Wastewater Energy Exchange Opportunities

Leveraging Building & Municipal Wastewater

“Doing our part to Change the Climate”

•Presentation by: Rick Lawlor P. Eng. LEED® AP Eastern Regional Sales Manager
Welcome all!

Tonight’s discussion is intended to introduce you to the fundamentals and opportunities with SWEE.
Why SWEE?

- Background / Drivers behind SWEE
- How SWEE works
- SWEE Technologies Available
- Real World Stuff: Where is SWEE in use?
- Advancing the concept; What technical parameters to consider?
- ???
Why SWEE?

1) Potential for Energy Savings
   - 15% to 30% of energy that goes into a building will leave down the drain
How much energy is available?

“350 billion Kw-Hrs worth of hot water are discarded annually through drains in North America”

– US Department of Energy
350,000,000,000 Kw-Hrs annually
Therm equivalent ~ 12,000,000,000
Natural Gas @ $0.80 / Therm
= $9.6 Billion Annually
Why SWEE?

1) Potential for Energy Savings
   - 15% to 30% of energy that goes into a building will leave down the drain

2) Supports Low-Carbon, High-Performance Green Building Culture
   - Buildings account for 18% of global emissions today, equivalent of 9 billion tonnes of CO2 annually.
Table A1: Total Ontario generation, and related CO\(_2\) emissions, in hour preceding 05:03 EST on Nov 19 2015

<table>
<thead>
<tr>
<th>FUEL</th>
<th>%</th>
<th>MWh</th>
<th>CO(_2), tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>67</td>
<td>9,550</td>
<td>0</td>
</tr>
<tr>
<td>Hydro</td>
<td>21</td>
<td>2,978</td>
<td>0</td>
</tr>
<tr>
<td>Gas</td>
<td>5.8</td>
<td>833</td>
<td>408</td>
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<tr>
<td>Wind</td>
<td>6.2</td>
<td>886</td>
<td>0</td>
</tr>
<tr>
<td>Biofuel</td>
<td>0.15</td>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>Oil &amp; Gas</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Solar</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>14,269</td>
<td>420</td>
</tr>
</tbody>
</table>

CO\(_2\) intensity per kWh (CIPK) in the last hour: 29.43 grams.
• 350 Bedroom Mixed-use MURB – ONTARIO
• Potable Water @ 40 Gal / Bedroom / Day
• 30% Potable = DHW Usage
SCENARIO A
90% Eff Ngas DHW Plant
148,000 Lbs CO₂ = 100% Annual Load

SCENARIO B
Built-up SWEE
Hybrid 4.0 HCOP / 90% Eff Ngas DHW
80 / 20 Load-share (HP / NGas)
34,000 Lbs CO2 = 100% Annual Load

B versus A
> 75% Reduction Lbs CO2 Emissions
Why SWEE?

% Energy Recovered

% GHG Reduction

[Bar chart showing the percentage of energy recovered and GHG reduction for different values, with 80% energy recovered and 80% GHG reduction at the highest point.]
Why SWEE?

THERE IS NO PLANET B
1) Potential for Energy Savings
   ▪ 15% to 30% of energy that goes into a building will leave down the drain

2) Solution to Green Building Culture & Carbon Reduction Initiatives
   ▪ Buildings account for 18% of global emissions today, equivalent of 9 billion tonnes of CO2 annually.

3) Water Savings
   ▪ Alternative to cooling towers
150,000,000,000 gallons /day

Water @ $1.50 / 1000 gallons

= $82 Billion Annually
Eliminates Cooling Towers;
✓ Leverages previously used water
✓ Eliminates primary make-up water
✓ Eliminates evaporation plume
✓ Eliminates chemicals for water-treatment
✓ Eliminates mechanical fan energy
✓ Eliminates airborne radiated sound
✓ Reduces AC Energy Operating Costs
✓ Disease Mitigation - Legionella
Life-cycle Cost - Owning & Operating a Cooling Tower

- Electricity
- Make-up Water
- Chemicals
- Maintenance
- Repairs
- Sound Abatement
- Legionella

Initial Purchase
HOW MIGHT SWEE TECHNOLOGY WORK?
Typical Potable Water Flow

- Condos & Apartments
- Commercial & Retail Buildings
- Schools
- Sport & Fitness Facilities
- Industrial Processes
- Aquatic Centers / Natatoriums
- Hospitals & Long-term Care
- University/College Campuses
- Prisons
- Industry
Building Integration - Standard Boiler System
Building Integration – Standard Built-up or Self-contained Energy Exchange System
Building Integration – Adding Wastewater Heat Recovery
Building Integration – Integrated Wastewater Heat Recovery with Traditional Heating

Diagram:
- SWEE
- Pre-Heat Tank
  - Domestic Pre-Heated Water
    - 50°C (122°F)
- Storage Tank
  - Domestic Hot Water
    - 60°C (140°F)
- WW Tank
  - Incoming Cold Water
    - 10°C (50°F)
WHAT SWEE TECHNOLOGY IS AVAILABLE?
Built-up Energy Exchange

Self-contained Energy Exchange
Built-up Energy Exchange

Hot Water Usage

Wastewater Storage

Pump

Solids Out

Heat Exchange

Heat Pump (Optional)

1) Hot Water Tank

2) Space Heating and Cooling

3) District Energy

Potable Water Supply
HEAT EXCHANGER

Sanitary Inlet

TS_{in}

TS_{out}

Sanitary Outlet

Load Inlet

Load Outlet

TL_{out}

TL_{in}

Energy Flow
SPACE CONDITIONING & DHW HEATING
Self-contained Energy Exchange
Self-contained Energy Exchange
Self-contained Energy Exchange

How it works
OPPORTUNITY

Deployment of Built-up / Self-contained Energy Exchange
Typical Self-contained Installation:

A - Holding tank
B – SWEE unit
C - Domestic water line
D - Overflow line
E - Drain line
Below-Ground Tank:
Above-Ground Tank:
Typical Built-up Installation:

A - Wastewater holding tank
B - Macerator
C – Sewage separator filter unit
D - Reversing valve tree
E - Heat exchanger
F - Heat pump
WHERE IS THE TECHNOLOGY BEING USED?
False Creek Energy Centre
Vancouver, BC

- 1st large-scale wastewater heat recovery system in North America
- Operational since 2010
- $42 M publically funded project
- In 2018 Serves 483,100 m² (5,200,000 ft²) of residential, commercial, and institutional space
- By 2028 will serve 1,858,100 m² (20,000,000 ft²) of residential, commercial, and institutional space
Advantages to District Energy

Low-carbon, Sustainable Energy - Multiple buildings connected to more sustainable sources

Affordable Energy – More stable and cost competitive prices

Fuel Flexibility – It’s possible to switch to different fuel systems, and take advantage of future innovation

Decreased Building Costs – Less HVAC equipment for each building and more usable space
False Creek Energy Centre
Vancouver, BC
False Creek Energy Centre
Vancouver, BC
False Creek Energy Centre
Vancouver, BC

- 3500 tonnes CO2 saved – 2017
equivalent to ~ 100 cars off the road
- 46,000 mwh produced – 2017
- 32 additional buildings added – 2017
- 6 kM underground piping – 2017
- ~ 4700 residential units added - 2017
False Creek Energy Centre
Vancouver, BC

https://www.sauder.ubc.ca/Faculty/Research_Centres/Centre_for_Social_Innovation_and_Impact_Investing/Core_Themes/Low_Carbon_Economy/~/
media/Files/ISIS/Reports/Carbon%20Management%20Reports/QUEST-ICES-Business-Case-Southeast-False-Creek-Neighbourhood-Energy-Utility.ashx
Gateway Theatre Richmond, BC

- 50,000 sq ft public theatre owned by the City of Richmond
- Built in 1984, an ideal candidate for significant energy retrofit projects (existing water source heat pump heating system with natural gas boiler and cooling tower)
- Theatre is built adjacent to an existing city sanitary lift station
Canada’s first multi-family project built to LEED® Platinum and Built Green Gold Standards

- In operation since 2012
- Sewage heat exchange used for domestic hot water heating
seven35 - 2012 Original Installation
Independent Owner Validation

- **75% Energy Reduction vs Ngas**

- **Offline Sanitary Energy Exchange System**

- **Primary DHW Heating system – Ngas Back-up**

September 30, 2012
File: 1125209099

Attention: Richard Madden
Adera Development Corporation
2200 - 1055 Duranmur Street
Vancouver BC
V7X 1K8
Canada

Reference: Seven35 – Waste Water Heat Recovery

Dear Richard Madden,

The purpose of this letter is to confirm that a waste water heat recovery system has been installed in the Seven35 development and that the system is capable of reducing domestic water heating energy use by a minimum of 75%.

The system utilizes water-to-water heat pumps to extract heat from waste water leaving the site. The water-to-water heat pumps preheat incoming domestic hot water to 52°C. Preheated water then flows to the main domestic hot water tanks where 90% efficient natural gas boilers complete the heating to 57°C.

Flow meters, temperature sensors, and electrical meters were installed throughout the heat recovery system in order to monitor and log both the system operation and the amount of energy used and recovered by the system.

One week of logged data from August 18, 2012 to August 25, 2012 was submitted to Stantec for analysis. From this information, it was determined that the average domestic water heating requirement over this period was 746.87 kWh/day. Heating this domestic water using only conventional means (in this case, the 90% efficient natural gas boilers) would require 829.86 kWh/day of energy.

Analysis of the submitted data indicated that the water-to-water heat pumps had consumed 81.03 kWh/day of electricity, 10.08 kWh/day was required for pumping energy, and the natural gas boiler usage had dropped to 114.64 kWh/day. The total energy now required for domestic hot water heating is 205.75 kWh/day, resulting in a 75.2% energy savings.
2016 seven35 Self-contained SWEE System retrofit
2016 seven35 In-Line SWEE System retrofit

![Image of SWEE System](image-url)
Regional Water Resource Centre - Sechelt, BC

- Shipped to site: Aug, 2014
- Supplies building space heating & cooling using inflowing untreated wastewater
- 1,790 square metre facility
- LEED® Gold certified
SPACE CONDITIONING & WATER HEAT
DC Water Headquarters
Washington, DC

- 150,000-square-foot, six-story headquarters facility for the District of Columbia Water and Sewer Authority (DC Water)
- Construction of the headquarters is scheduled to be complete in Sept. 2018
- Designed to achieve LEED Platinum certification
Mechanical Systems Overview

- Sewage Water Energy Exchange
- Energy Recovery Chiller
- Chilled Beams and DOAS VAV
- Outdoor Air Handling Unit
Built-up SWEE

Energy Recovery Chiller

WASTE WATER HEAT EXCHANGERS

ENERGY RECOVERY CHILLER = 225 TONS

CONDENSER WATER PUMPS

HOT WATER PUMPS

CHILLED WATER PUMPS

BACK-UP ELECTRIC BOILER = 1 MBH

4-Pipe Chilled Box
SPACE
CONDITIONING &
WATER HEAT
DC Water Headquarters
Washington, DC

Total Energy Savings = 48%
Total CO² Reduction = 42%
Total Water Savings = 90%
23 Site EUI
LEED Platinum - 96 Credits
All LEED Energy Credits Achieved
All LEED Water Efficiency Credits Achieved
100% Impervious Onsite Stormwater Retention
No Cooling Tower – 900,000 gallons saved
Rainwater for Flushing – 600,000 gallons saved
THE NEURONS ARE IN MOTION? PARAMETERS TO CONSIDER
Wastewater / Sanitary Info

What type of Sanitary supply is available?
- Connect to Sanitary Main Line of Municipality? Is it combined or just sanitary?
- Connect to Sanitary discharge of site/building?
- Estimated Sanitary Supply Qty (GPD/GPM): ______________
- New or Existing Pipe Diameter: ______________

Have flow measurements, calculations or estimates been made for any / all of the following?

a. Peak overall sewage/sanitary flow rate (Gals / Hr or Gals/ Min or Gals / Day);

b. Average overall sewage/sanitary flow rate (Gals / Hr or Gals/ Min or Gals/ Day);

c. Overall site water consumption and % of that figure that is to be heated.

d. Sanitary Temperatures either measured or estimated. Minimally summer and winter conditions, and a time trend profile is best.
e. Will there be one or several exit points available for the site sanitary connection to the municipal system?

f. Is there a specific purpose intended for the energy exchanged?

g. If this is a multi-unit residential application, will any utilities (Gas / Electricity / Water) be metered at the individual apartment level?

h. Are any utilities charged based on time-of-day rates, and if so are the rate schedule available?
Building Info

Purpose of Energy Exchange:

- Domestic Hot Water Production
- Space Heating and/or Cooling
- Combined DHW & Space Heating/cooling
- Heat Pump(s) Will be REQUIRED
- Heat Pump(s) Will NOT be REQUIRED
Why ?
What is the Simple Payback for a Marble Floor? (*)

Reinhold Wieland
Specialist in Energy Performance Contracting & Real Time Energy Management
LinkedIn November 8 2016
https://www.linkedin.com/pulse/now-what-simple-payback-marble-floor-reinhold-wieland
Or a Fire Sprinkler System?

An Emergency Lighting System?

A Security System?

Air Conditioning Maintenance?

A New Roof?

An Insurance Package?

Rewire of Electrical System?

An Energy Efficiency Project?

Which one of these seems to require a Simple Payback calculated every time? (*)

(*)

Reinhold Wieland
Specialist in Energy Performance Contracting & Real Time Energy Management
LinkedIn November 8 2016
https://www.linkedin.com/pulse/now-what-simple-payback-marble-floor-reinhold-wieland
THANK YOU!

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SHARC Energy Systems Inc.

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