Manufacturers Alliance for Productivity and Innovation

Robert Bruce Lung
Prakash Rao
Better Buildings, Better Plants

- Through Better Plants:
  - Companies set long-term efficiency goals (25% energy intensity over 10 years)
  - Receive technical assistance and national recognition for their leadership

- Manufacturers have two opportunities to engage in Better Plants:
  1. Broader-based *Program* level
  2. Higher-level *Challenge*

Better Plants Overview

Energy savings and program footprint continue to grow

Better Plants Snapshot

<table>
<thead>
<tr>
<th>Accomplishments</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Partners</td>
<td>191</td>
</tr>
<tr>
<td>Approximate Number of Plants</td>
<td>2,600</td>
</tr>
<tr>
<td>Percent of U.S. Manufacturing Energy Footprint</td>
<td>11.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reported Savings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative Energy Savings (TBtu)</td>
<td>600</td>
</tr>
<tr>
<td>Cumulative Cost Savings (Billions)</td>
<td>$3.1</td>
</tr>
<tr>
<td>Cumulative Avoided CO₂ Emissions (Million Metric Ton)</td>
<td>34.7</td>
</tr>
<tr>
<td>Average Annual Energy Intensity Improvement Rate</td>
<td>3.0%</td>
</tr>
</tbody>
</table>

33 new partners, 10 goal achievers in 2016.
Better Plants Challenge
Technical Assistance: In-Plant Trainings

Existing Training Topics:
- Compressed Air
- Pumping
- Steam
- Process heating
- Fans

New Trainings (2016):
- Energy treasure hunt exchanges

New Trainings (2017):
- Energy efficiency in Water/Wastewater treatment
- Industrial Refrigeration
- Strategic Energy Management (SEM)
New Initiative: Technology Transfer

Leveraging ORNL assets

Neutron scattering: SNS and HFIR
- World’s most intense pulsed neutron beams

Leadership-class computing: Titan
- Nation’s most powerful open science supercomputer

Carbon fiber manufacturing
- Open-access carbon fiber process development facility

Advanced materials
- DOE lead lab for basic to applied materials R&D

Science and technology park
- Co-location for industry collaboration
Diagnostic Equipment Loan Program

Helping Better Plants Partners measure operating data to evaluate equipment performance and quantify energy performance improvement

- Free of charge, including shipping
- Use equipment for one day, or up to four weeks
- Limited technical assistance to help w/ selection and use of tools
- First come, first serve application
Join 900+ Better Buildings Partners and Allies

- **EXPLORE AND SHARE**
  innovative strategies, emerging trends, and high-impact technologies in energy and water efficiency

- **CONTRIBUTE**
  to interactive sessions focused on industry-specific and proven solutions to help you take on what's next

- **PARTicipate**
  in showcase building tours, financial ally speed dating, ask-an-expert meetings, peer-to-peer networking

- **LEVERAGE**
  your organization’s commitment to sustainability

Register early - space is limited
REGISTRATION OPENS JANUARY 2017

FOR MORE INFORMATION AND TO REGISTER:
betterbuildingsinitiative.energy.gov/summit

@BetterBldgsDOE  #BBSummit2017
Better Buildings Solution Center

- Nearly 200 industrial solutions tested and proven by Partners – 100 added in 2016

- Find solutions by topic, building type, solution type, building size, sector, technology, location, and more.

energy.gov/bbsc
Water Savings
Background on U.S. manufacturing water use

- 94% freshwater, 6% saline
- 15% “consumptive” (from 1995 USGS)

Estimated 2010 water use (fresh and saline) by end use sector. Figure adapted from Maupin 2014

Estimated sources of manufacturing water use (fresh and saline).

- 62% Surface self-supply
- 14% Groundwater self-supply
- 24% Public

Commercial, public services, and system losses
Domestic
Manufacturing
Thermoelectric
Agriculture
Mining

6% 4% 8% 45% 45% 1%
Industrial water management

**Benefits**

- Operational resiliency
  - 2015 CDP Water Report: Respondents from the Industrial and Consumer Staples sectors ranked the US as a top country for facilities at risk of water related issues
- Allows for growth and planning
- Cost savings
  - Not just water, but energy, chemicals, regulatory costs too
- Improved public image
- Helps EE program

**Challenges**

- Resources and technical assistance not widely available*
  for manufacturers
- Water efficiency and management principles are less developed and promoted than energy efficiency and management principles
  - Less financial incentive to invest and/or reduce
  - But plenty of other drivers: regulation, business risk, community access,
- Lack of data

*Better Plants offers TA on water
DOE Better Buildings, Better Plants Water Savings Initiative

- DOE is working with 38 Better Buildings Challenge Partners in this effort
- Format of initiative similar to Better Plants Challenge:
  - Set water savings goals
  - Track progress
  - Publicly share success
- 9 Better Plants Partners participating

<table>
<thead>
<tr>
<th>Company</th>
<th>Baseline Year</th>
<th>Total Improvement (through 2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cummins</td>
<td>2010</td>
<td>45%</td>
</tr>
<tr>
<td>Ford</td>
<td>2009</td>
<td>44%</td>
</tr>
<tr>
<td>GM</td>
<td>2010</td>
<td>19%</td>
</tr>
<tr>
<td>HARBEC+</td>
<td>-</td>
<td>49%</td>
</tr>
<tr>
<td>Nissan</td>
<td>2013</td>
<td>13%</td>
</tr>
<tr>
<td>Saint-Gobain</td>
<td>2012</td>
<td>Pending</td>
</tr>
<tr>
<td>Toyota</td>
<td>2014</td>
<td>Pending</td>
</tr>
<tr>
<td>UTC</td>
<td>2006</td>
<td>43%</td>
</tr>
<tr>
<td>BD</td>
<td>TBD</td>
<td>20%</td>
</tr>
</tbody>
</table>

*2016 goal achiever

+Set goal to be water neutral
7 Pilot partners shared their water management strategies with DOE

Topics addressed include:
- Making the business case for water saving projects
- Facilities and water sources on which to focus initial efforts
- Establishing baselines and targets
- Water efficiency measures implemented

Available at: https://betterbuildingssolutioncenter.energy.gov/resources/corporate-water-management-strategy-manufacturers
Making the Business Case
Water costs

- Partners average water costs to water and sewer authorities were $5.78/1000 gallons
  - Ranged from $4.00 - $6.71/1000 gallons
- 5 partners reported water costs were negligible to less than 1% of overall production costs
- 1-2 year payback requirements
  - GM allows 3 year payback for projects at new facilities
- Projects that only save water are difficult to justify financially
Strategies employed by Pilot partners for making the business case

- Low or no cost actions (e.g. leak repair)
- Water savings as an ancillary benefit
  - Ford “3-Wet Paint” process reduced CO$_2$, VOCs, and water
- Connect water and sustainability programs
- Consider avoided risk, water availability concerns, local regulations when considering projects
- Use the “True Cost” of water: water volume, energy, chemicals, business risk, maintenance of equipment
  - Cummins calculated true cost to be 3-5x billed water costs
  - 10-12x for high energy/water intensive operations
Focusing Initial Efforts
Prioritizing facilities for implementation

UTC Global Water Conservation Guidance Document

GREAT OPPORTUNITIES FOR BEST PRACTICE MINING

GREAT OPPORTUNITIES FOR WATER CONSERVATION

TABLE OF CONTENTS
- Current state assessment
- Baseline consumption and water balance
- Continuous improvement (key areas to focus on)
- Required Actions
- Minimum expectations for best practices
- Case studies

BEST PRACTICES
- Water balance
- Leak management
- Eliminate make-up water
- Cooling tower management
- Flowmeters
- Low flow fixtures and flow restrictors
- Release tank overflow
- Xeriscaping
- Recycled process wastewater
- Rain water harvesting
Selecting water sources

- Water sources included by partners listed below

<table>
<thead>
<tr>
<th>Water source</th>
<th>Applicable source (# of partners)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public water supply</td>
<td>7</td>
</tr>
<tr>
<td>Ground water</td>
<td>3</td>
</tr>
<tr>
<td>Surface water</td>
<td>3</td>
</tr>
<tr>
<td>Rain water</td>
<td>2</td>
</tr>
<tr>
<td>Recycled/reuse water</td>
<td>0</td>
</tr>
<tr>
<td>Non-fresh water intake</td>
<td>1</td>
</tr>
</tbody>
</table>

- Other considerations when selecting sources:
  - Consumption versus use
  - Discharge water quality
DOE recommendations

- Include all facilities
  - Enables consideration of water use in strategic planning
  - Facilitates sharing of best practices across all facilities
  - Better prepares for unforeseen water issues

- Include all water sources
  - More comprehensive monitoring of water use
  - Creates stronger connection to other sustainability efforts
    - E.g. unbilled water sources will still require energy to pump
Baselines and Targets
Data collection for establishing a baseline

- Observed data collection methods
  - Meters for billed sources
  - Combination of estimation techniques and meters for other sources
- Most data collection occurred at the facility level
- Water use at the end-use level generally not tracked

<table>
<thead>
<tr>
<th>Water use Category</th>
<th>Applicable to company (# of partners)</th>
<th>Able to track or estimate usage volume (# of partners)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production and in-product use</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Auxiliary processes (e.g., pollution control)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Cooling and heating (e.g., cooling towers and boilers)</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Indoor domestic use (e.g., restrooms, kitchens, laundry)</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Outdoor (e.g., landscape irrigation)</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>
## Developing targets

- Metrics and targets influenced by corporate
  - UTC – adopted corporate target
  - Cummins – target represents U.S. contribution towards global target
  - Nissan – corporate-provided target used as a minimum

<table>
<thead>
<tr>
<th>Partner</th>
<th>% Reduction</th>
<th>Metric</th>
<th>Achievement Year</th>
<th>Baseline Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cummins</td>
<td>40%</td>
<td>Gallons/labor hour</td>
<td>2020</td>
<td>2010</td>
</tr>
<tr>
<td>Ford</td>
<td>30%</td>
<td>m³/vehicle</td>
<td>2015</td>
<td>2009</td>
</tr>
<tr>
<td>GM</td>
<td>20%</td>
<td>Gallons/vehicle</td>
<td>2020</td>
<td>2010</td>
</tr>
<tr>
<td>HARBEC</td>
<td>Water neutral</td>
<td>N/A</td>
<td>2015</td>
<td>2013</td>
</tr>
<tr>
<td>Nissan</td>
<td>2%</td>
<td>Gallons/unit</td>
<td>2016</td>
<td>2013</td>
</tr>
<tr>
<td>Saint-Gobain</td>
<td>6%</td>
<td>Gallons/ton produced</td>
<td>2016</td>
<td>2012</td>
</tr>
<tr>
<td>UTC</td>
<td>25%</td>
<td>Volume</td>
<td>2020</td>
<td>2015</td>
</tr>
<tr>
<td>Toyota</td>
<td>20%</td>
<td>Gallons/vehicle</td>
<td>2026</td>
<td>2014</td>
</tr>
</tbody>
</table>
Motivation for setting targets

<table>
<thead>
<tr>
<th>Driver</th>
<th># of partners applicable to (out of 7 in the pilot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation of water consumption and use</td>
<td>2</td>
</tr>
<tr>
<td>Overall cost of water</td>
<td>3</td>
</tr>
<tr>
<td>Energy benefits from water reduction</td>
<td>5</td>
</tr>
<tr>
<td>Availability of suitable water supplies</td>
<td>4</td>
</tr>
<tr>
<td>Risk associated with lack of access to water</td>
<td>4</td>
</tr>
<tr>
<td>Environmental stewardship/corporate sustainability</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
</tbody>
</table>

“Other” included costs and risks associated with wastewater and business continuity
Water Efficiency Measures
Identifying water saving projects

- Cummins, Saint-Gobain, and UTC develop water balances to identify projects
- Leak identification and repair a common water saving project
- Partners also demonstrated that advanced/novel actions are also doable
  - HARBEC: rainwater harvesting
  - Nissan: Water-reuse
Example of a water balance from Cummins
HARBEC: Rainwater harvesting

- 900,000 gallon rainwater retention pond offsetting cooling loads and tower make-up water
- 145,000 gallons/month reduction in purchased water
- 17,000 kWh/month in energy savings from reduction in cooling pump and fan loads from 50 hp to 6 hp
- Motivated by increasing fire insurance premiums

Simple financials:
- Saved $50,000 in avoided insurance costs
- Saved $3,000 in water cost
- Energy cost savings
- $250,000 implementation cost
Nissan - Water Reuse at Smyrna, TN plant

- Phosphate removal using once through rinsing
  - Water treated onsite (consumes energy) and discharged to sewer
  - Make-up water from municipal and RO water (consumes energy)
- Water filtration system installed
- Saved 50 million gallons of water in 2015 compared to 2014
- Simple financials:
  - $320,000 water cost savings
  - $640,000 implementation cost
For more Information

Eli Levine, eli.levine@ee.doe.gov, 202-586-9929

Bruce Lung, robert.lung@ee.doe.gov, 202-586-4411

Clifton Yin, clifton.yin@ee.doe.gov, 202-586-6151

BetterPlants@ee.doe.gov

Better Buildings, Better Plants:  
http://eere.energy.gov/betterplants

Better Buildings Challenge:  
http://betterbuildingssolutioncenter.energy.gov/
### Examples of projects implemented by partners

<table>
<thead>
<tr>
<th>Type of Measure</th>
<th>Examples of Type of Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leaks</strong></td>
<td>▶ Leak detection and correction</td>
</tr>
<tr>
<td><strong>Monitoring and controls</strong></td>
<td>▶ Adjustment on control valves to improve water efficiency</td>
</tr>
<tr>
<td></td>
<td>▶ Automate controls on continuous flow streams</td>
</tr>
<tr>
<td></td>
<td>▶ Change faucets to auto type faucets</td>
</tr>
<tr>
<td></td>
<td>▶ Install low flow fixtures</td>
</tr>
<tr>
<td></td>
<td>▶ Install thermal proportioning valves</td>
</tr>
<tr>
<td></td>
<td>▶ Install automatic shutoff valves</td>
</tr>
<tr>
<td></td>
<td>▶ Implement procedures to monitor and adjust the flow on water cooled equipment</td>
</tr>
<tr>
<td></td>
<td>▶ Monitor water quantity and quality</td>
</tr>
<tr>
<td></td>
<td>▶ Monitor cooling tower cycle of concentration</td>
</tr>
<tr>
<td><strong>Recycle/reuse</strong></td>
<td>▶ Eliminate once through cooling, including installing closed loop chillers</td>
</tr>
<tr>
<td></td>
<td>▶ Recycle non-contact cooling water</td>
</tr>
<tr>
<td></td>
<td>▶ Modify existing equipment to eliminate non-contact water cooling</td>
</tr>
<tr>
<td></td>
<td>▶ Clean and recirculate treated contact water</td>
</tr>
<tr>
<td></td>
<td>▶ Install semi-closed loop water system</td>
</tr>
<tr>
<td></td>
<td>▶ Use recycled water for process water</td>
</tr>
<tr>
<td></td>
<td>▶ Reuse process water, including capturing formerly discharged cooling tower wastewater for use in a recirculating chilled process water loop system.</td>
</tr>
</tbody>
</table>
### Examples of projects implemented by partners cont.

<table>
<thead>
<tr>
<th>Type of Measure</th>
<th>Examples of Type of Measure</th>
</tr>
</thead>
</table>
| Substitute water   | - Replace water with other coolants (i.e. air and antifreeze in a closed loop circuit)  
                     - Replace water cooled compressors with air cooled compressors  
                     - Replace water cooled chilled water system with air cooled system  
                     - Install air cooled systems in place of non-contact cooling water  
                     - Replace water cooled vacuum pumps with air cooled units  
                     - Install waterless urinals throughout the facility |
| Training           | - Increase water usage awareness throughout the facility  
                     - Train operators in the most water efficient procedures |
| Water storage      | - Design of rinse tank overflow systems  
                     - Install rain water harvesting system  
                     - Capture and store water during facility shutdowns for future use, instead of discharging to sewers |