T40 - Maximize Savings, Minimize Downtime with Power Quality & Energy Management
Agenda

Why Power Quality & Energy Management?

What is Energy Management?

Energy Management Solutions

Questions
Why Power Quality & Energy Management?

Global Economy:
• Economic pressure for process optimization to improve profitability
• Produce the same quality product at any plant around the world at lowest cost
• Maintain competitive advantage

Regulatory Requirements:
• Compliance to current and future government regulations
• Compliance to codes and standards

Sustainability:
• Reduce energy consumption across all phases of production
• Reduce environmental emissions
• Maintain brand reputation

Factory Uptime:
• Minimize equipment failure
• Energy reliability and availability
• Minimize scrap
Why Manage Industrial Energy?

- Energy is the largest unmanaged industrial expense
- Over 60% of Fortune 100 companies have made public commitments to reduce energy
- 195 countries participated in the 2015 UN Climate Change Conference
- Less than 5% use software to track and analyze energy data

Global Energy Usage by Sector

Energy management can result in significant savings

Improve Visibility to Energy Usage

Challenges:
- Reduce energy consumption
- Reduce operational costs

Solutions:
- Use existing automation devices and systems currently installed to gather data for Water, Air, Gas, Electricity & Steam usage
- Reduce energy costs by knowing how much, when & where you are using energy and deploying low cost / no capital cost operational changes

Energy Awareness Can Save Up to 20% in Energy Savings
Agenda

Why Energy Management?

What is Energy Management?

Energy Management Solutions

Questions
**TERMINOLOGY**

**ENERGY MANAGEMENT:** The direct costs associated with using energy in your facility

- Providing solutions that enable a customer to optimize the consumption of energy in their plant or at a specific process. Includes all components that make up a utility bill (Consumption, Demand, Power Factor).

**POWER QUALITY:** The ability to supply a clean and stable power source

- Related to fluctuations in electricity, such as momentary interruptions, voltage sags or swells, flickering lights, transients, harmonic distortion and electrical noise.
- Fewer such incidents indicate greater power quality.
- Events typically undetected or not monitored by Utilities.
- Sag & Momentary events can take out a process as many as 20-30 times per year.
Understanding Utility Bill

Energy Management

- Three major charges on your utility bill

- Consumption $\$\$
- Demand $\$
- P.F. Penalties $
- Other
  - Fuel cost adders
  - Taxes and fees
Utility Terminology
Energy Management

**Demand** is the rate at which power is used (kW)

**Consumption** is the quantity of energy used (kWh)
Demand Charges

Energy Management

- **Demand**: Average rate of energy transfer, measured in kW or kVA
- Calculated over a Demand Interval
  - Commonly 15 minutes
  - Defined by the electrical energy provider
  - Occasionally based on a sliding window
- Highest demand interval establishes the monthly charge
  - On- and off-peak demand rates may apply
- Ratchet Clauses
  - Peak demand in any 15-minute interval can impact charges for next 12 months

**Typical demand charges equal ~$10 per kW**
Power and Energy Measurements

Energy Management

- **Real Energy (kWh = “Kilo-Watt-hour”)**
  The amount of energy used to do work.

- **Reactive Energy (kVARh = “Kilo-VAR-hour”)**
  Amount of energy consumed/produced by inductive motors or capacitor banks.

- **Apparent Energy (kVAh = “Kilo-VA-hour”)**
  Total energy consumed/produced within a system; Dictates capacity requirements of system.

- **Real Power (kW = “kilo-Watts”)**
  The power which can be used to do work.

- **Reactive Power (kVAR = “kilo-vars”)**
  Power consumed/produced by inductive motors or capacitor banks.

- **Apparent Power (kVA = “kilo-Volt-Amperes”)**
  Total power consumed/produced within a system; Dictates capacity requirements of system.
Power Factor
Energy Management

- Power Factor = Ratio of Real Power to Apparent Power
  
  \[
  PF = \frac{\text{Real Power (P)}}{\text{Apparent Power (S)}}
  \]

- Dimensionless value between 0 and 1
  - Sometimes expressed as a percentage “lagging” or “leading”
  - Leading – The load is more capacitive
  - Lagging – The load is more inductive

- Utilities may impose a Power Factor penalty
  - Directly – Customers are charged per actual power factor measurements
  - Indirectly – Customers pay additional charges for higher amounts of reactive power
Importance of Power Quality

Power Quality

- Power quality events are mostly random
  - **Utility side:** Weather, animal / trees hitting power lines, car accidents, construction, equipment failure
  - **Facility-side:** Starting of large loads – motors, poor electrical connections, Customer equipment (arc welders)

- Impact on production
  - Shut down equipment: voltage sags with as little as 80% remaining can impact production (lights may not blink)
  - Immediate or long-term damage to sensitive electrical equipment
  - Potential for significant scrap due to unexplained shutdowns

- Consumer is responsible for power quality
  - Utility is responsible for power reliability

**Consumer is responsible for protecting their sensitive equipment**
Power Quality Study in Chicago

Power Quality

“Dots” below and to right of curves represent events that will cause profiled devices to “trip”
- The average site in Chicago experienced 13 voltage sags severe enough to impact production
- No events between 1.72 seconds and 196 minutes.

Data taken from 10 I-Grid monitors in the Chicago area.
Power Quality Event Types

Power Quality

Voltage Sag/Swell

Harmonics

Transient Detection

http://www.rockwellautomation.com/go/pems
A Universe of Possible PQ Events

Power Quality

<table>
<thead>
<tr>
<th>Frequency of Occurrence</th>
<th>Typical Incident Cost</th>
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</thead>
<tbody>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Very Low</td>
<td>Low</td>
</tr>
<tr>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

- **Sag** (0.5 cycles – 60s)
- **Unbalance** (Fluctuating)
- **Swell** (0.5 cycles – 60s)
- **Notching** (Constant)
- **Transient** (<50 ns – 5 ms)
- **Undervoltage** (>1 minute)
- **Overvoltage** (>1 minute)
- **Noise** (Constant)
- **Harmonics** (Constant)
- ** Interruption** (0.5 cycles – >1 hr)

Grid Related
Facility Related
# Power Quality Identification & Mitigation

## Power Quality

<table>
<thead>
<tr>
<th>Power Quality Issue</th>
<th>Identification Product</th>
<th>Mitigation Product</th>
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</thead>
<tbody>
<tr>
<td>Sag/Swell</td>
<td>i-Sense®</td>
<td>1609 UPS</td>
</tr>
<tr>
<td></td>
<td>PM5000 M5/6/8</td>
<td>1608 DySC®</td>
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<tr>
<td>Under/Over Voltage</td>
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<td></td>
<td>PM5000 M5/6/8</td>
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</tr>
<tr>
<td>Interrupt</td>
<td>i-Sense®</td>
<td>1609 UPS</td>
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<td></td>
<td>PM5000 M5/6/8</td>
<td>1608 DySC®</td>
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<tr>
<td>Individual Harmonics</td>
<td>PM5000 M6/8</td>
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<tr>
<td>Transients</td>
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<td></td>
<td></td>
<td>4983 Surge Protector</td>
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<td></td>
<td></td>
<td>4983 Filter</td>
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<tr>
<td>Frequency</td>
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<tr>
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<td>4983 Filter</td>
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</table>
Energy Management Solutions

Why Energy Management?

What is Energy Management?

Questions
Our Energy Monitoring products keep you well-informed of how much power you use, what your major loads are, when you use electric power the most, how much you pay for it, and the quality of the power you use. Use these Energy Monitoring products to improve your equipment life and productivity, reduce your power use, and increase your company's overall profits.
# PowerMonitor™ Comparison

<table>
<thead>
<tr>
<th>Description</th>
<th>PM 500</th>
<th>PM 1000</th>
<th>PM 5000 (M5, M6, M8)</th>
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<tr>
<td><strong>Energy Consumption</strong></td>
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<td><strong>Demand</strong></td>
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<td>X</td>
<td>X</td>
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<tr>
<td><strong>Power Factor</strong></td>
<td>X</td>
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<td>X</td>
</tr>
<tr>
<td><strong>Power Quality</strong></td>
<td></td>
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<td>X</td>
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<tr>
<td><strong>Sag/Swell Detection</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Harmonics</strong></td>
<td></td>
<td></td>
<td>M6 &amp; M8</td>
</tr>
<tr>
<td><strong>Waveform Capture</strong></td>
<td></td>
<td></td>
<td>M6 &amp; M8</td>
</tr>
<tr>
<td><strong>Communication Protocols</strong></td>
<td>Modbus RTU, Modbus TCP/IP, EtherNet/IP</td>
<td>DF1, Modbus RTU, DH485, Modbus TCP/IP, EtherNet/IP</td>
<td>EtherNet/IP, DeviceNet, and ControlNet</td>
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<tr>
<td><strong>Onboard Display</strong></td>
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<td>Limited</td>
<td>Optional</td>
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<td><strong>Internal Logging</strong></td>
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<td><strong>Status Inputs</strong></td>
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<td><strong>Relay Outputs</strong></td>
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<td><strong>Setpoint Control</strong></td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>CIP Energy / Logix AOP</strong></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
First Step - Energy Audit

- Create list of all major loads such as motors and HVAC equipment
- Understand WAGES utilization (Water, Air, Gas, Electricity, and Steam)
- Copy of 6-12 months of utility bills
- Downtime history or frequency of equipment damage
- Understand utility billing model (penalties, peak time, etc.)
- Review utility incentives
Energy Monitoring Architecture

- (3) **PowerMonitor™ 5000**
  - Main Input Meter
  - Point of Use Metering

- (5) **PowerMonitor™ 1000**
  - Sub Metering
  - Point of Use Metering

- (3) **PowerMonitor™ 500**
  - Point of Use Metering
  - Sub Metering
Power Monitor Hardware and Wiring

- **Power Monitoring Hardware Components**
  - Power Monitor
  - Current Transformers
  - Shorting Block
  - Fuses and Holders
  - PTs for >690V

### Power Monitoring Hardware Components

- **Control Power**
- **3 Phase Power**
- **Voltage Connection** (PTs > 600V)
- **Accessories Wiring Kit**
- **Current Connection** (CTs required)

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CT: Current Transformer
PT: Potential Transformer
Data Management and Analytics
Data Management Solutions

Component Level

Controller Integration

Energy Software

- EnergyMetrix
- VantagePoint
Project Execution Options

Rockwell Automation®

- SSB - System Solution Business
- IPS - Industrial Plant Services

http://www.rockwellautomation.com/global/solutions-services/overview.page

Recognized System Integrators

- Recognized System Integrators have a proven competency with Rockwell Automation® products and have a mutually supportive relationship with our sales and/or distributors

Additional Resources

- Virtual Brochure
  http://www.rockwellautomation.com/go/pems

- Selection Guide

- Energy Accelerator Toolkit
Thanks!