# This presentation premiered at WaterSmart Innovations

watersmartinnovations.com

watersmart
INNOVATIONS

# Calculating Energy and CO2 Savings Related to Water Efficiency (the Easy Way)

WaterSmart ’09 Innovations

Las Vegas

Thursday Oct. 8, 2009

Bill Gauley, P.Eng.
Veritec Consulting Inc.
Mississauga, Ontario

# The (our!) Environment

- People are generally becoming more aware of the negative impacts our actions can have on our environment –
  - We want “green” products with less packaging and lower life-cycle costs
  - We want sustainable lifestyles
  - Popularity of “Inconvenient Truth”
  - Solar power, wind power, electric cars, etc.

# Water and Energy

- Einstein discovered the relationship between mass and energy in the early 1900s
- It took us almost 100 years to discover the relationship between water and energy
- Energy is used by the water agency to:
  - collect raw water, treat water, distribute to customer
  - collect wastewater, treatment, discharge to environment
- Energy is used by customer for:
  - heating, cooling, pumping, etc.

# How much energy?

- The amount of energy depends on more than just the related volume of water,
- Also depends on system characteristics:
  - Efficiency of pumps, pipes, etc.
  - Distance water is pumped,
  - Elevation to which water is pumped, etc.
- And End uses:
  - Is water heated?  How hot?  How heated?

# Different degrees of Accuracy

- We know that we can save lumber (trees) if we build homes with studs placed on 24-inch centers vs. 16-inch centers.
  - But how much lumber can we save?
- Should we obtain the blue prints for all new homes and calculate the savings?
  - Big job!

# Water Savings

- How much water can Joe save by installing an HET?
  - How many toilets in Joe's house?
  - How many people in Joe's house?
  - How many times per day does each person flush?
  - How many #1s?  How many #2s?
- Lots of data required.
- Analysis not practical on large scale.
  - How much water can be saved in U.S. with HETs?

# Water / Energy Savings

- How much energy can be saved in U.S. by switching to HETs? Front-load washers? Washing clothes with cold water? Hot water recirculation systems? Etc.
- Important to know, but not practical (and probably not possible) to determine 100% accurately.
  - Evaluate every component of every water/wastewater system in the country.

# It’s all about ABOUT

- Question
  - How many jelly beans are in the jar?
- Answer
  - I would say about 400 or so…
- Reply
  - NOPE!  There’s only 398.

# Bang for the Buck…

- If there is no way to know the exact number, we need to determine the level of accuracy that we would be happy with.
- This is often related to the level of effort that would be required to move to the next level of accuracy.
  - e.g., miles of coast line
  - e.g., flush volume of a toilet

# Energy Savings Choice

- Which saves more energy?
  - Reducing hot water demand of shower by 20 gallons, or
  - reducing irrigation by 1,000 gallons.
- A: The shower would save about 7.5 kWh and the irrigation only about 2.3 kWh.

- But - how can we know this?

# Let’s consider what we don’t know -

- We don’t know:
  - where the water was produced or how far it is pumped
  - if the water was heated with an electric or gas water heater
  - the efficiency of the water heater
  - the temperature differential of the cold/hot water, etc.

# Now, let's consider what we do know (more or less) -

- We have a good idea of the:
  - energy required to heat water
  - average efficiency of water heaters
  - avg. temperature differential of cold/hot water
  - percentage of electric vs. gas water heaters
  - approximate avg. energy related to water treatment/supply & wastewater collection/treatment

# Hot, hot, hot

- We also know that the energy required to heat water is MUCH more than the energy required to treat/distribute water.
- In fact, it appears that – **on average** – it takes as much energy to heat about 1.0 gallon of water in a residential water heater as it does to treat/distribute/collect/treat about 150 gallons in a municipal system.

# Type of savings impacts energy

- Some savings can include hot water (showers, clothes washers, dishwashers)
  - less important to know details of water/wastewater system
- Some savings can include water and wastewater (toilets, showers, etc.),
- And some just water (e.g., irrigation).
- But, what about CO2e?

# Big variations in Co2/kWh

- The amount of CO2e varies significantly depending on how energy is produced –
  - Hydro, oil, natural gas, nuclear, etc.
  - Can range from about 0.01 kgCO2/kWh (hydro) to about 1.0 kgCO2/kWh (coal)
- Not only is each State and Province different, but there can be differences within each State and Province

# About…

- In most cases, however, having a State- or Province-wide value may be ‘close enough’
- Especially if the water-efficiency program is being done on a State-wide basis.
- By all means – if you have more accurate data, use it!

# The Excel-based Calculator

- Very simple – requires minimal input
- Uses accepted values, conversions, e.g.,
  - it takes 1.0 kcal to heat 1 L of water by 1C
- Plus (from Ont. research by Carol Maas)-
  - treat/distribute 1m3 water ~ 0.60 kWh
  - 440 gal ~ 1 kWh (700gal in plant?)
  - reduction savings water ~ 87%
  - collect/treat 1m3 wastewater ~ 0.55 kWh
  - reduction savings wastewater ~ 8%

# Calculator (con't)

- Makes assumptions that can be 'over-ridden', e.g.,:
  - Temperature differential cold/hot = 100F (55C)
  - Efficiency of electric water heaters = 88%
  - Efficiency of gas water heaters = 56%
  - 12% line losses (electrical transmission)
  - 1.93 kgCO2/m3 natural gas combustion
  - Lists kg CO2 / kWh for each State and Province

# Calculator (con't)

| State | kg CO2/kWh | | Province | kg CO2/kWh |
|---|---|---|---|---|
| Alabama | 0.60 | | B.C. | 0.02 |
| Alaska | 0.69 | | Alberta | 0.93 |
| Arizona | 0.51 | | Saskatchewan | 0.87 |
| Arkansas | 0.55 | | Manitoba | 0.02 |
| California | 0.27 | | Ontario | 0.27 |
| Colorado | 0.83 | | Quebec | 0.01 |
| Connecticut | 0.32 | | Nova Scotia | 0.66 |
| Delaware | 0.82 | | New Brunswick | 0.47 |
| District of Columbia | 1.22 | | PEI | 1.18 |
| Florida | 0.57 | | Newfoundland | 0.03 |
| Georgia | 0.65 | | Territories/Nunavut | 0.15 |
| **U.S. Avg.** | **0.605** | | **Canada Avg.** | **0.227** |

# Calculator (con't)

| | | |
|---|---|---|
| Water savings | 1,000 | m3 |
| Wastewater savings as a **percentage** of Water savings | 100% | see note #1 |
| Coefficient (kg CO2/kWh) | 0.605 | see note #2 |
| % of total water savings that is heated | 100% | see note #3 |
| % of water heating via gas | 50% | see note #4 |
| % of water heating via elect. | 50% | see note: #5 |
| **Savings** | **35,730.48** | **kg CO2** |

Note #1: irrigation, evaporation, etc. = 0%, toilets, showers, etc. = 100%

Note #2: input data for your system or select Provincial/State average from above.

Note #3: irrigation, toilets, etc. = 0%, showers = a value of approx. 50%, clothes washers = a value b

Note #4: in some areas one type of water heater is more prevalent. If you know the approx. installed

Note #5: if 0% of water is heated, these percentages are not used in calculations.

# Example 1- Irrigation

| | |
|---|---|
| Water savings (m3) | 1,000 |
| % Wastewater | 0% |
| Coefficient (kg CO2/kWh) | 0.605 |
| % heated | 0% |
| % heated via gas | 50% |
| % heated via elect. | 50% |
| **Savings (kg CO2e)** | **359** |

**Breakdown of Energy Savings, kWh**

| | |
|---|---|
| municipal water | 593.182 |
| municipal wastewater | 0.000 |
| **Total municipal energy** | **593.18** |
| | |
| heating (gas) | 0.00 |
| heating (electricity) | 0.00 |
| **total heating** | **0.00** |

| | |
|---|---|
| **Total kWh** | **593** |

# Example 2 - Toilets

| | |
|---|---|
| Water savings (m3) | 1,000 |
| % Wastewater | 100% |
| Coefficient (kg CO2/kWh) | 0.605 |
| % heated | 0% |
| % heated via gas | 50% |
| % heated via elect. | 50% |
| **Savings (kg CO2e)** | **389** |

**Breakdown of Energy Savings, kWh**

| | |
|---|---|
| municipal water | 593.182 |
| municipal wastewater | 50.000 |
| **Total municipal energy** | **643.18** |
| | |
| heating (gas) | 0.00 |
| heating (electricity) | 0.00 |
| **total heating** | **0.00** |

| | |
|---|---|
| **Total kWh** | **643** |

# Example 3 - Showers

| | |
|---|---|
| Water savings (m3) | 1,000 |
| % Wastewater | 100% |
| Coefficient (kg CO2/kWh) | 0.605 |
| % heated | 50% |
| % heated via gas | 50% |
| % heated via elect. | 50% |
| **Savings (kg CO2e)** | **18,060** |

**Breakdown of Energy Savings, kWh**

| | |
|---|---|
| municipal water | 593.182 |
| municipal wastewater | 50.000 |
| **Total municipal energy** | **643.18** |
| | |
| heating (gas) | 28,548.40 |
| heating (electricity) | 20,644.50 |
| **total heating** | **49,192.90** |

| | |
|---|---|
| **Total kWh** | **49,836** |

# Daily savings if USA (307 million persons) switched to:

- HETs (5 F/d x 2 G/F)
  - 4.5 M kg CO2e & 7.5 M kWh
- 2 gpm showerheads (75% x 7 min./shower x 0.5 gpm, 60% hot water)
  - 66 M kg CO2e & 182 M kWh
- Efficient irrigation (45 g/day x 50% savings)
  - 9.4 M kg CO2e & 15.5 M kWh

# Conclusions

- Can do calculations on a State-by-State or Province-by-Province basis
  - Or on a National basis
  - Or on a system-by-system basis
- Simple enough for average person to use
- A simple tool to help water agencies and governments prioritize water conservation projects and programs

# Thank you…

*Contact…*

**Bill Gauley, P.Eng.**
**Veritec Consulting, Inc.**
**Mississauga, Ontario**

**Tel. (905) 696-9391**
**bill@veritec.ca**