Better Plants
U.S. DEPARTMENT OF ENERGY

Driving Energy Savings in the Supply Chain

Better Buildings Summit
May 28, 2015

U.S. DEPARTMENT OF ENERGY

Speakers

- Catherine Potter, Director of Global Environmental Affairs, Johnson Controls
- Paul Bertram, Director of Environment and Sustainability, Kingspan Insulated Metal Panels
- Michael Muller, Director—Center for Advanced Energy Systems, Rutgers University

Hands-on Guidance. Measurable Results.

SUPPLIER EFFICIENCY PROGRAM

Johnson Controls

May 2015

Reaching outside our walls

SUPPLIER EFFICIENCY PROGRAM

WHAT

A scalable education and training platform that helps suppliers reduce their energy use and costs

HOW

Johnson Controls adapted its successful Energy Hunt Program into training materials for suppliers that help reduce energy use and costs

WHO

Johnson Controls' trained Energy Champions work directly with Johnson Controls suppliers

Johnson Controls

Better Buildings® CHALLENGE
U.S. DEPARTMENT OF ENERGY

GOAL

25%

Reduction in Energy Intensity (2009 to 2019)

PROGRESS TO DATE

21%

Cumulative (vs. baseline)

BUILDING ON OUR SUCCESS

CREATING A RIPPLE EFFECT

UNCOVERING OPPORTUNITY

Example Facility Improvement Measures

EMPLOYEE AWARENESS & ENGAGEMENT

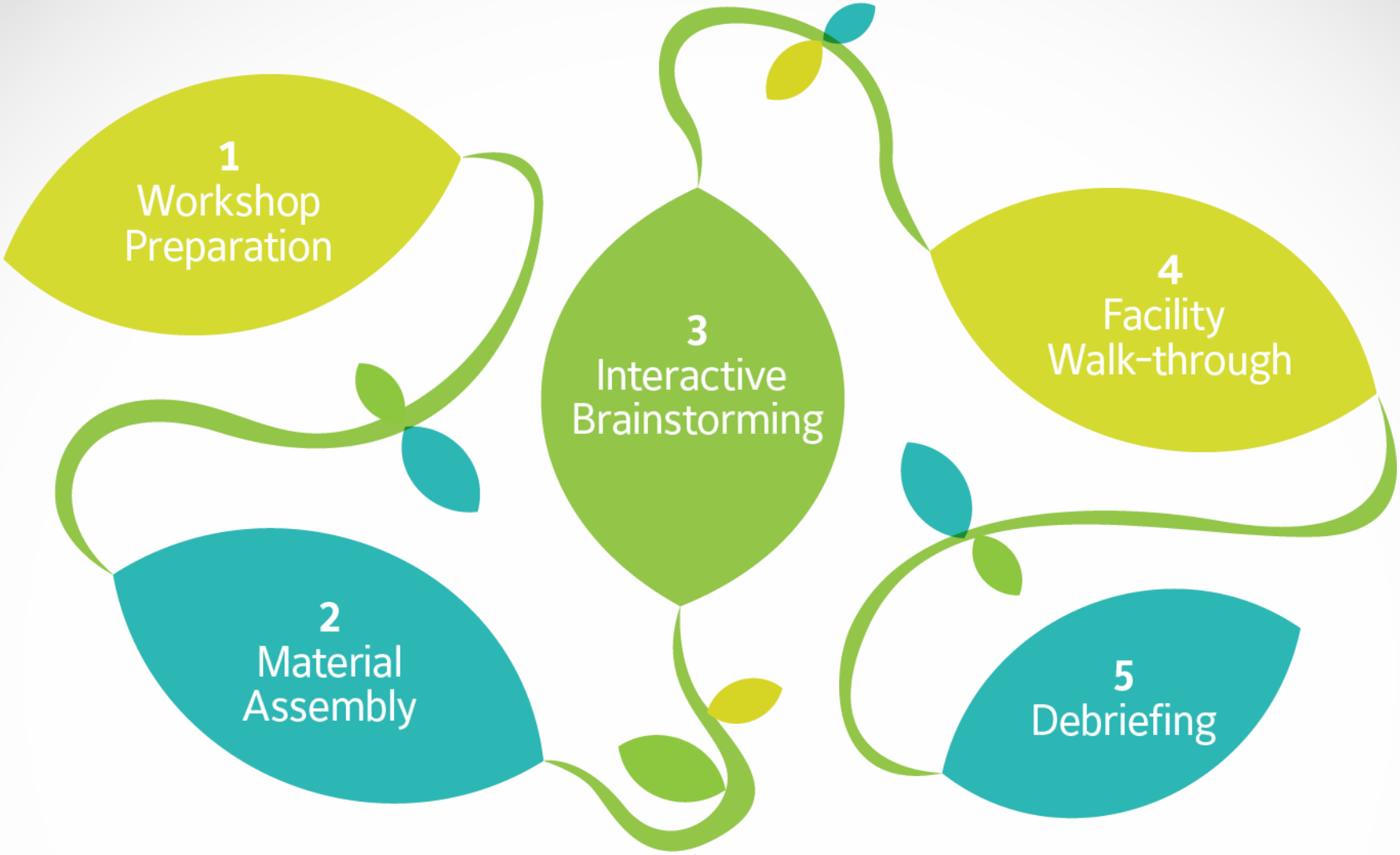
ENERGY MANAGEMENT

EQUIPMENT SCHEDULING

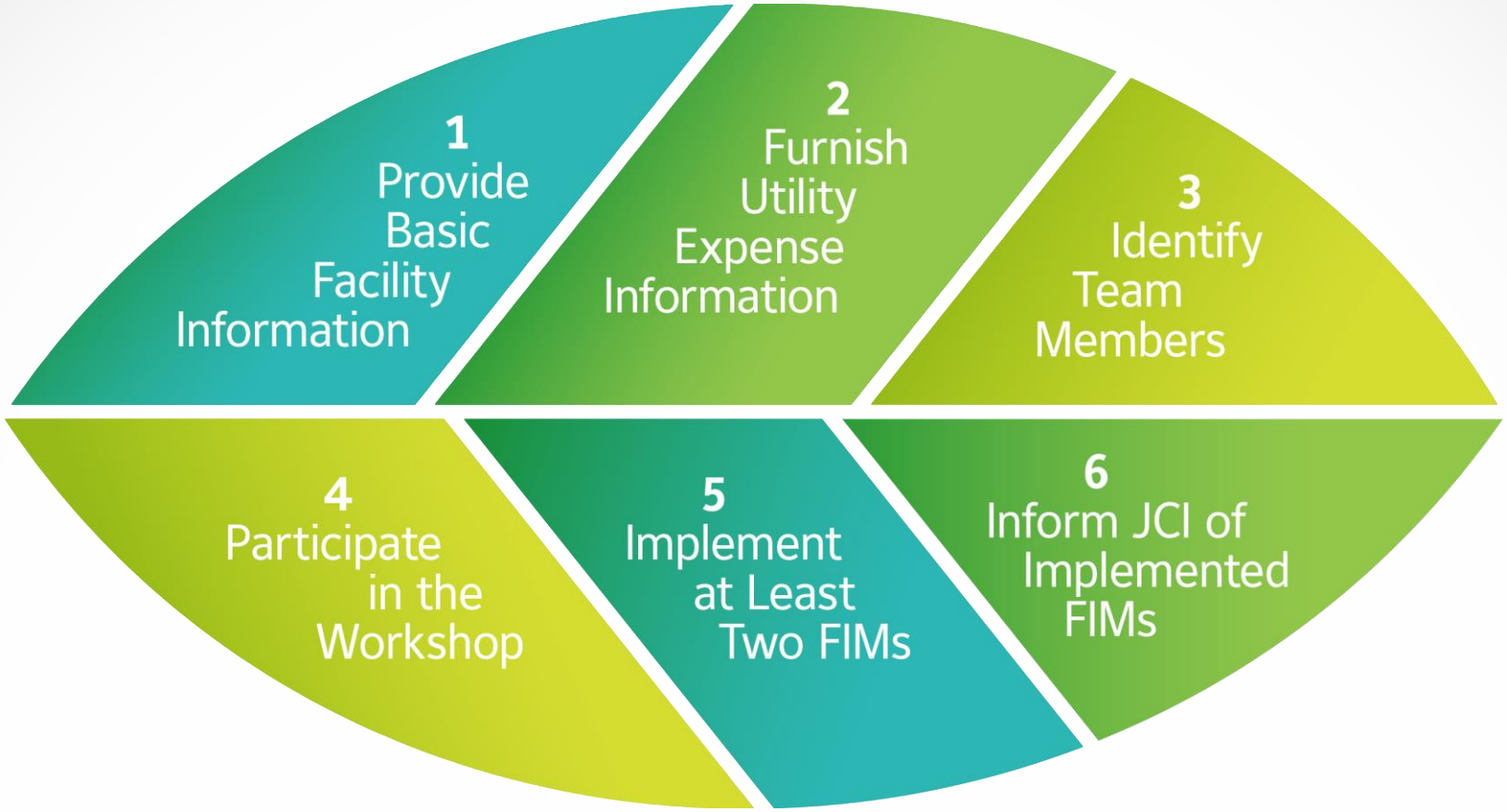
LIGHTING

HVAC

COMPRESSED AIR



ELEMENTS OF THE PROGRAM



SUPPLIER RESPONSIBILITIES

As a participant of the Program

MEASUREABLE RESULTS

Where they started

CASE STUDY: WOLVERINE TUBE

WOLVERINE TUBE, INC.

Preferred Supplier

20+ Years

325 Thousand Square Feet

575 Employees

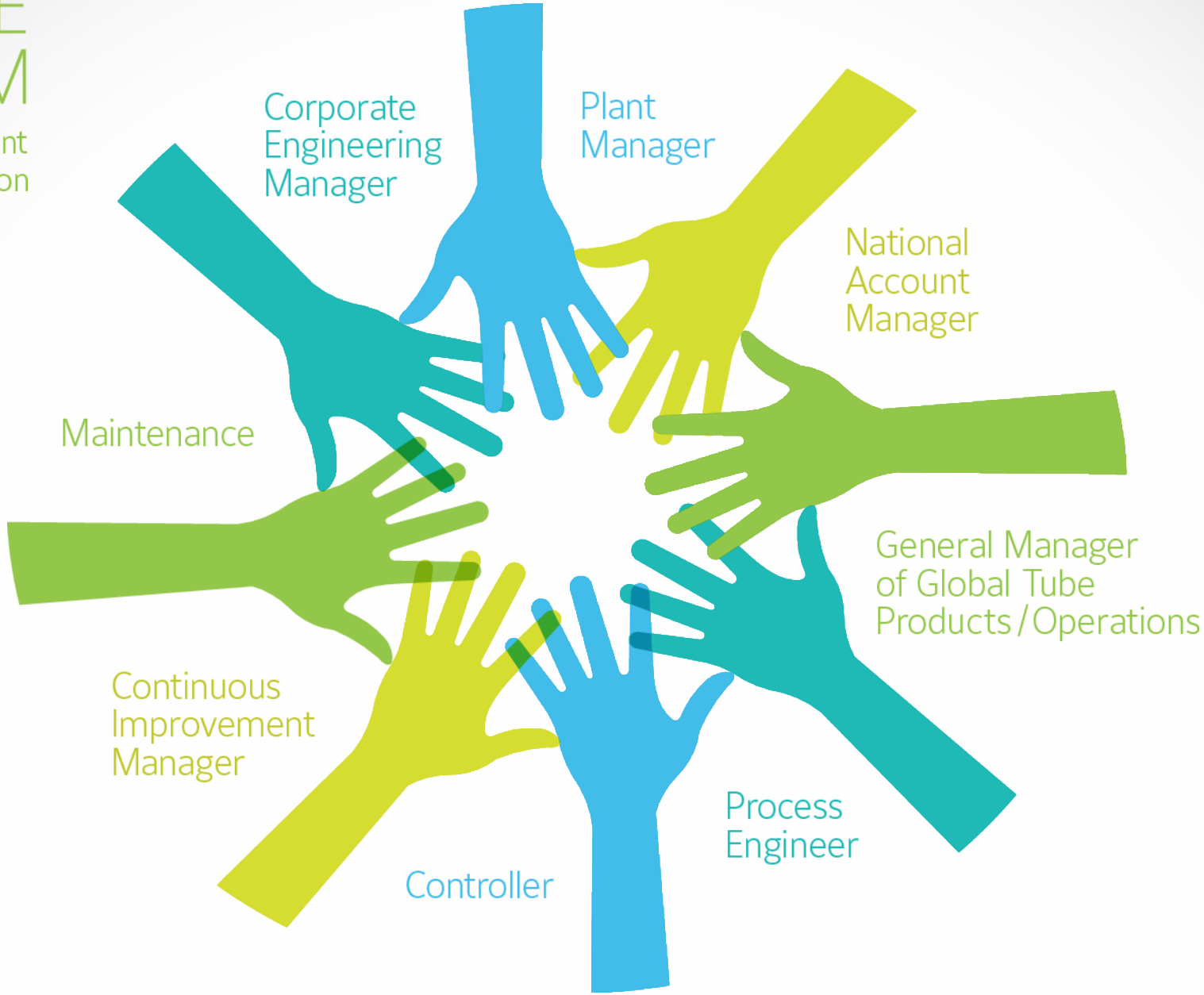
Copper Tubing and other Heat Transfer Products

36 Year-old Manufacturing Facility

CARBON DISCLOSURE PROJECT Supply Chain Responder Since 2009

CORE TEAM

Energy Hunt Participation



What they achieved

CASE STUDY: WOLVERINE TUBE

COMPRESSED AIR SYSTEM

3% Electric baseline SAVED

TURN IT OFF PROGRAM

1.5% Electric baseline SAVED

WATER LEAKS

1% Water baseline SAVED

“A GREAT PROGRAM!

Drove our costs down without capital expense.

Changed our culture regarding how we look at energy.

Since this program, we have looked at six other energy savings opportunities.”

WOLVERINE TUBE, INC.

Mark Brown
Engineering Manager Wolverine Tube

LET'S TALK

TIM RAYBURN
Director, Global Procurement, Supplier Sustainability
timothy.m.rayburn@jci.com

CATHERINE POTTER
Director, Global Environmental Affairs
catherine.potter@jci.com

Light Industrial Net Zero Energy

The Business Case

Paul Bertram, FCSI, CDT, LEED AP

Director: Environment, Sustainability Government Affairs

Kingspan®

Insulated Metal Panels

Better Plants®
U.S. DEPARTMENT OF ENERGY

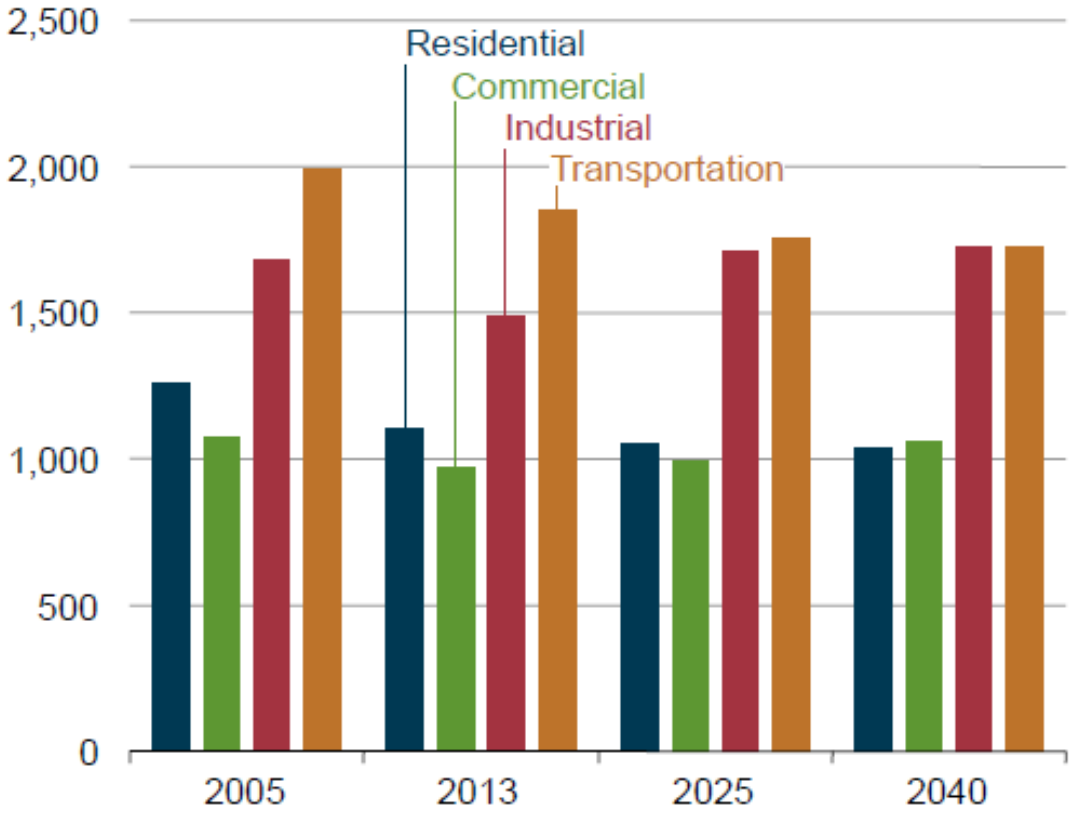
Learning Objectives:

- Kingspan's Global 2020 Net Zero Energy goal
- Market drivers and the business case
- Establishing the Net Zero Energy Project Team
- Defining Net Zero Energy
- Benchmarking strategies
- Energy Reduction/Conservation Measures
- Net Zero Energy Budgeting and Final Implementation

Better Plants®
U.S. DEPARTMENT OF ENERGY

EIA - Industrial Energy

Figure 37. Energy-related carbon dioxide emissions by sector in the Reference case, 2005, 2013, 2025, and 2040 (million metric tons)



A third of the world's energy consumption and 36% of carbon dioxide (CO_2)

Source: http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf

Better Plants®
U.S. DEPARTMENT OF ENERGY

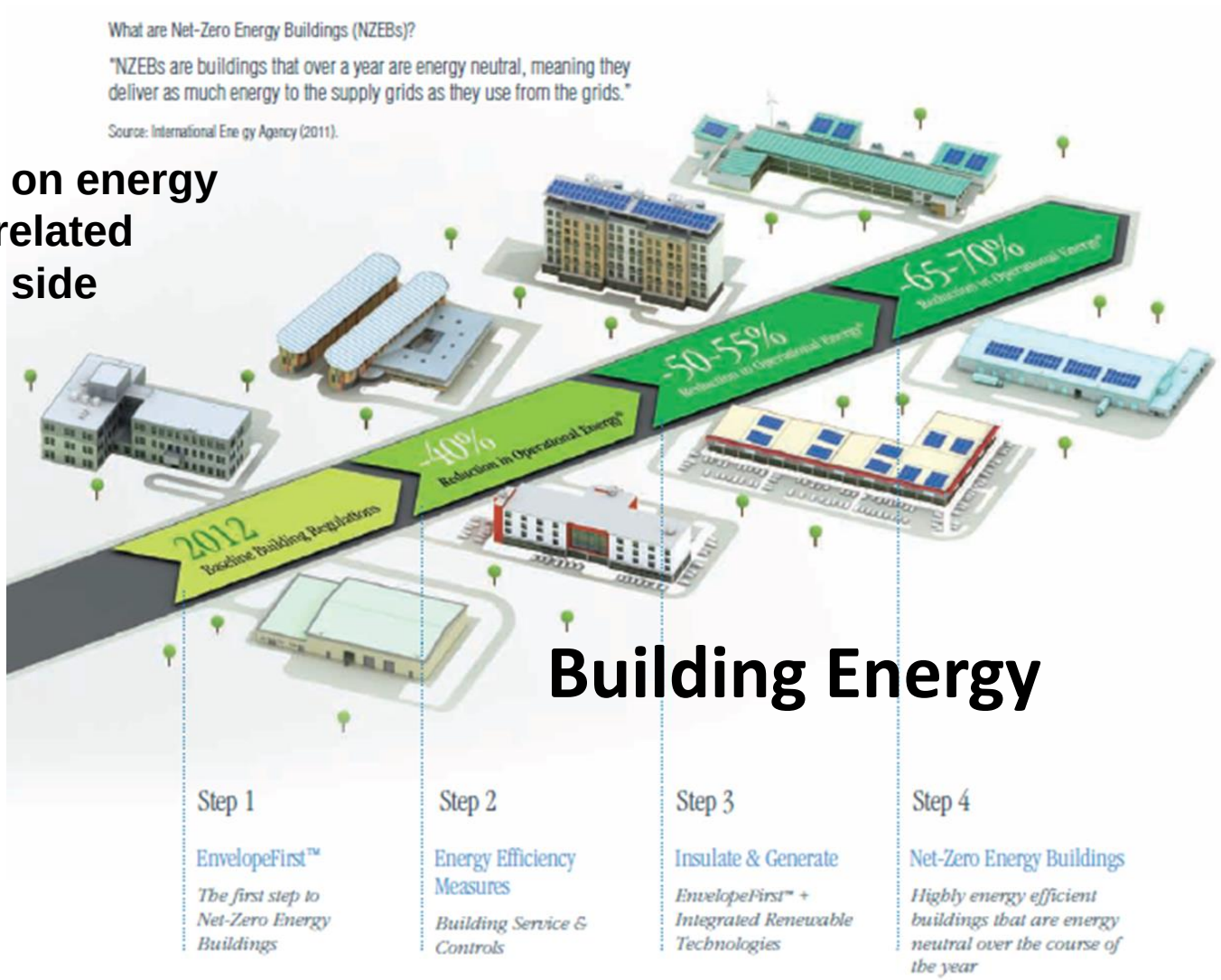
Kingspan's Global 2020 Net Zero Energy Goal

Case Study: Insulated Metal Panels

North American manufacturing division

Path to Net Zero

30% improvement on energy cost savings and related GHGs on Demand side



Building Energy

Better Plants®
U.S. DEPARTMENT OF ENERGY

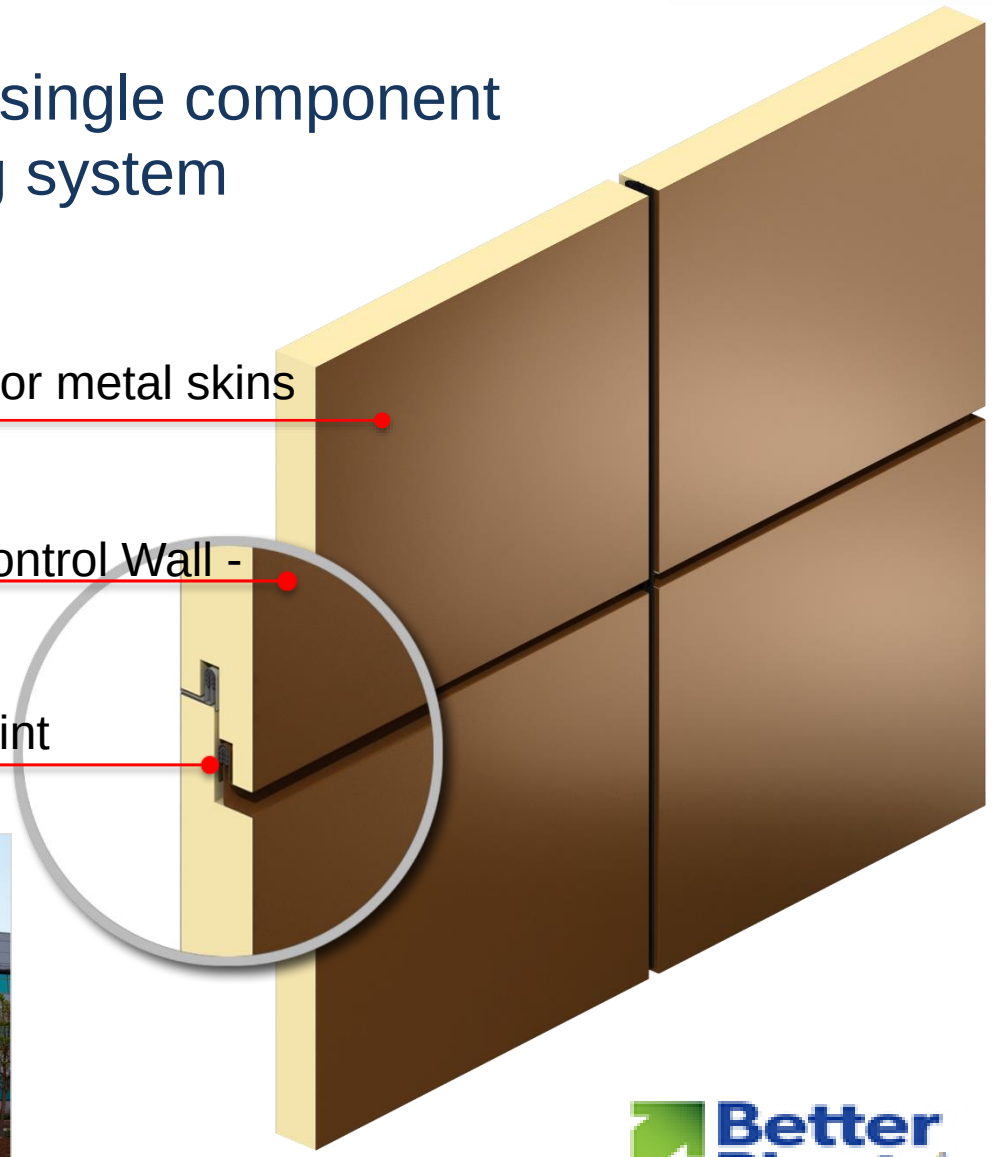
What is an insulated metal panel (IMP)?

Off –Site pre-engineered single component insulated exterior cladding system

Impervious Exterior and Interior metal skins

High Perfomance U- Value Control Wall - 7.5 R-Value /inch

Gasketed interlocking panel joint
Minimum air -infiltration



Better Plants
U.S. DEPARTMENT OF ENERGY

The Industrial NZE Business Case

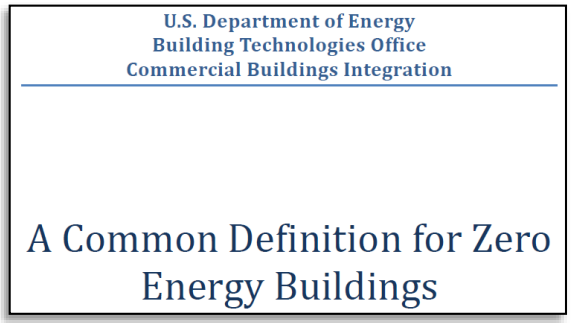
- Energy Cost Savings
- Energy Reliability
- Reduction of GHGs and related Environmental Impacts
- Environmental & Sustainability Market Leader Stewardship
- Carbon Disclosure Reporting
- Regulatory Compliance
- Positioning to building owners focused on energy cost savings

Better Plants
U.S. DEPARTMENT OF ENERGY

Net-Zero Energy Buildings Classification Systems

- **Buildings Classified as NZEB:A**
  - NZEB:A buildings generate and use energy through a combination of energy efficiency and renewable energy collected **within the building footprint.**
- **Buildings Classified as NZEB:B**
  - **and renewable energy generated within the site.**
- **Buildings Classified as NZEB:C**
  - **NZEB:A and/or NZEB:B** buildings to the maximum extent feasible.
- **Buildings Classified as NZEB:D**
  - **NZEB:A, NZEB:B, and/or NZEB:C buildings.**

Source: http://www.nrel.gov/sustainable_nrel/pdfs/44586.pdf

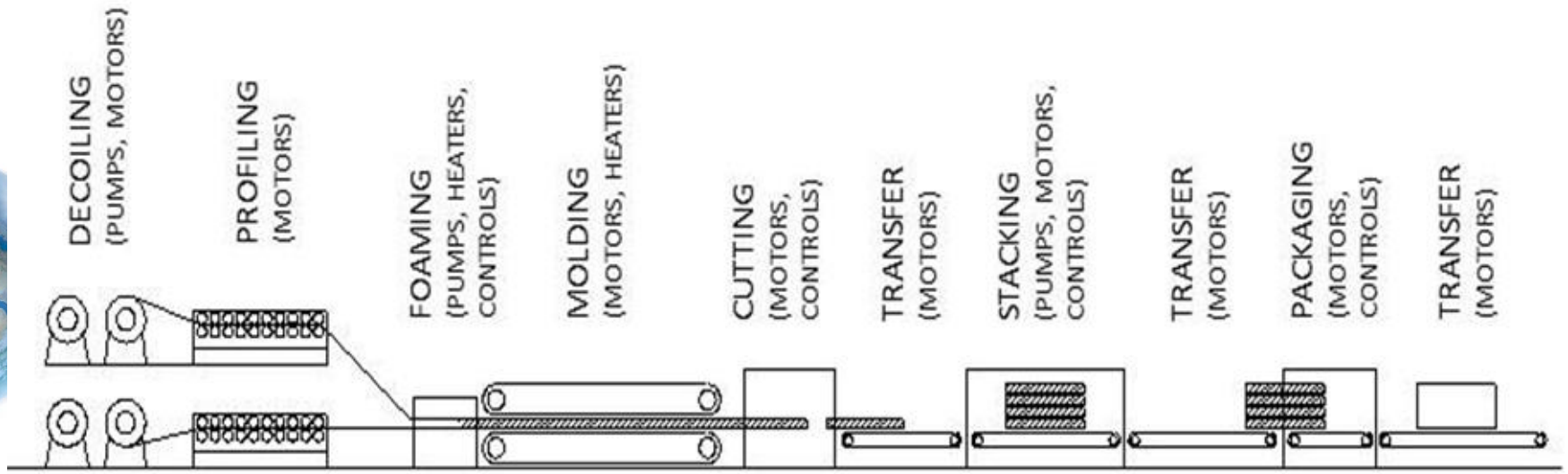


http://apps1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/zebdefinitionpublicreview1.pdf

Better Plants®
U.S. DEPARTMENT OF ENERGY

Basic Insulated Panel Production Line Layout

- Processing equipment typically accounts for the majority of the energy consumed in dedicated manufacturing facilities
- Improvements to date



Better Plants®
U.S. DEPARTMENT OF ENERGY

The Work Plan

- ACEEE and restructuring of NZE project team

Defining the Pledge Scope and Boundaries		
Included in Pledge	**Yes**	**No**
Corporate-wide commitment	✓	
Manufacturing or industrial operations	✓	
Energy use in buildings and non-manufacturing facilities	✓	
Energy reductions outside of an entity's operational or financial control (e.g., suppliers, product distributors, etc.)		✓
Energy data from operations both inside and outside of the United States	✓	
Feedstock energy use		✓
Byproducts from feedstock energy used as a fuel source	✓	
Cogeneration	✓	
On-site electricity generation	✓	
Renewable energy purchases from off-site sources		✓
Renewable energy generated on-site	✓	

Source: http://www1.eere.energy.gov/manufacturing/pdfs/betterplants_guide.pdf

Better Plants® U.S. DEPARTMENT OF ENERGY

Kingspan's North American NZE strategy

- Five IMP Facilities in North America
- 2 Single Skin Manufacturing Facilities
- Original project team structure
- NZE Global Guidance – *Get it Done*

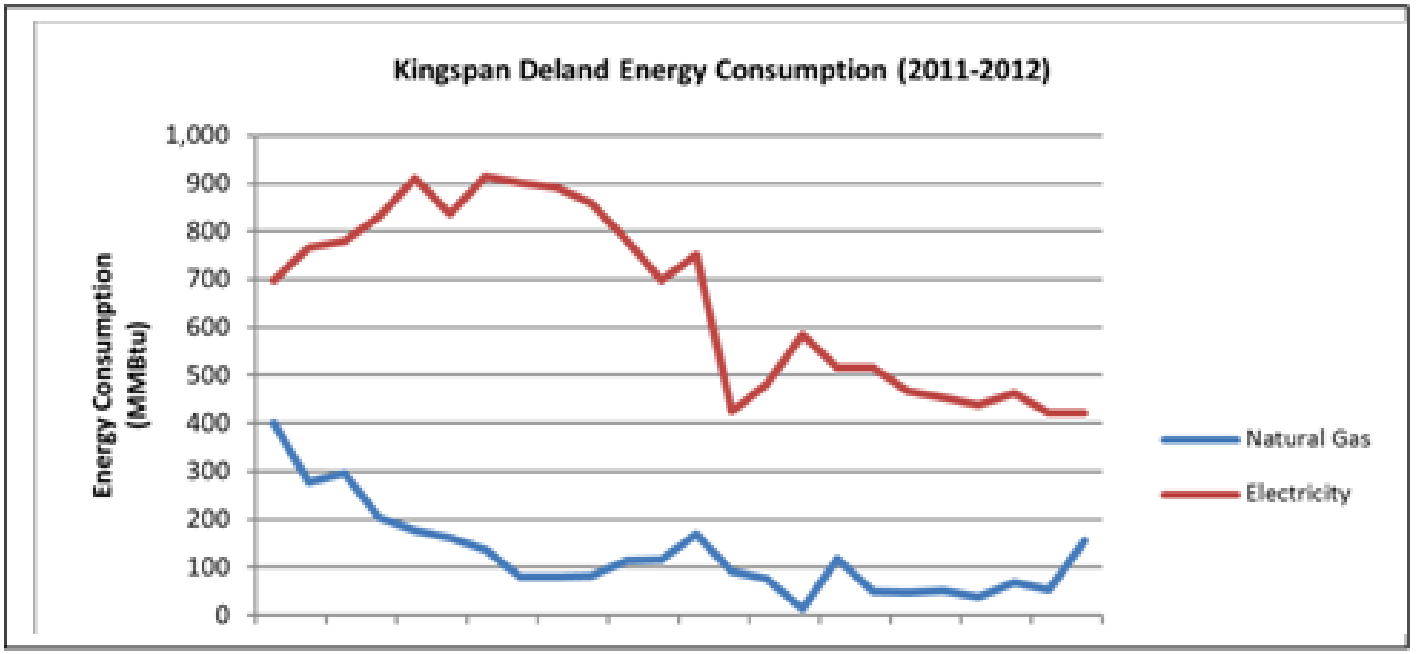
Table 1. Kingspan Insulated Panels North American Manufacturing Locations

Location	ASHRAE Climate Zone	Total Area	Conditioned Space	
		sq ft	sq ft	%
Deland, Florida, USA	2A	243,600	22,980	9.43%
Modesto, Califomia, USA	3B	96,250	6,100	6.34%
Columbus, Ohio, USA	5A	113,000	5,790	5.12%
Caledon, Ontario, Canada	6A	209,132	12,000	5.74%
Langley, British Columbia, Canada	5A	68,500	5,000	7.30%
Totals		**730,482**	**51,870**	**7.10%**

Better Plants®
U.S. DEPARTMENT OF ENERGY

Benchmarking

- **Type 1 Audit(ASHRAE 2011):** Initial macro-assessment of current energy usage
- **Type 2 Audit (ASHRAE 2011):** More detailed assessment of building's energy usage, including quantification of individual energy consumption systems.



Better Plants®
U.S. DEPARTMENT OF ENERGY

KS 2014 NZE Improvement

- Propane forklifts changed to electric.
- Dock door shrouds.
- VFD (variable frequency drive) fitted on large motor.
- Replace factory old heaters or broken units with new up to date units.
- Establish and enforce compressor shut-down cycle.
- Establish air line leak audits and repair (monthly).
- Replace old compressor/compressors with modern unit.
- Replace lighting
- Add motion sensors to existing lighting.
- Alter timers on lighting to reduce usage. (but stay safe).
- Install timers on heaters.
- Install lock boxes on lighting timers.
- Install lock boxes on thermostats.
- Lower plant temperature.
- Enclose ends of laminator.
- Buy green Electricity.
- Replace old water heaters with on demand units in washrooms.
- Vacuum slide shutoff to reduce energy required for foam vacuum system.
- Sub metering installed on gas burners.
- Electrical sub metering installed on one line.
- Pallets/wood sent for burning to indirect energy generation and landfill credits.

Better Plants
U.S. DEPARTMENT OF ENERGY

Energy Conservation Measures

- **Process Energy**
  - Power Distribution
  - Lighting
  - Heating, Ventilation, and Air Conditioning
- Building Envelope – less than 8% impact
- Service Hot Water Heating
  - No water in Manufacturing process

Better Plants®
U.S. DEPARTMENT OF ENERGY

Energy Budgeting

- Consider **higher comparative cost of efficiency** when evaluating alternative energy reduction solutions
- Individual **R.O.I. analysis for each subproject and comparison to its project "value" or kWh per square foot/meter of production**
- NZEM must meet its initial zero net energy usage and production requirements…
  - **Must to continue NZE performance into the future**

Average	53210.75	3.36	68361.5	2.225		
	2011		2012		2013	
20-30000	0.00	0	5.70	1	0.00	0
30-40000	0.00	0	4.62	2	3.36	2
40-50000	3.98	1	3.06	2	0.00	0
50-60000	3.37	3	3.84	2	0.00	0
60-70000	3.07	4	2.47	3	1.86	2
70-80000	2.87	2	2.34	1	1.79	1
80-90000	0.00	0	0.00	0	0.00	0
90-100000	2.29	1	0.00	0	1.69	1
100000+	0.00	0	0.00	0	1.52	1

M^2 / KwH

Better Plants®
U.S. DEPARTMENT OF ENERGY

Final Implementation:

- **Implementation of Energy Reduction Measures typically takes two forms:**
- **Procedural:**
  - Including: Changes to current **procedures and schedules** that create energy savings opportunities
- **Capital:**
  - Including technology upgrades (new equipment, higher efficiency replacements, etc.)
  - Renewables

Better Plants®
U.S. DEPARTMENT OF ENERGY

“Offset” Energy Production and Procurement

- **Unit offset energy cost** is a valuable financial tool when evaluating energy reduction measures
- Determine “unit offset energy cost” for each location
- Energy production from various operational sites are unlikely to be repeatable at each location

Better Plants®
U.S. DEPARTMENT OF ENERGY

2013 Better Plants Report

- **22.06% EUI reduction**, 2nd Yr.
  - **Future Challenges/Considerations**:
    - Green Power Purchasing
      - Wind
      - Landfill gas
    - Micro-grid
      - Renewable Energy
        - » Solar, geothermal,
      - Distributed Energy
        - » Reliable Energy
        - » CHP?

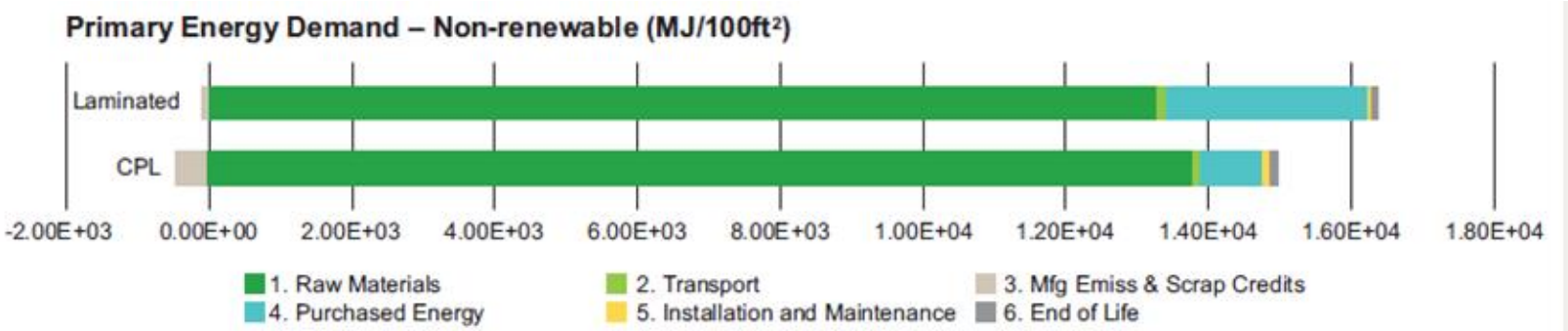
Superior Energy Performance®
U.S. DEPARTMENT OF ENERGY

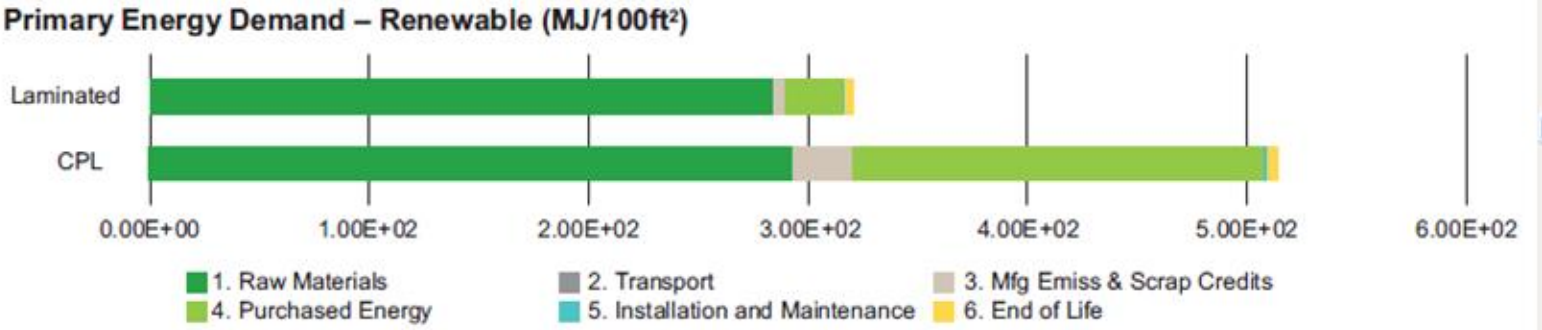
Certifying Increased Energy Productivity under ISO 50001

Better Plants®
U.S. DEPARTMENT OF ENERGY

Energy Efficiency and Life Cycle Assessment

- Kingspan's Life Cycle Assessment include process energy including energy burdens of upstream suppliers at the grid

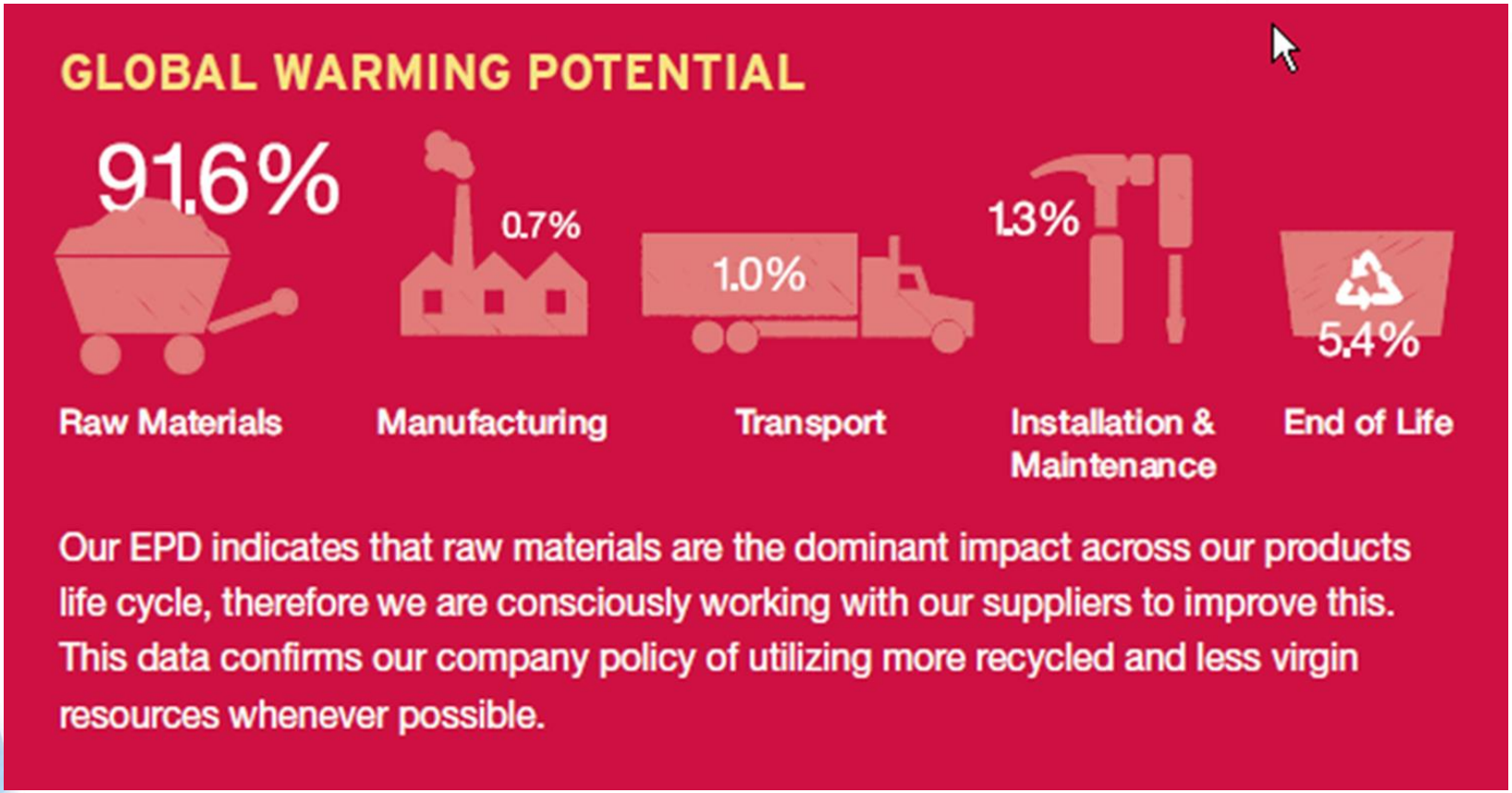




Source: http://www.kingspanpanels.us/media/3070/epd_2012.pdf

Better Plants®
U.S. DEPARTMENT OF ENERGY

Upstream Environmental Impacts



The Business Case for encouraging supplier participation

Save ENERGY Now®

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy INDUSTRIAL TECHNOLOGIES PROGRAM

Better Plants® U.S. DEPARTMENT OF ENERGY

Net Zero Energy Manufacturing Recommendations:

- **Define** Industrial/Manufacturing Net Zero Energy
- Requires **energy usage accounting** balanced with investment and future financial benefits
- **Continuous calculations** throughout the process guides management with implementation decisions
- Green Power purchasing consideration
- Correlate NZE impact with Life Cycle Assessment Environmental impacts

Better Plants®
U.S. DEPARTMENT OF ENERGY

US Energy Efficiency

Incentive Programs - The Quagmire

- DSIRE
  comprehensive online energy efficiency resource on state, federal, local, and utility incentives and policies
- ACEEE
- Better Plants Program Partners
- Utility Initiatives
- DOE Industrial Assessment Centers
- Partner Specialists

Better Plants®
U.S. DEPARTMENT OF ENERGY

Conclusions:

- Better Plants program is advantageous with **technical support and network of energy focused specialists**
- Net Zero Energy Manufacturing (NZEM) is a logical extension of net-zero energy buildings with **focus on process energy**
- **Incentives** for investment are needed
- Along with more affordable renewables

Better Plants®
U.S. DEPARTMENT OF ENERGY

Questions?

Light Industrial Net Zero Energy
The Business Case

Paul Bertram, FCSI, CDT, LEED AP

Director: Environment & Sustainability

paul.bertram@kingspan.com

386-785-3063

www.kingspanpanels.us

Kingspan®

Better Plants®
U.S. DEPARTMENT OF ENERGY

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

CAES
CENTER FOR ADVANCED ENERGY SYSTEMS

Panel: "Driving Energy Savings in the Supply Chain"
Opportunities for SME's

Michael R. Muller
Professor and Director
Rutgers University

May, 2015


Who Am I????
• At Rutgers since 1979
• Teaching Power Plants since 1993
• Director, *Center of Advanced Energy Systems* at Rutgers since 2002
Current passions:
• Organic Rankine Cycles
• Cooling tower operation
• Industrial Gasifiers
• Uses of Smart Grids

IAC – Industrial Assessment Centers

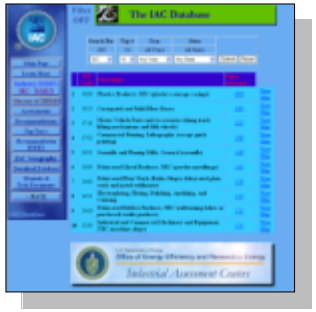
- University based technical assistance program
  - Funded by US DOE (no cost to clients)
  - Primarily directed toward small and medium sized manufacturers
- IACs perform industrial assessments at nearby manufacturing centers.
  - Performed by teams made up of faculty and students
    - This is NOT a student project
  - Normally consists of a 1 day site visit at an industrial plant
  - Each center serves factories within 150 miles of the campus
  - Yearly number of assessments depends on funding levels
    - Max = 40, Min = 12

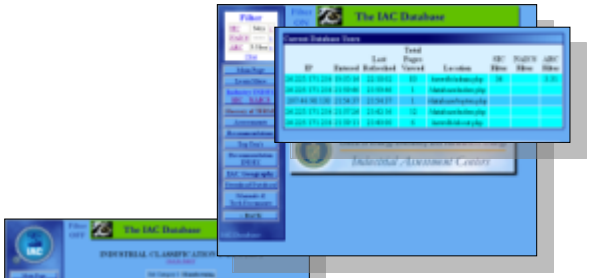
2015 marks the 40th Anniversary of the IAC's

- IAC program was formed in 1976, as the Energy Analysis and Diagnostic Program (EADC)
  - Result of Oil Embargo
  - Originally 4 Universities
- Students were always involved
  - Goal was to fill gap in education
  - Energy Conservation was not taught in Engineering
- Database was added in 1981
  - In 1992 the database was put online
- In 1995, waste minimization and productivity capabilities were added and the program became the IAC

The IAC DATABASE

- Publicly Available
- Contains:
  - Facility data
  - Recommendation data
  - Implementation data
- Searchable by
  - Size (in energy usage, employees, etc…)
  - Industry Type (NAICS or SIC)
  - Location
  - Recommendation Type
- Updated in Real-Time as the assessments are completed





IAC – Industrial Assessment Centers

- Currently 24 IAC's + 8 satellites
- Over last 35 years:
  - 16,859+ Assessments Conducted
  - 127,478+ Recommendations
  - Recommended Savings: $3.0 Billion*
  - Implemented Savings: $6.64 Billion*

* only counting 1 year savings, adjusted by CPI-U for recommended - assuming ~7 year persistence, adjusted by CPI-U for implemented

Industrial Assessment Centers 2012-2016

U.S. DEPARTMENT OF ENERGY

Energy Efficiency & Renewable Energy

Field Managers

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS CAES

CENTER FOR ADVANCED ENERGY SYSTEMS

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

“Nexii”

Nexus is fourth declension, so the plural of Nexus in Latin is Nexus (or Nexūs if you mark long vowels.)

RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

“Nexūs”

Driving Supply Chain Energy Efficiency

- **Costs are not doing it today!**
- **Need to connect energy use with something else**
  1. **Energy/Productivity Nexus**
  2. **Energy/Environmental Nexus**
  3. **Energy/University Nexus**

Productivity/Energy Nexus is Not New

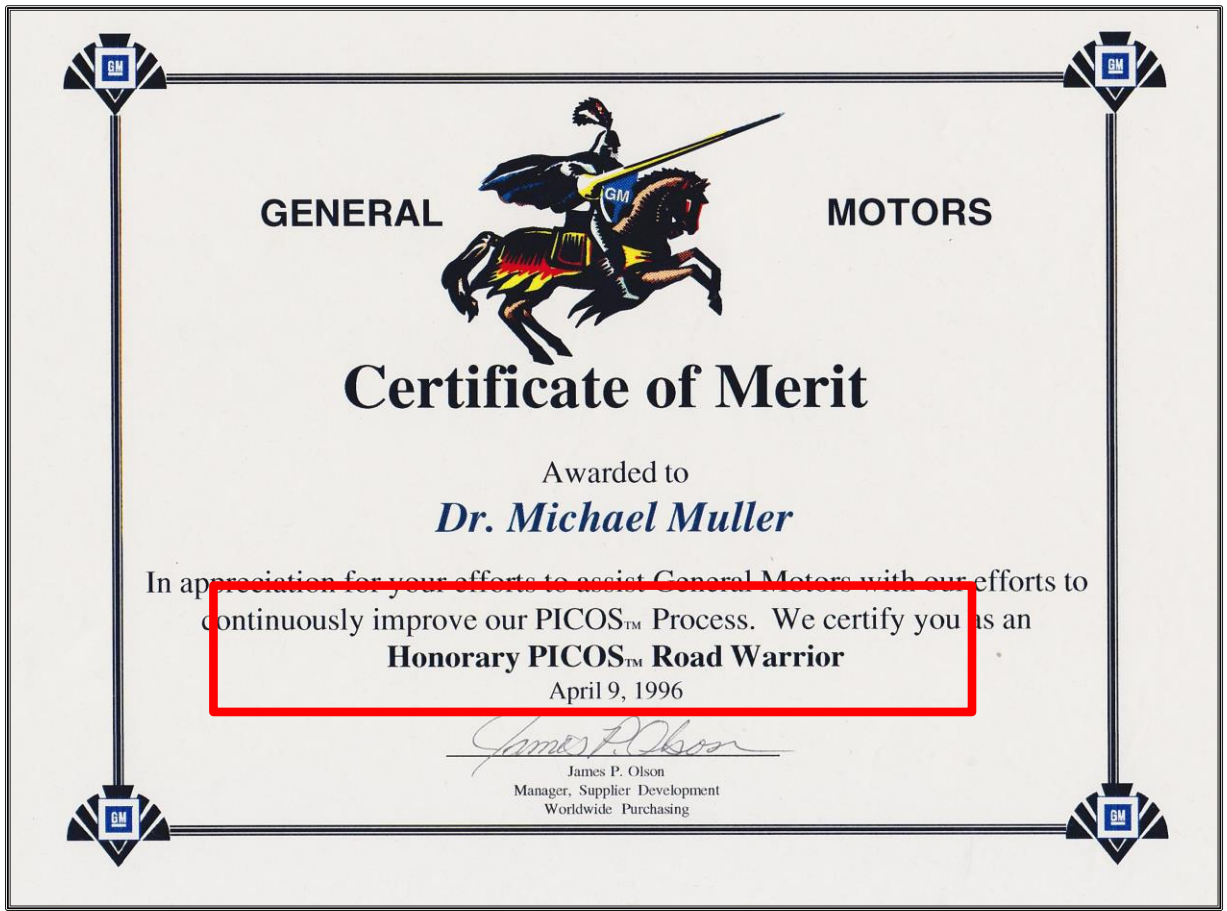
- 20 yrs ago Toyota production system and GM PICOS hit supply chains hard!
  - LEAN manufacturing
- PICOS, an acronym for Purchased Input Concept Optimization with Suppliers
- No Coddling!!!
  - GM would estimate savings – lower purchase price for goods
  - As a negative, companies would try to hide projects

PICOS

– Picos de Europa in Spain became the symbol for the program

Productivity/Energy Nexus is Not New

- In 1996 GM partnered with the IAC program to add energy to their PICOS portfolio



GENERAL MOTORS

Certificate of Merit

Awarded to

Dr. Michael Muller

In appreciation for your efforts to assist General Motors with our efforts to continuously improve our PICOS™ Process. We certify you as an

Honorary PICOS™ Road Warrior

April 9, 1996

James P. Olson
Manager, Supplier Development
Worldwide Purchasing

Productivity/Energy Nexus is Not New

- General Tire: Automated tire machines left presses empty!
  - Lean manufacturing principle led to excessive energy costs

Energy/Water Nexus

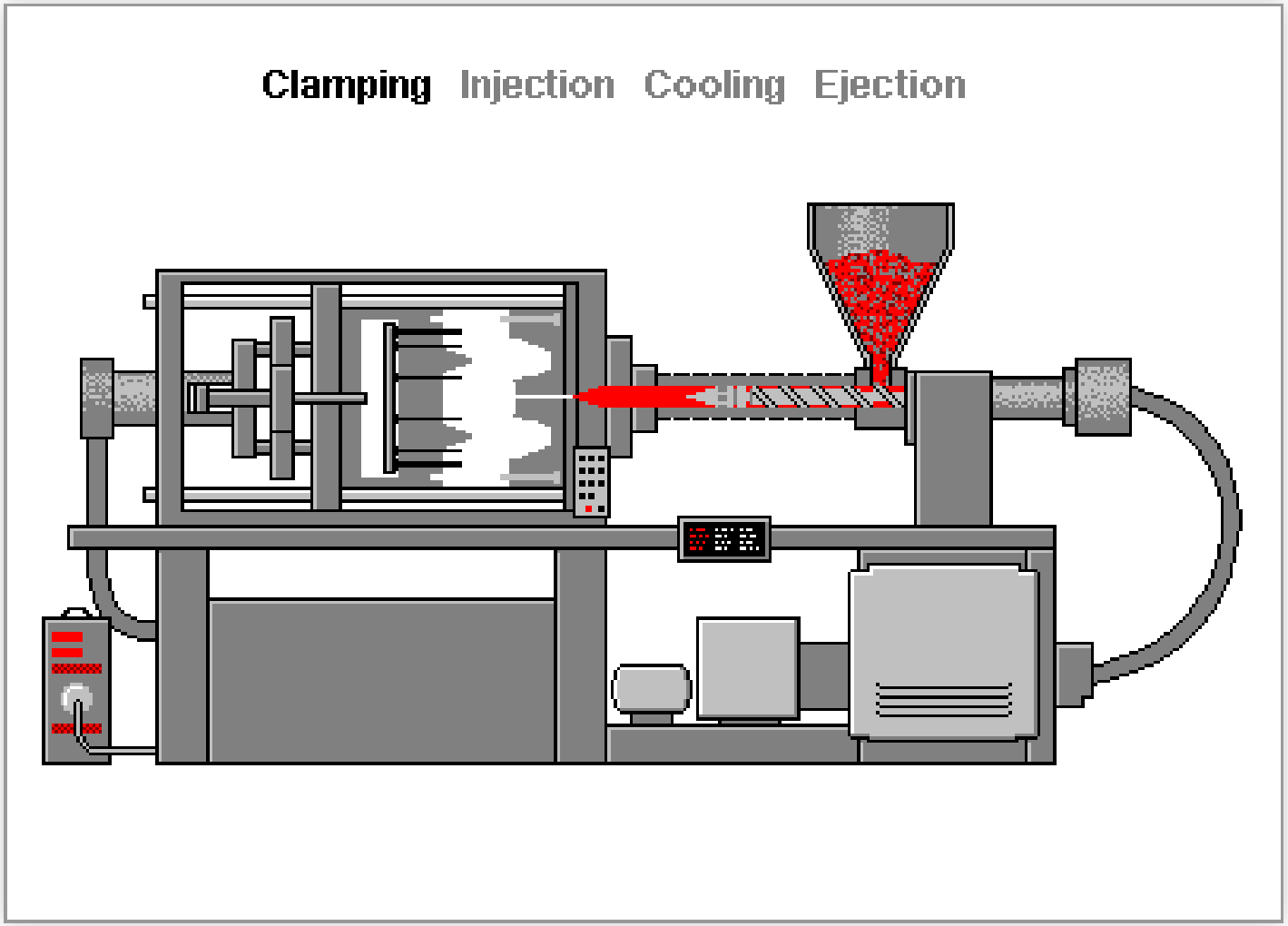
- Water costs, quality, and availability
  - Major factor in some parts of the country today
    - More places tomorrow
- More SMEs have environmental engineers than energy engineers
  - Easier to get attention
- Money (green is good, but money gets action)
  - Increasing prices get awareness
- Energy plays get a makeover
  - Here are two examples


Napa Valley

Impacts on evaporative cooling

- All of the wineries visited had dry cooling towers!!!!
- High cost of treatment added to water costs
  - Result = dry cooling towers
- Reduction in energy efficiency accepted
  - But, changes created a chance for system upgrades including metering

Mold Cooling/Quenching



Cooling technologies

- Chiller or fresh water channels build into molds

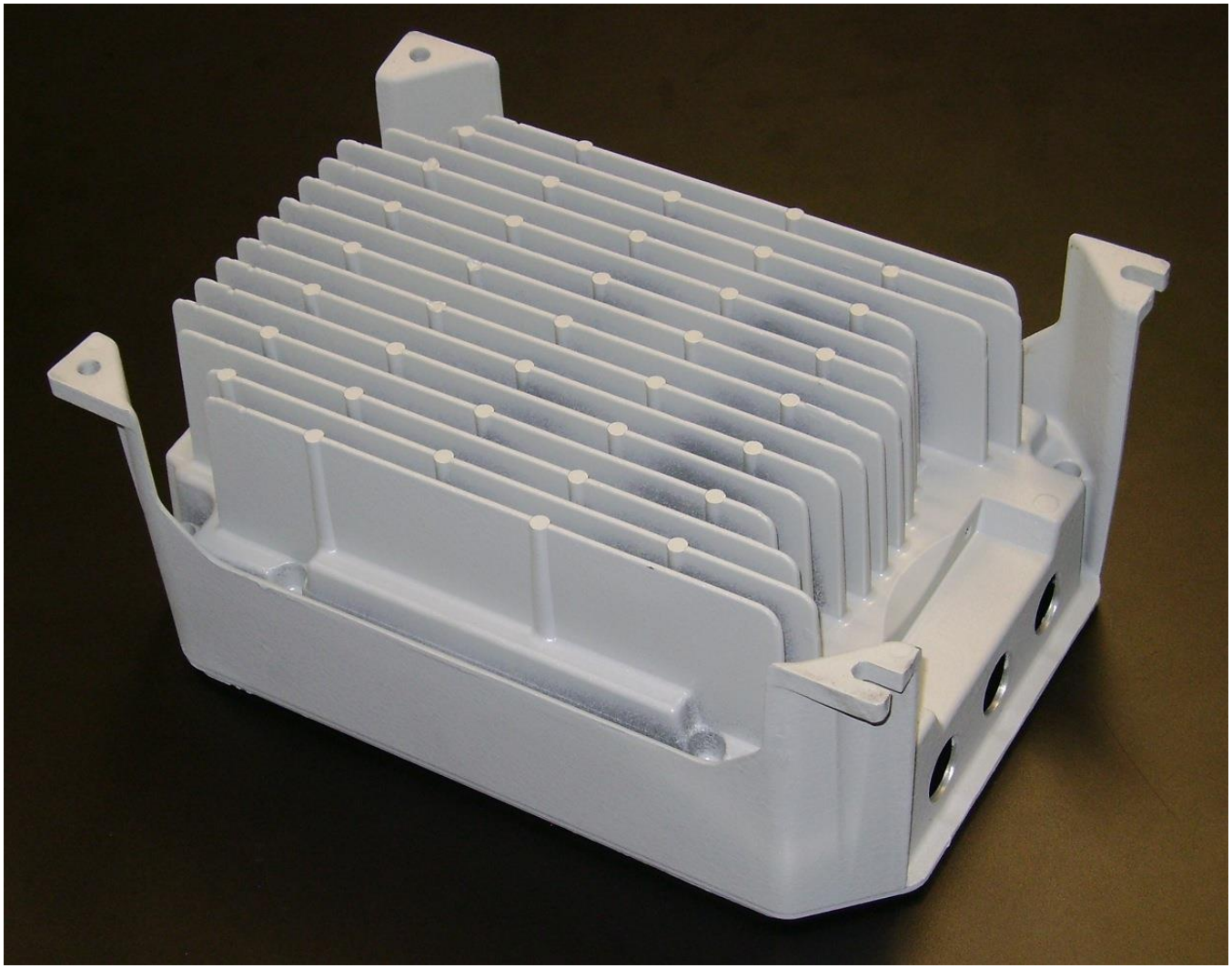
Quench tanks and spray systems

- Water is often not recycled

Direct air cooling

- Available when throughput is not critical
  - this method has limited cooling capabilities because the heat transfer from the mold to the air often isn't fast enough for the production levels required
- To enhance air's cooling capabilities, cooling fins as well as designing contours into the mold to allow the air more access to the internal segments of the mold

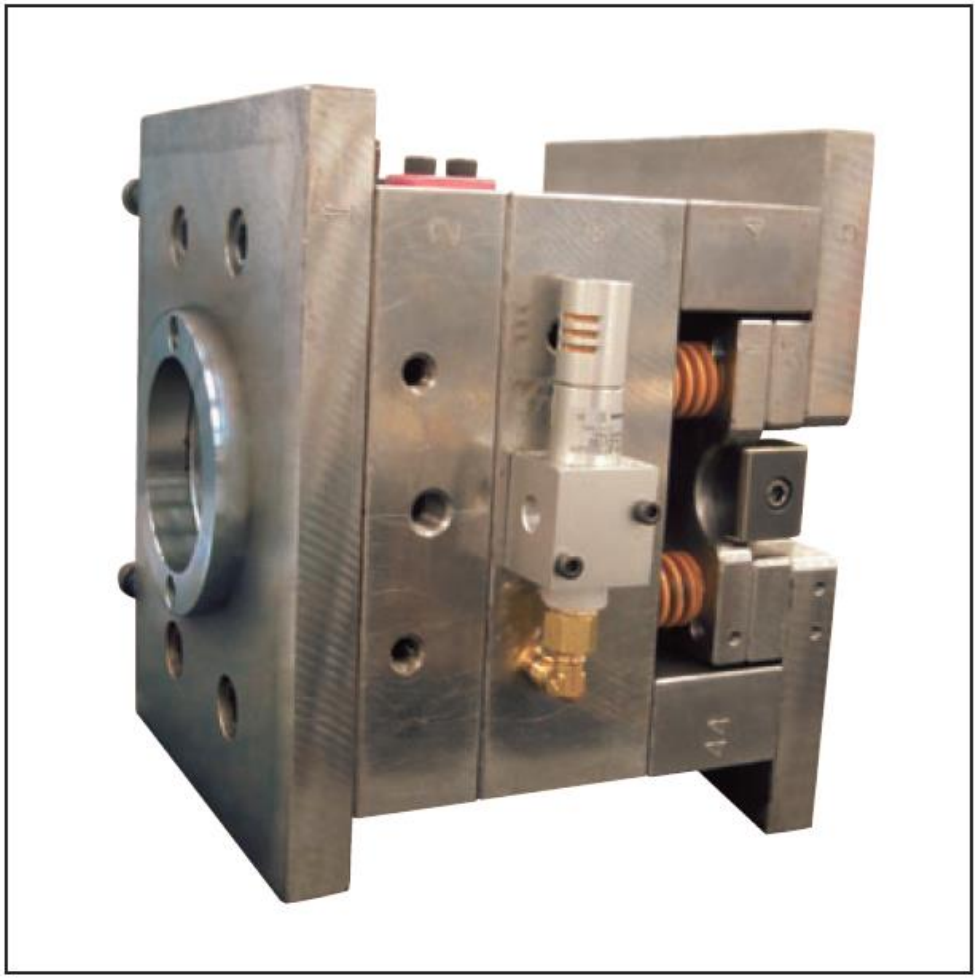
Air-cooled mold



Indirect Air-cooled molds

- Some applications can simply lower throughput and allow natural room cooling
  - Depends on business volume and amount of automation
- Closed circuit cooling with heat transfer fluids

Jet air coolers for molds



Hidden Benefit of Air Cooling

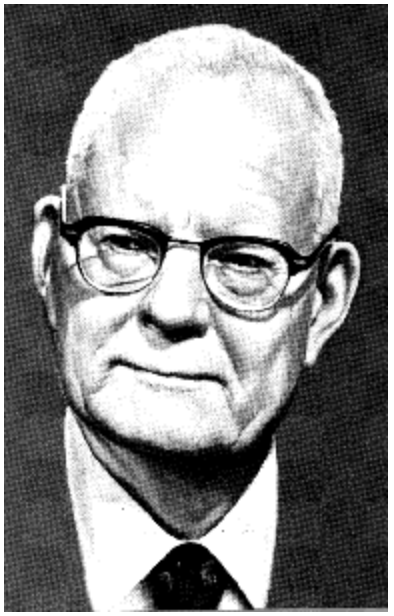
- Mold sweating is a major problem
  - Not only for very cool molds – dewpoints can get above 60 °F in summer
- Plants have put full A/C in to counter
- Dehumidification at the machine is also done
- Air cooling cannot create condensation

IT/Energy Nexus: Smart Manufacturing

- Began in 1801
  - Eli Whitney and "interchangeable parts“
  - He built ten guns, all containing the same exact parts and mechanisms, then disassembled and rebuilt them before the Congress
- Today, with 3-d printing, he would build one at a time
- Subtitle – the IT revolution in the factory
  - Digital controls
  - AI (artificial intelligence)
  - Use of Big Data

"You can't manage what you can't measure."

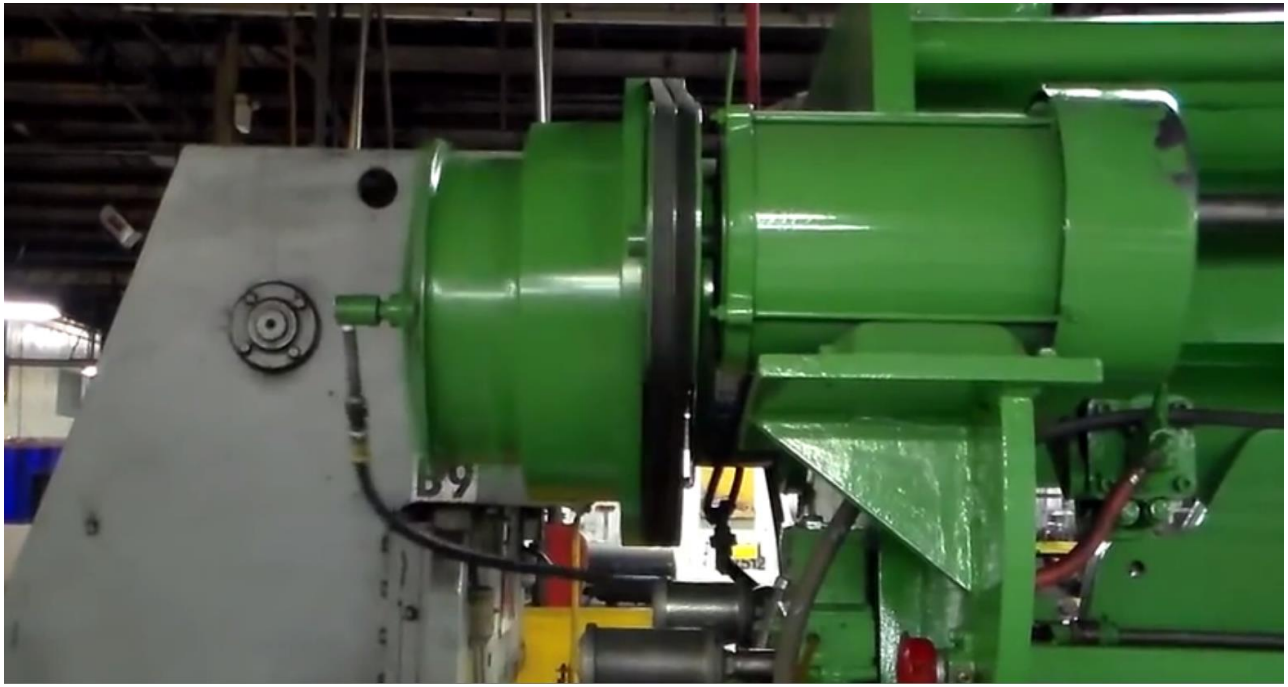
- Old adage that has new meaning
- New technology means too many choices
  - What to measure
  - How precise?
  - How fast?
  - How is info transmitted
  - How is info stored
    - The curse of Big Data
- The benefits and pitfalls of analytics!!!



W. Edwards Deming, Plan-Do-Study-Act (PDSA) cycle - 1993

SME's need help

- IAC program is in the process of developing the "measurement and instrumentation assessment" protocol
- Press Brake example: Flywheel needed?



Press Brake Example

- Instrumented with temporary, high-end power meter
- Learned
  1. Flywheels should be turned off after operations
  2. Power signature can also be used as a production tool
  3. What is required is only a low-end data logger with wireless transmission

SME/University Nexus

- Huge resource of low/no cost information
  - Generally untapped
- Good for today and tomorrow
  - Build long term relationships
- Obvious plug for IAC program
  - But many forms of technical assistance are available
- State university/extension agent model
- Also, universities are being pushed toward more applied research/industrial connections

Takeaways

- Efforts to impact supply chains are not new
  - We must learn from earlier efforts
  - What we do needs to focus on long term sustainability
- Connecting energy to other plant interests is effective
  - Most important when energy costs are down
- Things are getting more complicated; SME's need help
  - Direct help from "up the food chain" is limited
  - DOE programs are good and will adapt going forward
  - Best model is to promote collaboration between SME's and local technical expertise, i.e. Universities