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Direct Use of Geothermal Energy for Low Cost and No Pollution Manufacturing in Kenya

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ABSTRACT

Direct uses of geothermal energy provide a new paradigm and opportunity to exhaustively realize the benefits of a green economy for developing countries with high geothermal potential such as Kenya.

Manufacturing using geothermal resources ensures a stable supply of clean energy for industries, thereby greatly reducing manufacturing costs while giving a geographical advantage by using the energy at source. This leads to in situ creation of products for a global market with relatively cheap costs. Third party professional management of both resources relives the end user of the troubles associated with an inefficient energy delivery system allowing them to concentrate on manufacturing at a predictable cost of energy.

This paper presents a useful approach to designing geothermal industrial parks that can utilize the direct energy of steam after electricity production. It outlines some of the opportunities available as well as benefits that can be accrued if such systems are used.

1. INTRODUCTION

Geothermal energy resource in Kenya has a very high potential for energy generation (Government of Kenya, 2012a). The resource has mostly been developed into electricity. The country's current supply of electricity does not match the present and future demands. Even under the most ambitious government development programmes such as the Vision 2030 and the Least Cost Power Development Plan, Kenya will still face electricity shortfalls (Government of Kenya, 2012b and Government of Kenya, 2012c).

Kenya has set out to become a middle income country by the year 2030. As part of this strategy, Kenya will have to build new industries and expand the existing ones in order to make the manufacturing and value addition capacity commensurate with the intended economic growth. Geothermal energy can form the base load of projected electricity supply into the future, especially for industries with a prerequisite for sound manufacturing.

Kenya's manufacturing sector faces serious challenges when it comes to energy supply (PwC Kenya, 2012). The primary complaint has been the cost and availability of electricity and the fluctuating cost of fossil fuels, which is the primarily fuel oil for most of Kenya's industries. Wood fuel which is also used by a number of industries is a dwindling resource whose rate of replenishment is lower than its consumption rate. It is therefore not sustainable.

Most manufacturing industries in Kenya use fuel oil to produce steam or hot water for running their processes. Most fuel oil consumed in Kenya is converted to produce steam or hot water. In many industries, steam is the predominant type of energy used, in sheer energy value. Currently, the sugar processing sector has taken on the concept of co-generation to produce both electricity and useful heat. These industries use steam for both electricity and hot water production. Geothermal energy provides a unique opportunity for generating both steam and electricity at the same place.

While geothermal electricity can be available all year round and is easily fed into the grid, the issues of grid losses and stability erode some of its value as it is virtually impossible to supply this resource throughout, directly to industries. The U.S Energy Information Administration estimates that an average of 7% of electricity is lost during transmission (EIA, 2012). This is despite the fact that geothermal plants routinely achieve availability of over 90% of the time, throughout the year (Kagelet. al., 2007). Hence there is need to consider having these industries at the source of the geothermal energy to drastically reduce losses and costs while increasing productivity

2. KENYAS GEOTHERMAL POTENTIAL AND DIRECT USE OPPORTUNITIES

According to Simiyu (2010) Kenya's geothermal potential is estimated to exceed 7,000 megawatts of electricity.The process of industrialization is a major consumer of energy, both fuel and electricity and demands a reliable and consistent supply of the same.

Rather than generate and then transmit electricity with a loss of efficiency, it is possible to attract investment in highly efficient industries that will run entirely on a reliable and renewable energy source. By incorporating energy efficiency into the design of industries, productivity can improve industrial competitiveness of Kenyan industries as this is a preferred manufacturing destination for quality goods or services.

Mburu (2009) explains that geothermal energy can be utilized for either electricity generation or other direct applications depending on the enthalpy. An overview of the Kenyan industrial sector portrays the possibility of the direct use of geothermal energy in the various industries depending on their locations and the temperature of the given field.

Homa Hills, which is located on the Nyanzian Rift, has been evaluated as a low enthalpy geothermal field. Its close proximity to Lake Victoria, Kenya's largest producer of fresh water fish makes it viable for fish processing and cold storage using geothermal energy. The heat from the geothermal resource can be used to run processing procedures such as drying and canning as well as in heating pumps for cold storage.

The proximity of the greater Kericho Area to Nakuru's Menengai Geothermal Field makes it possible to transport tea to factories in Nakuru for drying. Kericho town is ranked as the largest grower and producer of tea in Africa (Unilever, 2012). Other plants that can also utilize the useful heat in Menengai after electricity generation include pyrethrum drying and textile manufacturing.

The Silali Geothermal Field, located north of Lake Bogoria can be utilized for meat processing. This area is mainly known for cattle keeping and produces a lot of meat. Processing and canning for export or local use can be done in situ using the geothermal energy thereby saving on costs.

Other industries that can make use of the resource are general manufacturing in Magadi, horticulture processing and large scale irrigation for food production in Naivasha (Kengen 2007).

3. PROPOSAL

This paper proposes the designing of geothermal industrial parks as special economic zones whereby industries which meet an energy mix requirement can use the resources at the points of production to manufacture goods and even provide services and special products. These industries would cater for a specific niche or combination of factors that are both unique to the local area where the geothermal source is or gives a big price advantage if an alternative is used. This system of manufacturing is also referred to as the Chauffage system, in which a third party provides all energy to a manufacturing concern, specific to their needs.

It can also provide an opportunity to develop new, green, urban centers and reduce the population migration to the traditional urban areas thereby transforming marginalized areas into globally competitive hubs that can attract investment.

3.1 Approach

The approach proposed in this paper is to form a consortium of interested parties such as those industries discussed in section 2 above, to come up with design parameters for what type of industry will be feasible. Depending on the energy requirements of an industry and the available energy for direct utilization, a cascade of industries can be done under the *chauffage* system. By simulating manufacturing scenarios using real data from qualified type of industries, it is possible to design industries with various given parameters.

It is necessary to assess the required legal, fiscal, and physical infrastructure needed to design geothermal industrial parks. The specific risks that can be encountered with such a model and prescribe mitigation measures must also be taken into account. Establishing feasible price points for energy is vital in order for such businesses and industrial parks to make economic sense.

3.2 Benefits

With the Geothermal Development Company plan model (GDC Strategic Plan, 2007), it is possible to have a fixed price on steam and a corresponding fixed price on electricity and steam, which will make the products very competitive in the international market. The overall benefits that can be accrued through such a system include:

- A reduction in capital investment for new industries as they will not need boilers;
- Operating costs will also be reduced tremendously as there will not be fluctuations occasioned by volatile fuel prices;
- The products manufactured in such zones can be labeled to be truly green and could attract premium on price because of reduced emissions;
- Road infrastructure development to such places will open up new settlement and spiral growth in the counties; and
- Price stabilization on the cost of energy as there will be no adjustments to make other than for inflation and interest on the capital.

3.3 Challenges and Concerns

Various challenges can be pinpointed. These include the following:

- The quality of steam and requirements for specific industries will vary for different processes. Obtaining the right energy mix for each industrial process can be challenging as some industries require heat for boiling, others for drying and others for running heat exchangers.
- There may be environmental and social impacts of having new industries built in hitherto uninhabited areas. The industrial parks will impact on cultural and social behaviors of the local communities where they are located.
- The industrial hubs will require the construction of access roads, rail and communication infrastructure to support the industries. This will open up the areas for further developments and may lead to population increase and a further encroachment on the available infrastructure.It will be important to obtain and retain skilled staff to work in such marginalized areas.

3.4 Opportunities

While there are challenges in creating unprecedented types of production processes, the opportunities are even greater and include the following:

- The system presents a case for zero carbon manufacturing processes. This is because the industries will run their industrial processes using geothermal energy, which is generally a clean form of energy, and the surplus heat retained after electricity production, will be further utilized directly for industrial purposes;

- Such a system will facilitate the designing and planning of entire cities with adequate supply of energy and create a harmonious co-existence with nature but within a manufacturing context;
- The system will provide an opening of new frontiers for settlement and production;
- By having fixed prices on the costs of electricity and steam, it is possible to predict the cost of energy intensive goods; and
- The system also presents innovation opportunities to re-think and re-design sustainable manufacturing.

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