UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Project Description for SPRING 2015
Project Title: Advanced Geothermal Power Plant Study

Supporter: CB&I
Supporter Technical Representative: ASSIGNED
Faculty Mentor: _____ ASSIGNED __X__ TBD (check one)
Single Team __X__ Dual Team _____ (check one)
Personnel (EN/ET): __1__ E, _____ Cp, _____ Cv, __4__ M, _____ SE
(Complete if the number of students required is known)
Expected person-hours: (250 per student)

Description of Project:

Enhanced Geothermal Power Plant systems have significant potential economic viability based on low cost fuel (heat source), use of hot rock hydraulic simulation and low temperature heat source generation of power through use of organic Rankine thermodynamic power cycle. Geothermal power has the benefit of being a renewable power source which does not emit CO2.

The study will be based on 100 MW net electrical output design (or use of multiple standard unit capacities comprising in multiples up to 100 MWs).

An enhanced geothermal system (EGS) generates geothermal power plant electricity without the need for natural convective hydrothermal resources. Until recently, geothermal power systems have exploited only resources where naturally occurring heat, water, and rock permeability area sufficient to allow energy extraction. However, by far most of geothermal energy within reach of conventional techniques is in dry and impermeable rock. EGS technologies enhance and/or create geothermal resources in this hot dry rock (HDR) through 'hydraulic stimulation'.

Geothermal injection water travels through fractures in the rock, capturing the rock's heat until forced out of a second borehole as very hot water. The water's heat is converted into electricity using an organic based thermodynamic binary power plant system. All of the water, now cooled, is injected back into the ground to heat up again in a closed loop.

EGS technologies, like hydrothermal geothermal, can function as base load resources that produce power 24 hours a day, like a traditional fossil fuels power plant. Unlike hydrothermal, EGS appears to be feasible anywhere in the world, depending on the economic limits of drill depth. Good locations are over deep granite covered by a 3–5 kilometers (1.9–3.1 mi) layer of insulating sediments that slow heat loss. EGS wells are expected to have a useful life of 20 to 30 years before the outflow temperature drops about 10 c (18 f) and the well becomes uneconomic.

Initial Project Requirements (e.g. weight, size, etc.):

The project will consist of a study for the practical application and description of a 100 MW (or multiple smaller units – 3x35MW, 2x50MW, etc.).

1. Determine requirements for the enhanced geothermal system (EGS) enhance and/or create geothermal resources in this hot dry rock (HDR) through 'hydraulic stimulation' to supply hot water needed to produce 100 MW of electric power. These requirements will include:

- Preliminary well and rock cavity formation size and capacity requirements
- Expected hot well water exit temperature for design, expected temperature ranges for multiple areas, installations with the USA
- Well hot water flow balance diagram with expected water flow rates
- Preliminary well water analysis
- Capacity requirements and materials of construction for the well water system
- List of companies which can provide services to install, drill the 'hydraulic stimulation' wells
- Estimated ROM cost for 'hydraulic stimulation' wells
- Conduct and provide pertinent internet, technical literature search of subject material to support findings (pdf files)

2. Determine power plant and thermodynamic power cycle requirements for the enhanced geothermal system (EGS) energy use to produce 100 MW of electric power. These requirements will include:

- Low temperature power cycle requirements based on use 100-300 ^{0}C hot well water temperature
- Design for converting water's heat into electricity using an organic based thermodynamic binary power plant system
- Determine possible organic power cycle working fluids based on temperature evaporation
- Investigate working fluid options, physical and thermodynamic properties, hazards, availability, practical use in a power plant
- Develop power cycle heat and mass balance(s) through use of excel. (CB&I will provide Thermoflex power cycle model as needed for checking and comparison purposes)
- Define power plant components, capacities, materials of construction
- Determine commercially available binary and organic cycle turbine generators, capacity ranges, working fluids, operational experience and delivery time (award purchase order to FOB manufacturing site)
- Investigate companies which can provide binary and organic cycle turbine generators
- Estimate ROM cost for power plant power cycle system
- Conduct and provide pertinent internet, technical literature search of subject material to support findings (pdf files)

Expected Deliverables/Results:

Deliverable will be a report that includes:

- Description of the power plant
- Major equipment list
- Pertinent power plant drawings (heat balance, general arrangement, etc.)

- Water balance
- Well water pumping and heat exchanger diagram
- Recommended materials of construction
- Results of technical literature searches

List here any specific skills or knowledge needed or suggested (If none please state none):

None