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Moving Toward Water Use Metrics

(and Benchmarks)

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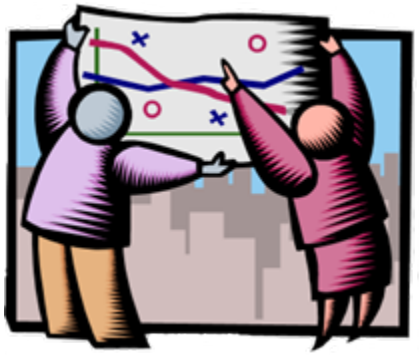
Overview

- Why embrace metrics and benchmarks?
- Background - What we already know
- Learning from the energy industry
- Proposin' water metrics for different applications
  - Residential Indoor
  - Commercial Indoor
  - Irrigation



Defining metrics and benchmarks

Metric: A standard of measurement.
e.g. gallons of water consumed

Benchmark: Any standard or reference by which others can be measured or judged.
e.g. distribution of water use for similar customers, which can result in agreed-upon "efficient" gallons of water consumed

Schools – water use comparisons by facility within a school district (8 gallons/sq.ft./year)
Hospitality – water use per room across a hotel's portfolio (15 gal/occupied room/day)

The terms are often used interchangeably

Why metrics and benchmarks are necessary

Hablar el mismo idioma

(speak the same language)

- *To foster an understanding of norms, standards and opportunities*
- *"Can't manage what you don't measure" - set goals and track progress*

- Different groups need a standard tool to measure and compare use
  - Everyone
    - Further conservation and efficiency goals
  - Utilities & states
    - Forecast future demand, revenue and capital/infrastructure needs
    - Analyze consumption patterns
  - Business
    - Optimize conservation expenditures
    - Identify opportunities or maintenance issues
  - Stakeholders (NGOs, government, etc.)
    - Set statewide or national reduction goals in a meaningful and measurable way
      - (e.g. energy's 2030 Challenge: 50% fossil fuel reduction goal)
    - Develop educational and certification programs and initiatives

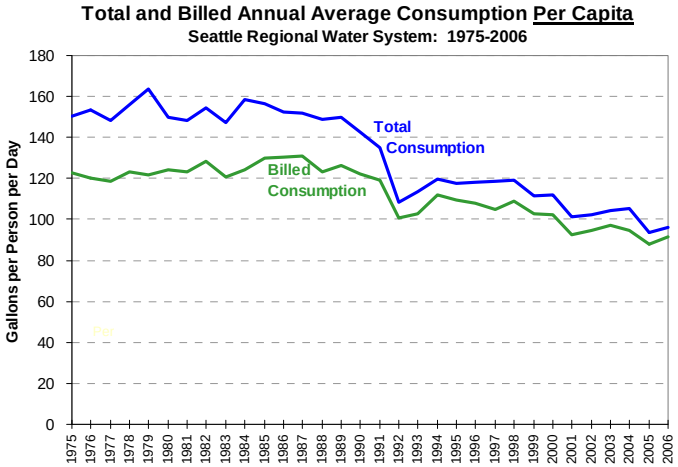
What we know about water metrics

- Residential
  - Single family indoor residential
    - Good data exist to promote benchmarks AWWARF/Aquacraft end use studies and other
    - Outdoor is a different story
  - Multifamily residential indoor
    - Similar use to single family
      - Slightly higher use than SF Valenquela/Babcock, Wood et al, 2002
      - Submetering results in lower use

- Commercial and institutional
  - Many studies have looked at local/regional water use
    - Inconsistent calculation methodology
      - U.S.GBC LEED – based on theoretical code/population assumptions
    - Wide variability
      - Need to know assumptions feeding measurements
      - Building uses and equipment have a significant impact
        - High variability shouldn't be a barrier to establishing benchmarks and goals

- Irrigation
  - Weather-based control reduces use

Common water metrics & benchmarks



- Laws/regulation/labeling programs
  - 1.6 gal/flush toilets, etc. (not a focus of today's talk)
    - WaterSense (1.28 gpf toilets)
- Percentage of system losses (utilities)
  - Billed consumption/Total production
- Gallons per capita per day (gpcd)
  - Used by utilities and organizations to evaluate consumption
  - Calculations are not yet standardized
- Gallons per square foot
  - Appears applicable in some sectors
- Irrigation
  - Various calculation methodologies
    - Water budgets
      - Should be based on evapotranspiration (ET)

Problems with current metrics and benchmarks

- Gallons per capita per day (gpcd) from a state perspective

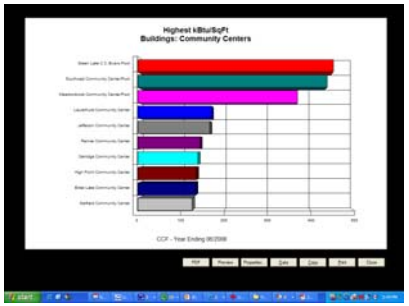
  Wide range of calculation methodology and rationale

  - Kansas: raw diverted + water purchased-(industrial, stock and bulk water)/total population
  - Arizona: all water pumped/total population (population = (SF+MF) x population per unit average from US census
  - Texas: water diverted/population (prior to 2004, industrial demand not included in equation)
  - Florida: projected per capita daily use = (res + bus+ insti+ind+misc meter+unaccounted for) – treatment losses)/permanent or seasonally adjusted population
  - Proposed for New Mexico: track by category is to track single family, multifamily, ICI, other, and non-revenue: use person per household, # of connections, and vacancy rates from census bureau

Vogel and Longworth, 2008

Learning from the energy industry

- Energy Use Index (EUI)
  - KBTU/sq. ft./yr
    - Energy use generally correlates with building square footage
    - Often corrected by for weather (KBTU/sq. ft./degree day)
      - Depends on who you ask
        - HDD = average daily temperature below 65 degrees
        - CDD = average daily temperature above 65 degrees



CBECS targets.pdf - Adobe Reader

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all source and site EUI values displayed below are annual figures.

TABLE 1 2003 CBECS[1] National Average Source Energy Use and Performance Comparisons by Building Type

Building Use Description[2]	Average Source EUI[3] (Kbtu/Sqft)	Average Percent Electric	Average Site EUI (Kbtu/SqFt)
Education	170	63%	76
K-12 School	*See Target Finder / Portfolio Manager*		
College/University (Campus-level)	280	63%	120
Food Sales	681	86%	225
Grocery Store/Food Market	*See Target Finder / Portfolio Manager*		
Convenience store (with or without Gas Station)	753	90%	241
Food Service	786	59%	351
Restaurant/Cafeteria	612	53%	302
Fast Food	1306	64%	534
Health Care: Inpatient (Specialty Hospitals, Excluding Children's)	468	47%	227
Hospital (Acute Care, Children's)	*See Target Finder / Portfolio Manager*		
Health Care: Long Term Care (Nursing Home, Assisted Living)	255	54%	124
Health Care: Outpatient	183	72%	73
Clinic/Other Outpatient Health	219	76%	84
Medical Office	*See Target Finder / Portfolio Manager*		

bldgs

Energy vs. water (indoor use)

- Energy use
  - Driven by systems to maintain a comfortable environment *(square footage and operating hours)*
    - Mechanical systems, Lighting
- Water use
  - Driven largely by users and user demand *(people and time spent in a facility)*
    - Restrooms, kitchen, laundry
    - Problem: Human uses are similar but counting people and days can be troublesome
  - BUT, use tracks with space if sq ft per user is consistent

Potential steps for the water industry

- Develop relevant metrics based on end use
  - Housing: People are more important than square footage
  - Commercial: Square footage may be appropriate
  - Irrigation: Consider weather, area and landscape type
- Agree upon standardized metrics
  - Residential
    - Gallons per capita per day
  - Commercial
    - Set assumptions and methods for addressing each sector
    - Address odd uses
- Establish a clearinghouse for information
- Encourage end users (and possibly utilities) to populate databases
  - Poor or inaccurate utility records may confound data from utilities

Who would best handle a national effort?

- EPA?
- Alliance for Water Efficiency?
- U.S. Green Building Council – LEED?
- ??

Some proposed metrics…(or at least furthering the discussion)

Energy Star Buildings: Enter information from each water meter, and view changes in use over time. The system will display Indoor Use per square foot to help you benchmark your water use over time. Soon EPA will add the ability to benchmark water use in other ways, such as Indoor Use per occupant or student, and ultimately plans to develop a rating system for water efficiency similar to the national energy performance rating system.

Proposed Water Use Index (WUI)

WUI proposed as a term to track consumption

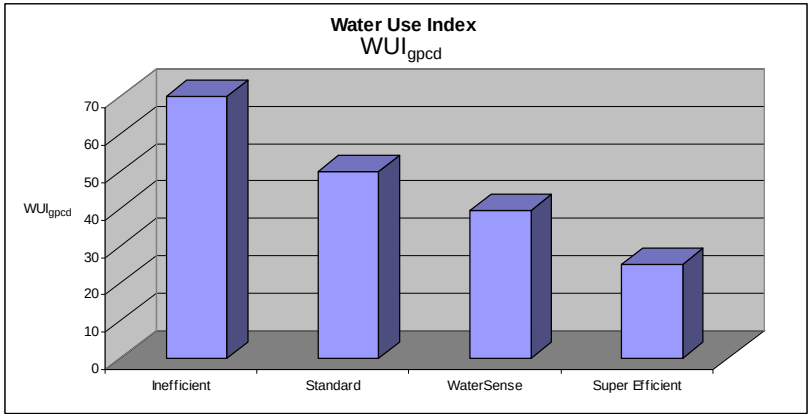
Options:

- WUI: single standardized calculation (gpcd, gal/sq.ft./day, gal/sq.ft./year)
  or
- WUI with descriptive sub-categories
  - Would allow for multiple metric categories for a single building
    - Useful until we know if certain metrics are more accurate for large sample sizes
  - Additional description without too much confusion
  - Agreed-upon definitions and calculation methods for each sub-category
    - $WUI_{sqftyear}$: gallons/sq.ft./year
    - WUI_{gpd} gal/human metric/day (office building)
    - WUI_{gpyear}:gal/human metric/year
    - $WUI_{bedyear}$: gal/occupied room/year (hotels)
    - WUI_{meal}: gal/meal served (food service)
    - WUI_{widget}: gal/widget produced (by manufacturing sector)
    - WUI_{irr}: inches/irrigated sq. ft. or CCF/1,000 irrigated sq. ft.

Water Use Index (WUI): indoor residential

Residential Indoor sector should set benchmarks based on **people**

- Inefficient (typical/pre-1994): WUI_{gpcd} = ~70+
- Standard (newer construction): WUI_{gpcd} = 50 (49.89 – EPA)
- WaterSense: WUI_{gpcd} = 40 (39.52 - EPA)
- Super Efficient: WUI_{gpcd} = 25
  - Best available technologies
    - WaterSense, Energy Star appliances, water reuse, 1.5 gpm showerhead

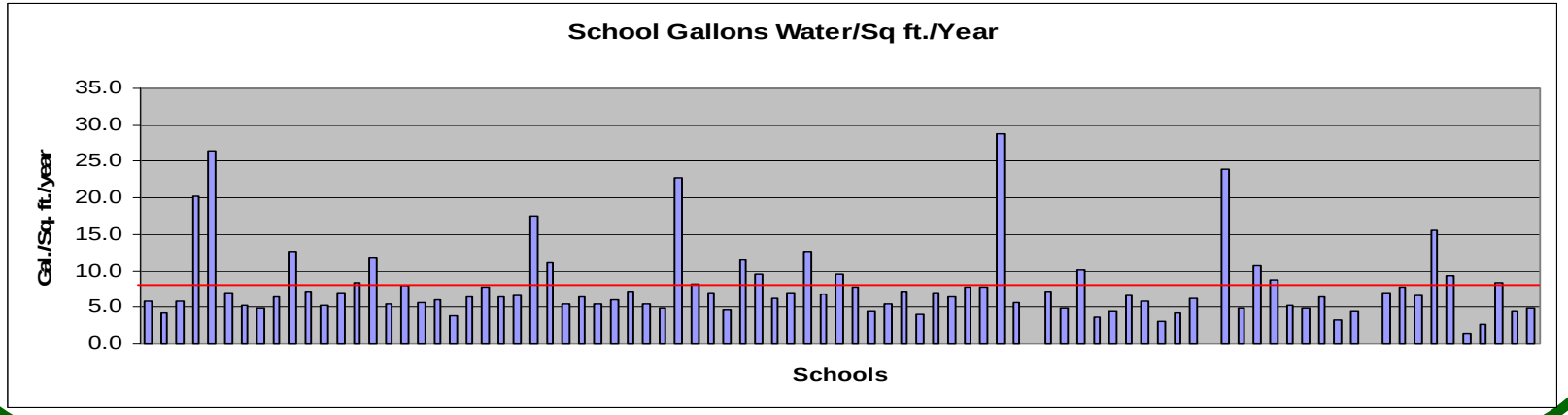


Outdoor: look at ET controllers

WUI example: school district indoor use

Schools could set benchmarks based on people or square footage

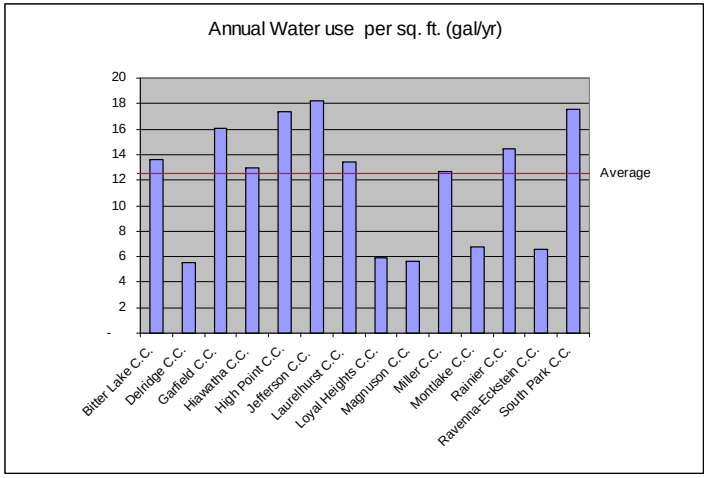
- ex. Seattle School District
  - Space and occupancy showed similar variability
    - Occupancy: $WUI_{studentday}$: 3.6 gal ± 2.5
    - Space: $WUI_{sqftyear}$: 7.8 gal ± 5.0
- Assumptions need to be standardized
  - What's a day? Calendar? Weekday? Actual in-school days?
  - What's a student? Count staff? Correct for absences?
  - What's square footage? Gyms? Auditoriums? Covered play area?

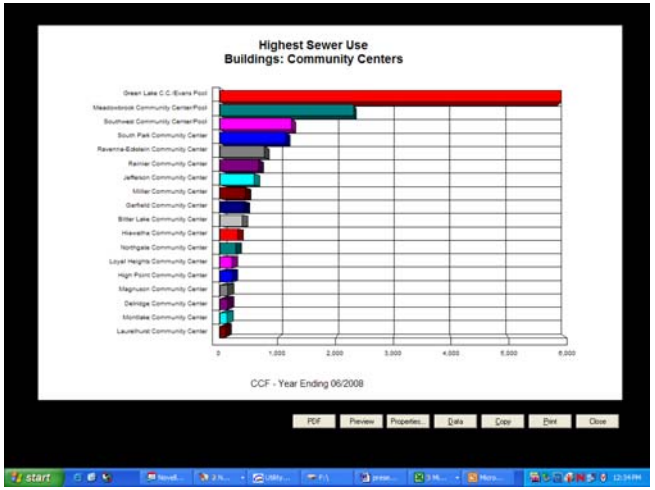


Comprehensive data could be used to categorize efficient (top 5%? 25%?) and non-efficient

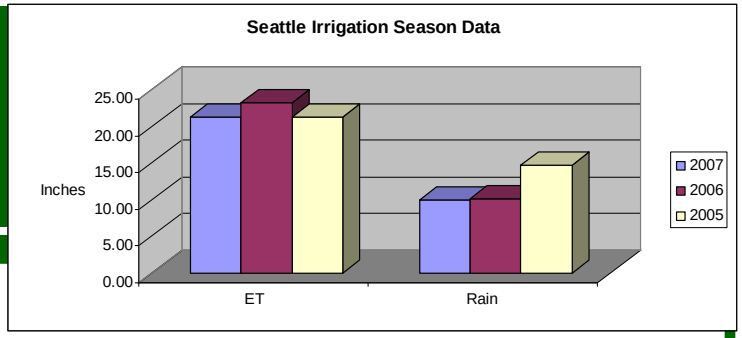
WUI example: community centers

- $WUI_{sqftyear}$: 11.9 gal ± 4.7
  - User data not readily available, or maybe not relevant





Measuring irrigation use



- Current irrigation “benchmarking”
  - Weather-based control to reduce use
    - Doesn’t necessarily optimize opportunities
  - Water budgets (calculation methodology should be standardized)
    - ET= Evapotranspiration
    - Kc = plant coefficient(s)
    - Irrigation system efficiency
    - LA= landscape area
  - But how to compare actual use from year to year?
    - Annual variability of +/-15%...or more
- Irrigation use tells only part of the story if it isn’t weather normalized
  - ET isn’t the be all/end all of efficiency
  - ET alone doesn’t correct actual consumption for annual variability
    - Rain and actual water use vs. presumed ET need

Irrigation Utilization Index (IUI)

Weather-corrected irrigation benchmarking proposed using Irrigation Utilization Index (IUI)

WUI_{Irr} = inches/irrigated square foot (non-weather adjusted)

IUI = Average WUI_{Irr} * (Current need/Average need)

Using IUI, ET and rain in a given year can be compared to an average or baseline use

- Tells if current water use is higher or lower than anticipated

Irrigation Utilization Index example

Example: Alki Playground, Seattle, WA

4-year average WUI_{irr} = 21.0”/sq. ft./year (WUI_{irr} = 21.0”)

- Average ET = 22.4’
- Average Rain = 11.8”
- Average need = 19.5” = (Average ET – (Average Rain *.25))
  - Assumes 25% of rain is effectively utilized by the landscape – or should it be 100%?

Comparing 2007 use to expected
2007 WUI_{irr} = 20.2”
2007 ET = 21.3”
2007 rain = 14.7”
2007 need = (21.3 - (14.7*.25)) = 17.6”

IUI = (Average WUI_{irr}) * (2007 need / Average need)
IUI = 21.0” * (17.6” / 19.5”) = 19.0”

- Comparing 20.2” to an adjusted expectation of 19.0”, we watered too much

Key question:

Can irrigation water benchmarks be weather-corrected to hold up for different geographical climate zones?

Metrics and benchmarks: potential stumbling blocks

- Can be driven by varying needs
- Urgency not immediately apparent
  - Databases are not as sexy as HETs and rain barrels
- Residential year-round irrigation data hard to separate from indoor use
  - Outdoor use could confound data
    - Seasonal irrigation: could be segregated
  - Inconsistent/inaccurate fixture consumption “in the field” could skew results
    - Useful to know to address concerns and minimize use
- Commercial odd uses skew comparisons
  - Accurately and consistently handling odd uses
- Commercial irrigation could be difficult to categorize
  - Difficult to categorize the wide range of landscape options
    - But could drive end users to efficient choices

Recommendations

- Standardize metrics
  - Metrics and benchmarks should be debated and agreed-upon for sectors
    - Water Use Index (WUI): Indoor consumption and manufacturing?
    - Irrigation Utilization Index (IUI): weather corrected…or not?
  - Water stakeholders should embrace standardized calculation methods
- Utilize existing knowledge
  - Build upon the metrics/benchmarks established by the energy industry
- Seek simplicity and consistency
  - Should take precedent over (perceived) accuracy
- Designate one or more information warehouses
  - EPA, AWE, USGBC or ??? should become a clearinghouse for information
- Populate databases
  - End users and utilities should be encouraged to share their information
    - Vast volumes of Information can help establish real-world efficiency benchmarks, by sector

Thanks

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