Water Measure Savings Calculations and ROI

Best Practices & Case Studies

Agenda

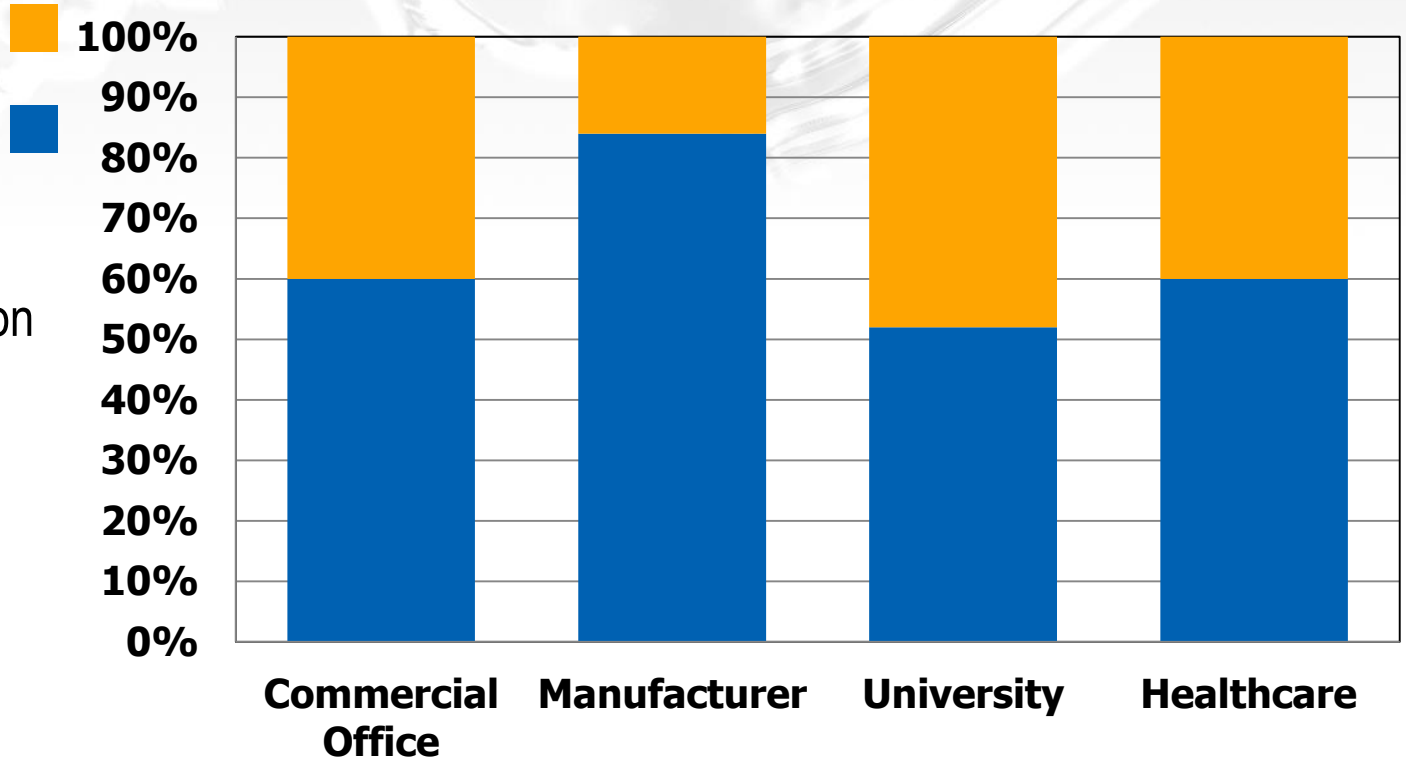
- Identifying process water saving measures
- Establishing a water balance - where does the water go?
- Validating savings using IPMVP protocols
- Savings calculations examples
- Measure payback and ROI

Look Outside of the Bathroom for Water Savings

Domestic vs. Non-Domestic Water Use by Building Type

DOMESTIC

NON-DOMESTIC
- Cooling/Heating
- Process Uses
- Landscaping/Irrigation
- Washing/Laundry
- Kitchen
- Other



H2O Applied Technologies
A Beacon Company

Comprehensive Process Water Measures

Process Water Reductions

- Irrigation Systems
- Steam Sterilizers, Vacuum & Gravity
- Vacuum Pumps/Air Compressors
- Food Service Area
- Refrigeration Equipment
- Pure Water Stills
- Analytical Equipment
- Animal Cage Washers
- Laundry
- Boiler Blow-down
- Swimming Pools
- Cooling Tower Makeup Water
- Tempering Systems

Steam

- Steam Distribution System Analysis
- Steam Trap Replacement
- Insulation of Steam Fittings
- Condensate Recovery

Reuse, Re-circulate and Replace

- Reverse Osmosis Units
- Rainwater Harvesting
- AHU Condensate reuse
- Leak Reduction

Domestic Water Reduction

- Toilets
- Sinks
- Showers

Identifying Process Measures Savings

Where Are The Savings?

- **Reduce** flow or frequency
- **Replace** with water-efficient models
- **Reuse** once-through water
- Many solutions based on:
  - Simple engineering principles
  - Existing equipment specs/plumbing code
  - Off-the-shelf retrofits

Water-cooled air compressors

Starting With A Water Balance Is Key

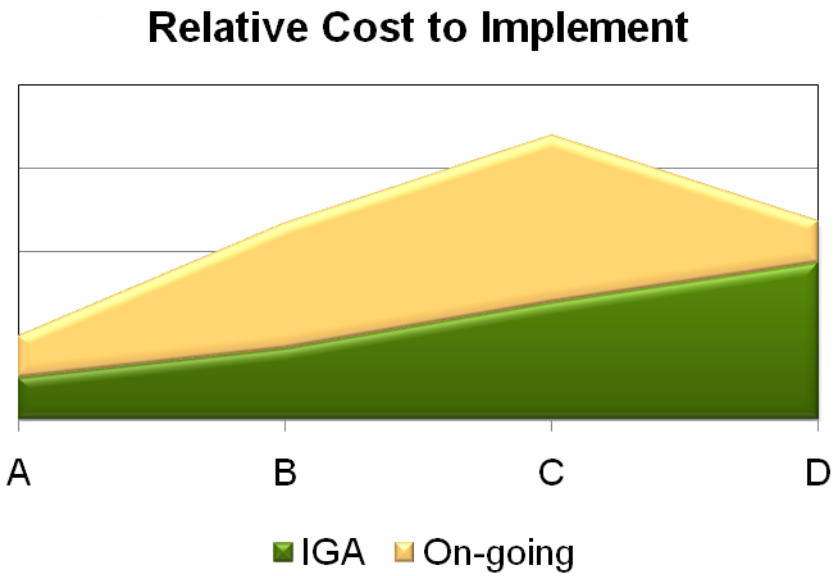
		Pre-Retrofit Conditions		Post-Retrofit Conditions		Savings	
Category	Subcategory	Amount (kgal/yr)	Percentage (%)	Amount (kgal/yr)	Percentage (%)	Amount (kgal/yr)	Percentage (%)
Domestic	Domestic	17,355	11.3%	11,849	15.0%	5,506	31.7%
Sterlizers - CTS	Condensate Tempering	16,354	10.7%	393	0.5%	15,961	97.6%
Sterlizers - VWS	Condensate Tempering	2,883	1.9%	721	0.9%	2,162	75.0%
Medical Vacuum Pumps	Process	5,657	3.7%	874	1.1%	4,783	84.6%
Medical Air Compressors	Process	3,224	2.1%	786	1.0%	2,437	75.6%
Condensate Coolers and Tempering	Condensate Tempering	41,199	26.9%	3,145	4.0%	38,054	92.4%
Chiller Cooling Tower Makeup (Main Bldgs)	Cooling	5,271	3.4%	-	0.0%	5,271	100.0%
Chiller Cooling Tower Makeup (Other)	Cooling	11,000	7.2%	11,000	13.9%	-	0.0%
HVAC (water cooled AC and ice machines)	Refrigeration	5,000	3.3%	5,000	6.3%	-	0.0%
Cafeteria and Food Service	Food Service	25,000	16.3%	25,000	31.7%	-	0.0%
Pathology, Morgue AC, Sewage Ejector	Process	5,000	3.3%	5,000	6.3%	-	0.0%
Cleaning	Process	3,000	2.0%	3,000	3.8%	-	0.0%
Unaccounted For	Unaccounted	12,092	7.9%	12,092	15.3%	-	0.0%
	Total	**153,035**	**100%**	**78,860**	**100%**	**74,175**	**48.5%**

Billing History (August through July)

Account #	Service Address	CCF	Kgal
#90001-31817-001	Address #1	35,064	26,228
#60001-31818-001	Address #2	167,654	125,405
#30001-30783-001	Address #3	1,874	1,402
	Total:	**204,592**	**153,035**

Establishing Baseline Usage - IPMVP Based Protocols

- Fundamental Formula
  - Savings = Baseline Consumption - Post Consumption ± Adjustments
- Four Options:
  - Retrofit Isolation
    - Option A – key parameters measured
    - Option B – all parameters measured, no stipulation
  - Whole Building Analysis
    - Option C – utility meters
    - Option D – calibrated simulation
- Option selection depends on:
  - Rebate Criteria
  - Financing Requirements (PACE)
  - Risk assessment
  - M&V cost tolerance



H2O's Approach to M&V

- Develop and validate standardized calculation methods
  - Use established engineering calculations whenever possible
- Focus on what matters
  - Accurate Flow Rates- Parametric
  - Usage profile (how often for how long)
- Conform to IPMVP guidelines
- Make quality control part of the process
- Be conservative
- Degree of application varies depending on each facility's reporting requirements and desired level of investment

RO Reject Reuse

- Gather
  - Boiler load profile vs. OAT and boiler efficiency
  - Condensate return rate
  - RO operating profile
- Measure
  - RO product water (average gpd)
  - RO percent reject
  - RO reject water temperature
- Calculation Method
  - Kgal saved = base (RO+BB) kgal – post (RO+BB) kgal +- adjustments
  - Adjustments: boiler load, RO product kgal, RO efficiency, blowdown penalty (higher TDS in RO reject water), condensate pump penalty

AHU Condensate Return

- Gather
  - Chiller load profile vs OAT (max/min tons, season)
  - Chiller efficiency
  - AHU capacity and OA%
- Measure
  - Tower makeup water (average gpd vs OAT)
  - Tower blow down water (average gpd vs OAT)
  - TDS tower makeup and basin water
  - AHU condensate (gal)
- Calculation Method

Program Savings (kgal/yr)	=	Metered AHU Condensate Supplied to Cooling Tower Makeup Line
Pump Electricity Use (kWh/yr)	=	kgal x 1000gal/kgal/gpm pump x HP pump x .7457 Kw/hp x 1/motor eff/60 min/hr
Cost Savings ($/yr)	=	Water savings (gal/yr) x 1,000 gals/kgal x [applicable utility rate] ($/kgal) – pump electricity use (kWh/yr) X [applicable utility rate] ($/kWh)

Steam Sterilizer Condensate Tempering System

- Gather
  - Sterilizer make/model
  - Days of operation
- Measure
  - Quench water flow rate
- Calculation Method

Baseline Water Use (gal/yr)	=	Flow Rate x Minutes per year
Post-Retrofit Water Use (gal/yr)	=	Proposed flow rate x Operating factor (%) x Minutes per year
Cost Savings ($/yr)	=	Baseline – Post-Retrofit Water Use] (kgal/yr) x [applicable utility rate] ($/kgal)

Refrigeration – Eliminate Single Pass Cooling

- Gather
  - Equipment make/model
  - Operating profile (hours/day and days/year equipment “on” time)
- Measure
  - Compressor cooling water flow rate
- Calculation Method

Baseline Water Use (gal/yr)	=	Flow Rate x Hours/Day X Days/Year
Post-Retrofit Water Use (gal/yr)	=	0 gal/year (cooling water use eliminated)
Cooling Penalty (kWh/yr)	=	Compressor Rating (Btu/hr) x 1 ton/12,000 Btu x 1.33 kW/ton x frequency of use [(hrs/day) x days/yr]
Cost Savings ($/yr)	=	Baseline – Post-Retrofit Water Use] (kgal/yr) x [applicable utility rate] ($/kgal) – cooling penalty (kWh/yr) X [applicable utility rate] ($/kWh)

Ozone Laundry System

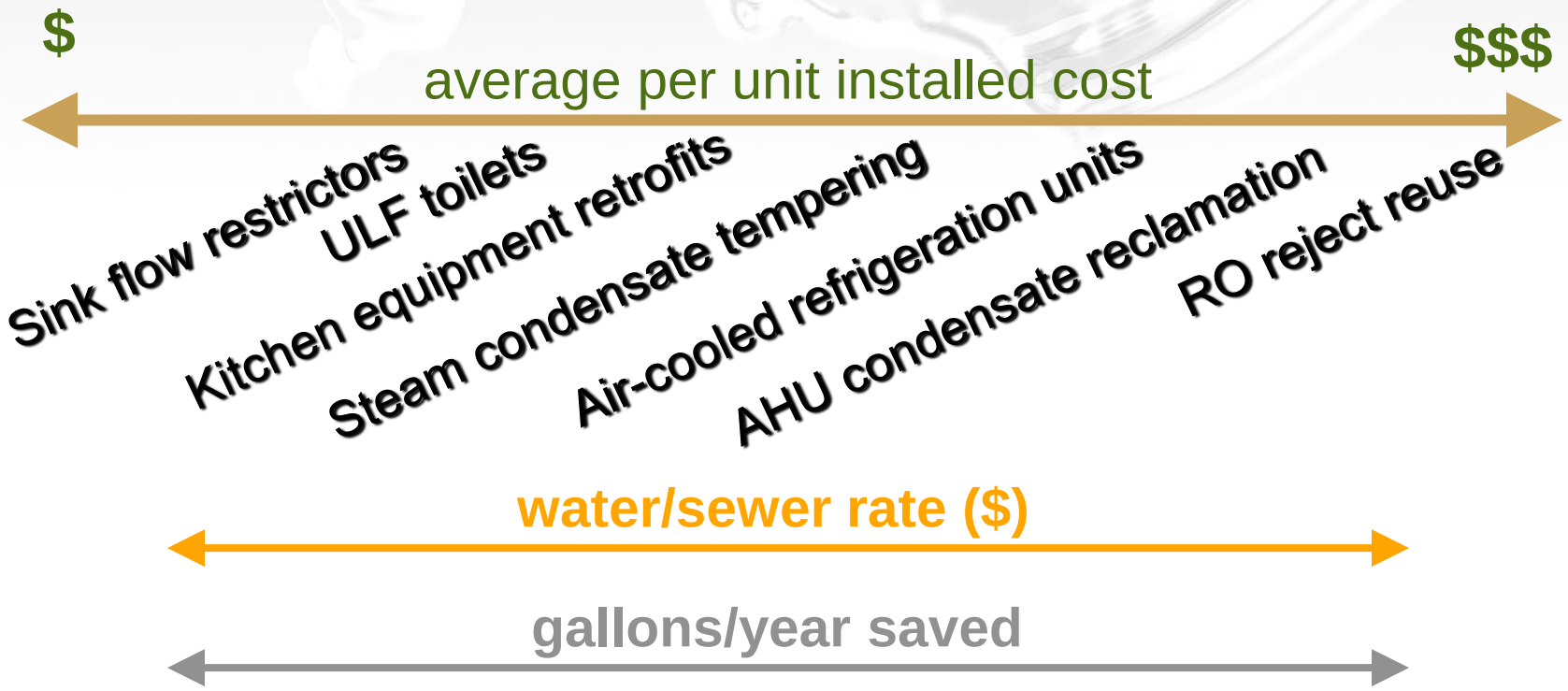
- Gather
  - Washing machine make/models and wash formulas
  - Volume of laundry processed (lbs. per year)
  - Chemical cost data
- Calculation Method

Baseline Water Usage	=	Average gal/lb x Annual lbs laundry
Estimated Water Usage	=	75% of Existing water usage
Water Savings	=	Baseline water usage - Estimated water usage
Baseline Thermal Usage	=	Avg. temp rise x % hot water x existing gal/yr x 8.34 lb/gal x 1 Btu/lb-oF x 1/water heater efficiency x 1MMBtu/ 1,000,000 Btu
Estimated Thermal Usage	=	Avg. temp rise x % hot water x existing gal/yr x estimated % x 8.34 lb/gal x 1 Btu/lb-oF x 1/water heater efficiency x 1MMBtu/ 1,000,000 Btu
Thermal Savings	=	Baseline thermal usage - Estimated thermal usage
Chemical Savings	=	Baseline chemical cost x 25%

Note: Electrical savings from reduced washer operation with fewer cycles are offset by the additional electrical consumption of the ozone generators. Accordingly, no electrical savings are reported.

Payback

- Paybacks for different types of measures vary
  - Measure-by-measure approach limits scope
  - Combine measures into single project with acceptable payback



Payback

Sample Water Conservation Project

	Savings		Installed Cost	Payback
	(gal/yr)	($/yr*)	($)	(years)
Domestic: High-Traffic Only	2,613,597	$34,290	$160,000	4.67
RO Reject as CT Makeup	1,172,198	$5,732	$70,000	12.21
CT Submetering	n/a	$15,150	$10,000	0.66
Kitchen Equipment	117,936	$1,547	$1,200	0.78
Steam Condensate Tempering	1,141,440	$14,976	$23,000	1.54
Vacuum Pump Partial Recirc.	48,812	$640	$8,500	13.27
Total	5,093,983	$72,336	$272,700	3.77

**$13.12/kgal comb w.s rate:*

- RO reject saves water charges only @ $4.89/kgal

- CT submeter saves sewer charges only @ 8.23/kgal