Concrete Floor Heating

Concrete floor heating is rapidly becoming mainstream in Australia. The practise of embedding water pipes in the slab is well known and proven, however the methods of heating the water are varied, and there are several 'boiler' options.

With concern for the environment, the industry is experimenting with Solar, and heat-pump technologies including Geothermal, Water Sourced, and Air Sourced.

Solar (direct radiation from the sun):

Solar is a well recognised and obvious choice for hydronic heating, but is not necessarily suitable for this application. The time when you need the most energy for hydronic heating is when the direct sunlight provides the least available energy – in the middle of winter and overnight. It is possible to harness solar heat energy during the day and store it in large tanks, but this system is very costly and the energy is soon depleted.

All solar hot water systems have a conventional backup heat source such as electric element or GAS boiler, and in hydronics situations it is usually this back-up system that ends up doing most of the work in mid winter. Over the entire heating season, these 'backup' systems will typically use more energy than a heat pump. The amount of energy saved by using a bank of high-efficiency evacuated tubes to boost a heat pump hydronics system – will never return an energy saving over the life of the system.

Hydronic Heat-Pumps:

The Heat-Pump's job is to first collect any available 'free' heat energy, then use conventional energy to push that collected heat energy to a useable temperature for the application. The medium used for the collection of available energy is refrigerant, it works well because the 'free' heat-energy absorption process begins at extremely low temperatures, typically around minus 30^{o}C.
Once pre-warmed with the 'free' energy, the refrigerant is then compressed which raises the temperature. The hot refrigerant then passes through a water heat-exchanger releasing its heat into the water.

'Free' heat Systems:

Geothermal : Below ground, the temperature doesn't fluctuate much and it gets warmer the deeper you go. Typically, plastic pipes are buried underground either horizontally or vertically. A water/anti-freeze mixture is pumped through the pipes into which heat is absorbed from the ground heat. The warmed mixture goes through a heat-exchanger where it releases its heat into refrigerant, thereby cooling the mixture which is then recirculated back through the underground pipes. The now pre-warmed refrigerant is then compressed as described above. The Geothermal heat-pump itself is typically about the same monetary cost as an air-sourced heat pump, but the extra *lifecycle-costs*[1] of burying the pipes actually negates the slight increase in operating efficiency.

Water-Sourced: If available a suitable water source can be used to extract 'free' heat energy. A large dam, running creek etc. may have a water temperature which is consistently warmer than the average air temperature. The process is similar to the geothermal system – pipes laid in the water rather than the ground.

Air-Sourced: Air-Sourced hydronic heat-pumps are largely underrated, as they offer the best overall compromise between efficiency/operating costs, and *lifecycle-costs*[1]. Air-sourced heat-pumps are fully self-contained, and connected only to the hydronic pipework. They have large fans to force high volumes of air over large single-pass Fin Coil Evaporators containing the very cold refrigerant, to absorb 'free' heat energy directly from the ambient air.

Which heat-pump system is best ?

If available, direct access to a lake or river using a water sourced heat pump, may provide a slight advantage over an air sourced heat pump. Must take into account the embedded energy and cost of trenching etc. ie. If the water source is 100m away from the hydronics system then the advantage may be lost.

Although a Geothermal system would seem to be more efficient, it will never save enough in lower operating costs, when compared to the lifecycle cost of an air-sourced system:

WORKED EXAMPLE:
Air-Sourced C.O.P.[2] is around 2.5 at 0°C ambient, rising to about 3 at 7.5°C ambient, and 3.5 at 15°C ambient.

Lets assume a typical domestic installation:

The installation of floorcoils etc, and the cost of a geothermal heat-pump will be roughly the same as for air-sourced heat-pump, the big difference is the cost of geothermal groundworks.

Air-Sourced system installed cost $30k, running cost approx. $5/day average.
Geothermal system installed cost $50k, (about $20k for groundworks)
Even if Geothermal were 50% better efficiency *(which it's not!)*
120days per year operating cost savings of 50% = $2.50 x 120 = $300/year

$20,000/$300 = 67years payback time . . . . .
(alternatively, put the extra $20k in the bank and earn the compound interest, and that 67 years payback will look more like 100yrs . .)

So for Australian climate we would recommend the air-sourced systems.

WARNING: Make sure any heat pump does not rely on an electric element for boosting/defrosting/low-ambient etc., this drastically reduces the overall efficiency. The element may compensate for lower-cost "undersizing" of the heat pump. *(some manufacturers actually promote this as a feature!!)*

NOTES:

1 Lifecycle costs include the embedded energy, the energy to source, process, distribute all components of the system, as well as the monetary costs.
2 The Coefficient of Performance (COP) is simply a way of measuring the efficiency of something. Usually expressed as a percentage, it states the amount of energy consumed compared to the effect produced. A COP of 2.5 means that for every 1kw of electricity consumed, 2.5kw of heat energy is produced.