Drain Water Heat Recovery – Applications & Case Studies

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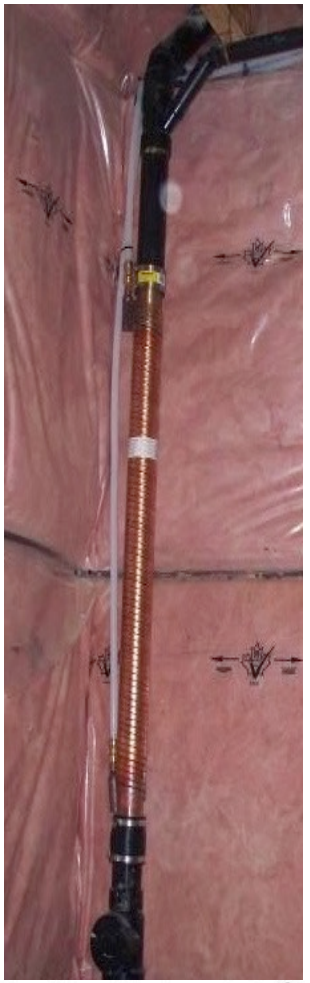
Drain Water Heat Recovery (DWHR): Definition

DWHR works by
using the outgoing
warm drain water
to pre-heat the incoming
cold fresh water



Fresh Inlet ~ 46°F

Drain Inlet ~ 101°F

Fresh Outlet ~ 75°F

DWHR is a Proven and Accepted Technology

- DWHR units passively save energy **every day** in:
  - over 100,000 homes
  - over 40,000 apartment/hotel suites
  - 100's of commercial operations
  - Industrial applications
  - In many countries
- RenewABILITY Energy Inc.
  - founded in 2000
  - developed and manufacturers the Power-Pipe DWHR Systems

Classifying DWHR Applications

A) Location:

- In-Building vs External

B) Orientation:

- Vertical vs Horizontal

C) Complexity:

- Stand-alone vs Coupled (e.g. heat pump)
- Passive vs Pumped (drain water and/or fresh water)
- Storage?
- Immersion?

D) Stage of Development:

- Proven vs Theoretical

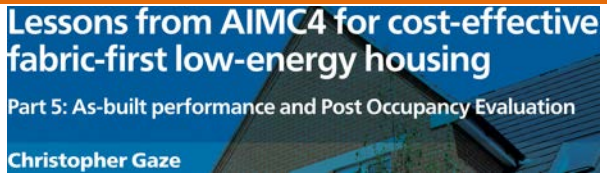
8 DWHR Applications shall be reviewed, inc. some case studies

- NOTE: other system types may exist now or in the future and/or have not been found to be practical

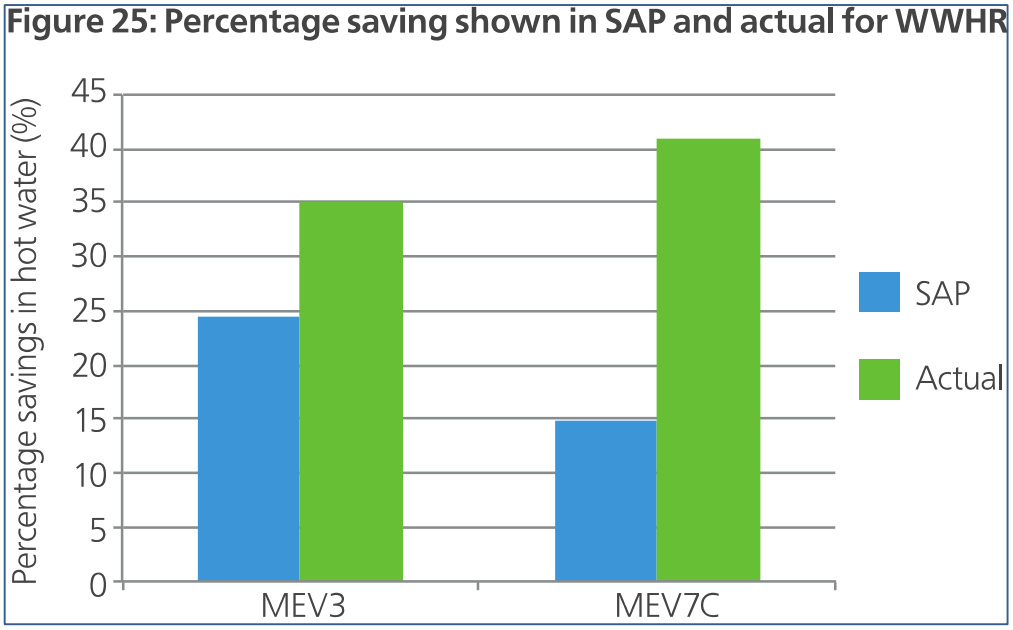
(1) In-Building, Vertical, Stand-alone, Passive, Single-pipe

- Over 100,000 Falling-Film Systems in Operation
- At least 4 manufacturers
- Paybacks of 1 to 10 years reported
- Flowrates: 1gpm to 9gpm
- Manitoba: *Baseline Mandatory Chosen by Builders rather than increasing wall insulation - min 42% efficiency for all new multi-family and single family residential since April 2016 and with pressure loss restrictions*
- Ontario: min 42% efficiency mandatory in SB-12 Prescriptive Paths Mandatory in New Residential in Ontario
- Included in T24 -2019 California for 2020 utilization
- Maintenance Free, Double-wall vented
- Connections:
  - Fresh: ½", ¾", 1"
  - Drain: 2", 3", 4", 6"

(1) In-Building, Vertical, Stand-alone, Passive, Single-pipe



- CASE STUDY: 2010-2014 – by UK's BRE
- Detailed Monitoring Results from 2 Homes with 4" dia. & 84" (efficiency rated 64.7%)
- Energy Savings (Delivered) was 35.5% & 41% of total domestic hot water
  - (which UK Energy Code calculated to be 24% & 15%)
- Gerald Van Decker (our company founder) publicly claimed in front of 100 persons and 4 years prior that %Savings would be 35%-40% with the Power-Pipe R4-84
  - **% Hot Water Savings = Efficiency * 0.59 (from 38.2%/0.647)**



(1) In-Building, Vertical, Stand-alone, Passive, Single-pipe

- CASE STUDY in 2000 by Oakridge National Labs
- in a Triplex in Duluth, Minnesota
- 3-coil 2nd generation DWHR unit which is 4” diameter, 60” long, heat exchange effectiveness was 50%
- With Electric Water Heater, saved 2,800 kWh over the year
- Examined the % Savings on Total Hot Water Load and found it to be consistently between 25% and 30% over the year
  - **% Hot Water Savings = Efficiency * 0.55** **(from 27.5%/0.50)**

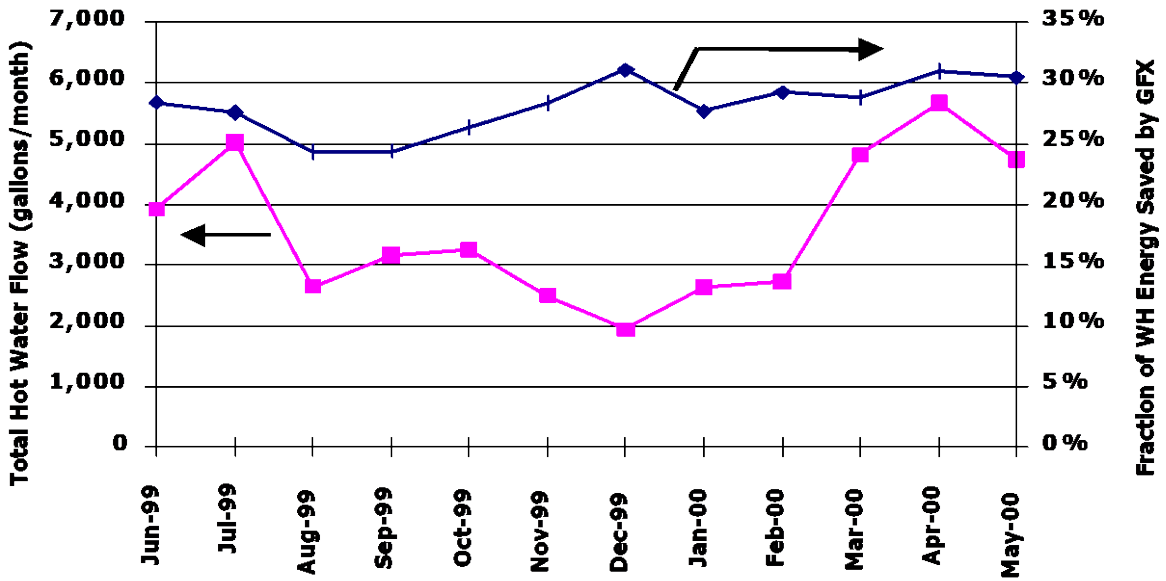


Figure 1. Total hot water use and GFX benefit over the field study in Duluth.

(1) In-Building, Vertical, Stand-alone, Passive, Single-pipe

- CASE STUDY in 2001 - in an Ottawa home with Ottawa Hydro
- DWHR Unit: single 1/2" coil, 3" diameter, 60" long, rated effectiveness of 55%
- With Electric Water Heater
- Normalized for volume of hot water used
- Examined the % Savings on Total Hot Water Load with and without DWHR per gallon of consumption
  - **% Hot Water Savings = Efficiency * 0.609** **(from 33.5%/0.55)**

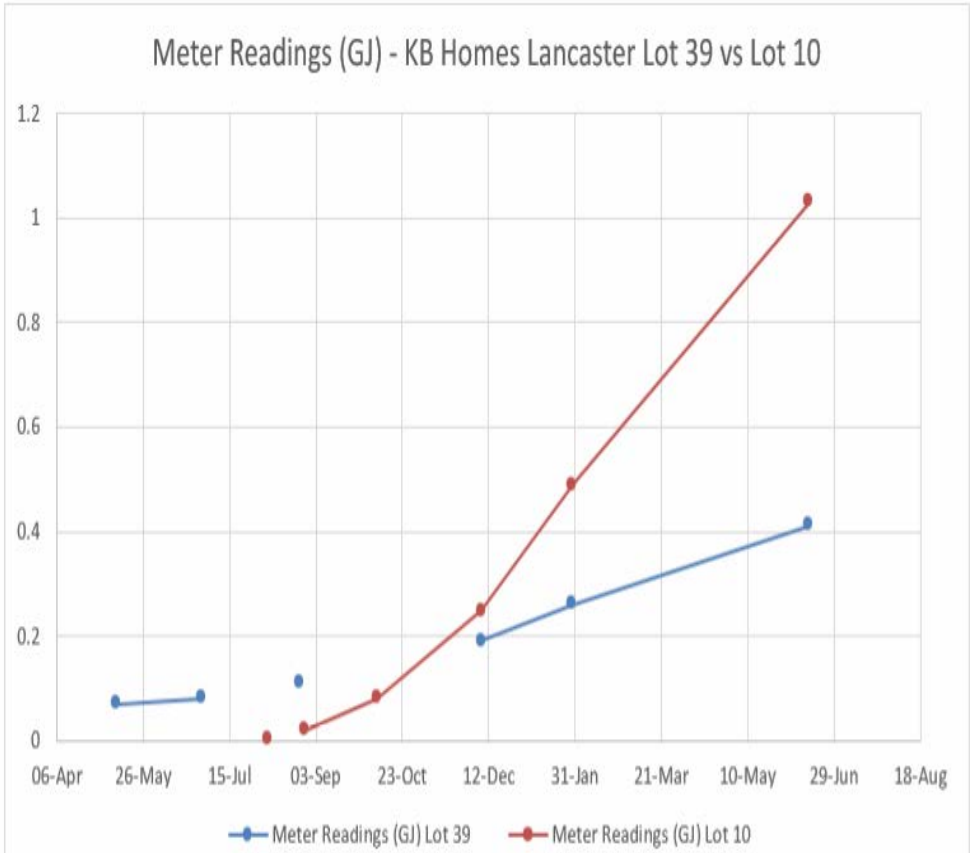
	Tank Time / Water Volume [min/gallon]	Tank Energy / Water Volume [kWh/gallon]
With DWHR	2.37	0.115
Without DWHR	3.53	0.173
Savings	**32.9%**	**33.5%**

(1) In-Building, Vertical, Stand-alone, Passive, Single-pipe

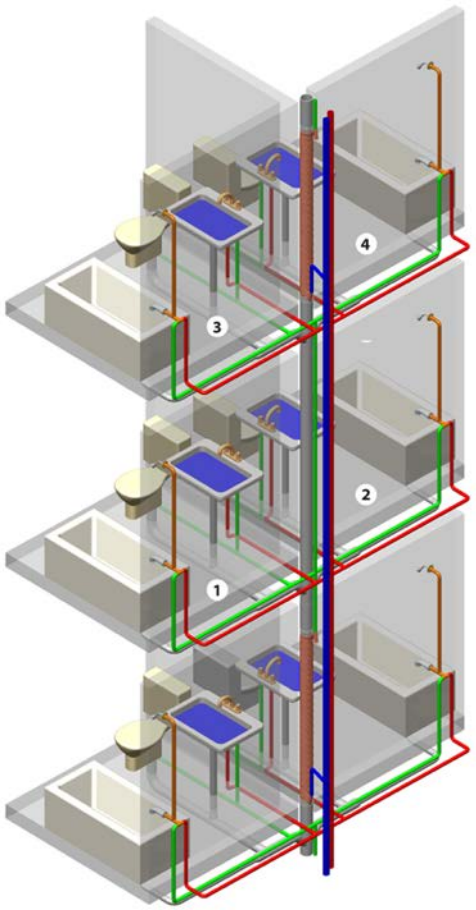
- CASE STUDY in 2015/2016 by Southern California Gas
- These are two different homes so this is not a controlled comparison
- Equal Flow Installation will always have higher energy savings than Unequal Flow Installation

- Lot 10 equal flow
- Lot 39 unequal flow
- Similar houses and both 3 showers / day

Heat Meter Summary Chart (Savings):



(1) In-Building, Vertical, Stand-alone, Passive, Single-pipe



4 WC arranged 2 by 2

Sample IECC Credit Calculation

- 3-4 Washrooms Connected, Unequal Flow
- DWHR Rating: 57% Efficient Rated DWHR Unit
- SWHF = 1 – (DWHR unit efficiency x 0.33) = 0.812
- With a baseline Domestic Hot Water Load of: 100,000 therms/year, we now have a revised Domestic Hot Water Load of 81,200 therms/year for a savings of 18,800 therms per year
- The rated pressure loss for this model is 0.8psi, therefore it is is compliant with the IECC pressure loss limitation of 2psi.

(2) In-Building, Vertical, Stand-alone, Passive, Multi-pipe

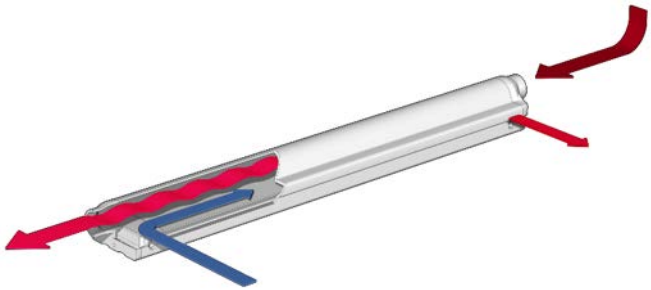
- Over 200 “pipes” in Operation
- At least 3 manufacturers
- Paybacks of 0.5 to 6 years reported
- Flowrates: ~4gpm to many 1,000s gpm
- Utilizes B55.2 compliant units from (1)
- Minimal maintenance, Double-walled vented
- All application types

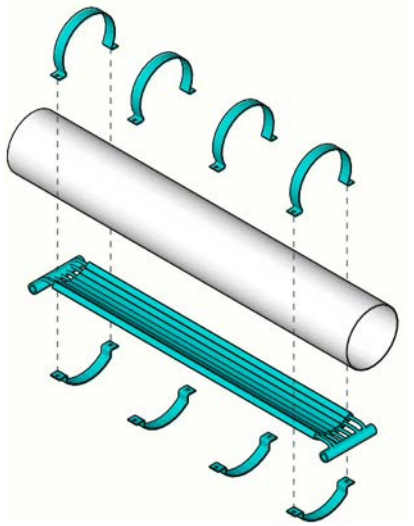
(2) In-Building, Vertical, Stand-alone, Passive, Multi-pipe

- CASE STUDY:
- 2004 – Unilever Sauce Facility, Ontario
- 90% measured Return on Investment
- Doubled hot water capacity which was needed because of plant expansion; the DWHR system cost less doubling with conventional natural gas water heaters, which means it provided an instant financial payback
- Zero Maintenance
- Peak thermal power delivered >300 kW
- Savings of 130 Tonnes CO2 per year

(3) In-Building, Horizontal, Stand-alone, Passive

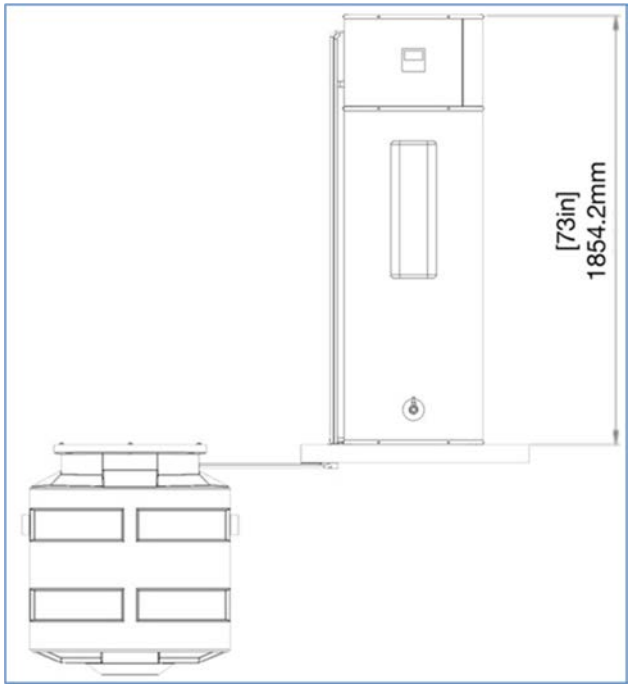
- Over 100 Systems in Operation
- At least 4 manufacturers
- >2x longer payback than
- No test standard, some not double-walled
- Cleaning needed to maintain initial efficiency
- Falling-film (1) systems installed horizontally can yield similar IRRs to “horizontal only” systems

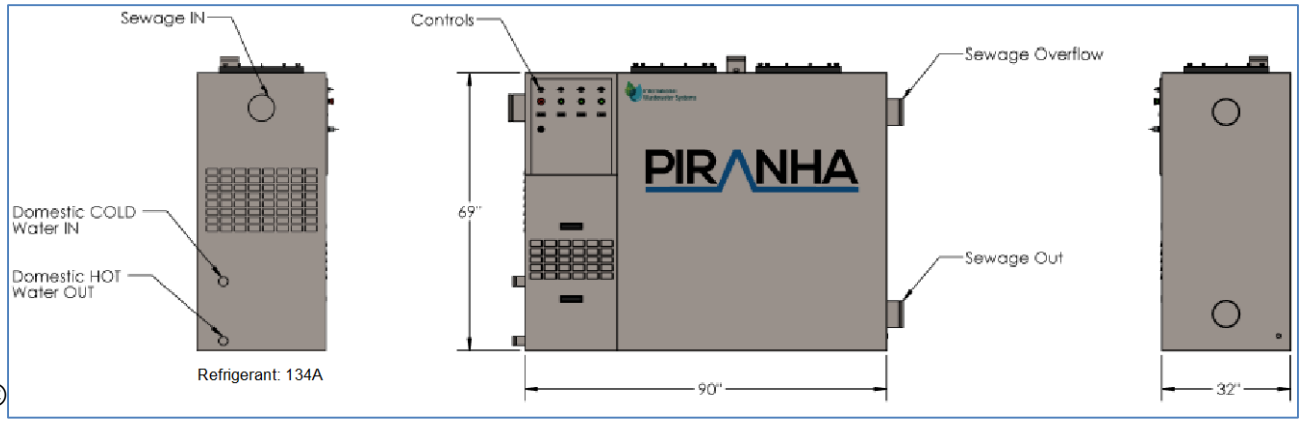




(4) In-Building, Coupled, Hot water storage

- Over 10 Systems in Operation
- Heat exchanger(s) installed inline with sewer
- 2 manufacturers: large and small systems
- Coupled with a heat pump water heater
- Paybacks: >5 years reported
- Possible to retrofit large system to serve entire building
- Small system can be primary water heater
- Maintenance





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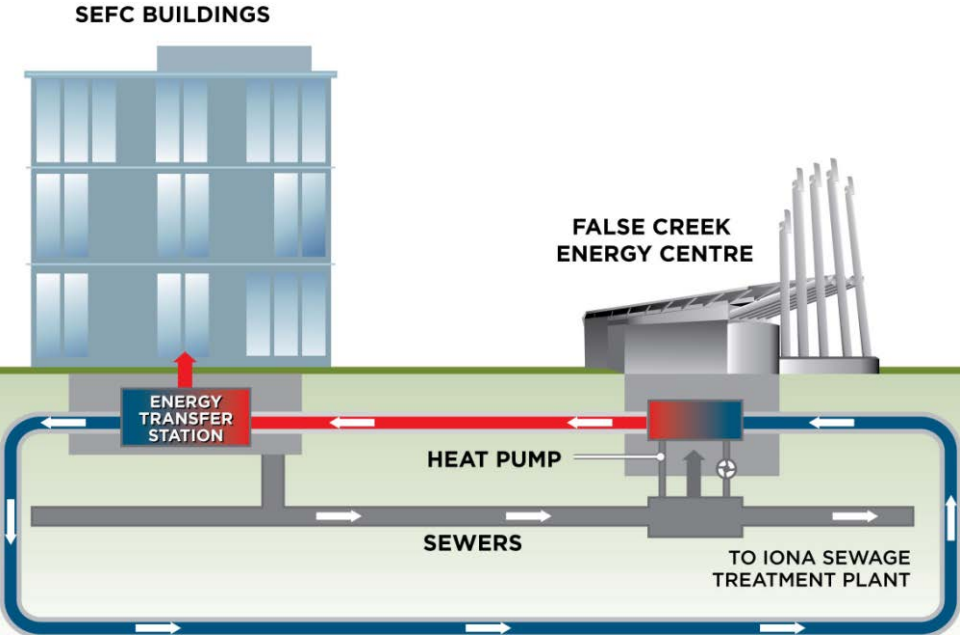
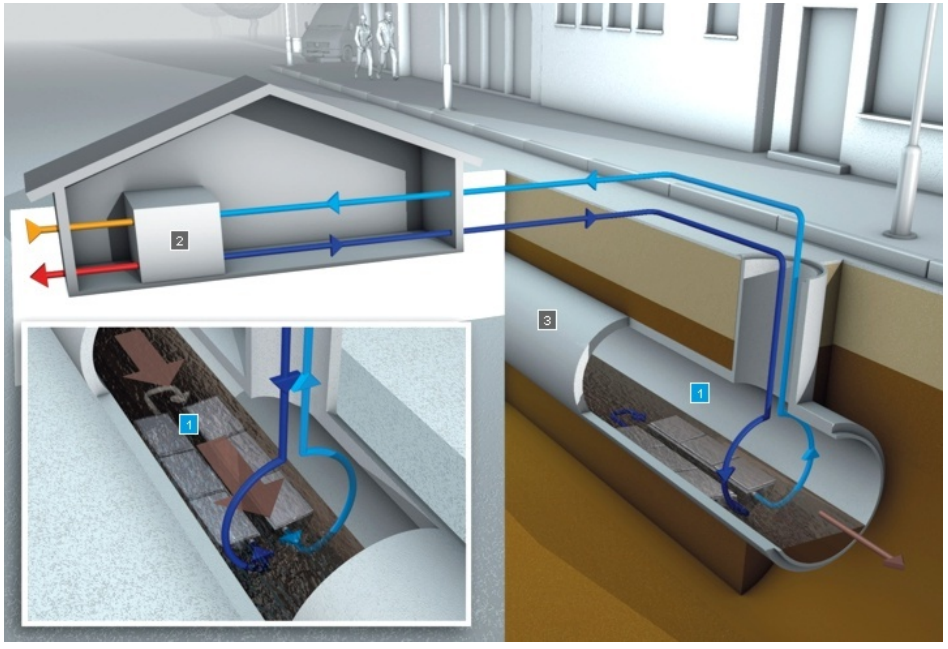
(5) External, Horizontal, Coupled, Hot water storage

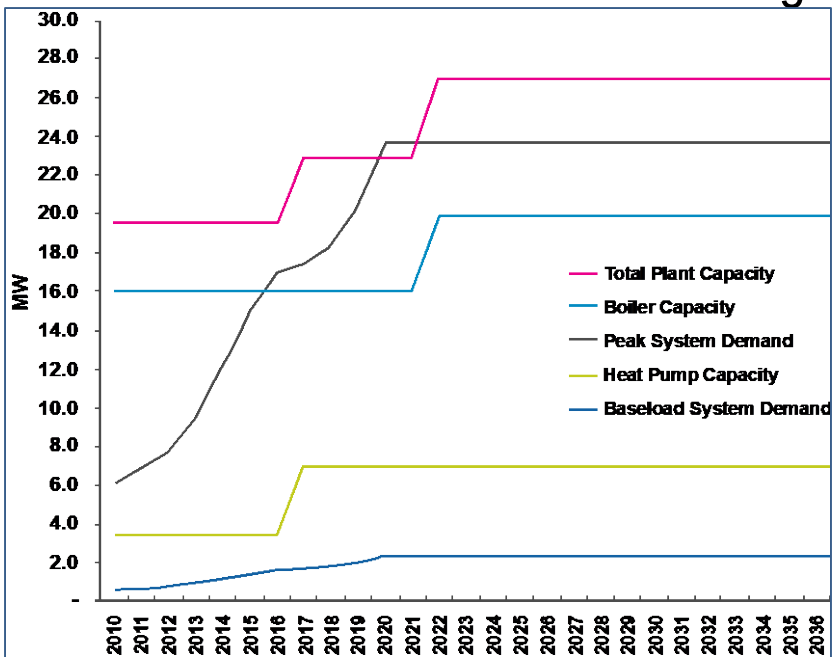
- Over 50 Systems in Operation, mostly in Europe
- Heat exchanger(s) installed inline with sewer
- At least 2 manufacturers
- Coupled with a heat pump water heater
- Can be utility scale or multi-family residential
- Paybacks: 6 years (Germany) to 17 years (Canada) reported
- Maintenance





(5) External, Horizontal, Coupled, Hot water storage

- CASE STUDY:
- Southeast False Creek Neighbourhood Energy Utility
- 2010 DWHR System begins operation
- Includes district heating network & heat pump for an entire neighbourhood
- Natural Gas Boilers kick in during peak periods
- IRR estimated to be 6.4%
- Stand-alone (1) and/or (2) DWHR units should still be installed in buildings because of better IRR



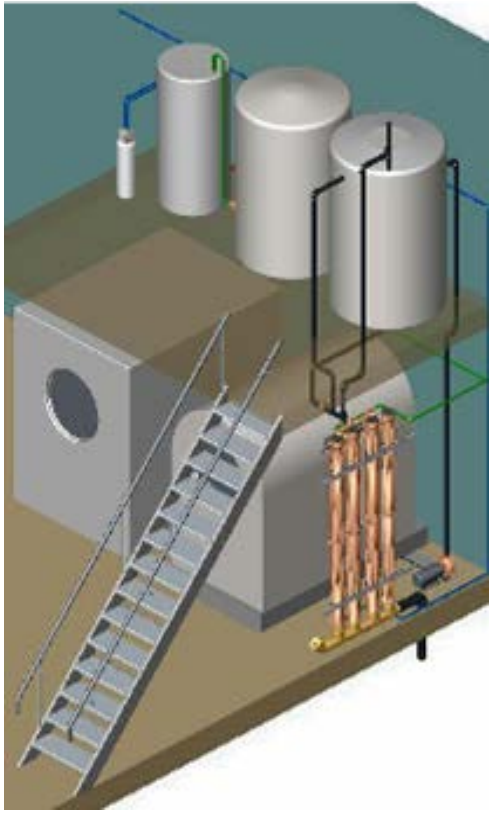
(6) In-Building, Horizontal, Stand-alone, Passive, Immersion

- At least 4 Systems in Operation
- Simple to install
- Heat exchanger(s) installed in a trough, from clothes washer
- 2 manufacturers
- Paybacks: 3-5 years
- Low Maintenance

- <u>CASE STUDY:</u>
- Retrofit in 2014 at the Holiday Inn, St. Catharine's, Ontario
- 3x Multi-Coil on Pipe heat exchangers (2x 4"diameter by 72"long and 1x 4" diameter by 96"long) installed into the laundry drain trough
- Monitored with a heat meter
- Average 27Fº (15Cº) temperature rise
- Payback: 3.5 years
- Low Maintenance

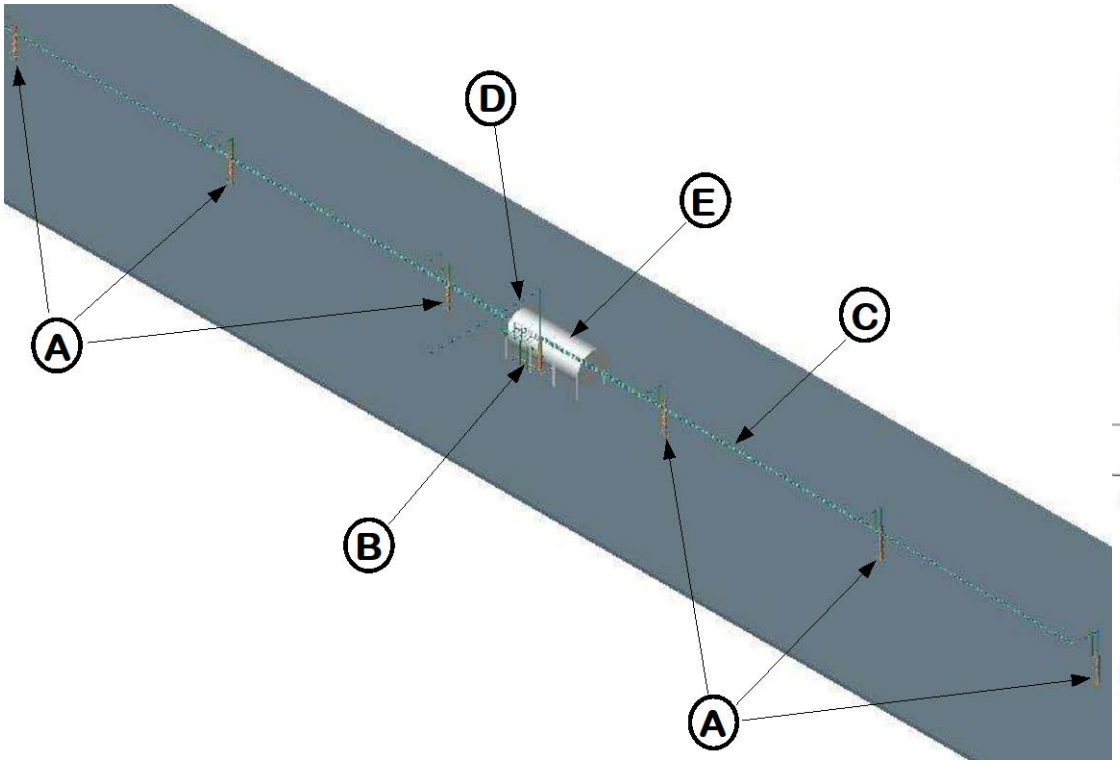
(7) In-Building, Vertical, Stand-alone, Drain-pumped, Storage

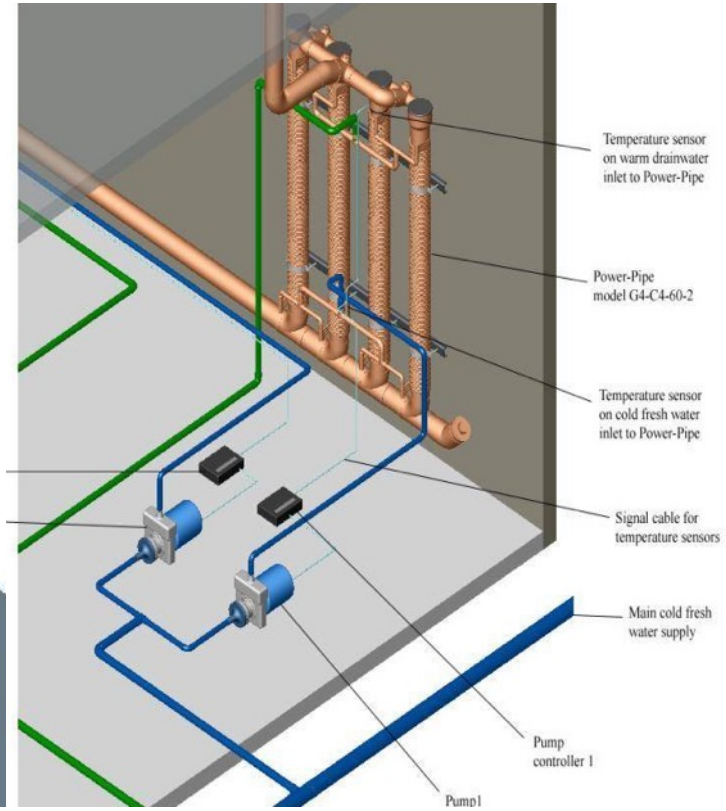
- CASE STUDY:
- 1 System retrofit at the Syfilco (Exeter, Ontario) Textile Mill in 2003
- System Includes 1x 4-pipe vertical DWHR Unit, Drain Water Storage Tank and Controls
- Drain water is pumped up and held in storage until next cycle
- Payback: 2.7 years
- Very Low Maintenance



(8) In-Building, Vertical, Stand-alone, Fresh water on recirc loop

- Variable speed recirc. pump running only when heat is available
- 1 manufacturers
- Paybacks: 2 to 5 years
- Over 70 Systems in Operation over 10 years
- Very Low Maintenance





(8) In-Building, Vertical, Stand-alone, Fresh water on recirc loop

- CASE STUDY:
- 73 Vertical DWHR units retrofit into 16 multi-family residential buildings in 2005 at the Cloverdale Housing Coop in Montreal
- Because of increased hot water capacity, domestic hot water set point temperature was changed from 140ºF to 127ºF
- 5 of 16 Buildings (representing 23 Power-Pipes) were monitored with Heat Meters and savings extrapolated
- **Measured Payback: 3.9 years**

Cloverdale DWHR Layout - Phase I			
Block ID	# DWHR Units	Lowest Block Address	
A	6	4502	Cloverdale
B	6	4509	Cloverdale
C	7	4514	Cloverdale
D	2	4526	Cloverdale
E	2	4530	Cloverdale
F	2	4534	Cloverdale
G	6	4529	Cloverdale
H	6	4542	Cloverdale
I	6	4541	Cloverdale
J	6	8656	Basswood
K	6	8644	Basswood
L	2	4601	Godard
M	5	4605	Godard
N	2	4617	Godard
O	3	4621	Godard
P	6	4639	Godard

Summary Hot Water Consumption and DWHR Performance at Cloverdale Housing Coop - Phase I								
Heat Meter Location within Block (Building)	Date of Hookup	DWHR Units in Block	Apart-ments in Block Connected to System	Annual Water Consuption [m3H2O]	Estimated Annual Energy Savings [MWh]	Estimated Annual Energy Savings [KJ]	Estimated Annual Energy Savings [m3 Nat Gas]	Est. Max. Natural Gas per [m3NG /m3H2O]
4517 Cloverdale	051031	6	18	1830.5	22.3	80,234,085	2155.1	2.52
4530 Cloverdale	051031	2	4	2040.7	11.5	41,328,392	1110.1	1.15
4546 Cloverdale	051031	6	18	2173.5	24.3	87,502,181	2350.3	2.50
8644 Basswood	051102	6	17	2951.8	39.8	143,240,642	3847.5	2.62
4625 Godard	051023	3	6	545.6	5.2	18,595,153	499.5	1.96
Average Hot Water Consumption				2318.6	Average Specific Energy Savings			2.55

Questions?

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