

Frequently Asked Questions on Smartclima Drain Water Heat Recovery Unit

A. How does Smartclima “Drain Water Heat Recovery Power Pipe” Work?

DWHR pipe transmits the heat energy from drain/grey warm water which flows from dishwasher, bathtubs, showers, sinks, washing machines. The incoming cold water captures and absorbs wasted heat and gets preheated, then enters into water tank or faucet to mix with existing hot water.

B. How will Smartclima “Drain Water Heat Recovery Power Pipe” benefit me?

Smartclima DWHR unit has features of Comfort, Convenience & Conservation.

Comfort: Smartclima DWHR unit can triple the shower-capacity of an electric storage water heater (while halving the cost of a shower) by recycling heat lost down the drain;

Convenience: Smartclima DWHR unit can eliminate waiting for a shower as the water heater recovers by tripling the First Hour Rating of an electric storage water heater;

Conservation: Smartclima DWHR unit can save vast amounts of energy (and reduce air pollution). DOE's conservative estimate excluded nonresidential, commercial, industrial, state and federal applications, as well as Smartclima DWHR unit's vast beneficial impact upon air pollution, thermal pollution of waterways and its potential to help conserve water in applications as simple as shortening shower warm-up times to ending a doubly-wasteful practice of adding cold water to hot industrial wastewater to avoid Btu taxes, notwithstanding Smartclima DWHR unit enables cost-effective cooling via recycling up to 85% of the available heat.

C. Why Smartclima's DWHR unit has better performance than other brand DWHR?

Because Drain Water Heat Recovery device from Smartclima has its own unique features. There is no space between hot drain water and clean cold water, the heat in drain water can be transferred to cold clean water directly; Another important characteristic is that plastic shell prevents heat from escaping to air. Therefore, compared to other brand DWHR products in the market, Smartclima DWHR unit has better performance to catch drain heat and improve incoming water temperature.

D. How can Smartclima DWHR unit be so effective; it seems too simple?

Gravity-fed, falling-film, double-wall-vented, balanced heat exchange is far from simple, as you will learn by pondering these questions & issues raised by consumers, engineers, architects, scientists, builders and editors. Smartclima DWHR unit's simplicity derives from ultra-high transfer coefficients, patented technology, years of engineering development and help from Mother Nature.

E. Why use copper pipe as drain pipe? and why use plastic pipe as outer shell?

Smartclima DWHR unit is a hybrid product with copper and plastic. Copper is a very conductive material, it has the best performance of heat exchanging, it can capture heat immediately at max. When the hot drain water flows down to the copper pipe, the heat can be transmitted to the clean cold water by copper wall quickly.

Plastic pipe is used because it is a very good insulation material, meaning that the heat will keep inside, it wouldn't escape to the air.

The plastic pipe is made from HDPE (High Density Polyethylene), non-toxic. HDPE is Food Grade Plastic, it does not contain dyes or recycled plastic deemed harmful to humans, they are usually used on Food Package field and Drinkable Water Supply field. Also, HDPE has long service life, its service capacity can reach 40 years.

That's why we choose copper pipe as drain pipe and use plastic pipe as outer shell.

F. How can Smartclima DWHR unit halve the cost of a hot shower, yet triple the shower-capacity of an electric water heater?

Typically, a 105F shower fed by 45-75F water at 2.25 gpm depletes a water heater's stored energy at rates of 20 to 10 kW until the heater's upper-element is energized and these rates are reduced to 15.5 to 5.5 kW, respectively. By feeding back 10 to 4 kW (50% to 40%), the Model S3-1500 can further reduce these depletion rates to extend showering-times by factors of about 2.8 to 3.7. In fact, third party testing at Old Dominion University found Smartclima DWHR unit boosted First Hour Ratings of a high efficiency 50-gallon electric water heater from 60 to 180 gallons. The significance of this finding is that gas-marketing ads attempt to move consumers away from clean and safe electric water heating by advertising "GAS WATER HEATERS HEAT TWICE AS FAST"; notwithstanding gas (and oil) water heaters are "the largest single-source polluter[s]."

G. Will Smartclima DWHR unit also improve the performance of gas and oil water heaters?

Of course, recycling energy with Smartclima DWHR unit will improve the performance of every water heater, but the improvement may not always be as dramatic as with electric heaters since modern residential gas and oil water heaters generally provide an adequate supply of hot shower water. Notorious exceptions are the millions of combination oil systems operating with lime-coated tankless-coil water heaters. Such systems rated at 140,000 Btu/hr input (1 gal/hr firing rate) could easily satisfy a space heating load of 100,000 Btu/hr, yet fail to deliver 35,000 Btu/hr for water heating. With a water heating efficiency of under 25%, they become one of the least efficient of all water heaters and one of the worst single-source air polluters. Consequently, such water heaters cannot sustain normal showers; even with low-flow showerheads demanding 57,000 to 68,000 Btu/hr and a 50% firing rate increase to 1.5 gal/hr (which degrades overall system efficiency). In this case, by recycling 27,000 to 34,000 Btu/hr and cutting the water heater's load Smartclima DWHR unit can provide many benefits: an endless shower at normal firing/showering rates, a boost in water heating efficiency from less than 25% at an inadequate flow rate to around 60% at the desired shower flow rate, reduced scalding if the set-point is lowered from the 160 to 180 range generally selected by oil company servicemen in response to customer complaints, far less point-of-use air pollution, and eliminate a secondary water heater costing far more than Smartclima DWHR unit to install and operate.

H. What about tankless electric and gas water heaters that heat water instantly?

There's no stored energy in this case, but the S3-1500 can instantly feed back 10 to 4 kW; corresponding to 50% to 40% of the power required to sustain a continuous shower at 2.25 gpm. Similarly, an instant gas water heater's load will be reduced by 34,130 to 13,652 Btu/hr (0.341 to 0.137 therms). Without Smartclima DWHR unit, a tankless electric water heater demands 83 to 41.5 amps at 240 volts to sustain a 20 to 10 kW shower stream. With Smartclima DWHR unit, AC current demand drops by 41.5 to 24.9 amps; providing many benefits for user and utility. For example, in addition to the virtual elimination of standby-loss, electric-service requirements are cut by 41.5 to 16.6 amps and corresponding IR transmission losses -- which add to utility operating costs -- are cut by factors of 4 to 2.8! Additionally, an independent evaluation by Old Dominion University yielded an Energy Factor range of 1.7 to 1.9 for the combination of Smartclima DWHR unit and a 14-kW instant electric water heater. This combination out performed a heat pump water heater under similar test conditions.

I. How much money and energy can Smartclima DWHR unit save my family?

The latest estimate of 34% is contained in a 1996 report submitted to the U.S. Department of Energy by Arthur D. Little Inc. This estimate is similar to those by other DOE consultants; none of which account for tremendous variations in true cost. [Note: A 1990 report of the U.S. Energy Information Administration indicated 38% of

America's households heat water by electricity. At a cost of about \$22 billion per year, just for electric water heating, we're talking about lots of \$-Energy dumped down the drain. A Canadian estimate projected "North America's 100 million families, heating many trillions of gallons of cold water totally wastes over 40 billion dollars annually and burns up some 300 million barrels-of-oil (or energy equivalent). In fact, hot graywater represents a vast renewable energy source.]

J. Then what's the payback and how much can Smartclima DWHR unit save me?

That depends upon many factors. For example, if Smartclima DWHR unit does the job of a new, or secondary water heater, the payback is day one! When Smartclima DWHR unit permits the installation of a 40 or 50-gallon water heater and provides the shower-capacity of an 80 to 120 gallon unit, payback could be two - three months only! If you're tired of fighting for the only shower in the house, Smartclima DWHR unit may pay for itself the first time it's used. The simplest way to determine Smartclima DWHR unit's monetary-payback is to estimate your family's shower-usage and accept additional savings as a bonus. Since this also varies wildly, as it depends upon climate, geographical location, type and number of showerheads, the following guide was prepared based upon a single, low-flow showerhead:

Smartclima DWHR unit Payback and Savings-Guide

For average cold water temperatures between:

45 and 75 deg. F

Low-flow showerhead delivering

2.25 gpm

The Model S3-1500 will save approximately:

10 to 4 kW

In 12-minutes of showering Smartclima DWHR unit will save:

2 to 0.8 kWh/shower

Totaling perhaps:

2200 to 875 kWh/year

So at 10-cents per kWh, Smartclima DWHR unit can save:

\$220 to \$ 85 per year

Doubling the flow rate saves:

\$366 to \$145

[NOTE: To convert to oil and gas, use 3413 Btu/kWh, 140,000 Btu/gal of oil, 100,000 Btu/therm and don't forget to factor in the lower Energy Factor of gas and oil water heaters.]

K. Just how much energy is used to heat water in America?

According to DOE's Energy Information Administration (EIA), electric water heaters provided 45% of US residential water heating needs in 1995. The EIA also estimated that in 1995 residential water heaters in the US consumed 740 billion kWh of energy and commercial water heaters consumed another 320 billion kWh. (1 kWh = 3,413 Btu) (See <http://oikos.com/products/mechanical/Smartclima DWHR unit/index.html>)

DOE estimates for U.S. water heating in 1990 were: 3.62 quads (Residential) + 0.79 quads (Commercial) = 4.41 quads

[Note: 1 quad = 1 quadrillion (10¹⁵) Btu = 293 billion kWh = 10 billion therms = the energy of 7.14 billion gallons of oil.]

L. How much of this energy goes down the drain?

Water takes lots of energy to heat and holds onto it for a long time; so approximately 80% to 90% of all hot water energy goes down the drain, carrying with it 3.5 to 4 quads in the U.S. alone. This equals the energy released by burning 25 to 28 billion gallons of oil/year.

M. How much energy can Smartclima DWHR unit save?

Applying the 1996 estimate by Arthur D. Little Inc. of 34%, Residential-Smartclima DWHR unit could save 1.23 quads per year. Although no estimate was given for Commercial-Smartclima DWHR unit, another 0.47 quads (60%) could be saved, for a grand total of 1.7 quads. That's 12 billion equivalent gallons of oil. [Note: A recent DOE Report to Congress, which failed to include graywater heat recycling, estimated potential residential savings of 2.38 quads (65%) and commercial savings of 0.48 quads (61%) could be attained via more efficient water heating technologies (DOE/EE-0066).]

N. Must Smartclima DWHR unit be located directly beneath a shower?

Hot shower wastewater holds its temperature as it speeds down the walls of a drain pipe at approximately 3 feet per second; falling from a second floor shower to the basement floor in under 10 sec. Of course the drain line will be heated by the first rush of drain water, but the energy to do this in the vast majority of homes will be negligible. Consequently, Smartclima DWHR unit can be located far enough from the shower to service several fixtures. An ideal location is in the main drain where it enters the basement floor.

O. Why is it important for Smartclima DWHR unit to feed both the water heater and plumbing fixtures?

The answer to this question is far from obvious, which is why U.S. Patent 4,619,311 was granted. Perhaps the easiest way to understand this is to consider an ideal example of 105F shower-water comprised of an equal mix of 155F and 55F water, and experiencing no air-cooling before entering a perfect contra-flow heat exchanger at 105F . Three cases are important:

The Obvious Case -- passing just the cold water feeding the water heater through the heat exchanger, where it's preheated by 50F to 105F as the 105F wastewater is cooled by just 25F because there is twice as much of it. This case corresponds to recycling 50% of the heat traveling down the drain. (In practice, the Model S3-1500 will cool the wastewater by about 20F at 2.25 gpm while recycling about 40% of the waste heat. Lowering the water heater set-point will decrease the flow-imbalance and increase the efficiency.)

The Equal-Flow Case -- passing water feeding both the water heater and cold side of the shower through the heat exchanger. Now the drain water will be cooled by 50F and the feed water will be heated by 50F because the flows are balanced. This case corresponds to 100% recycling efficiency. (In practice, the Model S3-1500 would cool the wastewater by about 30F at 2.25 gpm while recycling about 60% of the waste heat.)

The Confusing Case -- passing just the cold water feeding the shower through the heat exchanger and adjusting the mix to hold the shower temperature at 105F . Now the cold water exiting the heat exchanger will be heated to 105F , so to maintain a 105F shower, the hot water flow must be zero. This case also corresponds to 100% recycling efficiency because the flows will be balanced after the mix has been adjusted. (In practice, the Model S3-1500 would preheat the cold water to about 89F and cool the wastewater by about 26F at 2.25 gpm while recycling about 52% of the waste heat. Raising the water heater set-point will decrease the flow-imbalance and increase the efficiency.)

P. If all incoming cold water is preheated by Smartclima DWHR unit, how could someone have a cold drink of water?

This is not a problem in practice because there is no preheating unless hot water is flowing down the drain and the preheated water temperature is not much higher than that of water normally standing in the pipes. In most

instances the cold water pipe will bring preheated water feeding the sinks close to temperatures normally experienced when the shower is off.

Q. How can Smartclima DWHR unit help save water?

One way Smartclima DWHR unit saves water is by shortening shower warm-up times when preheated water feeds the cold side of the shower. Another way is by installing the Model S3-1500 in applications where tampering with low-flow showerheads is likely; taking advantage of its relatively high pressure drop to limit flow to about 4.5 gpm. In some industrial applications, enormous quantities of cold water are added to hot wastewater to avoid Btu-taxes. A better way to save water and energy is to cool the wastewater by recycling its heat. This may demand an efficient, double-wall-vented heat exchanger capable of passing debris-laden wastewater. For example, cooling steam condensate from a potato-blancher at 212F down to 100F during the summertime with 65F water requires a recycling efficiency of 76% at very high flow rates for both fluid streams. A Smartclima DWHR unit Cooling-Wall is the most cost-effective, if not the only way to accomplish this at flow rates of hundreds to thousands of gallons per minute. Cooling effluent from pulp and textile mills before it enters a cooling-pond yields another benefit, less stench from smelly wastewater evaporation.

R. What if Smartclima DWHR unit is installed horizontally, or the water connections are reversed?

The efficiency drops by a lot.

S. What about slab construction?

In two story homes, Smartclima DWHR unit can service upstairs bathrooms by being installed on the first floor. With existing slab construction, the only way to install Smartclima DWHR unit is to use a pump to divert shower drain water. For new construction, a short model can be installed in a pit. Smartclima DWHR unit will one day be integrated into shower stalls with a pump to reroute the drain water. This is practical, because far less energy is required to pump water than to heat it. For example, a 100-Watt pump can enable Smartclima DWHR unit to recycle 10,000 Watts from shower drain water.

T. Does Smartclima DWHR unit qualify for a U.S. EPA Energy Star rating in a new home?

No, because there's no Energy Star Water Heater program and no category for DHR systems like Smartclima DWHR unit, even though Smartclima DWHR unit Out-Saves Every ENERGY STAR Appliance. As of this writing (4/6/03) DHR systems continue to be excluded from construction by being denied Energy Star labels. (See [http://oikos.com/products/mechanical/Smartclima DWHR unit/index.html](http://oikos.com/products/mechanical/Smartclima%20DWHR%20unit/index.html))

U. Does DOE/EPA promote DHR like Canada's R2000 program?

Good question; especially since Canadian estimates"concluded that a well-designed graywater heat recovery system can, in practice, save 42% of total water heating energy and theoretically as much as 50%." and "Worldwide, about a billion tons of CO2 are released annually from hot water heating making it the largest single-source polluter." [NOTE: As noted above, a key aspect of Smartclima DWHR unit's patent raises this theoretical limit to 100%.]

V. Will Smartclima DWHR unit pass "black" water without fouling as the drain water is cooled?

Yes! The inner surface of a Smartclima DWHR unit is smooth and takes advantage of copper's inherent ability to prevent organic growth. As in a dishwasher, for example, fast-moving soapy-films whiz by at about 3 feet per second to continually scrub clean Smartclima DWHR unit's inner surface. They pass through in under 2 seconds in residential models; leaving little time for suspended grease and debris to accumulate. Smartclima DWHR unit's self-cleaning/anti-fouling mechanism is discussed in the "Falling Films" section of the 1986-report opened by this link Milton Pravda, DOE Consultant. This "mechanism" has been verified by thousands of drain-hours without a single customer-complaint, as well as in two recent DOE-funded evaluations: Oak Ridge National Laboratory (ORNL) monitored the 1st, a Duluth, MN Triplex. The Energy Center of Wisconsin (ECW)

monitored the 2nd, a larger scale demonstration in 72 apartments at the Monona Shores apartment complex in Madison, WI. No decrease in Smartclima DWHR unit's efficiency was detected in either case. No hint of fouling can be detected in the graph of Figure 3. "Annual Savings by Smartclima DWHR unit", which is on the last page of the report opened by this link Confirmation by ORNL. It's Figure. "1" was reproduced as Figure "6" in "Smartclima DWHR unit Shines in Measured Triplex Application", Energy Design Update (EDU), October 2000. (NOTE: The latter link opens the file on this DOE site: [http://www.eere.energy.gov/buildings/emergingtech/pdfs/Smartclima DWHR unit_prefindings.pdf](http://www.eere.energy.gov/buildings/emergingtech/pdfs/Smartclima_DWHR_unit_prefindings.pdf))

In some severe applications like a meat packing plant, for example, mechanical cleaning of Smartclima DWHR unit during normal operation is practical because the falling-films cling to the walls of drainpipes that can be left open at the top for easy access. In other severe applications, Smartclima DWHR unit's self-cleaning/anti-fouling mechanism will suffice, e.g.: "We have used plate and frame, and shell and tube heat exchangers in our processing operation. These were high maintenance, plugging up constantly. We switched to Smartclima DWHR unit units to resolve the plugging problems. They work! Our water heating system no longer has any trouble keeping up with demand. The Smartclima DWHR unit units have never plugged. The Smartclima DWHR units have been in for over 11/2 years; they are doing so well I've Forgotten about them."; says Jason Blankenship, Director of Engineering Meramec Group, Inc.; Missouri, USA; manufacturer of molded Polyurethane products.

W. Question from Smartclima DWHR unit user about "... self-cleaning performance. "My daughters use hair gels etc that clog my horizontal drains, so I already know that it won't self clean in horizontal mode. But what about the vertical mode? I find it hard to believe that these products couldn't form a film on the vertical walls, and I'm sure that this goop would impact thermal performance."

Believe it! As noted in "S", Smartclima DWHR unit's vertical walls are cleaned much the same way dishware, pots, and pans are cleaned in commercial or residential dishwashers -- by fast moving films of water with and without detergents. By "fast", we mean 25 to 60 times faster than drain water flowing in a flooded Model DS3-1500 Smartclima DWHR unit, e.g.:

A falling-film transporting 0.44 & 3.1 gpm will travel between 1.3 & 3.9 ft/sec down the walls of an S3-60. Its thickness will vary from about 0.0115" & 0.0277", respectively.

In contrast, if filled with water and mounted in any orientation, the same Smartclima DWHR unit can transport 0.44 & 3.1 gpm with water speeds of just 0.021 to 0.15 ft/sec, respectively.

A typical American household uses 308 gallons of water per day (gpd) with the following split: Shower & Bath 30%, Faucets 12%, Toilets 28%, Dishwasher 3%, Clothes-washer 22%, Leaks 5%. (See "Water Efficiency The Water Program", Rocky Mountain Institute, 1991, pg. 7). A typical hot water demand will cause the water heater to heat 79 to 64 gpd (26 to 21%) if its set-point is between 120 & 135F, respectively. "The typical household percentage of hot water originating from showers and running faucets was determined to be 56.9% from a published study by Lawrence Berkeley Laboratory", according to another Study Funded by A.D. Little for DOE (App. "A" pg. 9). By any estimate, there's plenty of clean water sent down-the-drain to rinse away soap, detergent, "hair gels etc" before they can degrade Smartclima DWHR unit's heat transfer coefficient. In fact, after an 18-month Hair Salon Evaluation Funded by DOE the inner walls of a Model P3-60 prototype were found to be clean. At first, there were concerns that hair gels and nail-finishing chemicals would build up on Smartclima DWHR unit's inner wall and require periodic cleaning. But Smartclima DWHR unit's efficiency did not degrade with time and our concerns were proved to be unfounded. After 18 months of continuous use, the P3-60 was removed for inspection. Its inner wall had become discolored, but we found no buildup of "goop".

X. What about air pollution?

Estimating how much Smartclima DWHR unit will save is difficult as it also depends upon type of energy available in a particular region. Burning one gallon of oil can release 22.5 pounds of CO₂ plus 0.78 pounds of

NOx emissions. Conserving 7 billion gallons of oil means eliminating about 80 million tons of CO2 plus 2.7 million tons of NOx . According to EPA standards, if just 6 million all-electric homes were to install Smartclima DWHR unit, U.S. greenhouse-gas emissions would drop by over 20 million tons.