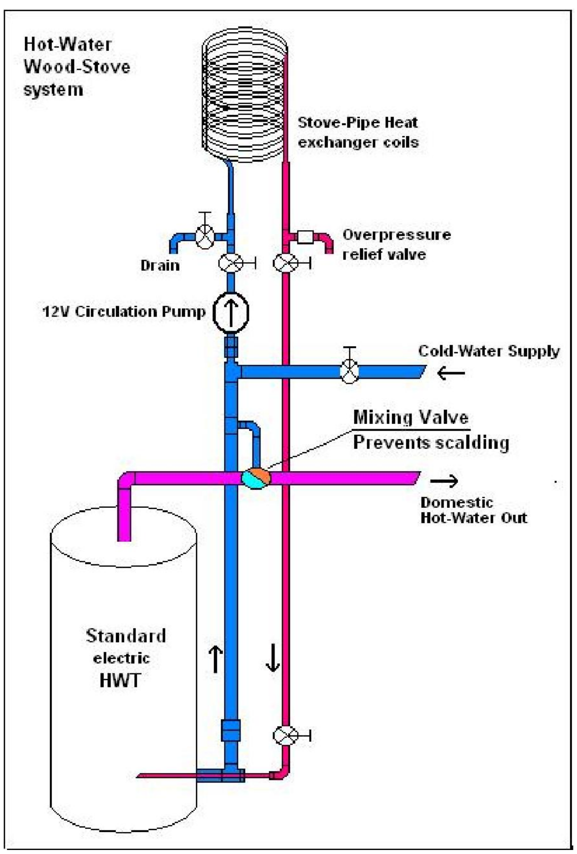
Wood-Stove Hot-Water

Our wood-stove has a 6" single-wall stove-pipe that rises straight up through the vaulted ceiling, 12' directly above. Single-wall stove-pipe was used to maximize the heat radiation from the stove-pipe to the room air. The stove-pipe is then converted to double-wall insulated before it passes through the ceiling/roof, to the chimney above.

Some of the energy generated by the wood-fire simply gets carried up through the chimney & is lost. The goal of this project was to harvest stove-pipe heat, and reduce the external electric energy required by our domestic Hot Water Tank (HWT). We live in SE British Columbia where winters are cold, firewood is plentiful and free, so wood-energy harvested is $$ saved.

Stove-Pipe Heat-exchanger : 3/8" soft-copper tubing (class-L) was tightly wrapped around the stove-pipe exterior between 2' and 4' above it's connection with the wood-stove. The total height of the coil is 2', and this required 60' of 3/8" soft-copper. Mortar was applied over the coils for thermal conductivity & then covered with aluminum foil. I'll wrap it all with stove-black tin for aesthetics.

Hot-Water Tank Tie-in : Our existing HWT is standard 36 US gallons, electric. No modifications of any kind to the tank or elements.



A basic electric HWT has a ¾" male nipple out both the CW inlet (bottom) as well as the HW outlet (top). We will never need all the flow available through a ¾" pipe, so this allows for a short piece of 3/8" copper pipe to pass through a ¾" Tee at the bottom supply fitting. This was accomplished using standard plumbing fittings.

By using this Supply-Tee plumbing arrangement (photo-2), there is no need for a secondary water-storage tank, or any type of fancy dual-inlet tank. This kept the cost down.

The water that circulates through the system is drawn from the bottom of the tank, and is returned to the bottom of the tank interior. After a bit of trial and error, this approach worked best. The harvested energy is effectively transferred to the HWT.

Photo-1 Un-shrouded stove-pipe heat-exchanger

Circulation Pump
Laing – D5 Solar/710 B available from WSE Technologies in Saskatoon Sask. Canada
http://www.solar-systems.ca/solarcircpump.php
The cost was reasonable ($285), it's 12VDC (good for 12V PV systems), it's very quiet, and appears to be very high quality. The pump is very serviceable, which is important since I'm passing unconditioned municipal water through it. Our water has very high lime content. Annual cleaning & de-scaling will be necessary, but easy to perform.

Mixing Valve
A mechanical mixing valve must be installed in any case where the possibility exists for the water temperature in a domestic HWT to exceed 55 DegC (130 DegF).
Caleffi 252 series, available from Thermomax Industries in Victoria BC Canada
http://www.solarthermal.com/wp-content/uploads/2010/02/252-mixing-valve-Series.pdf
About $160. The cost of this valve is minimal compared to the agony of a hot-water scalding injury.

Safety
Normally the isolating valves are open, and the pressure in the system can never rise above that of the municipal water system. However, if the isolating valves are inadvertently closed, then it would be possible for the system to develop unsafe pressure. Hence, an over-pressure relief valve, typical of those used on domestic hot-water tanks, is installed to mitigate this risk.

Photo-2 : Supply-Tee arrangement

Photo-3 : Amp-Hour meter (T690 module)

Control & Monitoring

A temperature sensor is mounted against the stove-pipe exterior immediately below the heat-exchanger. When the temperature rises above 55 DegC, the pump turns on. When it drops below 50 DegC, it turns off.

The controller has a small LCD display, with temperature sensors on both the supply and return pipes to the heat-exchanger coil. When the pump is running, the temperature differential is displayed, as well as the accumulated DegreeHours. Since I don’t know the exact flow-rate, this unit of accumulated degree-hours correlates to energy gained.

I suppose I could measure the pressure-rise across the pump, translate this to head & get an inferred flow-rate from the pump-curve. But there is little point, as energy savings are measurable otherwise.

Electric energy used by the HWT is metered by an accumulating Amp-Hour meter, with an external 20A current sensor in the electrical panel. The nominal voltage is 240VAC, and since a HWT is purely resistive, kWh = (AH x V)/1000. I had the AH meter running on the HWT for a month ahead of the project, so I had good base-line data. Both the controller/monitor as well as the AH meter are based on a small inexpensive industrial programmable logic module : Mountain Electric T690. (photo-3)
http://mountainelectric.ca/T690/

Performance

In November 2010 western-Canada experienced a cold-snap, with -30 DegC temperatures. This made me happy since it meant we would be burning some wood for heat… perfect for testing. Over a one-week period, the energy required by our HWT dropped from a prior average of 5.5 kWh/day, to about 2.1 kWh/day. Good!

Overall cost
~$1000.00ca (2010): Plumbing materials are expensive. All plumbing is insulated class-L copper, which is best for the temperature ranges expected. All materials were new. I dislike plastic plumbing, as I believe that copper plumbing is far more robust . As a young man (long ago) I worked for my father's plumbing company, so soldering copper pipe is second nature to me. I have confidence that the end result will have high endurance & low maintenance.

Future Plumbing
The system was designed to accommodate future tie-in to an external heat-exchanger which will harvest energy via an external heat-exchanger coupled solar-thermal glycol collector. This will be a spring 2011 project, which should reduce our domestic hot-water energy to near zero.

Secondary effects
Be aware that positioning a heat exchanger on out wood-stove pipe will result in cooler smoke & stove-pipe temperatures. This may result in increased deposits of creosote on the stove-pipe interior, as well as reduce the overall stove draft.

However, since our stove-pipe is 100% straight up, I wasn't too worried about the reduced draft. In fact the end-result is that our stove still has excellent draft.

Each summer we clean our chimney. Each time the amount of deposit removed is less than ¼" thick total. Thus I am confident that our stove-pipe can tolerate any increase in creosote deposit that might result from the existence of the heat exchanger.