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VERSATILE MINI BACK PRESSURE TURBINE FOR INITIAL PROJECT

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ABSTRACT

Indonesia, located along the Ring of Fire, is endowed with huge geothermal potential that has yet to be fully converted - into power to spur national development. The invention of the geothermal mini back-pressure turbine is expected to allow us to tap unused steam and waste heat scattered around steam fields and geothermal power plants (GPPs).

Among the potential sources that may be used to power the mini turbine are: ex exploration well, low-discharge steam from a large production well, underutilized high-discharge production well, and wet steam geothermal field.

The government is expected to capitalize this opportunity by ordering big GPP players either to utilze the tiny steam potentials scattered within their areas or to let smaller players who have expertise in mini steam turbines to convert the disposed or waste steam into electricity at a small scale. If this can be realized, it indicates that the geothermal development is duable and is able to generate power wihin limited time frame despite its small scale.

The benefits of the GPP mini turbine are as follows:

- For captive use such as lighting of offices, base camps, and roads, particularly in new GPP development areas where no PLN grid is available. The use of diesel genset will increase operation costs.
- For power construction. The GPP mini turbine's power output which ranges around 500 KW can be used for rock breaking, rotating batching plant, welding machine, lighting, and other power construction activities.
- Prime mover of the reinjection pump for brine water to reinjection wells.
- CSR for the surrounding community in the form of power supply to be used as lighting and providing power for small industry activities such as sewing, rice milling, etc.
- The availability of small-scale GPP will help developer to anticipate the delay or cancellation of the development of the bigger GPP due to the procrastination in the permit issuance or permit loss.
- Use as a test-well right in which the steam produced by both exploration and production wells can be directly used and the operator of test well can monitor and record the performance as well as the characteristics of the new well. When it enters commercial operation, the test-well has been clean, is supported with comprehensive data, and can provide optimum benefits.
- GPP mini-turbine is compact and mobile, easily moved between sites.

So far, the back pressure turbine is considered to be the most optimal tool for steam utilization, where the worn steam with more than 1 atmosphere pressure is straightly disposed into the air. The advantages of the back-pressure turbine include its simplicity of construction, mobility, low-cost fabrication and installation, and flexibility and lack of sensitivity to the quality of steam. This turbine can either process the dry steam directly or process it by using steam cleaner or simple separator. For the wet steam, the use of a separator or flasher is mandatory.

INTRODUCTION

Indonesia has abundant potential of geothermal energy, i.e. more than 29 GWe which are distributed in 285 locations along the country. Unfortunately less than 5% of the potential have been utilized *(MEMR, 2012)*.

Average growth of energy consumption is 8,5% per year. Up to now, energy national demand is still fulfilled by fossil fuels.

Presidential Decree No. 5 / 2006 on National Energy Policy (KEN) has targeted that by 2025, the electricity from geothermal power plant will be reached up to 9500 MW or equivalent to 5% of national energy consumption *(ibid)*.

To support the utilization of geothermal energy, the Government of Indonesia has issued The Fast-track Program Phase II in order to accelerate a 10.000 MW electricity development from geothermal power plant (4 925 MW).

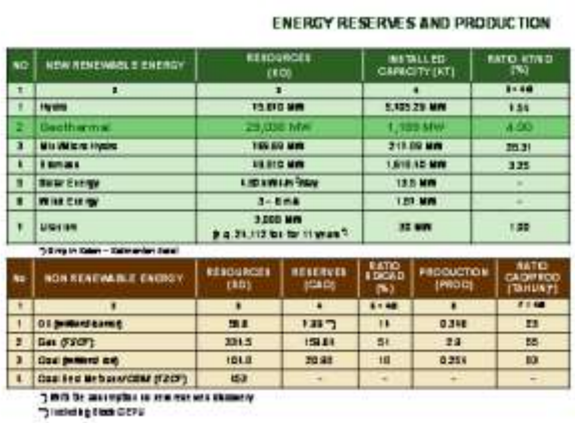
GOI has launched “Energy Vision 25/25”to support the program. The vision has a target that by 2025 the energy utilization based on new and renewable energy shall reach 25% of total national mixed energy. Whereas the target of geothermal utilization itself is 5.7% of equivalent to 12,000 MW

While some exploration drillings and exploitation have been done in some working areas, there are scattered tiny potentials in the abandoned geothermal wells waiting for exploitation.

Even in some projects that are already managed by large consortiums such as Patuha, West Java (60 MW), Sarulla, North Sumatra (330MW), Ulubelu (5 x 55 MW) there are some unused potential ready to be tapped by using simple type of turbine: mini back-pressure turbine.

Mini back-pressure turbine becomes the focus of this paper in regards with its simplicity of construction, mobility, low-cost fabrication and installation, and flexibility and lack of sensitivity to the quality of steam that are very suitable for remote areas in Indonesia.

ENERGY RESERVES AND ENERGY MIX


ENERGY RESERVES AND PRODUCTION

NO	NEW RENEWABLE ENERGY	RESOURCES (SD)	INSTALLED CAPACITY (KT)	RATIO KT/SD (%)
1	2	3	4	5 = 4/3
1	Hydro	75,670 MW	5,705.29 MW	[illegible]
2	Geothermal	29,038 MW	1,189 MW	4.00
3	Mini/Micro Hydro	769.69 MW	217.89 MW	28.31
4	Biomass	49,810 MW	1,618.40 MW	3.25
5	Solar Energy	4.80 kWh/m²/day	13.5 MW	-
6	Wind Energy	3 – 6 m/s	1.87 MW	-
7	Uranium	3,000 MW (e.q. 24,112 ton for 11 years*)	30 MW	1.00

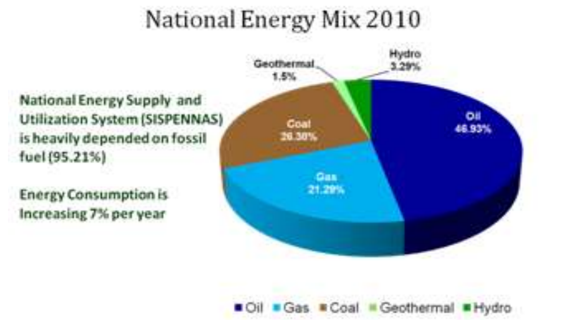
*) Only in Kalan – Kalimantan Barat

No	NON RENEWABLE ENERGY	RESOURCES (SD)	RESERVES (CAD)	RATIO SD/CAD (%)	PRODUCTION (PROD)	RATIO CAD/PROD (TAHUN*)
1	2	3	4	5 = 4/3	6	7 = 4/6
1	Oil (billion barrel)	56.6	7.55**)	13	0.346	22
2	Gas (TSCF)	334.5	[illegible]	51	2.9	55
3	Coal (billion ton)	104.8	[illegible]	[illegible]	0.254	83
4	Coal Bed Methane/CBM (TSCF)	453	-	-	-	-

*) With the assumption no new reserves discovery
**) Including Block Cepu

Source: MEMR, 2012

As has been mentioned above, Indonesia has more than 29 GW potential geothermal energy. Yet, the installed capacity is less than 1,200 MW. Several constraints in geothermal development has been identified, i.e., fiscal, financial, and institutional problems. Fiscal problems refer to economical price for area with less geothermal potential, particularly in East Indonesia. Financial problem in regard with the guarantee from the government on PLN viability to purchase power from geothermal power plant based on Fast Track Program(FTP) II. Thus, investors need regulation to be issued by Finance Minister on PT PLN feasibility guarantee (Perpres No. 04/2010 Pasal 7). The institutional problem is that there is only single buyer of the power produced by geothermal power plant (MEMR, 2012).



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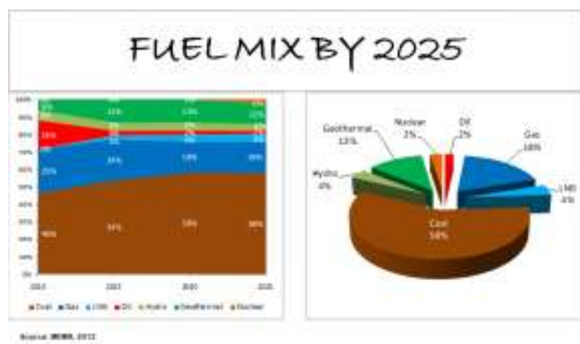
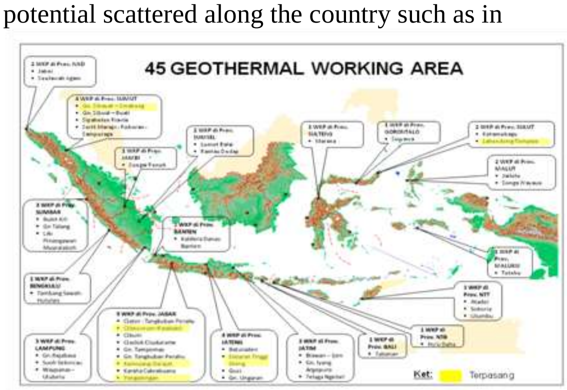


In regards with this target, we can tap tiny steam potential scattered along the country such as in



Bedugul, Bali (500 KW) and Ulumbu, Flores (700 kW) from low production well.

MINI BACK-PRESSURE TURBINE

The back pressure turbine belongs to a steam turbine. It is a device that extracts thermal energy from pressurized steam and uses it to do mechanical work on a rotating output shaft.

Non-condensing or back pressure turbines are most widely used for process steam applications. The inlet pressure is controlled by a regulating valve to suit the needs of the process steam pressure.

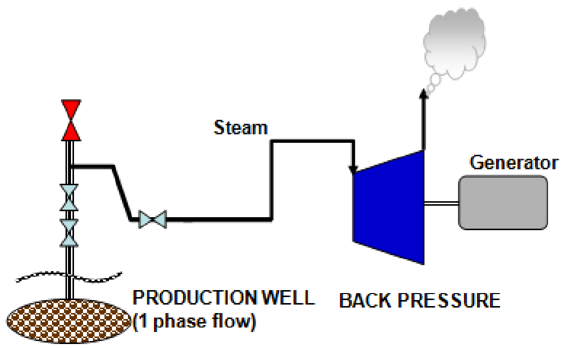


Fig. 1 Diagram of the Back-Pressure Turbine for Dry Steam

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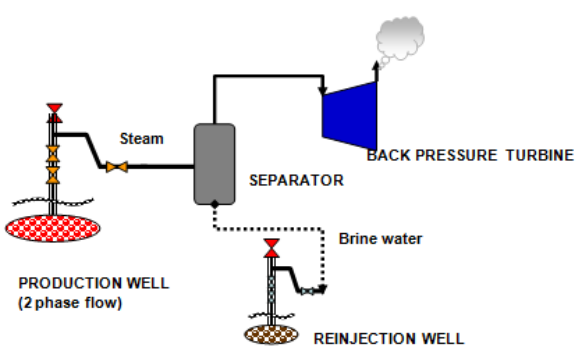


Fig. 2 Back pressure type for Wet Steam

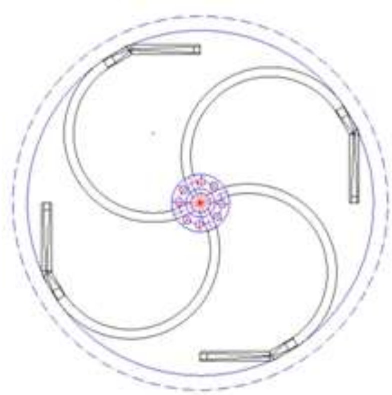
This turbine can either process the dry steam directly or process it by using steam cleaner or simple separator for the wet steam, the use of a separator or flasher is mandatory.

Typical of GPP mini turbine

Several types of turbine have been used in the construction of GPP Mini Turbine. They are axial turbine, radial inflow turbine, and hero turbine.

- Hero Turbine

The modified Hero Turbine serves as an alternative, for smaller power generators (1 –100 KVA). In this design, the steam flows through the *shaft* and then streams through the holes along the wall of shaft. Afterwards, the steam flows into the blades functioning as nozzle, and finally the steam is discharged through the nozzles. In the modified Hero turbine, the shape of nozzle is circular. Hero turbine has been used in Dieng, Central Java.



- Radial inflow

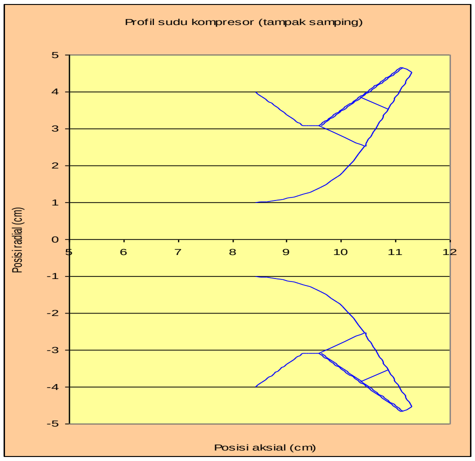
The shape of blades and nozzles of the radial inflow turbine are similar to those of the axial turbine. The difference lies mainly in the steam flow. In the radial inflow, the steam enters through the outer part of the radial and pushes the blade. The exhaust steam goes to the axis and turn into the horizontal direction. The radial inflow turbine is generally one-phase flow, so that it is effective only for mini turbine up to 200 kW. It is recommended to be used for the under 100kW turbine as the design of the construction is very simple.

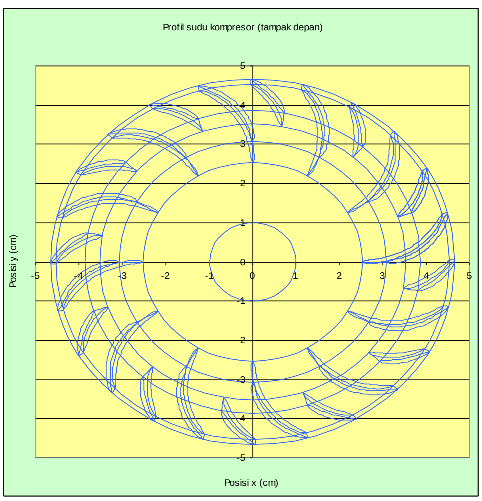
The rotation of the radial inflow turbine can reach 10.000 rpm, so we have to use reduction gear when we employ a 1500 or 3.000 rpm generator.

There are two types of the radial inflow turbine, one using the wide blade and one with a small circular blade.

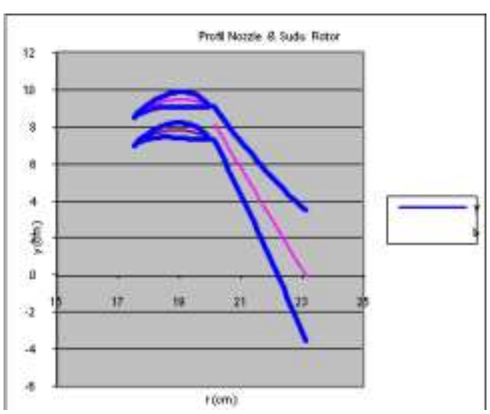
Diagram of rotor of the radial inflow turbine

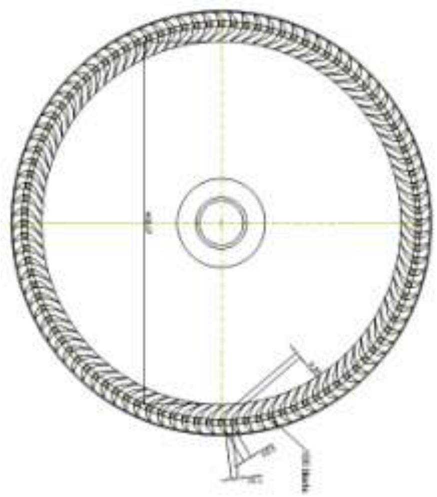
Type I





Type 2





- Axial turbine

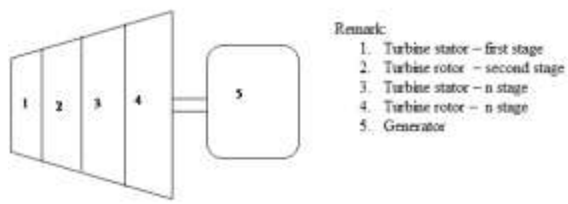
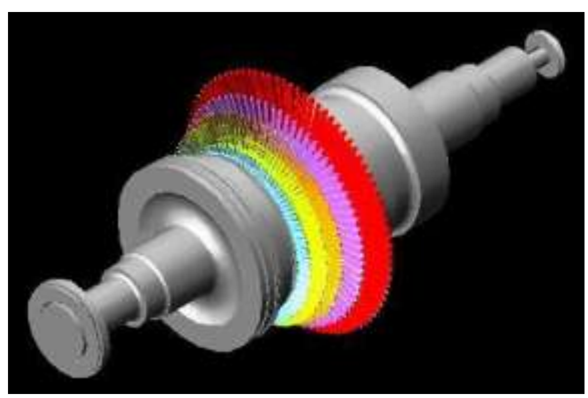


Fig. 3. Schematic Diagram of Geothermal Mini Axial Turbine

This type of turbine is suitable for small and large type of GPP. It is designed with 5 - 12 barabs steam inlet pressure and 1.1 - 1.5 barg steam exhaust pressure. The variation of pressure is adjusted to the need in the field. The construction of axial turbine is more complicated and more expensive than the other two types. The design of axial turbine has to consider the aspects of thermodynamics, fluid, and mechanics.



BENEFITS OF MINI GPP

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CONCLUSION

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