Better Buildings®
U.S. DEPARTMENT OF ENERGY

Innovative Industrial Projects: Technologies and Practices that Save Water

May 11, 2016

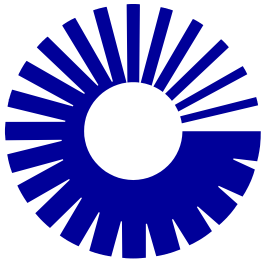
U.S. DEPARTMENT OF ENERGY

Panelists

- Mark Dhennin
  Director, Energy and Environment
  Cummins, Inc.

- Sean West
  EH&S Program Manager
  United Technologies Corporation

- Muneer Chowdhury
  Energy and Environmental Efficiency Manager
  Bridgestone Americas, Inc.



United Technologies

UTC Water Reduction Goals

May 11, 2016

Sean West

UNITED TECHNOLOGIES

Agenda

UTC at a glance

2015 Sustainability Goals

2020 Sustainability Goals

Absolute Water Reduction

Water Management Best Practice Implementation

UNITED TECHNOLOGIES

2015 REVENUE $56.2B

United Technologies
Climate | Controls | Security

Heating, ventilating, cooling & refrigeration systems

Security & fire protection services

Otis
A United Technologies Company

Elevators, escalators, moving walkways, people movers & horizontal transportation systems

UTC Aerospace Systems

Industrial & aerospace systems

Pratt & Whitney
A United Technologies Company

Aircraft engines, gas turbines & space propulsion systems

SUSTAINABILITY AT UTC

Driving sustainable performance

Our strategy is straightforward and effective:

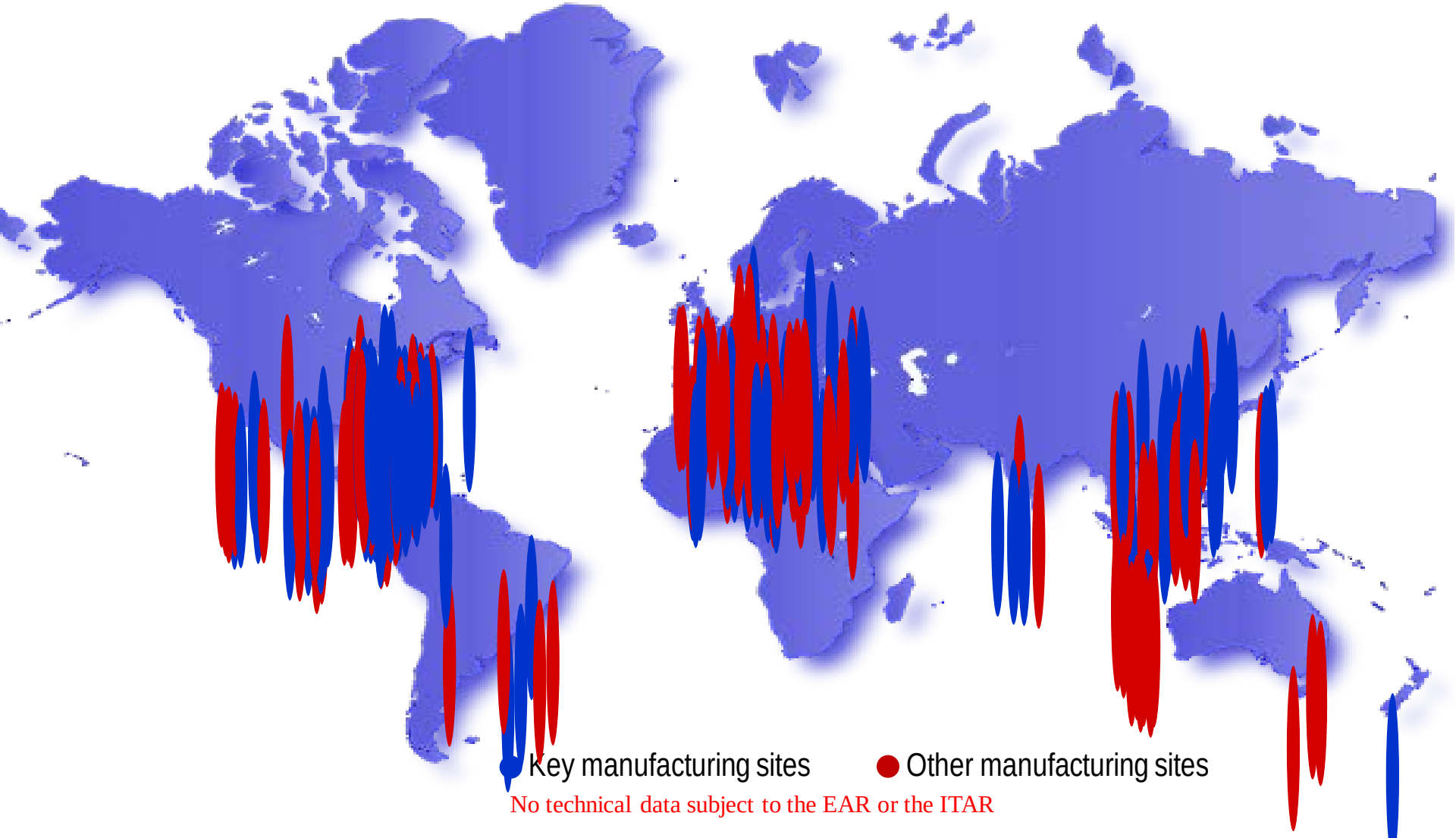
Innovate to meet growing demand for sustainable products

Implement sustainable solutions in our operations

Encourage suppliers, customers and employees to achieve sustainable outcomes

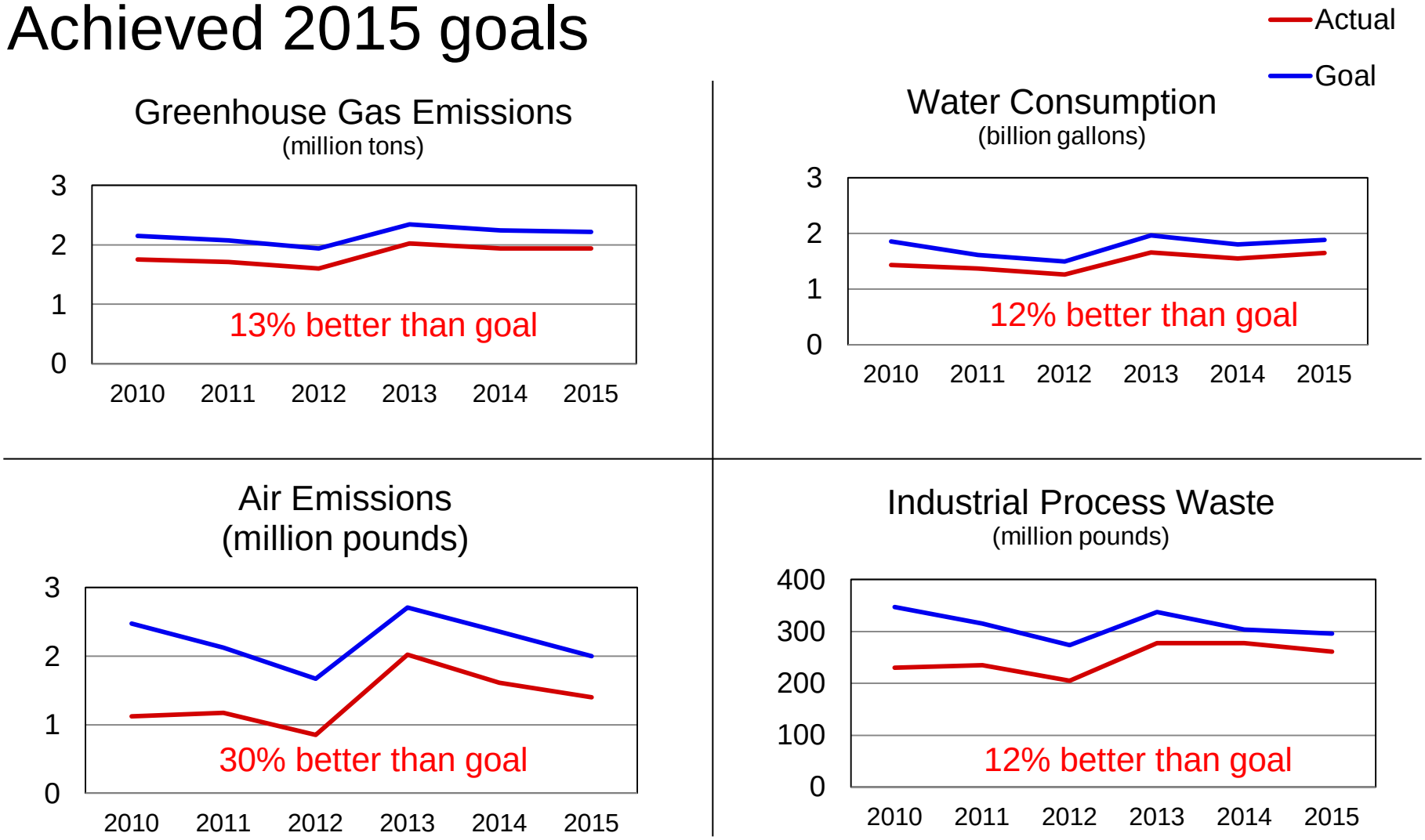
UNITED TECHNOLOGIES

Manufacturing Sites Worldwide



ENVIRONMENTAL PROGRESS

Achieved 2015 goals



Goodrich data included as of 2013

UTC 2020 SUSTAINABILITY GOALS

No technical data subject to the EAR or the ITAR

2020 WATER REDUCTION GOAL

Absolute water reduction goal

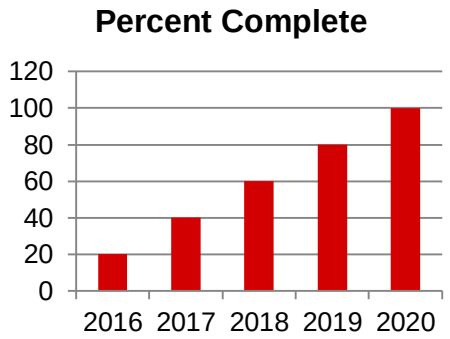
Annual Target: **annual increment 5% absolute reduction from baseline**

Reporting Sites: **Manufacturing, and non-manufacturing with annual energy/water spend > $100,000**

Baseline: **2015 water use amount**

2020 WATER BEST PRACTICE GOAL

Implementation of Best Practices



<u>Annual Target</u>: **Starting Q4-2016, 20% of business unit WMBP projects must be complete; Additional 20% each year 2017-2020**

<u>Reporting Sites</u>: All subject to 2020 water use goal

<u>Baseline</u>: **2015 site water scarcity level, total water use**

WATER MANAGEMENT BEST PRACTICE

Implementation matrix

	Large Sites ➢ 1 Million Gal/year	Small Sites < 1 Million Gal/year
Stressed Regions Scarce Regions Extreme Scarce Regions	71 sites (20%) 563.9 million gallons (29%)	76 sites (22%) 28.45 million gallons (1.5%)
Abundant Regions Sufficient Regions	71 sites (20%) 1,339 million gallons (68%)	79 sites (23%) 27.5 million gallons (1.5%)

Yellow = All ten best practices required
Blue = Must have current water balance and leak management PLUS five additional best practices
Green = Must have current water balance and leak management

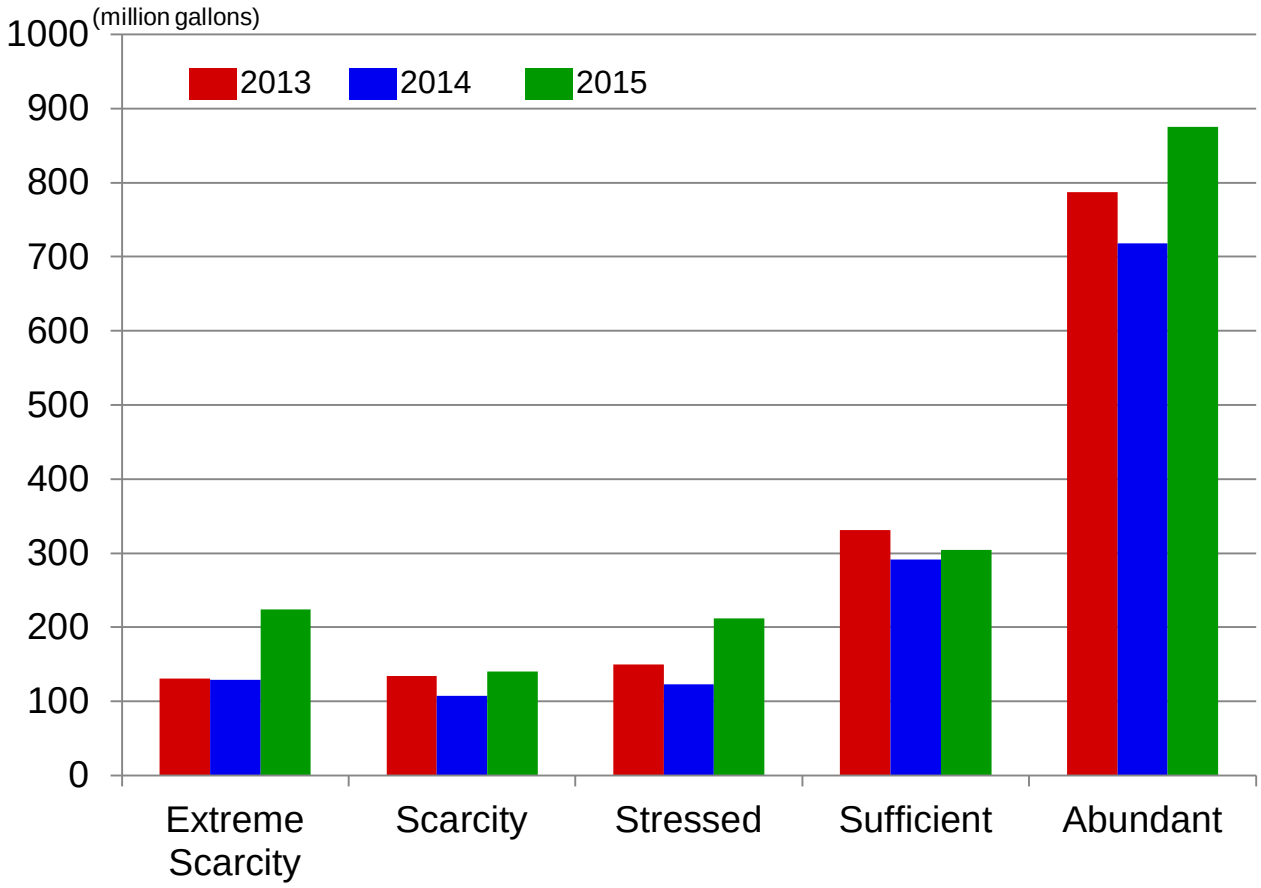
UTC MINIMUM BEST PRACTICES
Current water balance
Leak management

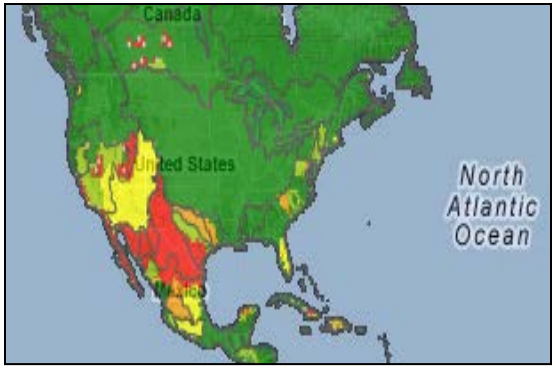
UTC ADDITIONAL BEST PRACTICES
Eliminate once-though cooling
Cooling tower management
Flow meters
Low flow fixtures and flow resistors
Rinse tank overflow
Xeriscaping
Recycle Process wastewater
Rain water harvesting

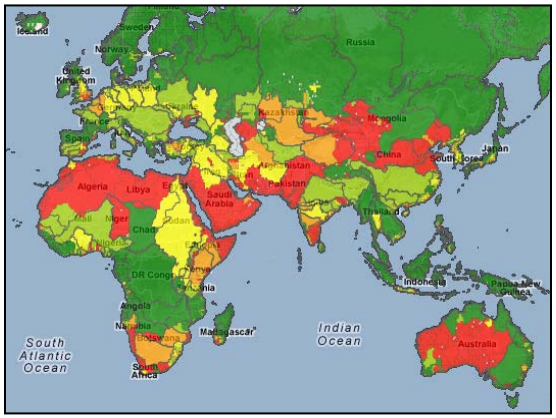
Goal Attainment: **Credit given when BMP implemented across > 50% opportunities at site**

WATER SCARCITY ANALYSIS

Water use by scarcity level – Water tool output



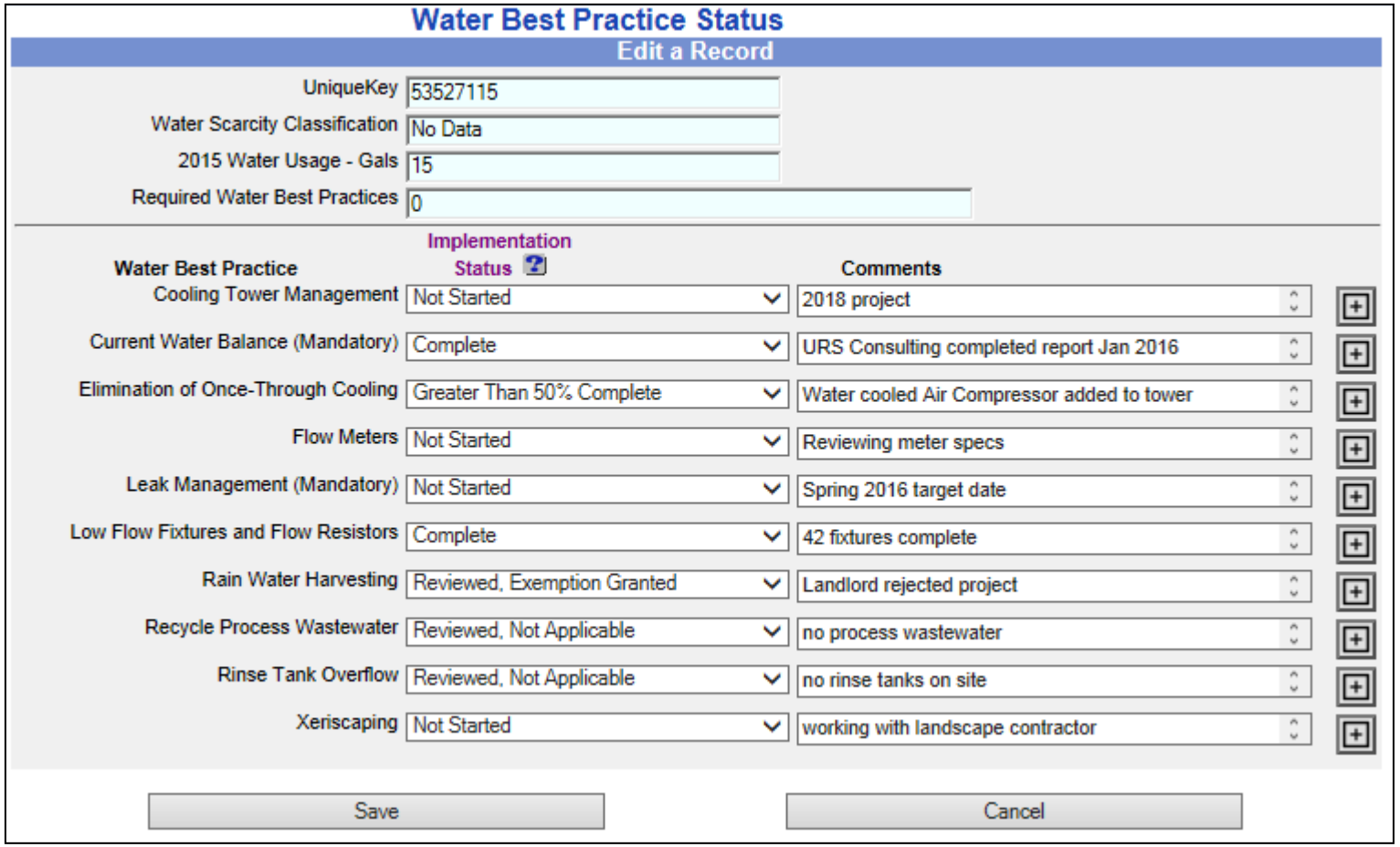




Extreme Scarcity	Scarcity	Stressed	Sufficient	Abundant
<500 (m3/person/year)	500-1000 (m3/person/year)	1001-1700 (m3/person/year)	1701-4000 (m3/person/year)	>4000 (m3/person/year)

UTC EH&S DATA COLLECTION

Documenting WMBP Implementation Status



Water Best Practice Status

Edit a Record

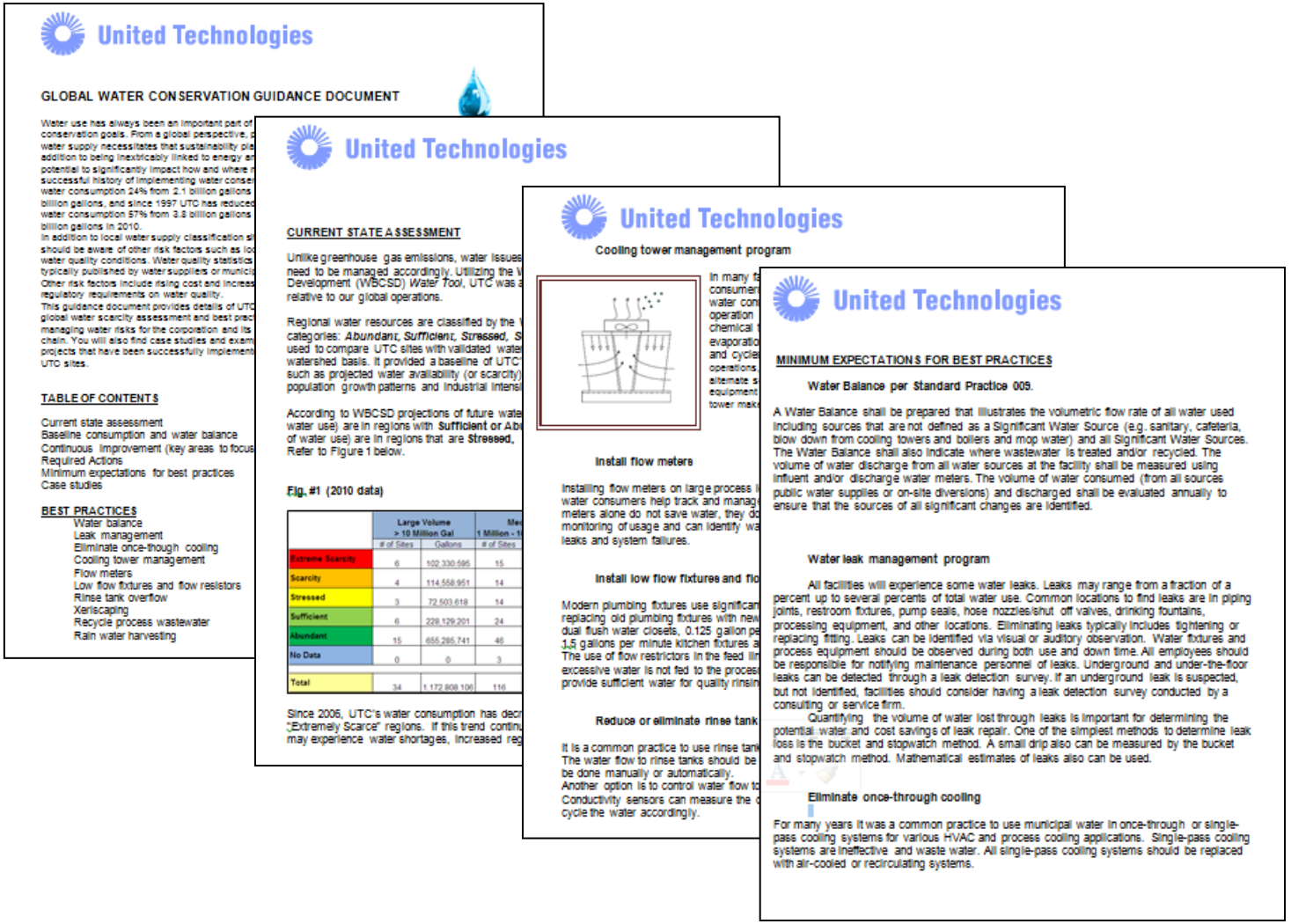
UniqueKey	53527115
Water Scarcity Classification	No Data
2015 Water Usage - Gals	15
Required Water Best Practices	0

Water Best Practice	Implementation Status	Comments
Cooling Tower Management	Not Started	2018 project
Current Water Balance (Mandatory)	Complete	URS Consulting completed report Jan 2016
Elimination of Once-Through Cooling	Greater Than 50% Complete	Water cooled Air Compressor added to tower
Flow Meters	Not Started	Reviewing meter specs
Leak Management (Mandatory)	Not Started	Spring 2016 target date
Low Flow Fixtures and Flow Resistors	Complete	42 fixtures complete
Rain Water Harvesting	Reviewed, Exemption Granted	Landlord rejected project
Recycle Process Wastewater	Reviewed, Not Applicable	no process wastewater
Rinse Tank Overflow	Reviewed, Not Applicable	no rinse tanks on site
Xeriscaping	Not Started	working with landscape contractor

Save Cancel

UTC WATER GUIDANCE DOCUMENT

List of ten water management best practices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GLOBAL WATER CONSERVATION GUIDANCE DOCUMENT

Water use has always been an important part of
conservation goals. From a global perspective,
water supply necessitates that sustainability pla
addition to being inextricably linked to energy a
potential to significantly impact how and where
successful history of implementing water conse
water consumption 24% from 2.1 billion gallons
billion gallons, and since 1997 UTC has reduced
water consumption 57% from 3.8 billion gallons
billion gallons in 2010.
In addition to local water supply classification s
should be aware of other risk factors such as lo
water quality conditions. Water quality statistics
typically published by water suppliers or municip
Other risk factors include rising cost and increas
regulatory requirements on water quality.
This guidance document provides details of UTC
global water scarcity assessment and best prac
managing water risks for the corporation and its
chain. You will also find case studies and exam
projects that have been successfully implement
UTC sites.

TABLE OF CONTENTS

Current state assessment
Baseline consumption and water balance
Continuous Improvement (key areas to focus
Required Actions
Minimum expectations for best practices
Case studies

BEST PRACTICES
Water balance
Leak management
Eliminate once-though cooling
Cooling tower management
Flow meters
Low flow fixtures and flow restrictors
Rinse tank overflow
Xeriscaping
Recycle process wastewater
Rain water harvesting

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CURRENT STATE ASSESSMENT

Unlike greenhouse gas emissions, water issues
need to be managed accordingly. Utilizing the W
Development (WBCSD) *Water Tool*, UTC was a
relative to our global operations.

Regional water resources are classified by the W
categories: ***Abundant, Sufficient, Stressed, S***
used to compare UTC sites with validated water
watershed basis. It provided a baseline of UTC
such as projected water availability (or scarcity)
population growth patterns and industrial intensi

According to WBCSD projections of future wate
water use) are in regions with **Sufficient or Ab**
of water use) are in regions that are **Stressed,**
Refer to Figure 1 below.

Fig. #1 (2010 data)

	Large Volume > 10 Million Gal		Me 1 Million - 1
	# of Sites	Gallons	# of Sites
Extreme Scarcity	6	102,330,595	15
Scarcity	4	114,558,951	14
Stressed	3	72,503,618	14
Sufficient	6	228,129,201	24
Abundant	15	655,285,741	46
No Data	0	0	3
Total	34	1,172,808,106	116

Since 2006, UTC's water consumption has decr
"Extremely Scarce" regions. If this trend contin
may experience water shortages, increased reg

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Cooling tower management program

In many t
consumer
water con
operation
chemical
evaporatio
and cycle
operations
alternate s
equipment
tower make

Install flow meters

Installing flow meters on large process l
water consumers help track and manag
meters alone do not save water, they do
monitoring of usage and can identify wa
leaks and system failures.

Install low flow fixtures and flo

Modern plumbing fixtures use significan
replacing old plumbing fixtures with new
dual flush water closets, 0.125 gallon pe
1.5 gallons per minute kitchen fixtures a
The use of flow restrictors in the feed lin
excessive water is not fed to the proces
provide sufficient water for quality rinsin

Reduce or eliminate rinse tank

It is a common practice to use rinse tan
The water flow to rinse tanks should be
be done manually or automatically.
Another option is to control water flow to
Conductivity sensors can measure the c
cycle the water accordingly.

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MINIMUM EXPECTATIONS FOR BEST PRACTICES

Water Balance per Standard Practice 009.

A Water Balance shall be prepared that illustrates the volumetric flow rate of all water used including sources that are not defined as a Significant Water Source (e.g. sanitary, cafeteria, blow down from cooling towers and boilers and mop water) and all Significant Water Sources. The Water Balance shall also indicate where wastewater is treated and/or recycled. The volume of water discharge from all water sources at the facility shall be measured using influent and/or discharge water meters. The volume of water consumed (from all sources public water supplies or on-site diversions) and discharged shall be evaluated annually to ensure that the sources of all significant changes are identified.

Water leak management program

All facilities will experience some water leaks. Leaks may range from a fraction of a percent up to several percents of total water use. Common locations to find leaks are in piping joints, restroom fixtures, pump seals, hose nozzles/shut off valves, drinking fountains, processing equipment, and other locations. Eliminating leaks typically includes tightening or replacing fitting. Leaks can be identified via visual or auditory observation. Water fixtures and process equipment should be observed during both use and down time. All employees should be responsible for notifying maintenance personnel of leaks. Underground and under-the-floor leaks can be detected through a leak detection survey. If an underground leak is suspected, but not identified, facilities should consider having a leak detection survey conducted by a consulting or service firm.

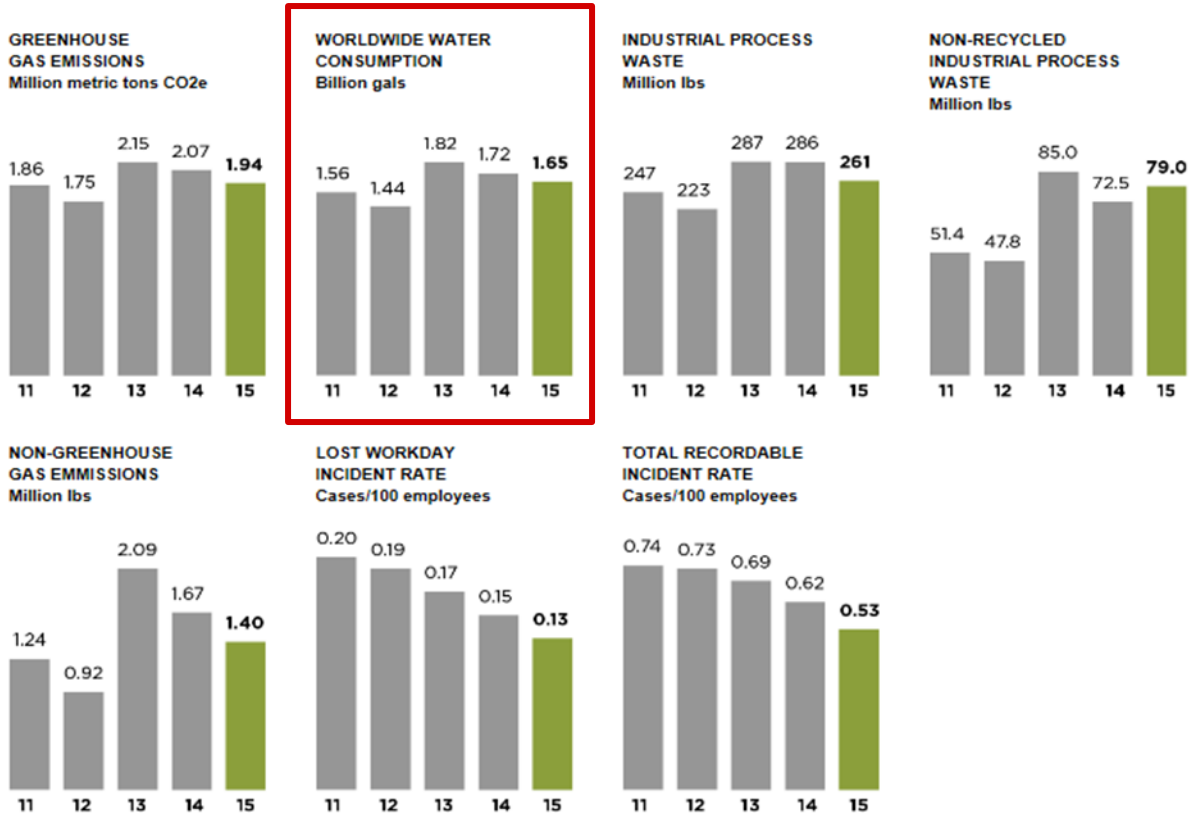
Quantifying the volume of water lost through leaks is important for determining the potential water and cost savings of leak repair. One of the simplest methods to determine leak loss is the bucket and stopwatch method. A small drip also can be measured by the bucket and stopwatch method. Mathematical estimates of leaks also can be used.

Eliminate once-through cooling

For many years it was a common practice to use municipal water in once-through or single-pass cooling systems for various HVAC and process cooling applications. Single-pass cooling systems are ineffective and waste water. All single-pass cooling systems should be replaced with air-cooled or recirculating systems.

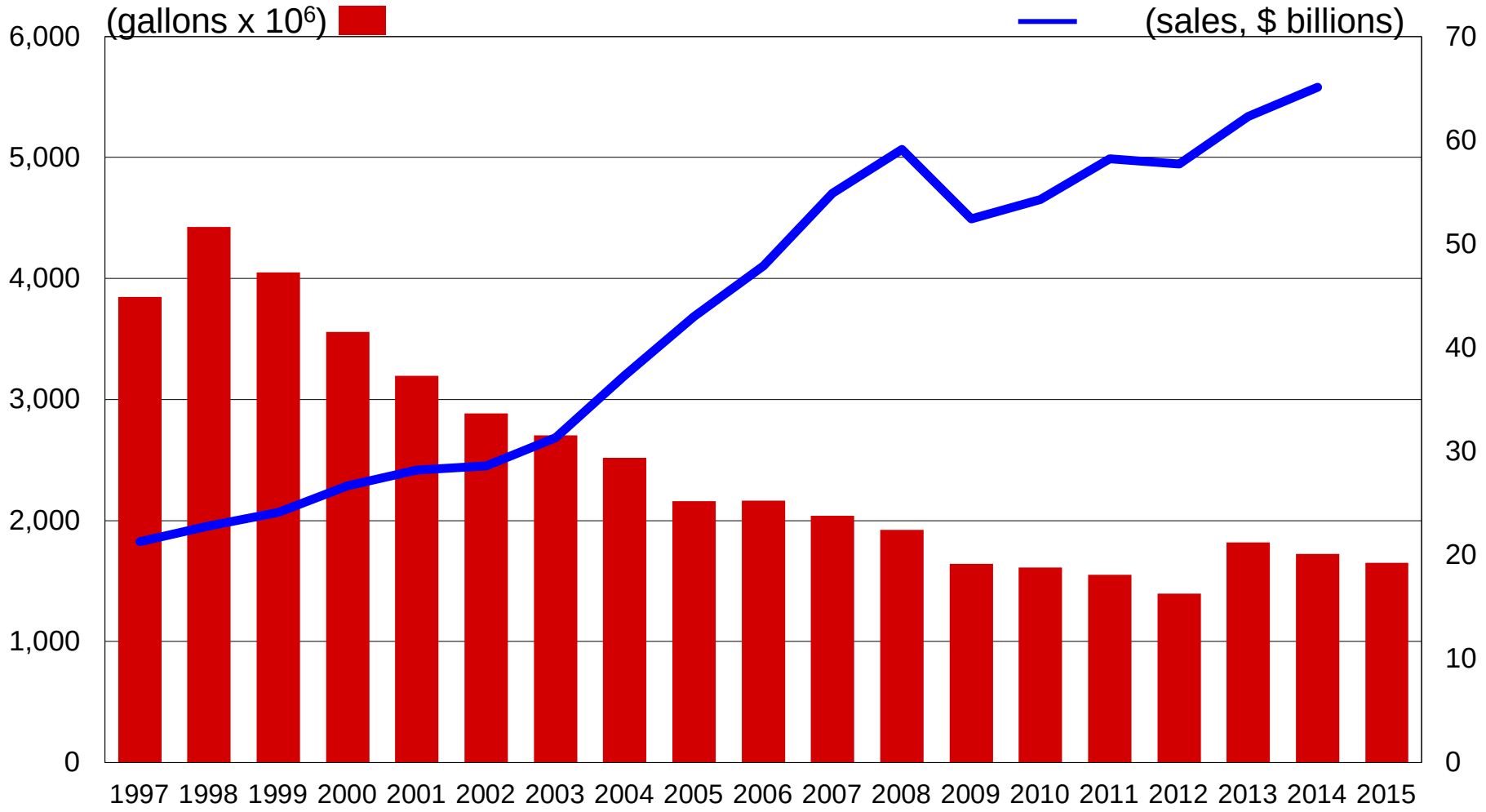
UTC 2015 ANNUAL REPORT

At UTC we measure our sustainability performance for current operations through key performance indicators. To learn more about our progress in protecting the environment and the health and safety of our employees and communities where we work, visit our 2020 Sustainability Goals page.



The increases in our 2013 environmental performance results reflect the addition of 100 former Goodrich sites to our EH&S management system.

WATER CONSUMPTION WORLDWIDE



Q&A

Sean West
EH&S Program Manager
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Environment, Health & Safety
United Technologies Corporation

One Team, One Planet.

BRIDGESTONE

Muneer Chowdhury

May 11, 2016

Bridgestone Americas' commitment to helping ensure a healthy environment for current and future generations to enjoy

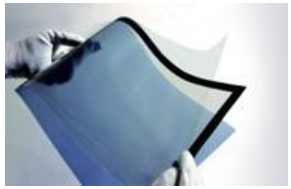
Bridgestone Corporation

- Founded in Japan in 1931, headquartered in Tokyo
- The world's largest tire and rubber company
- Manufactures tires and a broad range of diversified products, which includes Industrial Products, Building Products, Chemical Products and Sporting Goods.
- Products sold in more than 150 nations and territories around the world

Conveyer Belts

Seismic Isolation Rubber

Sporting Goods



High Performance film

Bicycles

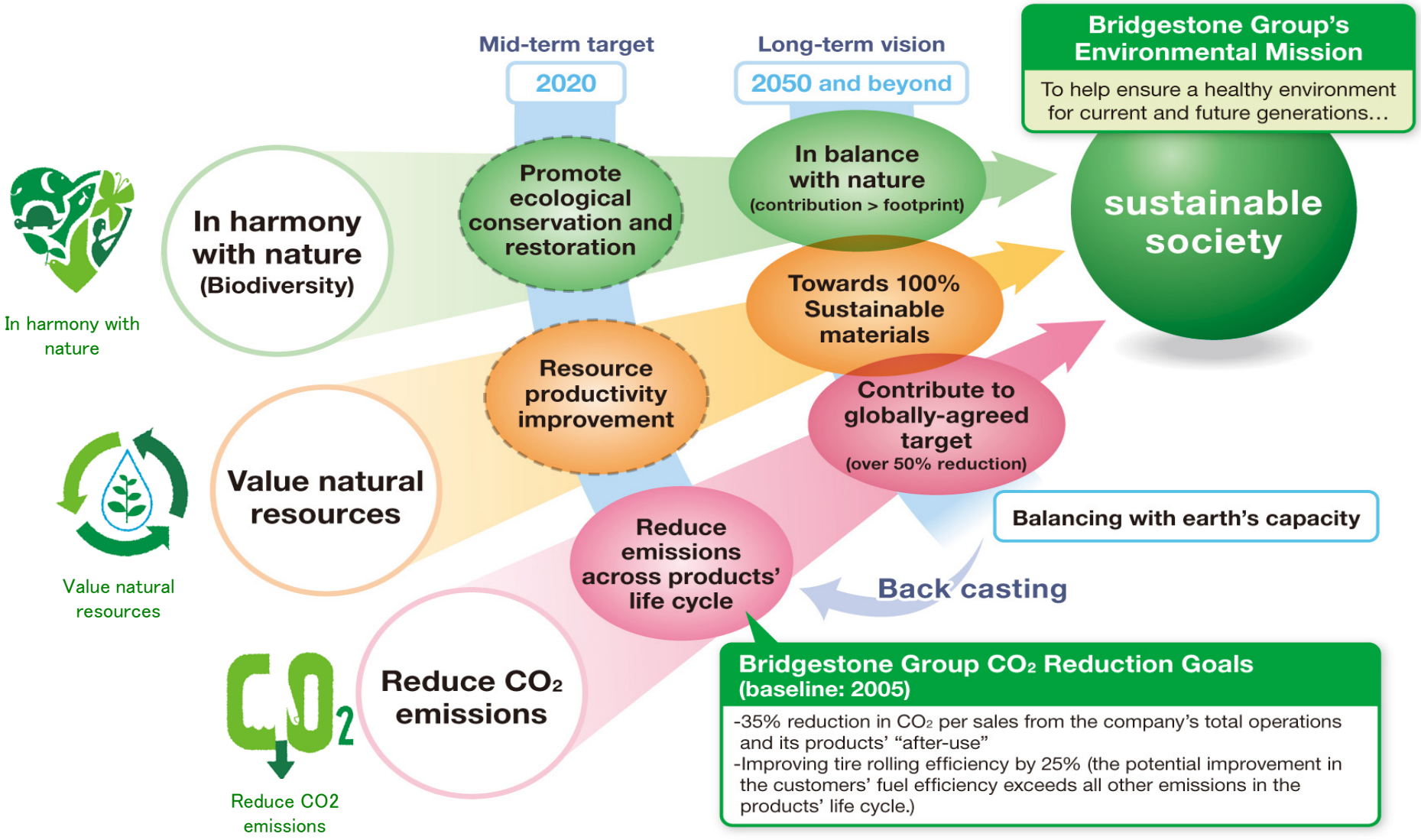
Seat pads for automobiles
(Polyurethane foam)

Brief Background of Bridgestone Americas (BSAM)

BRIDGESTONE
Your Journey, Our Passion

- Nashville, Tennessee-based BSAM is the largest subsidiary of Bridgestone Corporation with 50,000 teammates in North and South America.
- BSAM and its subsidiaries develop, manufacture and market a wide range of Bridgestone, Firestone and associate brand tires to address the needs of a broad range of customers, including consumers, automotive and commercial vehicle original equipment manufacturers, and those in the agricultural, forestry and mining industries.
- The company is also engaged in retreading operations throughout the Western Hemisphere and produces air springs, roofing materials, and industrial fibers and textiles.
- BSAM also operates the world's largest chain of automotive tire and service centers.

Long-term Vision



Water Savings projects

- Water savings in Manufacturing process –
  "Cooling tower installation project at Joliette Plant"

- Water savings by Rainwater Harvesting –
  " Rainwater Harvesting Project at Aiken ORR Plant"

- Water savings in facilities –
  "Facilities fixtures upgrade at Warren and LaVergne Plants"

Joliette Plant

Cooling tower project

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Your Journey, Our Passion

Current:

- The Joliette plant is one of the highest water consumption Plant in BSAM.
- Presently a process water circuit going to a cooling tower, but it provide services only for half of the plant.
- Major equipments of the power house like air compressors and dryers, as well as nitrogen exchanger are cooled with once through cooling process.

Proposed:

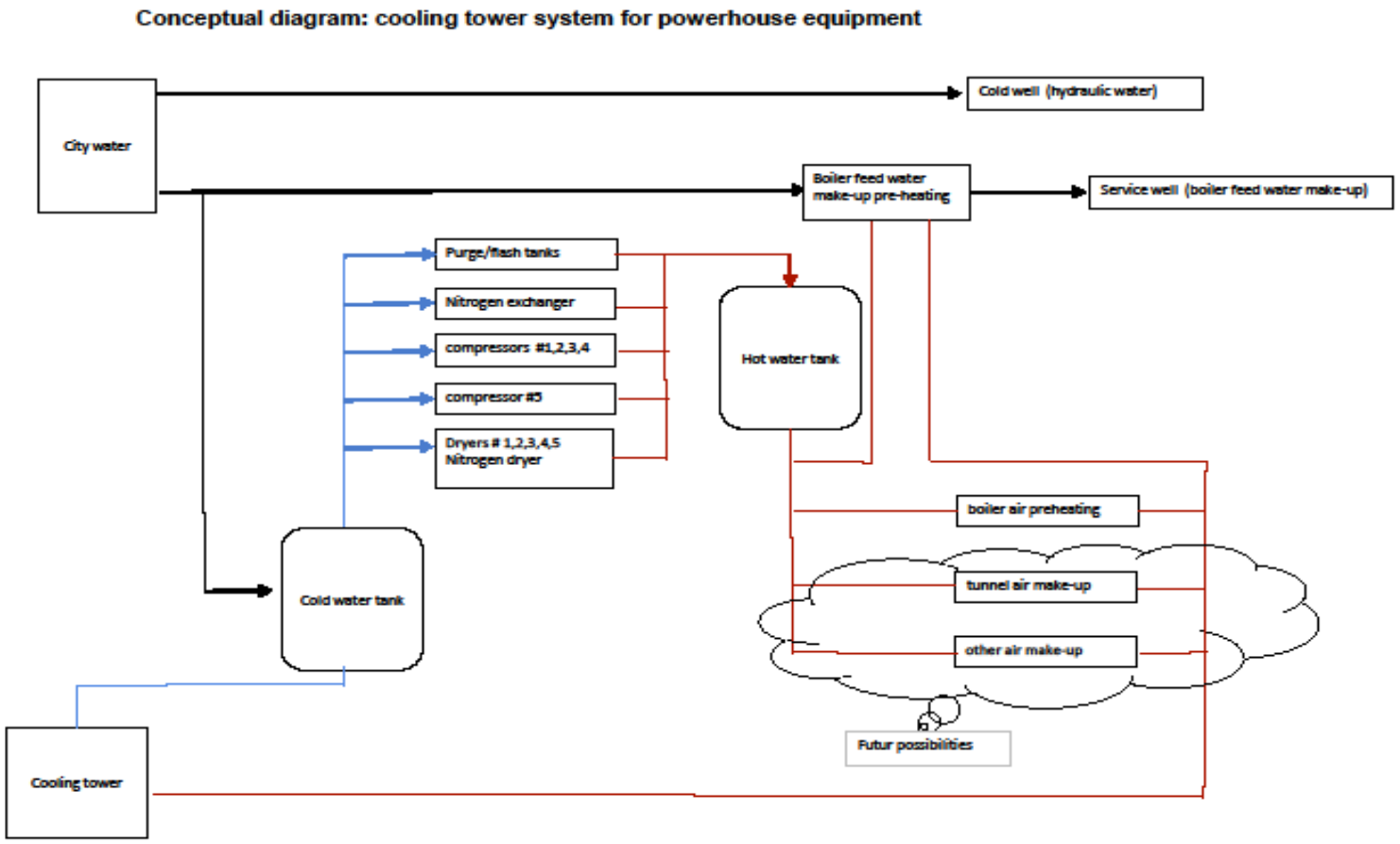
- Installation of a new cooling tower in the powerhouse area to provide a closed circuit cooling system that will reduce plant water consumption.
- Heat recuperated from the water will be used to preheat boiler feed water and combustion air, before going to the cooling water.

Cooling Tower Project Benefits

- The installation of the cooling tower to cool the powerhouse equipment in a closed loop circuit will reduce the plant water consumption by 60% that equals to 116.2 Million Gallons of Water.

- A saving of $168, 490 per year.

Schematic flow Diagram



Water savings details

Water saving potential, once through flow that would be replaced by closed loop cooling system

Major equipment	MMGal/ year	MMGal/ year saved (including Delta syst.)
Purge tanks / Flash tank	10.0	10.0
Nitrogen exchanger	12.4	12.4
Compressor #1	15.6	9.4
Compressor #2	15.2	9.1
Compressor #3	9.0	5.4
Compressor #4	3.6	2.1
Dryerr #5	17.9	17.9
Compressor #5	43.8	43.8
Compressor #6	0.2	0.2
Compressor #7	0.3	0.3
Minor equipment		
Dryerr #1 et #2	7.3	7.3
Dryer #3 et #4	5.5	5.5
Nitrogen compressor	2.5	2.5
Nitrogen dryer	0.3	0.3
TOTAL potential water saving	**Total flow saving**	**126.2**

Tower make-up water	new usage	-10.0
TOTAL net potential water saving	**Total net anticipated saving**	**116.2**

2015 water unit cost ($/Mgal) $1.45 US $1.89 canadian

TOTAL $ saving	$	168,490.00

Water usage in 2014	**188.6**
Percent anticipated saving	**62%**

Propose Tower Model

FXV Dual Air Intake

The FXV Dual Air Intake models provide many of the same features and benefits of the FXV, but on a much larger scale. It is the largest closed circuit cooling tower on the market, making it ideal for large projects where size matters.

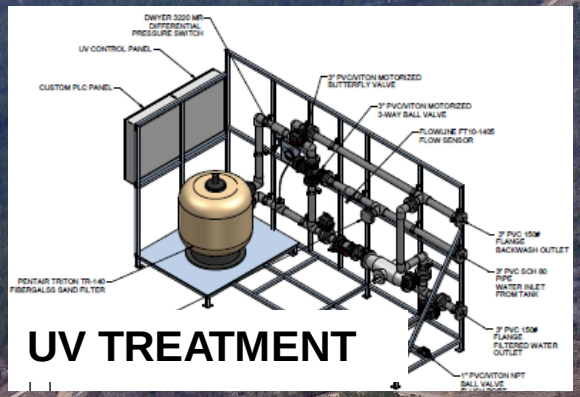
- **Ideal for Large Projects**
- **Crossflow Design Easiest to Maintain**
- **Easy Installation**

Multi-cell FXV Dual Air Intake Installation

10 QUESTIONS? CALL 410.799.6200 OR VISIT WWW.BALTIMOREAIRCOIL.COM

Aiken ORR Rain Water Harvesting

RAINWATER HARVESTING



UV TREATMENT

BOILERS & TOILETS

RAINWATER POND

AOR Rainwater Harvesting

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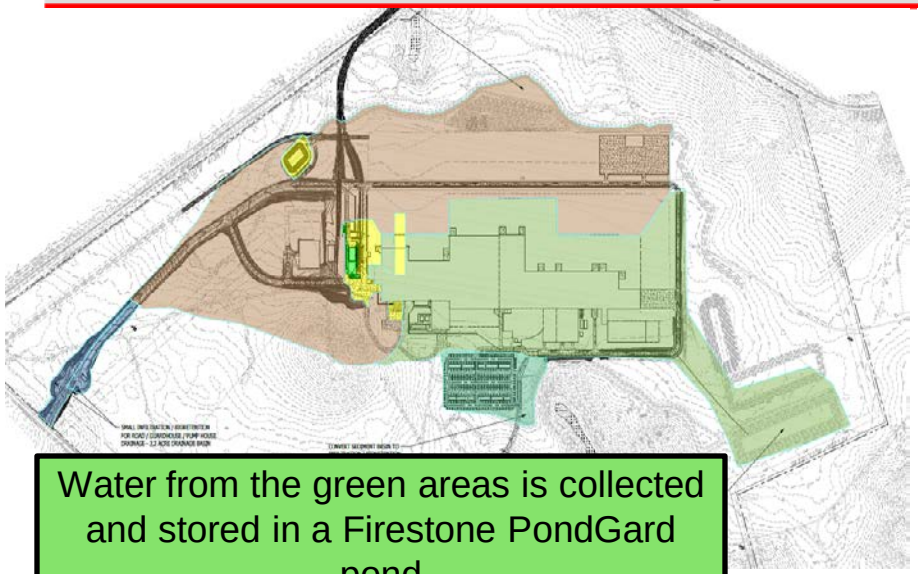
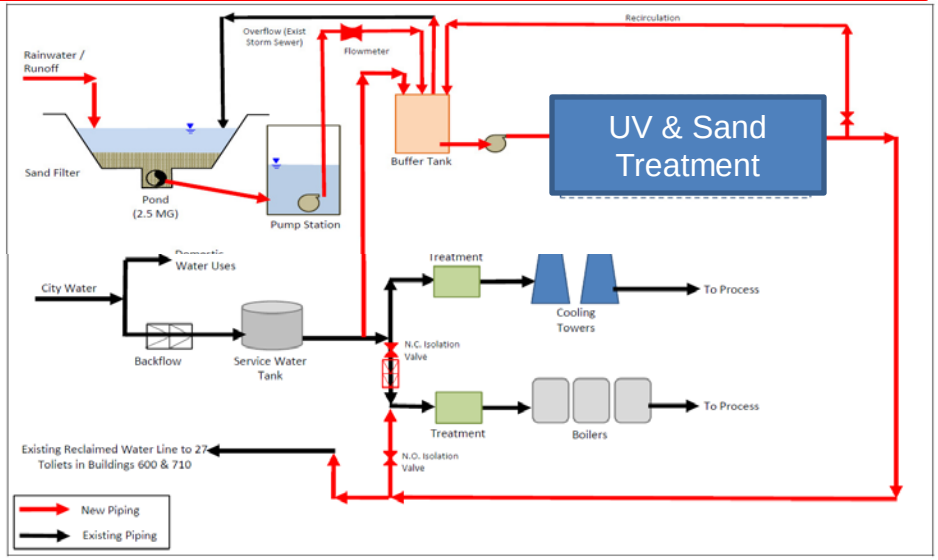
Your Journey, Our Passion



Water from the green areas is collected and stored in a Firestone PondGard pond



Project Summary

-FR written for $722,000
-Design Capacity of 100 GPM
-Savings at 50 GPM
- •$81,547/yr
- •26.8 million gallons

-Started-up 4/7/2015

Filter/Booster/Storage

- 100 Gpm Capacity
- 6000 gallon storage
- Ultraviolet Biocide Chamber
- Sand Filtration
- Mechanical redundancy with Service Water

Booster Pump Skid

- Currently provides supply water
  - 20 gpm to the boilers
  - Plant toilets
- Future
  - Cooling tower make-up
  - Curing hydraulic make-up

November 3, 2014

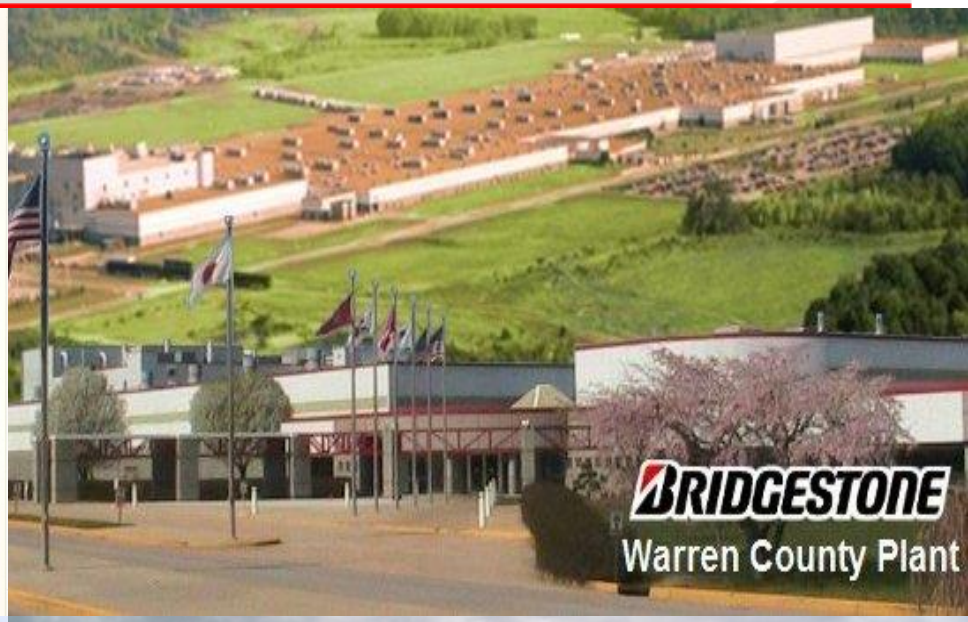
November 25, 2014

January 14, 2014

December 26, 2014

Tank & Booster

UV Treatment Skid


BRIDGESTONE
Warren County Plant


BRIDGESTONE
BRIDGESTONE
1201

Sink Area Before Renovation

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Your Journey, Our Passion

Sink Area After Renovation

Urinal Area Before Renovation

BRIDGESTONE

PASSION for EXCELLENCE

BRIDGESTONE

Your Journey, Our Passion

Public Information

Auto Faucets

Water Savings projects Savings

- Water savings in Manufacturing process –
  "Cooling tower installation project at Joliette Plant"
  a. 116 Million Gallons of water savings per year
  b. $168,000 Savings per year

- Water savings by Rainwater Harvesting –
  " Rainwater Harvesting Project at Aiken ORR Plant"
  a. 27 Million Gallons of water savings per year
  b. $82,000 Savings per year

- Water savings in facilities –
  "Facilities fixtures upgrade at Warren and LaVergne Plants"
  a. 20 Million Gallons of water savings per year
  b. $60,000 Savings per year

Total Savings: 163 Million Gallons of Water and $310,000/Year

Real pleasure for the opportunity

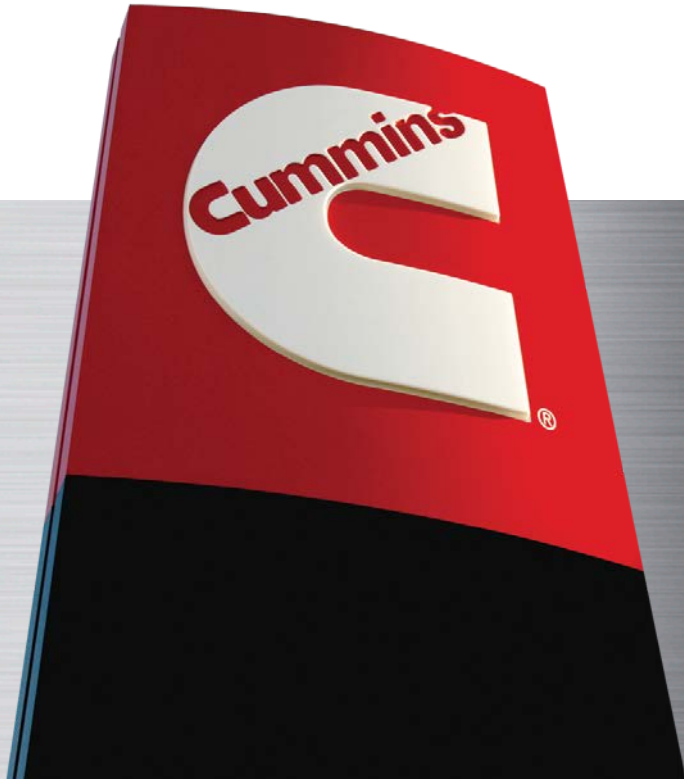
THANK YOU

Cummins Water Program

Mark Dhennin

Better Buildings Summit

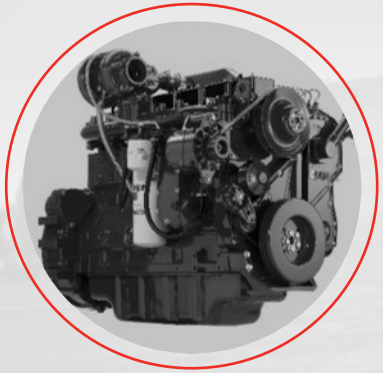
May 2016



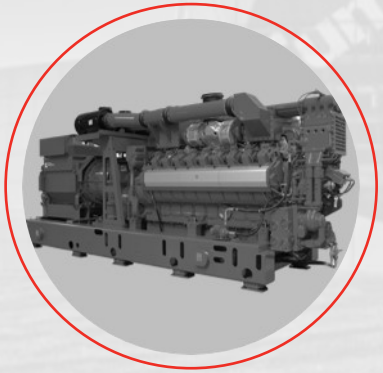
Cummins, Inc.

2015 Revenue: $19.1 billion

55,000 employees, 190+ countries & territories



Engines



Power Generation

Components

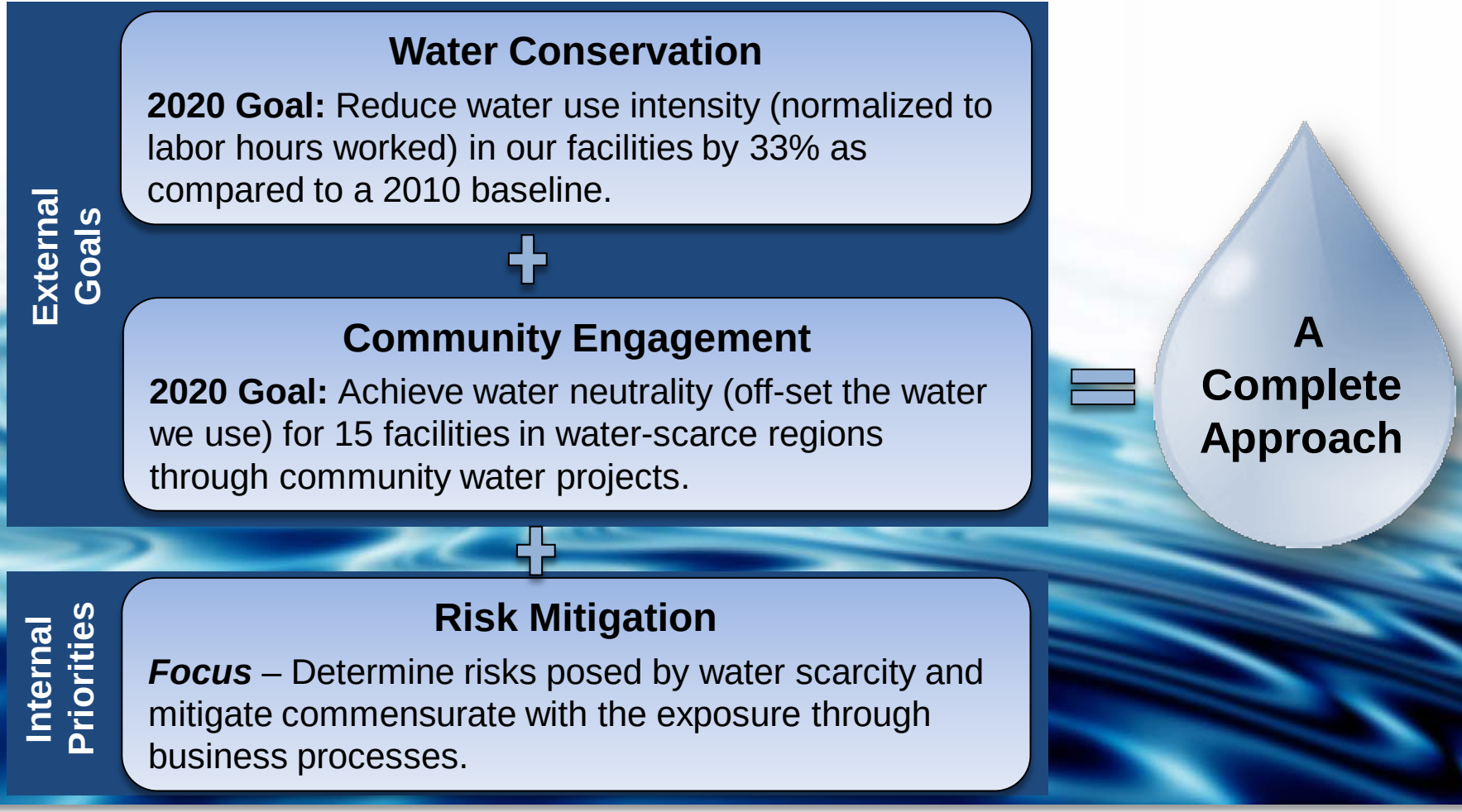
Distribution

2015 water consumption: 953 MG global; 494 MG U.S.

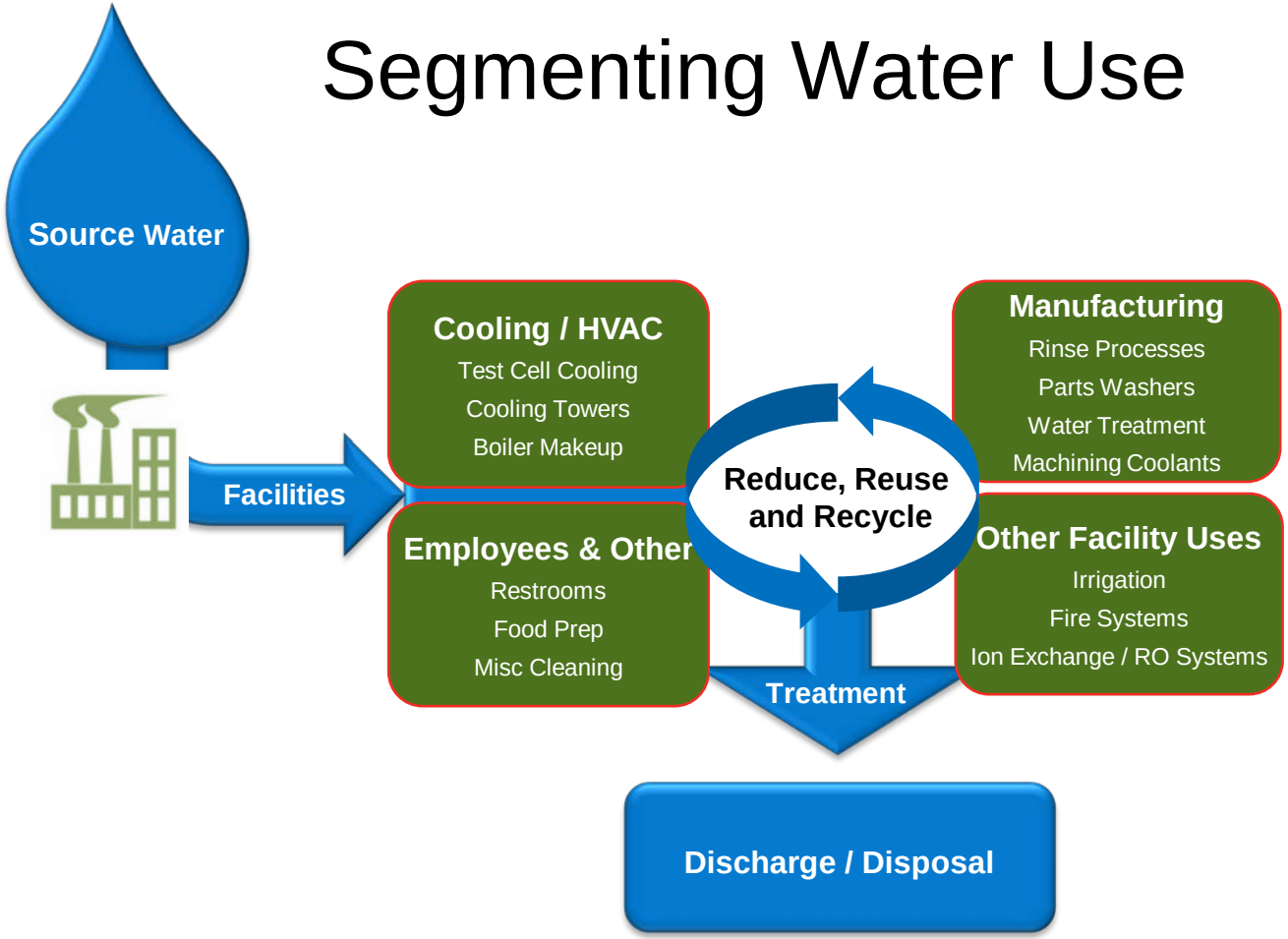
Envolve Cummins Priorities

	FOCUS	ACTION AREAS
Reducing our carbon footprint.		New product fuel efficiency • facility GHG reduction • renewable energy • products-in-use fuel efficiency • logistics • remanufacturing
Using fewer natural resources.		Water reduction and neutrality • increased recycling • zero disposal • materials efficiency • packaging • advanced manufacturing
Partnering to solve complex problems.		Supplier and community collaboration • new technologies • metals and water availability • NGOs • governments

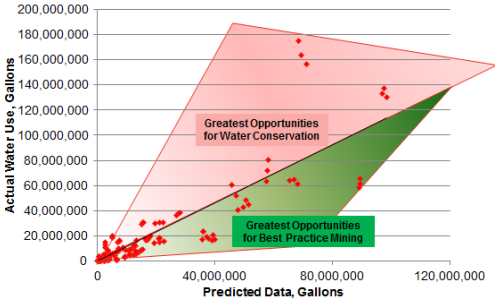
Water Stewardship at Cummins



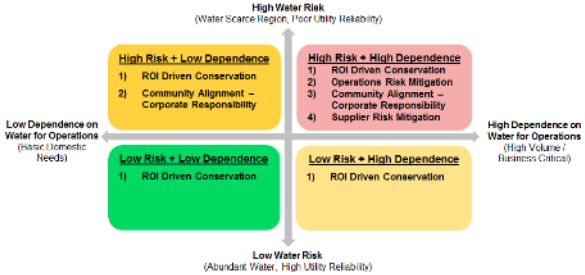
Segmenting Water Use

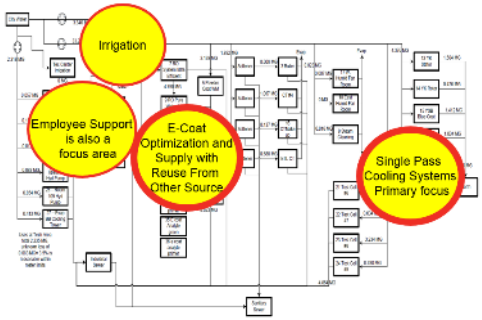


Make the Complex Simple

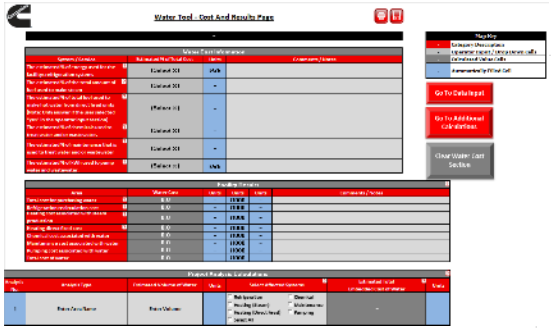


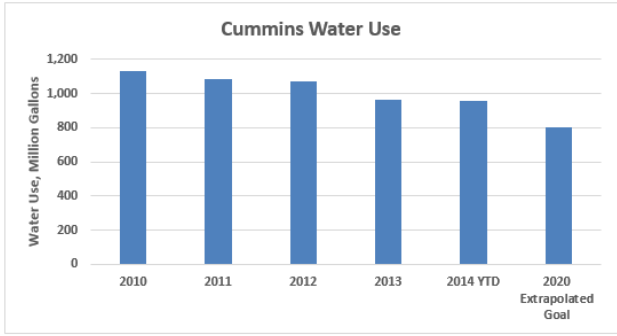
Prioritize



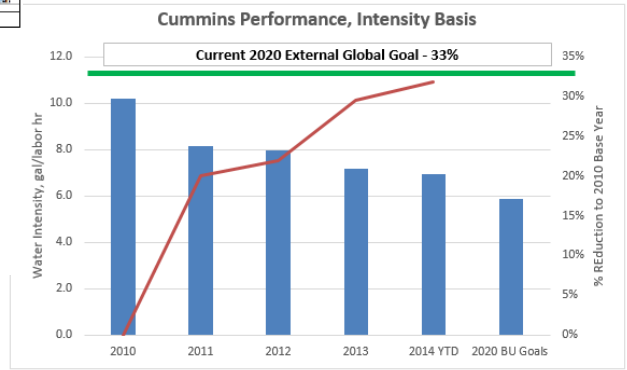


Consult





Achieve



Expanding the Champion scope

Energy Champions

- Energy/GHG training
- Energy toolkit
- Best practice sharing
- Site energy teams

Environmental Champions

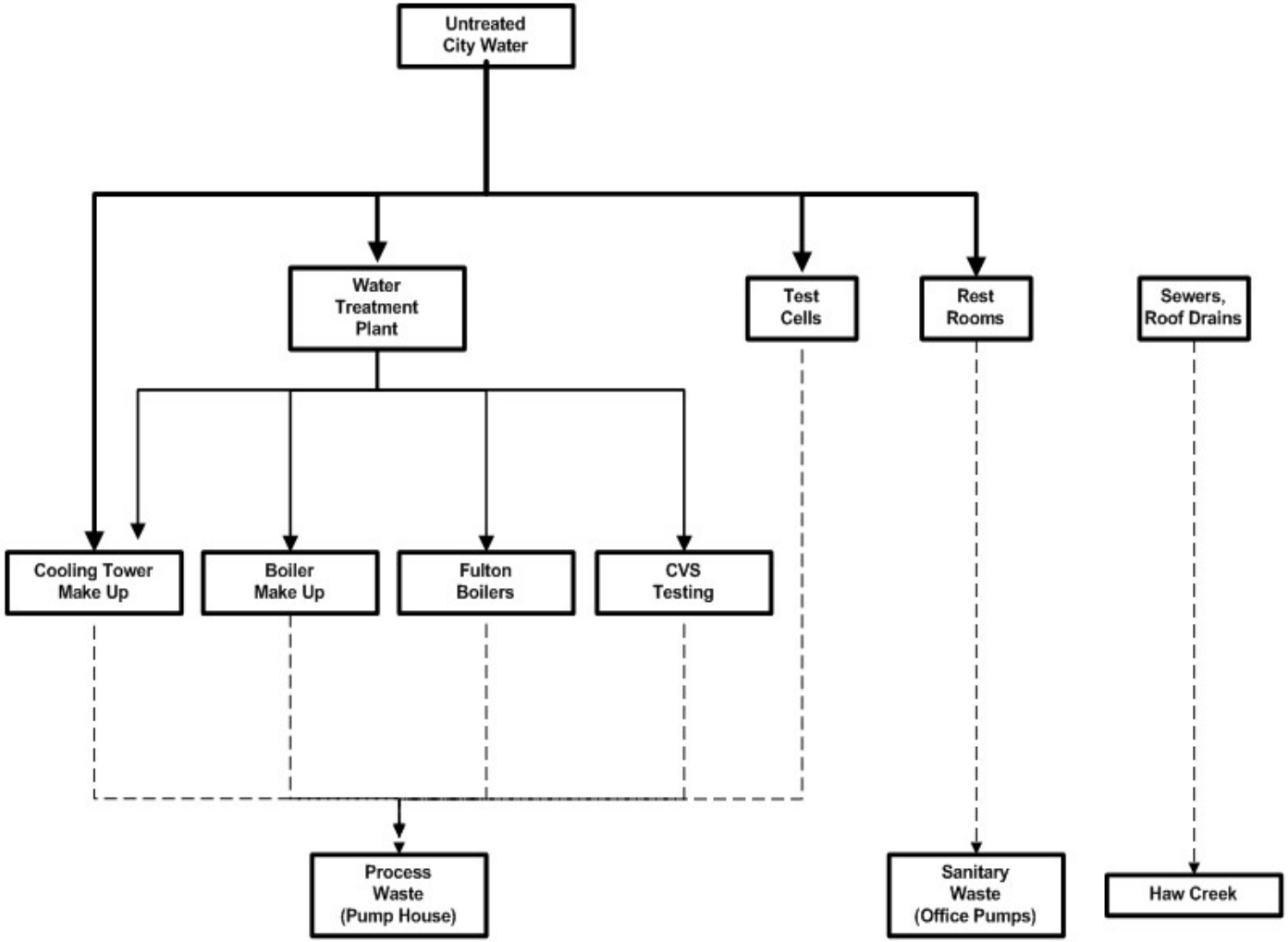
- Energy/GHG, water & waste training
- Energy, water & waste toolkits
- Best practice sharing
- Site environmental teams

- Holistic approach to environmental sustainability
- Utilize common, proven approaches and tools

Focus: Cummins Technical Center

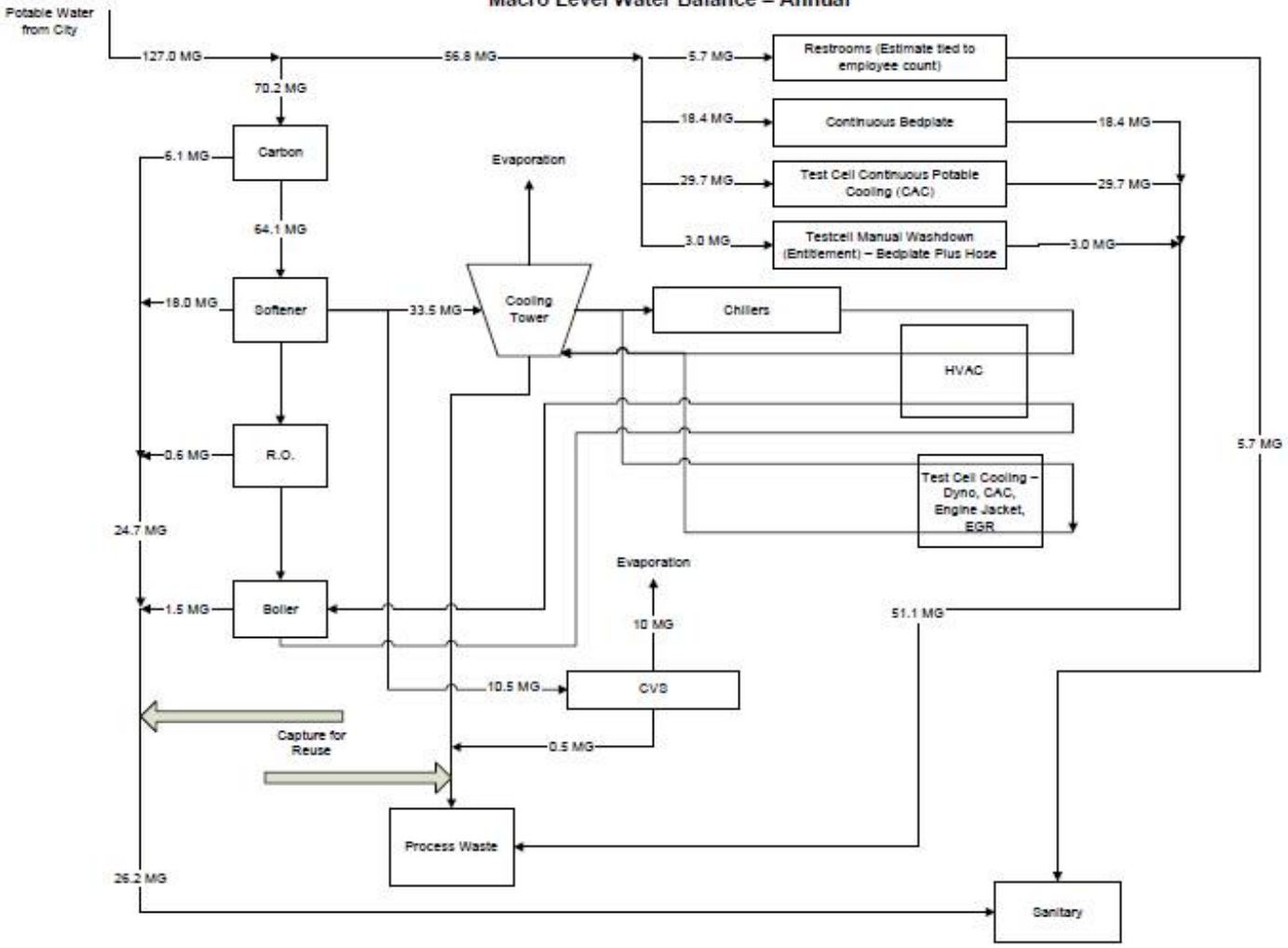
- Opened in 1967
- 88 test cells and labs
  - 500 – 3,000 HP
- 1,100 employees
- 500,000 sq. ft.
- ISO 14001, ISO 50001, Superior Energy Performance – Platinum
- 68.8 million gallons of water consumed, 2015
- 722,000 MMBtu energy consumption, 2015
  - 42% Electricity, 37% Diesel, 20% Natural Gas, 1% Other

Cummins Technical Center, Columbus, IN

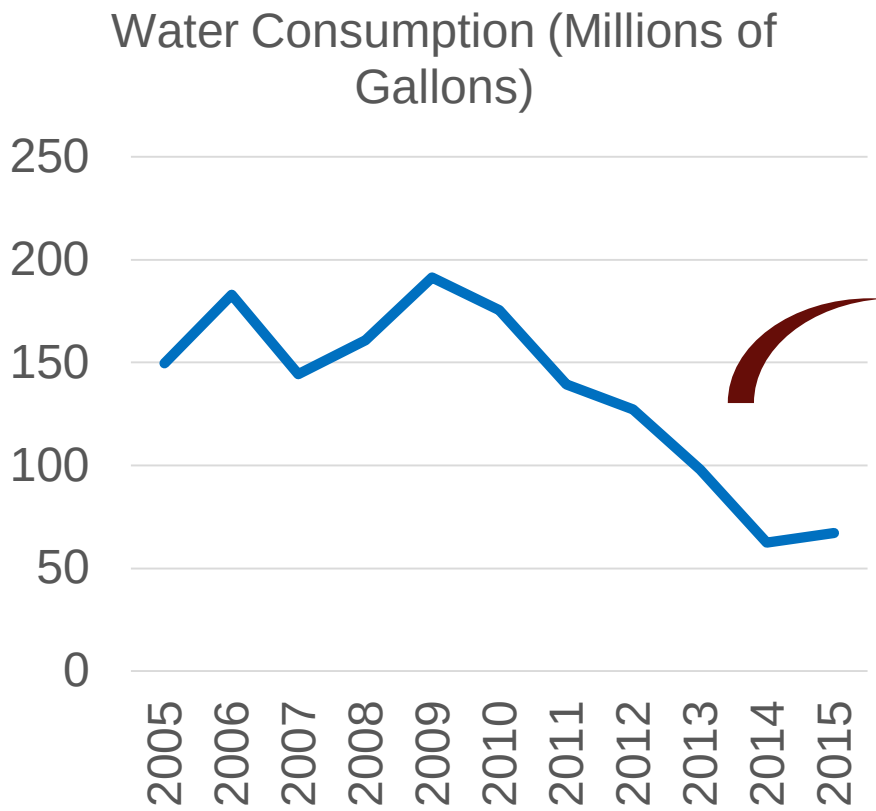


Cummins Technical Center: Water Tree

Cummins Technical Center
Macro Level Water Balance – Annual



Cummins Technical Center: Water Profile



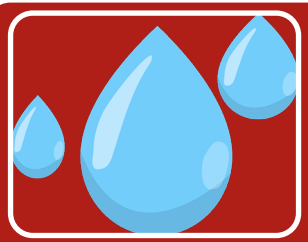
Largest Water Uses:

- Boilers – 38%
- Sanitary & Laboratories – 28%
- General process water cooling – 23%
- Bedplate washdown / test cell cleaning – 5%
- Chilled water system – 4%
- Other – 2%

Significant Efforts in Water Conservation:

- Test cell bedplate washdown
- Cooling tower water cycle improvements
  - From 2 cycles to 7
- Chemical management of process water
- Auditing and awareness

Water Management in a Research Environment



Leak Repairs and Auditing

- Maintenance team critical in fixing leaks
- Site communication on water conservation efforts led to a significant increase in employees reporting leaks
- One-pass cooling identified and addressed
- Test cell audits led to improved water valve placement, usage and control

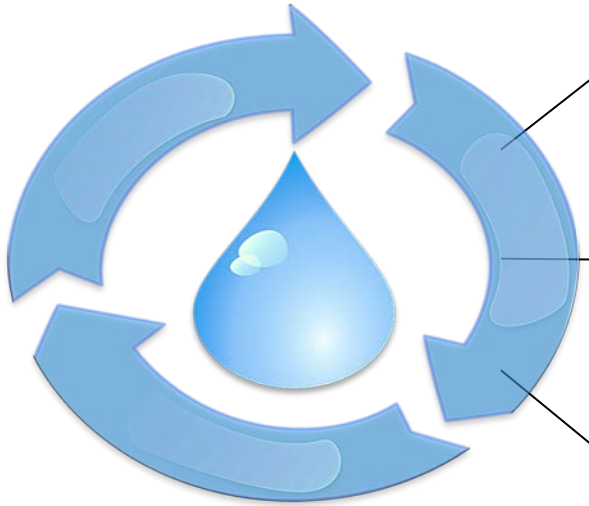
CTC Energy/Water Deputies

- Operational team focusing on ground-level improvements
- Comprised of test cell operation experts, facilities engineering, operational and environmental management
- Harness team's technical expertise to implement improvement projects
- Critical in bedplate washdown project and others
- Just-Do-It attitude

Regenerative Dynamometers

- Do not require the use of process water to cool the dyno
- Much less water required in test cells
- Increases engine testing technical capabilities

Observations



Corporate Water Audit

- Facilitated conservation momentum
- Offered a different perspective
- Technical expertise

Ground Level Involvement

- Maintenance Team - addressing small leaks adds up
- Vast knowledge of test cell water use and systems from Deputies Team
- Unique expertise from site personnel

Site Awareness

- Leaks and concerns reported and fixed
- Direct communication and awareness with site water users