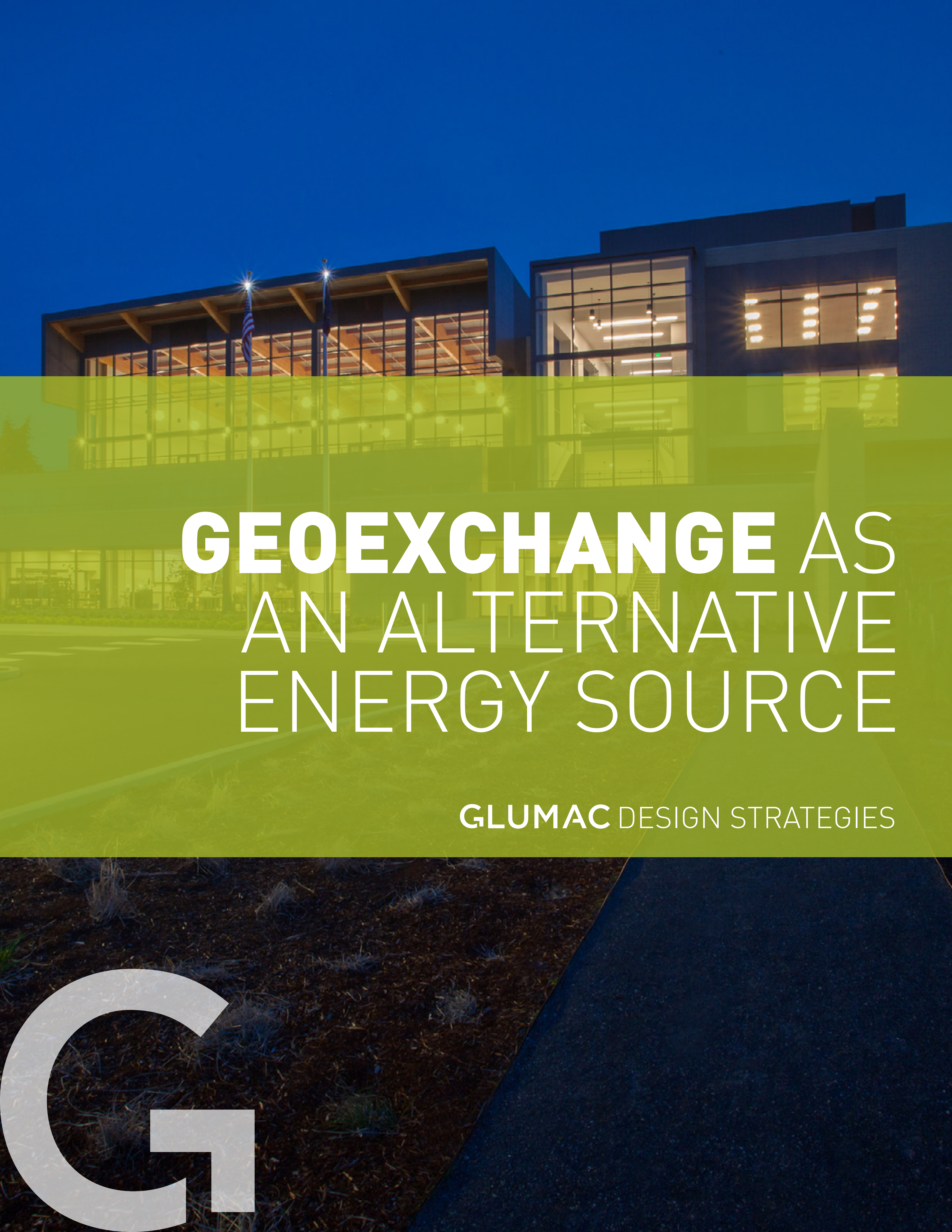


GEOEXCHANGE AS AN ALTERNATIVE ENERGY SOURCE

GLUMAC DESIGN STRATEGIES

GEOEXCHANGE

AN ALTERNATIVE ENERGY SOURCE

GEOEXCHANGE
Utilizing the constant, year-round temperature of the earth (or groundwater, lake or pond water) as both a heat source (in winter) and heat sink (in summer) via an electrically-powered heat pump for space conditioning

The earth provides the perfect heat exchange medium: harnessing constant, year-round temperatures to deliver highly efficient heating and cooling energy for all types of building projects. Although commonly referred to as geothermal, earth-coupled heat pump or ground-source heat pump technology, the industry now prefers the term "geoexchange" systems for this alternative source of energy.

Geoexchange carries a higher initial cost than standard HVAC – a cost that varies according to project size, scope and drilling conditions for each locale. Yet these systems also offer much higher year-round efficiencies than conventional systems, typically requiring 40 to 70 percent less energy and lower maintenance costs while resulting in longer equipment life and a smaller carbon footprint. The payback on investment on most installations is generally between five and eight years. Rising fossil fuel costs, LEED points for building efficiency, new government incentives, and utility rebates also contribute to making geoexchange the lowest life-cycle cost of any heating and cooling technology. For more than a decade, Glumac has recommended geoexchange systems for schools, retail, office buildings, single- and multi-family residential spaces and light commercial buildings. Ideal applications include spaces that do not operate 24/7 (like fire or police stations), so building loads allow temperatures within the earth/ground loop piping to settle out and recover during off-hours.

SYSTEM CONFIGURATION

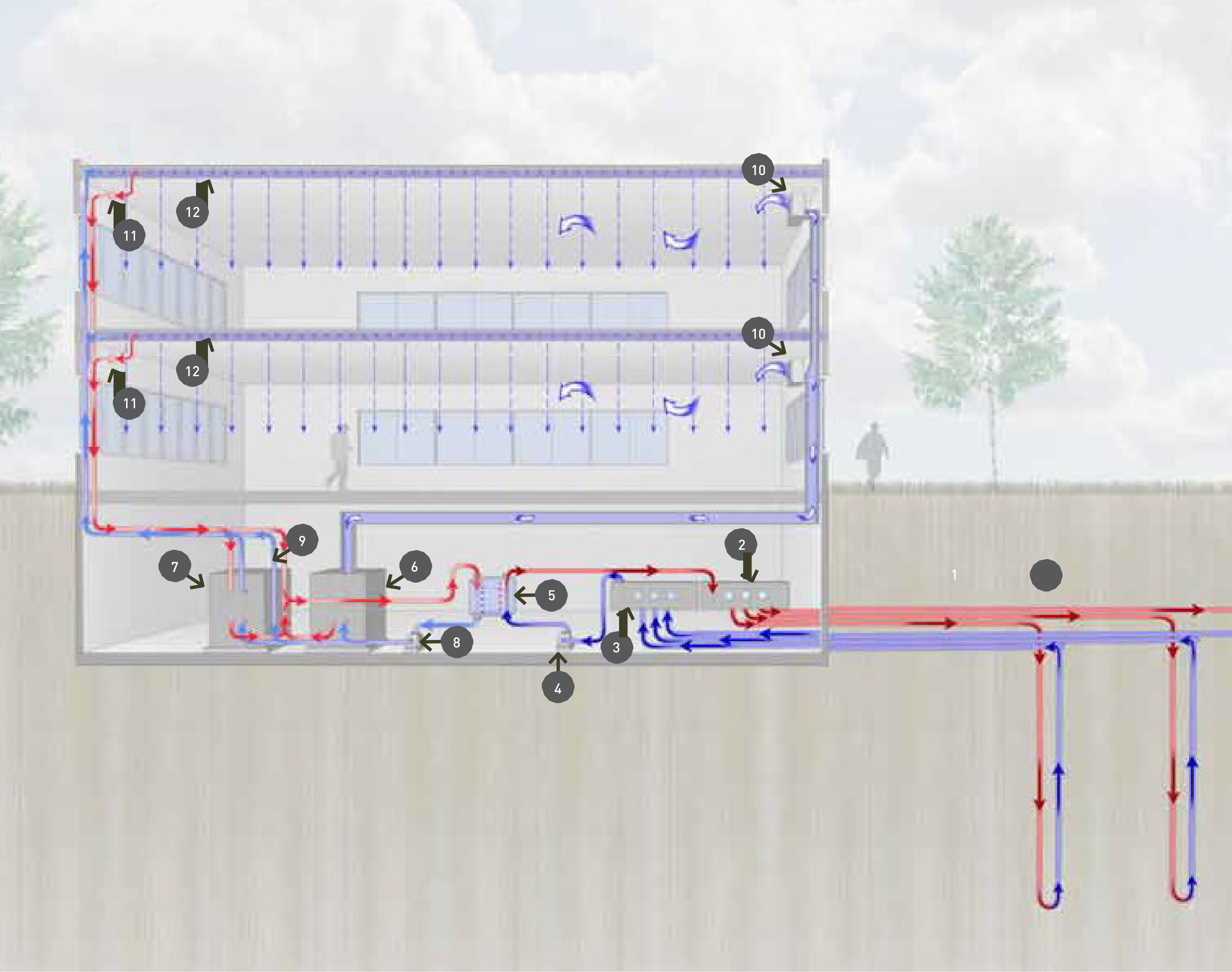
The optimal geoexchange system design for each project is dictated by building loads, acreage available, geotechnical (soil/rock) conditions and other factors. Earth exchange configurations fall into four main classifications: open or closed loop, and vertical or horizontal layouts. An open system involves groundwater (vertical wells) or lake/pond water as the supply source for heating and cooling. This approach can be very cost-effective, assuming there are sufficient quantities of high quality water and available discharge locations, and the system complies with all local codes and standards.

Glumac generally prefers closed loop systems due to

GEOEXCHANGE HEATING/COOLING SYSTEM

1. bore field with geothermal wells
2. supply material
3. return manifold
4. ground loop pump
5. heat exchanger
6. water-to-air heat pump
7. water-to-water heat pump
8. HVAC system pump
9. bypass line
10. ventilation air outlet
11. thermostatic control valve
12. thermally activated concrete with embedded radiant pipes

Ground to air: Offering highly efficient energy transfer, a vertical closed loop system extracts heat from air in the building (in summer), transferring it through circulating fluid via HDPE piping and back into the earth. In winter, the reverse happens, as geoexchange technology makes it possible to absorb heat from the earth, moving it inside for warmth



TAPPING THE EARTH AT THE DALLES READINESS CENTER

A TYPICAL **GEOEXCHANGE LOOP** PROVIDES ONE TON (3.5 kW) OF COOLING – UTILIZING BORES DRILLED UNDER A BUILDING, OR MORE TYPICALLY, IN A LANDSCAPED OR PARKING AREA. TO SUPPORT A 100,000-SQUARE-FOOT (9,300-SQUARE-METER) OFFICE BUILDING REQUIRING 200 TONS (700 kW) OF COOLING, THE SYSTEM WOULD FEATURE 200 BORE HOLES – A FIELD APPROXIMATELY 200 FEET BY 200 FEET (61 METERS BY 61 METERS).

cost, permitting requirements, and environmental concerns. In these systems, fluid circulating through buried plastic piping (a series of ground loops) absorbs heat from the earth in winter, delivering it indoors via a heat pump for warmth. In summer, the reverse occurs, as the system extracts heat from air in the building, transferring it through the fluid and piping and back into the earth. Vertical closed loops typically consist of four-inch (10 cm) diameter bores, drilled between 200 and 350 feet (61 and 106 m) depending on application and climate, and spaced 15 to 20 feet (4.6 to 6.1 m) off center (o.c.). Installers then place one-inch (2.5 cm) flexible HdPE pipe into the bore holes, filling and sealing the annular space with thermally-conductive grout. Water serves as the preferred heat exchange fluid, moving continuously through a vertical system's circuits (either "individual loops" or "common loop") and runouts. In colder climates with larger heating loads, the water contains a small percentage of glycol to prevent freezing.

Horizontal layouts – configured either as a closed loop or an open system that utilizes lake or pond water – are another option. This design requires more land and approximately twice as much piping. Loops/supply lines must be buried five or six feet (1.5 or 1.8 m) apart and a minimum of five feet (1.5 m) deep, as a buffer against ambient temperatures on the ground's surface.

THE BUILDING INTERFACE

Another advantage of geoexchange: the water loop (or "earth exchanger") also serves as the system's condenser – with no equipment actually placed outside the building. This technique is preferable for landscaping, is safer and quieter, and requires no maintenance. Glumac's recent geoexchange design for the Sacramento Housing & Redevelopment Agency relies on a closed vertical loop system to heat and a cool low-income housing development. A water-source heat pump, located within the storage closet of each unit, looks and functions much like a standard air-to-air heat pump, with forced air distribution/ductwork resembling a conventional HVAC system. In addition, these water-to-air heat pumps feature an extended range, enabling equipment to operate at lower temperatures (i.e., 50°F/10°C). An open system, which Glumac specified for a golf course clubhouse, pumps water from an adjacent lake and includes a filtration system and settling tank. In turn, that water is returned to the lake. A well system would typically utilize injection wells for reintroducing ground water to the aquifer.

PROCESS/TOOLS

Glumac's role on a geoexchange project begins with engineering the system layout to influence the design and construction of the bore/well field. Providing load calculations and energy modeling data early enables the driller or hydrogeologist to more accurately determine the system length and configuration to achieve optimal heat transfer. Larger systems also require test bores to gather thermal conductivity data based on soil and rock strata. A few additional facts to consider:

- A typical geoexchange well/vertical loop provides one ton (3.5 kW) of cooling
- The linear feet of piping required per ton to support a system can vary greatly – and depends on each project's specific load and site characteristics
- Generally, a horizontal layout/loop must be twice the length of a vertical system to achieve equivalent heating/cooling capacity

> GLUMAC'S ROLE ON A **GEOEXCHANGE PROJECT** BEGINS WITH ENGINEERING THE SYSTEM LAYOUT TO INFLUENCE THE DESIGN AND CONSTRUCTION OF THE BORE/WELL FIELD. PROVIDING LOAD CALCULATIONS AND ENERGY MODELING DATA EARLY ENABLES THE DRILLER OR HYDROGEOLOGIST TO TO ACHIEVE OPTIMAL HEAT TRANSFER.

FURTHER DESIGN FACTORS

While the interior (heat pump, ductwork) elements of a geoexchange system generally match the installed costs of conventional HVAC, its exterior elements (bore drilling, pipe, grout, pumps, etcetera) call for a bigger upfront investment. In addition, these hydrogeologic components require a potentially greater time commitment due to regulatory permits and the need for a timely, accurate assessment of the resources such as rock/soil conditions and ground water.

Selected projects may also utilize other traditional technologies to supplement geoexchange, particularly in areas with high boring costs or where heating and cooling loads are imbalanced. Cooling and heating profiles often require only 50 percent of peak loads for 80 percent of operating hours. This "hybrid loop" system can then optimize energy performance for most of the year, while shifting part of the load to a fossil fuel boiler or cooling tower for the warmest and coldest days. G