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Small-Scale Use of Geothermal Power at Oserian Farms, Naivasha, Kenya

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ABSTRACT

In November 2007, Oserian Development Company of Naivasha, Kenya, completed the construction and commissioning of its second geothermal power station. At the heart of the new plant is a nominal 2 MW steam turbine generator set provided by Geothermal Development Associates of Reno, Nevada. The simplicity of the plant allowed Oserian to install the plant using its own labor. Oserian's commitment to the environment and its advanced use of geothermal energy have made the company a leader in its field. The project demonstrated the potential of simple single-flash technology for small-scale applications.

1. OSERIAN DEVELOPMENT COMPANY

Oserian Development Company of Naivasha, Kenya, was established in 1969 near Lake Naivasha as a small vegetable farm with modest production acreage and a workforce of six employees. In 1982 they expanded the farm to include cut-flower production. Today, Oserian is one of the largest flower producers in Kenya, selling its products into Europe with a 30% share of the cut-flower market.

In the early part of this decade, Oserian decided to move forward with an innovative strategy to harness geothermal energy. Its vision was to develop a technologically advanced growing method based on full environmental control of its greenhouses. In 2003, Oserian initiated a major investment program to integrate geothermal energy into its business model. The decision to use geothermal energy was consistent with the overall company philosophy of conducting business in an environmentally responsible manner. Oserian's first geothermal power plant was a binary plant commissioned in 2004.

Oserian currently uses geothermal energy not only for electrical power production, but also for heating and humidity control of greenhouses, and for enhancing growing performance by directly using the carbon dioxide present in the geothermal steam. By implementing technologically advanced growing techniques, Oserian has been able to substantially reduce the total area under cultivation while maintaining overall production.

2. GEOTHERMAL DEVELOPMENT ASSOCIATES PLANT

In June 2006, Oserian contracted with Geothermal Development Associates (GDA) to supply a nominal 2 MW steam turbine generator set and related auxiliaries. Sinclair Knight Merz (SKM) of New Zealand was retained for engineering. Oserian purchased the balance of plant directly and used in-house skilled labor for construction.

Steam for the plant is sold to Oserian by the Kenya Electricity Generating Company (KenGen). Oserian was able to utilize a single well originally drilled in the 1970s as part of a World Bank project. Well OW 202 was drilled as an exploration well to a depth of 2.2 km, and is part of the extensive Olkaria geothermal field.

The GDA power block utilized an Elliott Company 4-stage GYR steam turbine, a Kato Engineering air-cooled generator, and a Lufkin Industries gearbox, all mounted on a heavy bedplate. In addition to the turbine generator set, GDA manufactured key auxiliary equipment, including inlet steam control valve assembly, lube oil system, and a PLC-based remote control panel. GDA also supplied the motor control centers, switchgear, transformers, and an uninterruptable power supply.

Specifics of the GDA turbine generator set when operating in a non-condensing mode (current plant configuration at Oserian) are shown below:

- turbine inlet steam pressure 470 kPa abs
- turbine inlet steam temperature 150°C
- steam non-condensable gas content 1.1%
- steam mass flow 26 T/hr
- turbine exhaust pressure 85 kPa abs
- gross generator output 1,340 kW

The plant was designed to allow operation in a partial condensing mode at a future date. Oserian wanted the flexibility to heat water for the growing operation. This could be accomplished by installing a condenser where water would be used to partially condense some of the geothermal steam. In this case, the power output would be higher:

- turbine exhaust pressure 50 kPa abs
- gross generator output 1,730 kW

The time required for GDA to perform under the contract from notice-to-proceed to export was 10 months. Once the equipment arrived on-site, approximately two months were required to complete the installation and perform commissioning.

In operation since late November 2007, the new steam plant operates in parallel with the existing binary plant. Together, the two geothermal power plants meet virtually Oserian's entire electrical load.

This project marks the re-entry of the Elliott Company into the geothermal market. Elliott is a global leader in the turbo machinery industry with a worldwide service network. The company has manufactured both geothermal steam turbines and binary turbo expanders in the past, but has not been active in the geothermal industry until recently. GDA and Elliott have joined together to offer packaged turbine-generator sets to the geothermal industry. The turbine-generator set for this project was based around the Elliott

GYR turbine, a version of their popular MYR turbine modified specifically for geothermal applications.

3. SMALL-SCALE GEOTHERMAL PLANTS

This project is an excellent example of the potential for utilizing small-scale geothermal power plants. For geothermal resources above about 175°C, a single-flash steam plant can be a viable option to other types of plants due to low first cost, ease of installation, and low operating costs.

In this case, simplicity was a major factor for Oserian in making the decision to proceed with a single-flash type of plant. Simplicity results in a short time frame for installation and start-up, reduced operator training requirements, and reduced maintenance costs. There is no "exotic" working fluid as required in a binary type application.

This project also demonstrates that wells not normally thought of as commercial may still have great value in certain instances. Although this project was designed to be a permanent installation, simple plants similar to the Oserian plant could be designed for mobility. Some small-scale plants have been used within larger geothermal developments because they fit with incremental energy development plans and were installed early in a site's development. Small-scale projects can also be very beneficial as a way to catalyze political support for larger geothermal projects.

CONCLUSION

The Oserian Development Company, Geothermal Development Associates, and SKM teamed up to demonstrate the potential of small scale geothermal power generation. Oserian is now the largest geothermal greenhouse operation in the world. Equally impressive is the fact that Oserian produces all of their electricity with geothermal energy. The intensive use of geothermal energy and the application of innovative growing techniques have made Oserian Development Company a world leader in its field.

This project demonstrates that a single-flash type of plant can be a viable alternative to other technologies, such as binary, for medium to high enthalpy geothermal resources in a small-scale application. This type of plant would be well suited for remote locations such as islands or rural areas where wells may exist but are not yet being utilized.

Figure 1: Well OW-202 Supplies Steam to the Oserian/GDA Turbine Generator Set

Figure 2: Steam Turbine and Gearbox Being Installed at Oserian's Facility

Figure 3: Completed Installation

Figure 4: Oserian Power Plant Staff