BUILDING A WORLD OF DIFFERENCE

1 April 2016

ENERGY EFFICIENCY PLANNING AND TREATMENT SYSTEMS OPTIMIZATION

RAFAEL FRIAS, PE
ISABEL BOTERO, PE

BLACK & VEATCH'S SUSTAINABLE WATER AND ENERGY SOLUTIONS TEAM

BLACK & VEATCH
Building a world of difference.

100 offices

$3.0B 2014 revenue

Founded 1915

6 projects on continents

AND

10,000 professionals

MARKETS

Energy Telecom Water

7,000 active projects **WORLDWIDE**

AGENDA

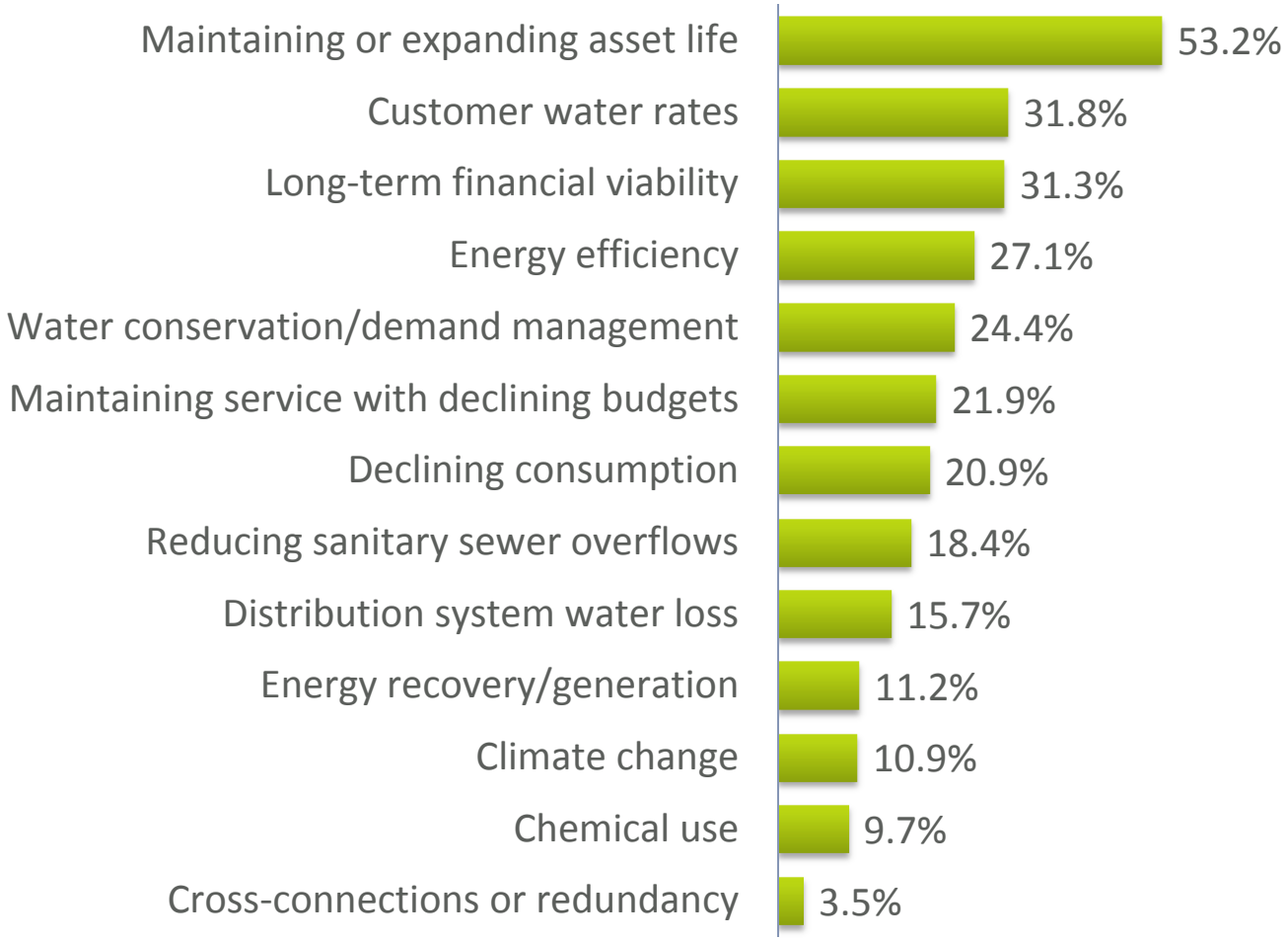
- Strategic Directions – US Water Industry
- Sustainable Energy Efficiency Master Planning
- Best Practices and Innovative Solutions
- Florida Utility Case Study
  - Results Highlights
  - Energy Usage
  - Energy Conservation Measures
- Questions

Market Leading Industry Research:

- SMART UTILITY
- U.S. WATER INDUSTRY
- U.S. ELECTRIC INDUSTRY
- U.S. NATURAL GAS INDUSTRY

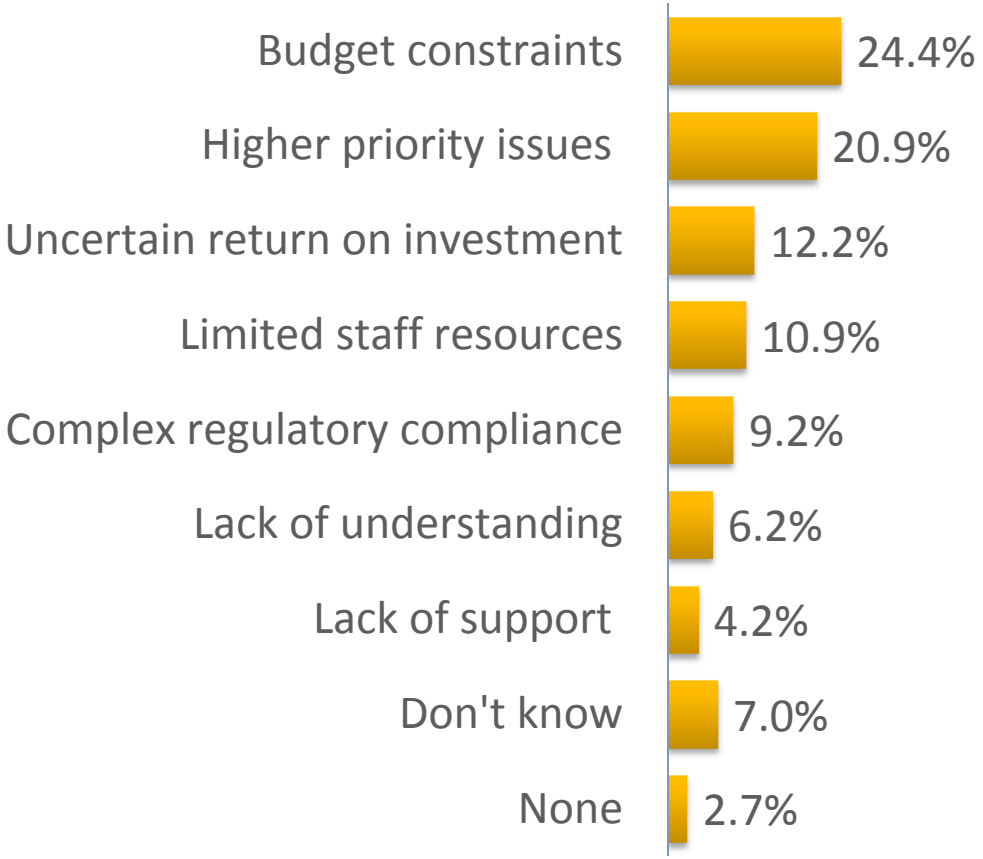
STRATEGIC DIRECTIONS REPORT | *Black & Veatch Insights Group*

MOST SIGNIFICANT SUSTAINABILITY ISSUES



Q2. Which items represent the most significant sustainability issues for your utility? (Select your top three choices) [If NON-UTILITY - Which 3 items represent the most significant sustainability issues for water utilities?]

CHALLENGES TO PURSUING SUSTAINABLE WATER AND/OR ENERGY SOLUTIONS



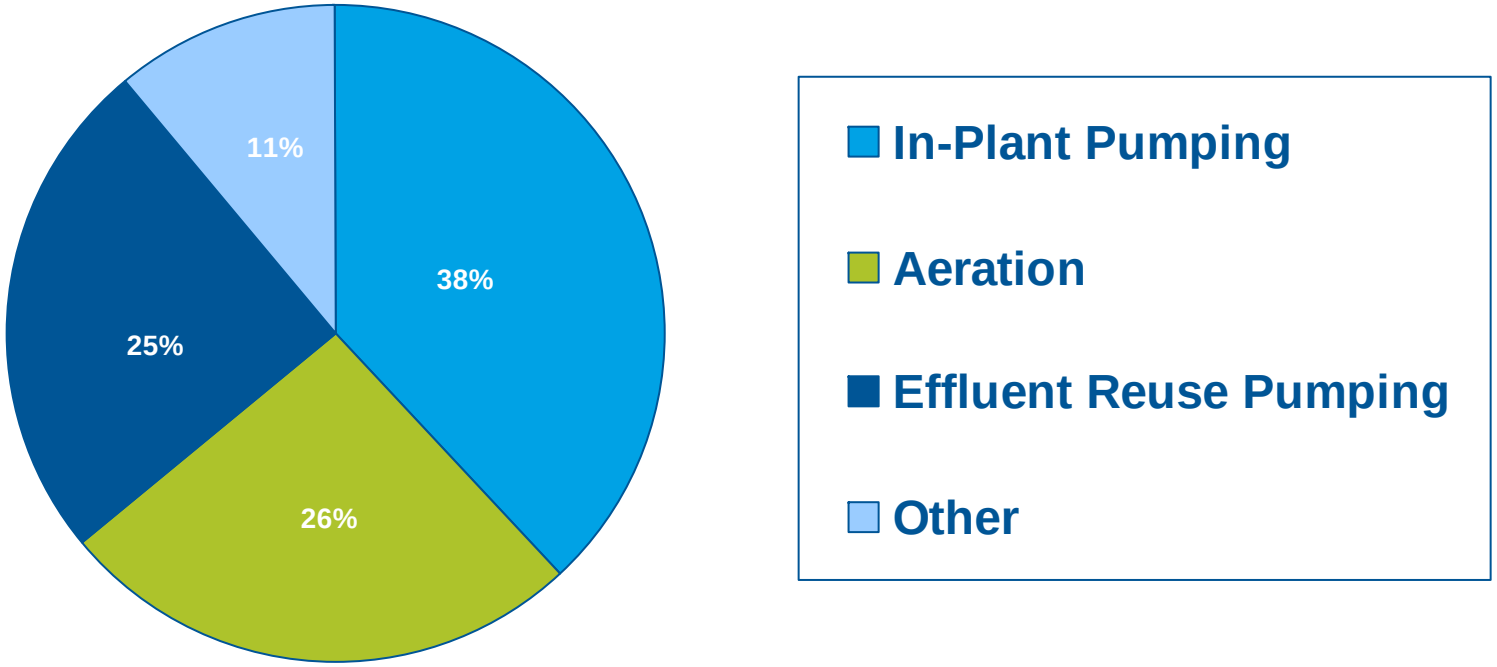
ENERGY CONSUMPTION IN THE WATER/WASTEWATER INDUSTRY

*"Nationwide, about **4 percent** of U.S. power generation is used for water supply and treatment…Electricity represents approximately **75 percent** of the cost of municipal water processing and distribution."*

Energy Demands on Water Resources - Report to Congress on the Interdependencies of Energy and Water

U.S. Department of Energy (DOE), December 2006

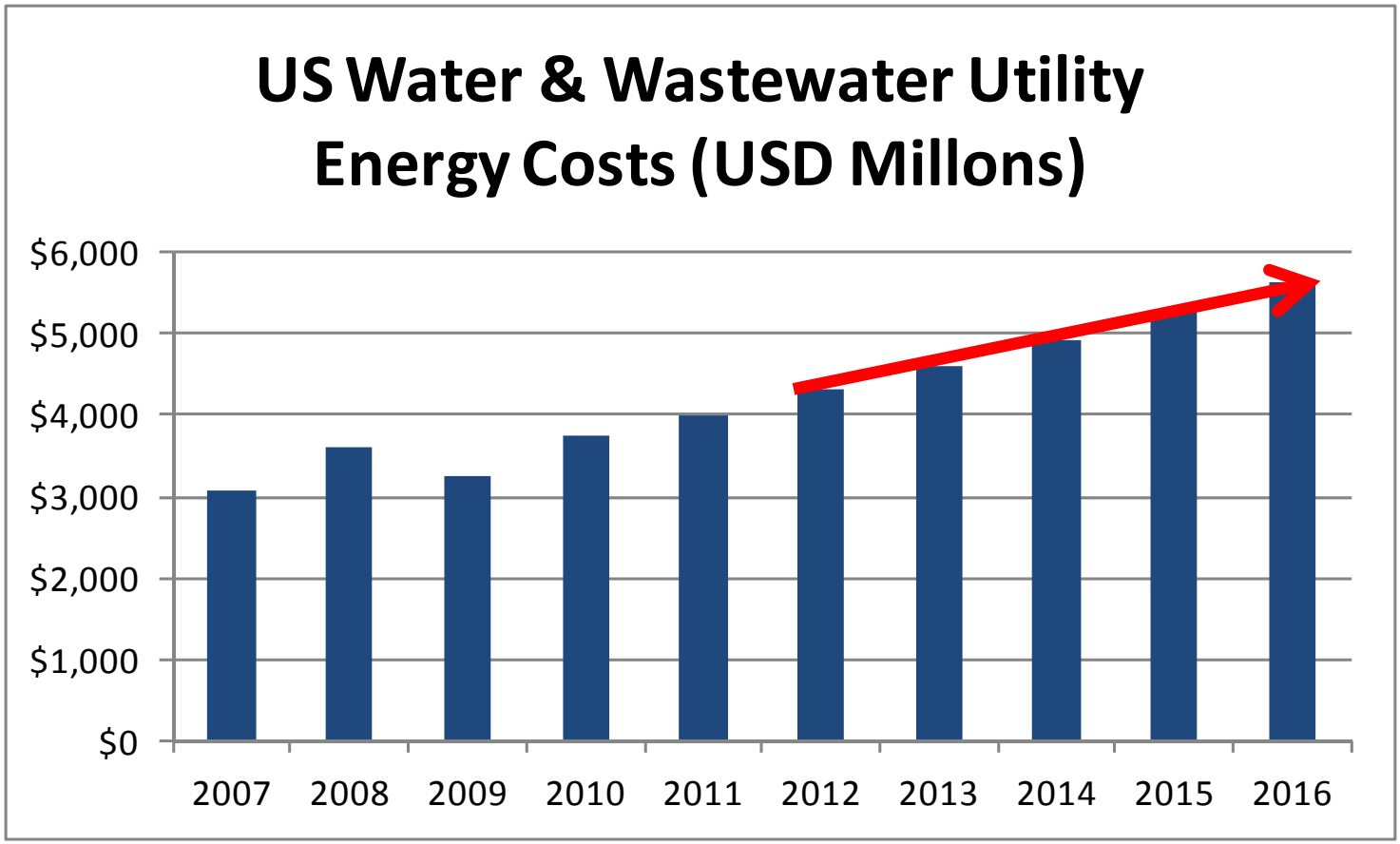
NATIONAL ASSOCIATION OF CLEAN WATER AGENCIES (NACWA) SURVEY OF ENERGY USE



89% of WWTP energy cost is Pumping or Aeration

Source: Adapted from CEE, Water-Wastewater Committee: Program Opportunities in the Municipal Sector, 2006

UTILITY ENERGY COSTS FORECAST TO INCREASE BY $1.6B IN NEXT 5 YEARS

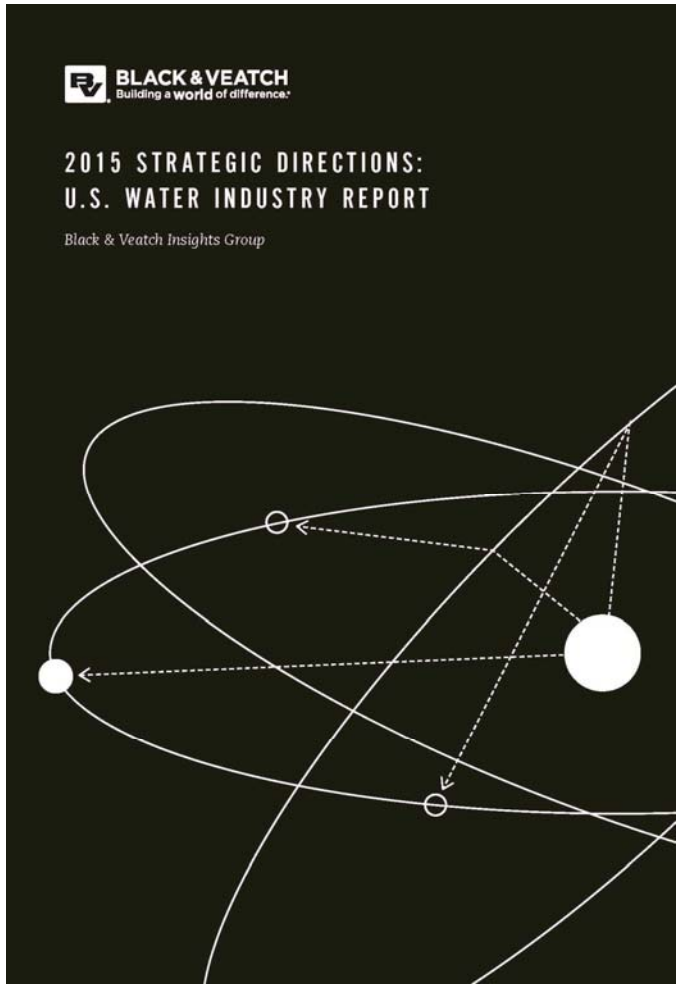


From GWI data, 2009

5.8% CAGR for Business as Usual Case

WHAT ARE UTILITIES DOING?

- When it comes to reducing operational costs, improving energy efficiency has been the low-hanging fruit
- Nearly 80% of utilities have replaced some level of inefficient equipment
- More than 70% are using SCADA and data analytics
- More than 60% have conducted energy audits



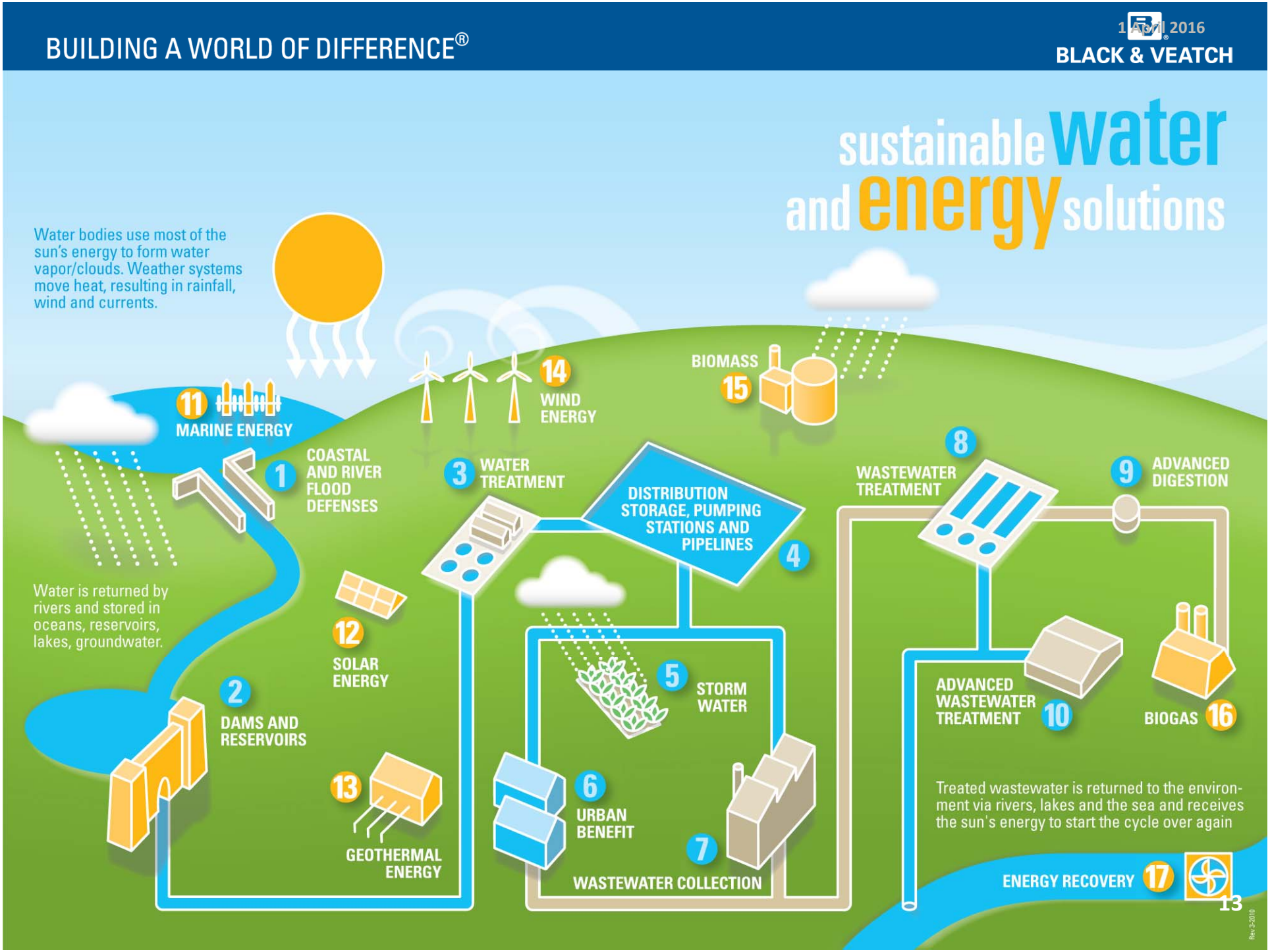
www.bv.com

SUSTAINABLE ENERGY EFFICIENCY MASTER PLANNING

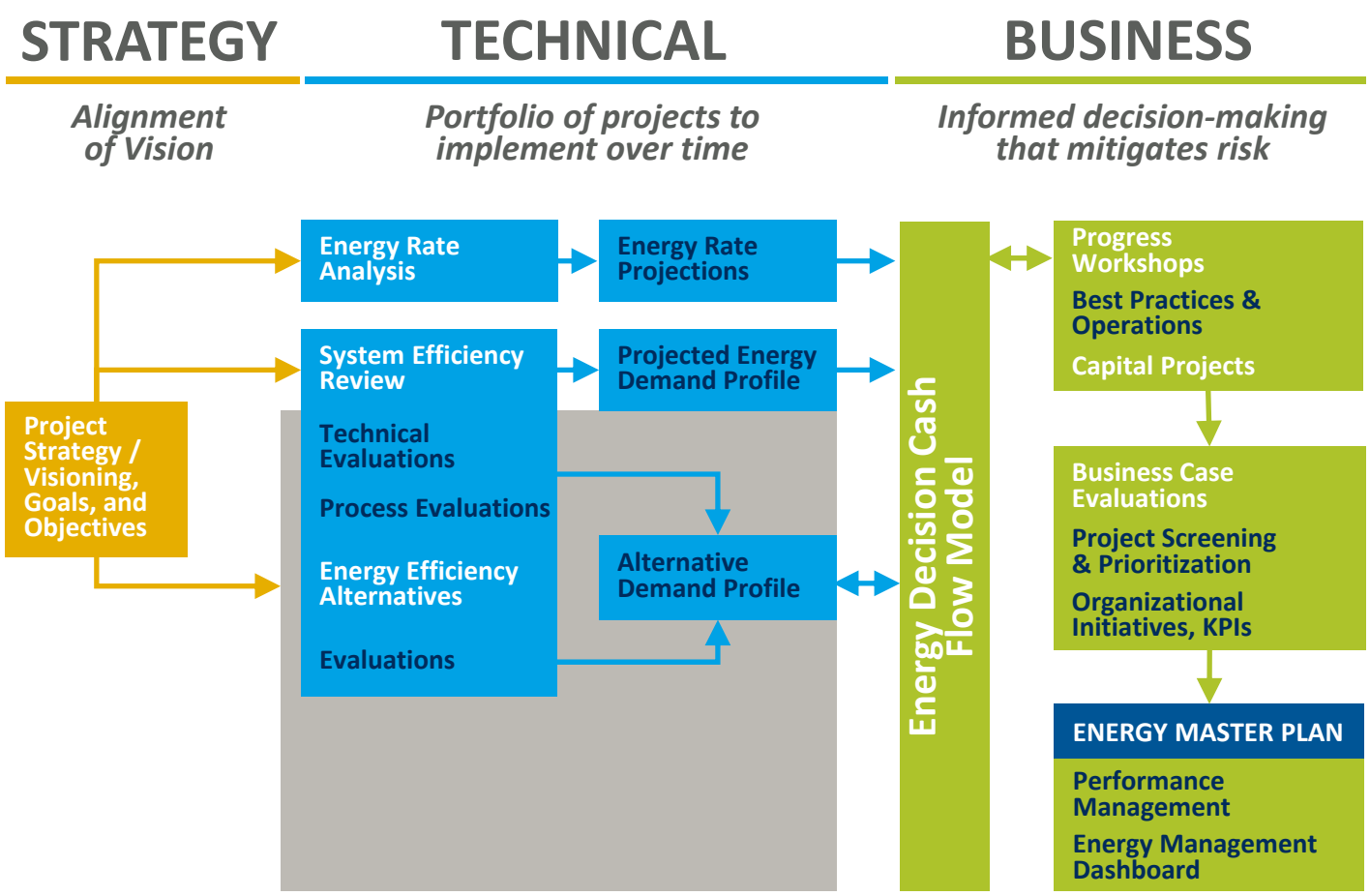
ENERGY MASTER PLANNING PHILOSOPHY

To align technical solutions and business imperatives with utility strategic objectives.

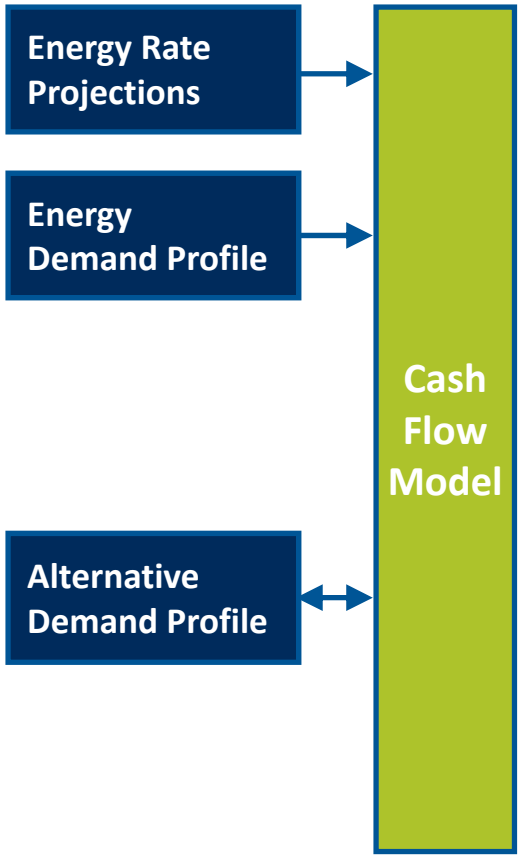
- **Vision for strategic and sustainable energy management**
- **Roadmap for strategic planning**
  - Regulatory requirements
  - Energy efficiency goals and performance indicators
  - Technologies
- **Organizational capacity**
- **Business practices**


sustainable water and energy solutions
Water bodies use most of the sun's energy to form water vapor/clouds. Weather systems move heat, resulting in rainfall, wind and currents.
11 MARINE ENERGY
1 COASTAL AND RIVER FLOOD DEFENSES
14 WIND ENERGY
BIOMASS 15
3 WATER TREATMENT
DISTRIBUTION STORAGE, PUMPING STATIONS AND PIPELINES 4
8 WASTEWATER TREATMENT
9 ADVANCED DIGESTION
Water is returned by rivers and stored in oceans, reservoirs, lakes, groundwater.
12 SOLAR ENERGY
5 STORM WATER
2 DAMS AND RESERVOIRS
ADVANCED WASTEWATER TREATMENT 10
BIOGAS 16
13 GEOTHERMAL ENERGY
6 URBAN BENEFIT
7 WASTEWATER COLLECTION
Treated wastewater is returned to the environment via rivers, lakes and the sea and receives the sun's energy to start the cycle over again
ENERGY RECOVERY 17
Rev 3-2010

HOLISTIC APPROACH DESIGNED TO MAXIMIZE PROJECT PORTFOLIO VALUE



CASH FLOW MODEL TO COMPARE NET PRESENT VALUE OF ALTERNATIVES



- **CAPEX and OPEX estimates developed for groups of projects (portfolios)**
- **Cash flow forecast for each portfolio**
  - Amortized annual CAPEX
  - Annual OPEX
- **Energy consumption and demand profiles**
  - Based on historic patterns
  - Dynamic modeling for energy conservation measures
- **TBL and economic risk analysis – Monte Carlo Simulation**

BCE provides utility stakeholders with assurance that energy program's value and risk are appropriately balanced

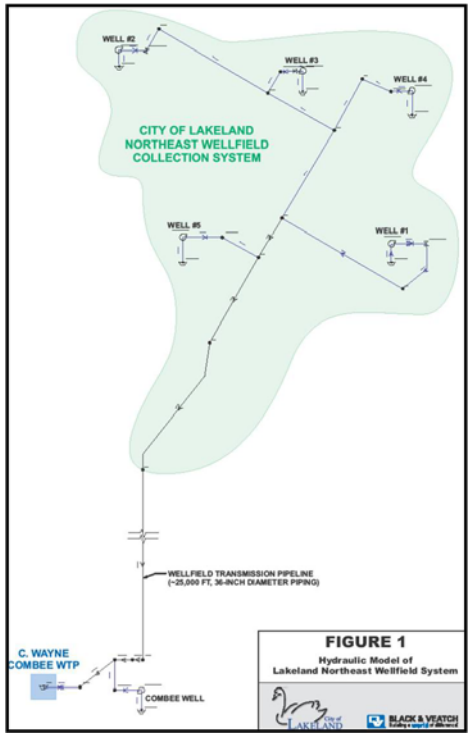
BEST PRACTICES AND INNOVATIVE SOLUTIONS

APPROACH TO ENERGY EFFICIENCY EVALUATIONS

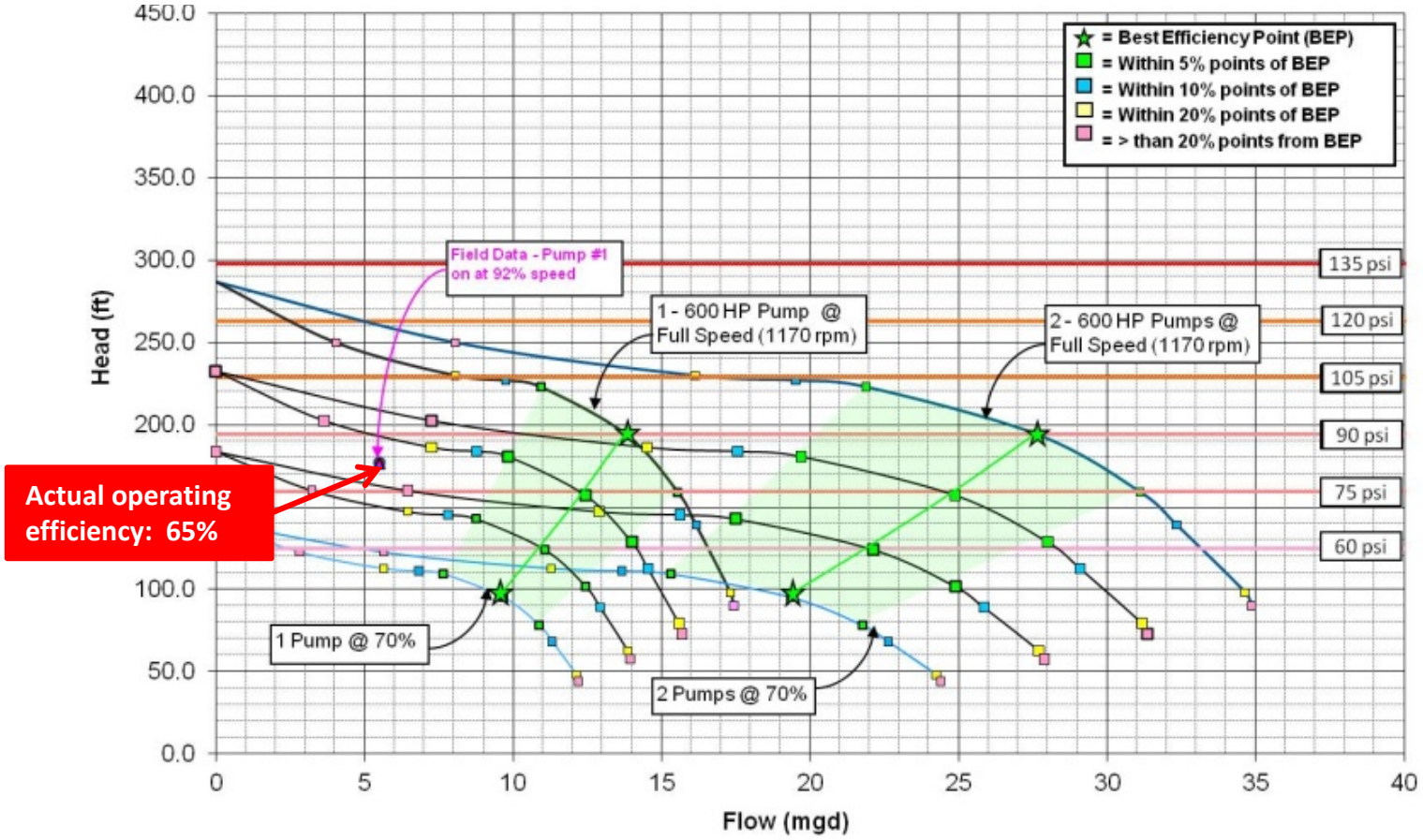
1. **Understanding energy use and power rate structures:**
   - Data collection, interviews, site visits, field testing
   - Define current energy use - Develop energy baseline
   - Evaluate power rate structure vs. energy needs
2. **Define energy optimization strategies and solutions:**
   - Reduce energy consumption
     - Equipment efficiency improvements
   - Reduce energy costs
     - Minimize “on-peak” energy use and “peak demands”
   - Renewable energy generation

WELLFIELD OPTIMIZATION

- **Improve well pump efficiencies and minimize valve throttling**
- **Optimize wellfield operations**
  - Consider how time-of-use and water quality impacts the energy cost at the WTP
- **Case Study – Lakeland Northeast Wellfield**
  - Evaluation of alternatives
  - Solution – Low Cost Pump retrofit
  - 30% energy savings
  - One year payback on capital cost

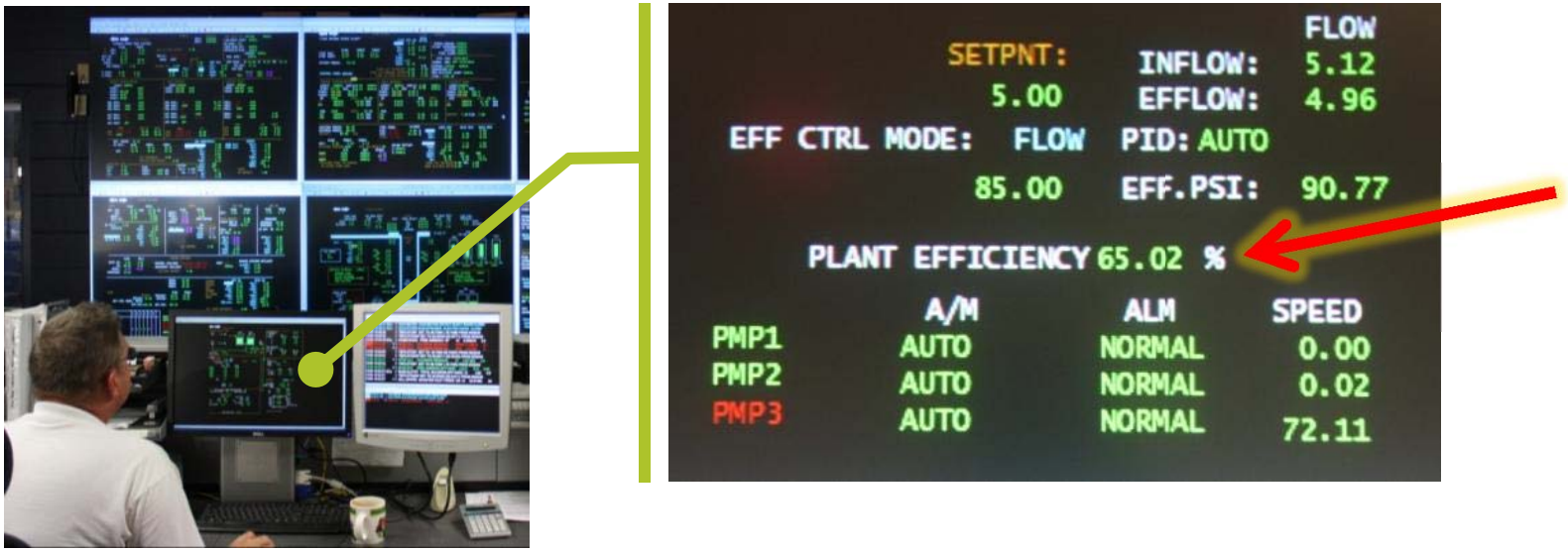


PUMP STATION EFFICIENCY EVALUATIONS

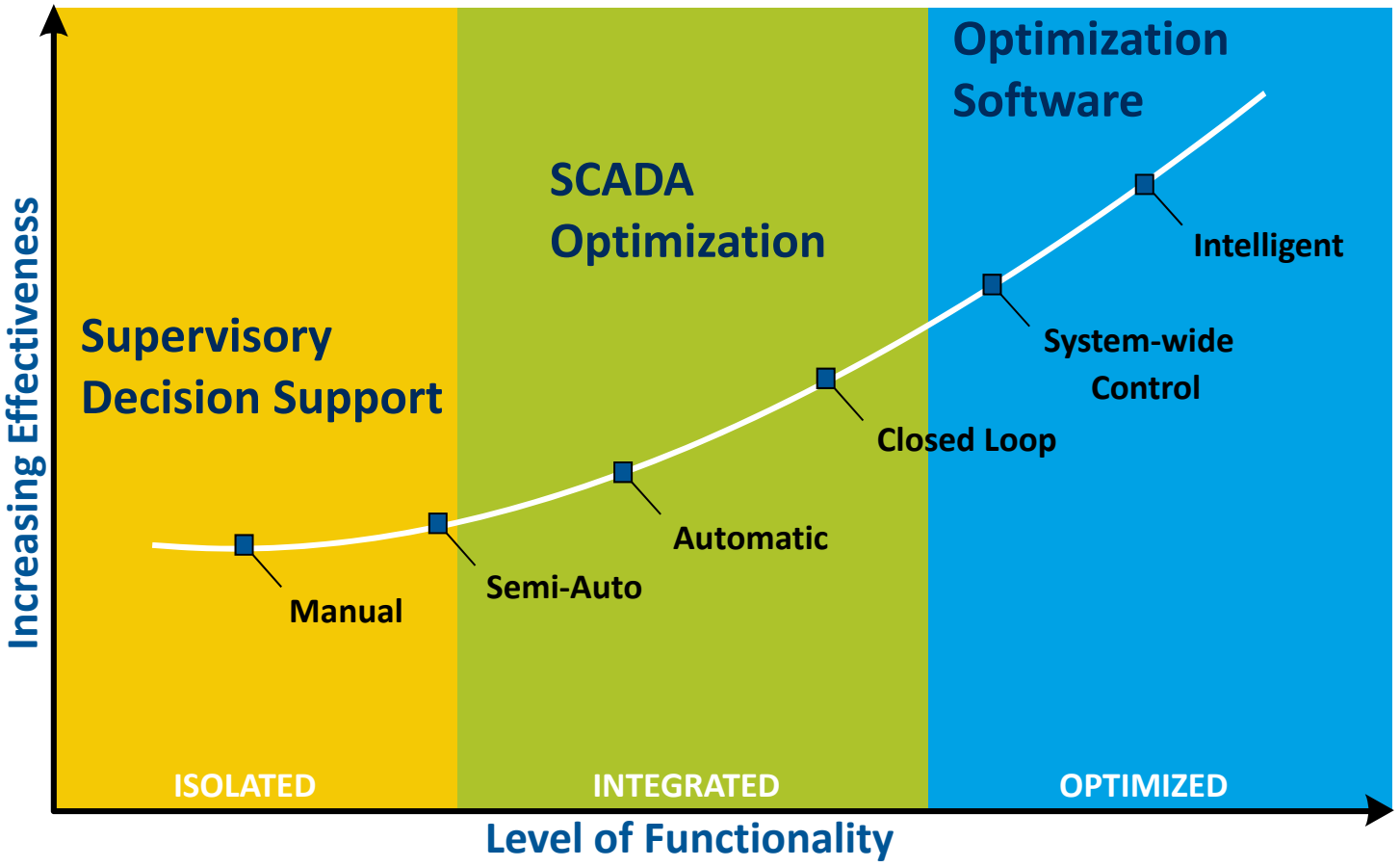


PUMP STATION EFFICIENCY CALCULATOR TOOL

- Real time, wire-to-water efficiency calculation



FINDING THE BEST AUTOMATION SOLUTION FOR YOUR SYSTEM



Empower operators to achieve optimization goals.

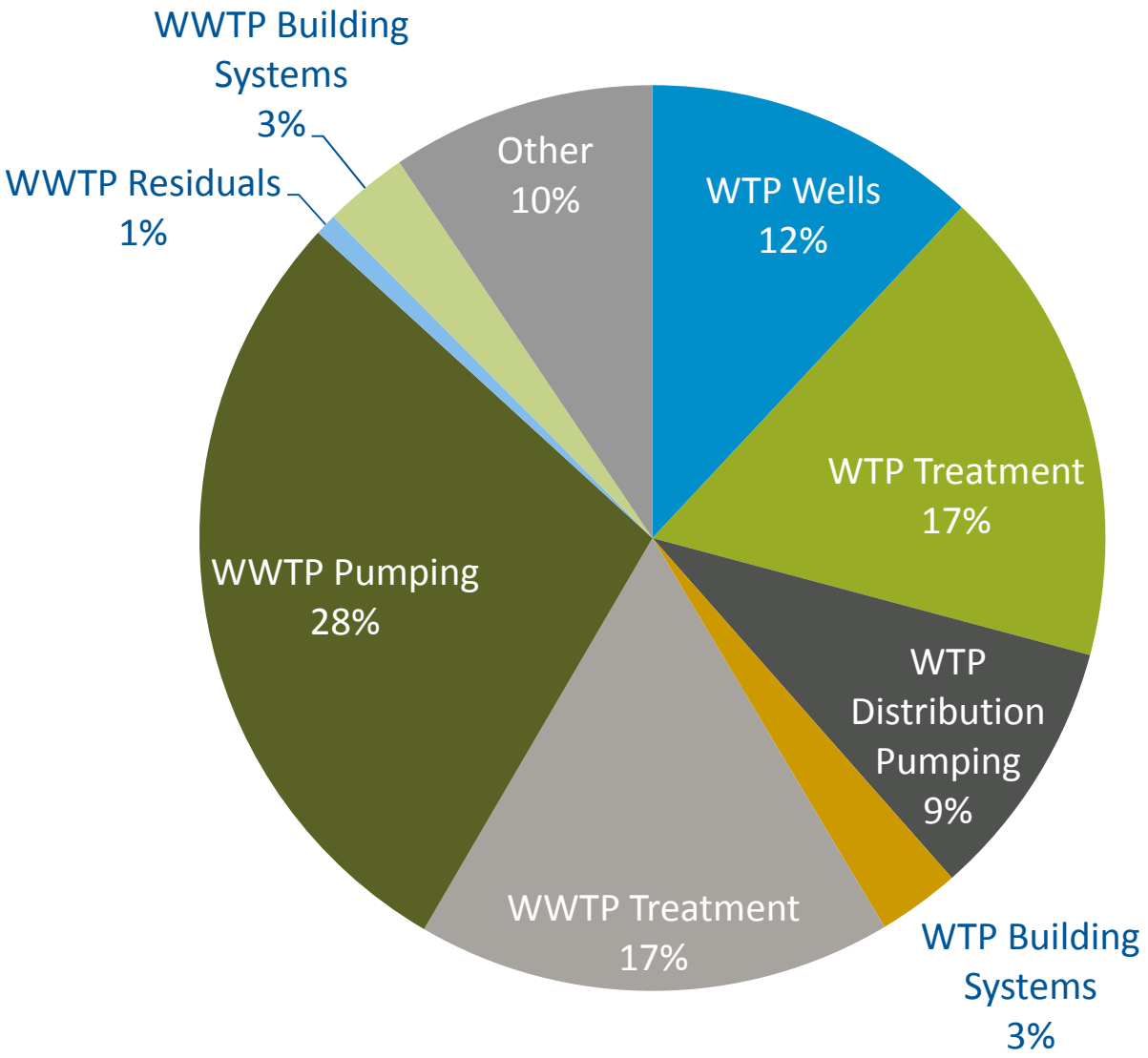
FLORIDA UTILITY CASE STUDY

ENERGY EFFICIENCY MASTER PLAN HIGHLIGHTS

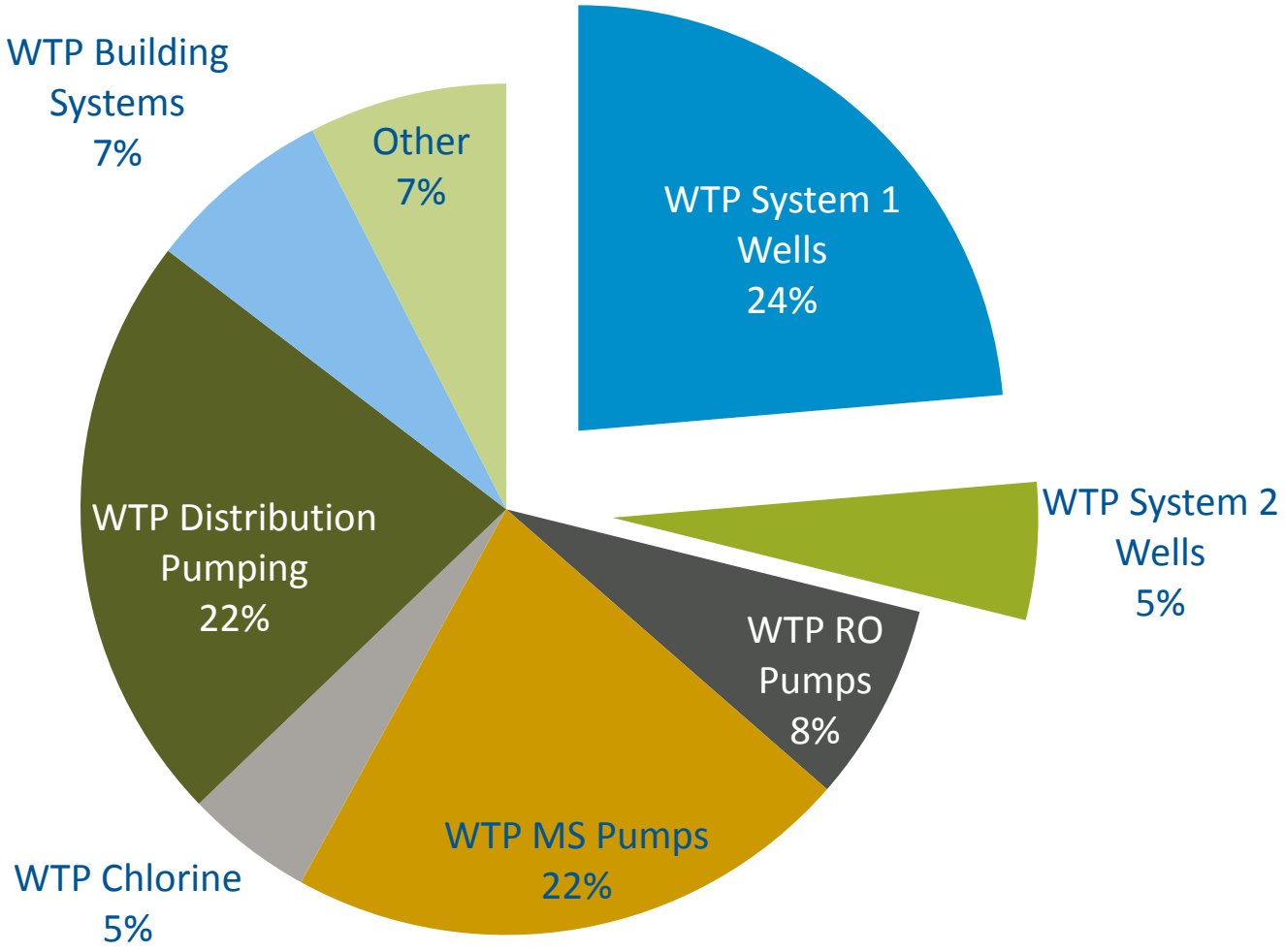
FLORIDA UTILITY

- 18 Energy Conservation Measures (ECMs) recommended (>60 total evaluated)
- Annual O&M savings = $250 k
  - 7% in annual savings
- Annual energy cost savings= $500 k
  - 14% in annual energy savings
- Estimated capital cost = $10 m
- 8 yr. NPV of $3.5 m

UTILITY ENERGY USAGE BREAKDOWN



WATER SUPPLY, TREATMENT AND DISTRIBUTION



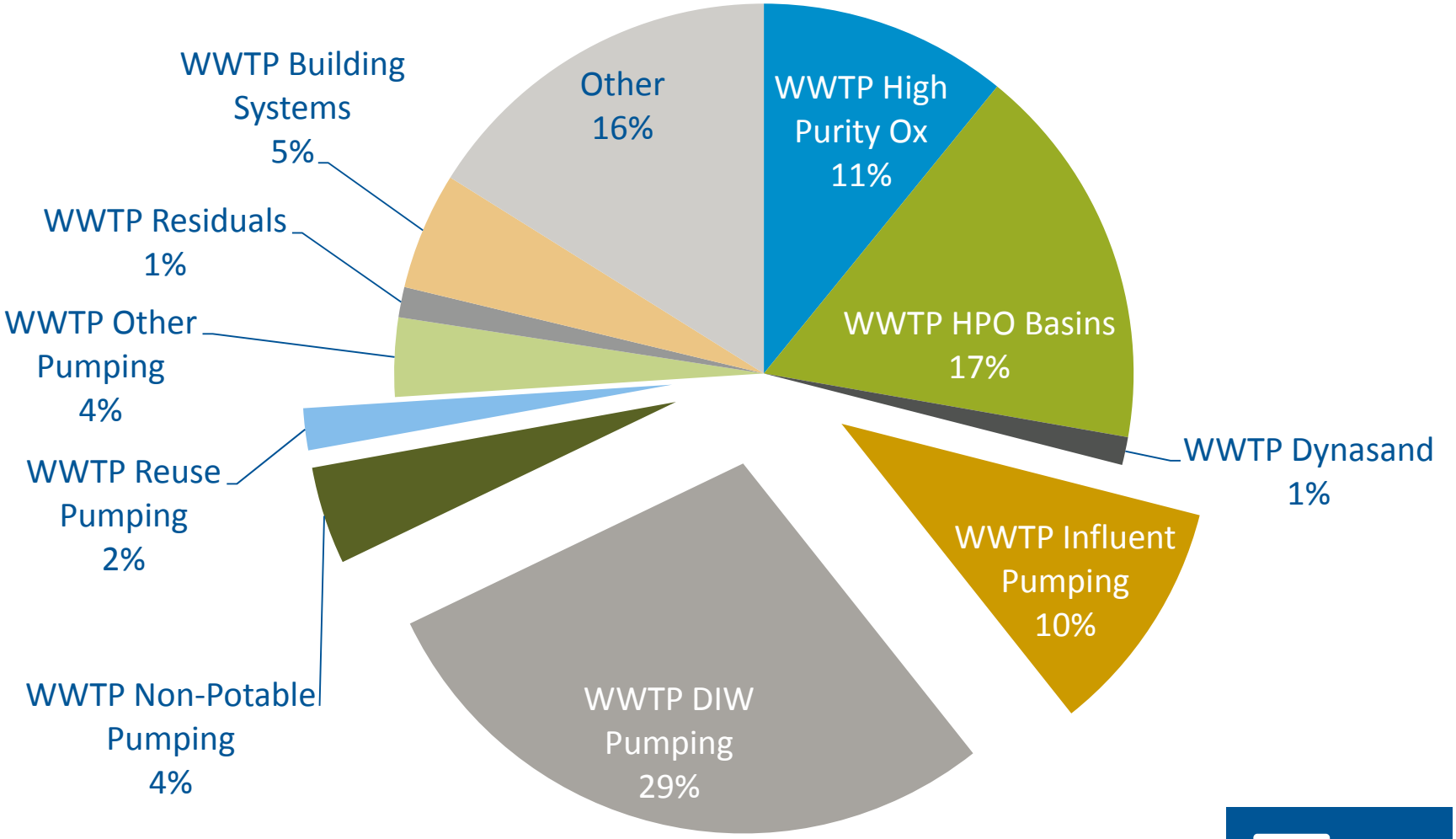
WATER SUPPLY, TREATMENT AND DISTRIBUTION

No.	ECM Description	Energy Reduction After ECM (KWh)/yr	Overall Percent Reduction (%)	Highlights
1	Operate Well System No. 1 pumps at BEP	201,500	0.40	Power cost higher at the wells. Operate at higher flow, more efficient.
2	Operate Well System No. 2 pumps at BEP & add variable frequency drives to membrane feed pumps	1,095,000	2.20	Power cost higher at the wells. Operate at higher flow, more efficient.
3	Modify membrane system feed pumps to operate near BEP	61,300	0.12	Bearings, rings, seals, add 4th stage, add VFDs
4	WTP Solar PV – Roof mounted	82,700	0.17	FPL incentives
5	High Service Pump Station rehabilitation	549,312	1.10	Replace/refurbish existing pumps, add VFDs, automation

WATER SUPPLY, TREATMENT AND DISTRIBUTION

No.	ECM Description	Energy Reduction After ECM (KWh)/yr	Overall Percent Reduction (%)	Highlights
6	Building Systems / Lighting ECMs	226,600	0.45	Thermostats, infiltration, insulation, occupancy sensors
7	***bv*ECO®** for WTP – Operations optimization • Membranes, On-site Hypo generation, filter back-wash operations – off-peak hours • High service pumps operations – use storage	900,000	1.80	Off-peak energy use, filling storage tanks
8	RO membrane element type replacement	129,400	0.26	More permeable membrane – water blend

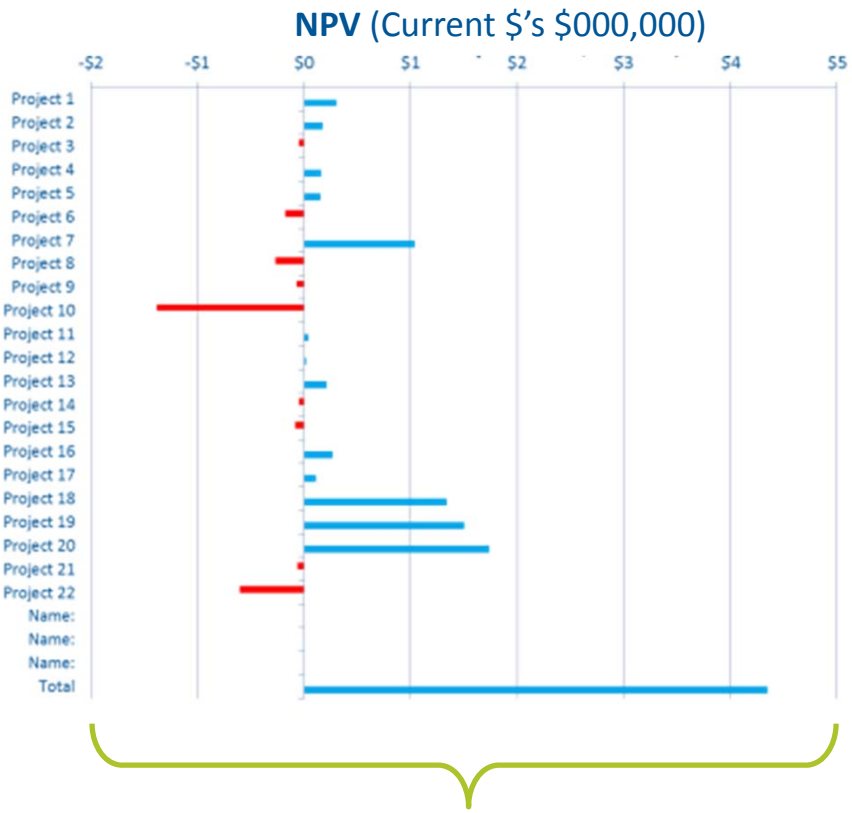
WASTEWATER TREATMENT AND RECLAIMED WATER DISTRIBUTION



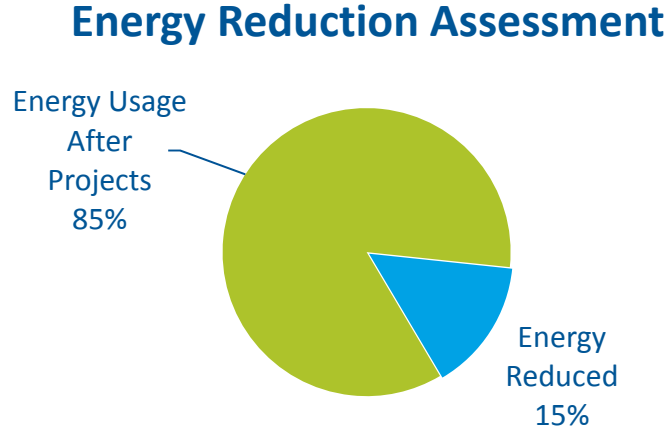
WASTEWATER TREATMENT AND RECLAIMED WATER DISTRIBUTION

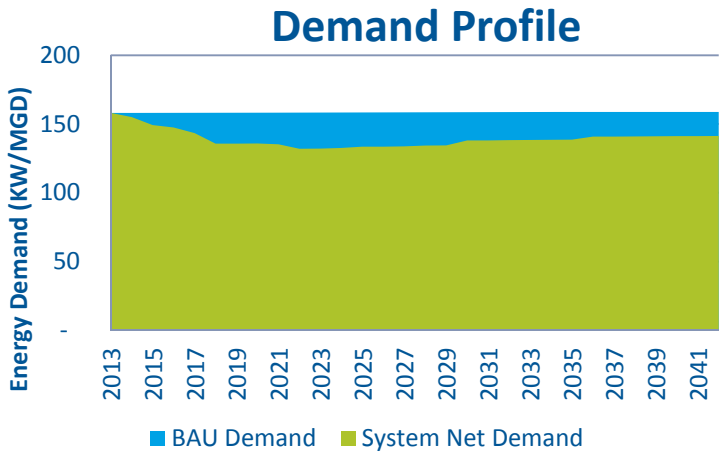
No.	ECM Description	Energy Reduction After ECM (KWh)/yr	Overall Percent Reduction (%)	Highlights
1	Upgrade mixers with DO control	1,997,300	4.00	New mixers, VFDs, DO probes
2	Add VFDs / replacement of reuse pumps	744,700	1.49	VFDs, new pumps
3	***bv*ECO®** for WWTP – Operations optimization • Efficiency monitoring for pump stations • Optimization of chemical dosing (polymer)	113,900	0.23	Best pump combination, optimal polymer use
4	Replace continuous filter backwash system	60,532	0.12	EcoWash – reject to 1.5% from 4%
5	Deep injection well acidization cleaning and VFD	1,146,810	2.30	Reduce pressure requirements
6	Building Systems / Lighting ECMs	429,411	0.86	Thermostats, infiltration, insulation, occupancy sensors

RESULTS-DRIVEN DECISION MAKING



Each ECM's NPV of cash flows compared to analyze long-term decisions





ENERGY EFFICIENCY MASTER PLAN HIGHLIGHTS

FLORIDA UTILITY

- 18 Energy Conservation Measures (ECMs) recommended (>60 total evaluated)
- Annual O&M savings = $250 k
  - 7% in annual savings
- Annual energy cost savings= $500 k
  - 14% in annual energy savings
- Estimated capital cost = $10 m
- 8 yr. NPV of $3.5 m

BLACK & VEATCH'S SUSTAINABLE WATER AND ENERGY SOLUTIONS TEAM:

Rafael E. Frias III, PE

Client Director

FriasRE@bv.com

(954) 465-6872

Isabel C. Botero, PE

Project Manager

BoteroI@bv.com

(954) 319-9861

Does your utility needs an Energy Efficiency Master Plan?

Building a world of difference.®

Together

BLACK & VEATCH

www.bv.com