

The case of geo thermal energy from productive, depleted and abandoned oil and gas wells

Humera Farah

Department of Earth and Environmental Sciences, Bahria University, Sector E-8, Islamabad, Pakistan

farahhzb@gmail.com

Keywords: Geothermal gradient, co-produce, oil & gas fields

ABSTRACT

Pakistan as the other developing nations of the world, is suffering from energy deficit for past several years. The country is dependent on mostly imported fossil fuels such as coal and oil. The renewable energy usage is limited such as hydro and solar power generation. Nevertheless little or no attention by government, industry and academia has been paid to geothermal energy for heat and power generation. Oil and Gas Development Company Limited (OGDCL) is the largest private enterprise in Pakistan, involved in exploration and production of indigenous oil and gas. This study aimed to identify and examine the feasibility of harnessing geothermal gradient and co-produced fluids of productive, depleted and abandoned oil and gas wells of the OGDCL, located in various parts of Pakistan. Field surveys data was collected from relevant organizations and interviews of the key personal of the company were conducted to gather required info. The findings revealed that the company holds over one hundred depleted and some abandoned oil and gas wells in the country, which could be a potential source of heat and power generation. The geothermal gradient and co-produced fluids of approximately 80-150°C has been estimated in many active oil wells located in Northern Province of Khyber PaktunKhwa (KPK) and Punjab as well. The potential of the hot waters (co-produced fluids) of various categories of the oil and gas wells (currently active or depleted and abandoned) as low cost heat and power source for residential and commercial purpose has also never been investigated. The hot fluids are presently drained into nearby streams as waste water or re-injected into the wells. A comprehensive investigation is recommended on selected wells of OGDCL to evaluate their pioneer usage for power generation in the country.

1. INTRODUCTION

Pakistan as the other developing nations of the world, is in energy deficiency, for past several years. The supply chain of energy sources in the country is shown in table 1. It clearly depicts the dependence on mostly imported fossil fuels such as coal, oil and its derived products. The renewable energy usage is limited and focused mostly on hydro power. Nevertheless little or no attention by government, industry and academia has been paid to geothermal energy for heat and power generation, Abbas et al (2014), Wakeel et al. (2016).

Table 1: Energy supply sources in Pakistan, HDIP (2016)

Source	Local (%)	Imported (%)
Coal	0.42	4.5
Crude oil	6.4	11.94
Petroleum products	-	18.81
Gas	41.60	-
Gas + LNG	-	0.66
LPG	-	0.22
Electricity	-	0.45
Nuclear electricity	1.92	-
Hydro electricity	10.75	-
Other renewables	0.27	-

The sectorial usage of both indigenous/imported oil and gas is given in Fig. 1 (a & b). It mirrors huge 40 and 30% of oil and gas consumption for power generation respectively. Such consumption not only burdens economy and foreign reserves, yet it contributes to greenhouse gases emissions and other environmental pollutants as well. Still, Pakistan's current electricity shortfall is estimated at 5800 MW, which escalates in seasonal peak demand such as in summer.

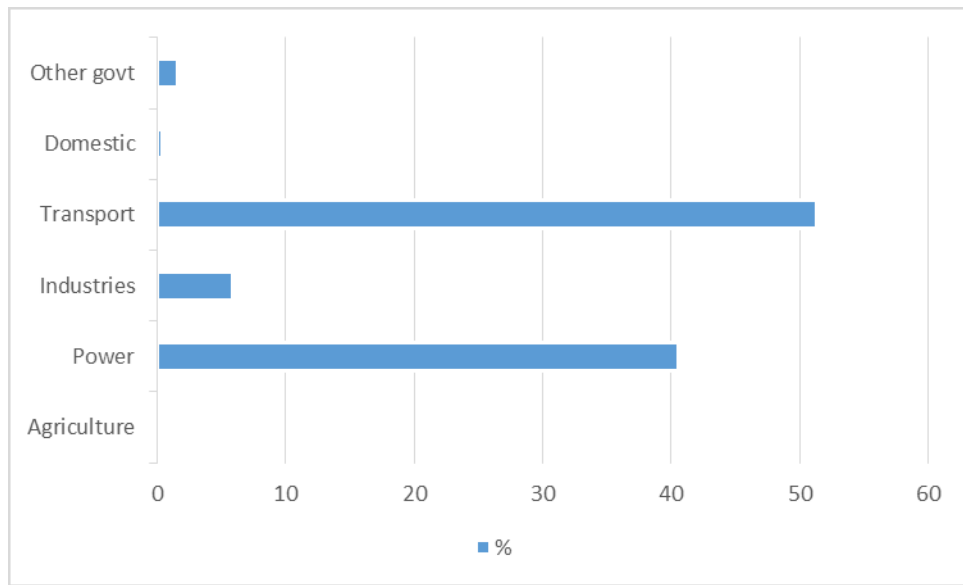


Figure 1 a: Sectorial oil consumption in Pakistan, HDIP (2016).

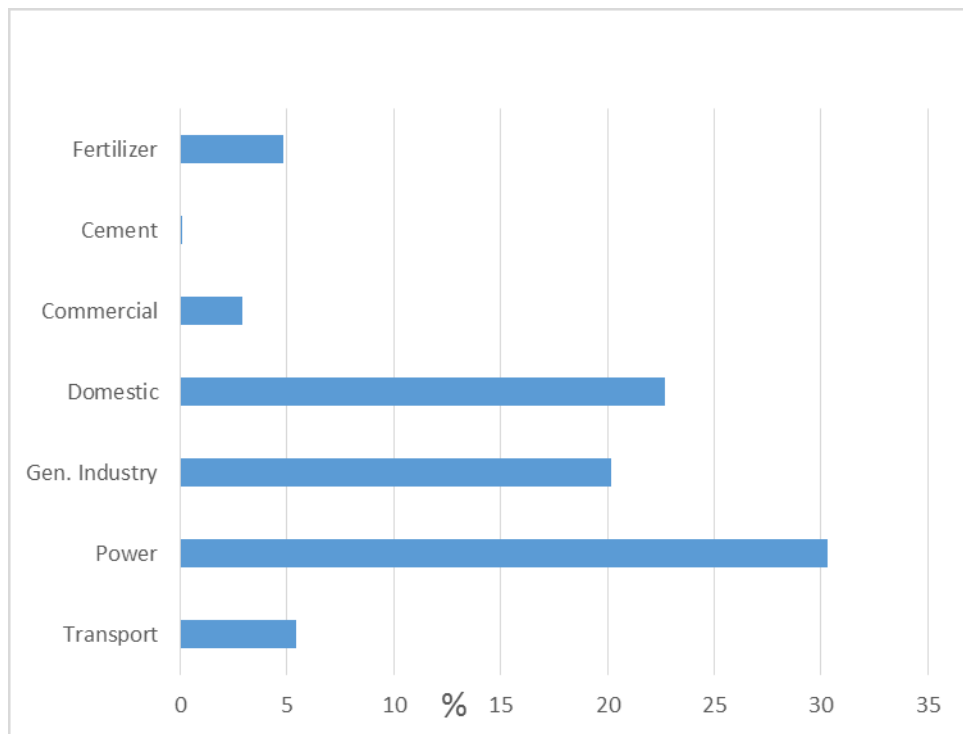


Figure 1 b: Sectorial natural gas consumption in Pakistan, HDIP (2016)

Oil and Gas Development Company Limited (OGDCL) is the largest private corporation in Pakistan, involved in exploration and production of indigenous oil and gas, operating in all the four Provinces. It has largest share in oil and gas exploration areas throughout the country, standing at 31%. Also, OGDCL holds 59 and 36% of the country’s recoverable oil and gas reserves respectively, OGDCL, (2016).

The company is currently producing approximately 48 and 28% of Pakistan’s oil and gas output respectively. It also have joint ventures with foreign and local exploration and production companies operating in the country. The company reported average net production of 40,028 barrels per day of crude oil and 1,116 million cubic feet per day of natural gas in last half of 2015. It also accounts for largest share of exploratory/discovery, development and productive oil & gas wells throughout the country, OGDCL (2016).

This preliminary study aimed to identify and examine the feasibility of harnessing geothermal gradient and co-produced fluids of productive, depleted and abandoned oil and gas wells of the OGDCL, located in various parts of Pakistan for heat and in particular power generation.

2. METHODOLOGY

Visit and interviews of the relevant personal of the company were conducted to gather required information on various categories of oil and gas wells owned and/or operated by OGDCL. The cartographic data obtained from field surveys and reports was also collected from OGDCL, Pakistan Petroleum Information Services, Directorate General of Petroleum Concession, and LMK resources.

3. RESULTS AND DISCUSSION

The company functions in segments for exploration and production fields etc. therefore only limited data on location and number of various categories of oil and gas wells held by company was available. A thematic cartographic data provided by DGPC-LMKR revealed that OGDCL holds 102 among 349 indigenous discovery oil and gas wells. However, the status and count of exploratory and active wells were not known for present investigation.

The findings also revealed estimated over one hundred depleted and some abandoned oil and gas wells of the company in the country, which could be a potential source of heat and power generation. Although no academic or other research has been conducted on geothermal assets of OGDCL in past, the company inclines towards academic research and development of its geothermal resources for potential commercial or residential usage i.e. power generation etc.

The other work carried by Khan and Raza (1986) on 74 exploratory and developmental oil and gas wells all over the country to estimate subsurface geothermal gradient for hydro carbon exploration portrays an intense gradient of 4-4.5°C/m in Potohar zone (north of the country) (Fig. 3), which is in consistency of areas indexed in discovery well map (Fig. 2).

Similar data has been reported by Ahmed (2014) while depicting the geothermal energy zones of the Pakistan. The findings also disseminate a geo-temperature gradient and co-produced fluids of approximately 80-150°C in many active oil wells located in Northern Province of Khyber PaktunKhwā (KPK) and Punjab as well. Additionally, the hot waters (co-produced fluids) of various categories of the oil and gas wells (currently active or depleted and abandoned) mostly in Punjab and Sindh provinces, as low cost heat and power source for residential and commercial purpose have never been explored or intervened. The hot fluids are presently drained into nearby streams as waste water or re-injected into the wells. A detailed investigation was recommended in this regard, Ahmad (2014). Another report, Ahmad (2016) suggests the estimated 300 dry, depleted and abandoned oil and gas wells in the country potentially available for geothermal heat and power generation.

Nevertheless, geothermal power generation from depleted and abandoned, and active oil wells has gained interest in developed world, Sullivan and Lopez (2009), Alimonti and Soldo (2014), Soldo and Alimonti (2014) and emerging economies like China, Cheng et al. (2016), Cheng et al. (2016), Gong et al. (2013), Wang et al. (2016) and utilized for this purpose. The Pakistan's geothermal estimate stands at about 100, 000MW, (costing 5-10cents /unit), which needs to be explored and developed urgently to assist in combating national power shortages Ahmad, (2016), Younas et al. (2016). Based on the preliminary results, a comprehensive investigation is to be planned and conducted for identification and estimation of geothermal power generation potential of OGDCL oil and gas assets. Further on, a detailed study on its selected wells will be carried to evaluate geothermal gradient and coproduce for their pioneer commercial and residential usage for heat and power generation.

4. CONCLUSIONS

A preliminary examination was undertaken to sketch out the potential geothermal energy to be derived from OGDCL oil and gas fields. Presently, only limited data is available on identify and estimate geothermal potential of oil and gas wells of the company for power or heat generation. A comprehensive investigation is recommended on identify, estimate power generation potential and geothermal gradient of selected wells of OGDCL to evaluate their pioneer usage for power generation in the country.

REFERENCES

- Abbas, T., Bazmi, A.A., Bhutto, A.W., and Zahedi, G.: Greener energy: Issues and Challenges for Pakistan-Geothermal Energy Prospective, *Renewable and Sustainable Energy Reviews*, **31**, (2014), 258–269.
- Ahmad, J.: The Geothermal Energy Potential of Pakistan, *Clean Sustainable Solution for Our Energy Future*, *GRC Transactions*, **38**, (2014), 571-576.
- Ahmad, J.: *Pakistan Energy Sources*, Energy Foundation-Pakistan, Islamabad, (2016) (www.energyfoundation-pk.org)
- Alimonti, C., and Soldo, E.: Study of Geothermal Power Generation from a Very Deep Oil Well with a Wellbore Heat Exchanger, *Renewable Energy*, **86**, (2016), 292–301.
- Cheng, W., Liu, J., Nian, Y., Wang, C.: Enhancing Geothermal Power Generation from Abandoned Oil Wells with Thermal Reservoirs, *Energy*, **109**, (2016), 537-545

- Cui, G., Zhang, L., Ren, B., Enechukwu, C., Liu, Y., and Ren, S.: Geothermal Exploitation from Depleted High Temperature Gas Reservoirs via Recycling Supercritical CO₂: Heat Mining Rate and Salt Precipitation Effects, *Applied Energy*, **183** (2016), 837-852.
- Directorate General of Petroleum Concession (DGPC), Ministry of Petroleum and Natural Resources, Islamabad, Pakistan, Discovery well map, 2016.
- Gong, B., Liang, H., Xin, S., and Li, K.: Numerical Studies on Power Generation from Co-produced Geothermal Resources in Oil Fields and Change in Reservoir Temperature, *Renewable Energy*, **50**, (2013), 722–731.
- Hydro carbon Development Institute (HDIP): Pakistan Energy Yearbook, Islamabad, 2016,
- Khan, M. A., and Raza, H. A.: The Role of Geothermal Gradients in Hydrocarbon Exploration in Pakistan, *Journal of Petroleum Geology*, **9**, (1986), 245-258.
- OGDCL Half Year Results, FY2016, OGDCL House, Islamabad, Pakistan, 2016.
- Soldo, E., and Alimonti, C.: From an Oilfield to a Geothermal One: Use of a Selection Matrix to Choose Between Two Extraction Technologies, *Proceedings, World Geothermal Congress, Melbourne*, (2015) 19-25.
- Sullivan, M., and Lopez, D. L.: Geothermal Energy in the Oil Field: Developments and Opportunities, E-Symposium, American Association of Petroleum Geologists, 2009
- Wakeel, M., Chen, B., and Jahangir, S.: Overview of Energy Portfolio in Pakistan, CUE2015-Applied Energy Symposium and Summit: Low Carbon Cities and Urban Energy Systems, *Energy Procedia* **88**, (2016), 71-75.
- Wang, S., Yan, J., Li, F., Hu, J., and Li, K.: Exploitation and Utilization of Oilfield Geothermal Resources in China, *Energies*, **9**, (2016), 798-810.
- Younas, U., Khan, H.B., Ali, S.M., Arshad, C.M., Farid, U., Zeb, K., Rehman, F., Mehmood, Y., Vaccaro, A.: Pakistan Geothermal Renewable Energy Potential for Electric Power Generation: A Survey, *Renewable and Sustainable Energy Reviews*, **63**, (2016), 398–413.

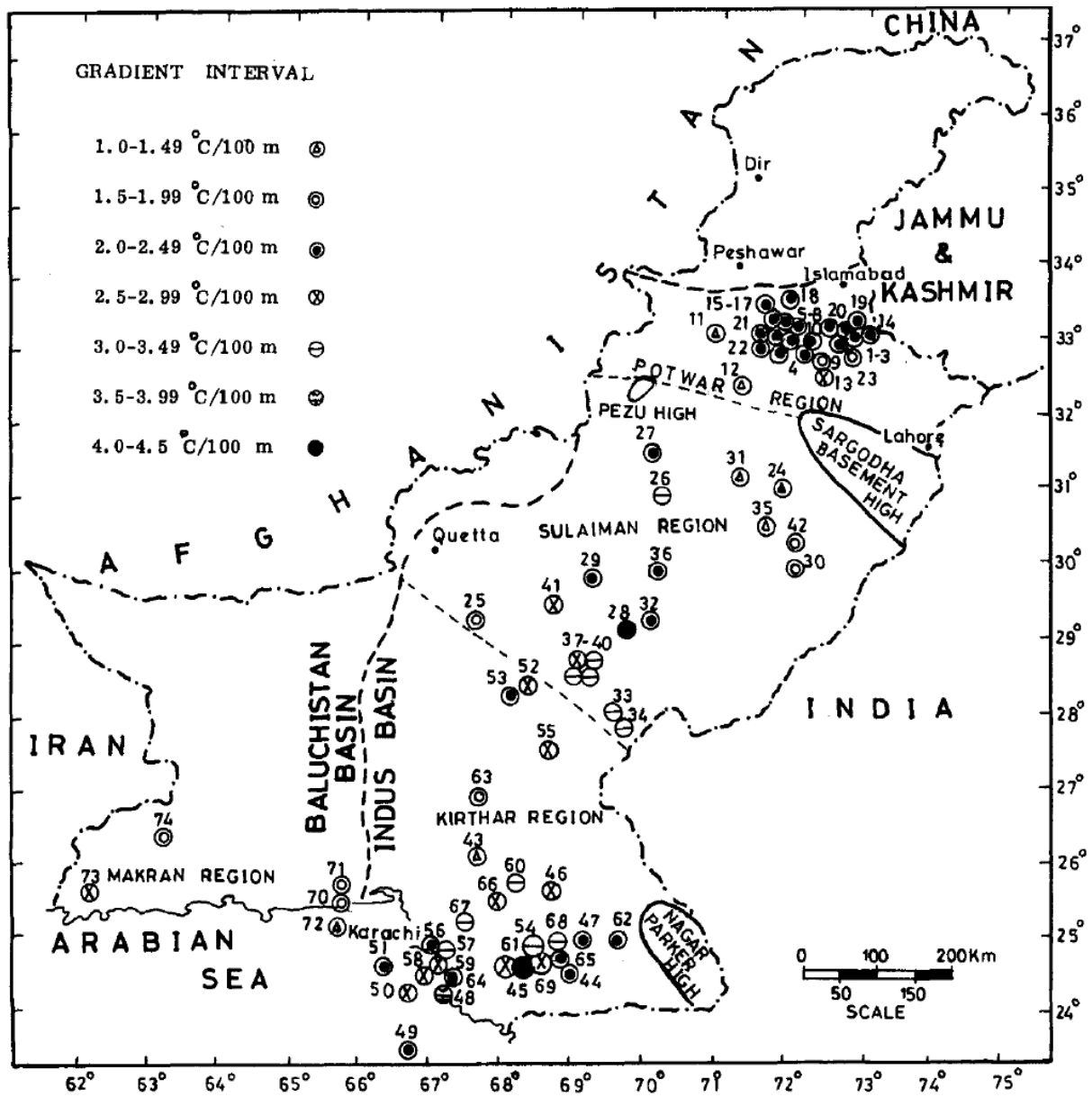


Figure 3: Exploratory and developmental wells map in Pakistan, from Khan and Raza, (1986)