



ENGINEERING
PHARMACEUTICAL
INNOVATION

**Carolina-South
Atlantic Chapter**

Energy Management: *2010 Automation Forum*

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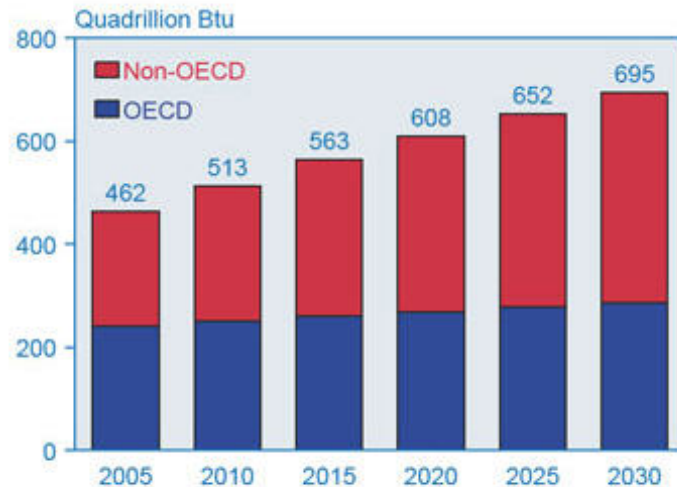
OMNI Professional
Research Triangle Park, NC

Why are we discussing Energy Management at an Automation Forum?

Pharmaceutical companies are facing a convergence of forces that will fundamentally alter traditional facility design, operations, and information management.

Energy management is an important factor in strategies for meeting these challenges, including efficient facility design, predictive maintenance, improved time to market, agile (LEAN) manufacturing, and sustainability.

Figure 1. World Marketed Energy Consumption, 2005-2030



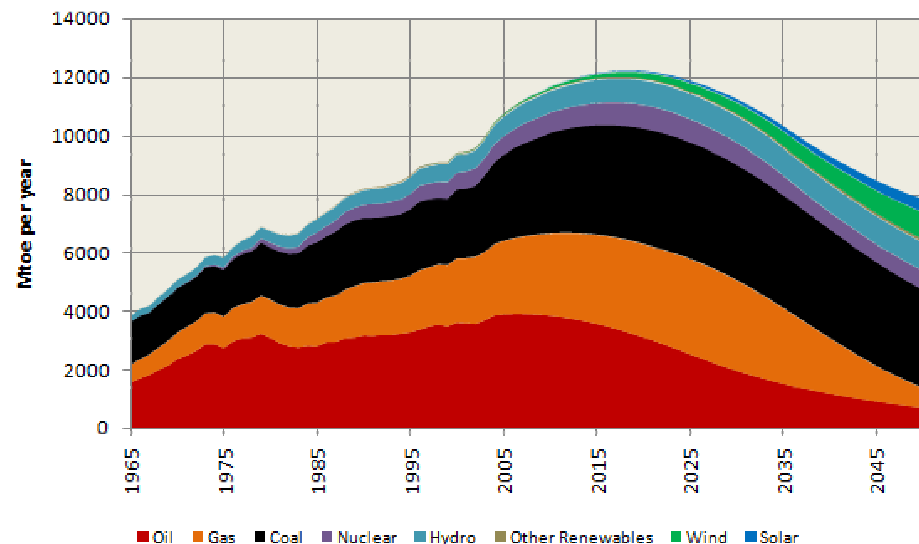
Sources: **2005:** Energy Information Administration (EIA), *International Energy Annual 2005* (June-October 2007), web site www.eia.doe.gov/iea. **Projections:** EIA, *World Energy Projections Plus* (2008).

Energy Supply & Demand

**Picture is an
Impending Train
Wreck**

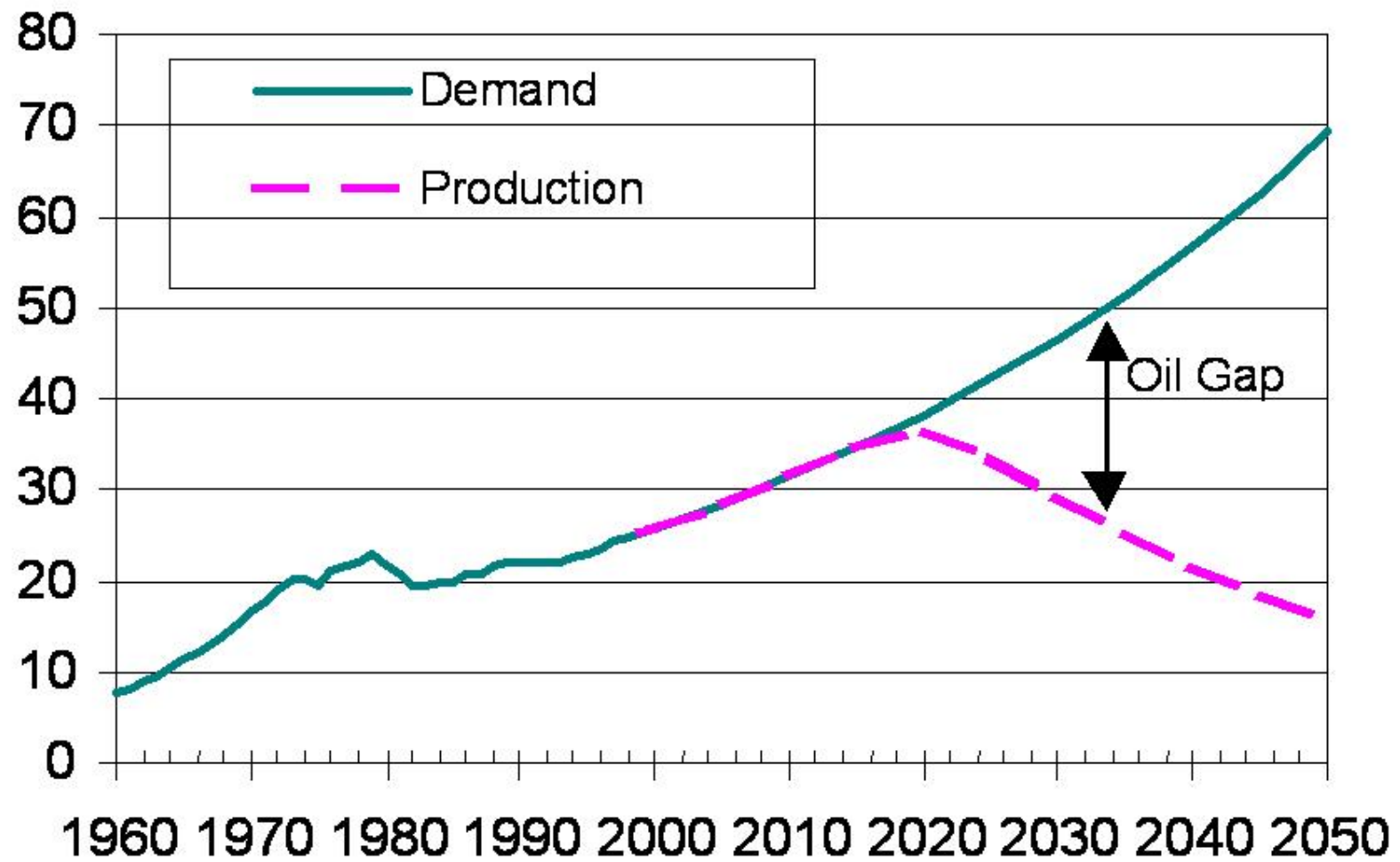
- **National Security**
- **Economic Stability**
- **Price Volatility**
- **Supply Disruptions**
- **Exploration Costs**

Global Energy Supply



An “Oil Gap” is Expected within the next 5 to 10 years.

Oil in Billion Barrels



Options

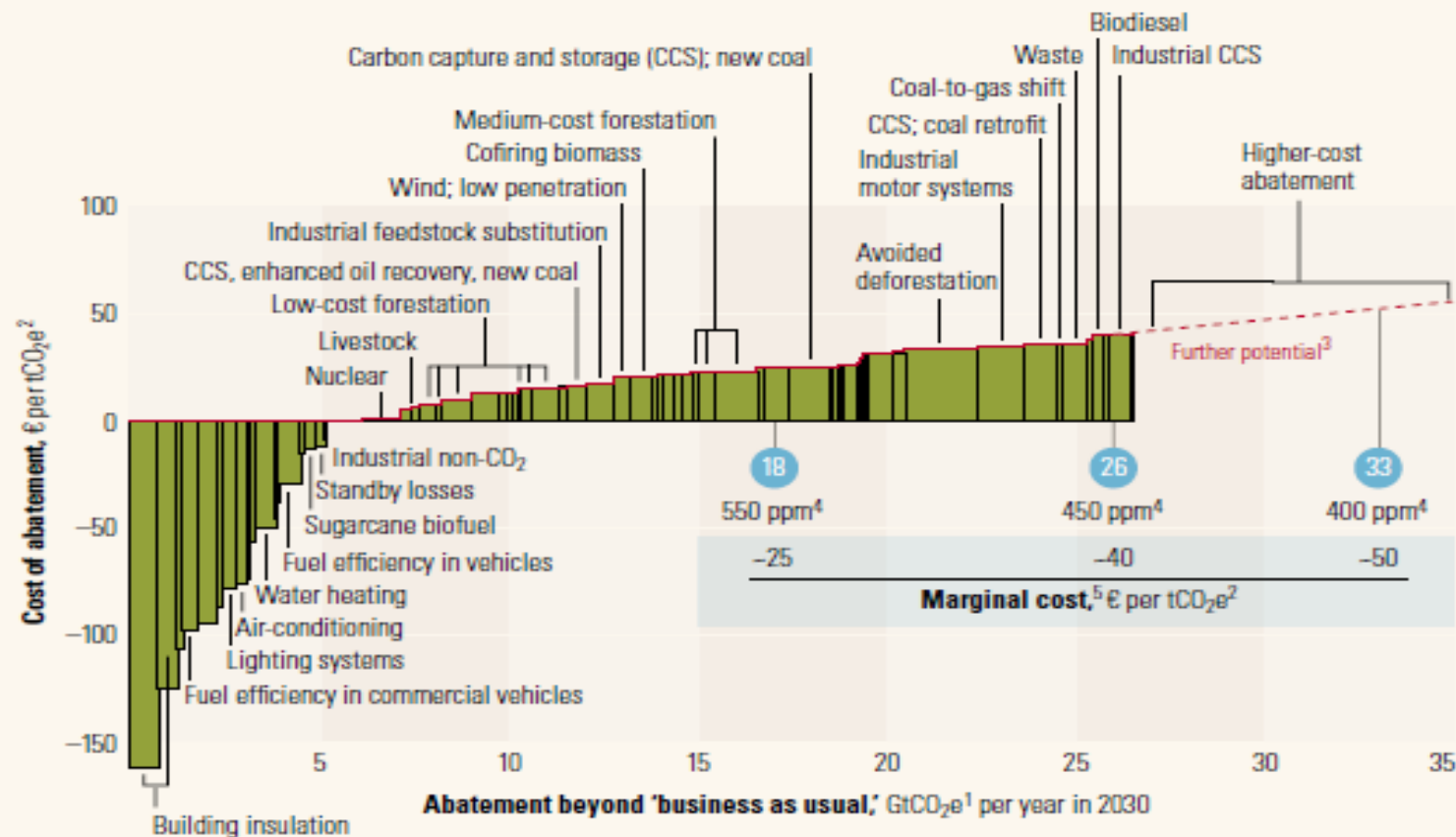
- **Hoarding & stockpiling of petroleum**
(The U.S. already does this to some extent).
 - **Diversification of energy supply sources**
(renewable, biomass, nuclear, etc.)
 - **Demand restraints**
(i.e., lowering standards of living)
 - **Sustainable development**
(dramatic changes in current practices), and
- ➔ **Energy efficiency.**

Is Energy Efficiency a “Free Lunch”?

What might it cost?

Global cost curve for greenhouse gas abatement measures beyond “business as usual”; greenhouse gases measured in GtCO₂e¹

- Approximate abatement required beyond “business as usual,” 2030



¹GtCO₂e = gigaton of carbon dioxide equivalent; “business as usual” based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.

²tCO₂e = ton of carbon dioxide equivalent.

³Measures costing more than €40 a ton were not the focus of this study.

⁴Atmospheric concentration of all greenhouse gases recalculated into CO₂ equivalents; ppm = parts per million.

⁵Marginal cost of avoiding emissions of 1 ton of CO₂ equivalents in each abatement demand scenario.

**When asked by the FBI why he
robbed banks, Willie Sutton
simply replied,**

***"Because that's where the
money is."***

Two Major Areas of Focus

Demand

Buildings

- HVAC

- Lighting

- Equipment

Process Requirements

Other

Generation

Boilers

Chillers

Cogen

Compressed Air

Other

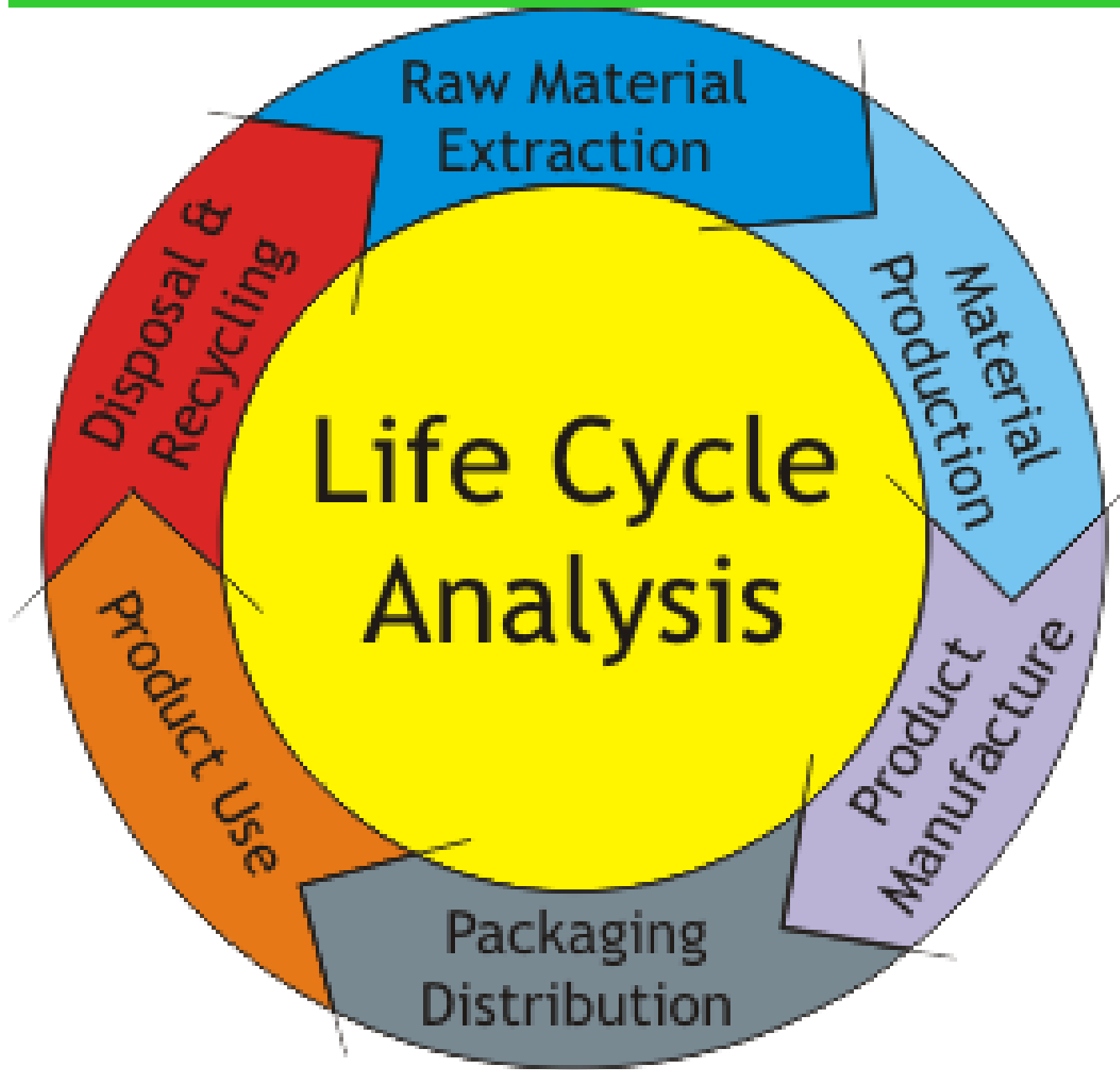
10 Major Systems to Consider at Pharma Plants

- **Building Envelope**
- **HVAC System – people comfort
(data centers are a specialized area)**
- **Electrical Supply System**
 - **Lighting**
- **Boiler & Steam Systems
(including steam traps)**

10 Major Systems to Consider (cont.)

- **Hot Water System - domestic**
 - **Compressed Air System**
 - **Motors – probably can't see**
 - **Special Process Equipment**
- *(Formulation, Blending, Milling, Granulation, Drying, Final Blending, Tableting, Tablet Press Tooling, Coating, and Encapsulation, etc.)*
 - **Water & Sewer System**





Pop Quiz

- Which Pump should you buy? (lowest first cost?)

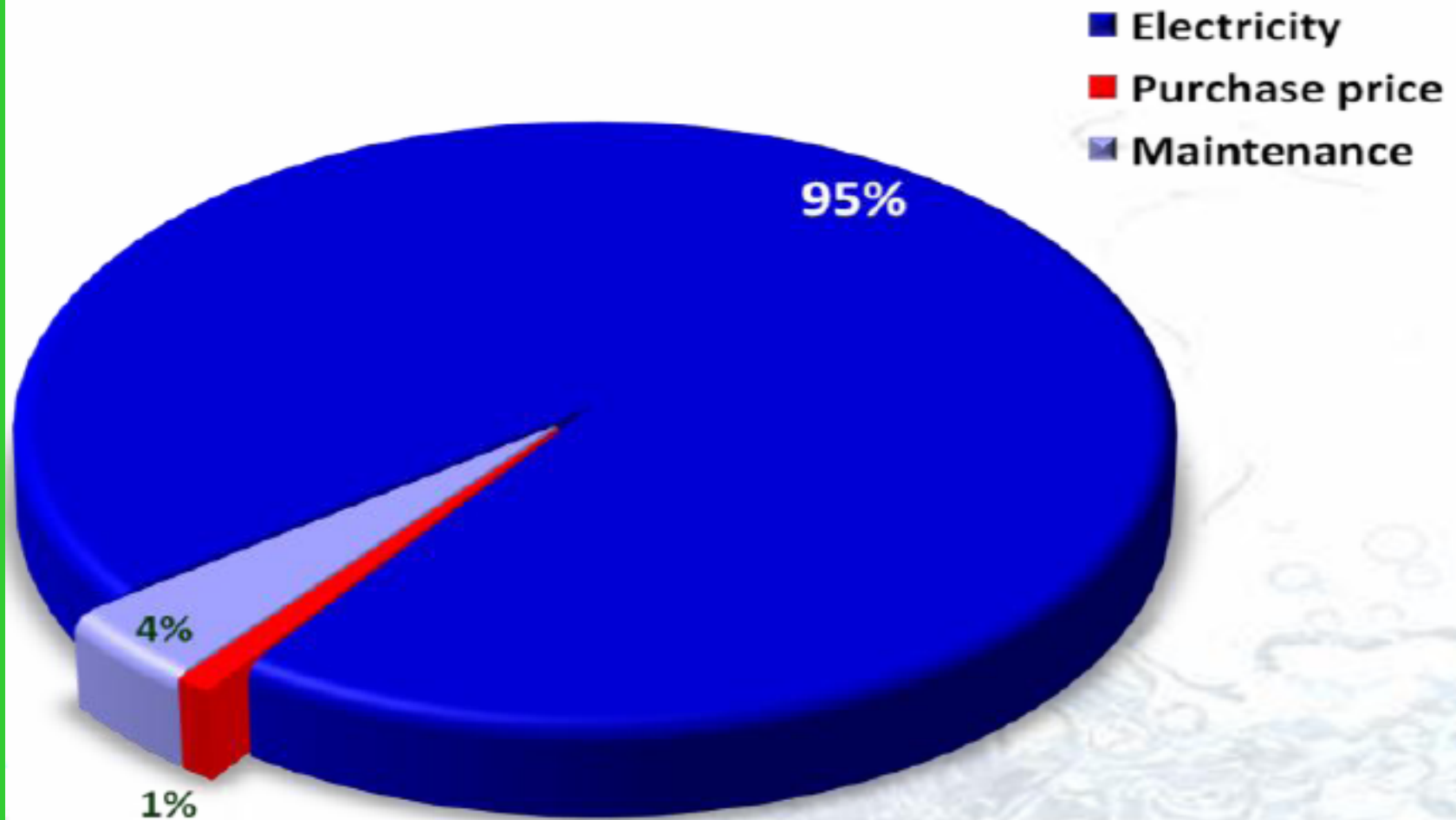
High Efficiency motors



Installation of VFD's



Pump Lifecycle Costs



God is in the details . . .

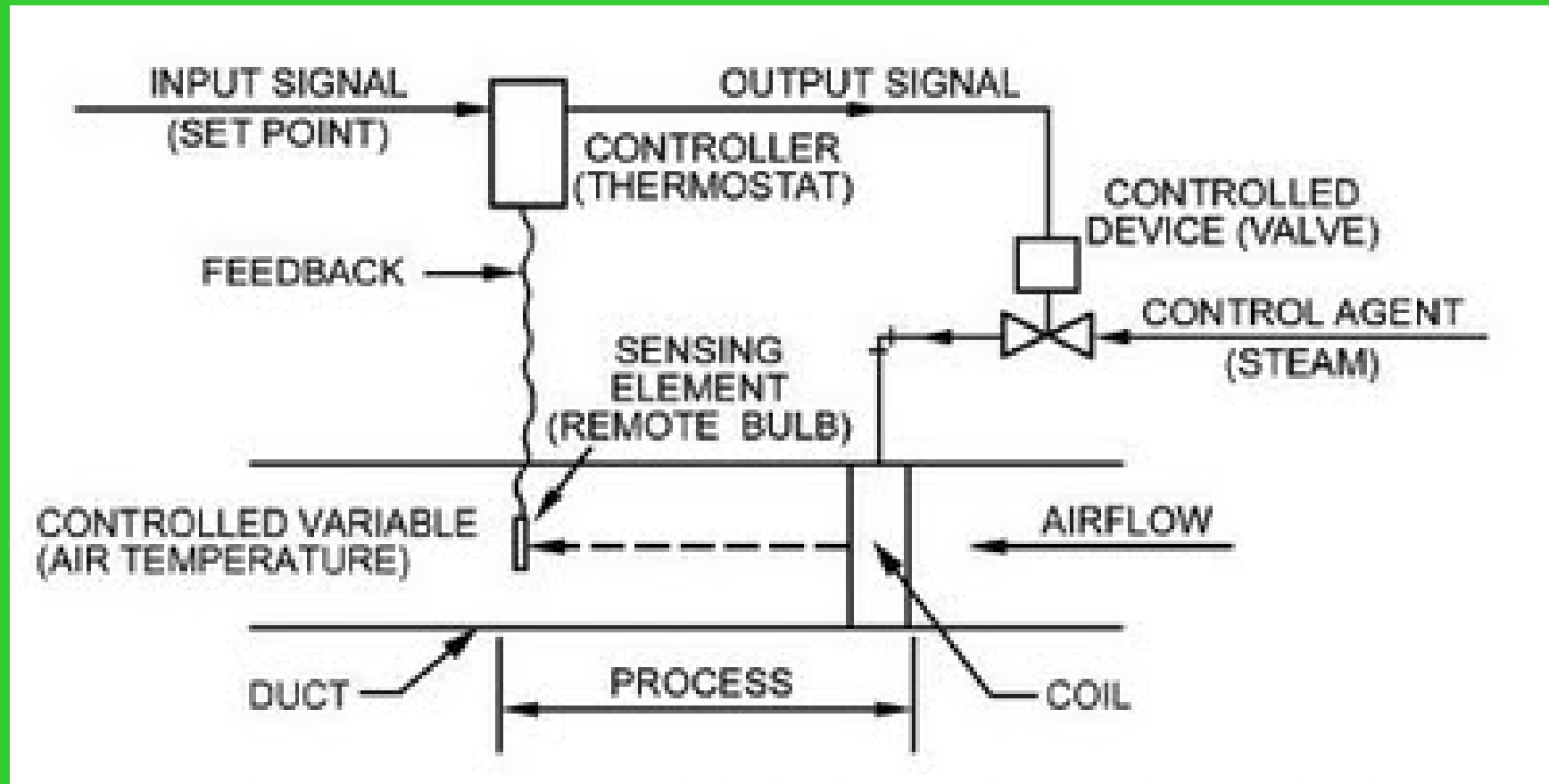
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Control Hierarchy

- Manual – Switches & Dimmers
- Open Loop Automatic
 - Timers
 - PLCs
- Closed Loop Automatic
 - Thermostat
 - Humidistat
 - Dimmable Ballast & Photosensor
(Studies show 40-60% savings
from daylight harvesting.)



Basic Feedback Control System



Note: Even a \$10 thermostat is a feedback control system.

Basic Types & Basic I/O

- **Two-Position** – On or Off, Open or Closed
- **Proportional** – Variation from set point produces a proportional action
- **Digital** – 1 or 0, but can be incremental.
- **Analog** – range of positions or values

Inputs & Outputs

INPUTS:

- **Temp – AI**
- **Flow – AI/DI**
- **Status/Proof AI/DI**
- **Rel. Humid AI**
- **Pressure – AI**
- **Air Quality AI**

OUTPUTS:

- **Motors DO**
(Pumps, Fans, & Process)
- **Lights DO**
- **VSD AO/DO**
- **Valves AO**
- **Dampers AO**
- **Light Contactors DO**

Evolution of EMCS

- **1st Generation: (Pneumatic)** Simply turn on/off devices based on need and ease of remote operation. *(little concern for energy usage control.)*
 - **2nd Generation: (PLCs)** Simple electronic control boards to convert electric signals to pneumatic actions. *(allowed for proportional control & basic strategy.)*
 - **3rd Generation: (DDC)** Electronic actuators replace pneumatic devices, software developments & improved control. *(Human Machine Interface (HMI) very key.)*
- ➔ **Modern Trends: Systems are more modular with “building blocks” architecture & greater standardization.**

Primary Objective of EMCS

- To optimize the control and sequencing of mechanical systems, thereby reducing energy consumption.
 - Peak Demand Limiting
 - Ambient Condition Lighting
 - Start/Stop Optimization
 - Sitewide Chilled Water Reset & HW Reset
 - Time-of-Day Scheduling
 - Outdoor Air Free Cooling/Humidity Controls

DDC EMCS

Control Strategies

- ***Manage the Demand*** or Need for Energy at any given time.
- ***Manage the Length of Time*** that devices consume energy.
- ***Set Alarms*** when devices fail or malfunction.
- ***Facilitate Monitoring*** of systems performance & present on dashboards or reports.
- ***Assist the Operator*** to administer equipment maintenance.

*Energy
Management
Systems*

***Good
Maintenance***

***Gives good
Energy
Efficiency***

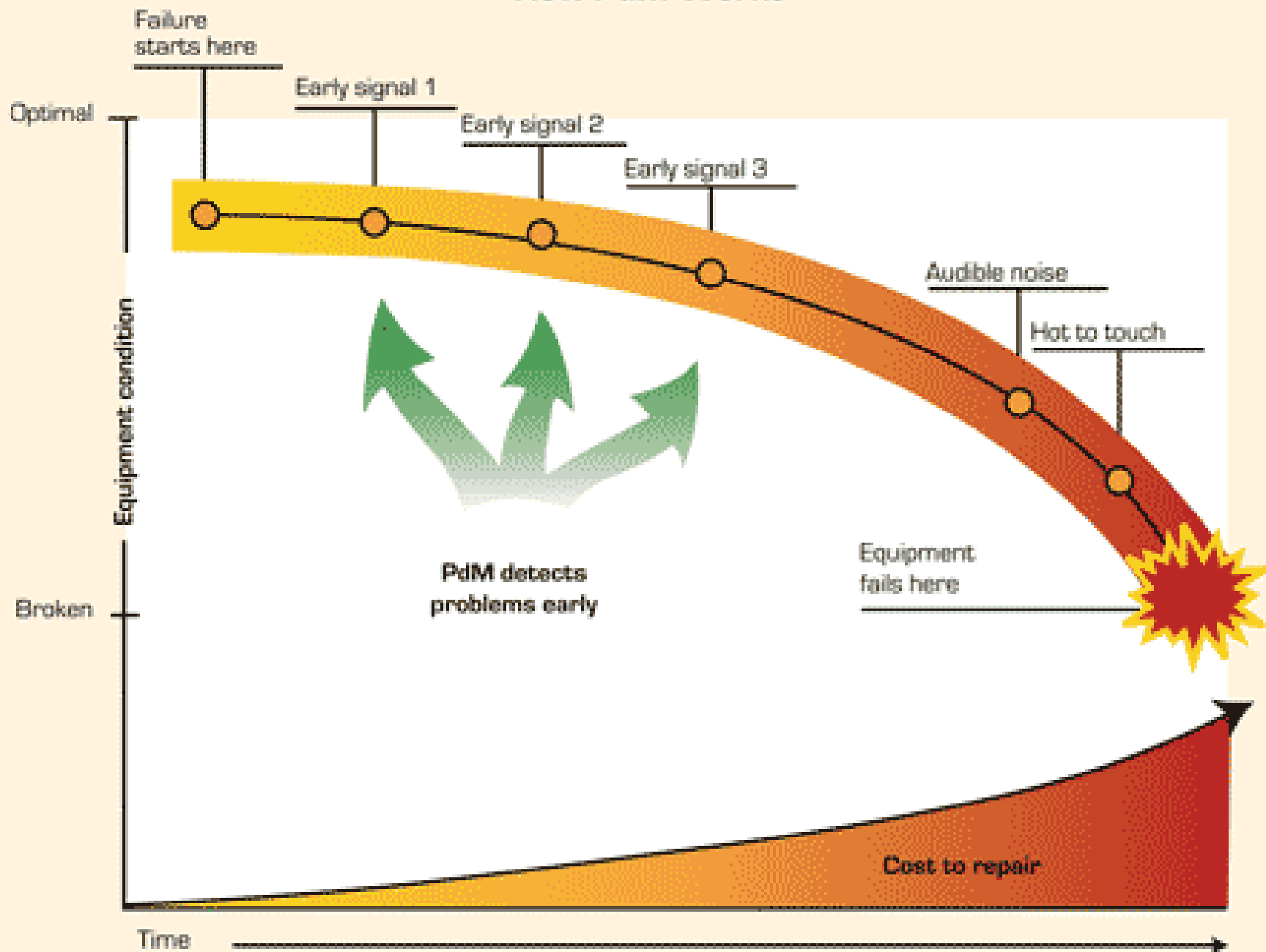


***Good Energy
monitoring
data can***

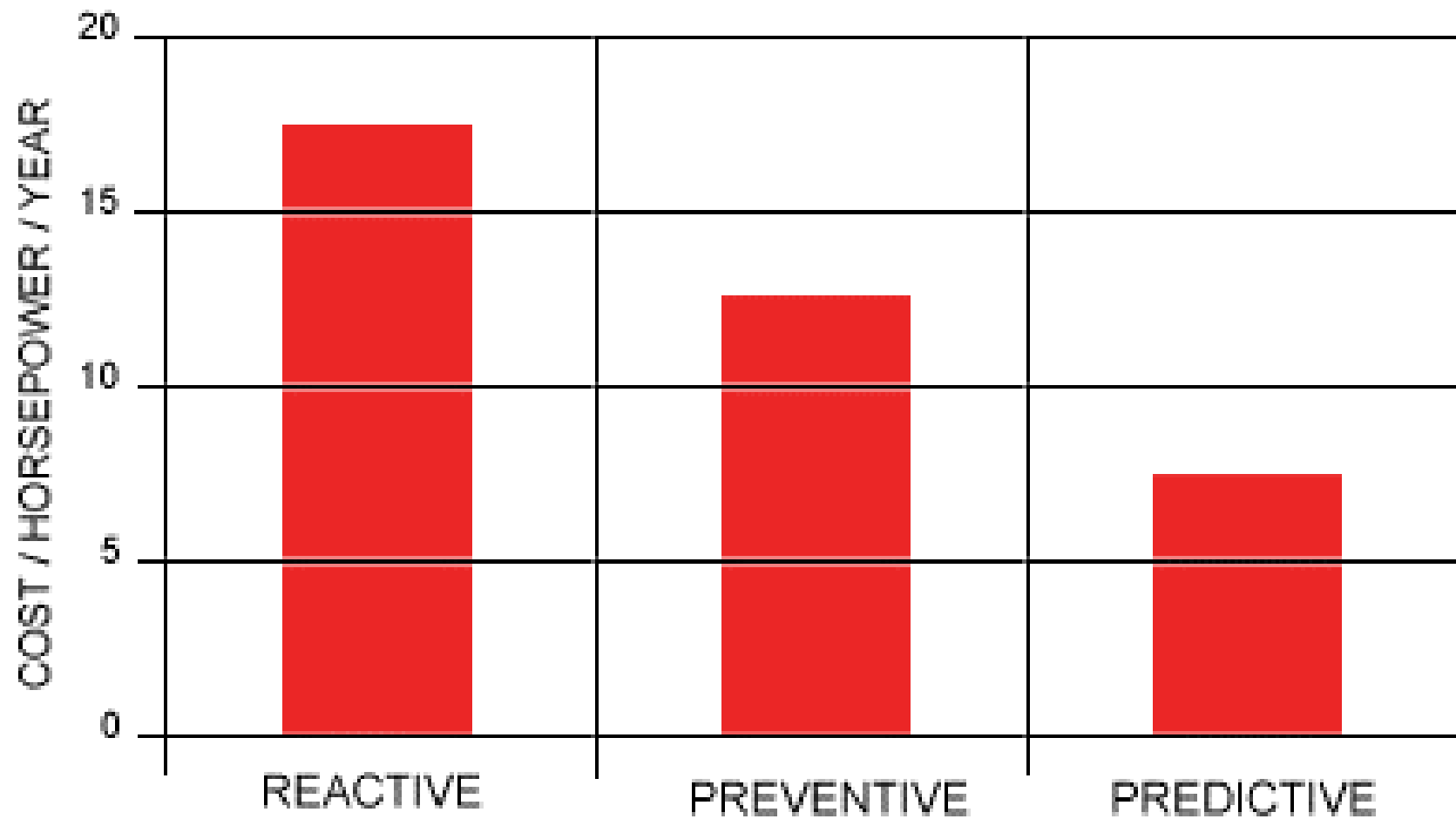
***Predict
Maintenance
Needs***

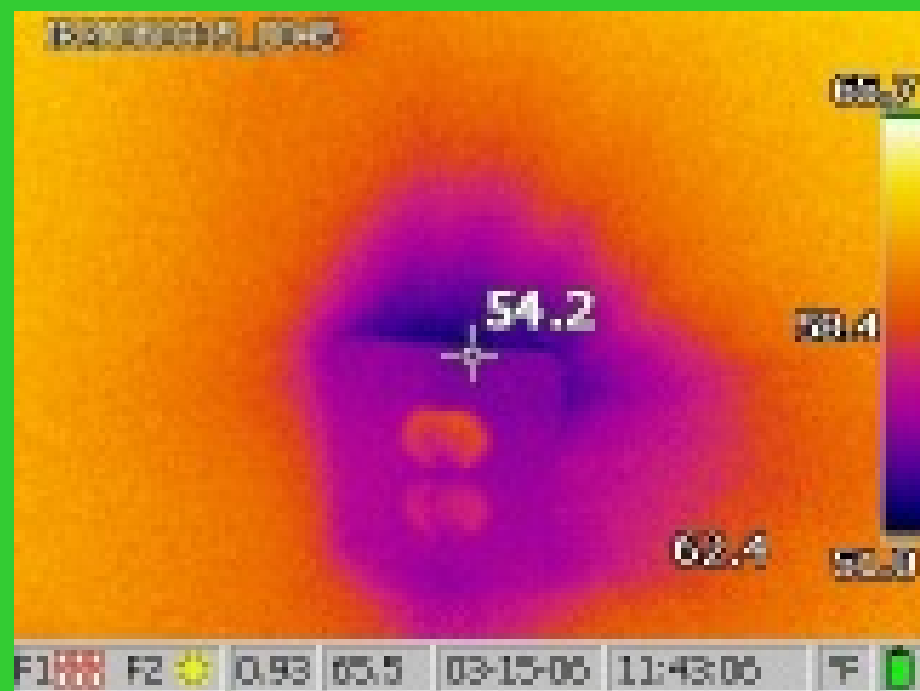
*Reliability of
Operations*

How PdM Works



Maintenance Cost per Horsepower
for General Industrial Rotating Machinery





Measurement and Verification

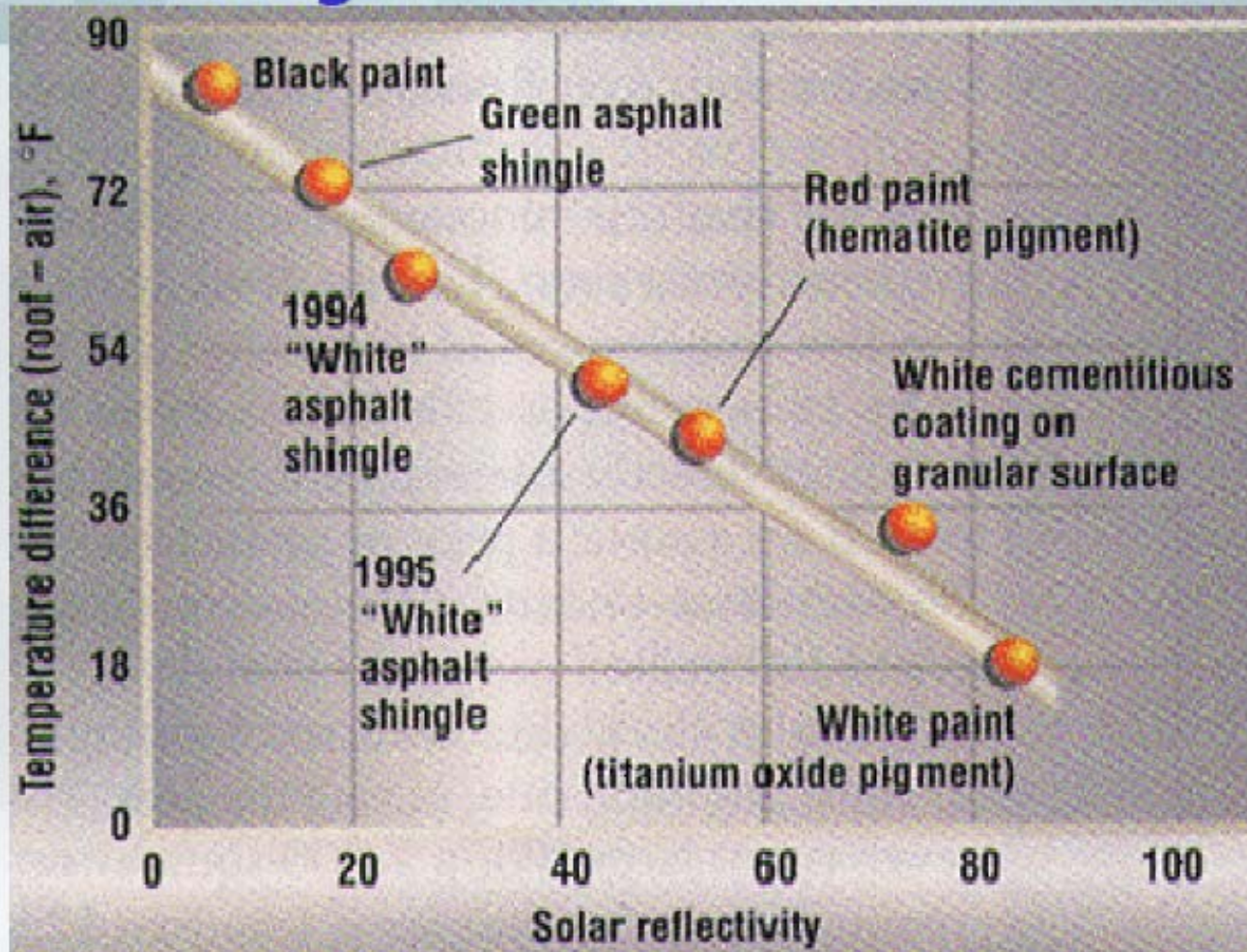


Retro-Commissioning Stages



Don't Overlook Low-Tech Savings Opportunities

Roofing



Watch Outs

- **Indoor Air Quality** – Energy Conservation measures and new control routines can create or aggravate IAQ issues.
- **Building Pressurization** – HVAC conversions and control methods may impact building pressurization.
- **Vibration & Noise due to VFDs** – Ex. VFD retrofit of existing cooling towers. Need to “walk-up” the fan speeds to observe where vibration occurs & program the VFD to skip those speeds.
- **Heat – Cool Overlap** – DDC should determine whether mechanical heating or cooling systems can be turned off. (Even overlap of “free cooling” with boiler heating operation is heat-cool overlap.)

Overall Justification for EMCS

- Manage Energy Consumption & Demand
- Predictive Maintenance
- Improve Comfort
- Improve IAQ
- Activate Alarms – Fewer Disruptions
- Assist Operators to Administer O&M
- Monitor/Log Energy Use & Equip Performance
- Others: “Green” Image, GHG reduced, LEED

Summary

Don't necessarily expect your Energy Director to be a cheerleader for sophisticated Automation . . .

- 1/ The basic idea is to save energy with the simplest and most reliable technology without adversely affecting comfort or operations.
- 2/ Don't underestimate the "human element" in interacting with the systems you design.
- 3/ Watch out for simultaneous heating/cooling in HVAC Systems – a silly waste of energy but sometimes hard to control.











