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Harnessing Geothermal Energy in Sri Lanka: A Feasibility Study

K.G.G.R.R. Abewickrama[1], R.H.G. Sasikala[2*]
[1,2]Department of Electrical and Computer Engineering, The Open University of Sri Lanka, Nawala, Nugeoda, Sri Lanka.

*Corresponding Author: email: rhsas@ou.ac.lk, Tele: +94715186953

Abstract – *Sri Lanka needs advanced technological power generation methods to face future electricity requirements when considering the present energy crisis in the country. As a gift of nature, several hot water springs occur in Sri Lanka, and these are the only geothermal manifestation seen in the country. Geothermal energy resource is one of the renewable resources which is still an unfamiliar energy source for the country. In this research the feasibility of power generation using existing geothermal resources in Sri Lanka is carried out including location selection, capacity estimation, plant design, and economic analysis for a geothermal power plant. Location selection is mainly based on geochemical and geophysical data, and the selected geothermal source must have an exploitable amount of heat at accessible depth. Four areas were analyzed to select the best location which has indicated maximum hot water temperatures from all other hot water spring areas. The volumetric assessment method is used to estimate the power generating capacity in a selected location. This research also includes the design of the plant layout with the most suitable power plant technology. An economic analysis of the power plant has also been presented. Volumetric method results indicate that the reservoir could produce 3.1 MW to 8.3 MW power for 130ºC to 70ºC reinjection temperatures respectively. Economic analysis results obtained that the Levelized cost of the energy lies between 73.34 Rs/kWh to 39.04 Rs/kWh for 130ºC to 70ºC reinjection temperatures.*

Keywords: *Geophysical data, geothermal manifestation, levelized cost of the energy, reinjection temperatures, volumetric assessment*

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1 INTRODUCTION

Sri Lanka is facing an energy crisis due to increasing energy demand day by day due to the growth of industrial and household energy requirements. The country's potential for hydroelectric power generation has already been largely exploited. With the ever-growing demand for power and energy in Sri Lanka, the country is increasingly becoming dependent on thermal sources, importing petroleum products mainly from oil-producing countries. These finite resources are rapidly depleting and make a considerable contribution to environmental pollution while increase the unit cost of electricity generation. Hence, an environmentally friendly, pollution-free, renewable energy source is very important to face future energy requirements.

Geothermal energy resources are one of the renewable resources in Sri Lanka which have been manifested as 10 low enthalpy thermal springs along a narrow belt that runs approximately parallel to the Highland complex (HC) and Vijayan complex (VC) lithological boundary. These hot springs are only used for bathing and no economic value from those except some of these places being visited by tourists. Medical bathing is popular at the Mahapelessa spring (Mangala and Wijetilake, 2011; Bandara, et al., 2019).

This research focuses on finding the feasibility of geothermal power generation from an available hot spring in Sri Lanka. The three main factors that should be considered to find the feasibility of power generation are the geothermal source, power generating capacity, and the total cost of the project. A geothermal source must have an exploitable amount of heat at accessible depth and the power generating capacity should be in a feasible range to minimize the total cost of the project. The main objective of this research is to explore the possibility of power generation using existing geothermal reservoirs in the country and find its technical and economic feasibility.

In this study several hot springs in HV and VC lithological boundaries were studied as geothermal sources. Spring temperatures were estimated to find a suitable location while considering other factors for location selection. A volumetric method is proposed to estimate the geothermal energy capacity of the reservoir. Due to the uncertainty inherent in many of the required parameters used in the volumetric method, Monte Carlo simulation was used to define a probability distribution for these variables. Power generation technology and power plant equipment were selected according to estimated power generation capacities, reservoir temperature, and depth. The Levelized Cost of Energy (LCOE) for the estimated power generation was calculated to find the economic feasibility of the project.

2 LITERATURE REVIEW

Until 20th century geothermal resources were used primarily for leisure purposes such as hot springs for geothermal baths. At the beginning of the 20th century, active exploitation of geothermal resources for electricity supply purposes was inaugurated. Successful production of electricity from geothermal heat was first achieved in Larderello, Italy, in 1904. But first commercial use of that technology occurred there in 1913 with the construction of a 250-kW capacity power plant where the generator was powered by the natural steam erupting from the earth.

In the year of 1920, many experimental generators were introduced in Beppu, Japan, and the Geysers, California, but Italy was the world's only industrial producer of geothermal electricity until 1958. In 1985 world second successful geothermal power plant was built in Wairakei in New Zealand which used flash steam technology at first. In 1960, Pacific Gas and Electric began the first successful geothermal electric power station in the United States at the Geysers in California which produced 11 MW.

The first binary cycle power started in Soviet Russia in 1967 and United States in 1981. This technology allows the use of much lower temperature resources than were previously recoverable. In 2006 Chena Hot Springs, Alaska started binary cycle plant which uses very low fluid temperature of 57 °C (135 °F) to generate electricity.

By 2015 more than 80 countries were using geothermal energy, either directly or in conjunction with geothermal heat pumps (GHP), China, Turkey, Iceland, Japan, Hungary, and the United States. The total worldwide installed capacity for direct use in 2015 was about 12635 MW utilizing about 73549 GWh per year (Max, Romanelli and Hussain, 2015 ; Moghtaderi, Zhou and Doroodchi, 2019 ; *Geothermal Power*, anon, 2017; Bertani, 2016 ; Serpen, Korkmaz and Satman, 2008)

3 METHODOLOGY

The literature survey for worldwide projects and geothermal resources in Sri Lanka is a compulsory critical step to finding electricity generation capability using geothermal energy because Sri Lanka is new to this technology. The collection of data to select a suitable location for the power station and finding the nature of the reservoir is the next step. The capacity of the power plant suitable for the country was determined by suitable plant technology. Then the power plant will be designed, and an economic analysis was done to determine the unit cost.

Relevant data are collected from the Sustainable Energy Authority and the National Institute of Fundamental Studies (NIFS). Lithological information (geophysical and geochemical) about the geothermal potential in Sri Lanka were collected from the department of geology, at the University of Peradeniya to select the best location for a power plant.

A volumetric method was used to estimate the geothermal energy capacity of the reservoir. The volumetric method refers to the calculation of thermal energy in the rock and the fluid which could be extracted based on specified reservoir volume, reservoir temperature, and reference or final temperature. Due to the uncertainty inherent in many of the required parameters used in the volumetric method, Monte Carlo simulation is used to define a probability distribution for these variables. Monté Carlo simulation was done using a Frontier analytic solver to predict the results. Analytic Solver can be used to create and solve Monte Carlo simulation and optimization models in the Microsoft Excel workbook.

4 IDENTIFICATION OF A SUITABLE LOCATION

4.1 The current situation in Sri Lanka

In Sri Lanka, Geothermal Energy has been manifested as 10 low enthalpy thermal springs along a narrow belt that runs approximately parallel to the Highland complex (HC) and Vijayan complex (VC) lithological boundary (Samaranayake, et al., 2015). They are located mostly in the eastern part of Sri Lanka as shown in Fig.1.

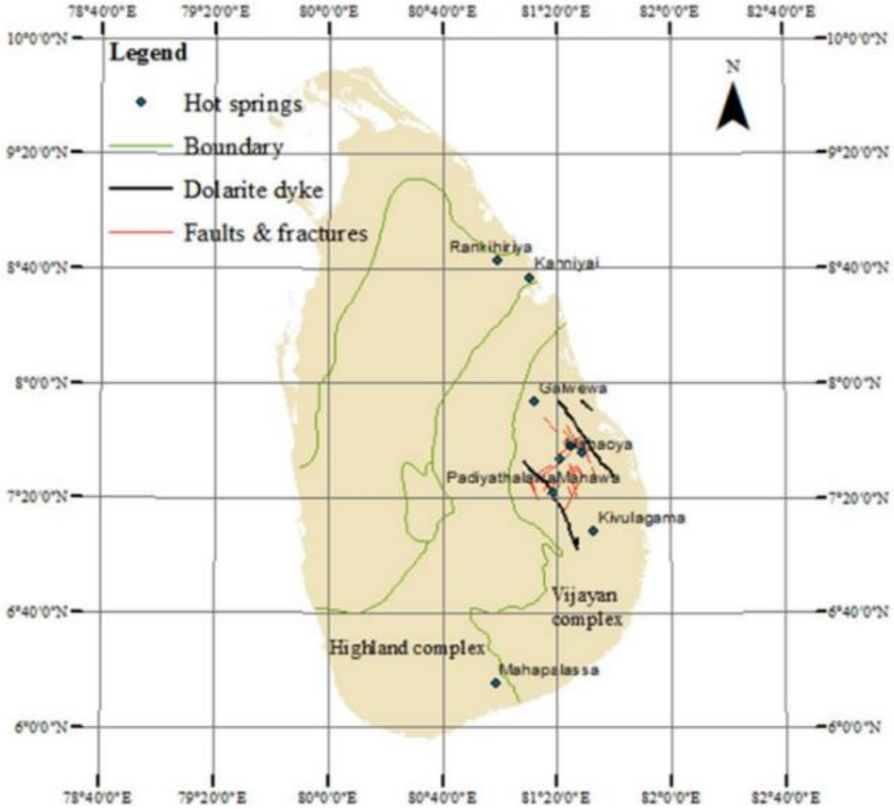

Fig. 1. Locations of hot water springs in Sri Lanka (Samaranayake, et al., 2015)

In the world, generally, locations near places with volcanic activity, places with geysers, and hot water springs are potential geothermal sites. Sri Lanka is situated far away from an active plate boundary, and there is no volcanic region close to Sri Lanka. In Sri Lanka, the only evidence for geothermal energy is hot water springs as shown in Table 1.

Table 1 Hot water springs and temperatures

Hot water spring	Temperature(°C)
Rankihiriya	-
Kanniya	42
Nelumwewa/Galwewa	61
Mutugalwela	-
Kapurella	70
Maha oya	54
Marangala/padiyathalawa	52

Therefore, there should be a possible location close to this HC and VC boundary line to develop a geothermal power plant. Research work by (Mangala and Wijetilake, 2015) and (Samaranayake, et. al.,2015) revealed that geothermometers indicate the subsurface temperature of the geothermal reservoirs could be between 100°C and 140°C. A potential geothermal energy source was estimated in a geothermal belt with a length of 350 km (length of the hot spring belt), a depth of 2 km, and a width of 2 km (Mangala and Wijetilake, 2015; Bandara, et al., 2019).

4.2 Geothermal exploration methods

Geothermal exploration programs utilize a variety of techniques to identify geothermal reservoirs and information that can point to areas of low density, high porosity, high permeability, and subsurface fault lines that can help define well field development. In this research study, observations of two exploration techniques are used to analyze a suitable location. They are geophysical methods (Magnetotelluric (MT) and Transient Electromagnetic (TEM))and geochemical methods.

This study used measurement data taken from previous research work due to unavailability of resources and limitation of the time for site measurements.

MT and TEM observations including figures used in this study are extracted from the thesis of “Mapping geothermal resources in Sri Lanka”, presented by Nuwan Buddika Suriyaarchchi, Postgraduate Institute of Science, University of Peradeniya (Suriyaarachchi, 2017).

Chemical geothermometry is a primary tool used to determine subsurface temperatures of geothermal reservoirs. The input parameters for the geothermometer are the chemical analyses of the water samples of hot springs (Franco and Donatini, 2017). Hence, the accuracy of the subsurface temperatures determined by the chemical geothermometers depends on the chemical analyses accuracy. Silica conductive and theoretically based cation geothermometers are the most appropriate geothermometers for estimating reservoir temperatures of Sri Lanka’s low enthalpy geothermal systems.

All geothermometer results including figures used in this study were extracted from the research of “An appropriate deep reservoir temperature estimate for thermal spring systems in the crystalline terrain of Sri Lanka; a comparison of geothermometers” presented by S.M.P.G.S. Kumara and H.A. Dharmagunawardhane (Kumara and Dharmagunawardhane, 2017).

4.3 Selected areas

In this feasibility study, four areas were selected (namely Kapurella, Padiyathalawa, Mahaoya, and Nelumwewa) for the analysis of the most suitable location among the 10 well-known hot spring locations using geophysical and geochemical observations.

4.3.1 Padiyathalawa hot spring area

There is a hot spring complex located in the Padiyatalawa village, also known as Wahawa/Marangala hot springs. Tanks are built in this hot spring to get the hot water out but only a few are being used. The temperature indication of hot water is 50- 60°C (Samaranayake, et. al., 2015).

According to the MT resistivity profile shown in fig 2, there is a high resistive (>1000Ωm) zone in depth from 500 m to 2000 m. There are two low resistivity (800Ωm) zones that appear at 2000m depth below No 7-sounding pointing and 4500m depth below No 2 sounding site. Middle of these low resistive zones, resistivity values drop further below 50 Ωm (Suriyaarachchi, 2017).

The estimated geothermal reservoir temperatures of Padiyathalawa hot spring are based on the Na/K, K/Mg, and Quartz geothermometers. The reservoir temperature is in between 123°C and 184°C (Kumara and Dharmagunawardhane, 2017).

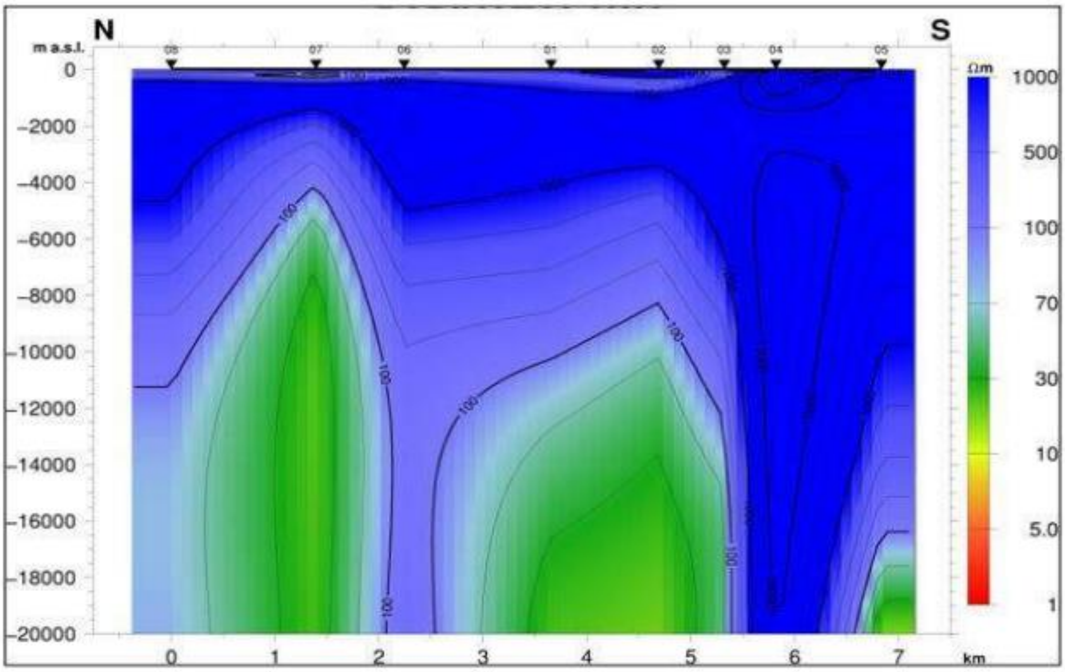

Fig. 2. Resistivity profile up to 20000m depth from MT method, Padiyathalawa hot spring area (Suriyaarachchi, 2017)

4.3.2 Kapurella hot spring area

Kapurella records the highest surface temperature (70 °C) among all Sri Lankan thermal springs. Kapurella hot spring is simply formed along NE to SW direction and the whole area is covered with marshy land vegetation (Ekanayake, et al., n.d.).

According to the MT resistivity profile shown in fig 3, there is a low resistivity zone (600Ωm) that starts to appear below point No 308 and point No 305 at a depth of 1000 m, and it extends further below. The resistivity value of the middle of that zone is 8-30 Ωm. The heat source of the hot spring could be connected to a cooling magmatic source at a depth of 10 Km (Suriyaarachchi, 2017).

The estimated geothermal reservoir temperatures of Kapurella hot springs based on the Na/K, K/Mg, and Quartz geothermometers revealed that reservoir temperature is between 130°C and 203°C (Kumara and Dharmagunawardhane, 2017).

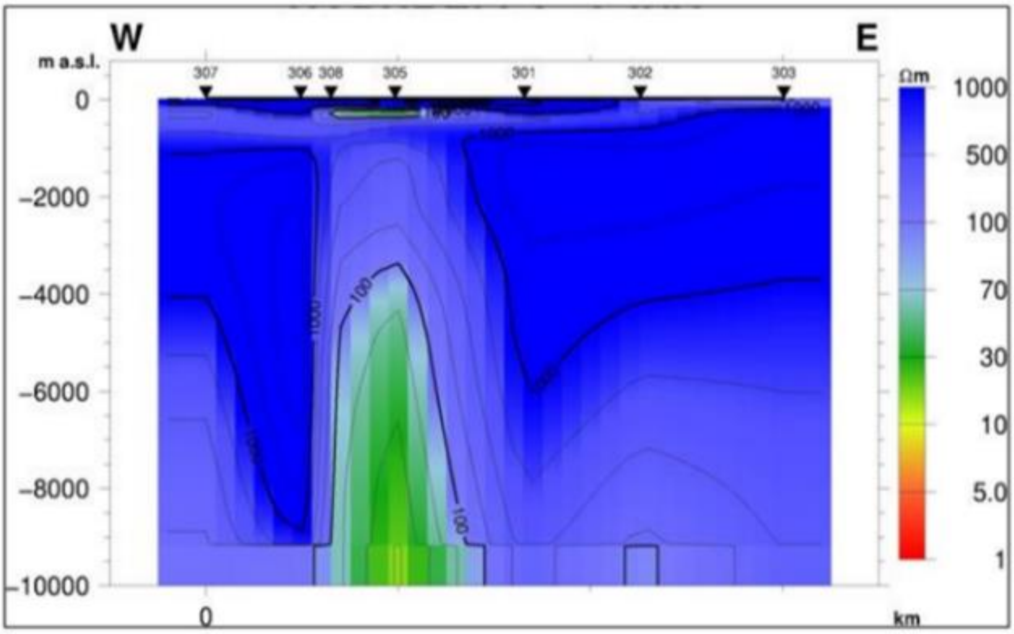

Fig. 3. Resistivity profile up to 10000m depth from MT method, Kapurella hot spring area (Suriyaarachchi, 2017)

4.3.3 Nelumwewa hot spring area

Nelum Wewa Hot spring in Polonnaruwa is the most recent discovery among all other hot springs. The temperature indication of the water is 61°C (Kumara and Dharmagunawardhane, 2014).

According to the TEM resistivity profile shown in fig 4, there are many low resistivity zones under the hot spring area. Because there are two irrigation tanks located close to the thermal water spring. The heat source of the spring is located under the Dimbulagala Mountain as a Hot Dry Rock, and it transfers heat to groundwater through fractures, and it provides a pathway for thermal water to emerge at the surface as the hot spring (Kumara and Dharmagunawardhane, 2014).

The estimated geothermal reservoir temperatures of Nelumwewa hot springs based on the Na/K, K/Mg, and Quartz geothermometers revealed that the reservoir temperature is between 134°C and 204°C (Kumara and Dharmagunawardhane, 2017).

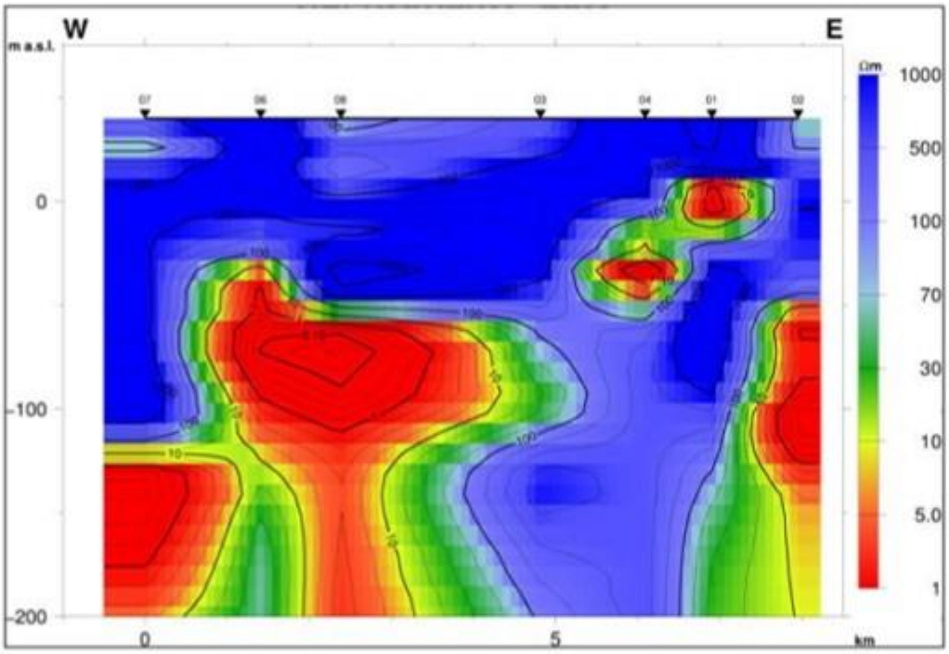

Fig.4. Resistivity profile for shallow depth from TEM method, Nelumwewa hot spring area (Suriyaarachchi, 2017)

4.3.4 Mahaoya hot spring area

There are seven hot water wells in the Maha Oya Hot water spring site. The average temperature of the hottest well is about 58°C while the lowest is 38°C (Kumara and Dharmagunawardhane, 2017). According to the MT resistivity profile shown in fig 5, there is no evidence of very low resistivity that could be holding water or HDR at accessible depth (Hobbs, et al., 2013).

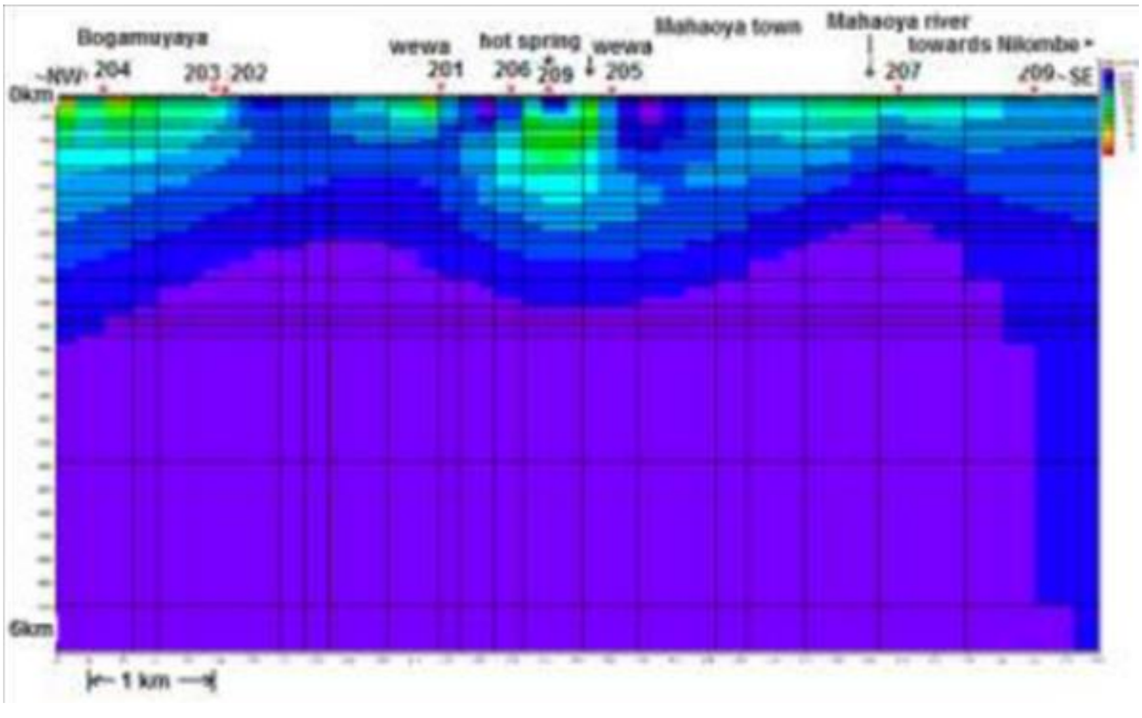

Fig. 5. Resistivity profile up to 6km depth from MT method, Mahaoya hot spring area (Hobbs, et al., 2013)

The estimated geothermal reservoir temperatures of Maha Oya hot springs based on the Na/K, K/Mg, and Quartz geothermometers revealed that the reservoir temperature is between 134°C and 204°C.

4.4 Most suitable location

The temperatures of geothermal reservoirs of the selected four hot springs are appropriate to develop a binary cycle power plant. Temperature, depth to the reservoir and heat amount should also be considered to find the best location. Table 2 shows the details of the locations.

A very low resistivity zone is evidence of a heat source that could be holding thermal water or HDR at accessible depth. In the Padiyathalawa area, the moderately low resistivity zone appears at 2000m depth and the low resistivity 100Ωm region appears at 4500m depth. But this low resistivity region is completely covered by a high resistive zone, and this high resistive layer is spread over the whole profile at a depth from 500m to 2000m.

The heat source of Nelumwewa is located under the Dimbulagala Mountain and it is a Hot Dry Rock which means there is no water, have to inject fresh water into it (Kumara and Dharmagunawardhane, 2017). The water will be heated, and when it comes to the surface, some portion turns into steam. This is called an Enhanced Geothermal System (EGS). The initial cost of EGS power plants is very high and is not suitable for developing countries like Sri Lanka.

Table 2 Details of Selected Locations

Location	Geophysical observation	Average Reservoir temperature(°C)
Padiyathalawa	Low resistivity zones start to appear at depths of 2000m and 4500m, and 100Ωm zone at 4500m.	144
Kapurella	A low resistivity zone starts to appear at depths of 1000m, and a 100Ωm zone at 3500m.	157
Nelumwewa	Heat source located under the Dimbulagala Mountain as a Hot Dry Rock	160
Mahaoya	No evidence of very low resistivity zones at accessible depth.	159

According to the MT resistivity profile, there is no evidence of very low resistivity zones at accessible depth in the Mahaoya hot spring area.

According to the MT resistivity profile of the Kapurella area, there is a low resistivity zone (600Ωm) at the start of 1000m, and it extends further below. The resistivity value of the middle of that zone is 8-30Ωm and there is no very high resistivity zone around the low resistivity region. So, that low resistivity zone should be the geothermal reservoir. Therefore, by considering the above details most suitable location for the geothermal power plant is the Kapurella area. Kapurella has an exploitable amount of heat, comparatively closer to the surface, at about 3 km depth (Suriyaarachchi, 2017).

5 ESTIMATION OF POWER GENERATION CAPACITY

There are several estimating methods used to estimate the energy and electric power generation capacity of geothermal reservoirs which can be grouped into two main categories with no production data and methods integrated with the use of production data (Franco and Donatini, 2017).

In this feasibility study, the volumetric assessment method is used to estimate power capacity. The volumetric method is the primary static modelling method, used in geothermal resource capacity estimation without any down hall data. This method assumes that extract the heat from a specific volume of the geothermal reservoir and cooling it down from an initial temperature (T) to a base temperature (T0). The accessible geothermal heat energy (Q) is computed using the following volumetric equation (Muffler and Cataldi, 1978; Trota, et al., 2019).

$$\mathbf{Q} = \mathbf{Q_r} + \mathbf{Q_w} \qquad (1)$$

$$\mathbf{Q} = \mathbf{Ah(1-\emptyset)C_r\rho_r(T-T_0) + Ah\emptyset C_w\rho_w(T-T_0)} \qquad (2)$$

Q_r = Stored heat of the rocks in selected volume (J)
Q_w = Stored heat of the water (J)
A = Area of the reservoir (m^2)
h = thickness of the reservoir (m)
$\emptyset$ = Porosity
C_r = Specific heat of rock (Kj/kg°C)
ρ_r = density of rock (kg/m^3)
T = Reservoir Temperature (°C)
T_0 = Base (reference) temperature (°C)
C_w = Specific heat of water (kJ/kg°C)
ρ_w = density of water (kg/m^3)

The power generation capacity or size of the power plant (P) is calculated using the equation (3) shown below (Trota, et al., 2019).

$$\boldsymbol{P = \frac{QR_fC_e}{P_ft}} \qquad (3)$$

P = Power generation capacity (MW)
R_f = Recovery factor
C_e = Conversion efficiency
P_f = Plant factor
t = Time in years

Due to the uncertainty inherent in many of the required parameters used in the volumetric method, Monte Carlo simulation is used to define a probability distribution for these variables. Monte Carlo Simulation is the most tenable method used when a model has uncertain parameters, or a dynamic complex system needs to be analyzed. It is a probabilistic method for modeling risk in a system (Shah, et al, 2018).

In the study, a model analytic solver was used for the Monto Carlo simulation and the Monte Carlo simulation was done to assess the electricity generation potential of the geothermal resource in the country for 30 years. Parameters used for a volumetric assessment are tabulated in Table 3. Those were applied to the Monte Carlo simulation.

Table 3 Input parameters for Monte Carlo volumetric assessment (For reference temp-130°)

Input parameter	Minimum	Most likely	Maximum	Distribution
Area (m^2)		1000000		Fixed
Thickness (m)	1000	2000	3000	Triangular
Porosity (%)	5		10	Constant
Specific heat of rock (kJ/kg°C)		900		Fixed
Specific heat of water (kJ/kg°C)		4370		Fixed
Density of rock (kg/m^3)		2750		Fixed
Density of water (kg/m^3)		900		Fixed
Reservoir Temperature (°C)	130	170	203	Triangular
Reinjection temperature (°C)		70-130		Fixed
Recovery factor (%)	12.5		25	Constant
Conversion efficiency (%)		7.8		Fixed
Plant factor		0.95		Fixed
Number of runs		1000		Fixed

Volumetric equations (2), (3), and parameter values in Table 3 were applied to the Monte Carlo simulation, and the results are shown in Fig.8.

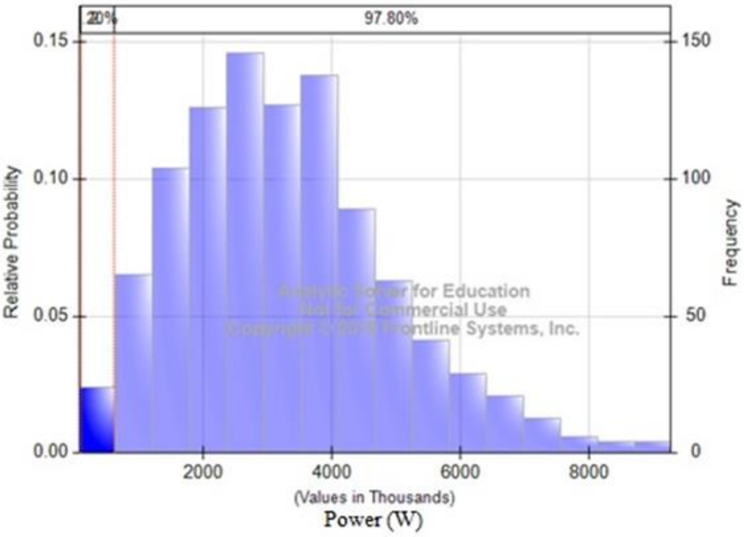

Fig.8. Probability distribution of power

The Monte Carlo simulation results show that the volumetric assessment predicts with the most probable value that the reservoir could produce is 3.2 MW for 30 years with a reference temperature of 130°C. According to the probability distribution shown in Fig. 8, it is most probable that the electrical power production capacity lies between 2.5 MW and 3.1 MW if the recoverable heat is used for 30 years, and this is the minimum power generation capacity for this geothermal field. To find an optimal value, a Monte Carlo simulation was done for eight different values of reference temperatures, and estimated power capacities are shown in Table 4.

Table 4 Estimated power generation for different reference temperatures.

Reference temperature (°C)	Average power (MW)
130	3.1
120	4.0
110	4.8
100	5.6
90	6.5
80	7.3
70	8.3
60	9.1

6 DESIGN OF POWER PLANT

Sri Lanka has low-temperature geothermal resources and due to the unavailability of downhole data, information on the state of geothermal brine is an uncertain parameter. Therefore, a binary cycle system is considered a suitable technology for this type of resource. Because binary cycle power plant is used where geothermal resources are not sufficiently hot to produce steam, or where the source contains minerals or chemical impurities to allow flashing (Mendrinos, Kontoleontos and Karytsas, 2006).

The heat exchangers used in the binary power plants are typically shell and tube exchangers with the geothermal fluid on the tube side of the exchanger and the working fluid on the shell side (Zhang, et al., 2020). A Shell-and-tube heat exchanger is suggested for this research with working fluid on the shell side and cooling water (CW) on the tube side. For cooling purposes, dry cooling systems are not suitable for the Kapurella area since the high ambient temperature and large area requirements. Therefore, a wet cooling system is proposed for the design. The typical temperature difference between the inlet and outlet cooling water is 10°C (Mendrinos, Kontoleontos and Karytsas, 2006).

The heat transfer area of the preheater, evaporator, and condenser can be calculated using the standard formulas. But due to the unavailability of field measured data heat exchanger areas are assumed by comparing other existing binary cycle power plant specifications in the world. Working fluid selection is one of the most critical considerations in Organic Ranking Cycle (ORC) design (Valdimarsson, 2017; Rowshanzadeh, 2010). For working fluid selection, several criteria are considered such as environmental sustainability, ozone depletion potential, global warming potential (GWP), safety (non-flammable, non-toxic, and non-corrosive), and the vapor pressure in the boiler, critical temperature, and thermal stability. Working fluids have lower critical pressure and temperature than water. Isopentane was selected as the working fluid for this research design with low vaporizer pressure and at a comparatively lower price.

6.1 Life Cycle Cost Analysis

Geothermal capital costs are relatively low since geothermal energy projects usually require less land compared to wind or solar energy projects. Due to the lack of certain parameters in the geothermal field, Geothermal Electricity Technologies Evaluation Model (GETEM) is used to do the cost analysis of the study. Electrical power generation is the sole geothermal use considered by GETEM and does not provide assessment capabilities for geothermal direct-use or geothermal heat pumps. The model evaluates either a Hydrothermal or an EGS resource type, and then either a flash-steam or binary power plant based on specific resource parameters.

Input parameters to GETEM are reservoir temperature, depth, and power. The reservoir temperature of 157°C, the depth of the reservoir is 3km and the estimated power is taken as 3.1 MW to 8.3 MW. According to GETEM direct and indirect costs are tabulated in Table 5 for the 3.1 MW to 8.3 MW estimated capacity

Table 5 Levelized Cost of Energy for estimated generation capacity

Reinjection Temperature (^{0}C)	Power capacity (MW)	Levelized Cost of Energy LCOE (₵/kWh)	Levelized Cost of Energy LCOE (Rs/kWh)
130	3.1	40.19	72.34
120	4.0	33.644	60.56
110	4.8	30.06	54.108
100	5.6	27.46	49.428
90	6.5	25.276	45.49
80	7.3	23.768	42.78
70	8.3	22.276	40.09

6.2 Environmental Impact

Binary cycle geothermal power plants are relatively small and require little land to produce the same amount of energy as other common power generation systems. And the amount of land required by a geothermal plant varies depending on the properties of the resource reservoir, the amount of power capacity, the type of energy conversion system, the type of cooling system, the arrangement of wells and piping systems, and the substation and auxiliary building needs.

Geothermal power provides many environmental advantages over fossil fuel power sources in terms of air emissions because geothermal energy production releases no nitrogen oxides, no sulfur dioxide, and much less carbon CO2 than fossil fuel power. For the Kapurella area, a binary cycle power plant is proposed and Binary plants have no CO2 emissions.

7 DISCUSSION

Since Sri Lanka is unfamiliar with geothermal energy, a literature survey for worldwide projects and geothermal resources in Sri Lanka was a compulsory critical step to finding the feasibility of electricity generation.

The biggest challenge was to find the input parameter values (data) relevant to the volumetric Equation which is used in Monte Carlo simulation. Reservoir temperatures are directly extracted from geothermometer results in previously done research. Other necessary parameters were also found in previous studies.

Power generation technology and power plant equipment are selected according to estimated power generation capacities, reservoir temperature, and depth. A Basic power plant layout was designed considering a preheater, evaporator, cooling system, and turbine. Due to the limited available parameters of the resources cost analysis was a difficult task. Therefore, Geothermal Electricity Technologies Evaluation Model was used to find the fixed capital costs and operating and maintenance costs to calculate the specific life cycle cost of the power plant.

8 CONCLUSION

By analyzing collected lithological data from the department of geology, University of Peradeniya, Kapurella hot water spring area was selected as the best location to develop a geothermal power plant. Kapurella has an exploitable amount of heat, comparatively closer to the surface, at about 3 to 4 km depth. Geothermometer results point out that the average temperature of a geothermal reservoir of the Kapurella hot water springs is about 157oC. To find an optimal value, a Monte Carlo simulation was done for eight different values of reference temperatures, and eight power generation capacity values are estimated. The results of the Monte Carlo simulation point out that the reservoir (10 km2 Area) could produce 3.1 MW to 8.3 MW of power for 130ºC to 70ºC reinjection temperatures.

The economic analysis points out that the Levelized Cost (LCOE) of energy from proposed power plant lies between 72.34 Rs/kWh to 40.09 Rs/kWh for 130ºC to70ºC reinjection temperatures respectively. Comparing the Levelized cost values of thermal and hydro power which was around 13.68 Rs/kWh and 2.32 Rs/kWh respectively, this feasibility study results, 72.34 to 40.09 Rs/kWh is a higher range, and power generation from geothermal energy is not economically feasible (Annual report_ CEB, 2020).

The results point out that, this study is not economically feasible for a base-load requirement. Therefore, based on the results of the Geothermal Electricity Technologies Evaluation Model, the development of a geothermal power plant in the Kapurella area will be a difficult task. This is largely due to development barriers and risks related to site access and a lack of data indicating the location of a deeper geothermal resource capable of supporting a utility-scale development. Even though there is a technical potential to generate electricity from the existing geothermal reservoir it is not economically feasible.

The gathering of more resource information is highly recommended for future studies. From previous research work, it is concluded that the heat source of the Nelumwewa hot springs is located under the Dimbulagala Mountain as a Hot Dry Rock, and it transfers heat to groundwater through fractures. Therefore, this area may be suitable to develop an Enhanced Geothermal System (EGS). A feasibility study needs to be carried out in this area to find out the capability of electricity generation from an EGS power plant.

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