Using VFDs to Drive HVAC Energy

May 10th 2016
Dan Cooper
Intro to Toyota North America
HVAC Energy at Toyota

14 Plants

660 HVAC units

Approx. 40K HP (30 MW)

Target HVAC energy by:
1. Optimizing run time (non production)
2. Reducing air flow
1. Remove
2. Install
3. Integrate

Install VFD to control fan motor
Fan Affinity Laws

Basic fans laws:
1. Flow varies directly with fan speed
2. Pressure varies with square of fan speed
3. Power varies with cube of fan speed

2.5 Hz = 44 HP
4% reduction in fan speed results in reduced HP (50 HP)
1. Design temperatures
2. Building set points are 81° F summer and 65° F winter.
3. Units operate M-F, setback on weekends
Savings Concept

Current condition –
- Constant volume
  100% cfm

Opportunity –
- Spring & Fall 40% cfm reduction
- Winter 50% cfm reduction
- Non production time 20%-60% cfm reduction
Project Summary

8 Plants

531 HVAC Units

659 VFDs

31K Horse Power

179,632 MMBTU Energy Reduction
BBBP Showcase Project

Showcase Project: Fan System Upgrade

SECTOR TYPE
Industrial

LOCATION
Georgetown, Kentucky

PROJECT SIZE
7,500,000 Square Feet

FINANCIAL OVERVIEW
$1.25 Million

Annual Plant Electricity Use

<table>
<thead>
<tr>
<th>Baseline (2015)</th>
<th>450,000 MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected (2018)</td>
<td>438,300 MWh</td>
</tr>
<tr>
<td>Actual</td>
<td>Coming Soon</td>
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</tbody>
</table>

Electricity Savings: **2.6%**

Annual Plant Electricity Cost

<table>
<thead>
<tr>
<th>Baseline (2015)</th>
<th>$28,000,000</th>
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</thead>
<tbody>
<tr>
<td>Expected (2018)</td>
<td>$27,300,000</td>
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</table>

Cost Savings: **2.5%**
Objective: Reduce HVAC energy consumption

Scope: Install VFDs on 163 HVAC

Method: Seasonally adjust set points

Toyota Motor Manufacturing Kentucky (TMMK)
Constraints

- Energy Savings
- Schedule
- Install $
- Integrate $
- VFD $
- Codes/Reg
- 2 Yr Payback
Issues / Challenges

1. Age of units
2. Motor compatibility
3. Line/Load Reactors
4. Integration

Vortex Vanes

Building Mgmt. System

Fan Motor

Reactors
Project Savings

Total kWh reduction: 11,715 MWh
Total savings: $702K

Project cost: $1.2M

Simple payback: 1.8

Total HP: 8898

# HVAC Units: 163
Future Opportunity

- Reduce speed during non production
- BMS integration
Summary

1. Energy opportunity with <2 year payback
2. Started as a pilot, replicated to other plants
3. M&V – confirm energy savings

Additional benefits:
1. Reduced maintenance - belt replacement
2. Improve control of building balance
3. Ability to monitor and adjust system performance
Thank You

Questions / Comments ?