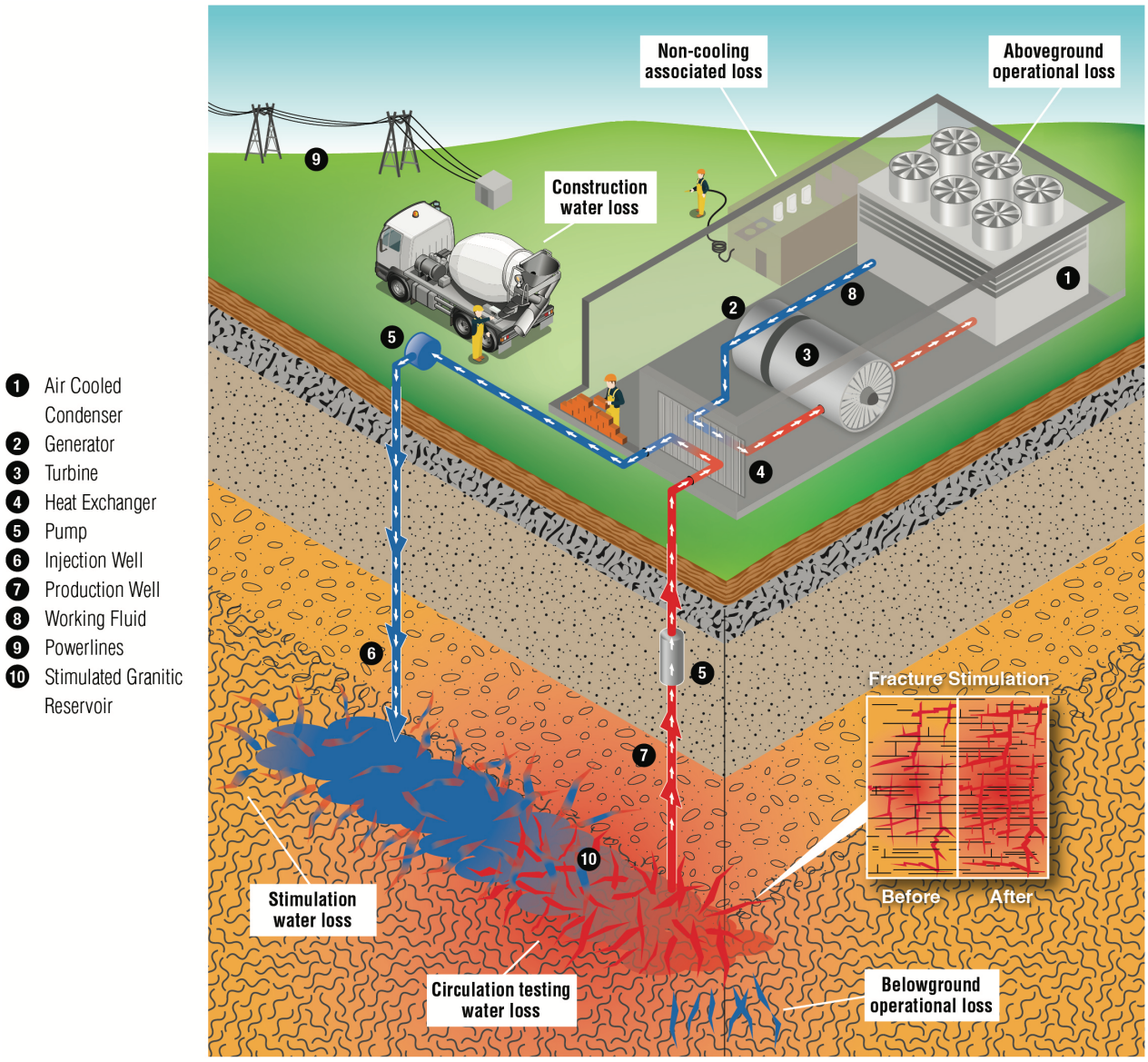
Water Efficient Energy Production for Geothermal Resources



EGS – Air-Cooled Binary Plant

Water consumption in geothermal energy development occurs at several stages along the life cycle of the plant, during construction of the wells, piping, and plant; during hydroshearing and testing of the reservoir (for EGS); and during operation of the plant. These stages are highlighted in the illustration above. For more information about actual water use during these stages, please see the back of this sheet.

Why is water consumption important? While the quantity of fresh water required for many geothermal systems is low compared to most conventional thermoelectric power plants, a significant portion of the geothermal resource is located in areas with existing or potential future water stress. In addition, geothermal fields are often located in remote areas, without existing water infrastructure, presenting challenges in obtaining and delivering water supplies. The use of certain technologies, such as air-cooled binary plants, and the use of alternative water sources like municipal waste water and brackish groundwater for stimulation and injection for EGS systems can potentially reduce these challenges. When technologies such as these are employed, geothermal can make a significant contribution to a more water-efficient and lower carbon energy future.

Visit the Geothermal Technologies Office website at geothermal.energy.gov for more information on geothermal development and policy, or contact geothermal@ee.doe.gov.

	Drilling and Construction	Stimulation	Circulation Testing	Belowground Operational Loss	Cooling-Related Operational Loss	Non-Cooling-Related Operational Loss	**TOTALS**
EGS Binary – Air Cooled	0.79 – 9.0 gal/MWh	1.9 – 32 gal/MWh	1.8 – 29 gal/MWh	190 – 4,100 gal/MWh	0 gal/MWh	40 gal/MWh	235 – 4,210 gal/MWh
EGS Flash – Wet Cooled	0.40 – 2.0 gal/MWh	0.8 – 4.7 gal/MWh	0.0 – 4.2 gal/MWh	49 – 490 gal/MWh	1,500 – 2,300 gal/MWh	40 gal/MWh	1590 – 2841 gal/MWh
Hydrothermal Binary – Air Cooled	0.49 – 2.0 gal/MWh	0 gal/MWh	0 gal/MWh	0 gal/MWh	0 gal/MWh	40 gal/MWh	40.5 – 42 gal/MWh
Hydrothermal Flash– Wet Cooled	0.64 – 1.0 gal/MWh	0 gal/MWh	0 gal/MWh	0 gal/MWh	0 gal/MWh	40 gal/MWh	41 gal/MWh

It is important to note that the numbers in the table above represent freshwater consumption and do not represent the geofluid consumed during these stages. For certain plant configurations, particularly EGS and wet-cooled hydrothermal flash, these losses can be considerable. However, much of the geofluid loss, particularly for EGS, will not necessarily require freshwater for makeup.

Explanation of Key Water Usage Stages in Geothermal Development[1]

Adapted from Schroeder, Jenna N., Christopher B. Harto, Robert M. Horner, and Corrie E. Clark. 2014. *Geothermal Water Use: Life Cycle Water Consumption, Water Resource Assessment, and Water Policy Framework.* Argonne National Laboratory. (ANL/EVS-14/2).

- Drilling and Construction – includes all water consumed during well drilling, pipeline construction, and power plant construction. In general, during these stages, water is used primarily as an ingredient in concrete and for drill lubrication.
- Stimulation – includes water consumption for all fluids injected underground for the purposes of stimulating an EGS reservoir. Stimulation is a process by which naturally-occurring fractures in the reservoir are widened so that water can flow more freely.
- Circulation Testing – includes consumptive losses from testing the circulation of the newly enhanced reservoir.
- Belowground Operational Loss – otherwise known as reservoir loss, this was assumed to be either 1% or 5%, depending on the scenario analyzed. During and after stimulation, it is not uncommon for some of the injected water to migrate outside of the reservoir. This loss is accounted for here.
- Cooling-Related Operational Loss – includes all water consumed during operation of the plant itself, including losses from cooling the power plant and replacing the water lost to evaporation during the cooling process.
- Non-Cooling-Related Operational Loss –encompasses all other losses not included in the other life cycle stages. It is a constant value of 40 gallons per hour (gal/MWh) and represents the water consumption from non-cooling related activities, such as dust suppression, maintenance, and domestic use (bathrooms).

[1] A standardized set of scenarios was developed by the DOE Geothermal Technologies Office (GTO) for evaluation of the levelized cost of electricity (LCOE) and the associated environmental impacts of geothermal technologies. These scenarios were provided by the GTO for consistency between this and any other analyses that might rely on these scenarios. The scenarios were run in DOE's Geothermal Energy Technology Evaluation Model (GETEM) repetitively to create a range of possible outcomes by varying parameter options. Key parameter values from the scenario definitions and select GETEM outputs were then used to help calculate the life cycle water consumption for each scenario. These included, but were not limited to, the number of production and injection wells, the well flow rates, the water consumption for flash system cooling, and the plant lifetime. For more information, please refer to Schroeder et al. 2014, available at http://osti.gov/scitech/biblio/1155056.