Poster download and other renewable energy resources: www.leightyfoundation.org/earth.php GRC Conference, Oct 2017, Salt Lake City

Electro Pulse Boring (EPB): Low-cost Access to Deep Geothermal Energy
Baseload Electricity + District Heat + Cool Almost Anywhere on Earth

The Leighty Foundation, www.leightyfoundation.org/earth.php Juneau, AK, Bill Leighty, Director wleighty@earthlink.net

Primary European EPB researchers and contacts:

- Arild Rodland <arild.rodland.ntnu@gmail.com> Retired professor, NTNU, Trondheim, NO
- Hans-Olivier Schiegg <h.o.schiegg@bluewin.ch> CEO, SwissGeoPower, Zurich, CH

If proven capable of distributed, low-cost, benign, baseload, electric and thermal energy production from an inexhaustible, nearly-ubiquitous source -- with free energy storage by leaving the heat in the deep rock until it is needed -- global commercial deployment of EPB may be "disruptive and transformative" to both nation-states and multinational businesses. It may also be humanity's best hope for preventing the even-more-disruptive effects of continued unrestrained combustion of fossil fuels. New, profitable business models will be needed to attract large capital. The global energy industry seeks such "integrated energy solutions" opportunities and has the resources to thoroughly investigate EPB's technical and economic merit, to commercialize it if warranted.

We cannot estimate the probability of technical and economic success of EPB. Only an adequately-funded, well-managed, ~ 3-year R&D program can discover and demonstrate EPB merit -- if any. An international collaborative of industry, governments, and philanthropy may be necessary, and ideal. An adjunct to the USDOE's "FORGE" program, at established drilling sites in Utah and Nevada, may be efficient.

We have no equity interest in Electro Pulse Boring (EPB), but we wish it to be well-considered by relevant expert business and research interests, to discover and demonstrate whether and how -- if at all -- it might help deep and prompt decarbonization of humanity's total energy economy. Our strategy has been to:

- Acquaint diverse private sector, non-profit, and military entities with EPB, usually at energy conferences, hoping to spark interest in meeting with Rodland, Schiegg, et al. I represent The Leighty Foundation (TLF) in this pro bono effort. I'm trying to "sell" a concept that neither TLF nor I own, nor from which either will benefit, in case someone discovers EPB's value and deploys it to benefit us all.
- Apply for funding for R&D & Demonstration projects, by Alaska Applied Sciences, Inc. (AASI), in the apparent absence of funding and progress on EPB by its pioneers in Europe. If AASI succeeded, we would immediately attempt to include these pioneers in a collaborative venture to advance EPB.

Ubiquitous, deep (5-10 km) geothermal remains an energy "silver bullet", if we could afford to access it. We cannot, with conventional, rotary, abrasive drilling. The European EPB collaborative of NO, CH, and RU, active in about 2005 - 2012, estimated that a 50 cm diam vertical borehole to 5 - 10 km depth by EPB would cost ~ $ 150 / m, about 10% the cost of conventional rotary drilling to 5-10 km. In good geology, this would enable delivering useful geothermal heat to Earth's surface at ~ $ 0.01 / kWht (thermal), at T adequate for organic rankine cycle (ORC) electricity generation, and with abundant hot water for district heating and cooling systems (DHCS).

My understanding of geothermal energy and EPB, after several conversations with PI's Rodland and Schiegg and after attending several geothermal energy conferences:

- Hydrogeothermal energy is limited to provinces with shallow hot water, and presents large exploration and production risks.
- Enhanced Geothermal System (EGS) requires two boreholes plus fracking of the deep rock between them, which often causes earthquakes; pumping cost is a large parasitic load.
- EPB would use thermosiphon and branched boreholes, also by EPB, to increase rock contact area and energy production, with little pumping cost. Thus, "enhanced" energy production per motherhole is via deep branching, rather than by deep fracking.
- The EPB researchers at NTNU (NO), SwissGeoPower (CH), and Polytechnic University of Tomsk (RU) achieved proof-of-concept boreholes to 200 m in granite, 20 - 400 cm diam, in ~ 2005 - 2012, using a surface-mounted pulse generator supplying 400 - 700 kV pulses, of 1,000 - 5,000 J, at ~ 10 ns, at ~ 10 - 20 pulses per second (pps; prr) to the electrode assembly, where interelectrode gaps were 4 - 10 cm. Excavation rate of 19 cubic cm (cc) per pulse was achieved in shallow tests to 10 m.
- The surface-mounted pulse generators were designed and built by Polytechnic University of Tomsk (RU)
- Deep EPB requires a down-hole pulse generator (DHPG) that can function at T and P at full depth, 300 C and 1,000 bar, powered by an umbilical from the surface. No comparable component has been built, although military Directed Energy Weapon (DEW) and subatomic particle accelerator pulsed power technology is available and applicable. This is probably the main technical barrier to EPB success at 5 - 10 km depth. New power semiconductors of silicon carbide and diamond may enable DHPG technology.
- EPB cuttings removal is by mud, as in conventional drilling, although this may present a pulse power short-circuit problem at the borehead electrode array, requiring insulating oil deployment at rock face.
- EPB technical progress seems stalled by disintegration of the collaborative that achieved ~ TRL 3 in 2006 - 2010, and by lack of funding. Rodland and Schiegg no longer communicate; some disagreement. .
- Rodland and Schiegg estimated, 5 years ago, that advancing to TRL 7-8 with a successful DHPG and progressively-deeper boreholes would cost ~ $ 10-20 million; full commercialization ~ $ 150 million.
- Rodland commissioned a tech and econ report by SINTEF, probably about 2006 - 2012, to estimate energy production and costs from successful EPB boreholes. This study remains confidential; owned by Rodland. He has provided me selected information from it.

EPB, if it can be commercialized, could be the ultimate in a benign, autonomous, indigenous, nearly-ubiquitous, equitable, Distributed Energy Resource (DER), minimizing the need for:

- Fossil fuel extraction and combustion;
- CAPEX and O&M and land use costs of gathering, transmission, storage, and distribution infrastructure;
- Blockchain certification, as proposed by Rocky Mountain Institute (RMI), via the Energy Web Foundation.