COMBINED GEOTHERMAL HEAT AND POWER PLANTS

Combined heat and power (CHP) plants are not a new use of energy, whether it be from conventional fossil fuels or geothermal. However, what has been happening recently in the geothermal arena is the use of low-temperature resources (down to 98ºC or 208ºF) in combination with binary or Organic Rankine Cycle (ORC) power units. Two installations, one in Australia at Birdsville and one in Germany at Neustadt-Glewe, both reported in this issue of the *Quarterly Bulletin*, are using temperatures this low–the lowest currently operating in the World!! However, there was an even lower temperature use at Paratunka, Kamchatka, Russia; a binary power plant using 81ºC or 178ºF producing 680 kWe and the wastewater used for heating the soil and water plants in greenhouse, was in operation for a number of years in the late 1960s and early 1970s.

This issue of the *Quarterly Bulletin* reports on high temperature CHP installations in Iceland at Svartsengi and Nesjavellir, and low-temperature installations in Iceland at Husavik, in Austria at Bad Blumau and the two mentioned above in Australia and Germany. We took some liberty in interpreting the CHP description, as the Birdsville installation, after producing electric energy uses the spent fluid for domestic drinking water and for stock watering, and not for space heating. We also know of CHP plants elsewhere in world, described below.

However, first a little background. Why CHP?? The main reason is that it makes more efficient use of the resource by cascading the temperature (energy use), which in turn improves the economics of the entire system. Low-temperature power generation alone is often not economical below 150ºC or 300ºF as the net plant efficiency for ORC units varies from 12% down to 7% (to 90ºC or 194ºF) (see a paper by Kevin Rafferty on Geothermal Power Generation on the GHC website). One of the exceptions in the U.S. is at Wineagle in northern California using 110ºC or 230ºF resource; however, this plant has no pumping cost and disposes the spent fluid to the surface. There are several other stand-alone ORC plants in the United States and elsewhere in the world using low-to- moderate temperature geothermal resources (*GHC Quarterly Bulletin*, Vol. 20/2–March 1999). Many CHP plants, especially those using a low-temperature resource, started as just a district heating project. The electric power plant was later added, and became economical, as the well and pumping systems were already in place. All the power plant designers/ operators did was take some temperature off the top, yet still providing enough temperature (energy) for the district heating system.

This cascaded use of geothermal energy in the form of CHP plants has been described in previous issues of the *GHC Quarterly Bulletin*, and thus, is not reproduced here, but is summarized below:

- **Empire Energy** in northwest Nevada, where the heat is cascaded to an onion/garlic dehydration plant and also planned to be used for fish raising (see article by R. G. Bloomquist – "Empire Energy, LLC – A Case Study," Vol. 25/2, 2004).
- **Altheim, Austria** using 106ºC or 223ºF to operate an approximately 500-kWe plant and providing heat to about 650 consumers (see article by G. Pernecker and S. Uhlug–"Low-Enthalpy Power Generation with ORC-Turbogenerator–The Altheim Project, Upper Austria," Vol. 23/1, 2002).
- **Suginoi Hotel, Beppu, Japan** using 143ºC or 289ºF to operate a 3-MWe condensing steam turbine and supplying the waste fluid to the hotel for space heating and baths. (see article by K. Kudo–"3,000 kW Suginoi Hotel Geothermal Power Plant," Vol. 17/2, 1996).
- **Hatchobaru, Japan** using 106ºC or 223ºF from the condenser of the Hatchobaru power plant (2x55 MWe) for heating a demonstration greenhouse (see article by P. Lienau–"Geothermal Greenhouses in Kyushu, Japan," Vol. 17/2, 1996).
- **Fang, Thailand** using 116ºC or 241ºF to operate a 300-kWe ORC plant and the waste water then cascaded for use at a refrigeration (cold storage) plant, crop drying and a spa (see article by J. Lund and T. Boyd–"Small Geothermal Power Project Examples," Vol. 20/2, 1999).
- **Mt. Amiata, Italy** using 184ºC or 363ºF steam to operate a 15-MWe condensing plant and the waste water piped to 22 hectars (54 acres) of greenhouses and for a vegetable dehydration plant (see article by J. Lund–"Cascading of Geothermal Energy in Italy," Vol. 10/1, 1987).
- **Palinpinon, Philippines** using 160ºC or 320ºF fluid from the Palinpinon I steam gathering system, where 192 MWe are produced. The steam is passed through a shell-and-tube heat exchanger and the 154ºC or 309ºF fluid is used in a drying plant producing copra (dried coconut meat) (see article by S. Chua and G. Abito–"Status of Non-Electric Use of Geothermal Energy in the Southern Negros Geothermal Field in the Philippines," Vol. 15/4, 1994).
- **New Zealand: at Broadlands**, the Ohaaki power plant provides steam to dry alfalfa (Lucerne); **at Wairakei**, the power plant provides waste heat for 19 giant Malyasian freshwater prawns ponds; and **at Taupo**, the power plant operated by Mercury Geotherm provides steam to a greenhouse, where orchids are raised (see *GHC Bulletin*, Vol. 19/3, 1998 for details).
- **Los Azufres, Mexico** using condensate from the steam pipeline feeding a 50-MWe unit at about 170ºC or 338ºF for use in an experimental lumber drying kiln, a greenhouse and fruit dehydrator (see article by J. Lund–"Design of a Small Fruit Drier Using Geothermal Energy," Vol. 17/1, 1996) and the companion article in the GRC Transactions, Vol. 19 (1995) by E. Sanchez-Velasco and E. Casimiro-Espinoza–"Direct Use of the Geothermal Energy at Los Azufres Geothermal Field, Mexico" – pp. 413-415.

The Editor