Westhills

District Energy Sharing System

How Does Performance Meet Design Expectations

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Initial DESS Concept

- We had the idea for an ambient temperature district energy system that would be capable of providing heating and cooling simultaneously.
- The ability to connect multiple heat sources and sinks that would allow sharing of thermal energy was essential.
- A cost effective distribution system that could be applied to either dense or less dense developments.
- A system that could be easy to expand and extend over large distances to allow transfer of waste heat from industrial areas to residential/commercial areas.
- A built-in level of reliability that did not put all the eggs in one basket.

DESS Design Development

- The first proposal to develop an ambient temperature DESS was for the Olympic Village at False Creek, and was prepared in 2004.
- This system was based on a local sewer providing both a heat source and a heat sink.
- The proposal was not accepted, but drew considerable interest.
- A similar system was proposed for Whistler athletes' village based on various sources for heat such as methane from the closed city dump, groundwater, and geo exchange.
- A DESS was installed, ready for the 2010 winter Olympics using the effluent from the sewage treatment plant as the source/sink.

Westhills DESS Challenges

- Convincing the developer that an untested district energy system would work.
- Determining sources of heat for initial and future phases of Westhills.
- Deciding on suitable loop temperatures.
- Determining appropriate piping arrangement.
- Designing plant layouts for alternative sources and sinks.
- Pumping arrangement.
- Establishing housing /DESS interface
- Control and monitoring.
- Operating and management arrangement.

Selling the concept to the client

- Demonstrate that although the total system was untested , the individual components were proven.
- Describe energy and environmental benefits.
- Present a plan that was modular, adaptable and expandable.
- Explain the reliability to be built-in.
- Provide a cost benefit analysis that did not rely on subsidies.
- Emphasize potential revenue source.
- Avoid unrealistic expectations.
- Acceptance of shared risk.
- Prepare to finance the system.

Site Potential

- Westhills is a treed rocky site of 519 acres next to a lake in a growing suburban area near Victoria on Vancouver Island.
- A mixed residential development of 6000 dwellings plus a commercial area was planned.
- A 400 ft. deep bore field with 212 bores located under a playing field. Provide the initial heat source/sink.
- An ice rink near the site provides supplementary heat.
- The lake has potential to be a major heat source/sink and circulation of water from and back to the lake has environmental advantages for the lake.
- The Victoria Region was planning a new sewage treatment system(s) and Westhills proposed a sewage treatment plant that would provide waste heat to the site.
- Other source include solar collectors, bore fields, and commercial waste heat.

Westhills – 58 Acre Site

First Phases

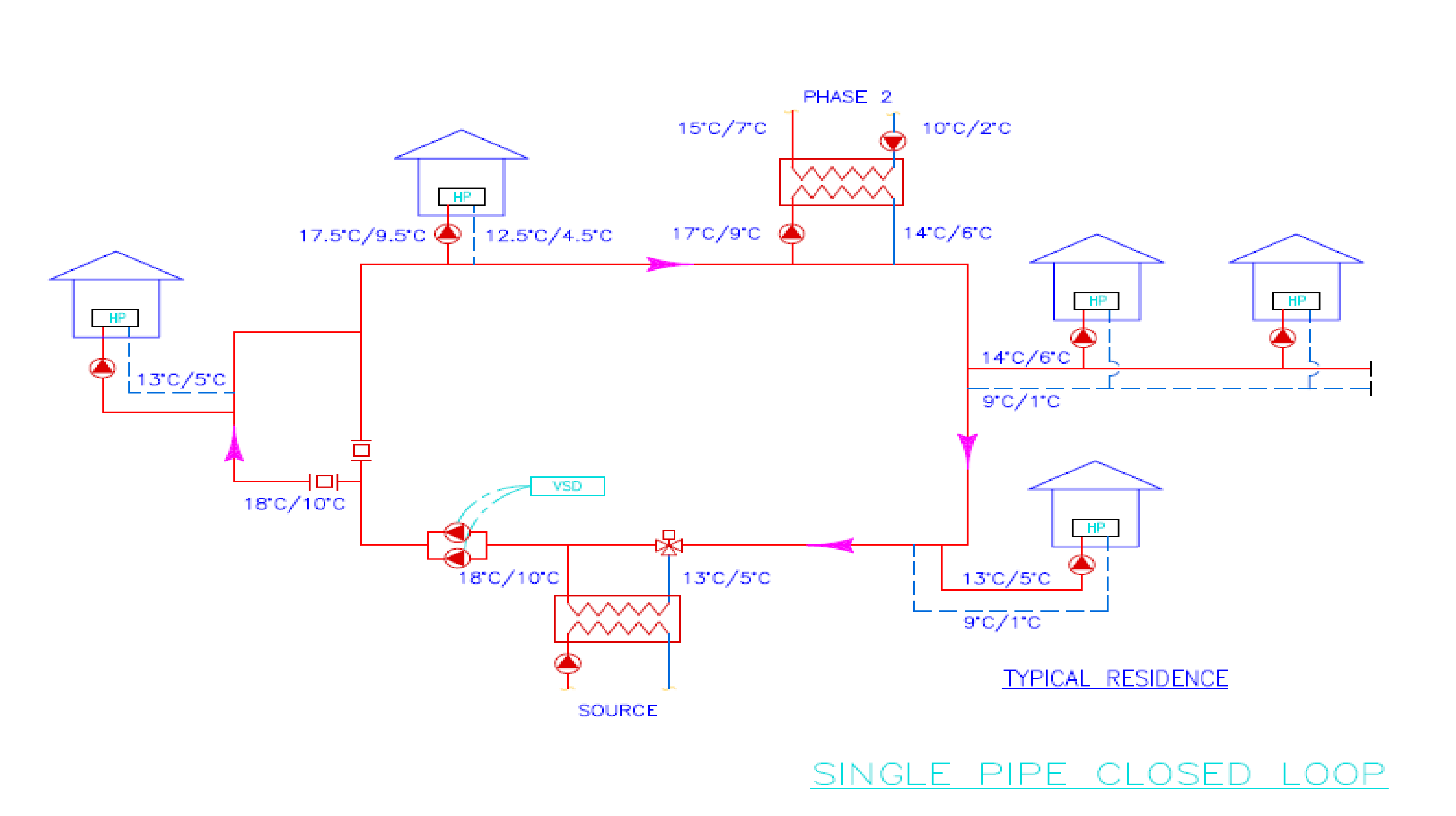
Loop temperature Criteria

- Acceptable temperatures for a variety of sources such as sewers.
- Min and Max temperatures for heat pumps.
- Min temperatures to prevent freezing without use of antifreeze.
- Close to ground temperature to limit loss or gain.
- Pipe service limits.
- Maximum differential to limit flow.
- Winter design 10°C to 5°C.
- Summer design 10°C to 25°C.

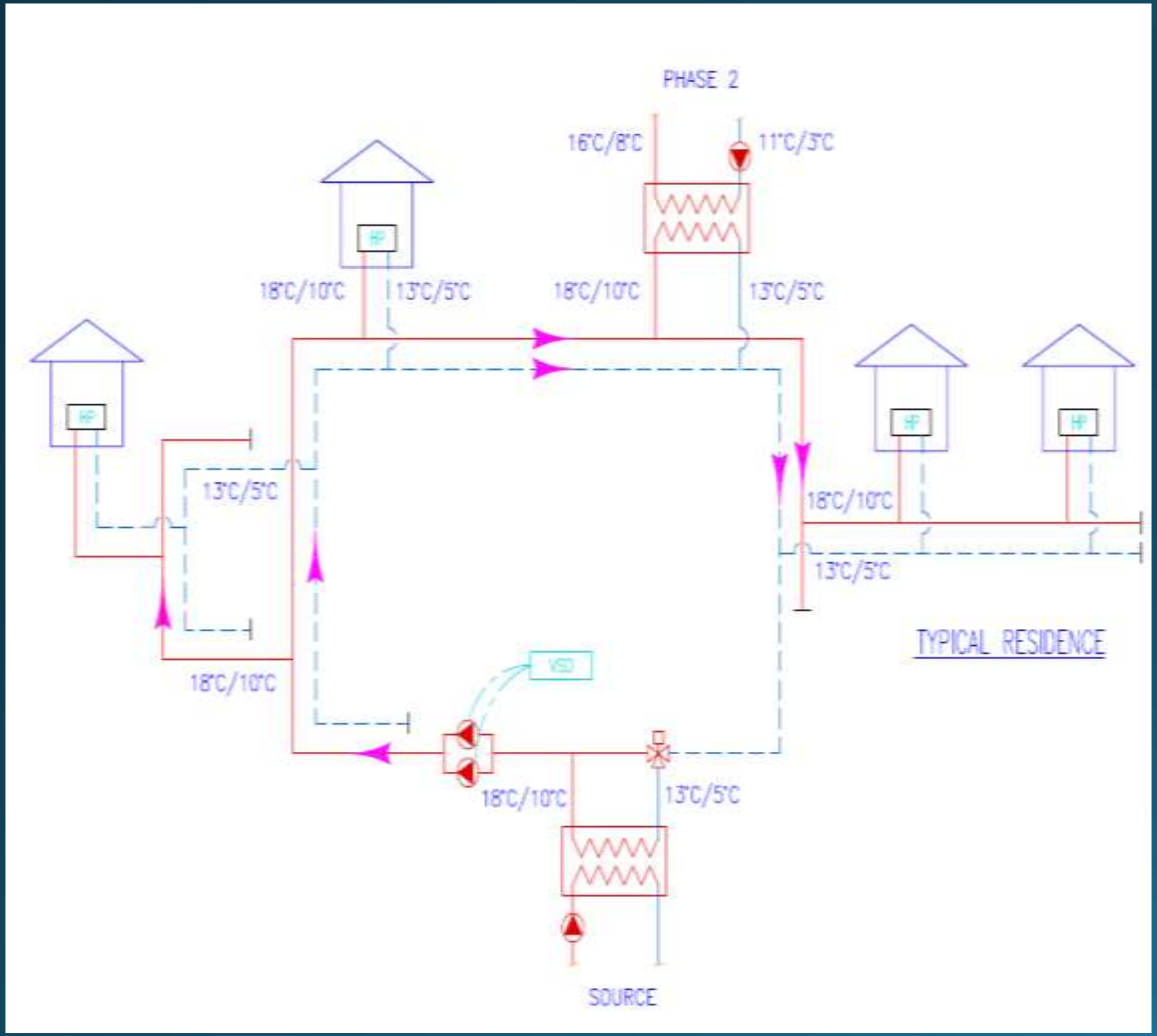
Loop Design

- Two Pipe Supply and Return – Central plants pump into the loop, and loads draw from the loop.
- Single Pipe – Pumping stations serve the loop and each source or load pumps into the loop.
- Two Pipe Warm and Cool – Central plants pump into two separate loops, and loads pump from one loop to the other.
- Hydraulic separation using heat exchangers for large elevation changes.

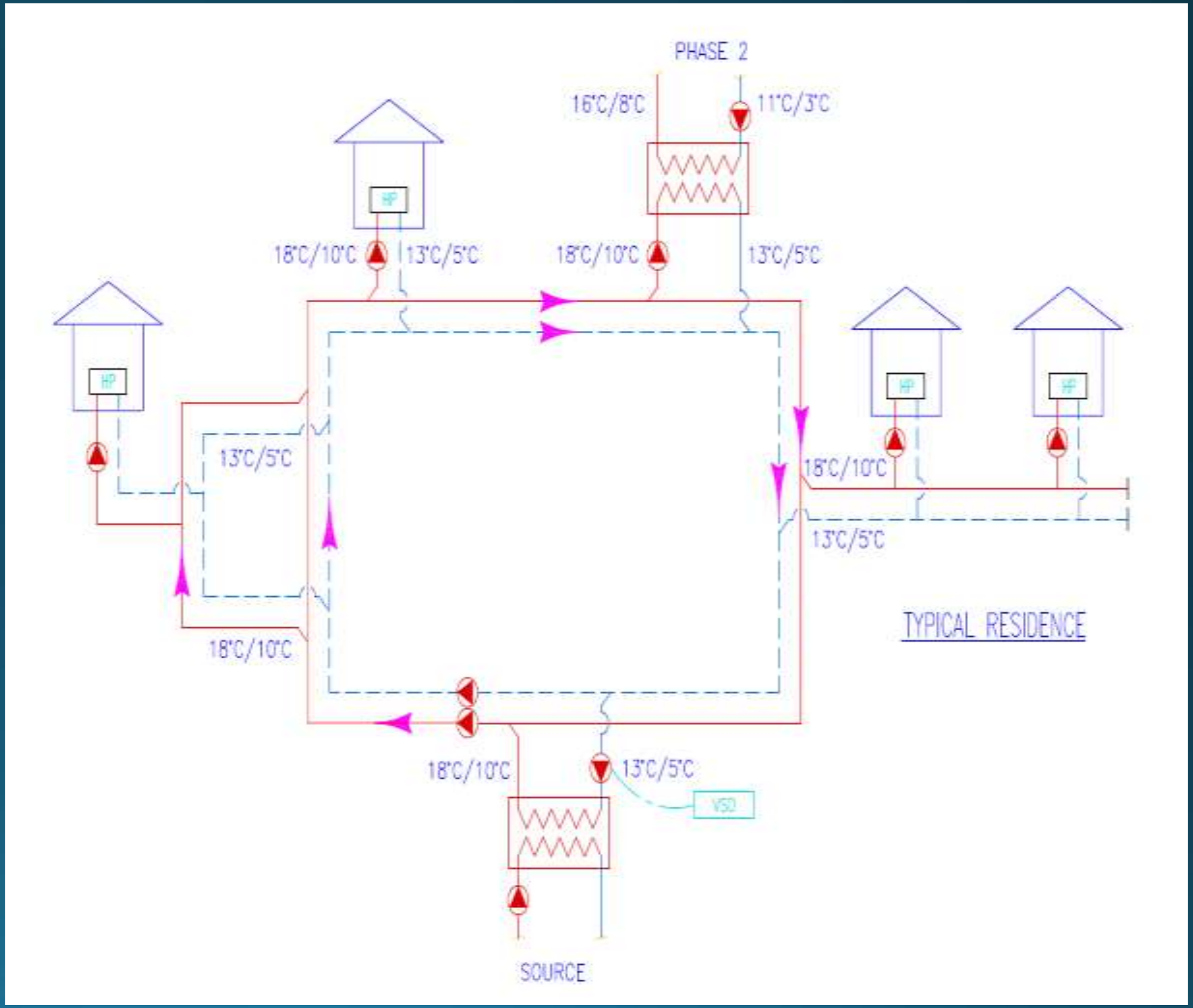
SINGLE PIPE CLOSED LOOP



Two pipe Supply/Return



Two Pipe Warm/Cool



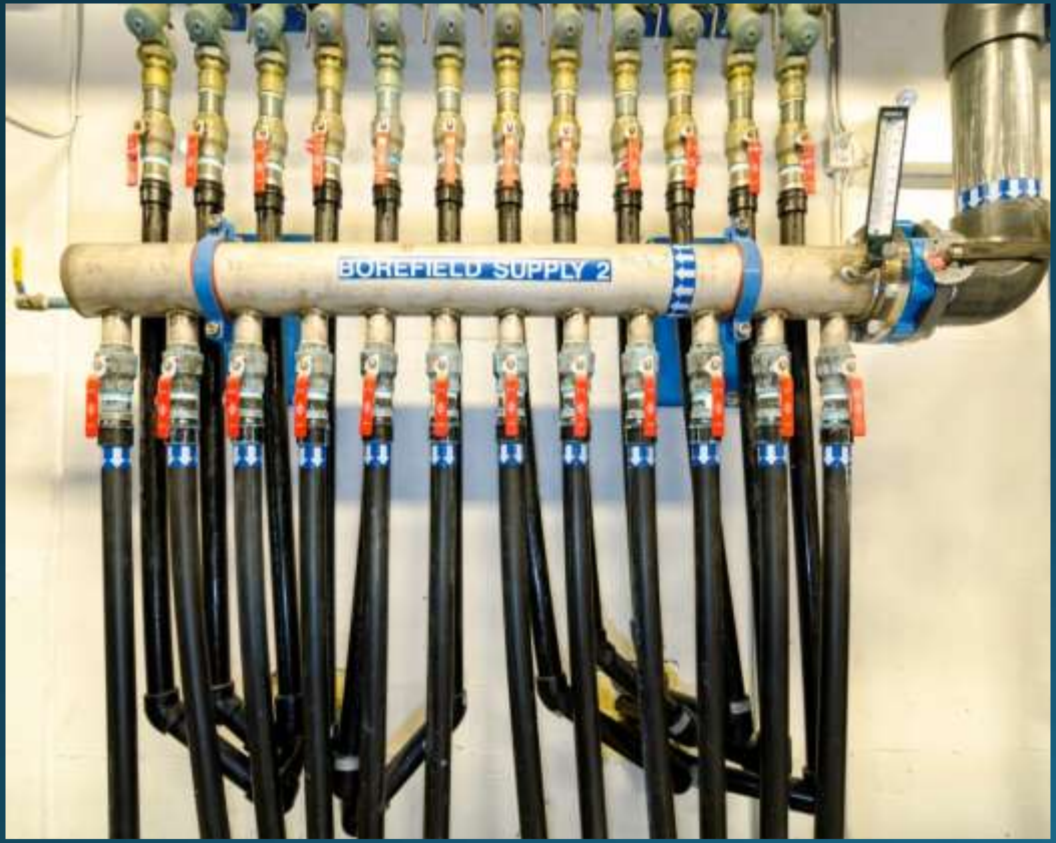
BORE FIELD 400 feet deep into granite

Header pipes in reverse return arrangement

X-ray view of header pipes 6 feet below playing field

Central Plant with ammonia heat pump

Bore Field Connections and Pumps



Supply and Return Headers for ½ of Field

Double Head Bore Field Pumps for 100% Standby

Loop Pumping Arrangement

- Pressure difference between warm and cool pipes 5psi or less.
- Sufficient flow on loop to ensure temperature within limits.
- Booster pumps to maintain flow in multiple parallel paths.
- Interconnecting controls between pumping stations.
- Initial ability to provide supply return pumping prior to completion of loops.

Loop Piping Material

- Traditional district heating systems use steel pipe with insulated jackets and typically designed for 20°C ΔT.
- Ambient systems use high Density Polyethylene Pipe (HDPE) and designed for 5 °C ΔT.
- Flow rate is 4 times higher for the same heat delivery so HDPE pipe is twice the diameter for the same pressure drop.
- Installed cost for insulated heating pipe is over 10 times that of the equivalent HDPE.
- No expansion tanks or loops required for HDPE.

HDPE PIPE INSTALLATION

HDPE PIPE THERMALLY FUSED and FLEXIBLE – can be rolled into trench and moved after fusing.

THERMALLY FUSED SADDLE TAKE-OFF – integral heating coil for fusing. Can be hot tapped.

Housing Interface

- Heat pump for each house for heating, cooling, and domestic water heating.
- Heat pumps owned by utility.
- Mech Rooms accessible from outside.
- Heating/cooling loop control valves integrated with HP controls.
- Duplex heat pumps for simultaneous hating and cooling.
- Remote monitoring.

Housing Interface

Heat pump and hot water tank accessed from outside.

Detail of loop pipe connection to heat pump with 3-way valves for switching between heating and cooling.

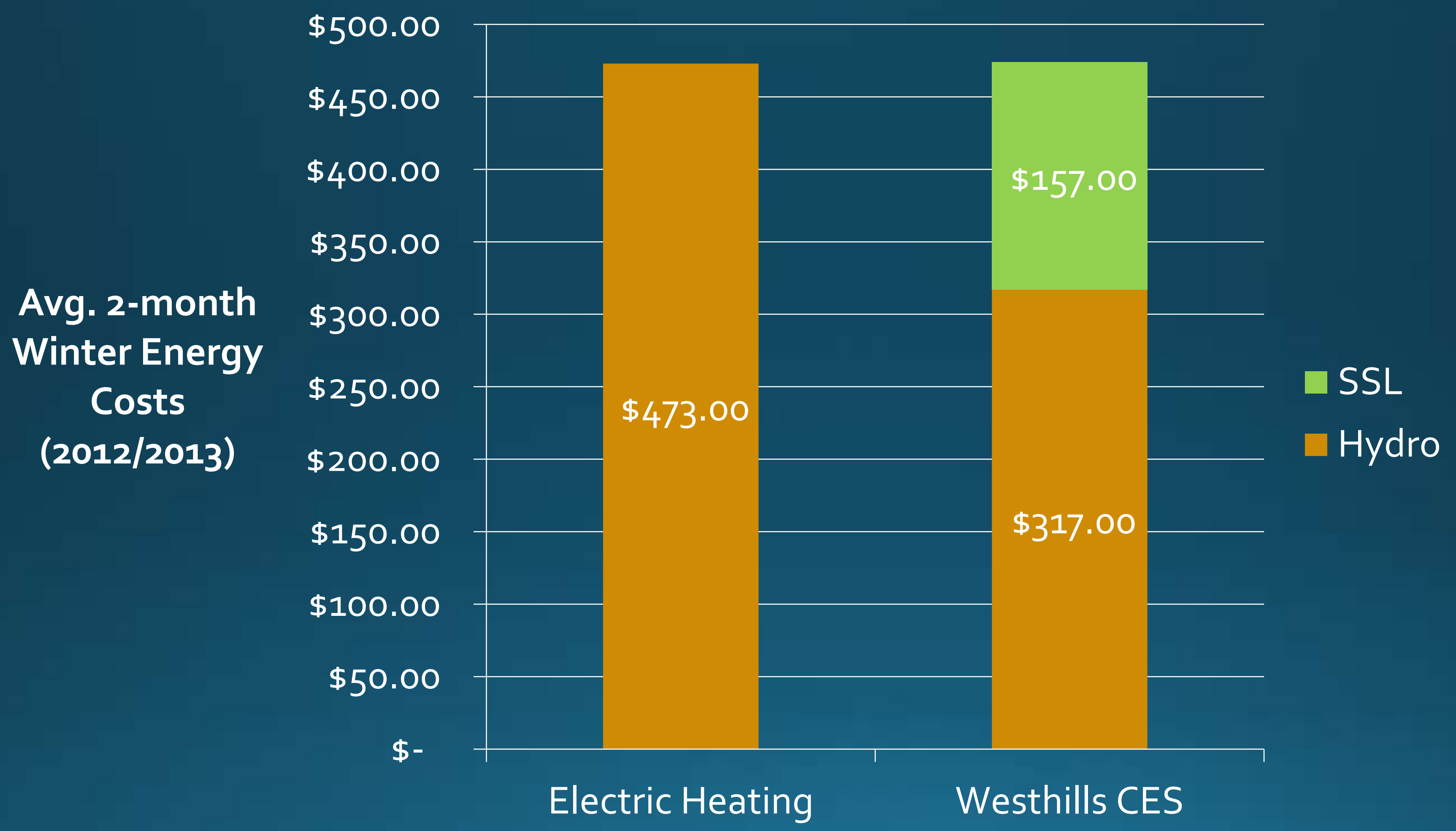
How has the System Performed?

- Now serving almost 600 homes the DESS has performed remarkably well.
- 212 bore holes at 400 feet provides less than 150 feet per home.
- There have been no leaks in the bore field.
- The ammonia heat pumps generally run at a very high COP.
- The plant has proved to be reliable and flexible with no major outages.
- Spring and fall see only the loop circulating pumps running with no heat transfer at the plant. Full energy sharing between the homes!
- Pressure difference between warm and cool pipes is normally maintained within parameters, but a failure of a sensor in a manhole can cause an excursion.
- The temperature difference between warm and cool pipes is lower than hoped for and some home heat pumps distant from the plant can trip on high head.

How have the homes performed

- Domestic hot water from heat pumps is not hot enough for some occupants.
- Home owners do not respond positively to the green concepts used here.
- Original heat pumps were not the best quality and are no longer made.
- Ownership of heat pumps by the utility has been essential for proper maintenance.
- There are only a few service companies with the needed abilities for working on the heat pumps and the DESS interface.
- Initial layouts of houses did not have external access to the heat pumps, but this was corrected in later phases.
- The cost of the DESS heating and cooling has been no more than electric heat.

Average Home Energy Cost Comparison



Conclusions

- The Westhills DESS has provided heating and cooling to the homes at a cost less than or equal to electric heat with no subsidies.
- With increasing electrical rates and dropping gas rates the economic viability is under pressure.
- Environmental pollution – greenhouse gases and noise – have been minimized.
- The source, central plant, and distribution system have performed reliably.
- Under the right conditions the low temperature DESS is viable.