

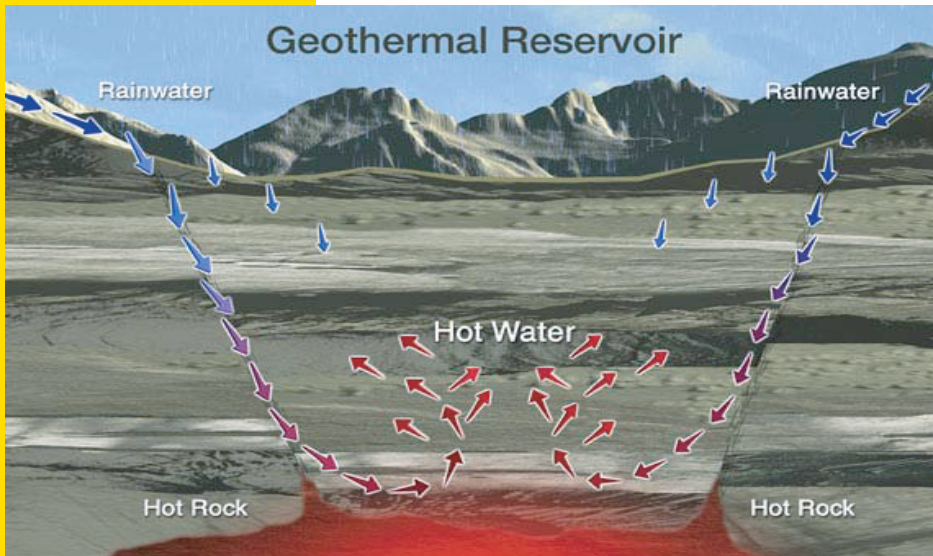
## PNOC-EDC Uses Wonderware® Software to Generate Electricity from Geothermal Steam

**Mindanao, The Philippines** — The source of geothermal power is the heat contained inside the Earth, a heat so intense that it creates molten magma. There are several types of geothermal systems formed when hot magma nears the surface (1,500 to 10,000 meters deep) and heats groundwater directly. The heat generated from these "hot spots" flows outward toward the surface, manifesting as volcanoes, geysers and hot springs. Naturally occurring hot water and steam can be tapped by energy-conversion technology to generate electricity.

### Environmentally Friendly

From an environmental standpoint, geothermal energy offers clear advantages over fossil fuels in the generation of electricity. Fossil-fired plants emit sulfur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and ash into the atmosphere, while geothermal emissions consist mostly of water vapor. Fossil fuel plants also require cooling water from local sources. Whereas, for geothermal plants, reservoir fluids satisfy the cooling requirements.

Wonderware's InTouch® HMI supervises the process that harnesses geothermal steam, generates electricity, manages waste and reinjects the used fluids back into the earth for re-use.



The geological conditions necessary to create a geothermal resource exist in very few parts of the world, most often along the Pacific Rim. There, where deep fractures occur in the earth's crust, molten material, or magma, pushes close enough to the earth's surface to heat geothermal reservoirs.

The first geothermal power plant residing on the island of Mindanao is at Mount Apo, the highest point in the Philippines. It is noted for having been constructed under strict environmental conditions, due to protracted public debates.

Precipitation seeps deep into the earth, where it is warmed by the earth's heat. In a few places, magma occurs close enough to the surface to heat fluids that can be reached by drilling wells. The hot water is then brought to the surface, flashed to steam and delivered by pipeline to electricity-generating plants.

Strict environmental conditions were imposed, including zero wastewater discharge, protection of the forest cover, bio-diversity, appropriate land use, a risk assessment study, provisions for

a relocation policy to replace lost structures and amenities, augmentation of basic services provided by the government, the development of long-term livelihood projects, and the adoption of a multi-sectoral monitoring policy.

### The Control System

The system was implemented by PNOC-Energy Development Corporation (PNOC-EDC), which specializes in developing and operating geothermal energy and power projects in the Philippines. At the heart of PNOC-EDC Geothermal's control system is InTouch® human-machine interface

(HMI) software from Wonderware, a business unit of Invensys Systems, Inc. Housed in a central control room, the InTouch software provides process visualization and control, historical logging, and interface to the different loop controllers, recorders, distributed control systems (DCS) and programmable logic controllers (PLCs) in the plant.

Automation is critical to the operations of any power plant. In addition to the normal day-to-day operation of equipment, there are also operations pertaining to plant efficiency, maintenance and reliability. The PNOC-EDC geothermal plant in Mindanao resides within a mountainous rain forest covering many kilometers of thick vegetation. Because of its limited operation and support staff, the control system at each facility must be easy-to-use and reliable.

The engineers at PNOC-EDC worked with the local Wonderware distributor and system integrator (SI) to develop a solution using Wonderware® FactorySuite® software, which offers the following benefits:

- \* Real-time monitoring of the power plant and geothermal production field, covering twenty kilometers of pipeline through rugged terrain;
- \* Control of the separator level with automatic drain during high-level conditions;
- \* Automatic control along the steam pipeline, to maintain constant pressure and steam quality;
- \* Emergency shutdown system for the power plant;
- \* Interface to the power plant's turbine control system;

- \* Trip evaluations, to help operators determine the sources of plant trips and shutdowns;
- \* Historical logging and analysis;
- \* Control of the re-injection of used fluids back into the earth; and
- \* Waste management control, to assure zero emissions during normal plant operations.



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