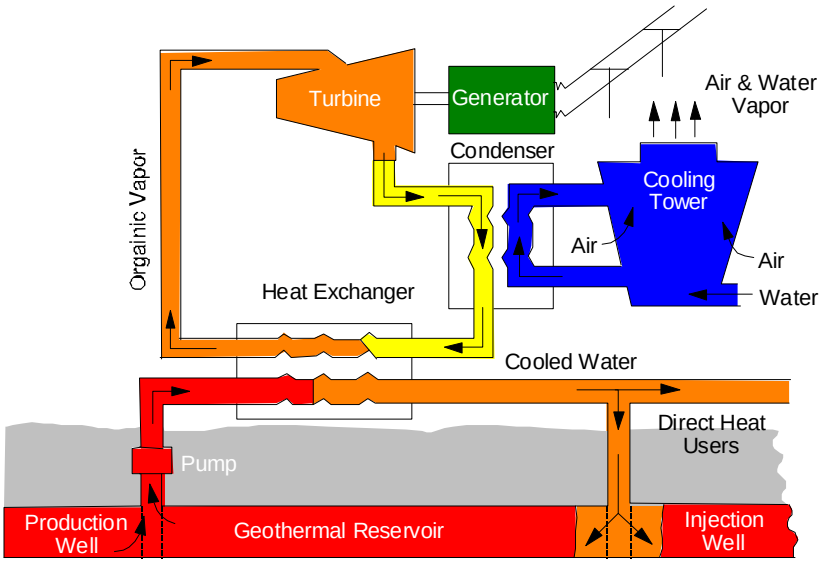
CAMPUS GEOTHERMAL PROJECTS UPDATE
April 29, 2009

As you may know, the OIT campus has been heated with geothermal energy since it was moved to the present location in the early 1960s. Three production wells, up to 1,800 feet (550 m) deep, were drilled on campus property at the time, producing 192°F (89°C) water, at a maximum flow of 700 gpm (44 L/s) and an average of 250 gpm (16 L/s) providing all the heating and domestic hot water needs of campus. This renewable energy use saves the campus an estimate $1,000,000 per year. Two injection wells were drilled in the 1990s to recharge the geothermal reservoir, as wasting the water to surface drainage was no long allowed by a city ordinance.

Based on new technology, the campus is in the process of developing the geothermal resource for electric power generation – to satisfy all the electric needs of campus, thus making the campus the first in the world to have all of its energy needs met using geothermal energy from a resource on campus property. We will then be an all "green" energy campus.

To produce the electrical energy for campus, we have drilled a deep (5,300 feet - 1615 m) geothermal well to intersect the high angle normal fault on the east side of campus. The geothermally heated fluid upwelling along the fault is already tapped by our existing geothermal wells. Based on surface water geochemistry (analyzing the existing well water) researchers predict that up to 300°F (150°C) geothermal fluids exist at depth. Thus we hope to supply a 1.0 MWe (gross) geothermal power plant to provide electrical energy for campus.

The 1.0 MWe power plant (gross) would probably be on a binary type (organic Rankine cycle using a secondary low boiling point hydrocarbon) supplying around 800 kWe (net) to campus, enough to cover most of the electric energy requirements. This would save the campus round $500,000 per year.



Binary (Organic Rankine Cycle) Geothermal Plant

The cost of the well and 1.0 MWe power plant would be around $9.0 million, however, the "waste water" from the power plant at around 175°F (80°C) could then be sold to adjacent

property owners or used to supplement the existing and new OIT heating demands, generating additional income or savings. Funding for the project comes from a US Department of Energy grant, and from Oregon State bonds and grants. Additional support may come from the Energy Trust of Oregon and the Oregon Business Energy Tax Credit.

Last year we contracted for and completed a seismic survey of campus to better locate the fault and thus located the drilling site (approximately 64 2.2 lb – 1 kg dynamite charges at 18 feet (6 m) depth were set off on campus and surrounding property to bounce energy waves off subsurface structures). The seismic survey can be viewed at http://geoheat.oit.edu/oit/Sesimic_Final__Report.pdf. This investigation determined the optimum drilling target at about the 3,000 to 4,000 foot (900 to 1,040 m) depth. The drill site is in the southeast corner of the upper parking lot. As part of the USDOE grant, we completed an environmental assessment (EA) under the NEPA requirements. The final EA can be viewed at http://geoheat.oit.edu/oit/OIT-Deep-Geothermal-Well-and-Power-Plant-Project-FEA_0908.pdf. A Request for Proposal (RFP) for drilling the deep well was prepared and a contract was awarded to ThermaSource, Inc. of Santa Rosa in December.

The surface conductor pipe of 30-inch diameter was set in early January by Roger Chancellor Drilling an Pump Company of Klamath Falls, A 40-foot, 36-inch diameter hole was drill in the upper parking lot through the surface “chalk rock” (a mixture of diatomaceous earth and volcanic ash). The casing was then cemented in place and a 2-foot deep by 6 x 6 foot cellar was constructed around it.

The ThermaSource, Inc. (from Santa Rosa, CA) rig was trucked onto site in early January, 2009 with 24 large truck loads of parts and additional loads of drill pipe and casing. The 105-foot rig, #105, was set up with the associated trailers, diesel generators and mud (drilling fluid) mixing tanks. The 26-inch diameter hole for the 20-inch diameter casing was spudded, drilled to 300 feet and the casing cemented. The official “ribbon cutting” ceremony was on the 24th of January. President Chris Maples, Vic Chancellor Bob Simonton, ThermaSouce CEO Louis Capuano, Jr. and Oregon Senator Ron Wyden spoke and officially opened the well drilling project. Drilling was completed on March 10th to a depth of 5,300 feet.

The casing program after, the 20-inch pipe was followed by a 13-3/8-inch casing in a 17-1/4-inch hole to 2,500 feet which was then cemented to the surface. Finally the well was drilled with a 12-1/4-inch bit to 5,310 feet, with a 9-5/8-inch casing with 500 feet of perforations set to 5,030 feet. This later casing could not be set to full depth due to some obstruction around the 5,000-foot depth. At 3,284 feet the well was deviated with a directional motor and bit to better intersect the inferred fault. The maximum deviation was 25.5 degree from vertical. Thus, the 5,310-foot hole had a true vertical depth 5,215 feet from surface. Whereas the drilling to around 3,300 feet was done using normal drilling mud, below this point aerated mud was used so as not to seal any potential aquifers. A number of loss circulations zone were encountered (as indicated by reduced mud return to the surface), indicating potential permeable zones for fluid. An initial temperature and gamma radiation log was run at this point, but results were mixed with maximum temperatures around 200 degrees F.

The well was then air lifted to remove any mud from the hole to open potential permeable zones. This was followed by a final temperature and pressure log. Then, the drilling rig was removed and in approximately two weeks a full scale pump test was in order to determine flow, temperature and surface water draw-down.

The pump test was performed on April 24, 2009. A line-shaft pump was used and waste water was piped uphill to a natural sump between the 3 existing geothermal wells on campus. Pumping rates started at 300 gpm, and then progressed to 500, 1,000 and 1,500 gpm (95 L/s). Maximum drawdown experience was 23 feet (7 m), which is small, and the maximum temperature was 196^{o}F (91^{o}C). Unfortunately, since permeability and fluid production looked good, we were not able to increase the pumping rate due to equipment limitations. Based on projections, it is estimated that 2,000 gpm (126 L/s) could be pumped with only 47 feet (14 m) drawdown and producing approximately 200^{o}F (93^{o}C). At 1,500 gpm and 196^{o}F, approximately 750 kWe gross (600 kWe net) could be generated, and at 2,000 gpm and 200^{o}F approximately 1,000 kWe (1 MWe) gross (800 kWe net) could be produced. An additional pumping test will be required by the Oregon Department of Water Resources in order to obtain our water rights. At this that time the adjacent wells will be monitored for interference, and rates of 2,000 to 2,500 gpm will be attempted>

Two OIT faculty members and geologists, Harriet Cornachione and Anne Hiller-Clark, will be working with the mud-logger to take cutting samples of the formations every 10 feet. We expect to be drilling through various volcanic layers: basalts, andesites, pyroclastic cinders and pumices, and into the fractured fault zone where the geothermal fluid is moving vertically towards the surface. The fault, which dips approximately 70 degree to the southwest, runs along the east side of campus, and at least one of our existing geothermal hot water wells taps into this fault at around 1,800 feet. At depth it should be hotter and permeable enough to provide the energy needs for the power plant.

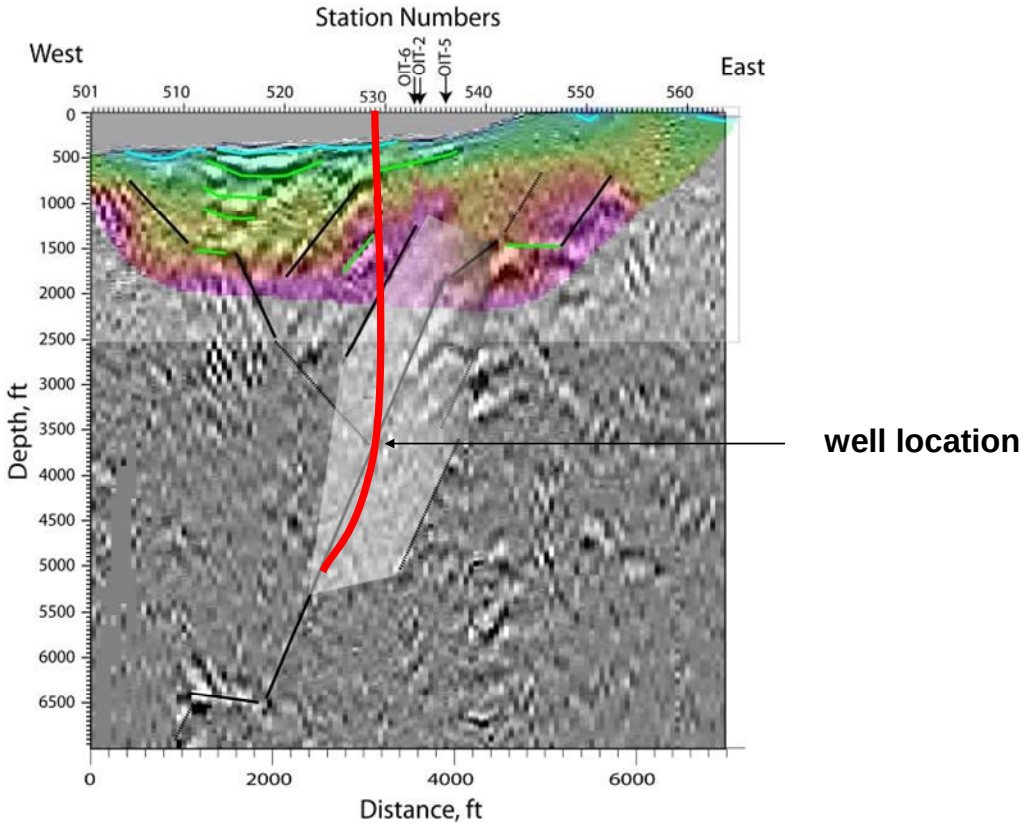
Once the well is completed and tested, and we know the temperature, flow rate and mineral content, the power plant will be designed – through a competitive solicitation (RFP). This should take approximately six month to a year, and thus, the plant will be ordered and on site sometime in late 2009 or early 2010, and operational soon after that. The plant will be instrumented so that any agency, campus, etc. can monitor the operation and output of the plant.

Finally, we have also installed a low temperature power plant also of the binary type, to use the existing geothermal wells. This unit is a 280 kW gross and use the 192^{o}F (89^{o}C) water supplied by United Technology Corporation of Connecticut. This plant will be up and running by late May or early June. The “waste water” from the power plants after providing space heating, could also be used to provide heat to greenhouses and aquaculture projects to be constructed on campus, using the spent water at around 140^{o}F (60^{o}C).

All of these power plant installations will be available to the public for tours, and more importantly, available to students of the Renewable Energy Program for class projects. Hopefully, the information gained from these plants will provide “spin-off” for other project in the State of Oregon and other western states. Oregon and OIT will become a leader and show-case for geothermal energy development and use as well as the first to use geothermal energy for electricity in the state.

Additional information of these power projects and the proposed greenhouse and aquaculture projects can be found at http://geoheat.oit.edu/greenoit.htm.

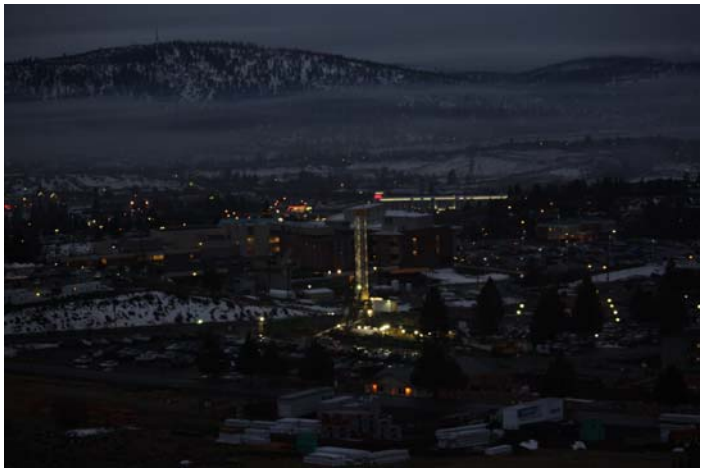
If you have additional questions, contact: John W. Lund (john.lund@oit.edu) or Toni Boyd (toni.boyd@oit.edu) or call: (541) 885-1750.



E-W seismic profile of the proposed drilling target.

Start of drilling for surface casing.

The drilling rig being set-up.



Drill rig at night looking southwest.

Sen. Wyden at the controls of ThermaSource Rig #105