Table of Revisions/Changes

Revision Number	Addition/ Revision	Issue Date	Effective Date	Measure	Description of Change	Location/Page in TRM
3-22-03	R	4/29/2022	4/29/2022	R/MF Drain Water Heat Recovery (DWHR)	No revisions applied – measure marked for removal from TRM.	Pg. 139

Note: Revisions and additions to the measures listed above were undertaken by the Joint Utilities Technical Resource Manual (TRM) Management Committee between January 28, 2022 – April 29, 2022.

MEASURE RECOMMENDED FOR REMOVAL FROM TRM

DOMESTIC HOT WATER – CONTROL

DRAIN WATER HEAT RECOVERY (DWHR)

Measure Description

This measure covers the installation of drain water heat recovery systems on a main waste drain in residential applications. Drain water heat recovery (DWHR) systems are drainage heat exchangers that recover heat from drain greywater to preheat cold water entering the water heater. By preheating cold water entering the storage tank, the water heater consumes less energy to heat the water to the desired temperature.

This measure is only applicable to buildings with storage type water heaters.

Method for Calculating Annual Energy and Summer Peak Coincident Demand Savings

Annual Electric Energy Savings (Electric Water Heating Only)

$$\Delta kWh = units \times \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{3{,}412} \times \frac{1}{UEF} \times ESF$$

Summer Peak Coincident Demand Savings (Electric Water Heating Only)

$$\Delta kW = units \times \frac{UA \times \Delta T_{amb}}{3{,}412} \times \frac{1}{UEF} \times ESF \times CF$$

Annual Fossil Fuel Energy Savings (Fossil Fuel Water Heating Only)

$$\Delta MMBtu = units \times \frac{GPD \times 365 \times 8.33 \times \Delta T_{main}}{1{,}000{,}000} \times \frac{1}{UEF} \times ESF$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
ΔMMBtu	= Annual fossil fuel energy savings
units	= Number of measures installed under the program
GPD	= Gallons per day
ΔT_{main}	= Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F)
ΔT_{amb}	= Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F)
UEF	= Uniform energy factor
UA	= Overall heat loss coefficient (BTU/h-°F)
ESF	= Energy savings factor
CF	= Coincidence factor

365 = Days in one year
8.33 = Energy required (BTU) to heat one gallon of water by one degree Fahrenheit
3,412 = Conversion factor, one kWh equals 3,412 BTU
1,000,000 = Conversion factor, one MMBtu equals 1,000,000 BTU

Summary of Variables and Data Sources

Variable	Value	Notes
GPD	17.2 X # of people	Calculated based on number of people served by the system. If unknown, use 46 GPD.[1]
ΔT_{main}	T_{set} - T_{main}	Average temperature difference between water heater set point temperature and the supply water temperature in water main (°F)
ΔT_{amb}	55 = T_{set} - T_{amb}	Average temperature difference between water heater set point temperature and the surrounding ambient air temperature (°F)
T_{set}	125	Water heater set point temperature (°F).[2]
T_{main}		Supply water temperature in water main (°F). Lookup in Cold Water Inlet Temperature table below based on nearest city.
T_{amb}	70	Surrounding ambient air temperature (°F).[3]
UEF		Uniform Energy Factor of the baseline condition, from application, or use default based on Uniform Energy factor section below
UA	7.85	Overall heat loss coefficient of the baseline condition (BTU/h-°F).[4]
ESF	0.25	Oak Ridge National Laboratory. [5]
CF	0.8	

Cold Water Inlet Temperature (T_{main})
Supply water main temperatures vary according to climate, and are approximately equal to the

[1] Water Research Foundation: Residential End Uses of Water, Version 2, April 2016, p. 5; 17.2 GPD equated from the report findings indicating an average 2.65 people per household and 45.5 GPD per household.
[2] 10 CFR 430 Appendix E to Subpart B of Part 430 Uniform Test Method for Measuring the Energy Consumption of Water Heaters, Section 2. Test Conditions, 2.5 Set Point Temperature.
[3] Water heaters are generally located in conditioned or partially conditioned spaces with a typical average temperature of 65°F to 70°F to avoid freezing. A value of 70°F is used for the purposes of estimating tank/ambient air temperature differential, which aligns with standby loss specification testing standards.
[4] Based on computation of heat loss coefficients via conversion equations found in 10 CFR 429, 430, and 431 Docket No. EERE-2015-BT-TP-0007, Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters. Heat loss coefficient was equated for two minimally code compliant gas storage water heaters found to be the most typical in terms of storage and input capacity, representing storage type water heaters of between 20 and 55 gallon capacity (40 gallon, 40,000 BTU/h assumed) and between 55 and 120 gallon capacity (75 gallon, 76,000 BTU/h assumed). Results of heat loss coefficient evaluation at these two data points agreed to within 0.3%, so the lower of the two was selected to represent the $UA_{baseline}$ term.
[5] GFX Evaluation, Oak Ridge National Laboratory, August 2000, lower end of the energy savings range (25-30%)

annual average outdoor temperature plus 6°F.[6] Supply main temperatures based on the annual outdoor temperature are shown below.

City	Annual average outdoor temperature[7] (°F)	T_{main} (°F)
Albany	48.3	54.3
Binghamton	46.3	52.3
Buffalo	48.3	54.3
Massena	43.5	49.5
NYC	55.4	61.4
Poughkeepsie	49.8	55.8
Syracuse	48.3	54.3

Uniform Energy Factor

UEF shall be calculated as a function of existing equipment tank volume (v_t) with the appropriate equation, looked up based on existing equipment type, capacity and draw pattern. Draw pattern can be established based on the existing equipment First Hour Rating (FHR), rated in gallons; see the First Hour Rating vs. Draw Pattern table below. If FHR is unknown, a Medium draw pattern should be assumed for storage type water heaters with rated storage capacity ≤50 gallons and a High draw pattern should be assumed otherwise.[8]

Residential Water Heaters[9]

Product Class	Rated Storage Volume and Input Rating	Draw Pattern	$UEF_{baseline}$
Gas-Fired Storage Water Heater	≥ 20 gal and ≤ 55 gal	Very Small	0.3456 - (0.0020 x V_r^*)
		Low	0.5982 - (0.0019 x V_r)
		Medium	0.6483 - (0.0017 x V_r)
		High	0.6920 - (0.0013 x V_r)
	> 55 gal and ≤ 100 gal	Very Small	0.6470 - (0.0006 x V_r)
		Low	0.7689 - (0.0005 x V_r)
		Medium	0.7897 - (0.0004 x V_r)
		High	0.8072 - (0.0003 x V_r)
Oil-Fired Storage Water Heater	≤50 gal	Very Small	0.2509 - (0.0012 x V_r)
		Low	0.5330 – (0.0016 x V_r)
		Medium	0.6078 – (0.0016 x V_r)
		High	0.6815 - (0.0014 x V_r)

[6] Burch, Jay and Christensen, Craig, "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory

[7] Average annual outdoor temperatures taken from NCEI 1981-2010 climate normals

[8] Based on review of typical usage bins for AHRI certified residential water heating equipment (https://www.ahridirectory.org/ahridirectory/pages/home.aspx)

[9] 10 CFR 430.32(d)

Product Class	Rated Storage Volume and Input Rating	Draw Pattern	$UEF_{baseline}$
Electric Storage Water Heater	≥ 20 gal and ≤ 55 gal	Very Small	0.8808 - (0.0008 x V_r)
		Low	0.9254 - (0.0003 x V_r)
		Medium	0.9307 - (0.0002 x V_r)
		High	0.9349 - (0.0001 x V_r)
	> 55 gal and ≤ 120 gal	Very Small	1.9236 - (0.0011 x V_r)
		Low	2.0440 - (0.0011 x V_r)
		Medium	2.1171 - (0.0011 x V_r)
		High	2.2418 - (0.0011 x V_r)

*V_r = Rated storage tank volume (in gallons)

Residential-Duty Commercial Water Heaters[10]

Product Class	Rated Storage Volume and Input Rating	Draw Pattern	UEF
Gas-Fired Storage Water Heater	> 75,000 BTU/h and ≤ 105,000 BTU/h and ≤ 120 gal	Very Small	0.2674 - (0.0009 x v_t^*)
		Low	0.5362 - (0.0012 x v_t)
		Medium	0.6002 - (0.0011 x v_t)
		High	0.6597 - (0.0009 x v_t)
Oil-Fired Storage Water Heater	>105,000 BTU/h and ≤140,000 BTU/h and ≤ 120 gal	Very Small	0.2932 – (0.0015 x Vr)
		Low	0.5596 - (0.0018 x V_r)
		Medium	0.6194 – (0.0016 x V_r)
		High	0.6740 – (0.0013 x V_r)

*v_t = tank volume in gallons

First Hour Rating vs. Draw Pattern[11]

First Hour Rating	Draw Pattern
< 18 gallons	Very Small
≥ 18 and < 51 gallons	Low
≥ 51 and < 75 gallons	Medium
≥ 75 gallons	High

Coincidence Factor (CF)

The prescribed value for the coincidence factor is 0.8.[12]

Baseline Efficiencies from which Energy Savings are Calculated

The baseline condition is a storage type water heater without a DWHR system in a residential application.

[10] 10 CFR 431.110(b)
[11] 10 CFR 429.17
[12] *No source specified – update pending availability and review of applicable references.*

Compliance Efficiency from which Incentives are Calculated

The compliance condition is a storage type water heater equipped with DWHR on the main waste drainage line in a residential application. DWHR units must have a minimum efficiency of 40% if installed for equal flow or a minimum efficiency of 52% if installed for unequal flow.[13] DWHR units shall comply with CSA B55.2 and shall be tested in accordance with CSA B55.1. Potable water-side pressure loss of DWHR units shall be less than 3 psi.[14]

Operating Hours

Water heater run hours are not utilized in the estimation of energy or demand savings, but water heater is assumed to be available for operation 8,760 hours per year. Additionally, it is assumed standby losses are incurred 8,760 hours per year.

Effective Useful Life (EUL)

See Appendix P.

Ancillary Fossil Fuel Savings Impacts

Ancillary fossil fuel savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

Ancillary Electric Savings Impacts

Ancillary electric savings impacts, if appropriate, will be researched and incorporated into this measure algorithm in future revisions to the TRM.

References

1. 10 CFR 430.2 Definitions.
   Available from: https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=78ea8c7c6bf5379d6e0fd2b41e335739&mc=true&n=pt10.3.430&r=PART&ty=HTML#se10.3.430_12
2. 10 CFR 430.32 Energy and water conservation standards and their compliance dates.
   Available from: http://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8
3. 10 CFR 431.110 Energy conservation standards and their effective dates.
   Available from: https://www.ecfr.gov/cgi-bin/text-idx?SID=a69096e892b13c204bbe6da3a92f8111&mc=true&node=se10.3.431_1110&rgn=div8
4. Water Research Foundation: “Residential End Uses of Water, Version 2: Executive Report”, April 2016
   Available from: http://www.waterrf.org/PublicReportLibrary/4309A.pdf

[13] NYSERDA NYStretch Code – Energy 2020, Section R403.5.4.3 Drain water heat recovery units
[14] ECCCNYS 2020, Section R403.5.4 Drain Water Recovery Units

5. 10 CFR 430 Subpart B – Test Procedures, Appendix E – Uniform Test Method for Measuring the Energy Consumption of Water Heaters
Available from: https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=&SID=9624a8ba0987aaae248454c49194a661&mc=true&n=pt10.3.430&r=PART&ty=HTML#ap10.3.430_127.e
6. GFX Evaluation, Oak Ridge National Laboratory, August 2000
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7. 10 CFR 430 Subpart B – Test Procedures, Appendix E – Uniform Test Method for Measuring the Energy Consumption of Water Heaters
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Available from:
https://energy.gov/sites/prod/files/2016/08/f33/Water%20Heaters%20Test%20Procedure%20SNOPR.pdf
9. AHRI Directory of Certified Product Performance
Available from: https://www.ahridirectory.org/ahridirectory/pages/home.aspx
10. Burch, Jay and Craig Christensen; "Towards Development of an Algorithm for Mains Water Temperature." National Renewable Energy Laboratory.
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11. NOAA National Centers for Environmental Information – NCEI 1981-2010 Climate Normals
Available from: https://www.ncdc.noaa.gov/cdo-web/datatools/normals
12. 10 CFR 429.17 Water heaters.
Available from: : https://www.ecfr.gov/cgi-bin/text-idx?rgn=div5&node=10:3.0.1.4.17#se10.3.429_117
13. NYSERDA NYStretch Code – Energy 2020, Section 403.5.4.3 Drain Water Heat Recovery Unit
Available from: https://www.nyserda.ny.gov/All-Programs/Programs/Energy-Code-Training/NYStretch-Energy-Code-2020
14. ECCCNYS 2020 Section R403.5.4 Drain Water Heat Recovery Units
Available from: https://codes.iccsafe.org/content/NYSECC2020P1/chapter-4-re-residential-energy-efficiency

Record of Revision

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12-18-7	12/28/2018
3-22-3	4/29/2022

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