Policy Brief

Geothermal Feasibility in Sulawesi, Indonesia

Katie Dittrich
Pol 452 W: Energy Policy
Spring 2012
Dr. Anil Hira

Executive Summary

In 2005 Indonesia's energy sector, dominated by petroleum, had a stern wakeup call as their national oil consumption surpassed their domestic supply of oil. The shift to become a net importer of oil has greatly shaken the Indonesian government as they search for a means to retain energy security while still providing for an ever increasing energy demand. Indonesia has the fourth largest population in the world with 237 million people spread over an archipelago of over 17,500 islands. Naturally, the islands have various energy supplies and demands. Where some islands such as Kalimantan and Sumatera are abundant with oil and coal, others like Sulawesi have a rich potential for geothermal energy. As Indonesia develops a plan to move away from an energy sector so reliant on oil, it is important to look at their various domestic energy endowments and conduct a cost-benefit analysis of each one.

The policy brief will assess the feasibility of harnessing the estimated 2,302 MW of geothermal energy reserves in Sulawesi in order to move away from their dependency on petroleum products in addition to helping increase their supply and access to electricity.[1]

This analysis will begin by giving an overview of Indonesia's energy sector and the problems of relying on the current oil driven system. With a competitive rate of return on geothermal plant investments coupled by political support, and available technology, the second part of the paper will look at the positive prospects of geothermal development in Sulawesi. Finally, the brief will explore the various policy options available to Sulawesi to develop geothermal. After reviewing the advantages, risks and limitations of geothermal energy, it is recommended that two new geothermal plants, one in North Sulawesi and the other in South Sulawesi, be developed so that the island can shift away from diesel powered electricity as well as increase the supply so that more people have access to electricity.

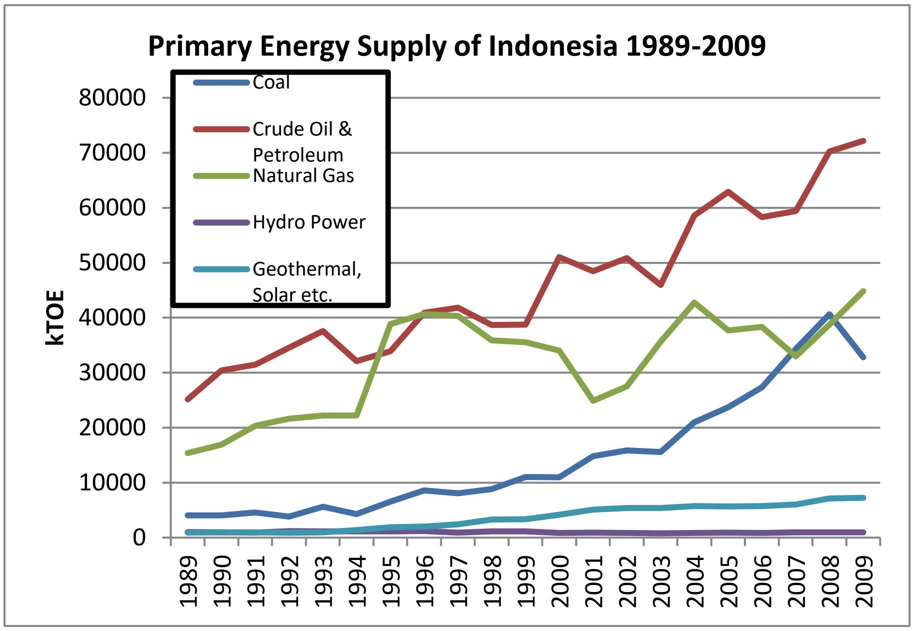
[1] Ministry of Energy and Mining Resources, *Handbook of Energy and Economic Statistics of Indonesia Energy Statistics, 2010*. MEMR, 2010. http://www.esdm.go.id/publikasi/handbook.html (accessed February 2012) 65.

1.0 Background and Existing Policy Framework

1.1 Primary Energy Sources and Trends

Indonesia's energy sector is heavily reliant upon petroleum products. In 2009, 40% of primary energy consisted of oil. Beginning in the later part of the nineties coal made a breakthrough. The use of coal continues to rise in order to deal with the ever increasing price of oil and the decreasing oil reserves.

Figure 1: source APEC Data



As well coal power plants are a quick and affordable way to provide electricity to a population that has a 65% electrification rate.[2] Coal is now the leading source of electricity in Indonesia. The Government of Indonesia made plans in 2006 in their first *Fast Track Program* to increase electricity produced from coal by 10,000 MW by 2011.[3]

In 2005, as Figure 2 demonstrates, Indonesia's energy sector made a big shift from being a long time net exporter of oil to a net importer. This change of supply and demand has forced Indonesia to reassess its energy policies and look for ways to diversify its energy sector in order to sustain energy

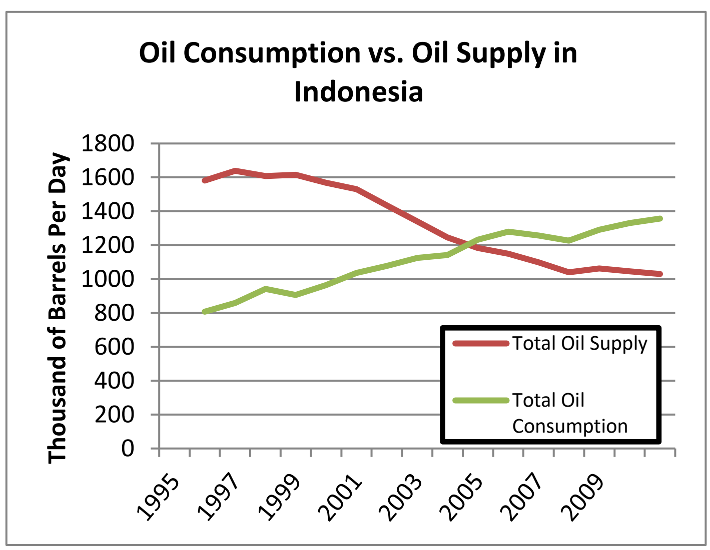


Figure 2: source EIA database

[2] World Bank, "World Development Indicator Database," WDI. http://databank.worldbank.org/ (accessed February 2012).
[3] US AID, *Indonesia energy Assessment,* http://indonesia.usaid.gov/en/programs/environment (accessed February 2012) 10.

security.

The current trend in Indonesian energy policy is to incorporate indigenous energy sources into their energy mix so that they are less reliant on importing energy from the international market. A source like geothermal energy is a local energy that is much less vulnerable to international price swings.

1.2 Electricity Supply and Demand

Electricity generation in Indonesia relies heavily on conventional thermal sources such as coal, gas and oil. As Figure 3 demonstrates, in 2009, 87 % of electricity in Indonesia was produced by coal, oil and natural gas. Not all islands have easy access to these conventional energy sources.

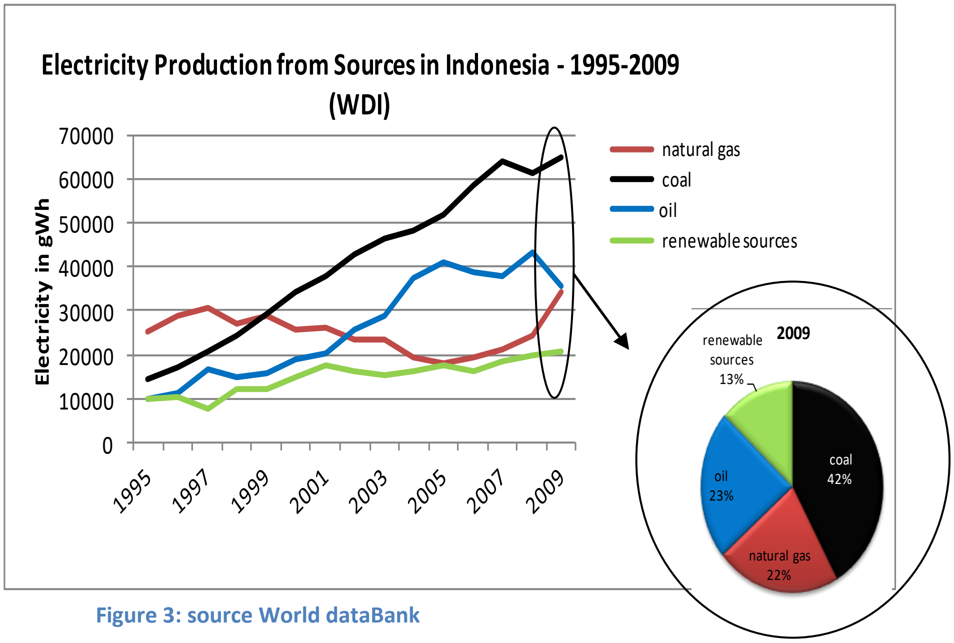


Figure 3: source World dataBank

Sulawesi has a small share of Indonesia's coal and oil reserves.[4] If the island's energy sector turned to coal they would have to import the fuel from other islands. Additionally, Sulawesi currently does not have any coal powered plants, as they rely on diesel, hydro and geothermal plants to produce electricity. Therefore, construction of power plants would need to occur. To further understand the means of electricity production in Sulawesi, Figure 4 breaks down the electricity mix in the province of North Sulawesi.

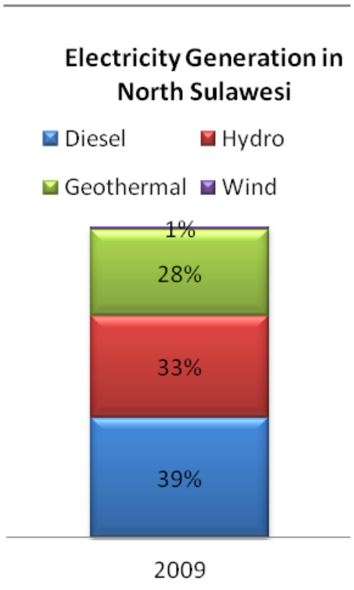


Figure 4: source PLN Statistics 2009, adpated from World Bank

The current energy situation in Sulawesi is not meeting the demands of the 17.3 million inhabitants. The island has an average

[4] Sulawesi has 0.12 million metric tons of reserves which is less than one percent of Indonesia's overall coal reserves. Sulawesi's oil reserves of 49.78 Million Stock Tank Barrels (MSTB) make up 0.6% of the total Indonesian reserves (MEMR).

electrification rate of 51% which is much lower than the national average of 65%.[5] The National Electricity Company (PLN) reports there are 150,000 households in Sulawesi currently on a wait list for an electricity connection. Compared to neighbouring countries in the region, Indonesia has a relatively low rate of electrification rate.[6] As these numbers demonstrate, there is significant demand for electricity in Sulawesi.

1.3 Electricity Demand Profile

Consumption of electricity has been increasing at an average rate of 8.3%. Statistics Indonesia reported that in 2010, households consumed the majority of the national energy supply at 41%. The industrial sector was close behind, consuming 34%. Both the household and industrial sectors will continue to demand more and more electricity as Indonesia continues to develop. The World Bank reported that Indonesia's industrial sector in 2010 added 47% value to the country's GDP. With an industrial sector that continues to increase and is a big contributor to the value of GDP, it is no surprise that Indonesia will need to find ways to increase their ability to provide electricity.

Indonesia - 2010 Electricity Consumption by Sector

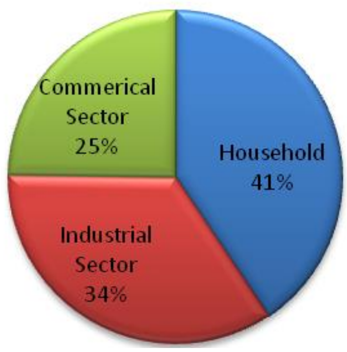


Figure 5: source 2011 Handbook of Energy and Economic Statistics Indonesia

1.4 Environmental Impact of Energy Sector

Indonesia, is following many other developing countries, in that it is trying to build its country quickly and become a global economic contender, at any cost. The current energy sector is reliant on fossil fuels that have large greenhouse gas emissions. Indonesia has been blessed with many indiginous thermal resources such as oil, natural gas and coal, however they also have great potential in renewable energies. Geothermal energy is friendly to the environment as it requires little land, is renewable and emits few emissions.

[5] Praptono, Bambang, "Presentation on Energy Efficiency and Renewable Energy Development in Power Sector in Indonesia,"
[6] The Philippines and Thailand are both developing countries in the region that the World Bank reported as of 2009 have above 90% electricity rates.

Emissions from Electricity Generated by Source (g/kWh)

	Coal (best practice)	Coal (FGD and low NOx)	Oil (best practices)	Gas (CCGT)	Diesel (embedded)	Geothermal
CO_2	955	987	818	430	772	79
SO_2	11.8	1.5	14.2	-	1.6	0.02
NOx	4.3	2.9	4	0.5	12.3	0.28

Table 1: source International Energy Agency, 1998[7]

The table above displays the amount of emissions from the current energy sources in Indonesia. The biggest emitter, coal, makes up 42% of the Indonesian electricity production. This can have detrimental effects on both the local and global environment. Diesel powered electricity is also environmentally unfriendly emitting nearly one hundred times more carbon than geothermal powered electricity.

1.5 Conclusion:

Sulawesi is currently increasing their demands for electricity and is looking for options so that more people have access to power. With an energy sector that is trying to move away from oil, significant energy policy changes will have to occur in order to increase their energy security. The government's plan to increase the amount of electricity produced by coal fired plants, has both environmental and logistical problems for the region of Sulawesi. Instead of importing fuel, it would make more sense for Sulawesi to further develop the 2,302 MW of geothermal energy that they are estimated to have.[8] By investing in an indigenous, environmentally friendly energy such as geothermal, Sulawesi will diversify their energy mix while providing further electricity to the 49% of their population who currently do not have any access.[9]

---

[7] M.J. Heath, "Environmental Aspects of Geothermal Energy Resources Utilization," In *Geothermal Energy Resources for Developing Countries*, edited by D. Chandrasekharam and J. Bundschuh. (Lisse, Netherlands: A.A. Balkema Publishers, 2002) 273.

[8] Ministry of Energy and Mining Resources, *Handbook of Energy and Economic Statistics of Indonesia Energy Statistics, 2010*. MEMR, 2010. http://www.esdm.go.id/publikasi/handbook.html (accessed February 2012) 65.

[9] Praptono, Bambang, "Presentation on Energy Efficiency and Renewable Energy Development in Power Sector in Indonesia,"

2.0 Prospects for Geothermal Power Generation in Sulawesi

This section will discuss the feasibility of geothermal power in Sulawesi in terms of the financial, technical and political practicalities. Firstly, in order to properly assess the option of geothermal, the costs will have to be compared to the other technologies available to the region including the status quo. The second part of this section will address the technical feasibility by addressing both the technology available as well as the logistics and the potential risk factors involved in the development. The final part will look at the political support that geothermal energy production has in Sulawesi.

2.1 Costs

When assessing the costs of various energy options, it is important to remember both the financial and social costs. Planning a geothermal development will involve an array of potential investors including the Government of Indonesia, international organizations as well as private investors. In the short term geothermal development is burdened with high capital costs but this is at a trade off for low operating and maintenance costs in the long run. Since geothermal power plants do not rely on purchasing fuel and have a high running capacity of 90%, their Internal Rate of Return (IRR) is very competitive. Estimates vary from project to project, but the IRR is generally in between 12- 17%.[10] The high investment return coupled with the low operating and maintenance costs will quickly compensate the initial high capital costs.

As can be seen in table 2, the high capital costs of geothermal plants are compensated by low generation costs. Generating costs are less than half the cost of diesel generated electricity. Additionally the plant's running capacity is high since geothermal does not rely on a fuel source or uncontrollable events such as weather.

[10] Glacier Partners, "Geothermal Economics 101," Glacier 2009. http://www.georestore.com/cms_files/Geothermal%20Economics%20101%20-%20Glacier%20Partners.pdf (accessed March 2012) 17.
Engineering and Consulting Firms Association, Japan, "Pre-feasibility study for Geothermal Power Developemt Projects in Scattered Islands of East Indonesia," 2008. http://www.ecfa.or.jp/japanese/act-pf_jka/H19/renkei/wjec_indonesia.pdf (accessed March 2012) ix.

Typical Capital and Generating Cost of Power Plants 2005

	Capital Cost per kW	Generating Costs per kWh	Running Capacity
Geothermal Flash Plant	US $2,510	4.3 US ¢	90%
Diesel Generator	US $890	8.97 US ¢	30-80% (intermittent)
Coal	US $1,260	4.29 US ¢	80%
Solar PV	US $7,060	61.6 US ¢	20-30%
Wind	US $1,440	6.8 US ¢	30%
Mini Hydro	US $2,370	6.9 US ¢	45%
Large Hydro	US $2,140	5.4 US ¢	50%

Table 2: source ESMAP

Another facet of financial planning is the lack of predictable pricing in Indonesia's electricity market. The government is currently in discussion about creating a Green Subsidy policy that will provide incentives for renewable energy development. The incentives will include special pricing and implementing subsidies that will bridge the price difference of renewable energy with fossil fuel energy.[11] These are steps in the right direction; however in order for renewable energy to have a fair chance in the market, the Indonesian Government will have to greatly reduce the amount that they currently subsidize for non-renewable energy such as petroleum. According to Indonesia Statistics (BPS), 32% of the Indonesian Government's overall expenditures in 2011 were towards energy subsidies.[12] Realizing the unrealistic nature of heavily subsidizing petroleum, the Indonesian Government has created policies to phase out subsidies. However, a major part of the public policy cycle is implementation, which has not occurred. In 2001, Oil and Gas Law no. 22 was passed that aimed to eliminate subsidies by November

[11]Ministry of Energy and Mining Resources, "Green Subsidy for Renewable Energy," MEMR, February 24, 2012. (accessed March 2012)
[12] Budan Pusat Statistik, *Statistical Yearbook of Indonesia 2011*, BPS, http://dds.bps.go.id/eng/flip/flip11/index3.php (accessed February 2012) 55.

2005; however, this deadline has been continually pushed back because of community resistance.[13] Once Indonesia has shifted subsidies away from non-renewable energy, renewable energy such as geothermal will be much more competitive.

Since the Indonesian government is trying to move away from petroleum products, the biggest competitor to geothermal power plants are coal plants. In order to give a fair comparison of the costs of electricity production from geothermal versus coal-fired plants, the social and environmental externalities must be taken into consideration. Coal-fired plants have both local pollutants such as NOx, SO_2 and Total Suspended Particles (TSP) as well as global pollutants such as CO_2. A study conducted by the World Bank and China State Environmental Protection Agency (SEPA) measured the negative impacts of pollutants and the costs that it would have on the local population. The results demonstrated that there are financial costs associated with energy production that have heavy emissions; between US$0.0013/kWh and US$0.013/kWh will be the cost of externalities on the local population from coal-fired plant pollutants.[14] These externalities could include health costs, environmental degradation, loss of livelihoods etc. The global costs of CO_2 emissions also range from low estimates of US$20 per ton of CO_2 to higher estimates of US$100.[15] The environmental and social costs of geothermal are minimal as geothermal produces very little pollution in comparison. Above, Table 2 shows the difference between the sources of energy for electricity generation and their overall pollutants.

Table 3 Source World Bank

Present Value of the Costs of 40 MW Plant in Tompaso	Cost US$ million
Geothermal Plant	$208.62
Coal Plant	$150.36
Coal Plant with cost of local negative externality	$162.35
Coal Plant with cost of local and global externalities	$203.64

The World Bank compared the cost of a projected geothermal development in Tompaso, North Sulawesi to an equal sized coal powered plant. The results can be seen in Table 3. The difference when factoring in the costs of negative externalities from coal is a mere $5 million more for geothermal. This is a small price when considering

[13] International Energy Agency, *Energy Policy Review of Indonesia,* IEA, 2008. http://www.iea.org/textbase/nppdf/free/2008/Indonesia2008.pdf (accessed February 2012) 131.
[14] World Bank, "Project Appraisal." 82.
[15] World Bank, "Project Appraisel," 82.

the amount of greenhouse gas emissions that will be prevented. As well, the indigenous nature of geothermal energy provides Sulawesi's energy sector with stability as there is a local supply of it.

The costs that come from having to transport masses of coal to Sulawesi are large. As mentioned previously Sulawesi does not have a large reserve of coal. The PLN acknowledges that the freight charge of the coal to places outside of Sumatra and Kalimantan will incur another US$15 per ton. Therefore the cost for Sulawesi to import coal from other Indonesian islands will be approximately US$50 per ton.[16] For Sulawesi, this freight charge would impact the cost to produce electricity from coal.

2.2 Technical and logistical

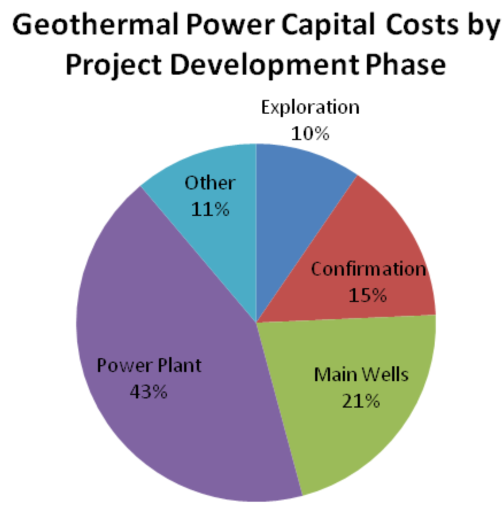
Harnessing geothermal energy for electricity has been around since the early 20th century. Geothermal exploration in Indonesia began in 1970.[17] By the 1980s Sulawesi's geothermal potential was well known and the development of the current 60MW Lahendong plant began.[18]

With over a hundred years of experience geothermal technology has advanced greatly. In Indonesia the majority of geothermal projects utilize single flash power plant technology.[19] This technology is best suited for high temperature geothermal liquid (above 150 degrees Celsius) which is found beneath the surface of Sulawesi.[20] A flash system works by pumping fluid from below the earth's surface by a system of high pressure into a tank at the surface. The tank at the surface is at a much lower pressure which causes the fluid to vaporize. This vaporized fluid drives the turbine which generates electricity.[21] The fluid changes back into liquid and is re-injected into the ground.

---

[16] Ibid., 80-81.
[17] Hochstein, Manfred, "The History of Geothermal Exploration in Indonesia from 1970 to 2000," *Geothermics* 37 (2008) 220.
[18] Ibid., 228.
[19] Bertani, Ruggero. "Geothermal power generation in the world 2005-2010 update report." *Geothermics* 41, (2011): 1-29. www.sciencedirect.com 23.
[20] Chamorro, Cesar R., Maria E. Mondejar et al. "World geothermal power production status," *Energy*(2011):1-9. www.sciencedirect.com 1.
[21] US Department of Energy "Geothermal Technologies Program: Electricity Generation." EERE http://www1.eere.energy.gov/geothermal/powerplants.html

Figure 6 Source ESMAP



A considerable amount of risk is involved in developing a geothermal site. In order to prove there are sufficient energy reserves to potential investors there is a large amount of capital needed. The placement of geothermal energy deep beneath the earth's surface greatly increases costs and risk. Exploratory drilling is necessary to assure investors that there is enough geothermal energy for commercial use. As Figure 6 depicts, 25% of the total cost of developing a power plant comes from the exploration and confirmation stages of geothermal sites. If during these first stages, it is discovered that there is not enough geothermal energy, a significant amount of money is lost. To mitigate this risk it is necessary for the Indonesian Government as well as other potential organizations like the Asian Development Bank (ADB) and World Bank (WB) to help financially support the initial stages of exploration.

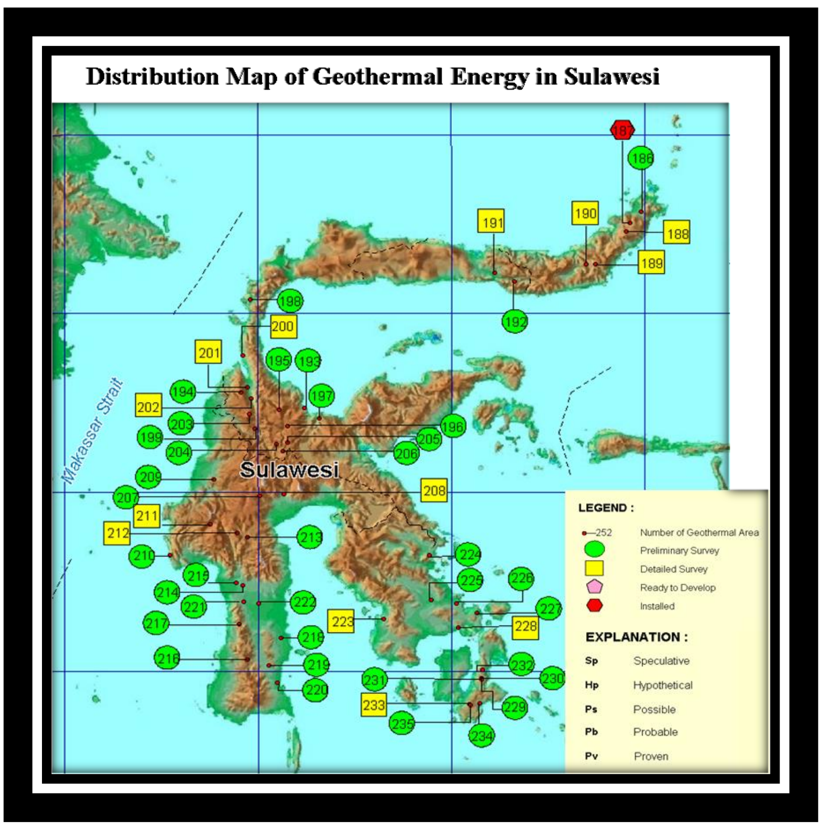


Figure 7 North Sulawesi Regional Planning and Development Agency

The level of risk is complemented by the abundance of geothermal energy reserves in Sulawesi. The map in Figure 7 gives a detailed depiction of how much geothermal potential exists. Although the majority are speculative sites that have been discovered after just a preliminary survey, there is a total 803 MW from various sites that are categorized as possible. Possible sites mean that there has been an extensive survey conducted. The geothermal site no. 188 located in the map above is located in Tompaso, North Sulawesi and is currently being appraised by the World Bank as a potential project. The appraisal process has undergone a detailed scientific investigation that was supported by well drillings. The appraisal process confirmed that the area has resources that can sustain 83 MW over thirty years with a ninety-percent probability and 124 MW over thirty years with a fifty-percent probability.[22] This site is one of the two that will be discussed later in the recommendation section.

2.3 Political Feasibility

There is political support for geothermal energy. The Indonesia Government is very interested in moving their energy sector away from imported oil and geothermal energy is a step in the right direction. The government likes geothermal energy because it is indigenous, renewable and has low emissions. In 2006, President Susilo Bambang Yudhoyono passed into law the National Energy Policy (NEP). NEP sets targets to decrease the amount of oil in the national energy mix from 40% down to 20% by 2020.[23] To compensate for the decrease of oil, NEP outlines other energy alternatives including geothermal energy production which is targeted to increase from 1% to 5% of the total energy mix. The government took further action to help increase geothermal production by announcing in their second phase of their *Fast Track Program* that they will be actively developing over 4,000 MW of geothermal energy.[24] In order to increase geothermal energy production by five-fold, the government will need to concentrate on areas of the country that have concentrated geothermal potential such as Sulawesi.

3.0 Policy Options and Recommendations

3.1 Policy Options

The policy options of developing geothermal energy are explored in Figure 8. There are three options: not developing geothermal and maintaining the status quo, taking a mixed approach or investing in geothermal energy. It is important to explore the options; however it is clear in the case of geothermal energy that it should be further developed in Sulawesi. It is financially competitive, provides energy

[22] World Bank, "Project Appraisel." 18.
[23] Susilo Bambang Yudhoyono. *National Energy Policy, Presidential Regulation No. 5/2006*. http://faolex.fao.org/docs/pdf/ins64284.pdf (accessed February 2012).
[24] Praptono, Bambang, "Presentation on Energy Efficiency and Renewable Energy Development in Power Sector in Indonesia," PLN, 2009. http://www.aesieap0910.org/Presentation_Slides_PL03-03.pdf (accessed March 2012).

security, has minimal impacts on the environment, has technological strengths of a high running capacity and long life span and is supported by the Indonesian government.

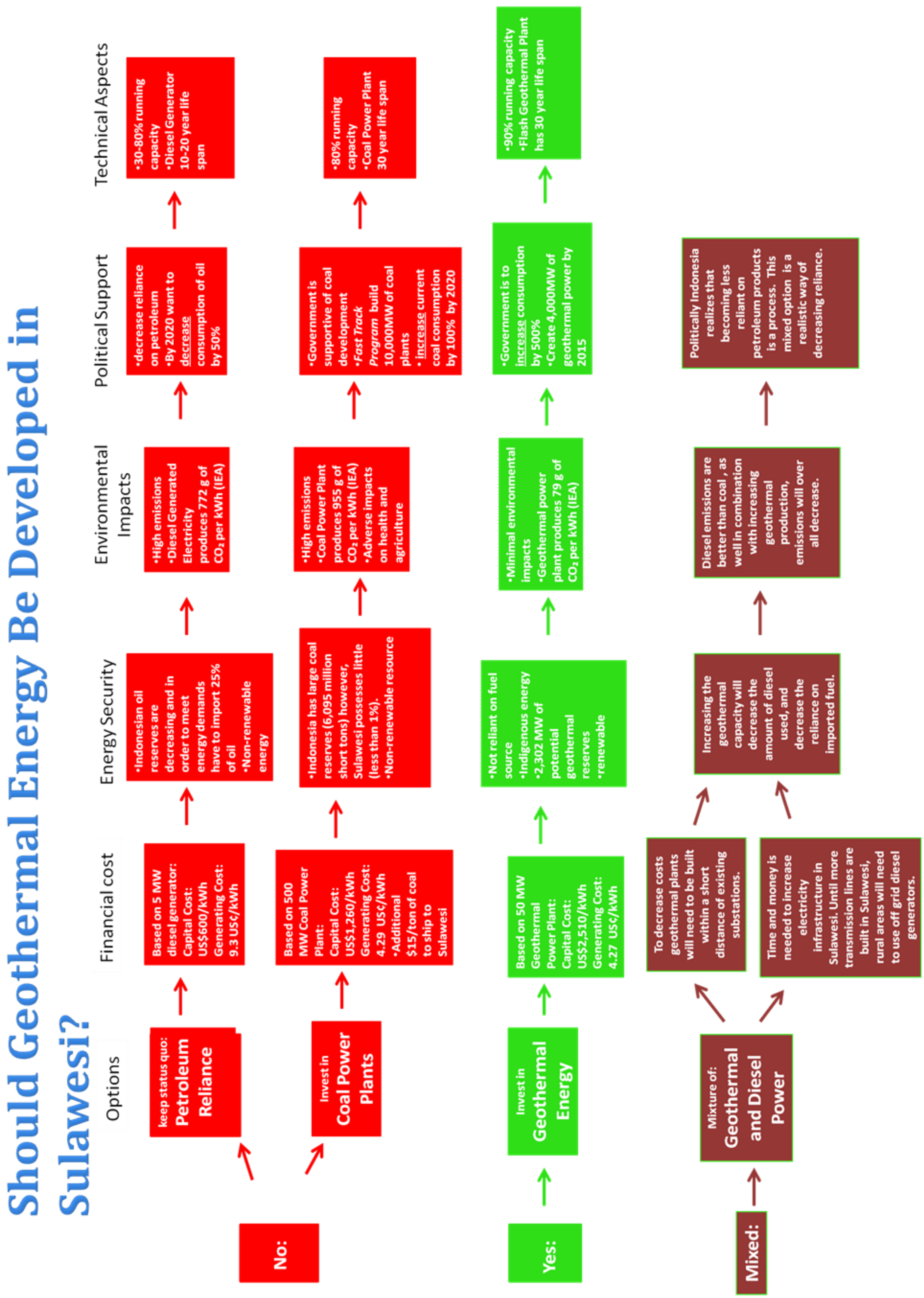


Figure 8: Yes, No, Mixed Policy Options

3.2 Recommendations

Sulawesi has the potential to provide nearly all of their electricity needs from geothermal energy. However, due to the high capital costs (see Table 2) as well as the time and further costs needed to develop adequate infrastructure to deliver electricity, it is recommended that for the time being Sulawesi focuses on building two additional 40 MW flash geothermal plants. As can be seen in Figure 9, the two ideal locations are situated in North and South Sulawesi. Since North Sulawesi has already developed two plants in the region, the additional plant at Tompaso will face fewer obstacles as there are already plants that have broken into the market. The lessons learned from the existing plants can enhance the development of the new plant. Furthermore, the World Bank along with the Asian Development Bank and the Government of Indonesia have already invested into the exploration stages of the site.

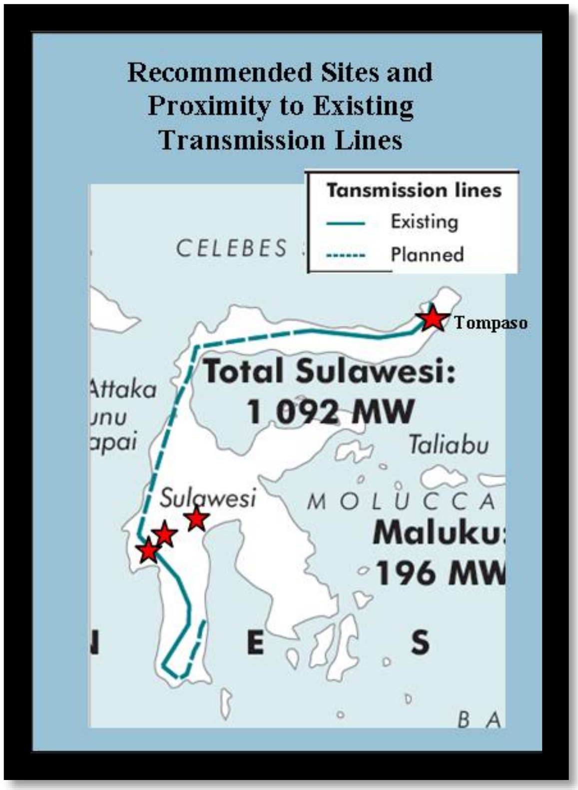


Figure 9 Source EIA

The need to expand geothermal power production beyond the province of North Sulawesi is caused by the lack of infrastructure connecting the northern and southern areas of the island. Unfortunately the current state of infrastructure consists of two disconnected lines. This makes it hard to transport electricity generated in North Sulawesi to the other provinces on the island. This impacts the rate of access to electricity in the southern provinces. As of 2008, 66% of North Sulawesi had access to electricity whereas the rest of the island had a staggering 47% access rate.[25] Since infrastructure is expensive and timely to build, it makes sense to build power plants close to existing lines in South

[25] Praptono, Bambang, "Presentation on Energy Efficiency and Renewable Energy Development in Power Sector in Indonesia," PLN, 2009. http://www.aesieap0910.org/Presentation_Slides_PL03-03.pdf (accessed March 2012).

Sulawesi. There have been detailed surveys in South Sulawesi that concluded there are three different possible sites that consist of 50 MW of possible geothermal energy.[26]

The government intends to put US$11.2 billion dollars into increasing transmission lines and substations across Indonesia by 2020.[27] Such financial funding would result in the completion of the planned transmission line depicted in Figure 9, but as for now these are just plans and nothing has resulted in concrete action. In the future once the planned line is built, more geothermal plants can be constructed in Central Sulawesi.

Instead of developing numerous geothermal sites on the island of Sulawesi it is more economically and technically feasible to develop two power plants. Financially, the sites pose a better chance of attracting enough private and international investors. By taking a slow and steady process to development it will give the Indonesian Government time to further improve its laws and regulations to encourage further investment. Major regulatory changes need to happen to shift energy subsidies away from petroleum based products and into the green sector. The slow and steady pace will also provide Sulawesi time to gather the technical expertise needed and potentially develop a geothermal vocational school to increase the engagement and benefits for locals from the proposed developments.

3.3 Stakeholders Involved in Implementation of Policy

There are various stakeholders involved in the Indonesian energy sector. Specific to geothermal development in Sulawesi the main actors consist of the national, provincial and local governments, private investors and international organizations needed to aid in acquiring capital and the locals in the area. The importance of stakeholders is the relationship the government has in creating investor friendly regulations to promote private and international organizations to invest.

[26] North Sulawesi Regional Planning and Development Agency, "Presentation for Katie Dittrich on Geothermal Energy in North Sulawesi." Compiled by Coba Malingkas from office of Noldy Tuerah, Professor of Economics at University of Sam Ratulangi, Manado North Sulawesi. February 2012

[27] International Energy Agency (IEA). *Energy Policy Review of Indonesia, 2008*. IEA, 2008. http://www.iea.org/textbase/nppdf/free/2008/Indonesia2008.pdf (accessed January 2012).

Government:

When looking at harnessing geothermal energy in Sulawesi, there are many government agencies that are involved in the process. The process is very decentralized. One agency owns the geothermal steam whereas another agency owns the electricity produced from the steam. To break it down, the Ministry of Energy and Mineral Resources (MEMR) is the ministry responsible for overseeing the development of geothermal energy. The state owned oil and gas company Pertamina legally owns all geothermal steam.[28] In 2006 a subsidiary of Pertamina was established to look after the geothermal sector: PT Pertamina Geothermal. This subsidiary company is responsible for operating and developing geothermal resources. The State Electricity Company (PLN) has a monopoly on all the electricity that is produced from the geothermal plants and therefore purchases the electricity and redistributes it for sale within the region. [29]

Since 1974 with government decree No. 16/1974, Pertamina has been in charge of exploring and operating geothermal fields. By 1981 with presidential decree no. 20/1981, Pertamina was given permission to enter joint ventures with local and international partners. At this point private investment increased with firms such as Chevron.

Although at first glimpse it sounds like with the control of Pertamina and PLN that geothermal energy production would be predominantly state run, the contrary is true. Due to the high cost of developing geothermal plants, there are many Joint Operations Contracts (JOC) and Independent Power Producers (IPP). The private involvement in geothermal makes up the majority of geothermal steam production as can be seen in the graph below in Figure 10.

[28] US AID, "Indonesia Country Report," http://indonesia.usaid.gov/en/programs/environment (accessed February 2012) 12-15.
[29] Pertamina, *2010 Annual Report*, http://www.pertamina.com/uploads/download/Annual_Report_2010_for_web.pdf (accessed February 2012) 64.

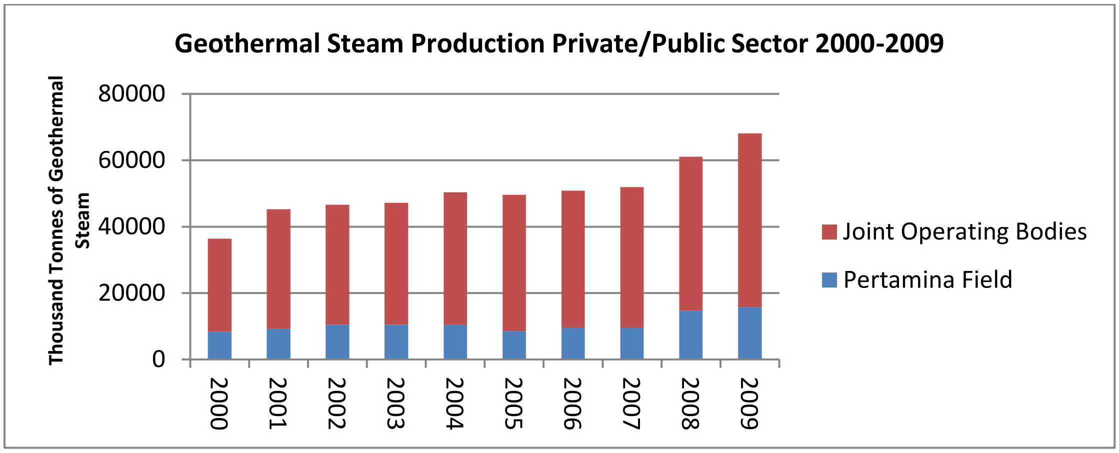


Figure 10 Source: Government of Indonesia Handbook of Energy and Economic Statistics of Indonesia

Private:

Shortly after the presidential decree no. 20 in 1981, that allowed Pertamina to undergo joint ventures with local and international partners, private investment began in the geothermal sector in Indonesia. One of the first JOCs was with the Union Oil Company of California (Unocal) which later merged in 2005 with Chevron, began to develop geothermal production on the island of Java.[30] Chevron continues to play an important role in geothermal sector supplying 630 MW of power to the Indonesian grid which is the equivalent to supplying electricity for around 4 million local households.[31]

In Sulawesi private international investors including Oxbow International and the Japanese firm Kanematsu Corporation along with the Indonesian private communication company Wahana Kumunikatama have negotiated contracts with the Indonesian government. Together they have agreed to develop a 60 MW capacity

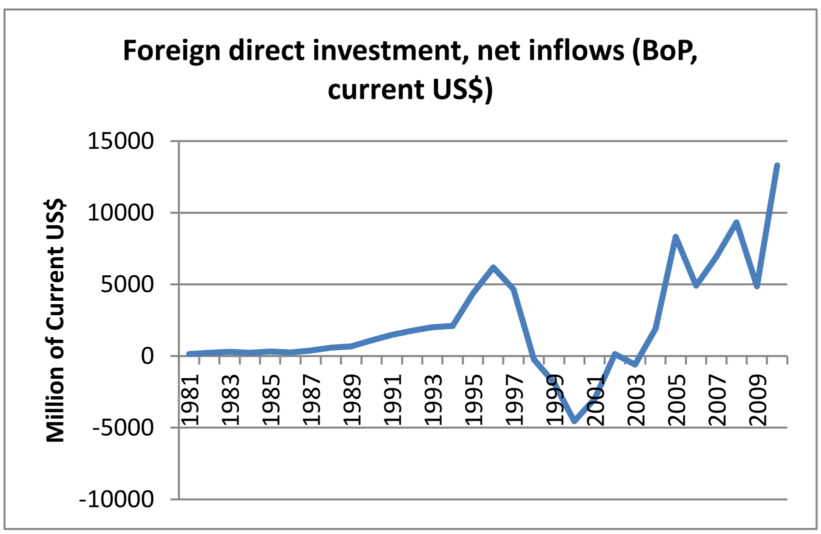


Figure 11 Source: World databank (WDI)

[30] Chevron, "Indonesia Fact Sheet," March 2011. http://www.chevron.com/documents/pdf/indonesiafactsheet.pdf (accessed February 2012).
[31] Ibid.

site in Tompaso, North Sulawesi. They have made an investment of US$197 million to support the project.

Further private involvement is likely to increase from foreign private interests. As seen in Figure 11, the Foreign Direct Investment (FDI) in Indonesia has steadily increased since 1997. This is likely contributed to Indonesia's swift economic recovery from the 1997 Asian Financial Crisis. As well as Indonesia's stable transition in 1998 from thirty years under Suharto's authoritarian state to a democracy. The FDI will continue to increase if the government is cooperative in making regulations that make investments into geothermal easier.

International Organizations:

International organizations are also heavily involved in the development of geothermal energy in Indonesia. As of 2011, the World Bank has endorsed a US$574.7 million geothermal development project that consists of funding from the Clean Technology Fund (CTF), the World Bank and the state company Pertamina. These funds will be distributed to invest in the development of two geothermal plants of which US$191.9 million will be assigned to the Tompaso plant in North Sulawesi.[32]

Sulawesi Locals:

The geothermal energy production can help increase the current electricity rate of a mere sixty-one percent in Sulawesi.[33] This access to energy will have profound impacts on the local population. By choosing a renewable energy that has limited emissions, the local population will not face an increase in poor air quality from local pollutants that can result from coal and diesel powered energy.

Land acquisition for geothermal power plants is minimal compared to that of hydropower. However, when land is needed, the Pertamina Geothermal Company has a policy of willing buyer/ willing seller. This enables voluntary, transparent and fair land acclamation that results in Pertamina paying above market prices for land. When land is refused to be sold to Pertamina the project can still be

---

[32] World Bank, "Project Appraisal," 9.

[33] US AID, *Indonesia energy Assessment,* http://indonesia.usaid.gov/en/programs/environment (accessed February 2012) 22.

conducted as geothermal development is relatively flexible in an area with potential. Small alterations may be needed, but to certain degrees can be manageable.[34]

Sulawesi locals can also benefit and contribute to the geothermal energy development by becoming trained in the field. Thus the plant is bringing jobs to the local area. It also engages locals to be part of the operations and management team. When communities become engaged in local projects they take ownership which can greatly benefit projects' level of success.

3.3 Steps of Implementation

The table below demonstrates the several steps needed to implement geothermal development in Sulawesi. The stakeholders mentioned in the previous section play an integral role in the various steps.

			Recommended Geothermal Power Plants	
	Task	**Stakeholder(s) involved**	**Potential Sites, South Sulawesi**	**Tompaso, North Sulawesi**
Step 1	Find reserves with high temperature geo liquid	Government, International Organization, locals.	√	√
Step 2	Exploration drilling to confirm size and quality of reserve	Government, international organization,		√
Step 3	Find investors through bidding process	Government, private investors		√
Step 4	Construction of power plant and erection of transmission lines to existing infrastructure	Government, private investors, international organizations		
Step 5	Train staff for operations and maintenance of facility	Government, Sulawesi locals		
End Result	Electricity production and distribution increases for Sulawesi	Sulawesi locals	40 MW	40-60MW

Table 4

These are the most apparent steps, but as the information is limited, potential obstacles may arise that require additional steps. The end result of implementing these plants will be improving energy

[34] World Bank, "Project Appraisal," 20.

security. Sulawesi will have increased their access to electricity and be able to shift a portion of their current energy mix away from diesel powered generators. Presently Sulawesi is only harnessing 60 MW or 2.6% of the island's geothermal potential. This in turn is providing electricity for 18% of the island's overall electricity demand.[35] By adding an additional 80-100 MW as proposed in this policy brief, the proportion of energy supplied by geothermal will increase substantially.

4.0 Conclusion

As the island of Sulawesi looks for ways to supply electricity in order to meet the increasing energy demands and connect the 51% of the population who currently have no access to the grid, it is important that they look at indigenous products. Despite having high start up costs, geothermal is a reliable source that due to many factors such as running capacity, low operations and maintenance costs, etc. is a profitable investment in the long term. By investing in a native, environmentally friendly energy, Sulawesi will diversify their energy mix while increasing their ability to meet energy demands.

The current energy trends in Sulawesi are not sustainable. Since 2005 Indonesia has become a net importer of petroleum products. With diesel accounting for 39% of Sulawesi's electricity production, the region is playing a risky game. Not only is diesel a heavy emitter of greenhouse gasses, but it is a natural resource that relies on the international market to determine pricing. Volatile oil prices and the non-renewable nature of diesel energy can lead to great instability.

The evidence presented in this policy brief highlights the strengths and weaknesses of geothermal. In the end it is recommended that Sulawesi develop two additional geothermal sites: one in North Sulawesi and the other in South Sulawesi. These sites will help the island move away from diesel powered electricity and in doing so will increase the availability and accessibility of electricity to reach the population of Sulawesi.

[35] World Bank,"Project Appraisal," 71.

Bibliography:

BPS Statistics Indonesia. *Statistical Yearbook 2011*. BPS, 2011. http://dds.bps.go.id/eng/flip/flip11/index3.php (accessed February 2012).

Brierley, Joanna. *Spices: The Story of Indonesia's Spice Trade*. (Singapore: Oxford University Press, 1994).

Bertani, Ruggero. "Geothermal power generation in the world 2005-2010 update report." *Geothermics* 41, (2011): 1-29. www.sciencedirect.com

Chamorro, Cesar R., Maria E. Mondejar et al. "World geothermal power production status," *Energy*(2011):1-9. www.sciencedirect.com

CIA World Factbook. "Indonesia," https://www.cia.gov/library/publications/the-world-factbook/geos/id.html (accessed February 2012).

Chevron. "Indonesia Fact Sheet." March 2011. http://www.chevron.com/documents/pdf/indonesiafactsheet.pdf (accessed February 2012).

Dickson, Mary H. and Mario Fanelli eds. *Geothermal Energy: Utilization and Technology.* (Bangalor, India: UNESCO Publishing, 2003).

Energy Sector Management Assistance Program World Bank, *Technical and Economic Assessment Off-grid, Mini-grid and Grid Electrification Technologies.* ESMAP, 2007. http://www.esmap.org/esmap/sites/esmap.org/files/Technical%20and%20Economic%20Assessment%20of%20Off-grid,%20Minigrid%20and%20Grid%20Electrification%20Technologies_Report%2012107.pdf (accessed February 2012).

Heath, M.J. "Environmental Aspects of Geothermal Energy Resources Utilization." In *Geothermal Energy Resources for Developing Countries*, edited by D. Chandrasekharam and J. Bundschuh. Lisse, Netherlands: A.A. Balkema Publishers, 2002. 269-280.

International Energy Agency (IEA). *Energy Policy Review of Indonesia, 2008*. IEA, 2008. http://www.iea.org/textbase/nppdf/free/2008/Indonesia2008.pdf (accessed January 2012).

International Energy Agency (IEA). *Energy Policy Review of Indonesia, 2008*. IEA, 2008. http://www.iea.org/textbase/nppdf/free/2008/Indonesia2008.pdf (accessed January 2012).

Kimura, Ehito "Changing the Rules: Historical conjuncture and transition in Indonesia," *Asia Pacific Viewpoint* 51, no. 3 (December 2010).

Ministry of Energy and Mining Resources. *Indonesia Energy Statistics 2010*. MEMR, 2010. http://prokum.esdm.go.id/Publikasi/Indonesia%20Energy%20Statistic%20%28Leaflet%29/Indonesia%20Energy%20Statistic%20Leflet%202010.pdf (accessed February 2012).

Ministry of Energy and Mining Resources. *Handbook of Energy and Economic Statistics of Indonesia Energy Statistics, 2010*. MEMR, 2010. http://www.esdm.go.id/publikasi/handbook.html (accessed February 2012).

North Sulawesi Regional Planning and Development Agency, "Presentation for Katie Dittrich on Geothermal Energy in North Sulawesi." Compiled by Coba Malingkas from office of Noldy Tuerah, Professor of Economics at University of Sam Ratulangi, Manado North Sulawesi. February 2012.

Pertamina, *2010 Annual Report*, http://www.pertamina.com/uploads/download/Annual_Report_2010_for_web.pdf (accessed February 2012)

Praptono, Bambang, "Energy Efficiency and Renewable Energy Development in the Power Sector in Indonesia." PLN, 2009. http://www.aesieap0910.org/Presentation_Slides_PL03-03.pdf.

Susilo Bambang Yudhoyono. *National Energy Policy, Presidential Regulation No. 5/2006*. http://faolex.fao.org/docs/pdf/ins64284.pdf (accessed February 2012).

World Bank. "Project Appraisal Document on a Proposed Loan to the Republic of Indonesia for a Geothermal Clean Energy Investment Report no.: 56321," June 27, 2011. http://go.worldbank.org/XQUMY0JIC0 (accessed February 2012).

World Bank. "World Development Indicator Database." WDI. http://databank.worldbank.org/ (accessed February 2012)

Databases:

US AID, "Indonesia Country Report," http://indonesia.usaid.gov/en/programs/environment (accessed February 2012)

US Energy Information Administration. "International Energy Statistics Database." EIA. http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm (accessed February 2012).

World dataBank. "World Development Indicators." http://databank.worldbank.org/ddp/home.do (accessed February 2012).