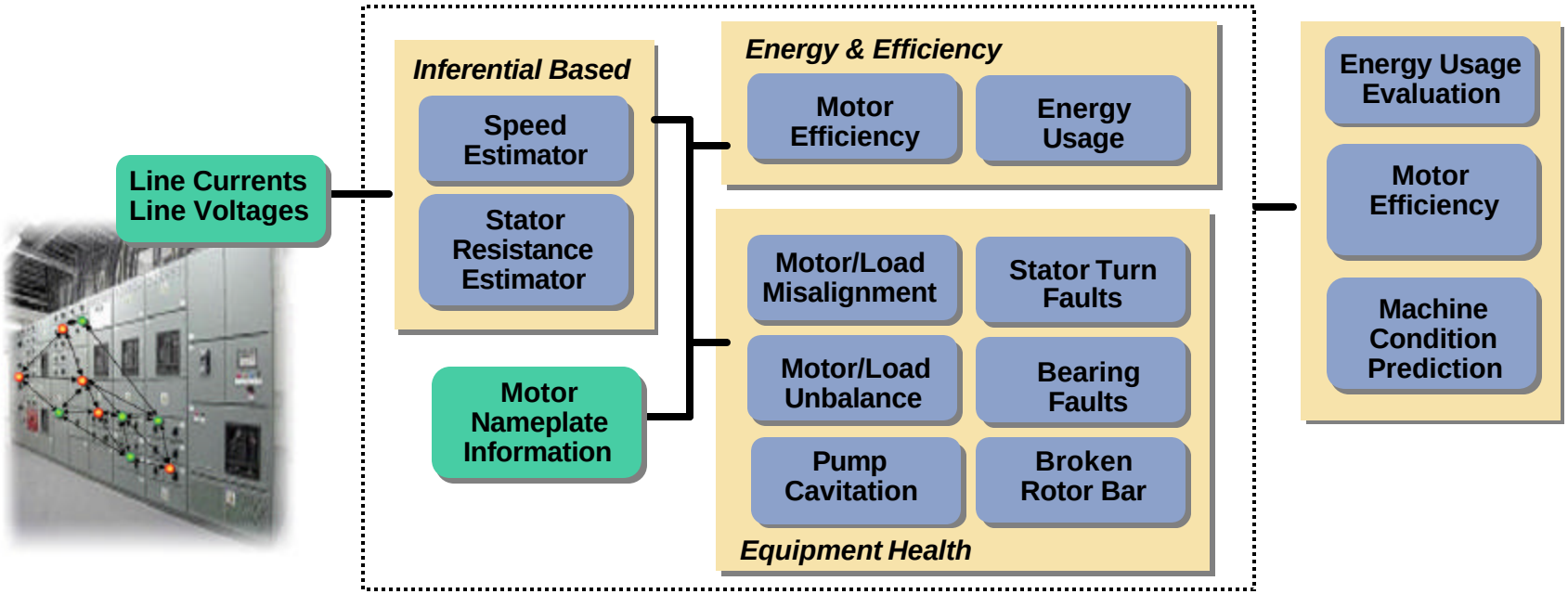
— Ben Grimes, Production Manager, Manitowoc Packaging Plant

"Weyerhaeuser manages energy costs in many ways, including curtailment agreements with utilities. When energy usage curtailment is required many plants guess at what systems/ processes to shutdown. Energy monitoring at the lowest (motor) level would dramatically improve upon this decision process."

— Thomas Dunn, Energy Efficiency Manager
— Bob Kenney, Region Energy Manager

Project Description

Challenge—Research, develop, test, and deploy a robust and self-configurable Wireless Sensor Network (WSN) for advanced energy management solutions that will inferentially estimate energy, efficiency, and wellness



No speed and torque sensors needed? Inferential, non-intrusive, low-cost!

Project Description

Goal—Enable significant energy savings for Advanced Energy Management Solutions (AEMS) in the Industries of the Future (IOF)

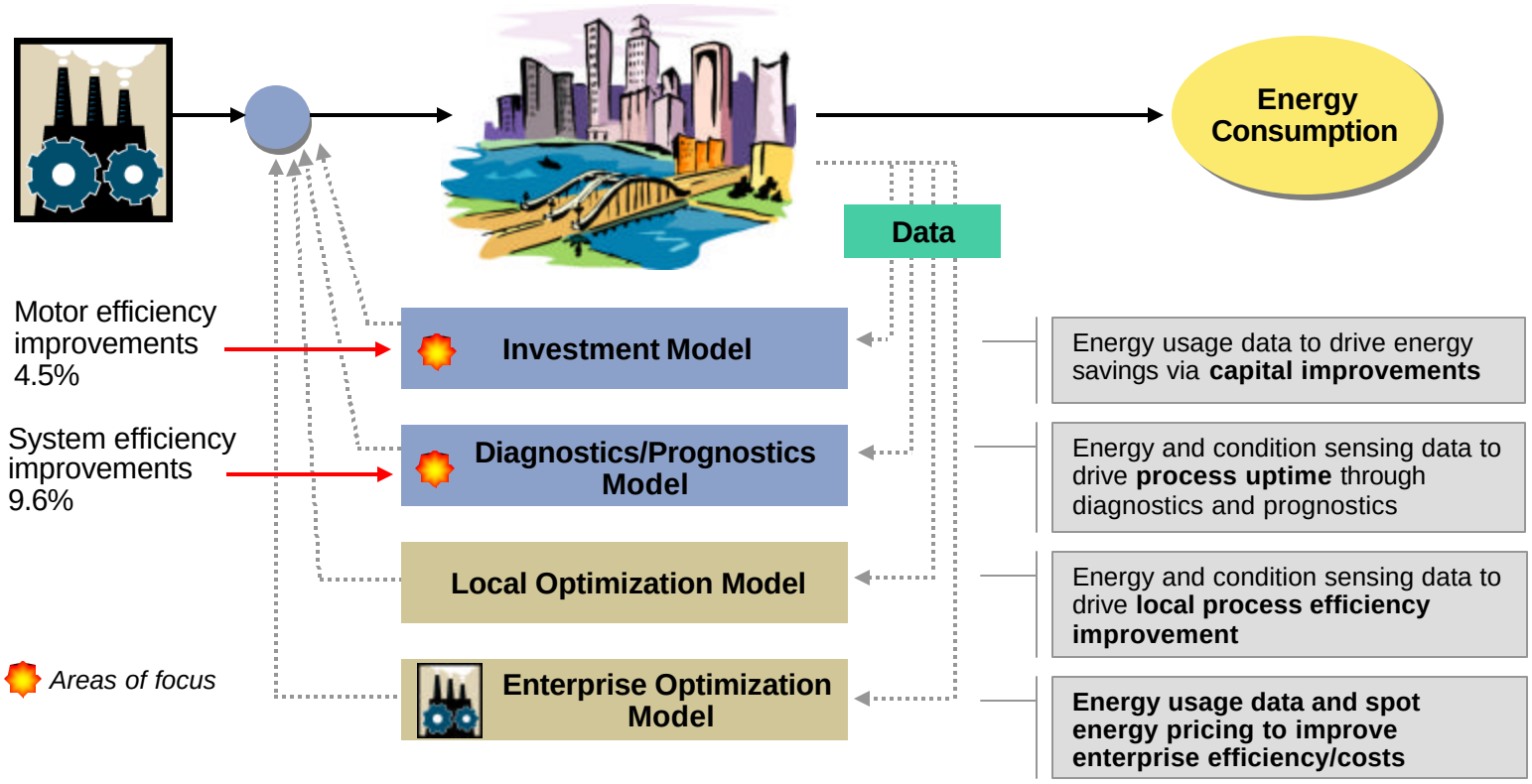
Core Technologies

- Inferential algorithms
- Industrial wireless sensor networks
- Parasitic power
- Communications security

WSN removes cost barriers enabling application of proven technology realizing 11% to 18% energy savings in industrial process systems

Focus Area	Energy saved
Motor efficiency	
• Upgrade motors to meet fed std	2.4%
• Use most efficient motors available	1.2%
• Improved process to rewind motors	0.9%
System efficiency and speed control	
• Correct for motor oversizing	1.2%
• Pump systems	4.9%
• Fan systems	0.8%
• Compressed Air systems	2.7%

Project Description



Wireless ? Low Installation Cost ? Pervasive Measurements
Measure ? Quantify Value ? Knowledge Enables Actions ? *Save Energy!*

Barriers and Pathways

Barriers

- Current barriers to broader energy management system usage
  - Wiring costs—up to $1000/foot
  - Information overload
  - Daunting cost/benefit analysis—especially for small motors
- Lack of robust, secure, and cost-effective communication networks to enable collection of critical monitoring and diagnostic information in energy management solutions
- Lack of cost effective electrical motor energy sensing methodologies that minimize intrusiveness, while providing required accuracy
- Lack of standards that promote interoperability

Pathways

- Communication of value proposition to customers—focusing on uptime and ROI
- Development of robust, self-configuring, low cost wireless sensor networks for advanced energy management solutions
- Advanced modeling to design and develop on-line electrical motor energy monitoring systems using distributed data
- Eaton's industry leadership in IEEE802, WINA, ISA/SP-100, IEEE1451 and the ZigBee Alliance

Energy Savings

Conservative Estimates

- Calculations using DOE Energtics tool set
- Savings related to electrical energy management only
- Based on 10% energy savings (vs. DOE est. of 11% to 18%)
- Realized savings based on capitalization schedule
  - Assume 6 to 10 yr motor life
  - 100% R&R by 2020
- DOE OIT report based data
  - Fuel Consumption tables per industry segment (SIC)
  - Industry segment growth rates

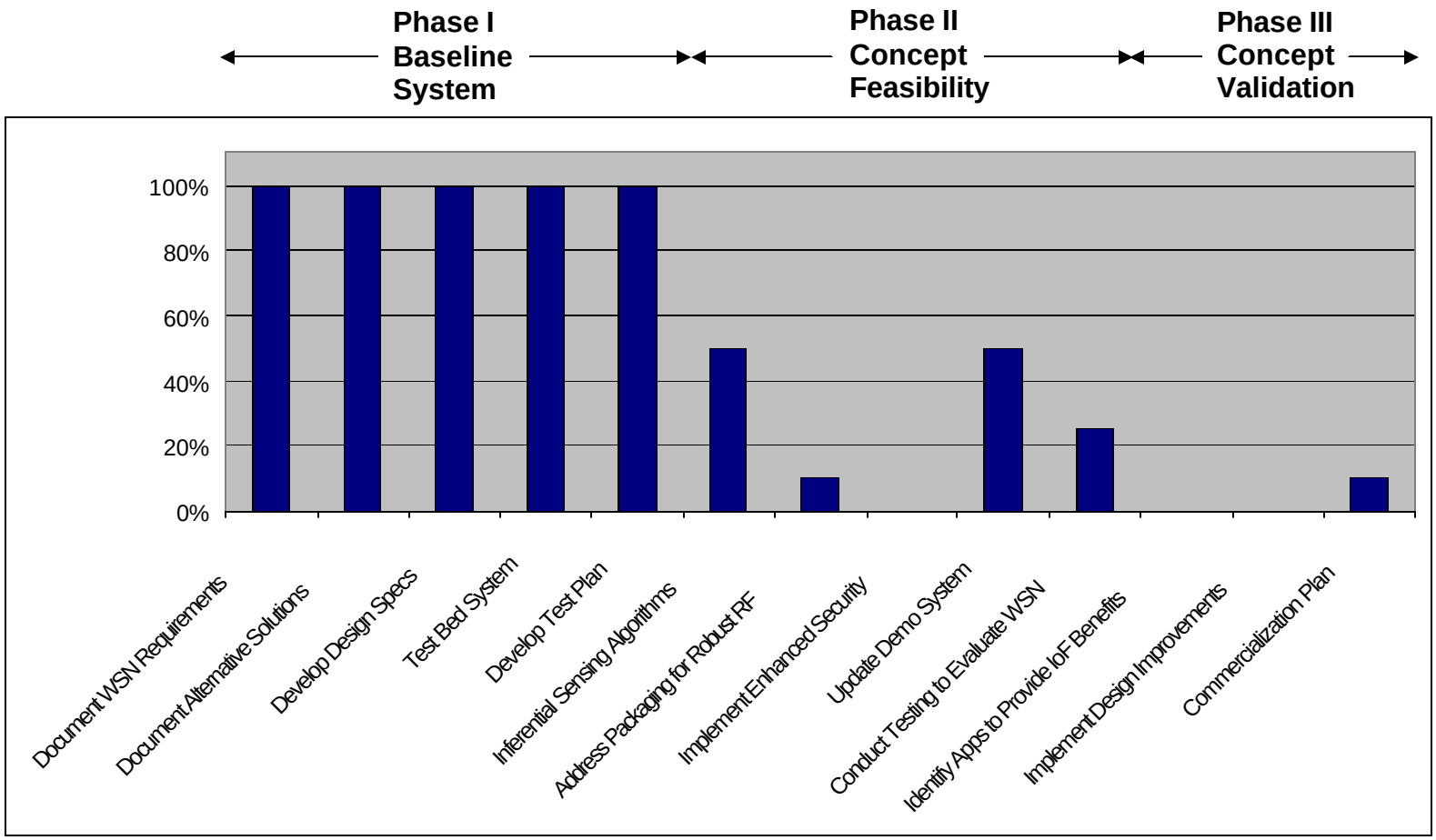
http://www.energetics.com/sensor_tool/

	Energy & Environmental Benefit in 2020								
	Petroleum	Aluminum	Chemical	Forest Products	Glass	Casting	Mining	Steel	2020 Total Impact
Electrical energy savings (trillion Btu's)	29.8	14.9	78.7	33.5	7.7	4.4	99.0	10.9	279.0
Pollutant Reduction (million lbs)	12.4	6.2	32.7	14.0	3.2	1.8	41.2	4.5	116.1

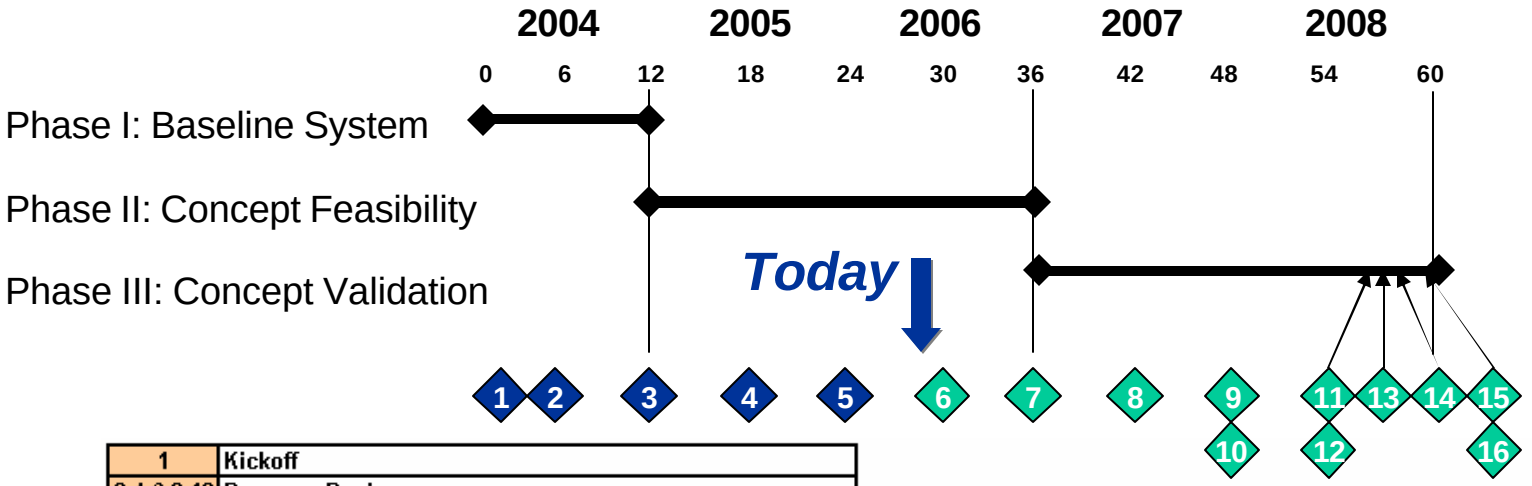
Benefits (est.)	2020
Energy Savings	>279 trillion Btu
Cost Savings	$1300 millions
Pollutant Reduction	116 Million lbs

Using conservative DOE-based data yields significant electrical energy savings of 279 Trillion Btu's year!

Project Status



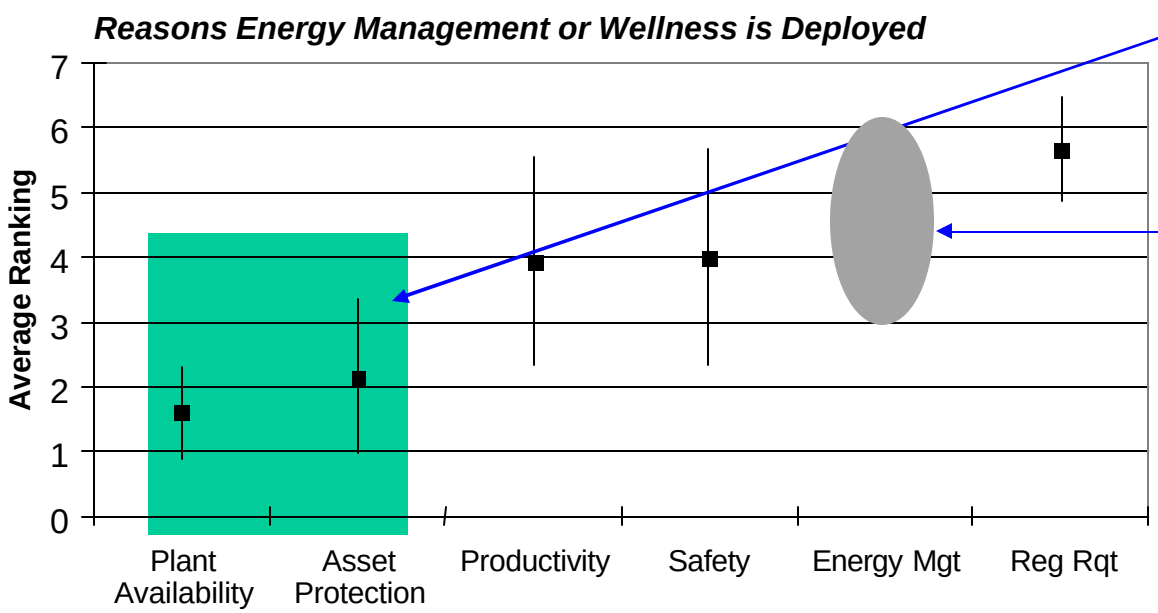
Milestones



1	Kickoff	
2,4,6,8,10	Progress Reviews	
3	Baseline Demo	Accomplished!
5	Phase II Interim Demo	Accomplished!
7	Phase II Concept Feasibility Demonstration	Laboratory-based demonstration of advanced wireless network and on-line energy monitoring estimators addressing industrial environment/application conditions
9	Phase II Concept Validation Demonstration	Demonstration in end-user facility using test / prototype hardware. Wireless / inferential systems may be tested separately.
11	Phase III: Integrated Concept Validation Demonstration	Demonstration at end-user facility of integrated wireless/inferential/actionable/information system
12	All external testing completed	
13	Draft final report	
14	Commercialization plan report	
15	Final Demo	
16	Final Report	

Value Proposition for End User

Customer wants uptime—energy and efficiency are secondary

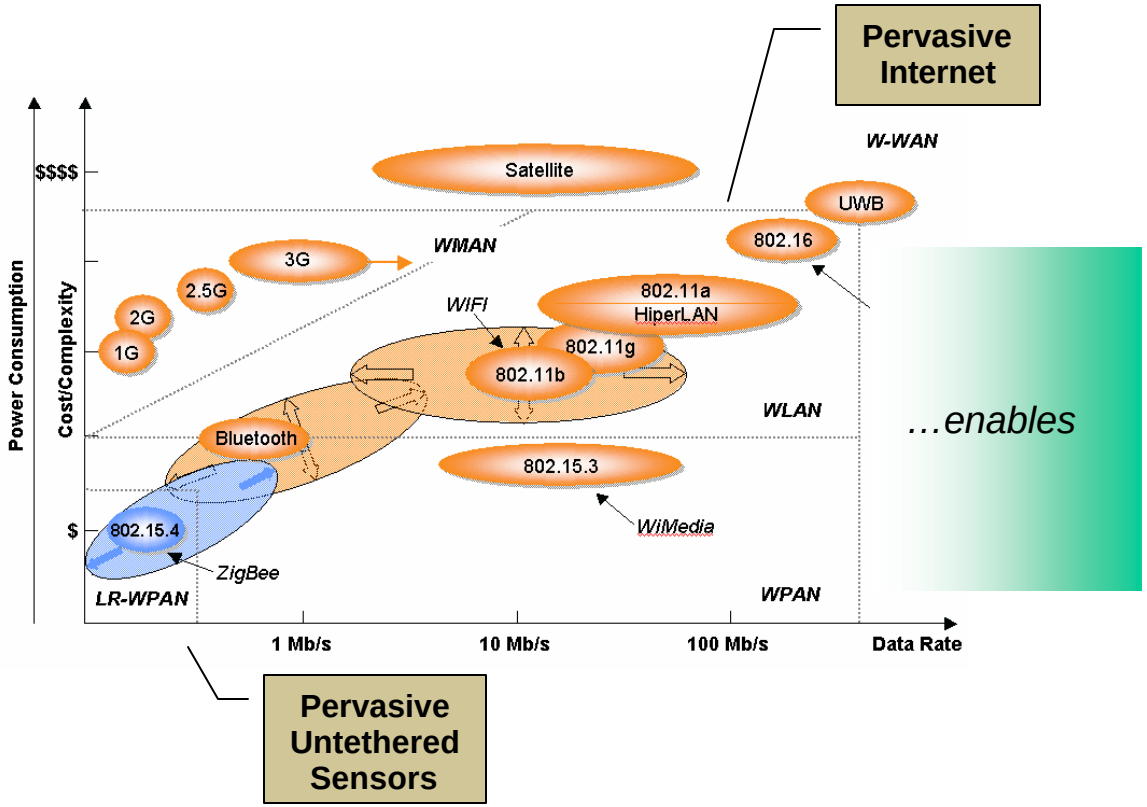


Plant availability and asset protection receive highest rankings

Energy management must be translated to real dollars at acceptable payback (6 to 18 months)

- *It is the difficulty of calculating return on investment that currently prevents broader deployment of energy management systems. Wireless Sensor Networks enables quantification of ROI.*

Wireless Communication Landscape



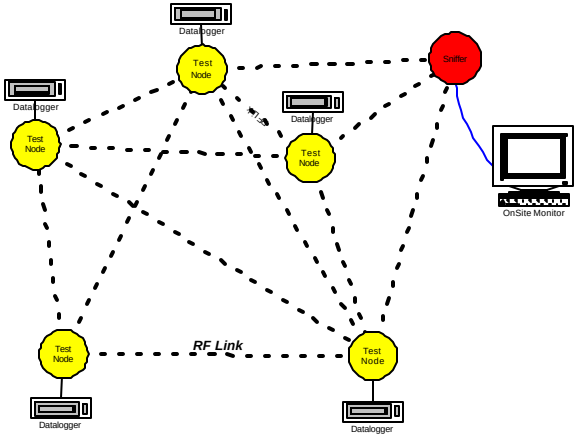
Industrial Wireless Sensors

- Low cost
- Low power**?** energy harvesting
- Secure
- Harsh environment
- Location awareness

…enables

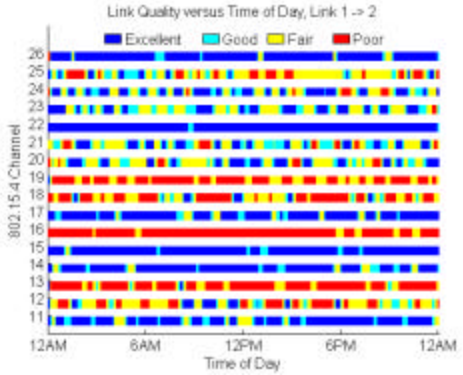
- *Diagnostics and prognostics*
- *Energy monitoring*
- *Safety*
- *Asset management*

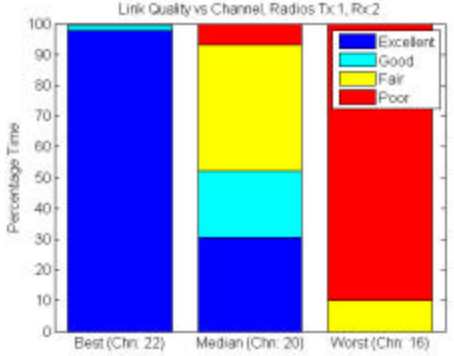
Accomplishments to Date

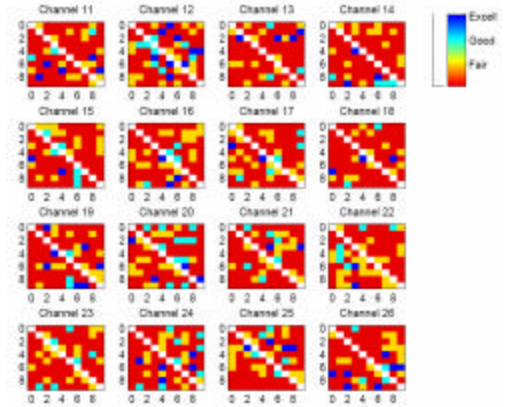


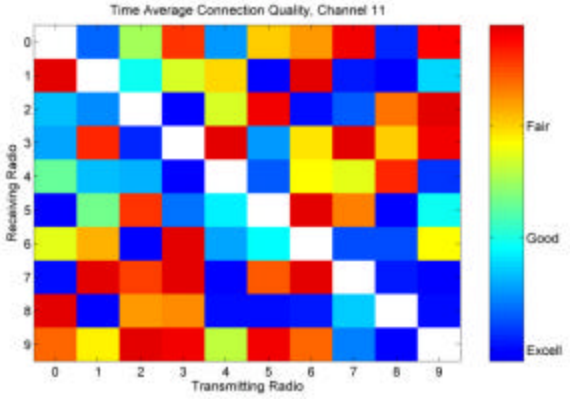
Deployment of Eaton's wireless mesh performance characterization system

- Measure the reliability and performance of the wireless communications over an extended period of time
- Provide key engineering data for designing robust industrial WSN
  - Throughput
  - Latency
  - Reliability
  - Security









Showcasing Opportunities

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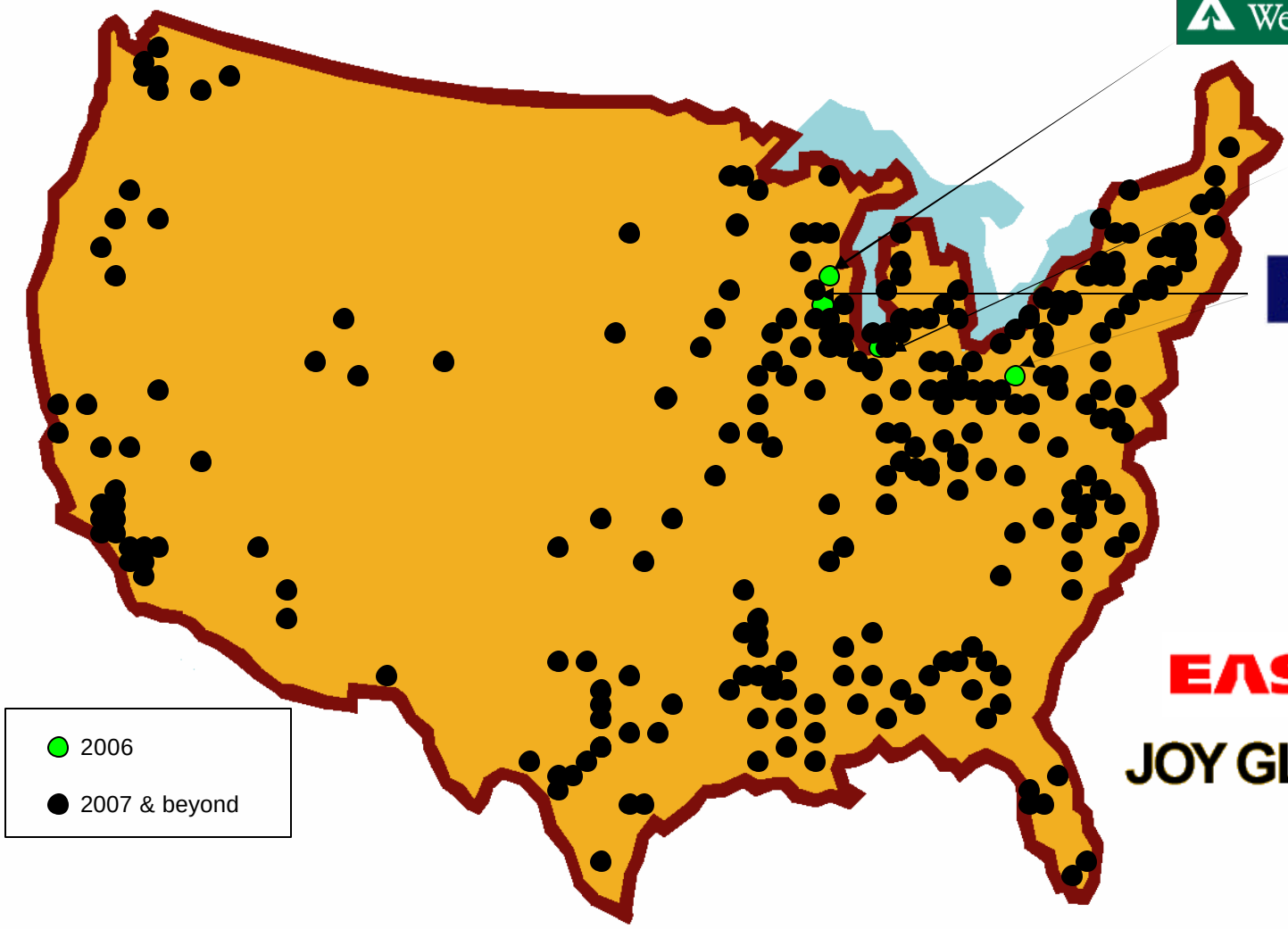

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EATON
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EASTMAN
JOY GLOBAL INC.

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Saving it at the Customer Partner site

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Customer Partner Locations / Applications

Test Hardware

Results as seen by Customer Partner

Industrial Controls

Prognostics and Diagnostics Technology Program

Program Description—Develop an intelligent technology platform that will monitor the condition of a motor and connected load using primarily the motor currents and voltages

Strategic Objectives

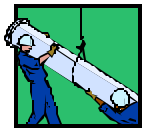
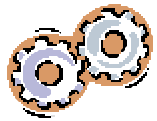
- Cutting edge prognostic and diagnostic technology at a low price point enabled by wireless communication and inferential (soft) sensing
- Provide customers with valuable energy, efficiency, wellness monitoring information
- Drive high up-time and lower unscheduled maintenance
- Provide energy data to drive cost savings

Critical Dependencies/Interdependencies

- Customer value proposition
- Product implementation embodiments
- Integrate with power control products offering

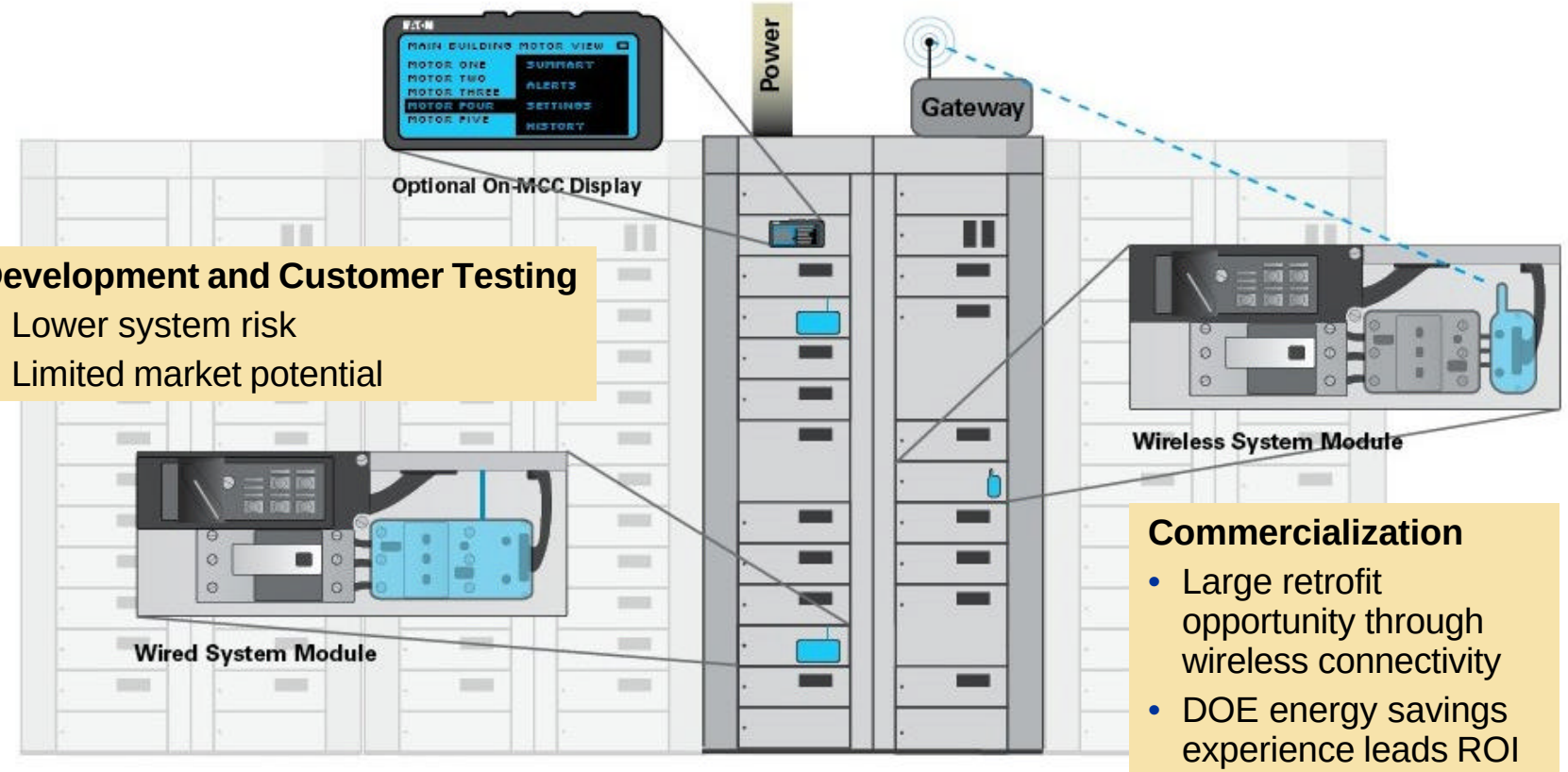
Critical Success Measures

- Cost—compatible with small motor applications
- Ease of installation for retrofit market—wireless
- User interface provides actionable information (not just data)
- Field testing from DOE 1
  - Robust field proven wireless
  - Proven customer value—energy, efficiency, wellness


Energy, Efficiency, Wellness

Wireless Network for Advanced Energy Management Solutions



Development and Customer Testing

- Lower system risk
- Limited market potential

Commercialization

- Large retrofit opportunity through wireless connectivity
- DOE energy savings experience leads ROI

Eaton PowerXpert Gateway - Mozilla Firefox

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EATON | PowerXpert GATEWAY

Friday, April 28, 2006
15:31:15

AE Meeting 2006
Sheraton Midtown Atlanta

Home | **Summaries:** Buses | Configuration

SOURCE:
Main #1

Status: CLOSED

METER
Volts(AVG): 121V

POWER & ENERGY
Power: 99kW
Capacity: 4%
Energy: 2,491kWh

QUALITY
THD 0.12

Bus #1

Feeders	Status	Current	% Capacity
Lighting	CLOSED	40 A	45 %
MCC#1	CLOSED	40 A	65 %
MCC#2	CLOSED	40 A	35 %
Sub-Station #1	CLOSED	40 A	95 %

Motors	Status	Current	% Capacity	°F	Hz	%Thermal
Motor #1	CLOSED	40 A	8 %	165	---	50
Motor #2	CLOSED	40 A	5 %	165	---	50
Conveyor Belt	CLOSED	40 A	5 %	165	---	50
Water Pump	CLOSED	40 A	5 %	165	---	50

SOURCE:
Main #2

Status: CLOSED

METER
Volts(AVG): 121V

POWER & ENERGY
Power: 99kW
Capacity: 8%
Energy: 2,491kWh

QUALITY
THD 0.12

Bus #2

Feeders	Status	Current	% Capacity
Feeder 1	CLOSED	40 A	6 %
MCC #3	CLOSED	40 A	8 %
Feeder 3	CLOSED	40 A	8 %
MCC #4	CLOSED	40 A	8 %
Feeder 5	CLOSED	40 A	8 %
Feeder 6	CLOSED	40 A	8 %
Feeder 7	CLOSED	40 A	8 %
Feeder 8	CLOSED	40 A	8 %

Next Project Steps

- Implement industrial wireless network enhancements extracted from Eaton's Wireless Mesh Performance Characterization system
- Continue aggressive testing of algorithms and communications performance at customer sites

INTERNATIONAL PAPER Weyerhaeuser bp

- Continue active participation in standards efforts, to maximize the benefits from interoperability
- Optimize soft sensing wellness algorithms
- Develop software architecture for algorithm integration
- Continue developing commercialization plan covering the manufacturing, marketing, and introduction of the WSN into an energy management system optimization product offering

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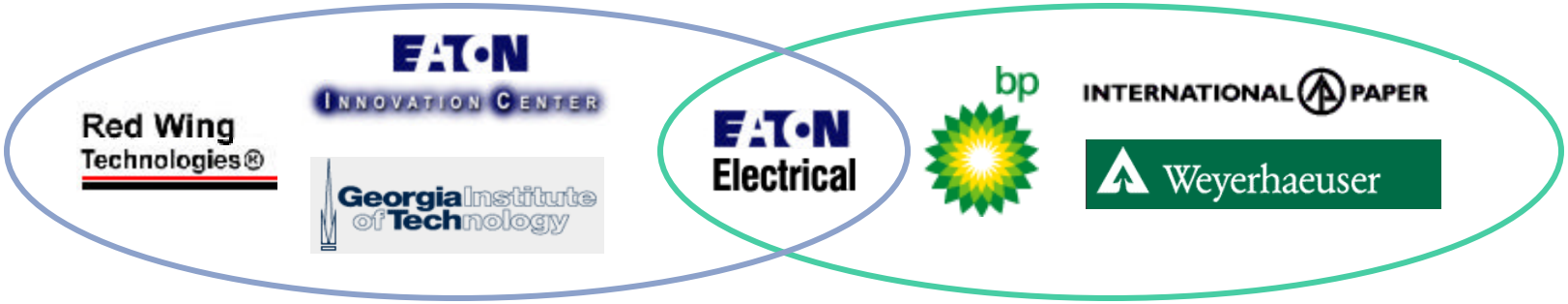

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