Drain Water Heat Recovery
Engineer's Presentation

RenewABILITY ENERGY INC.

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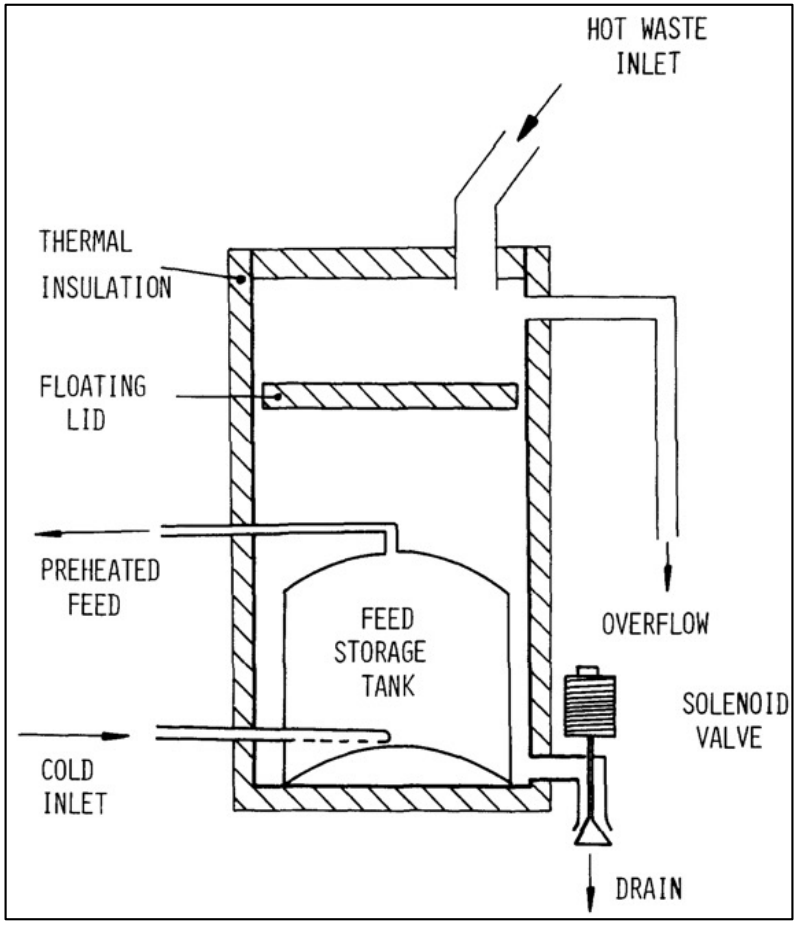
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By: Gerald Van Decker, M.A.Sc., P.Eng.

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1975 – Cranfield Institute of Technology, UK

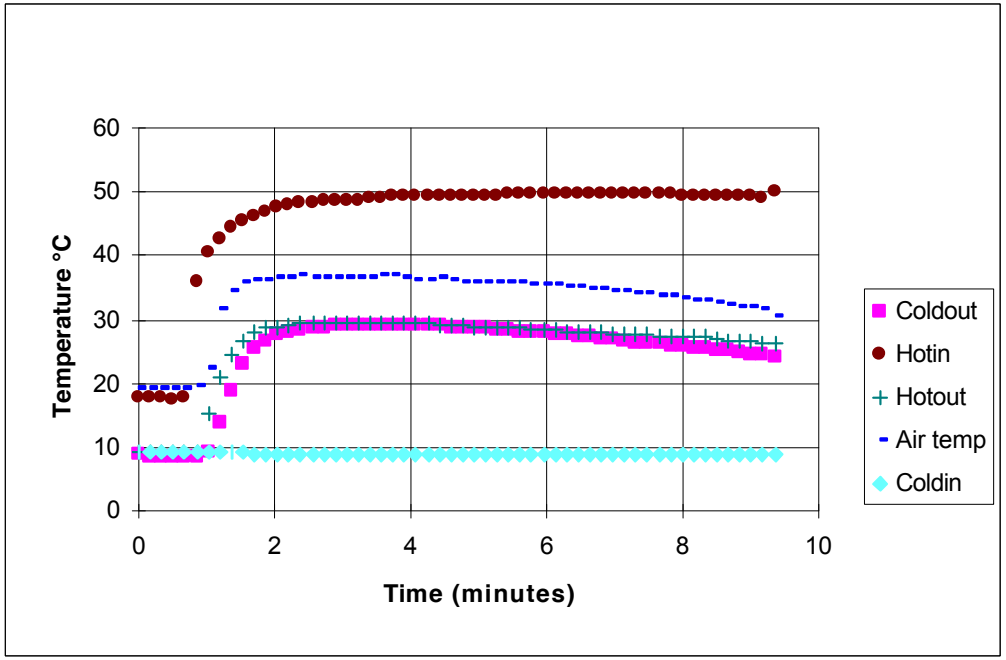
- Earliest known Drain Water Heat Recovery research
- *"Recovery and Utilisation of Heat from Domestic Waste Water"*, I. E. Smith
- Novel Concept in 1975
- Proof of concept test in a home over 1 year
- Storage of both Drain Water and Fresh Water
- Not double-walled, not vented
- 30% reduction hot water energy consumption
- Never commercialized



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2001 - University of Ulster, Northern Ireland

- Dr. Neil J Hewitt and Dr. Peter Henderson
- Earliest known bench-scale lab testing of falling-film systems / single coil tested
- Tested equal and unequal flows
- Analyzed start up (transient)
- No pressure loss measurements





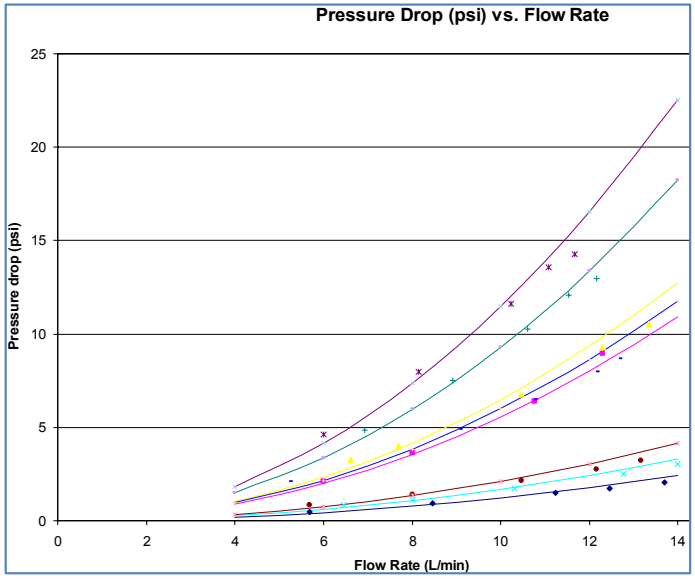
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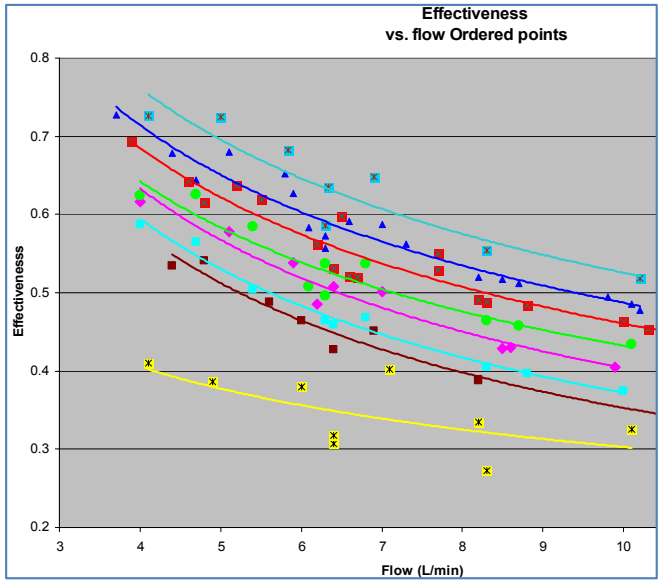
2001, 2006, 2007 – Canadian Government

- Natural Resources Canada (CANMET), National Research Council and CMHC at the Canadian Centre for Housing Technology
- Bench-scale in a “test house”
- Simulated actual cold and hot water draws
- Vertical testing of 8 models from 4 manufacturers
- Pressure Loss also tested and reported
- Tested equal and unequal flows down to 1gpm
- Calculation algorithm developed
- Scatter with steady state results



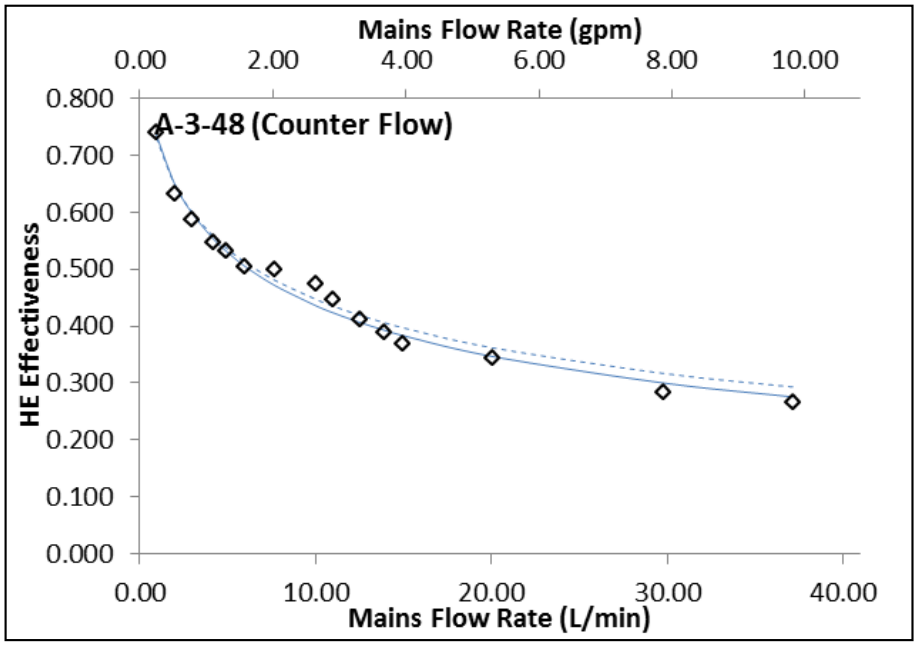


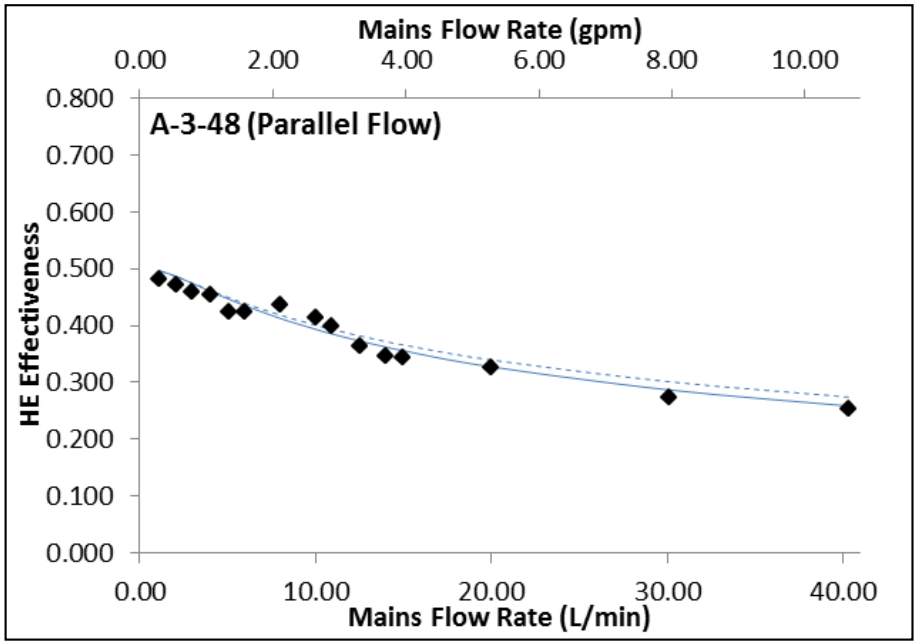




2013 – University of Waterloo et al

- *"Characteristic effectiveness curves for falling-film drain water heat recovery systems" Professor Michael Collins, Gerald Van Decker, Joel Murray. HVAC&R Research Vol. 19 , Iss. 6,2013*
- Testing performed on testing station using direct mains water
- Very repeatable test results measuring effectiveness (efficiency) vs flowrate
- Discovered a "transition zone" where the effectiveness is held higher
- Determined that efficiency curve cannot be properly modelled with a polynomial, as was initially permitted in CSA B55.1
- **Curve fit: Eff = 1 / (a + b * flowrate),** which is a simplification from theory, was found to very accurately model the efficiency curve as a function of flowrate; now it is mandatory in CSA B55.1

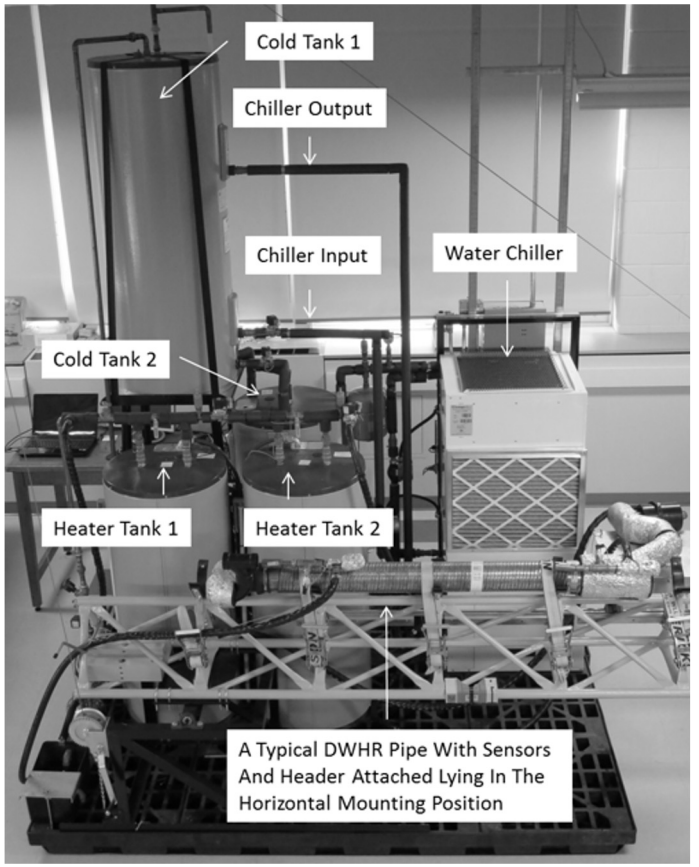


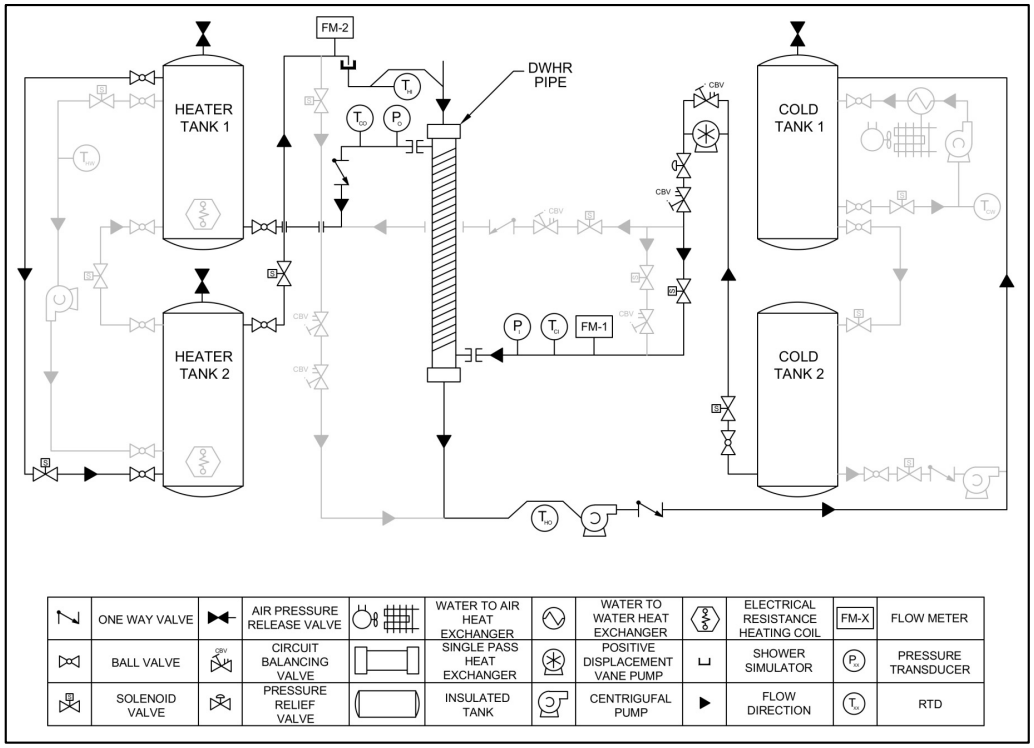


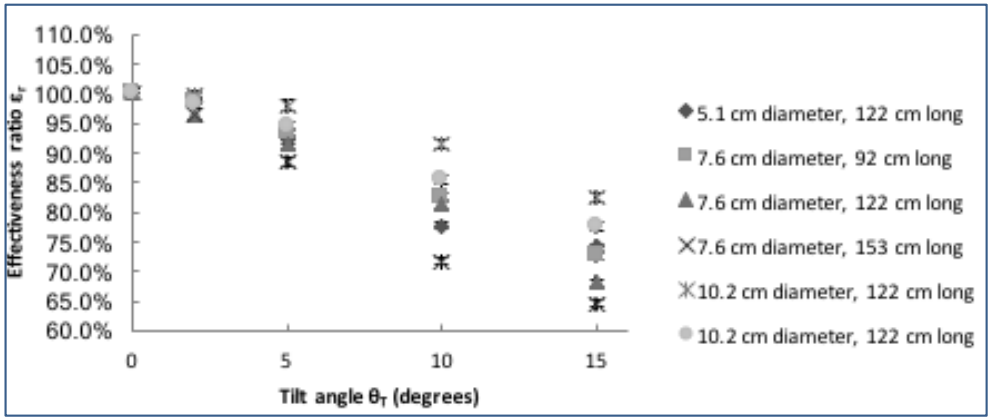
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2015 – University of Waterloo, Mechanical Engineering

- Master's Thesis by Ramin Manouchehri and subsequent published papers with Professor Collins et al.
- Self contained, highly controllable bench scale test station was designed and assembled
- Comprehensive Study and Modelling Developed for Falling-Film DWHR with 2", 3" and 4" diameters







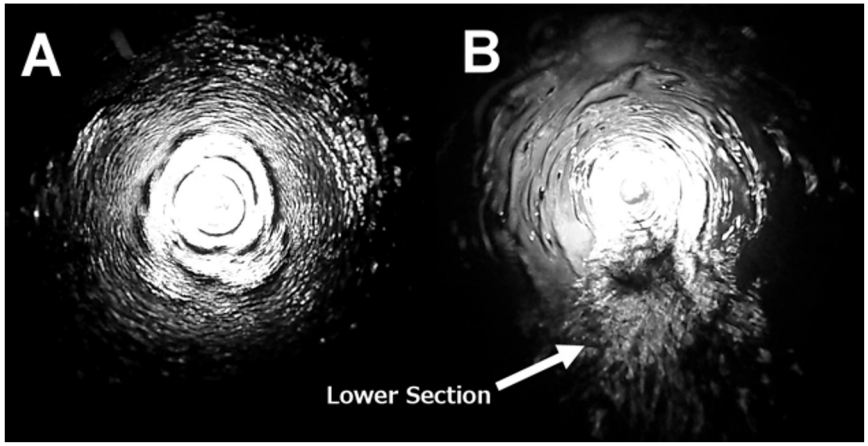
2015 – University of Waterloo, Mechanical Eng. (cont)

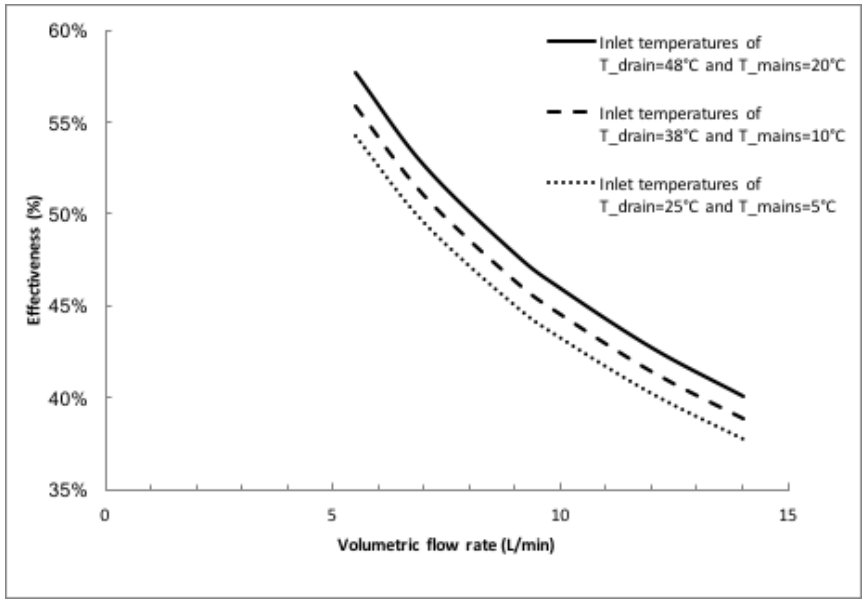
- Studied and reported on the effect of tilt angle upon efficiency up to 15° from vertical
- Developed an general model that is accurate to within +/-3% for adjusting heat exchanger effectiveness (efficiency) based upon:
  - Changing Drain and Freshwater inlet Temperatures
  - Higher Flowrates (outside of the CSA B55.1 Standard)
  - Unequal Flowrates

$$q_{@\dot{V}_c,\dot{V}_h} = q_{eqfl@\dot{V}_c} \times \left[0.3452 \times \ln\left(\frac{\dot{V}_h}{\dot{V}_c}\right) + 1 \right]$$

Case #	$T_{c,i}$ (°C)	$T_{h,i}$ (°C)	$\dot{V}_c$ (LPM)	V_h (LPM)	Measured q_c (kW)	Predicted q_c (kW)	Percent Difference
1	10.5	38.1	25.28	24.83	13.30	13.75	3.25%
2	10.5	37.9	16.04	15.92	10.21	10.33	1.19%
3	9.6	38.1	22.06	21.78	12.70	13.06	2.75%
4	9.6	37.9	19.32	19.05	11.74	11.94	1.65%
5	9.7	38.0	19.18	7.07	8.04	7.88	2.02%
6	9.7	37.9	15.95	9.00	8.54	8.55	0.10%
7	9.8	38.0	12.09	16.05	9.72	9.73	0.11%
8	9.7	38.0	10.01	19.02	9.56	9.51	0.50%
9	14.6	44.9	14.02	13.93	10.71	10.54	1.63%
10	14.7	44.7	9.00	8.96	8.16	8.21	0.65%
11	14.8	44.4	5.47	5.42	5.89	5.79	1.67%
12	14.9	45.0	14.01	10.05	9.52	9.30	2.34%
13	14.9	44.8	11.97	9.03	8.76	8.69	0.77%
14	4.8	35.1	14.06	13.97	10.29	10.23	0.61%
15	4.8	35.0	9.00	8.92	7.85	7.96	1.33%
16	5.1	34.8	5.49	5.44	5.77	5.67	1.79%
17	4.8	35.1	9.03	13.99	9.02	9.30	2.96%
18	4.8	35.0	7.03	9.99	7.55	7.71	2.14%

System #	Manufacturer	Diameter (cm)	Length (cm)
1	A	5.1	92
2	A	7.6	122
3	B	7.6	102
4	B	10.2	122





Classifying DWHR Systems

- Location:
  - In-Building vs External
- Orientation:
  - Vertical vs Horizontal
- Complexity:
  - Stand-alone vs Coupled (e.g. heat pump)
  - Passive vs Pumped (drain water and/or fresh water)
  - Storage?
  - Immersion?
- Stage of Development:
  - Proven vs Theoretical
- 8 DWHR System Types shall be reviewed
  - NOTE: other system types may exist now or in the future and/or have not been found to be practical

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(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
- Mandatory in New Residential in Manitoba & Ontario
  - Standards: B55.1 & B55.2
  - Minimum Efficiency 42%
- Maintenance Free, Double-wall vented
- Connections:
  - Fresh: ½”, ¾”, 1”
  - Drain: 2”, 3”, 4”, 6”











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

- CASE STUDY:
- 2000 - in a Triplex in Duluth, Minnesota
- 3-coil 2nd generation DWHR unit which is 4” diameter, 60” long
- With Electric Water Heater, saved 2,800 kWh over the year
- Examined the % Savings on Total Hot Water Load and found it to be 25% to 30% over the year

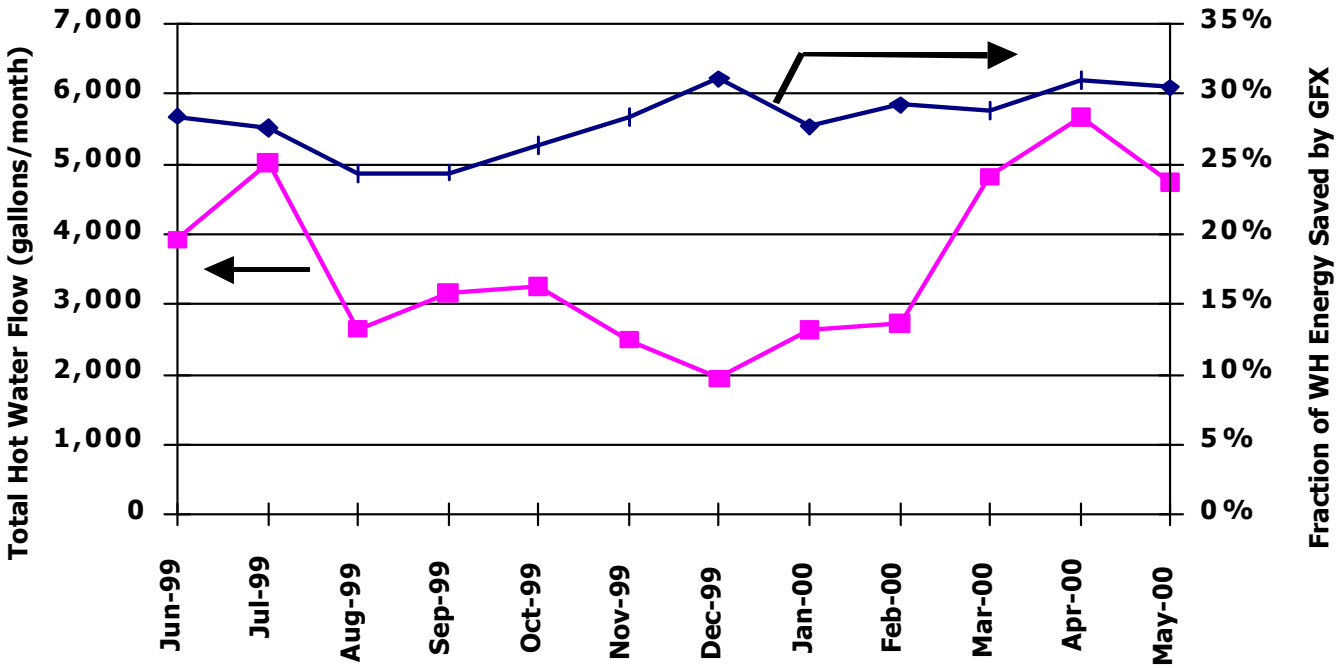
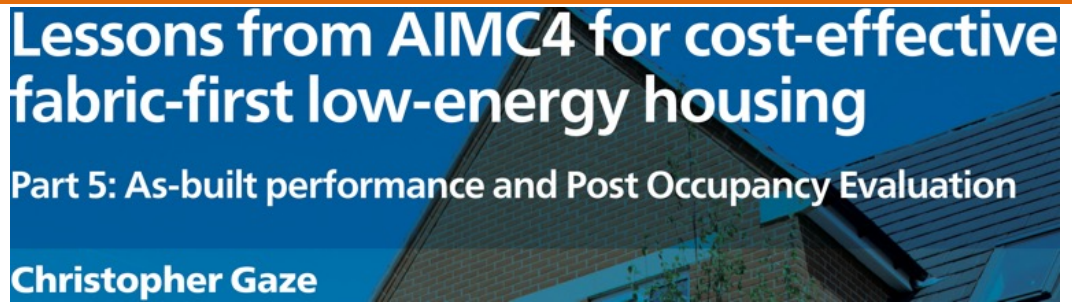


Figure 1. Total hot water use and GFX benefit over the field study in Duluth.

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

- CASE STUDY:
- 2010-2014 - AIMC4, UK Sites
- DWHR Units installed in 8 homes



- Detailed Monitoring Results from 2 Homes with 4” dia. & 84” long units
- Energy Delivered was 35% & 41% of total domestic hot water, which UK Energy Code (SAP) calculated 24% & 15%
- Manufacturer claimed 4 years prior that it would be 35%-41%
- SAP uses an “Energy Balance” Calculation Method for DWHR that has 7 errors in it, thus demonstrating pitfalls with the Energy Balance method

Figure 24: Savings from waste water heat recovery per person

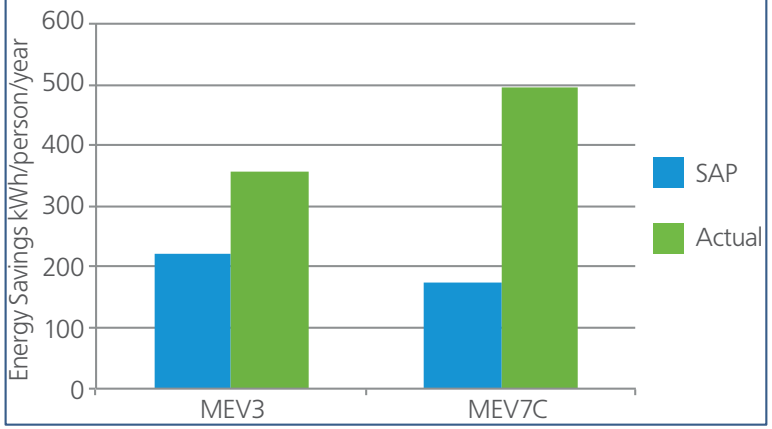
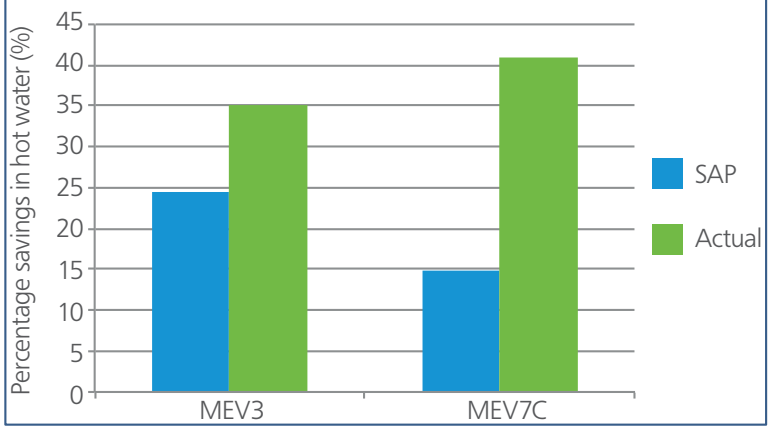


Figure 25: Percentage saving shown in SAP and actual for WWHR





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

- CASE STUDY:
- 2001 - in an Ottawa home with Ottawa Hydro
- DWHR Unit: 3” diameter, 60” long
- With Electric Water Heater
- Examined the % Savings on Total Hot Water Load with and without DWHR

	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%**

	Energy Consumption Water Heater [kWh]	Energy Delivered GFX [kWh]	Energy Delivered Water Heater [kWh]	Volume Water GFX Kent [litres]	Min.Tank is ON	Tank Time / Water Volume [min/litre]	Tank Energy / Water Volume [kWh/litre]
With GFX	53.19	32	51	1753	1097	**0.6258**	**0.0303**
Without GFX	26.96	0	26	591	551	**0.9323**	**0.0456**
			Reduction in Tank Time and Tank Energy			32.9%	33.5%

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(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









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(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



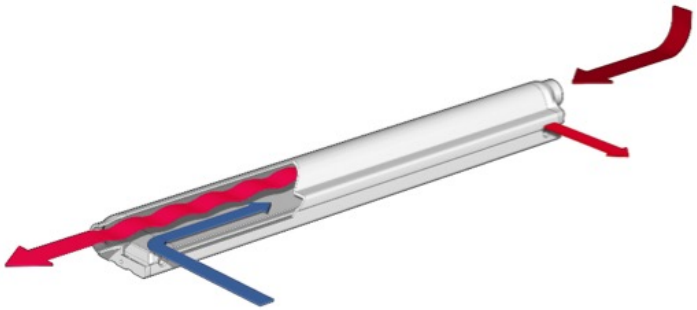


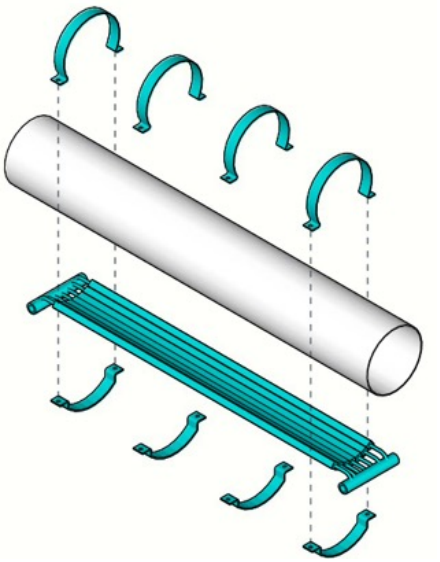
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(3) In-Building, Horizontal, Stand-alone, Passive

- 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







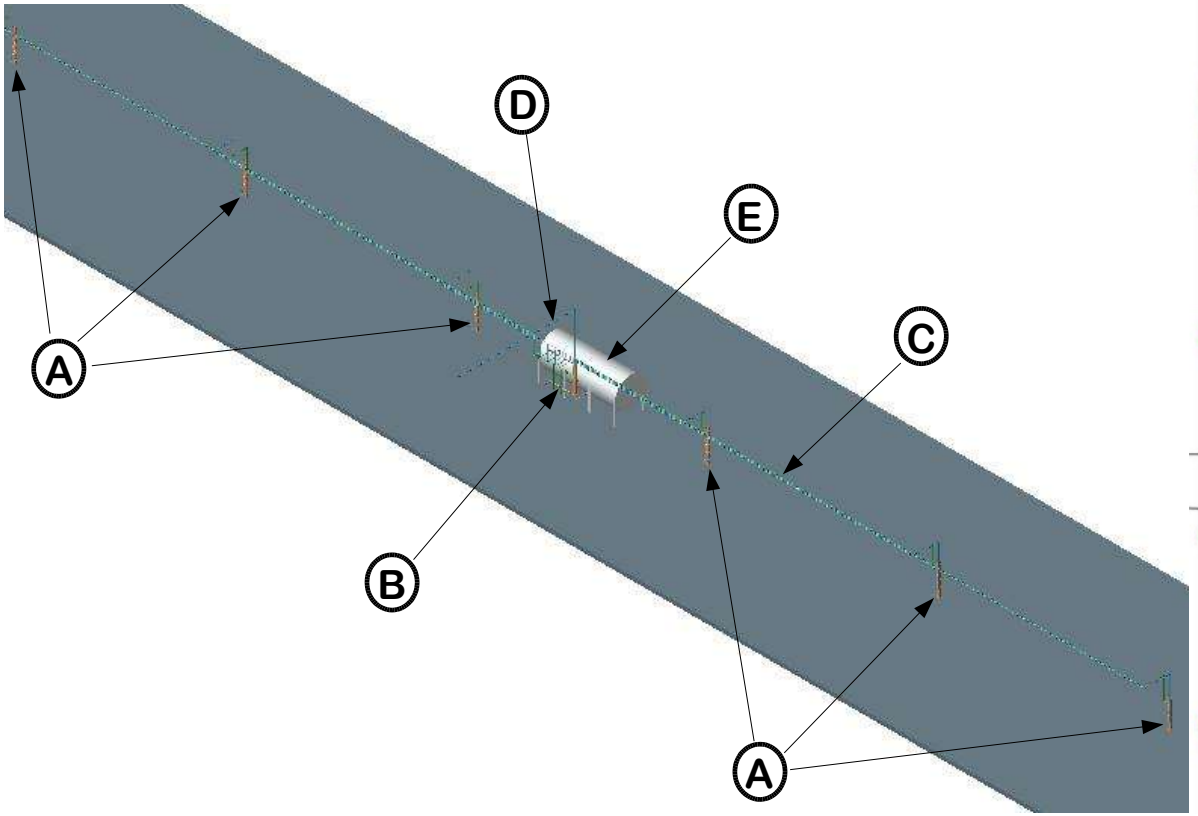


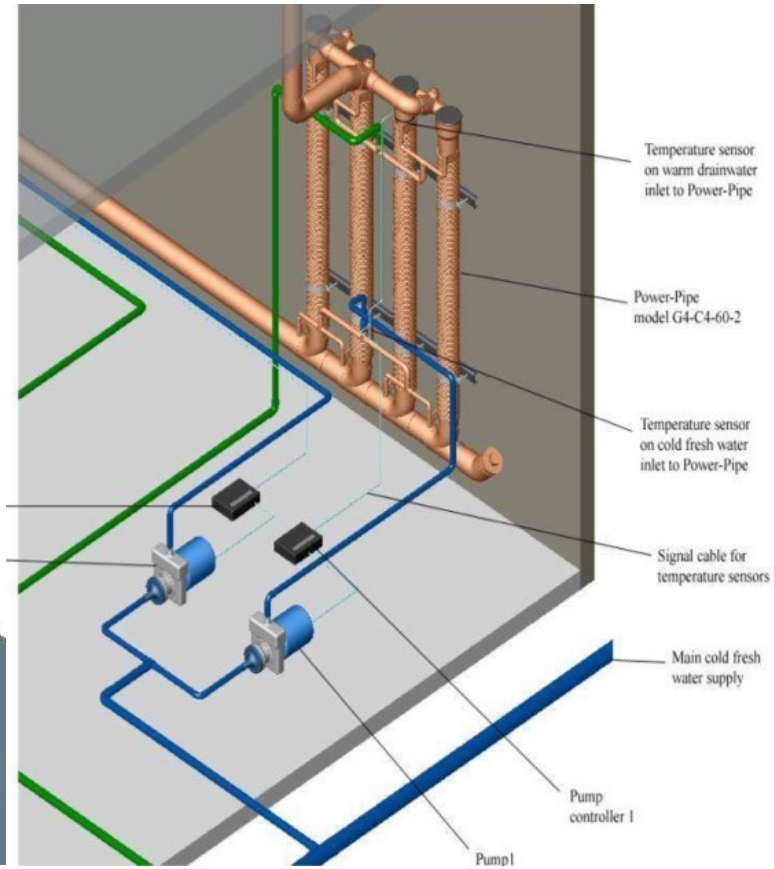


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(8) In-Building, Vertical, Stand-alone, Fresh water on recirc loop

- 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





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(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
- Project 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

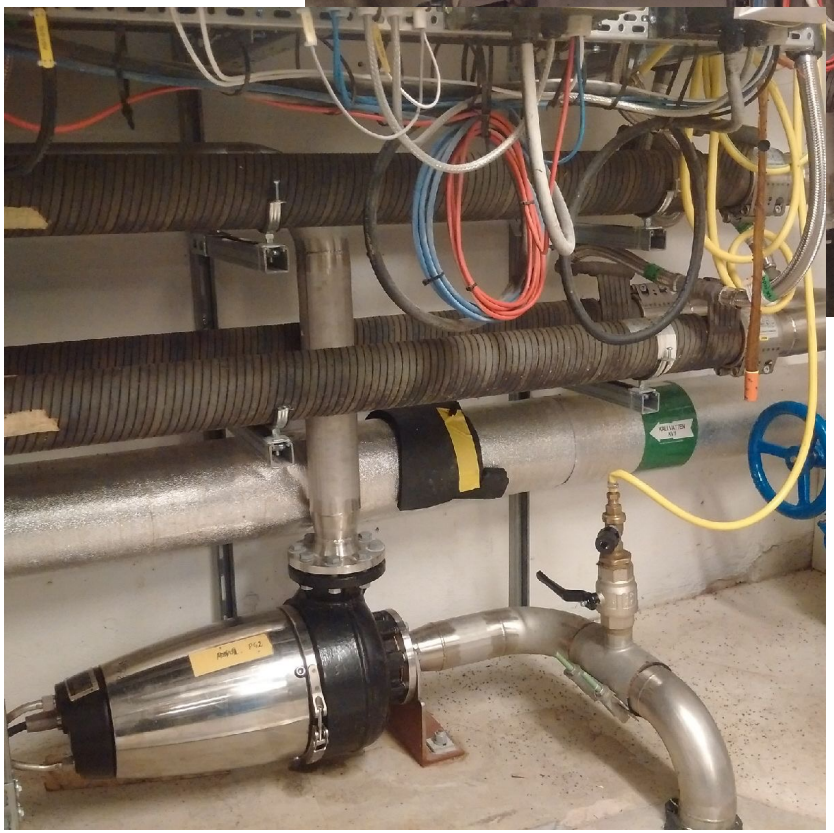
Summary Hot Water Consumption and DWHR Performance at Cloverdale Housing Coop - Phase I

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

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

- About 12 Systems installed in Europe
- Can take “black water”
- Paybacks of 4 to 6 years reported
- Many configurations available
- Can be retrofit into large percentage of buildings
- Projects planned in North America





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Cold Water Preheating Scenarios

Central Water Heating

- DWHR unit placed in main drain stack with back-to-back washrooms or stacked vertically 1 to 6 washrooms/unit
- The annual savings will depend partly upon how many washrooms are connected to each DWHR unit

Apartment Buildings, Condos, and Dormitories

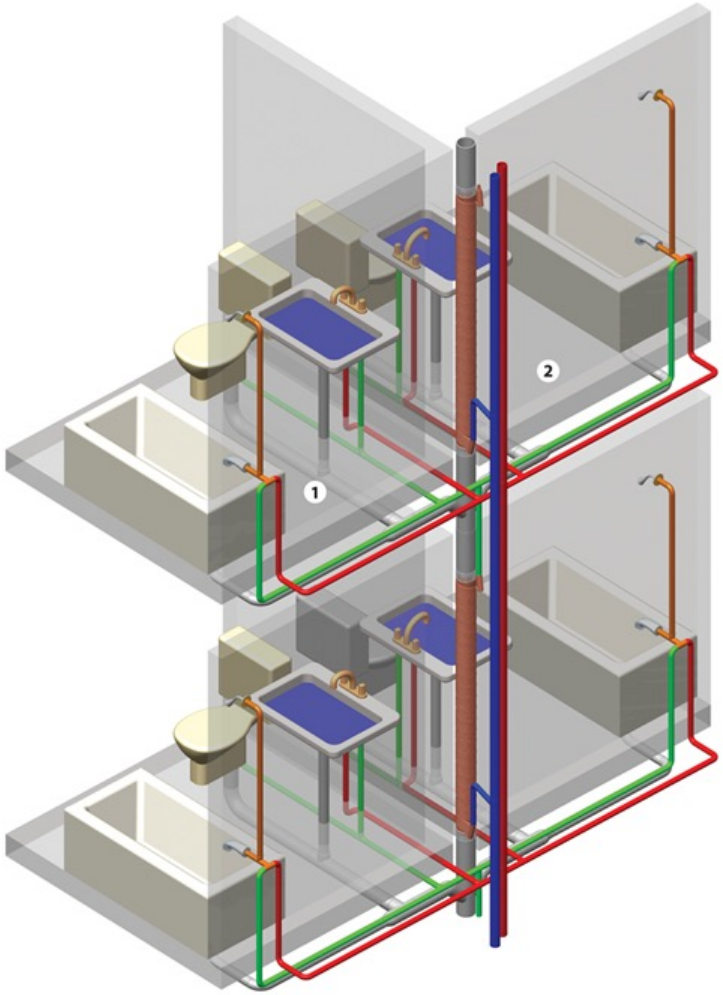
- water from DWHR unit supplies cold water to showers, lavatory and toilet

Hotels

- pre-heated water from DWHR unit supplies cold water line to showers and toilet, where desired. Not to the lavatory.

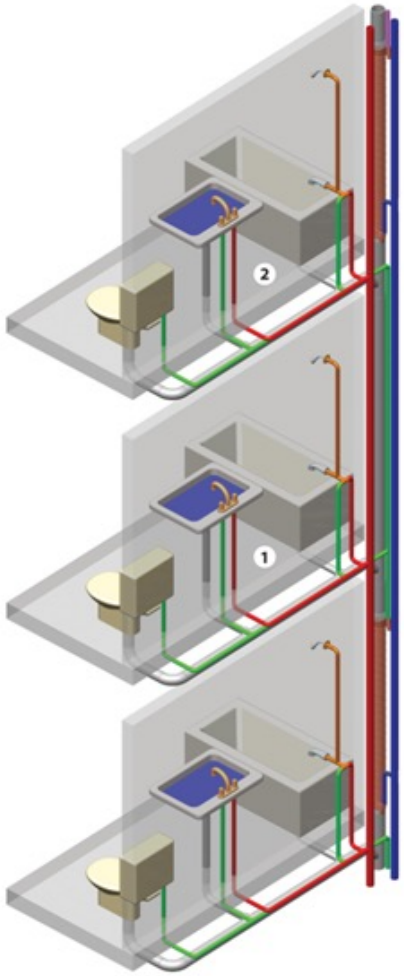
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1-2 Washrooms per DWHR Unit – Central Hot Water



2 WC arranged 2 by 1

-Fresh water from DWHR to cold water fixtures only

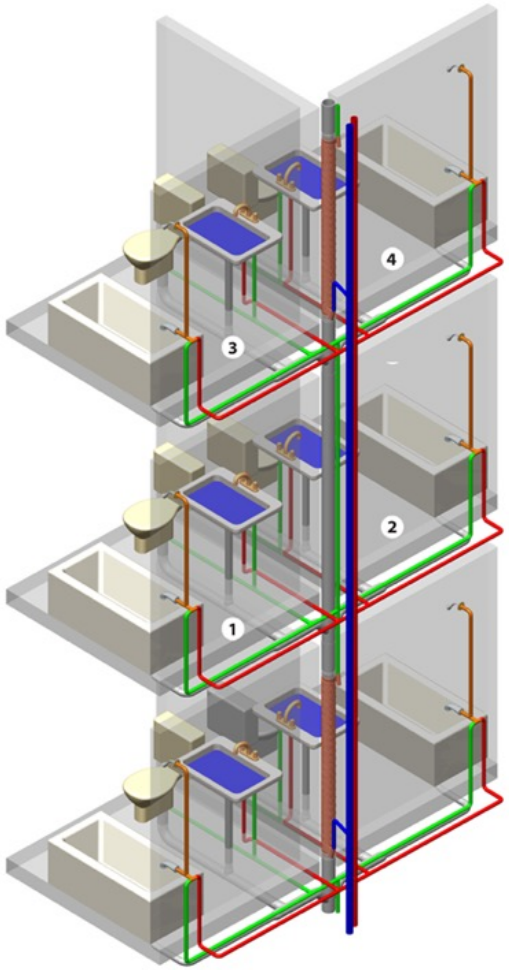


2 WC arranged 1 by 2

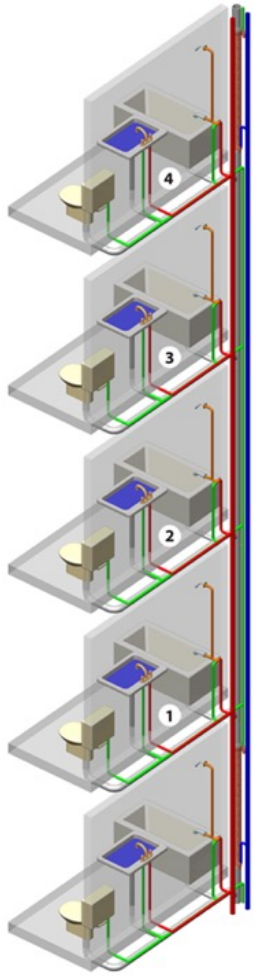
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3-4 Washrooms per DWHR Unit – Central Hot Water

-Fresh water from DWHR to cold water fixtures only



4 WC arranged 2 by 2

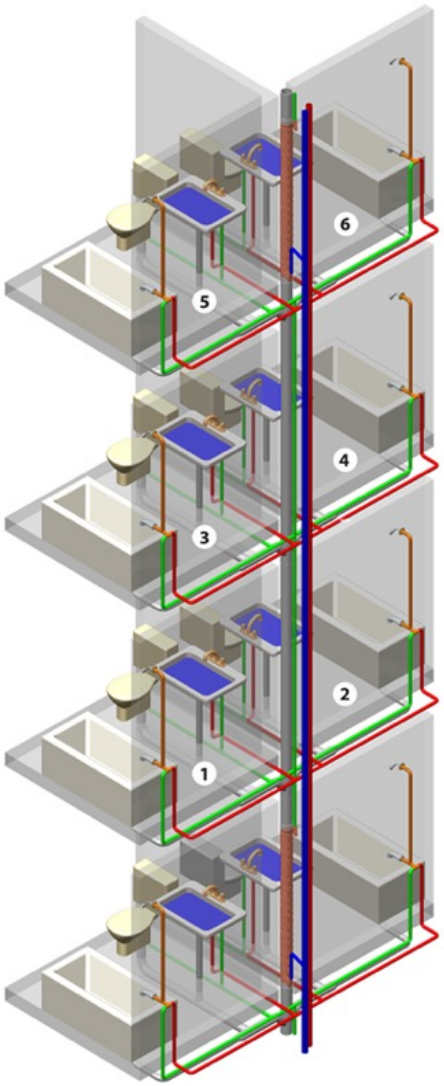


4 WC arranged 1 by 4

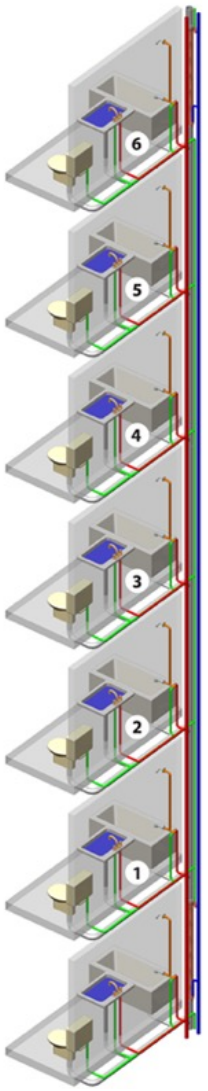
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5-6 Washrooms per DWHR Unit – Central Hot Water

-Fresh water from DWHR to cold water fixtures only



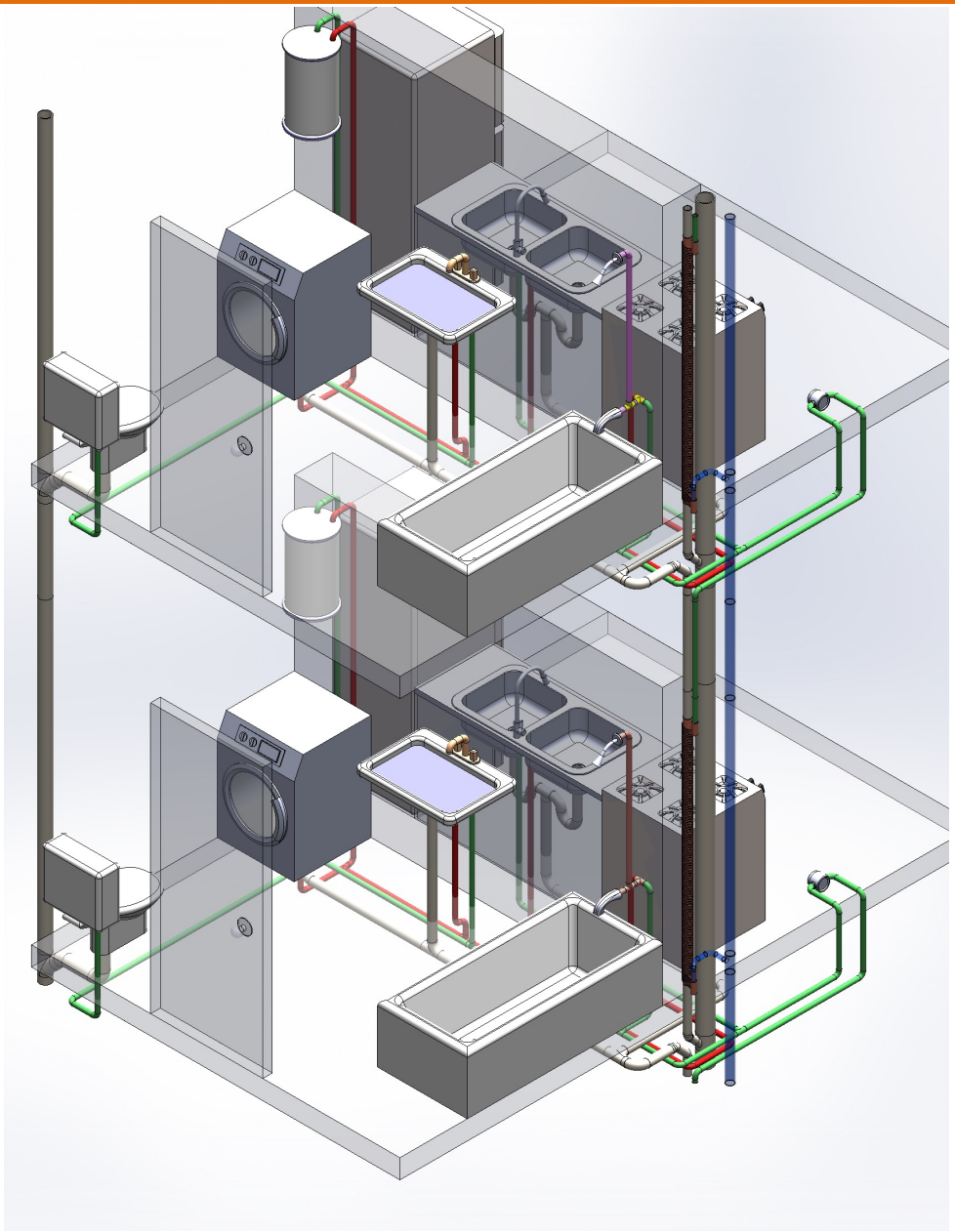
6 WC arranged 2 by 3



6 WC arranged 1 by 6

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Equal Flow Installation



-1x DWHR unit per Apartment

-Drain water runs parallel to main stack and through unit

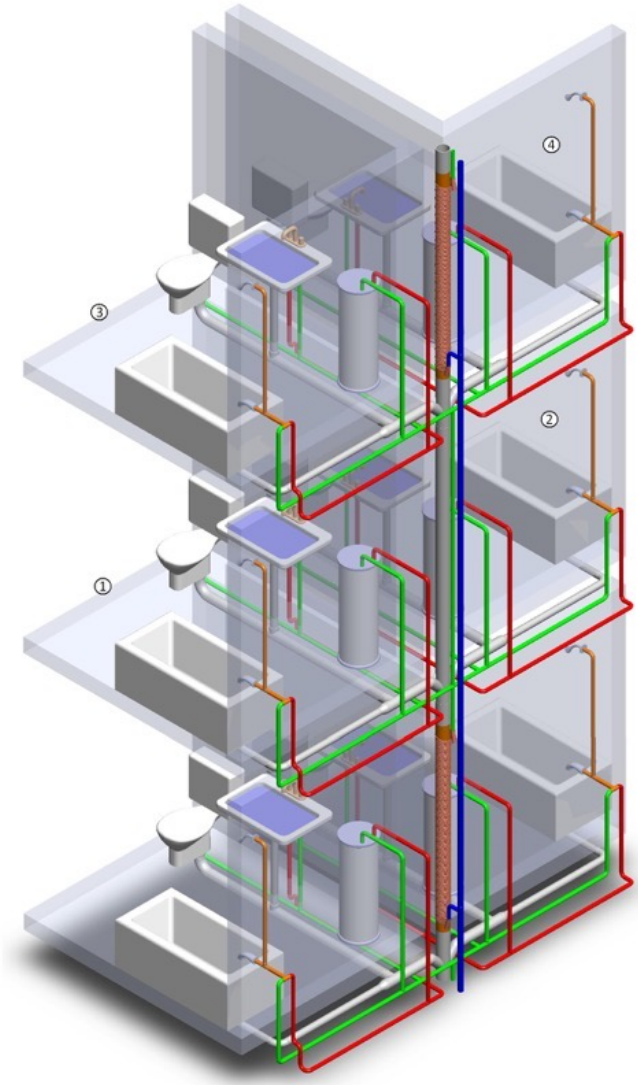
-2” diameter DWHR for grey water or 3” diameter DWHR for all drain water

-Each apartment with small 20 gallon wall-mounted water heater / off peak heating recommended with electric water heating

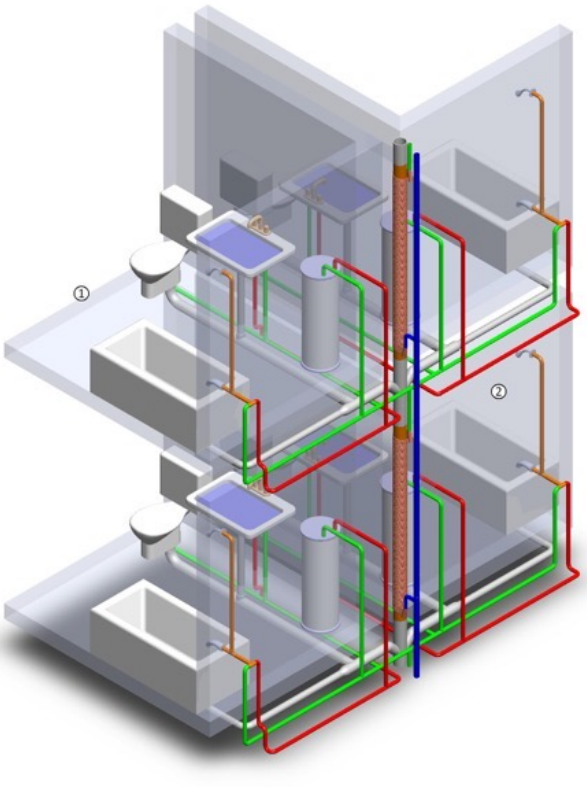
-Fresh water from DWHR to water heater and all cold water fixtures

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Equal Flow Installation – in main drain stack



4 WC Equal Flow arranged 2 by 2



2 WC Equal Flow arranged 2 by 1

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Calculation Method #1: "Top Down Based on Total Load"

- Used in IECC 2015 and Canadian MNECB for Multi-Family Residential and some Commercial Applications

IECC 2015 Method for Multi-Family Residential

Revised Hot Water Load = SWHF * Baseline Hot Water Load

Where for Multi-Family, SWHR is calculated as follows:

*1-2 Washrooms per DWHR Unit: SWHF = 1 – (DWHR unit efficiency† * 0.36)*

*3-4 Washrooms per DWHR Unit: SWHF = 1 – (DWHR unit efficiency† * 0.33)*

*5-6 Washrooms per DWHR Unit: SWHF = 1 – (DWHR unit efficiency† * 0.26)*

†DWHR unit efficiency is as per rated and labelled according to CSA B55.1

NOTE: This assumes unequal flow. For equal flow, also multiply by: 1.29. For example, 0.33*1.29

Advantages:

-Quick and easy to Calculate

-Most accurate and generally applicable

-Can be used for a single building or for an average over millions of homes

-Savings is useful for LEED and Energy Code Compliance

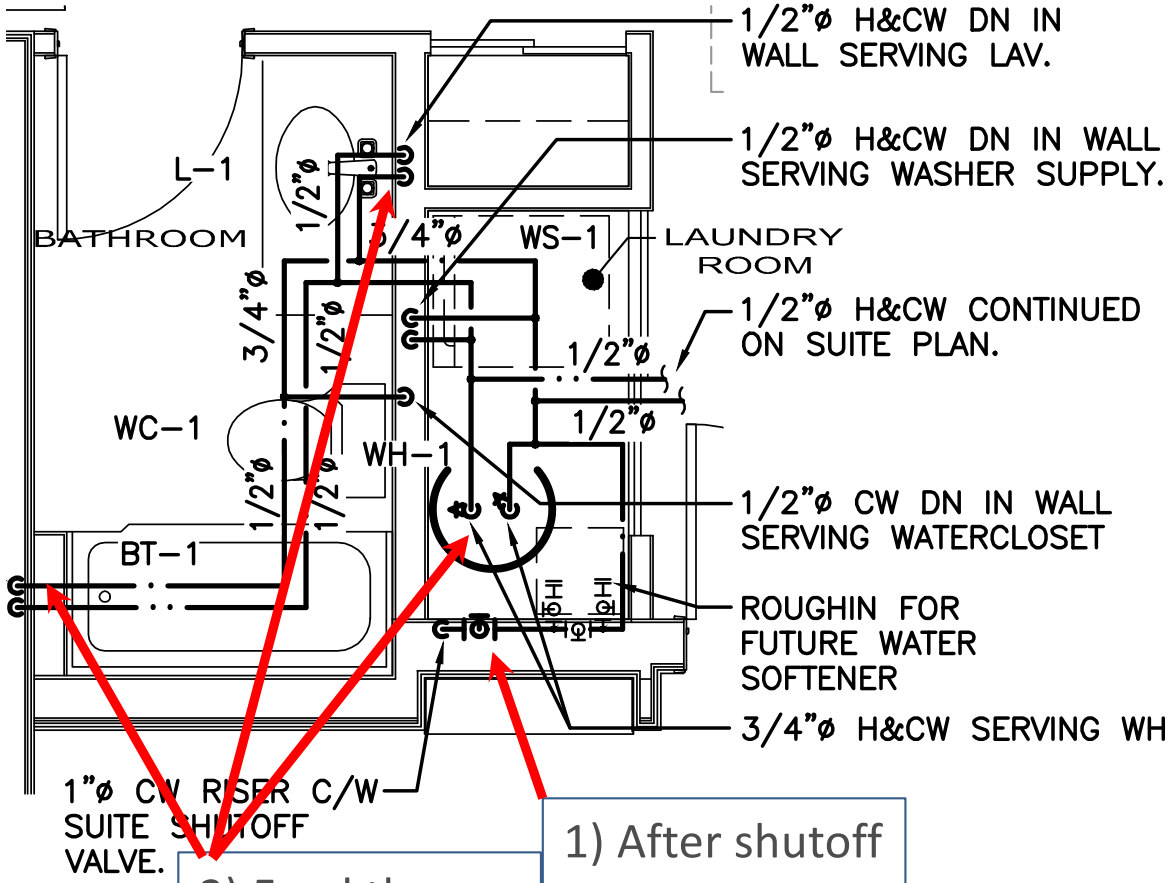
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Sample 1: IECC Credit Calculation

- 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.

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Sample 2: IECC Credit Calculation



1) After shutoff valve, ¾" line down to floor below and back up

2) Feed the Line to the water heater, cw side of shower & lavatory

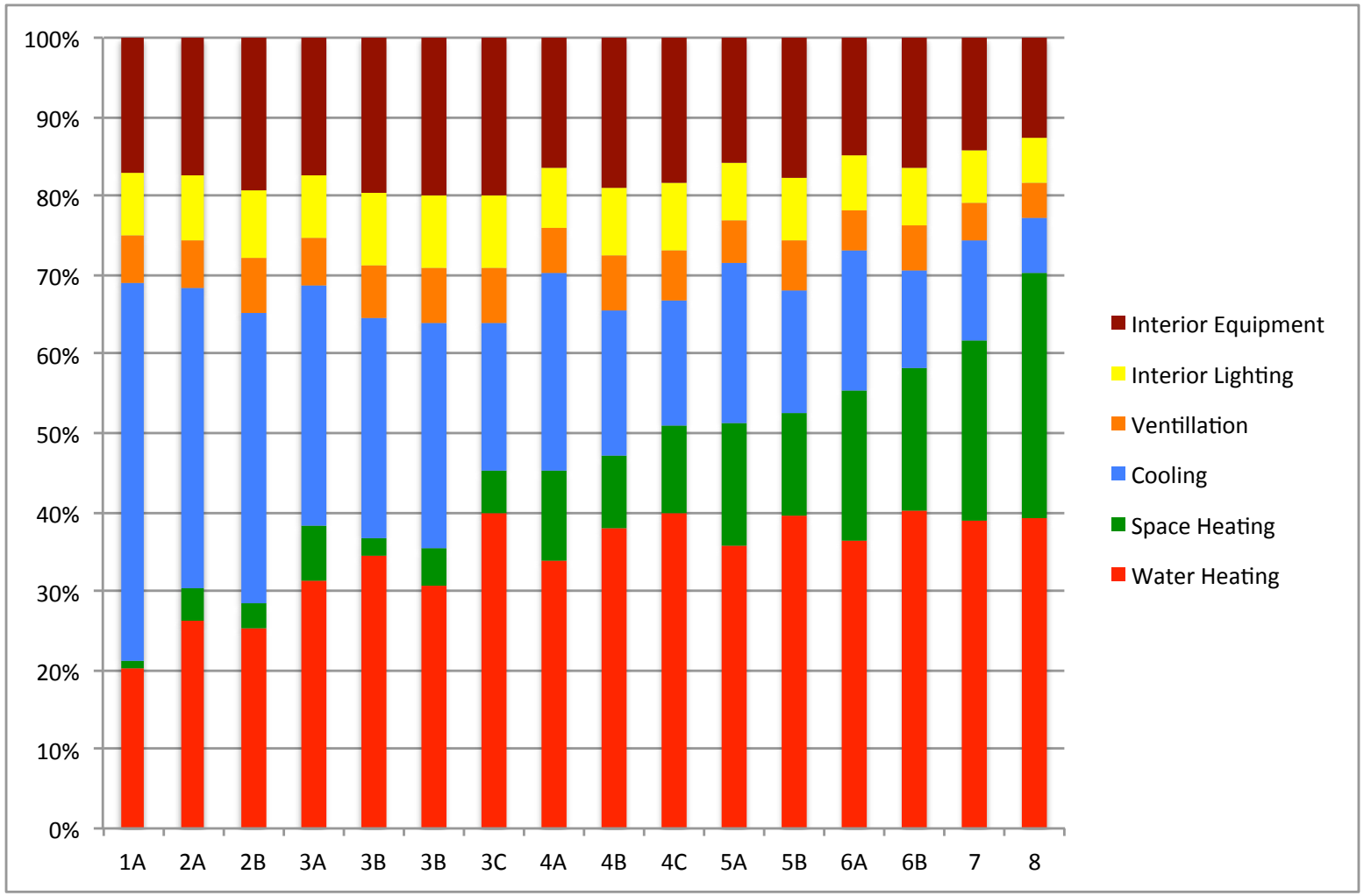
3) Cannot service the first floor showers/suites with DWHR.

4) Typical Models to use are 2", 3" and/or 4" diameter and 72" long

Washroom per Unit:	1-2
# of Showers:	62
# of Showers Fed by DWHR:	48
DWHR utilization:	77.4%
Weighted Average DWHR % Efficiency:	59.4%
Weighted Average SWHF where Installed:	72.5%
Hot Water Savings for Building:	**21.3%**

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New Large Hotels: Breakdown of Energy Consumption



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Energy Savings in New Large Hotels

New Large Hotels: Percent Savings on Water Heating from the Power-Pipe C4-72

Sample City - Climate Zone	Off Water Heating	Off Total Building
Miami - 1A	18.8%	3.8%
Houston - 2A		4.9%
Phoenix - 2B		4.8%
Atlanta - 3A		5.9%
Los Angeles - 3B		6.5%
Las Vegas - 3B		5.8%
San Francisco - 3C		7.5%
Baltimore - 4A		6.4%
Albuquerque - 4B		7.1%
Seattle - 4C		7.5%
Chicago - 5A		6.7%
Boulder - 5B		7.4%
Minneapolis - 6A		6.8%
Helena - 6B		7.6%
Duluth - 7		7.3%
Fairbanks - 8		7.4%

Sources:
http://buildingsdatabook.eren.doe.gov/DataBooks.aspx
and IECC 2015

***Source: http://buildingsdatabook.eren.doe.gov/DataBooks.aspx**

New Large Hotels: Breakdown of Energy Consumption

Energy Benchmarks for Newly Constructed Large Hotels,
by Climate Zone and End-Use

Climate Zone	Water Heating	Space Heating	Cooling	Ventillation	Interior Lighting	Interior Equipment
1A	20.3%	0.9%	47.8%	6.0%	7.8%	17.1%
2A	26.2%	4.2%	38.0%	6.1%	8.0%	17.5%
2B	25.4%	3.0%	36.8%	6.8%	8.8%	19.2%
3A	31.3%	7.1%	30.2%	6.1%	7.9%	17.4%
3B	34.4%	2.5%	27.6%	6.8%	9.0%	19.7%
3B	30.6%	4.8%	28.5%	7.1%	9.1%	19.9%
3C	39.9%	5.3%	18.7%	7.2%	9.1%	19.9%
4A	33.8%	11.5%	24.8%	5.7%	7.6%	16.6%
4B	37.8%	9.4%	18.3%	6.8%	8.6%	19.0%
4C	39.9%	11.2%	15.7%	6.4%	8.4%	18.5%
5A	35.6%	15.5%	20.3%	5.5%	7.2%	15.9%
5B	39.5%	13.1%	15.4%	6.2%	8.0%	17.7%
6A	36.3%	19.1%	17.5%	5.2%	6.8%	15.0%
6B	40.2%	17.9%	12.3%	5.7%	7.5%	16.4%
7	38.8%	22.8%	12.6%	5.0%	6.5%	14.3%
8	39.2%	31.3%	6.8%	4.3%	5.8%	12.7%

Source: http://buildingsdatabook.eren.doe.gov/DataBooks.aspx

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Objective 3: Multi-Family Residential Building & Hotel designs

Budgetary Scenario for Large Hotels (Zone 5B-Denver)

Building Type	Typical Hot Water Energy Load (% of total)	How it is Plumbed (e.g. Suites per DWHR Unit)	Plumbing Configuration / Comments	Typical Potential Savings of Total Building Energy Load (% of total)	Typical LEED Points Achievable for High-Rise	Budgetary Total Cost Per Suite	Suites	Total Budgetary Cost for DWHR	Cost per LEED Point	
Large New Hotels (>=6 storeys) IECC Zone 5B e.g. Boulder	39.5%	1 or 2 WC per DWHR Unit	CW Pre-Heating Only	11.6%	5.8	$620.00	200	$124,000	$21,400	/point
		3 or 4 WC per DWHR Unit	CW Pre-Heating Only	9.3%	4.6	$400.00	200	$80,000	$17,200	/point
		5 or 6 WC per DWHR Unit	CW Pre-Heating with 1.5gpm Showerheads	6.6%	3.3	$320.00	200	$64,000	$19,400	/point
		>=7 WC per DWHR Unit	recirc. loop / custom engineered	1.6%	0.8	unknown				

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Commercial Applications

Application	Variation	Plumbing Configuration / Comments	Typical Hot Water Energy Load (% of total) A	Typical Reduction in Hot Water Load B	Typical Potential Savings of Total Energy Load (% of total) A*B	Typical LEED Points Achievable for High-Rise (NC and Major Retrofit) Multi-Residential
Foodservice (e.g. Restaurants, Cafeterias, etc.)	Batch Dishwasher	Any Load Size - savings estimated	15.6%	31.5%	4.9%	2.5
	Continuous Dishwasher	2.5gpm - savings estimated		37.8%	5.9%	2.9
	Continuous Dishwasher	5gpm - savings estimated		42.2%	6.6%	3.3
Hospitals - Inpatient	1-2 WC per DWHR Unit	CW Pre-Heating Only	19.4%	29.4%	5.7%	2.9
	3-4 WC per DWHR Unit	CW Pre-Heating Only		23.5%	4.6%	2.3
	5-6 WC per DWHR Unit	Pre-Heating with 1.5gpm Showerhea		16.7%	3.2%	1.6
NOTE: DWHR from showers illustrated. Hospitals have other loads which DWHR can recover heat from at an even higher energy savings rate.						
Education (Locker Rooms in High School & Colleges)	Multi-pipe DWHR Unit	Equal Flow	7.0%	48.2%	3.4%	1.7
	Multi-pipe DWHR Unit	Equal Flow		44.4%	3.1%	1.6
NOTE: DWHR for locker room showers & cafeterias. Excludes dorms. Multi-pipe DWHR units are assemblies of 2, 4 or 8 standard units.						
Recreation Facilities	Multi-pipe DWHR Unit	Equal Flow	project specific	50.0%	project specific	project specific
Laundry Facilities	Multi-pipe DWHR Unit	Equal Flow	project specific	60.0%	project specific	project specific
Prisons	Multi-pipe DWHR Unit	Equal Flow	project specific	55.0%	project specific	project specific

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Recreation Facilities, High Schools, and Prisons

Application	Variation	Plumbing Configuration / Comments	Typical Hot Water Energy Load (% of total) A	Typical Reduction in Hot Water Load B	Typical Potential Savings of Total Energy Load (% of total) A*B	Typical LEED Points Achievable for High-Rise (NC and Major Retrofit) Multi-Residential
Education (Locker Rooms in High School & Colleges)	Multi-pipe DWHR Unit	Equal Flow - R-series DWHR units	7.0%	48.2%	3.4%	1.7
	Multi-pipe DWHR Unit	Equal Flow - C-series DWHR units		44.4%	3.1%	1.6
Recreation Facilities	Multi-pipe DWHR Unit	Equal Flow	project specific	50.0%	project specific	project specific
Prisons	Multi-pipe DWHR Unit	Equal Flow	project specific	55.0%	project specific	project specific



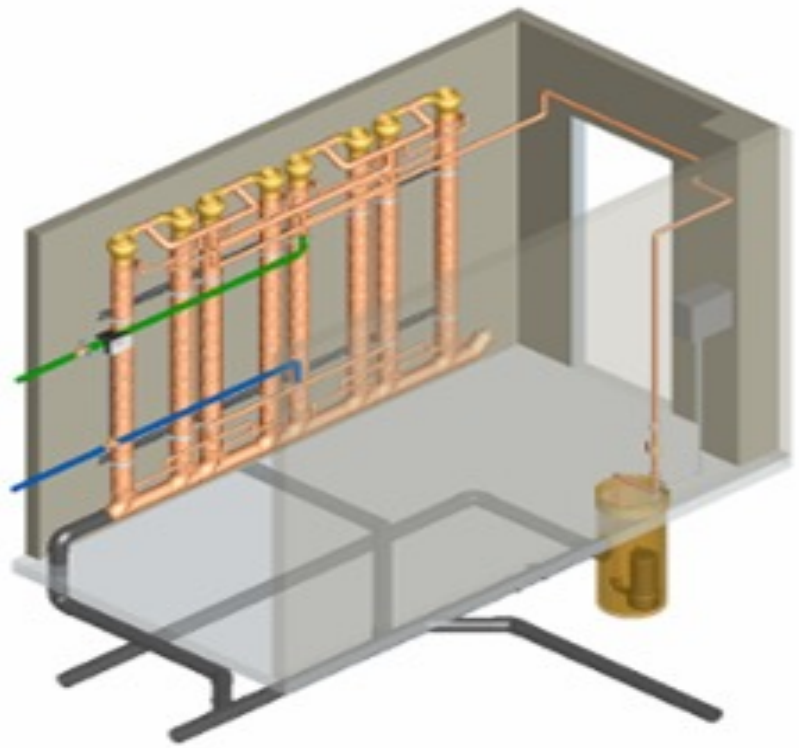




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Recreation Facilities, High Schools, and Prisons

- slab-on-grade/drain flow in floor – elevate drain water using pump
- electrical consumption – only 1-2% of DWHR energy savings
- high schools/prisons - controller may not be required if showers are used all at once or not at all



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DWHR for Food Services

Application	Variation	Plumbing Configuration / Comments	Typical Hot Water Energy Load (% of total) A	Typical Reduction in Hot Water Load B	Typical Potential Savings of Total Energy Load (% of total) A*B	Typical LEED Points Achievable for High-Rise (NC and Major Retrofit) Multi-Residential
Foodservice (e.g. Restaurants, Cafeterias, etc.)	Batch Dishwasher	Any Load Size - savings estimated	15.6%	31.5%	4.9%	2.5
	Continuous Dishwasher	2.5gpm - savings estimated		37.8%	5.9%	2.9
	Continuous Dishwasher	5gpm - savings estimated		42.2%	6.6%	3.3

Typical Energy Savings: 5% to 7%, but can be double

Typical Budgetary Cost: $1,000 (gravity fed, single unit) to $15,000 (large hospital operation)

Typical Payback Range: 3-5 years

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DWHR for Food Services – Many Installation Options

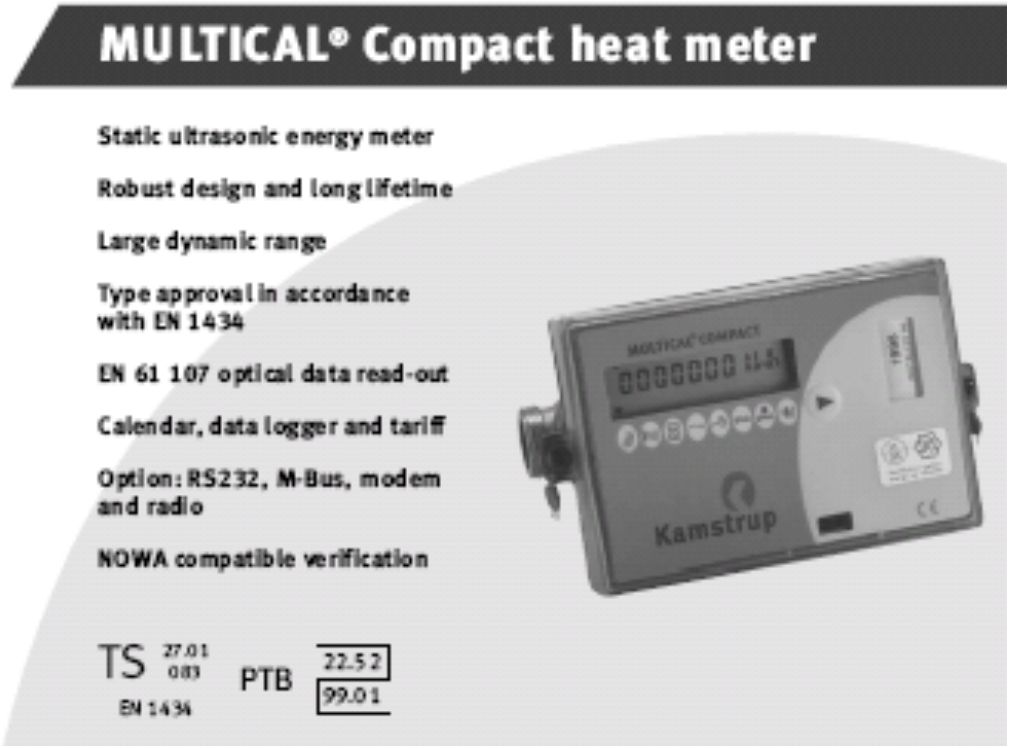
System Configurations for Falling Film Drain Water Heat Recovery for Dishwashers

Washer Type (and total flow)	Slab on Grade	Vertical Fall >2ft., <8ft	Vertical Fall >8ft	DWHR Units
Batch	to primary water heater or direct to booster water heater	in recirc loop prior to primary water heater		**Single-or Multi-Pipe**
Continuous <5gpm	to primary water heater or direct to booster water heater	to primary water heater or recirc. Loop	to primary water heater, recirc. loop or direct to booster heater	**Single-Pipe**
Continuous >5gpm	to primary water heater or direct to booster water heater	to multi-pipe unit / Fresh water to primary water heater	to primary water heater or direct to booster heater	**Multi-Pipe**
Drain Flow	**Pumped**	**Not Pumped**		

Legend:	Systems that have been installed	Simple to install and operate

Simple Performance Monitoring

- Heat Meters (aka BTU Meters) are used
- Include flow meter, 2 temperature sensors and electronics
- Danish heat meters have been used for with excellent success



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Questions?

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Thank You for Attending!