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Demonstration On Direct Use Of Geothermal Energy For Space Heating In Chumathang, Laddakh (U.T), India

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ABSTRACT

North-Western Himalayas is a promising area for geothermal utilization with more than 400 thermal springs. The ‘Himalayan Geothermal Belt’ was formed as a result of the collision of the Indian plate with the Eurasian plate, about 50 million years ago. It hosts nearly 150 thermal springs with temperature varying from 47°to 87° Celsius. Although hot spots in Ladakh has a potential to produce geothermal energy, but there has been no progress to harness this energy due to political and financial constraints. The Laddakh is situated in the northern part of the Himalayan belt bordering Tibet (China) hence experiences severe cold during the winter season dipping temperature to minus 15 to 25 degrees Celsius. An effort has been made to demonstrate the use of geothermal energy for space heating at Chumathang near a hot spring source.

At present, the city of Leh uses diesel to meet its major power demand for electricity and space heating. It is estimated that diesel generators are generating about 28,000 metric tones of CO_2 resulting in greater threat to the Himalayan Glaciers. It is reported that over the last 61 years, the Gangotri glacier has receded by a distance of 1,164 meters. Unlike solar and wind energy, Geothermal energy is available 24x7 and 365 days per year. It emits 80% less greenhouse gases compared to coal and oil. Geothermal energy is independent of adverse weather conditions prevailing in Laddakh region. Initial cost may be high (estimated 40 crore per MW) but will drop over a long period. It is estimated with 90% probability that Geothermal field at Puga could sustain 20 MW power plant at current depth of 250 m. The plant of this capacity at Puga could annually save about 3.5 million litres of diesel costing about 4 million USD apart from saving the environment from toxic gases.

1. INTRODUCTION

The Himalayan Geothermal Belt (HGB) hosts nearly 150 thermal springs with temperature varying from 47° to 87° C (Chandrasekharam, D. and Varun Chandrasekhar). Although hot spots in Ladakh has a potential to produce geothermal energy, but there has been no progress to harness this energy due to political and financial constraints. Various scientists who worked in this field in the Laddakh region has estimated that over 5000 MWh of Geothermal Energy is available at Puga at current depth, which can be utilized for electricity generation, space heating and green house cultivation. Puga, Chumathang, Nubra geothermal are located in Leh, and other thermal locations Manali and Manikaran in Kullu valley falls within HGB. North-Western Himalayas is a promising area for geothermal utilization with more than 400 thermal springs. The ‘Himalayan Geothermal Belt’ was formed as a result of the collision of the Indian plate with the Eurasian plate, about 50 million years ago. India was a large island situated off the Australian coast about 225 million years ago.

An effort has been made to demonstrate the use of geothermal energy for space heating at Chumathang with the help of Geological Survey of Iceland (ISOR), Norwegian Geotechnical Institute (NGI), Wadia Institute of Himalayan Geology Dehradun (WIHG), National Institute of Technology Hamirpur (H.P) in coordination with Department of Science & Technology, New Delhi as part of Indo- Norwegian cooperation programme.

At present, Leh uses diesel to meet its major power demand for electricity and space heating. Unlike solar and wind energy, Geothermal energy is available 24x7 and 365 days. It emits 80% less greenhouse gases compared to coal and oil. Geothermal energy is independent of adverse weather conditions prevailing in Laddakh region. Initial cost may be high (estimated 40 crore per MW) but will drop over a long period.It is estimated with 90% probability that Geothermal field at Puga could sustain 20 MW power plant at current depth of 250 m. The plant of this capacity at Puga could annually save about 3.5 million litres of diesel costing about 4 million USD apart from saving the environment from toxic gases. It is estimated that diesel generators are generating about 28,000 metric tones of CO_2 resulting in greater threat to the Himalayan Glaciers. It is reported that over the past 61 years, the Gangotri glacier has receded by a distance of 1,164 meters.

2. OBJECTIVES

To maintain the demonstrative pilot project on innovative and sustainable technologies for utilization of geothermal sources to supply N-W Himalayan region with renewable energy by usage of Residual heat from the earth´s origin which is produced by natural radioactivity (some minerals containing uranium, thorium or potassium) where decomposition produces heat or Heat flow from the core of the Earth that has a high temperature.

Pilot project on Demonstration of Geothermal Energy for heating the space at Chumathang, Laddakh is to maintain its functioning so that potential of geothermal energy can be realized and demonstrated to larger scientific community as well general public.

The available geothermal energy can be utilized to generate power and for other direct applications and save the pristine ecosystem of the Himalayas.

Geothermal resources will enhance the energy supply through renewable resources and contribute in efficient energy use and has the potential to enhance social development in the area.

2.1 Location

Chumathang, a village located at an altitude 4200 m above mean sea level on the banks of river Indus. It belongs to the administrative District of Laddakh an Union Territory of India nearby to Indo-China Border.Please be very careful to use styles throughout the document, so that all the papers will have a similar appearance. Normal text is in <Normal Style>

2.2 Criterion for demonstration site selection

1. Hot spring available nearby saving drilling cost.

2. A place of public gathering.

3. Hotel/restaurants used by local tourists while travelling in Ladakh.

4. Site famous for its hot springs and its usage for bathing

5. Restaurant and hotel owner is a village councilor who played major role in development of infrastructure of geothermal energy for public usage for other direct use such as bathing.

2.3 User requirement

1. Lack of electricity: Electricity supply available only 4 hours a day in winter which is insufficient for continuous running of pumps

2. High heat load due to non insulated building structure material and construction

3. Easy installation and maintenance not feasible due to distant project site location

4. Risk of freezing of working fluid during non operating period which can cause permanent damage to the heating system

5. If heating system is damaged due to non or ill maintenance then it will be difficult or may take long time to bring the equipment from Scandinavia to India.

Figure 1. The Café is constructed over the rocks which radiate heat and keeps the space warm.

Figure 2. Solar panel fixed over the heating space for power required to run the electrical appliances for regulating hot water

3. METHODOLOGY AND EQUIPMENTS USED

3.1 DESIGN PARAMETERS

3.1.1 Energy potential available

Geothermal energy: water at constant temperature of 78º C

Solar Energy: High solar radiation intensity due to high altitude and thin atmosphere layer

3.1.2 Heat load requirement

Restaurant: 11 kW

Hotel Rooms: 18 kW

Heat load calculated considering existing building structure with outside ambient temperature of -15º C and maintaining inside temperature of 20º C

3.1.3 Pump power requirement

Primary side: 370 W

Secondary side: 160W

Panel type radiators (11 no) with manual control valves

Heat Exchanger

Capacity: 29 kW

Material: Stainless steel AISI 316L/1.4404 plates Brazed welding

Separate heating fluid and circulating fluid loop considering chemical analysis of fluid samples done in ISOR laboratory, Iceland.

Two pump units

Primary side: Self priming, thermostat control pump

Secondary side: Normal centrifugal pump

Expansion cylinder for maintaining pressure head

Piping with Rockwool insulation to avoid freezing of working fluid

Temperature and pressure gauges in secondary loop inlet and outlet

3.1.4 Solar Power Unit

100W panel (24 no) four panels in series

Banshtu and Versain

Single panel output: 12V X 7.2 A

Total panel output: 48 V X 43.2 A

2000 Volt Ampere inverter with solar controller

Battery backup: 150 Ah battery (4 no) connected

Output Load: 2000W 230V AC

3.1.5 Accessories

Insulation for roof to avoid cold air seepage

Temperature data logging system to check long term performance

Figure 3. View of hot water springs at Chumathang

Figure 4. One of the five boiling water source at Chumathang

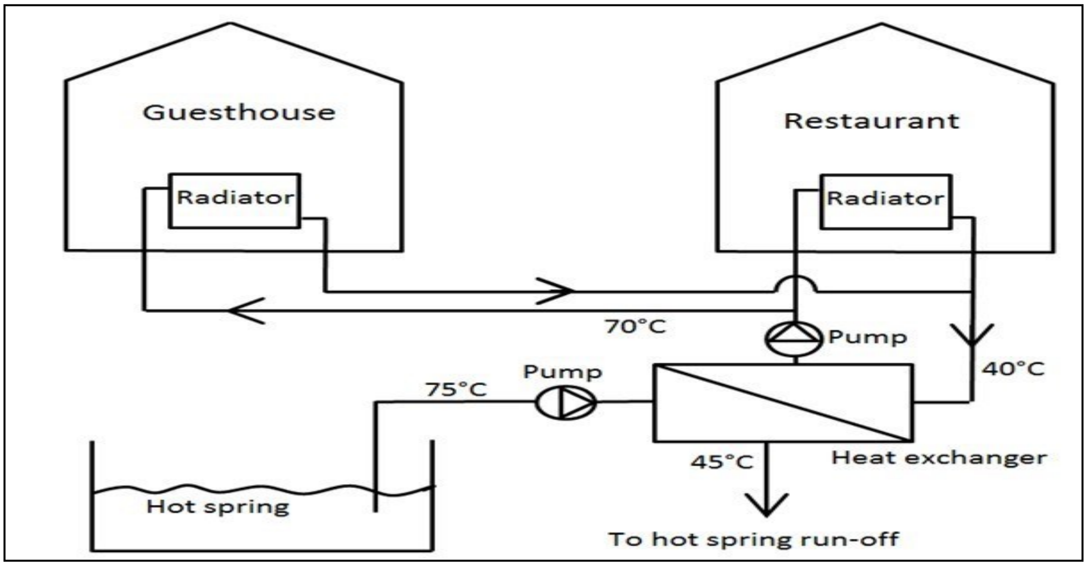

Figure 5. Schematic diagram of the space heating system in Chumathang

4. GEOTHERMAL ENERGY AT PUGA

Puga Valley has significant potential for geothermal energy which is evident in the form of hot springs, mud pools, sulphur and borax deposits. Puga Valley is situated at an altitude of 4400m above mean sea level and is locatedabout 40 km from Chumathang (175 km from Leh) and stretches over 15 km in length with a maximum width of about 1 km. Various geo-investigations including exploratory drilling and studies on geothermal energy utilization on an experimental basis were carried out without much benefit to the local inhabitants. An Orphan Residential School for Tibetanchildren which is situated barely one kilometer fromPuga geothermal site is still using kerosene heaters “Bukhari” for space heating. If government provides sufficient funds space heating on the pattern of Chumathang can also be replicated for about half a dozen schools nearby apart from facility to the Army camps situated in the Laddakh valley.

The School building has no provision for space heating (even by traditional methods) and the children sleep in the bunker beds, braving the cold, using only blankets during the harsh winter season.

Kerosene from a storage tank is pumped in to a closed hollow cinder. Kerosene burns continuously in the cinder radiating heat into the space outside. The exhaust CO_2 is released into the atmosphere through an exhaust tube connected to the cylinder.

Figure 7. Hot water gyser source at Puga (Laddakh).

Figure 6. The ice screen fromed around the hot water spring (gyser) where hot water alogwith steam gushes out and is freezed in the air itself.

Figure 8. Picturesque view of Tsomoriri Lake near Puga Valley

5. EFFECT OF DIESEL GENERATORS IN LEH

Ladakh has no resources of fossil fuels Energy based on such fuels, is therefore, not the answer to Ladakh's energy requirements.

In recent times, Ladakh's needs for power have witnessed a sharp increase, as the people of the region have started adopting a lifestyle that is more and more in line with the outside world and in addition to this lifestyle, as mentioned above, tourism, being a revenue for the local population, is given priority.

This requirements is mostly been met by transporting fossil fuels from outside the state.

Currently, 8,000 litres of diesel is needed to generate sufficient power for a day's consumption in Ladakh, and all of this fuel is imported from other states.

This is arrangement is economically as well as environmentally unsustainable.

At present 300,000 litres of diesel is burnt to generate 13 MWe of power annually.

At the prevailing cost of diesel, 120 million Indian rupees are spent annually to generate 13 MWe.

A rough estimate shows that 28,000 metric tones of CO_2/ MWh are generated from the diesel generators (Chandrasekharam, 2004b).

The effect of CO_2 on the Himalayan glaciers is already felt and the Gangotri glacier, during the period between 1936 and 1996, has receded by a distance of 1,164 m amounting to an average receding of 18 m per year during this period (Naithali et. al., 2001).

Figure 9. Residential school for Children of Nomads at Puga.

Figure 10. Tibetan orphan children in a residential school near Puga geothermal site.

Figure 11. A typical "Bukhari" tradionally used in leh for space heating during winter.

6. TECHNOLOGY FOR ELECTRICITY GENERATION

There are two types of the plants.

Flash steam plants: When the geothermal energy is available at 150°C and above temperature, the fluids can be used directly to generate electricity. In some cases, direct steam is available from the geothermal reservoir; otherwise the steam is separated and turbines are used for power generation.

Binary plant: These plants are used when geothermal temperature is between 100°C and 150°C. The fluid is extracted and circulated through a heat exchanger where the heat is transferred to the low boiling point organic liquid. This gets converted into high pressure vapour, which drives organic fluid turbines.

7. FEEDBACK FROM USERS

Children of Mr. Zodpa (the owner of the premises) and his neighbors gained more time for study during harsh chilling winters.

Improved health and life expectancy of users expected in long term.

More people staying in hotel during winters making villagers to have full time employment in hotel.

More social gatherings in the restaurant during evenings in winters.

A step towards utilization of geothermal energy in the country through this Indo-Norway demonstration project.

8. CONCLUSION

It is appropriate to utilize the available geothermal energy source for direct applications as well for power generation and preserve the pristine atmosphere of Leh and reduce the impact of green house gases.

This will provide sufficient energy for the Leh population for the next decade and meet their internal power demand for electricity and space heating requirements.

This energy source will improve the socio-economic status of the Leh population including the Tibetan children located in the orphan schools.

Besides the civilians, the army personal will also greatly benefit by the geothermal sources.

Utilizing geothermal energy source in the Himalaya province will not only provide clean energy for lighting, space heating and green house cultivation but also reduces carbon dioxide emission and protect the pristine ecosystem of the Himalayas and also the glaciers.

If the available geothermal energy is utilized in the entire HGB, this province can become one of the major food producing and processing regions in the country.

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