Feasibility of Geothermal Energy in Rural Communities of Australia and Indonesia

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Abstract

This report investigates the feasibility of geothermal energy for domestic purpose, one of many alternative energy options, in two separate rural communities. The communities chosen are Warmundi, Indonesia, of approximately 70 residents, and McArthur, NT, Australia, of approximately 295 residents. This report researches the energy requirements to maintain a household at a constant 23 degrees, with heat loss through single glazed or double glazed windows, in both locations.

Introduction

In today's world, the implementation of renewable energy resources is becoming more and more necessary. Approximately 80.056% [1] of the world's energy consumption comes from fossil fuels, which have been proven to have damaging and costly effects on our earth and its population [2]. While the global demand for energy is increasing rapidly, with the world consumption expected to rise 28% by 2040, some rural communities still struggle to gain access to power from traditional grid systems due to the hindrances of location. Renewable energy provides opportunity for these remote locations to access an energy source that not only is compatible with their location, but is reliable and has less harmful impacts on the environment than fossil fuels.

The opportunity to expand renewable energy varies by location, as certain resources are more feasible in specific geographies based on temperature, weather patterns, and proximity to water. In this report, we will explore the feasibility of installing geothermal systems in two separate remote communities of Indonesia and Australia, for general domestic use of energy. Geothermal energy was chosen specifically for the two locations to compare its feasibility in Indonesia, a country that is a world leader in geothermal energy production, and Australia, a country that not fully explored its geothermal opportunity.

Literature Review

Geothermal energy is power produced by utilising the thermal energy beneath the Earth's surface. A basic geothermal power plant operation consists of a hot water and steam reservoir situated a few kilometres under the surface of the Earth where temperatures range from as low as 80°C to as high as 350°C. The steam produced by the contained hot water is then used to drive a turbine connected to a generator to produce electricity. To make the system renewable, some power plants use a condenser to convert the used steam back to a liquid state which is then injected back to the reservoir to heat into steam again. As a renewable energy source, the use of geothermal power proves to be better and more cost-effective compared to electricity produced by petroleum power plants as it is also non-polluting. However, in a long-term situation, there could be a risk of exhausting the steam/hot water reservoirs. [3]

Geothermal Resources:

Convective Hydrothermal Systems

In regions of high volcanic activity, heat tends to be very close to the surface of the land. Aside from very warm surfaces, volcanic regions can also produce heat by convection through hot springs and geysers [3].

Enhanced Geothermal Systems (EGS)

Because of the natural radioactive decay of the minerals deep into the Earth's surface, dry and non-porous rock 3-5km in depth can also provide high temperatures and slow heat loss. To utilise this heat as a source, hydraulic stimulation is done which is by pumping high pressure cold water into this hot dry rock (HDR), then using the produced steam to power a turbine or a binary power plant system for electricity production [5].

Hot Sedimentary Aquifers (HSA)

Aquifers formed underground can also provide geothermal heat by having water seeping into the earth which is then heated by hot and porous rocks. These aquifers can be drilled into and deliver hot water onto the surface to generate electricity or for direct use [6].

Geothermal Energy Processes [5]:

Dry Steam Power Plants

This is the direct use of geothermal steam (>150 degrees Celsius) to power turbines for electricity generation. It is one of the oldest and simplest power plant designs.

Flash Steam Power Plants

High-temperature and pressure water is sent into low-pressure tanks. This subsequent 'flashed' (>180 degrees Celsius) steam is then used to drive turbines to generate electrical power. This method is most commonly used in plant operation today.

Binary Cycle Power Plants

Recently developed, this method is capable of using geothermal fluid as low as 57 degrees Celsius. This relatively warm water is then used to pass along another fluid that has a lower boiling point than water. This secondary fluid is then turned to vapour simultaneously, powering the turbines needed for electricity generation. As of today, this type of geothermal electricity production is most commonly built.

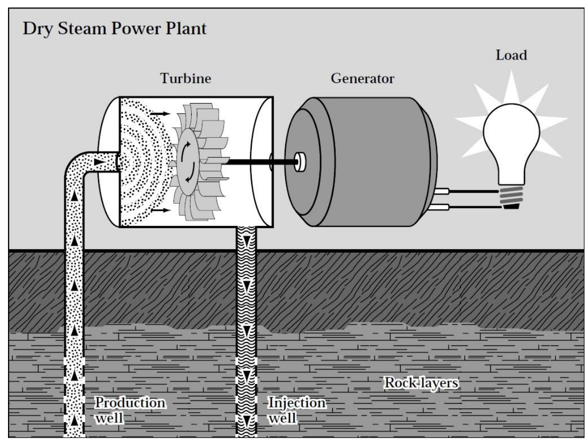

Figure 1: Dry steam power plant obtaining steam from a reservoir heated geothermally, powering the turbine to turn the generator and produce electricity. The used steam is then condensed and injected back to the reservoir [6].

A number of factors influence the design and planning of geothermal power plants. The most significant aspect is the temperature of the proposed location. The design of the components within the system is influenced by the projected temperatures that are achieved by the earth, according to its depth. Besides temperature, the size of the proposed reservoir also needs to be considered as it indicates how much volume of water is needed for the application to be conducted. Aside from design, the cost of geothermal energy projects also greatly affect the planning. The drilling of the land is what mostly influences the cost of projects; great depths require large amounts of drilling, as well as the different properties (such as hardness) of the rocks and earth that come in contact with the drill [4].

Another benefit gained from geothermal energy is heat production. Besides electricity generation, the heat from the high temperatures from beneath the surface of the Earth can also be used for bathing (spas, hot springs, etc.) and heat pumps to name a few. Hot springs exist from water discharged by the ground heated by either volcanic activity or through convective circulation by the normal temperature gradient of the Earth's crust [3]. As for geothermal heat pumps, they act as a central heating/cooling system pumping heat to or from the ground. This system can use earth as a heat source during cooler months or as a heat sink during warmer months. By taking advantage of the geothermal energy produced by the earth, these applications can be utilised to improve efficiency and reduce operating costs from using conventional heating and cooling systems [5].

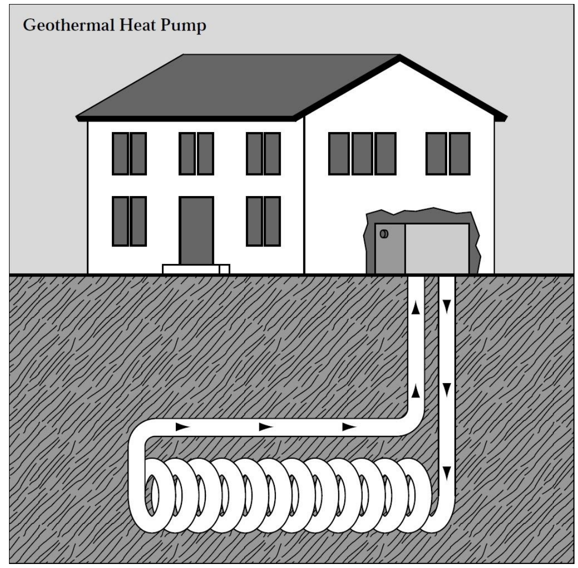

Figure 2: Geothermal Heat Pump System – using electrical power to transport the thermal energy between the house and the earth to manipulate the temperature according to the heating or cooling demands [6].

As of 1997, the thermal energy found six miles (~9.7km) deep from the earth's surface amounted 50,000 times the combined energy produced by oil and gas power plants around the world. This shows the abundance and the potential presented by geothermal power resources globally [6].

Background

McArthur, Australia

McArthur is a state suburb in the Northern Territory (NT) of Australia, located 2,000 KM west of Perth, and bordering the McArthur river. The community is home to approximately 295 inhabitants, 40% being of Aboriginal and/or Torres Strait Islander descent [7].

Data from the 2016 census states that McArthur contains approximately 70 occupied private dwellings. The median weekly income, per household, is $718 AUD, far less than the national average of $1,203 AUD. The community borders the McArthur River Mine, one of the largest Zinc and Silver mines on the planet. The mine provides road access to the McArthur community that otherwise would not exist, however, local waterways have been affected by the leaching zinc and lead from the mine dumping. The waste leaves the supply of fish, a common food source of the communities along the waterway, contaminated and dangerous to consume [13].

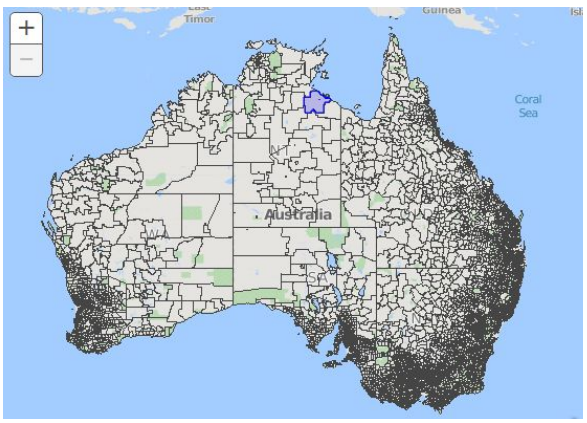

Figure 3: McArthur, NT, Australia [7]

The average maximum temperature in McArthur is recorded to be 34.6 degrees Celsius, with minimums averaging at 19.7 degrees Celsius. Figure 4 illustrates the average maximum and minimum temperatures at McArthur River Mine Airport from 1969 to 2017. The data is assumed to be equivalent to the temperatures in of the McArthur Community based on the proximity of the locations.

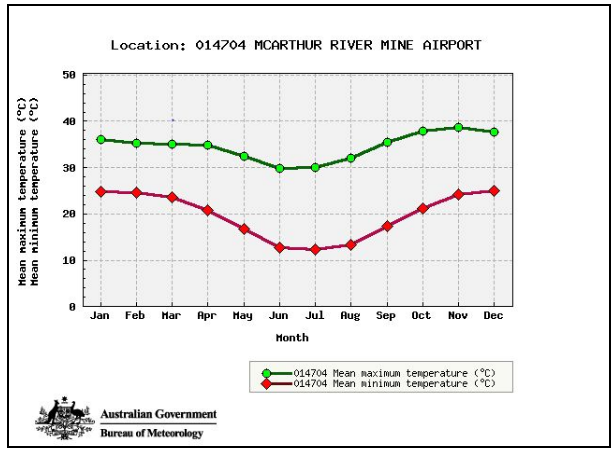

Figure 4: McArthur maximum temperature (1969-2017)

Discussion:

In all of Australia, 86% of energy consumption relies on fossil fuels, higher than the global average. Geothermal energy, however, is not yet produced for commercial consumption and makes up only .001% of energy production, from a single plant in Queensland with the energy capability of 0.12 MWe m-2. The lack of volcanic structures limits the geothermal potential within the country by convective hydrothermal methods, however enhanced geothermal systems and geothermal heat pump systems are in exploratory stages. Drilling technology is currently the main limitation in the development of EGS, however many potential locations are being explored based on identified regions of earth temperatures at 5km deep. It has been estimated that one percent of geothermal energy from these depths greater than 150 degrees could supply Australia with energy for 26,000 years [8]. Based on research performed by GeoScience Australia, the interpreted temperature 5km below the earth's crust in McArthur is thought to be greater than 235 degrees Celsius, appropriate for EGS development. The map, visible in Figure 5, demonstrates indication of the geothermal potential throughout Australia.

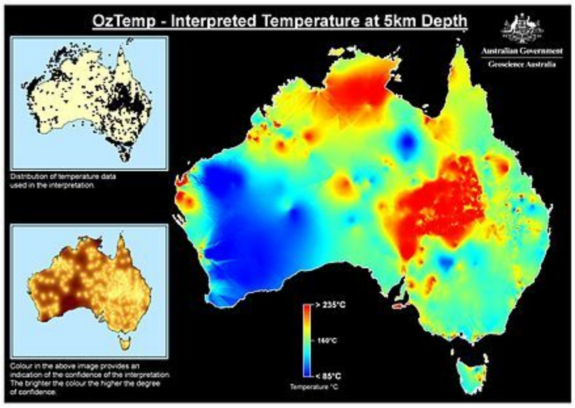

Figure 5: Geothermal Indication Map at 5km depth, Australia [8]

<u>Warmandi, Indonesia</u>

Warmandi is a small coastal village on West Papua, Indonesia, located on the northern coast of the Bird's Head Peninsula. It lies approximately 200 km from the capital, Sorong.

Figure 6: West Papua, Indonesia. Warmandi Village is located on the northern coast of central West Papua.

The village of Warmandi has approximately 80 residents, who mainly work in fishing, farming, logging, and mining [9]. It is approximated that there are 30 households within the village.

Temperatures in Warmandi have a relatively small range, with an average maximum temperature of 30 degrees Celsius, and average minimum of 24 degrees Celsius, as seen in Figure 7.

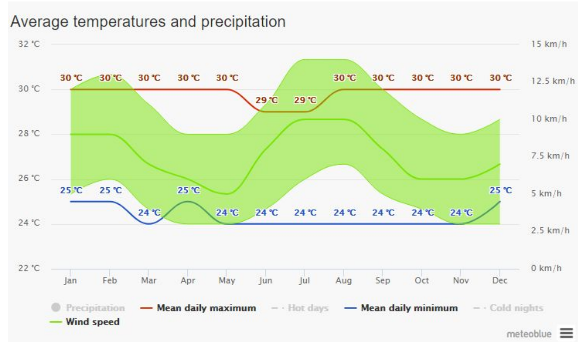

Figure 7: Average Monthly Temperatures of Warmandi, degrees Celsius

Discussion:

Because of its location at the meeting point of three tectonic plates, Indonesia is a country with large potential for geothermal reserves. It's current reserves amount to 29 GW, approximately 40% of the world's reserves, with a current generation of 1,197 MW. For a map of Indonesia's geothermal potential, see Figure 8. It is the world's third largest producer of geothermal energy, trailing the United States and the Philippines. Despite this, development of geothermal energy faces geographical, and social challenges. The soil surfaces and mountainous geography of much of Indonesia make road access to facilities difficult. The Warmandi community is relatively poor due to challenges in economic development. The average annual income of the community remains at Rp31.5 million, or $4,378.79 AUD. These challenges in development are due to both physical barriers of the land, and social barriers of the culture, a very fragmented one with religious and language divides. Additionally, community resistance towards geothermal drilling and lack of education on the subject presents limitations. These factors all contribute to Indonesia's low geothermal development, with only 6% of its potential reserves developed.

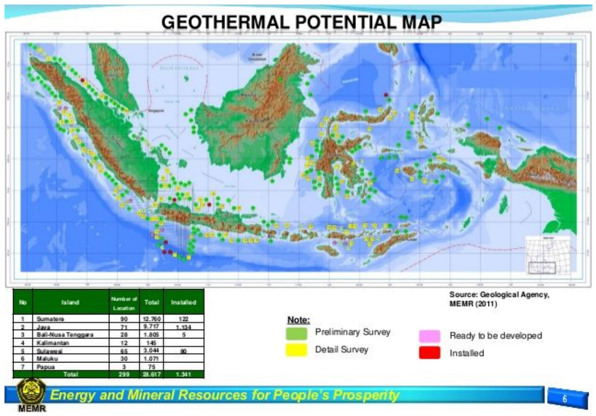

Figure 8: Geothermal Potential of Indonesia Map [12]

Assessment

Energy Consumption Analysis

To determine the parameters for energy production and geothermal plant specification, the required energy must be calculated. To simplify the process, the household is required to maintain a temperature of 23 °C by heating or cooling. The required energy for this process is estimated at how much energy is gained/lost from the household via the windows to the surrounding environment due to temperature difference. This is derived using the following formulae:

$$Q = UA(T_{in} - T_{out})$$

The following variable are described as:

Q = Energy lost (W)

U = Heat transfer of window (W/ m² * °C)

A = Surface Area of window (m²)

Tin = Temperature inside °C

Tout = Temperature outside °C

To do this it must be assumed that the windows are the only point of loss and that the surface area of windows is 15 m². It is also assumed that the heat transfer of a single paned window is 5.57 W/ m² * °C. The outside temp was taken from local data of temperature averages per month. Additionally, double glazed windows were added to this calculation for comparison. For double glazing windows a heat transfer of 3.2 W/ m² * °C is used. Below are the results as energy in kW/h per month for each location.

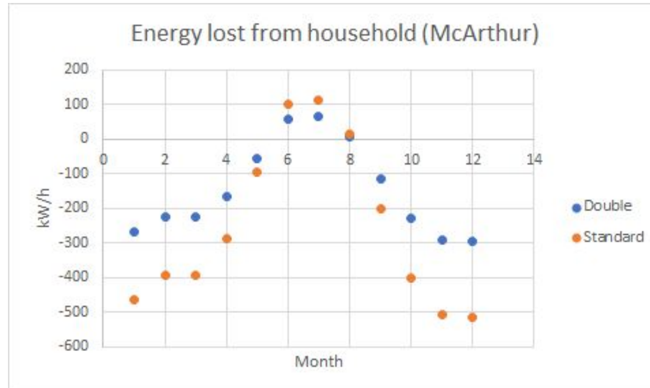

Figure 9: Monthly energy requirements to maintain household at 23°C, McArthur, Australia

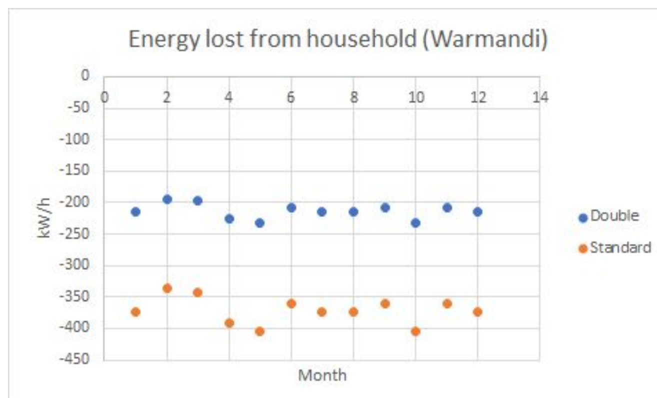

Figure 10: Monthly energy requirements to maintain household at 23°C, Warmandi, Indonesia

These initial calculations indicate that the majority of energy is being added to the system in both locations. In Warmandi there is no heat loss at all, and only heat gained by the outside environment, meaning the system must be cooled. As for power values in McArthur, the maximum energy transfer is 515 kW/h for single glazed window, and 296 kW/h for double. Warmandi shows a maximum energy transfer equal to 404 kW/h for single, and 232 kW/h double glazed windows.

The use of double glazed windows proves to be an opportunity for energy savings. The comparison below in Table 1 demonstrates the savings involved in upgrading to double glazing windows in both remote locations, with cost of electricity at $0.095/kWh for heating and cooling. The savings is not dramatic, only $141 and $180 in McArthur and Warmandi per year, respectively. However, taking into account the low annual income of both locations, double glazed windows could have a large impact on the communities energy savings.

	$ (McArthur)	$ (Warmandi)
Jan	18.72	15.08
Feb	15.89	13.62
Mar	15.83	13.82
Apr	11.55	15.81
May	3.89	16.33
Jun	4.13	14.59
Jul	4.52	15.08
Aug	0.63	15.08
Sept	8.15	14.59
Oct	16.21	16.33
Nov	20.55	14.59
Dec	20.86	15.08
Average	11.74	15.00

Table 1: Energy savings required for the system comparing single glazing and double glazing windows (AUD)

Location wise, the type of geothermal energy needs to be assessed. This assessment takes into account location, geography surface and ground temperatures, surveying data etc.

For McArthur, a deep well plant is the recommended choice, either sourcing from EGS or HCS. McArthur is located in a rather flat and sparse desert basin. No natural geysers or springs exist near the town due to the dry conditions and distance from any fault lines. The geothermal energy must be drilled for. Using the geological data from Oztemp's well survey database [15], the plot below was created.

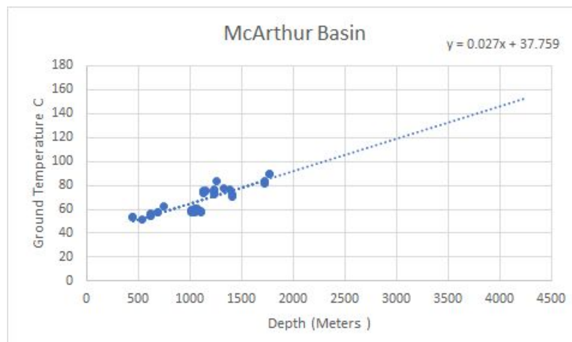

Figure 11: McArthur Basin ground temperature measurements in relation to depth

The graph shows data from Pacific Oil and Gas's survey points and the temperature and depth have been plotted. It shows very low temperatures in comparison to depth. The relationship between depth and temperature when simplified is best explained as linear, so an estimation is made based on the other data to predict temperatures at greater depth.

When assessing the methods of energy conversion, dry steam becomes very impractical, due to the low gradient of the relationship. To achieve temperatures greater than 150 °C, a depth greater than 4 km must be drilled. In these locations, Binary Cycle is much more practical as these temperatures are proven and the depths have already been assessed.

Calculating the size of the plant is the next step. To meet the required energy levels the maximum amount of power need is 515 kW/h (Figure 9).

A formula derived by CSIRO simplifies this complicated process into a much smaller relationship to highlight the influences of the process.

$$MW \approx c\, p \times F \times \Delta T \times \eta - P \qquad [14]$$

In this formula, we have factors such as specific heat, flow rate, temperature difference and efficiency all directly proportional to the energy output, subtracting parasitic loss. Most energy transfer cycles run at around 10% efficiency. This value considers the binary cycle efficiency of 55%, as well as the realistic capture of heat from the pumped water. Therefore, the plant's output comes relies mainly on flowrate of the water being pumped through, and the source temperature. As the depth of the well is increased to achieve a higher temperature, the flow rate will reduce due to extra load, which is a limitation of this method.
A rough value could be calculated, however the largest unknown variable is the parasitic loss. The plant requires a large amount of power to operate. This value is less than the output, however it is extremely variable and specific for each individual setup. These calculations become very complex and are often kept secret from supplier to supplier. Influences that contribute to this loss include: pumping the water from depths greater than 1000m below to the surface; pressurising the refrigerant in the binary system; cooling the rejected refrigerant.

<u>Cost</u>
Geothermal plants are very uncommon in Australia and the technology and supporting infrastructure is very minimal. Despite the energy source being the cheapest currently available, at $0.05/kWh, the sheer size of the initial cost is the factor which has prevented this industry's growth, especially in Australia.
Using data from American oil rigging operations, CSIRO [14] estimates well drilling to be $2750/m. This does not even include the initial surveying involved to determine where the best reserves of energy may be located, as discussed above. Surveying is estimated to cost well in the millions, which remains the largest setback in geothermal development. As shown in Figure 11, the required depth of drilling would need to be between 1000-2000m, assuming zero heat loss in pumping the water to the surface. At this depth simply drilling one well would cost around $3 million.
Building a plant which would have an upfront capital cost above $5 million in a town which has around 70 households is not feasible or practical. The plant would also be too far from surrounding cities to benefit from transporting this generated power, as too much infrastructure would need to be built.

<u>Payback</u>
Averaging the estimated upfront costs of geothermal plants per kW from CSIRO, EPRI and the IEA [14], the average cost is $6468/kW. If our plant needs to be a minimum of 515kWh then the overall cost is $3.331 Million. For a single well sourced plant the cost of production is $0.06/kWh [16]. If the town is using on average 145kWh per month, and the cost of electricity is $0.095/kWh then the company receives $0.035/kWh. Thus the payback period is unfeasible and very impractical. When the initial capital investment for the plant reduces as technology improves, it will become more viable.

<u>Warmandi</u>

For Warmandi this energy source runs into similar issues, however is much better suited to a geothermal electrical system. This is because Warmandi lies on the ring of fire, more specifically at the end of the Bougainville trench. This is a major fault line and causes volcanic activity close to the surface. This means that the region of Warmandi has many hot springs and geysers. This source is a Convective Hydrothermal System, where water is taken from a source on the surface and no drilling is required. This will cut down the costs significantly.

A good solution to most of the problems listed above comes in the form of a household geothermal heat pump. This system is a small house by house unit and will cut costs whilst performing the minimum amount of work required.

Geothermal Heat Pump

A geothermal heat pump absorbs free heat from the warm earth and transfers it into your home.

Unlike conventional heating systems like oil, natural gas, coal or wood heat, there is no combustion or fuel source required. These conventional forms of home heating burn fuel to create heat. This is an inefficient process because some energy is lost up the flue, meaning less energy is put into the home than what the actual fuel contains.

Ground source heat pumps are an extremely efficient form of space heating and cooling. They use little energy, have a long lifetime and they need little maintenance. They do, however, require a significant upfront capital investment and with a payback period of anywhere from 5 to 15 years, and are not a viable option for everyone.

What is most beneficial about the heat pump system is its simplicity and specificity towards the assigned task. When looking at Figure 9 and 10, most of the heat is in fact entering the system as the outside temperature is almost always above 23 degrees Celsius. This means that the system needs to be designed to cool the household. The heat pump system sources cool temperatures from around 3 meters below the surface often between a constant 10-15 degrees Celsius, no matter the location [20]. This system, when running will only draw small amounts of energy for the fans.

Cost analysis

The cost of geothermal energy is intimately linked to the location, depth and temperature of the Geothermal Resource. The most expensive cost element is the drilling of boreholes to produce and reinject the fluid. The cost of 'failed' boreholes (those that do not produce at the required rate) must also be factored into the overall project cost.

Setting up a ground-source heat pump takes a bit of work because pipes have to be buried underground. When choosing horizontal systems, the pipes are laid up to 1.8 metres deep and a large area of ground is required. The other option is to drill several holes straight down to a depth of at least 80 metres. This is the most expensive method but uses only a comparatively small area. If there is some sort of water body available, such as a dam, pond, river or the ocean, this can also be used, but the pipes must be covered by at least three metres of water.

Factors

In order to compare the economics of geothermal heat pump systems to other HVAC alternatives, a direct comparison must be made between capital costs, operating costs, and maintenance costs. Once a clear understanding of the relative costs associated with the various alternatives is established, it is then possible to use the information to conduct a simplified life cycle cost analysis in order to compare the relative costs of the alternatives.

Australia

Geothermal Heat Pump Cost
AUD$ 150,000
Drilling Cost
AUD$ 80,000
Installation Cost
AUD$ 25,000
Maintenance Cost
AUD$ 5,000

Total Cost
AUD$ 260,000

Indonesia

Geothermal Heat Pump Cost
AUD$ 150,000
Drilling Cost
AUD$ 8,000
Installation Cost
AUD$ 5,000
Maintenance Cost
AUD$ 1,500

Total Cost
AUD$ 164,500

Conclusion:

Sources:

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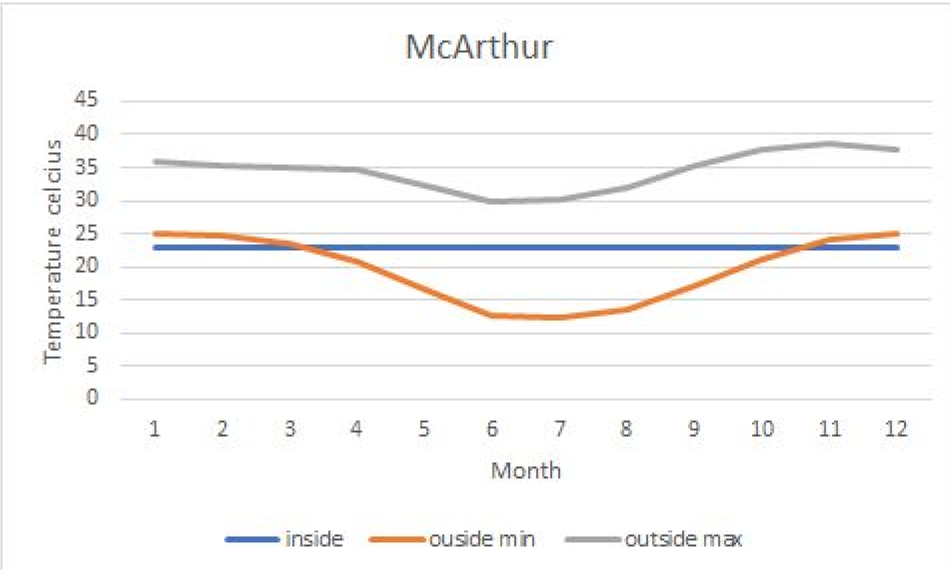
ADDITIONAL INFORMATION IF NEEDED (for appendix???)

McArthur																		
Energy Consumption Per Household																		
			Temp			Standard				Double				Costing	Single		Double	
Day	Month	inside	ouside min	outside max	Window Area	q min	q max	avg	KWh	q min	q max	avg	KWh		Household	Plant	Household	Plant
31	Jan	23	24.9	36	15	-158.745	-1086.15	-622.448	-463.101	-91.2	-624	-357.6	-266.054		43.994589	23.15505	25.275168	13.30272
28	Feb	23	24.7	35.3	15	-142.035	-1027.67	-584.85	-393.019	-81.6	-590.4	-336	-225.792		37.336824	19.65096	21.45024	11.2896
31	Mar	23	23.5	35.1	15	-41.775	-1010.96	-526.365	-391.616	-24	-580.8	-302.4	-224.986		37.203478	19.58078	21.373632	11.24928
30	April	23	20.7	34.8	15	192.165	-985.89	-396.863	-285.741	110.4	-566.4	-228	-164.16		27.145395	14.28705	15.5952	8.208
31	May	23	16.7	32.4	15	526.365	-785.37	-129.503	-96.3499	302.4	-451.2	-74.4	-55.3536		9.1532367	4.817493	5.258592	2.76768
30	June	23	12.7	29.9	15	860.565	-576.495	142.035	102.2652	494.4	-331.2	81.6	58.752		9.715194	5.11326	5.58144	2.9376
31	July	23	12.3	30.1	15	893.985	-593.205	150.39	111.8902	513.6	-340.8	86.4	64.2816		10.629565	5.594508	6.106752	3.21408
31	Aug	23	13.4	32.1	15	802.08	-760.305	20.8875	15.5403	460.8	-436.8	12	8.928		1.4763285	0.777015	0.84816	0.4464
30	Sept	23	17.3	35.4	15	476.235	-1036.02	-279.893	-201.523	273.6	-595.2	-160.8	-115.776		19.144647	10.07613	10.99872	5.7888
31	Oct	23	21.1	37.8	15	158.745	-1236.54	-538.898	-400.94	91.2	-710.4	-309.6	-230.342		38.089275	20.04699	21.882528	11.51712
30	Nov	23	24.2	38.7	15	-100.26	-1311.74	-705.998	-508.318	-57.6	-753.6	-405.6	-292.032		48.290229	25.41591	27.74304	14.6016
31	Dec	23	25	37.6	15	-167.1	-1219.83	-693.465	-515.938	-96	-700.8	-398.4	-296.41		49.014106	25.7969	28.158912	14.82048
														avg	27.599406	14.526	15.856032	8.34528
				37.74545455														

Warmandi																		
Energy Consumption Per Household																		
			Temp			Standard				Double				Costing	Single		Double	
Day	Month	inside	ouside min	outside max	Window Area	q min	q max	avg	KWh	q min	q max	avg	KWh		Household	Plant	Household	Plant
31	Jan	23	25	33	15	-167.1	-835.5	-501.3	-372.967	-96	-480	-288	-214.272		35.431884	11.18902	20.35584	6.42816
28	Feb	23	25	33	15	-167.1	-835.5	-501.3	-336.874	-96	-480	-288	-193.536		32.002992	10.10621	18.38592	5.80608
31	Mar	23	24	33	15	-83.55	-835.5	-459.525	-341.887	-48	-480	-264	-196.416		32.479227	10.2566	18.65952	5.89248
30	April	23	25	34	15	-167.1	-919.05	-543.075	-391.014	-96	-528	-312	-224.64		37.14633	11.73042	21.3408	6.7392
31	May	23	23	36	15	0	-1086.15	-543.075	-404.048	0	-624	-312	-232.128		38.384541	12.12143	22.05216	6.96384
30	June	23	23	35	15	0	-1002.6	-501.3	-360.936	0	-576	-288	-207.36		34.28892	10.82808	19.6992	6.2208
31	July	23	23	35	15	0	-1002.6	-501.3	-372.967	0	-576	-288	-214.272		35.431884	11.18902	20.35584	6.42816
31	Aug	23	23	35	15	0	-1002.6	-501.3	-372.967	0	-576	-288	-214.272		35.431884	11.18902	20.35584	6.42816
30	Sept	23	23	35	15	0	-1002.6	-501.3	-360.936	0	-576	-288	-207.36		34.28892	10.82808	19.6992	6.2208
31	Oct	23	24	35	15	-83.55	-1002.6	-543.075	-404.048	-48	-576	-312	-232.128		38.384541	12.12143	22.05216	6.96384
30	Nov	23	24	34	15	-83.55	-919.05	-501.3	-360.936	-48	-528	-288	-207.36		34.28892	10.82808	19.6992	6.2208
31	Dec	23	24	34	15	-83.55	-919.05	-501.3	-372.967	-48	-528	-288	-214.272		35.431884	11.18902	20.35584	6.42816
														avg	35.249327	11.13137	20.25096	6.39504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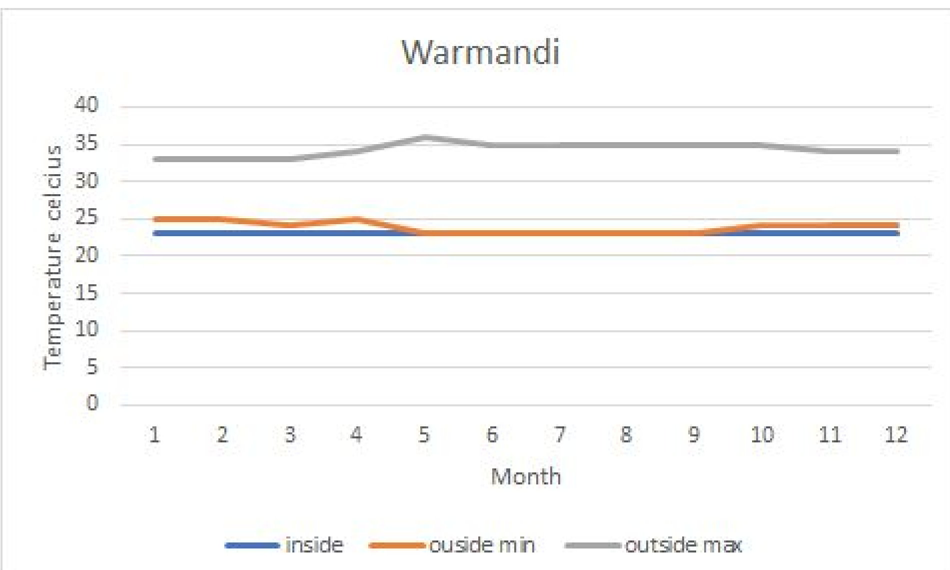
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Member % Contribution

Group Member	% Contribution (Total 100)	Signature	Date
Dana Anne Hartlein	25		03/10/2017
Andrew Ganther	25		
Syed Hassan Ali	25		
Mark Tolentino	25		

TEAM MEETING LOG

Date: 15th August 2017
Members present: Andrew Ganther, Dana Anne Hartlein, Mark Tolentino, Syed Hassan Ali

Problem areas: Group Formation, Familiarising with each other

Work completed	Group member(s) responsible
• Formed the group • Introduced one another • Familiarise with each other • Discuss the project briefly	ALL

Agreed action for next meeting	Group member(s) responsible
• Read more about the project and its requirements • Research on potential topics for report • Decide on group leader	ALL

TEAM MEETING LOG

Date: 22nd August 2017
Members present: Andrew Ganther, Dana Anne Hartlein, Mark Tolentino, Syed Hassan Ali

Problem areas: Project topic, Group leader, Report resources

Work completed	Group member(s) responsible
• Decide on a project topic • Designated Andrew Ganther as the group leader • Research on potential location for the topic	ALL

Agreed action for next meeting	Group member(s) responsible
• Send project proposal to tutor • Research for good resources for the report	• Andrew • ALL

TEAM MEETING LOG

Date: 29th August 2017
Members present: Andrew Ganther, Dana Anne Hartlein, Mark Tolentino, Syed Hassan Ali

Problem areas: Report resources, Report discussion

Work completed	Group member(s) responsible
• Discuss the resources found for the report • Further discussion on what needs to be written in the report	ALL

Agreed action for next meeting	Group member(s) responsible
• Delegate parts of the report to be written by each member	ALL

TEAM MEETING LOG

Date: 5th September 2017
Members present: Andrew Ganther, Dana Anne Hartlein, Mark Tolentino, Syed Hassan Ali

Problem areas: Report writing

Work completed	Group member(s) responsible
• Delegate tasks for each member to write on the report • Start working on what needs to be written	ALL

Agreed action for next meeting	Group member(s) responsible
• Continue working on report	ALL

TEAM MEETING LOG

Date: 19th September 2017
Members present: Andrew Ganther, Dana Anne Hartlein, Mark Tolentino, Syed Hassan Ali

Problem areas: Report writing

Work completed	Group member(s) responsible
• Recap on what has already been done for report • Continue working on report	ALL

Agreed action for next meeting	Group member(s) responsible
• Review report • Make any improvements on report	ALL

TEAM MEETING LOG

Date: 28th September 2017
Members present: Andrew Ganther, Dana Anne Hartlein, Mark Tolentino, Syed Hassan Ali

Problem areas: Review report, Oral Presentation

Work completed	Group member(s) responsible
• Review the report • Make additional improvements • Start working on the oral presentation	ALL

Agreed action for next meeting	Group member(s) responsible
• Final changes for report before printing • Prepare for oral presentation	ALL

TEAM MEETING LOG

Date: 2nd October 2017
Members present: Andrew Ganther, Dana Anne Hartlein, Mark Tolentino, Syed Hassan Ali

Problem areas: Final meeting, Final report, Oral presentation

Work completed	**Group member(s) responsible**
• Polish the content of the report • Print report • Finalise preparation for oral presentation	ALL

Agreed action for next meeting	**Group member(s) responsible**
N/A	N/A