12. Electricity Generation

Oil and gas wells such as those in eastern Montana are typically thousands of feet deep, and often produce very hot fluid. Most oil and gas wells produce large quantities of hot water that have to be separated from the fossil fuel. This waste water is usually reinjected deep below domestic aquifers. But new technologies have been developed that may allow the hot water from Montana's oil wells to be used to economically generate electricity.

For several decades Montana was thought to have little potential for producing electrical power for geothermal energy. Although several wells in eastern Montana produce water between 200 and 270 degrees F, electric generation technology in the past required water in the 300 degree F range or above.

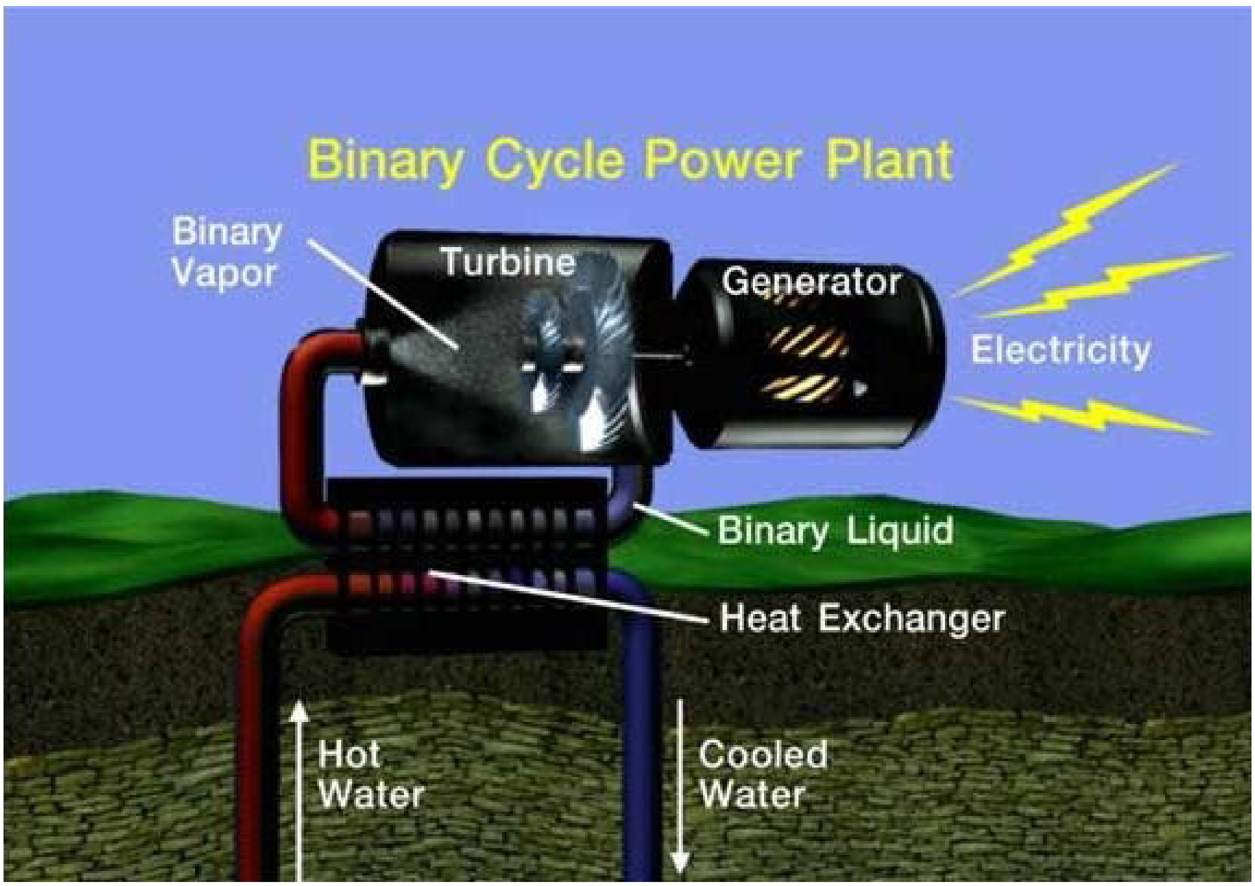
This hot water well located near the town of Angela, north of Miles City in eastern Montana, produces 185 degree F water. Brilliant white terraces of mineral deposits are shown in the photo above. *Photo by Jeff Birkby*

Since the mid 1990s, breakthroughs in geothermal system designs using new turbines and secondary fluids have significantly lowered the temperatures needed for power generation. Geothermal fluids as cool as 165 degrees F are now being used for electric power generation in Alaska. And these lower geothermal temperatures are available in many areas in Montana, which opens up the possibility of geothermal electrical generation in the near future in the state.

12. Electricity Generation – *continued*

Newer geothermal electric generation systems, called binary cycle plants, do not directly use geothermal fluids to run a turbine. Instead, these power plants use heat exchangers to extract the energy from the geothermal water that is pumped to the surface. The hot water is used to boil a second fluid that has a boiling point much lower than that of the hot water coming out of the well.

After the vaporized secondary fluid passes through the turbine blades to generate electricity, the vapor is cooled with cold water or with outside air, which turns the vapor back into a fluid. The fluid is then recycled through the loop. The cooled geothermal water is usually pumped back into the ground after it passes through the heat exchanger.



Schematic Diagram of a Binary Cycle Geothermal Power Plant.

Source: National Renewable Energy Laboratory

Binary power plant technology is constantly evolving, and new transfer fluids are being investigated; this research will allow lower temperature resources to be used to produce electricity in the future.

12. Electricity Generation – *continued*

Research and demonstration programs using geothermal fluids from oil wells could lead to significant new developments of geothermal energy in Montana and other western states. An operating binary geothermal plant is being demonstrated at the Rocky Mountain Oil Testing Facility near Casper, Wyoming, and a new demonstration plant is under design just across Montana's eastern border in North Dakota.

Montana also is examining these promising new geothermal opportunities. In late 2011 the Flathead Electric Cooperative began drilling an exploration well near the town of Hot Springs, Montana in search of sufficiently hot water to use in a binary generator. And in 2012 a federally-funded feasibility study on using geothermal water from oil and gas wells is being conducted on the Fort Peck Assiniboine and Sioux Tribes Reservation in northeast Montana.

A binary generator at the Rocky Mountain Oilfield Testing facility near Casper, Wyoming. This power station uses 195 degree F water from an oil well to generate 250 kW of electricity.

Photo by Jeff Birkby

12. Electricity Generation – *continued*

A small binary generator that will use geothermal fluids from an oil well is being evaluated at the Rocky Mountain Oilfield Testing Center near Casper, Wyoming.

Photo by Jeff Birkby

Enhanced Geothermal Energy Systems (EGS)

Natural geothermal systems occur in only a few special places where geologic conditions provide access to hot water at or near the surface. But enhanced (or engineered) geothermal systems open up the possibility of extracting heat from deep, hot but naturally dry rock. In this scenario two deep wells are drilled, pressurized fluids are injected into both wells, and existing cracks in the rocks between the wells are opened. The wells are typically drilled to depths of 2 to 6 miles. These Enhanced Geothermal Energy Systems (EGS) require deeper drilling, hydro-fracturing, and use of fluids to bring the heat to surface.

A significant barrier to EGS is the availability of water. Finding water to charge and maintain the initially dry reservoir of an enhanced geothermal system can be challenging in an arid environment. Although this system is nominally a "closed loop," small to moderate amounts of water are lost into the fractured reservoir.

In Montana, EGS systems are still far in the future — using geothermal coproduction from existing oil and gas wells in the near term is more likely and more economical. But if drilling technology continues to improve, perhaps someday much more of the deep geothermal heat underlying Montana will be accessible for power generation.

EGS Development Sequence