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PAYNE COMMENTARY SERIES: **COMMENTARY**

A Geothermal Transition

By Elsa Barron and Morgan D. Bazilian

The global energy sector is changing rapidly, and in myriad ways. Geothermal energy is poised to play an important role going forward. While the technology has been in place for many decades, new innovations are opening up possibilities for the expansion of geothermal energy production into areas beyond traditional geothermal hotspots (e.g., volcanoes). Geothermal also has an important benefit among renewable energy technologies: it has considerable overlap of required data and skill sets with the oil and gas industry—this has big implications for ensuring so called just transitions. With expanded investment into research and development of this energy source, geothermal can help countries reach their climate change goals effectively.

Geothermal energy deserves renewed attention for its unique contributions to the energy puzzle. It has started to receive notice, with $850 million from last year's $1.4 trillion federal spending and tax extension package earmarked for geothermal energy research. Additionally, Google announced a major effort on geothermal energy in order to reach their own zero-carbon goal by 2030. Yet, there are still more opportunities for further investment.

Geothermal's attractiveness stems from its ability to provide clean and reliable power that is not variable like wind or solar energy. Additionally, geothermal energy overlaps with many of the technical skill sets that already exist in the oil and gas industry, from the roughnecks and roustabouts that run the drilling rigs, to the geologists and engineers that plan the wells and developments. These workers are well-trained and available for jobs in the renewable energy sector as the world works to phase out oil and gas. There are even opportunities for knowledge sharing between the oil and gas and geothermal energy sectors, since oil and gas developers have, in many cases, already conducted robust underground characterization of sedimentary heat deposits. Most importantly, geothermal power resources are widespread worldwide, and have massive potential for both electrical generation and heat generation. The main focus of today's R&D and policy efforts are related to decreasing the costs of the energy services it can provide.

Historically, geothermal energy has been derived from naturally fractured reservoirs with hot water or steam, like the Geysers in California. This need has made geothermal energy difficult to harness widely due to the limited number of locations that have reservoirs with suitable characteristics. The key goal of research and development is to eliminate this scarcity by developing a new geothermal technology: a workable and economic Enhanced Geothermal System or EGS – basically a subsurface heat exchanger. EGS is simple in concept, inject cold water into the hot rock reservoirs that are found underground almost anywhere on Earth, heat the water, and then harvest it for use in electricity production.

The major existing challenge to this development is also simple: ensuring that heat is drained from a large enough volume of rock to ensure that the decline in temperature of the water produced over time is small enough to ensure many years of power generation. So far, EGS attempts worldwide have fallen short of expectations. Primarily, this is because the injected water has short-circuited between the injector and producing wells, resulting in premature cooling of the produced water. To overcome these challenges, research at the Colorado School of Mines has developed a patent-pending technology called GeoThermOPTIMAL, which incorporates rows of horizontal wells linked by fractures in the underground rock to create a man-made geothermal reservoir and provide controllable conduits for water to travel from injector wells to producer wells and harvesting heat without short-circuiting.

Further advances and innovations in the sector are happening rapidly with improvements in bit technology driving the same improvements in drilling speeds and resulting lower well construction costs. This will hopefully improve the economics of EGS developments in a similar manner to shale development well economics, which now can be drilled and completed in a fraction of the time it took to develop the original Barnett Shale wells. Given these advances, and the possibility for major breakthroughs to scale up, we will likely see vastly more investment and implementation of geothermal projects globally.

Such investment can't come soon enough, as geothermal energy is off-track to meet its 2030 energy generation requirements under the International Energy Agency's Net Zero Emissions by 2050 Scenario. In order to do so, geothermal energy production must increase thirteen percent every year between now and 2030. Meeting this goal will require serious investment in research for new innovations, especially given that geothermal production increased by only two percent in 2020.

In order to keep national energy targets alive, we need advances in and expansion of geothermal supported by bolstered investment and committed research.

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