

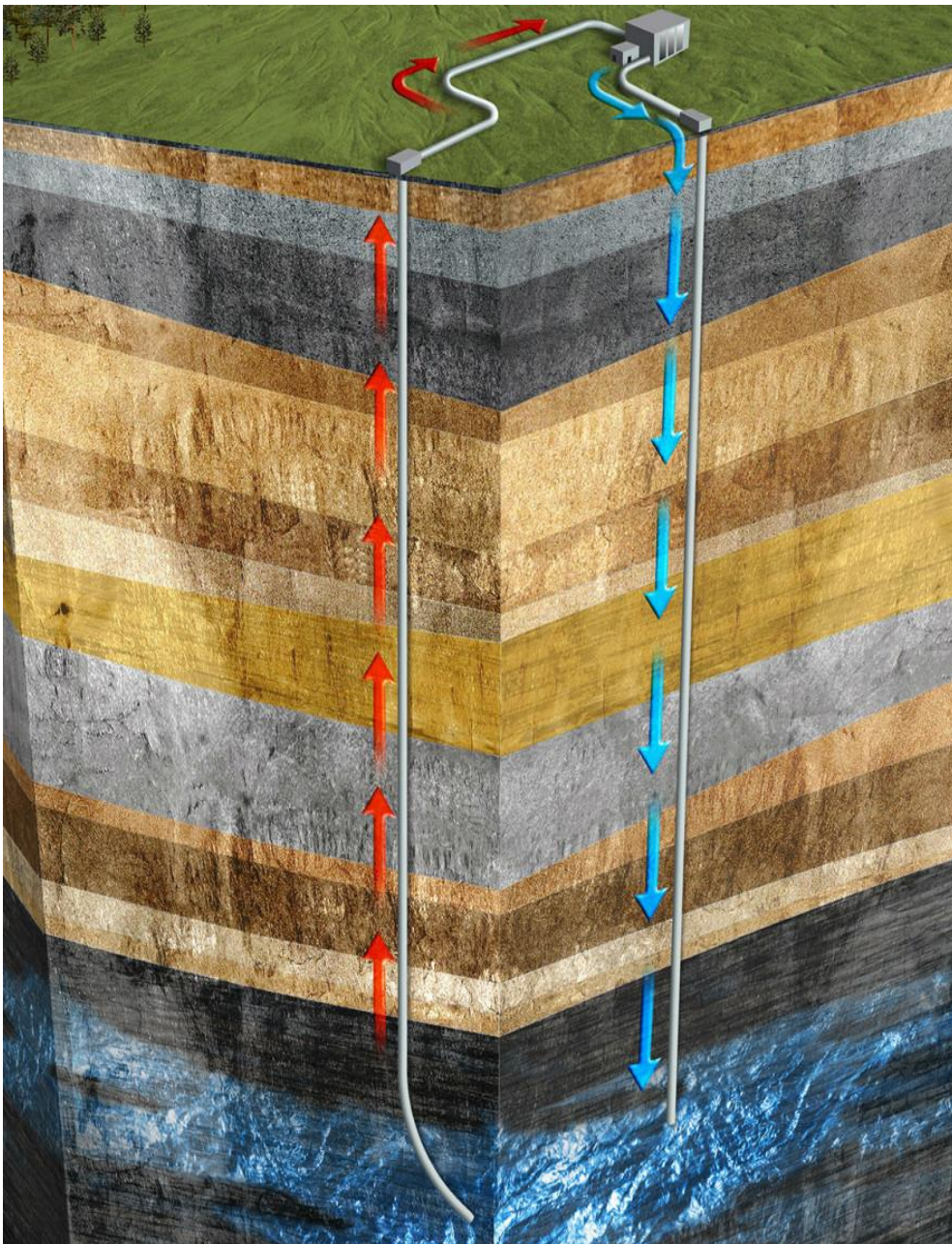


THERMAL
ENERGY PARTNERS



GEOTHERMAL & DESALINATION

Dec 20, 2016



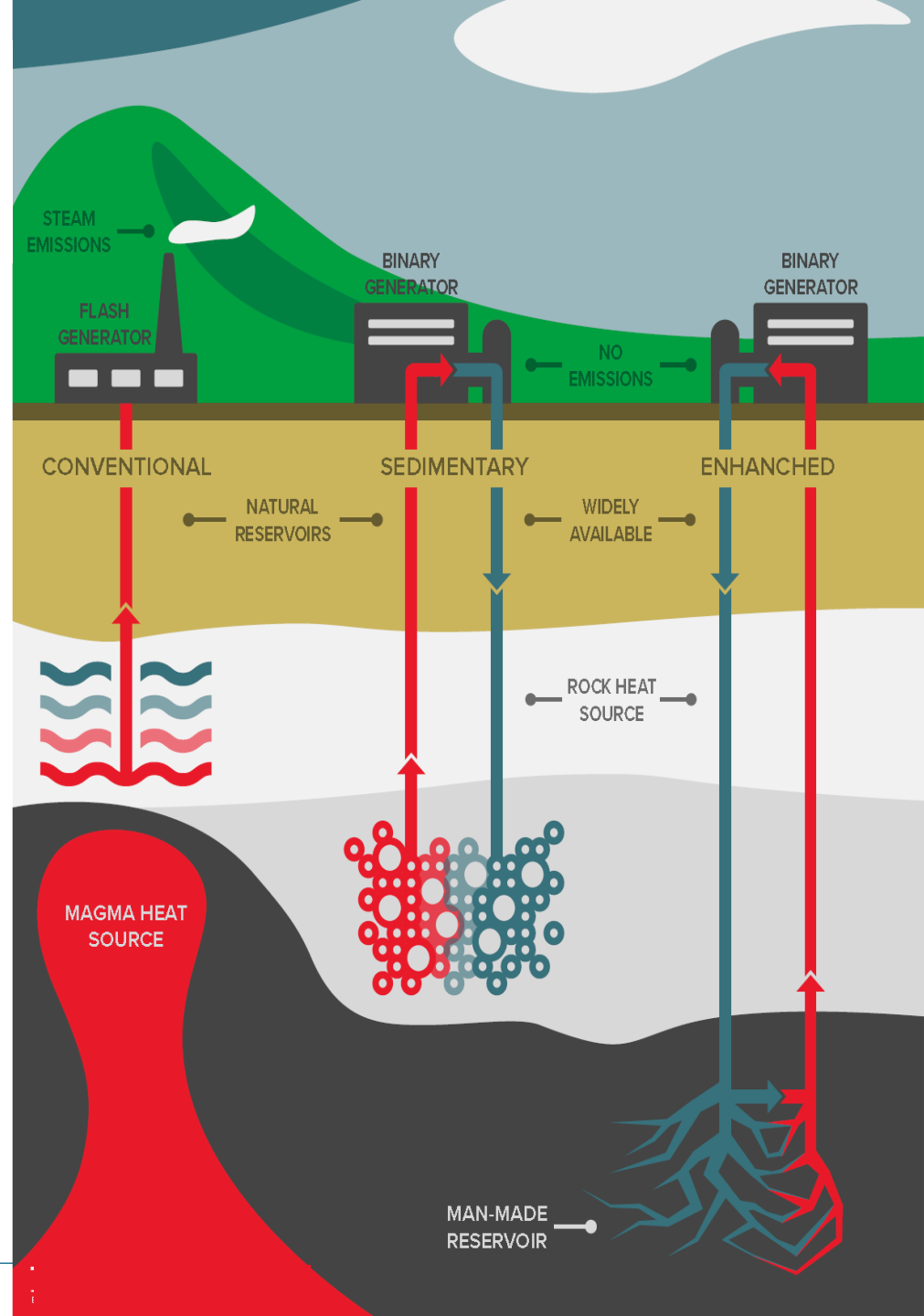
Geothermal power is produced by

1. drilling deep into the earth where the in situ temperature exceeds 300 degrees F,
2. extracting the hot fluids contained in the pore spaces of the rocks through a well,
3. passing these hot fluids through a heat exchanger, and
4. then re-injecting the cooled fluids back into the deep subsurface.



WHAT IS GEOTHERMAL ENERGY?

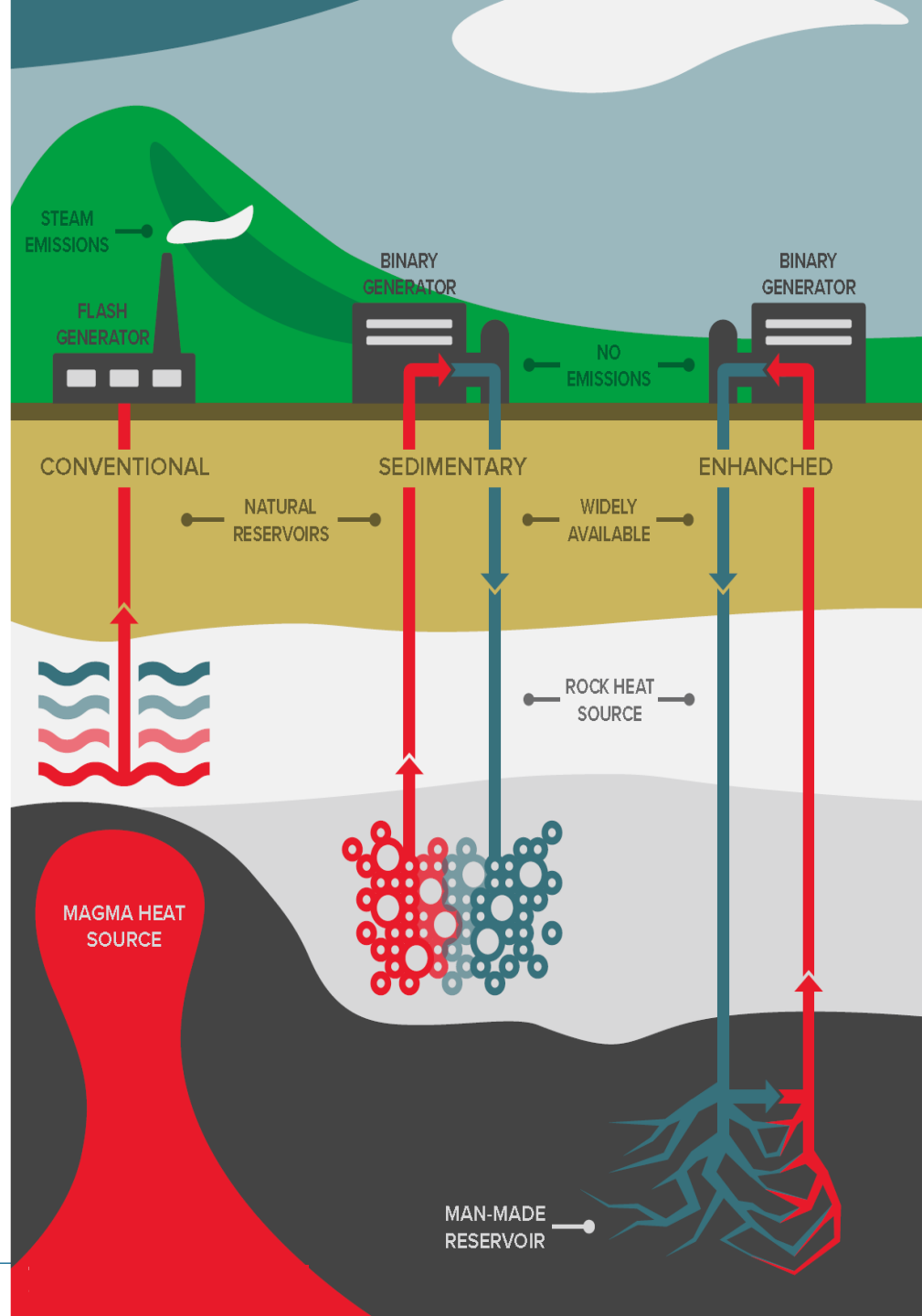
- Heat flows from the interior of the earth due to the natural generation of heat from the decay of radiogenic minerals and the thermally driven movement of materials in the crust and mantle.
- Geothermal energy production captures this heat energy to generate electrical power. As you go deeper into the earth, temperatures increase, due to the geothermal gradient.
- There are 3 main types of geothermal energy production: 1) conventional, 2) sedimentary and 3) enhanced (or engineered geothermal systems, EGS).
- Conventional geothermal energy production relies on the occurrence of near-surface magmatic deposits such as hot springs or volcanos.
- Sedimentary geothermal occurs where thick sequences of permeable rocks contain hot fluids heated by the normal geothermal gradient.
- EGS systems rely on high heat flow areas and the ability to create sufficient permeability in these areas using well stimulation technology developed by the petroleum industry.



WHICH GENERATOR IS BEST?

There are 3 main types of geothermal energy production:

- 1) Conventional where Flash Generators are used but produce emissions
- 2) Enhanced Geothermal Systems w Binary ORC (cold water is pumped through a well deep enough to reach hot basement rock)
Widely available but can be expensive
- 3) Sedimentary w Binary ORC (existing water at depth is brought to surface then re-injected to the same place)
Widely available and cost competitive

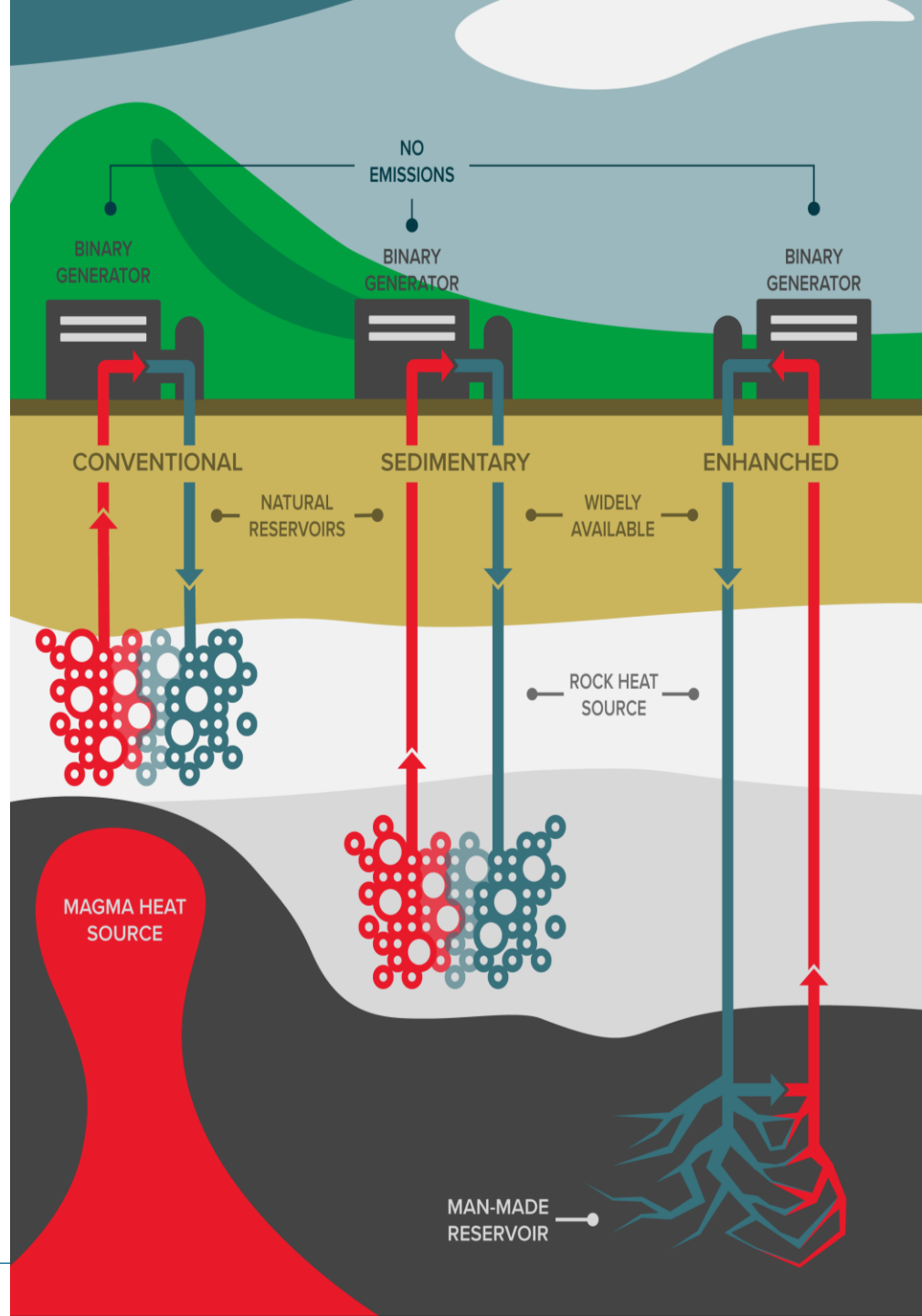


WHICH GENERATOR IS BEST?

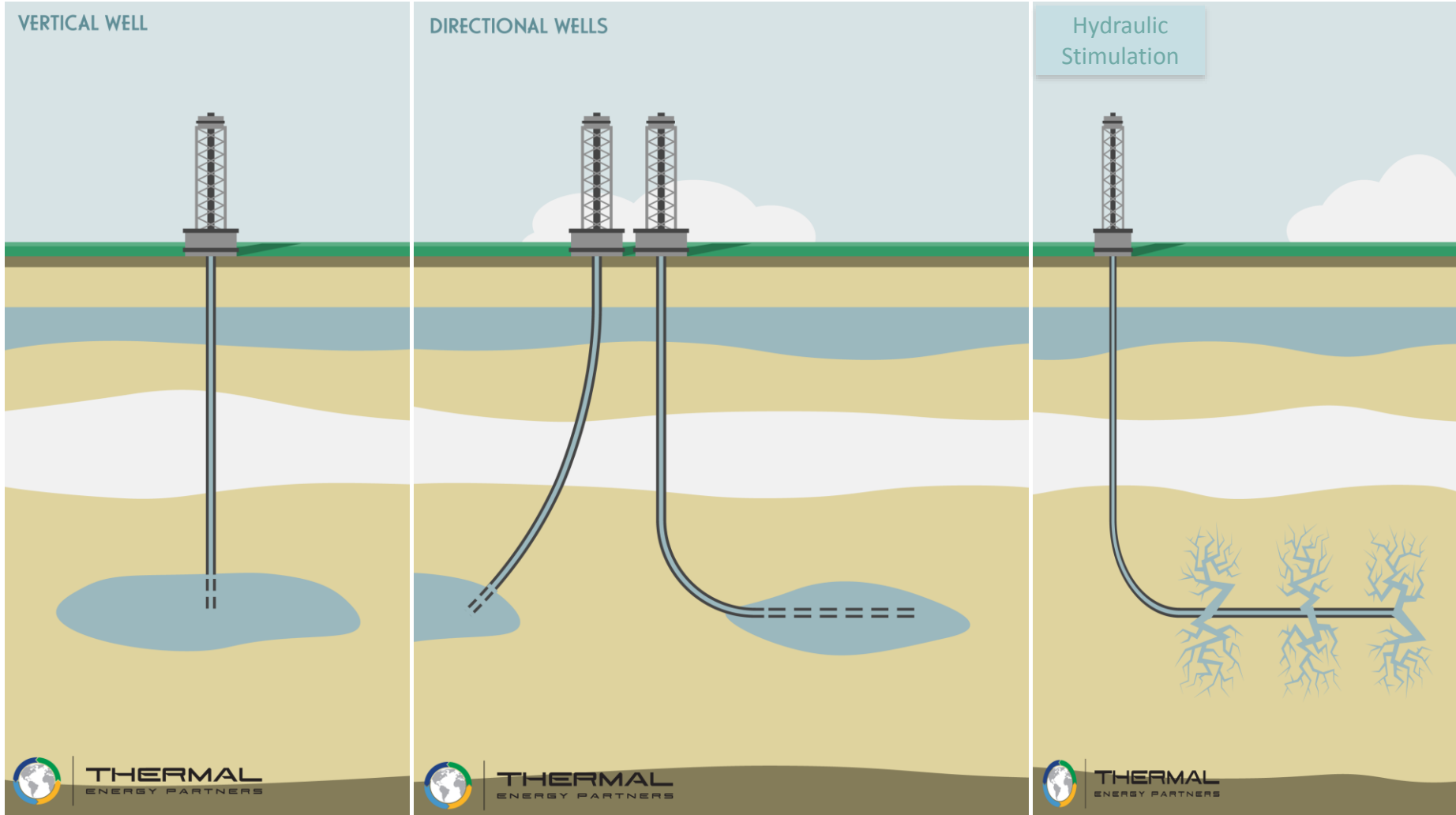
For TEP's Island projects, we're utilizing the strengths of Binary Generators that are used in Sedimentary basins that can be incorporated into a Conventional Scenario

➤The upside benefits for the Islands are Zero-Emissions along with Dispatchability, and Base-load power

➤98% Capacity Factor



TYPES OF GEOTHERMAL DRILLING



BENEFITS TO GEOTHERMAL



- Capacity Factor exceeds 97% on line availability
- Requires 0.2 to 1 Acre per MW (2 acres for 10 MWs)
- Production of Geothermal Power is available 24/7. (on an annual basis, down time for maintenance is estimated at 1, 8-hour day)
- Geothermal is base-load and does not require active backup power storage

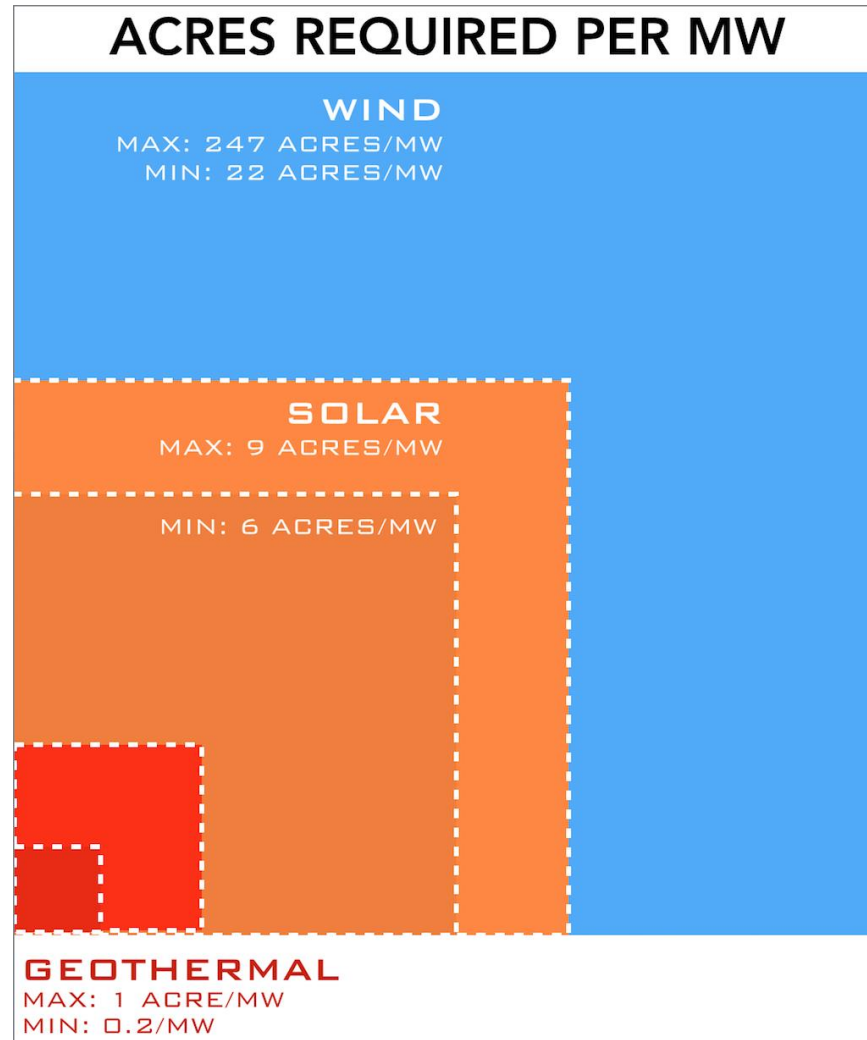
The relative cost for 1 MW of 24/7 available Geothermal Energy is \$4.0 to \$5.5 Million (defined by location and drilling costs)

THE TOTAL COST OF SUPPLYING 1 MW OF GEOTHERMAL ENERGY FOR 24/7 = \$4.0 TO 5.5 MILLION (Excluding land costs).



GEOHERMAL PLANT SIZE VS. SOLAR & WIND

- Geothermal's footprint for an equivalent power output is less than 20 percent of solar and less than two percent of wind at capacities less than 10 MWs.
- As capacities increase above 10 MWs, the footprint advantage for geothermal increases drastically.



TEXAS GEOTHERMAL POWER RESOURCES

