

Brush Geothermal Project 2008

- Commissioned in August 2008
- Better than expected annual savings of \$10,000
- Total elimination of our LPG bill
- Power cost on track for slight reduction
- After site charges, energy *used to be* our next highest expense
- Substantially improved comfort (best in 28 yrs)
- Highest installation in Aust (with the coldest ground)
- Unanimously praised by guests, members, visitors, RMB

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Project Summary

- Package of renovation works inc insulation upgrades, efficiency improvements & décor updates as well as the GeoExchange
- GeoExchange system was an alpine environment Pilot Project (Four Seasons Energy Pilot) in partnership with the State Govt (Regional Development Victoria)
- Combined team of over 70 worked on the projects at some stage
- Included a comprehensive energy audits & lodge thermal analysis, identifying where & how much to target our attention
- Several innovative solutions were developed to optimise performance (as GeoExchange is new to Australia)

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Energy Cost Summary (at effective heat output, current tariffs and 1700 m altitude, inc GST)

- Hotham LPG: 26 c/kWh, up 40 % in 18 months, future ?
- TRU Power: 15 c/kWh avg (18.3/11.7 c/kWh peak/OP)
- GeoExchange: 5 c/kWh avg (6.1/3.9 c/kWh peak/OP)
- For comparison Melb Nat Gas ~ 5 c/kWh (at sea level), Melb GEx ~ 3 c/kWh avg, heating/cooling/DHW while a Melb ASHP (AirCond) would be around 5 c/kWh
- TRU tariffs assume a standard discount contract (10 %), but note that extra TOU tariff periods are anticipated over the next few years with the State Govt's Smart Metering rollout

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First & foremost – energy audits

- Significant savings available, most by simple measures, low cost
- Upgrade lamps (eg CFLs) where practical (except outside)
- Check thermostat programs & setbacks, don't overheat
- Minimise drafts, seal unused ducts, fit chimney damper
- Improve door & window seals
- Upgrade window glazing
- Improve insulation where practical, inc underfloor
- Turn off unused lights – consider using timers & sensors

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First & foremost – energy audits

- Use 3-star shower heads – they can substantially reduce the required hot water (storage, peak demand & energy). (*Tip: Use good quality roses, not the ones from the \$10 discount bin*)
- These will also reduce steam & amount of ventilation required
- Detailed building thermal & energy analysis may surprise you where the greatest losses are occurring
- The size of the heating plant is determined by the amount of building heat loss (insulation), not the building size *per se*
- LPG efficiency is typically derated by 22 % at our altitude
- LPG is now more expensive than peak rate electricity

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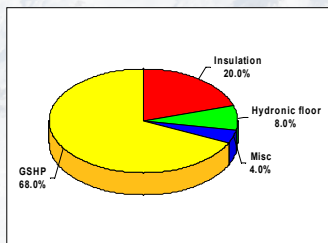
First & foremost – energy audits

- Our LPG boiler pilot light consumed more energy over the season than our gas cooktops.
- 80 % of our gas bill is now just the Service Charge.
- Consider drying room humidity control rather than only heat (ensure removal of moisture rather than recirculating)
- Service fridges – check door seals & clean fan units
- Regularly check all appliances for efficiency & safety
- Mt Hotham is the highest building precinct in Aust with the coldest & most extreme climate, therefore consider the best and most effective insulation available.

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First & foremost – energy audits

• Estimated savings analysis



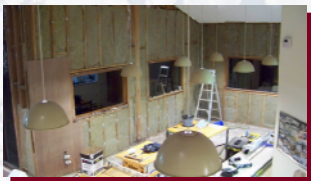
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Replacing wall insulation (original had deteriorated)



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Replacing wall insulation



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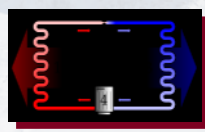
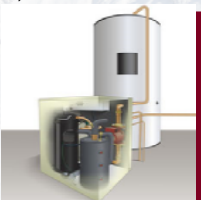
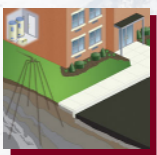
GeoExchange System Basics

- Correct description is a Ground Sourced Heat Pump (GSHP)
- Similar principal as a reverse-cycle air conditioner, also known as an Air Source Heat Pump (ASHP) - not very efficient below 0°C
- Below several metres, ground temperature is constant, warmer than the winter air and is a massive renewable source, heat bank
- For every kW of power supplied to the GSHP, 3 kW of heat is produced, an "efficiency" of 300 % (or COP of 3)
- Higher efficiencies possible with warmer ground (eg sub-alpine)
- Efficiency is also output temperature dependent – basically 40°C is the practical limit (compared with over 60°C for boilers)

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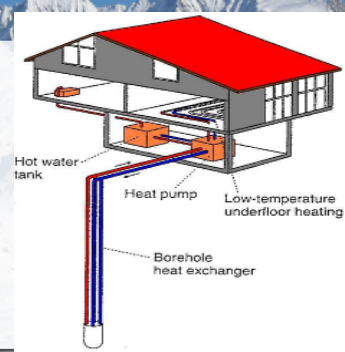
GeoExchange System Basics

- System of bore lines drilled into the ground which extract heat
- The heat is transferred by the heat pump compressor (vapour-compression cycle) and distributed within the building



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GeoExchange System Basics



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GeoExchange Pros & Cons

- Low running costs
- High efficiency
- High reliability anticipated
- Hydronic, ducted air or DHW
- Power tariff expected more stable than LPG
- Reduced CO₂ emissions
- Sept 07 LPG, 14 MWh (52GJ)
- Sept 08 GSHP, 2.9 MWh
- Updating of current heating distribution systems (panel radiators etc) highly likely
- Domestic Hot Water (DHW) requires pre-heat & final tanks
- Design & installation is more complex
- No local standards or specific plumbing codes
- High installation cost

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Drilling Rig No. 1



Drilling Rig No. 1



Rig No. 1 – non stop in all conditions!



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Oops! - Mountain vs Rig – mountain wins!
Can we have another one?



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Rig No. 2 – 4 times the power!



Rig No. 2 with self-loading rods, much faster!



Installing the bore lines



Grouting the bore lines



Preparing manifold trenching



Preparing manifold trenching



Sure beats a shovel!

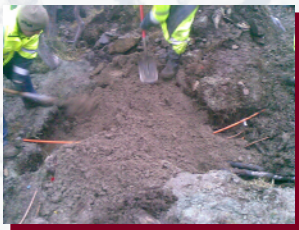


Manifolding & connecting bore lines



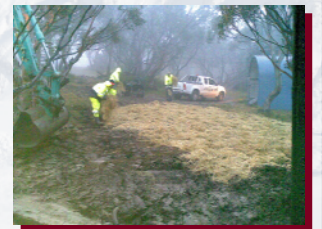
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Backfilling



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Backfilling



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Preparing the new Plantroom



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Au revoir to the old LPG boilers



New plantroom installation



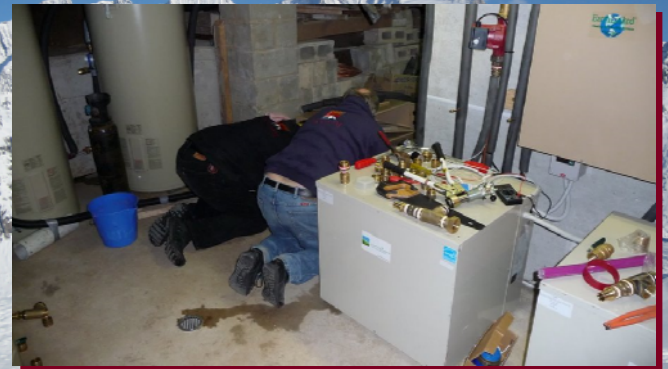
New plantroom installation – buffer tanks



Sure this is the right size?



It's just gotta be down here somewhere!



A few more plumbing connections



Completed heat pumps



Our Challenges

- Previous ageing LPG plant & its plumbing were overdue for major refurbishment. The heating system had deteriorated & comfort levels were unsatisfactory.
- Upgrading estimates (with new LPG plant) were around \$30,000, at best saving \$1000 per year from improved efficiency
- We then looked towards a quantum improvement offering massive energy savings from a renewable source coupled with a major comfort improvement from a more efficient floor system
- Net additional cost of GSHP (c/w an LPG upgrade) \$50,000 including associated plumbing/elect works and Pilot Project Grant, implying a payback of about 5 years on present tariffs

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Sensational Hydronic Floor System

- Upgraded public areas (lounge/mezz/dining) to new hydronic floor system – for greatly improved comfort - virtually mandatory for a GSHP system due to its lower temperatures (40°C max)
- Extensive research into floor systems – under floor, above floor dry panels and overlay screeds
- Identified a light weight product with high thermal conductivity in only a 32 mm screed (defying industry advice – *must be* 80 mm)
- The floor is now very solid (c/w an old squeaking timber floor!)
- Installation crew of 5 with their arsenal of equipment, batching plant & trucks fully & professionally installed over 24 hrs on site

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Hydronic Floor Installation



Hydronic Floor Installation



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Hydronic Floor Installation



Hydronic Floor Installation





Sensational Hydronic Floor System

- Floor covering choice is critical (especially for carpet) with virtually no local product data available for hydronic floor applications so we had to create the data ourselves from our own resources
- We worked closely with a major supplier to achieve this then select the best product – amazingly which turned out to also be one of their highest quality commercial underlays.
- Higher quality underlay & wool carpet with better performance than specialised “thermal floor” European & UK carpet products
- Net result of the new floor screed, the thermally efficient underlay and carpet is spectacular – truly “invisible comfort”

Sensational Hydronic Floor System

- It's so effective, that hardly anyone bothered with the traditional fireplace – saving another \$1000/yr in firewood (down 70 %)
- There are other forms of GeoExchange (GSHP) systems, the vertical ground bores being the most practical for Hotham
- GSHPs operate most efficiently with and are a perfect match for hydronic floor systems
- Hydronic floors offer the highest quality of space heating with ideal room temperature distribution and lowest energy input
- Air Source Heat Pumps will not be very efficient at Hotham due to the very low air temperatures

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Existing panel radiators

- Panel radiator outputs will be substantially lower with the GSHP temperatures (perhaps down by ab 70 %) compared with normal 60°C boilers
- In our case most of our bedroom panels were originally oversized and are OK with the lower temperatures
- Lower temperature hydronics will also reduce energy losses in the distribution plumbing
- Ducted air systems also possible with a GSHP, although not quite as efficiently as a hydronic floor (except for drying rooms)

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Completed Heat Pumps



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Heat pump compressor



Domestic hot water control



Comprehensive SCADA control & monitoring with remote access



Official Opening 31st August by Michael Crutchfield,
parliamentary sec for water & environment



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Heat pumps extracting heat from under 2 m snow!



Heat pumps extracting heat from under 2 m snow!



Site access just a little more challenging now!



Community Project Benefit

- Being a trailblazer, it was more costly & involved more resources (inc 2000 hrs of detailed engineering, evaluation, design, project management & commissioning)
- No single contractor can provide all the necessary works (despite their claims) which will require specialist design, custom mods to existing systems plus supplementary plumbing & electrical work
- We now have acquired a substantial knowledge base of what's achievable and practical and how to implement at significantly lower cost and are keen to share our experiences for the benefit of our resort, so others don't need to reinvent the wheel

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The Future

- Our project has established benchmark reference efficiencies in the most extreme Australian climate
- The concept is new to Aust but quite established in the northern hemisphere (often featured in the UK "Grand Designs" program)
- Off-season viability has been dramatically improved (especially for small groups) due to the energy reductions and low lodge start-up costs.
- Our hope is now to inspire others to enjoy the benefits of what is described as the most environmentally friendly heating system available

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Acknowledgements

- Regional Development Victoria (Four Seasons Energy Pilot) for design assistance, minimising risk & funding grant
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- MHRMB for support
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- Brush members & the Mt Hotham community for their overwhelming support

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Thank you & good night!

Thank you for viewing our presentation

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