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Deep (6-10 km), hot dry rock (HDR) geothermal -- Ubiquitous energy for CO2-emission-free mini- and microgrids, with free storage

Additional submitted attachment is included below.

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CEC Commissioners, 10 July 2020

Mini- and micro-grids supplied entirely by deep (6-10 km), hot dry rock (HDR) geothermal could eliminate the need for most electricity transmission and storage infrastructure and replace variable renewable energy (VRE) wind and solar plants. Energy storage is free: leave the heat in the HDR until needed. But, we haven't yet the boring technology to go "deep enough, cheap enough" to profitably access this benign, ubiquitous, inexhaustible source. We may be close.

Please attend: NREL and others have organized "Pivot2020", an important virtual geothermal energy conference, 13-17 July, including partners Shell, UT Austin, and others. Pivot2020 is being hosted by the Geothermal Entrepreneurship Organization (GEO) at the University of Texas at Austin, and the International Geothermal Association (IGA), with industry and organizational partners and friends.

- Agenda: <https://www.texasgeo.org/pivot2020>
- <https://www.thinkgeoenergy.com/pivot-2020-kicking-off-the-geothermal-decade-virtual-event-july-13-17-2020/>

Register soon at sites above. This is a free online event and open to all, but is first come, first served, based on audience limitations of the virtual platform.

I recommend you especially pay attention to these panels and panelists related to deep hot dry rock (HDR) geothermal, *aka* enhanced geothermal systems (EGS), the technology most likely to achieve the energy system features menu below. Significant technology challenges will need to be solved and ready for field trials:

- 13 Jul 1000 (CDT) Building a Geothermal Strategy: Lessons from the Oil Patch
Robert Lance Cook, former Chief Scientist of Wells, Shell
- 14 Jul 1145 Geothermal Anywhere: Closed Loop Systems
John Redfern, CEO, EAVOR
- 15 Jul 1000 Geothermal Project Development
Kate Young, NREL Doug Hollett, Consultant
- 15 Jul 1145 Future of Drilling: New Concepts
Bill Moeny, TETRA
- 16 Jul 1000 Drilling Wells of the Future
Christian C. George, Shell Robert Lance Cook, former Shell
- 17 Jul 1000 Green Drilling Pivot: Career Opportunities
Philip Ball, TOTAL Jeanine Vany, EAVOR
- 17 Jul 1145 Our Geothermal Future: Leveraging the Subsurface
Alicia Williams, Shell Jeff Tester, Cornell Ann Robertson-Tait, Schlumberger,
GeoThermEx Simon P. Todd, former VP, BP

When we can bore deep enough, cheap enough, to access HDR at 6 - 10 km depth, at competitive long-term cost of energy (COE), we may have the "silver bullet" for a global energy system which is:

- Benign
- Relatively safe
- Inexhaustible
- Affordable
- Profitable: attracting capital to high reward-to-risk ratio investments
- Baseload
- Distributed (DER), autonomous, to supply microgrids and minigrids; minimize transmission & storage
- Firm and dispatchable via inherently-free energy storage: leave the heat in the HDR until needed
- Ubiquitous on Earth
 - Via the "geothermal constant" of ~ 30 deg C per km depth
 - Limited primarily by surface and shallow Earth conditions, by urban installation constraints
- Equitable: monopoly resistant; enabling quality energy access to all
- Cyberattack resistant
- Resilient, robust: resistant to damage by acts of God and man
- Unobtrusive infrastructure
- Able to deliver both electric and thermal energy: electricity from Rankine blocks, including ORC, plus copious hot water for district heating and cooling systems (DHCS).

If commercialized, deep HDR geothermal would be the ultimate DER (Distributed Energy Resource): wherever we need energy, bore a pair of holes -- or even a single hole -- to HDR at 6-10 km. No "fracking" at depth needed if the boring technology is steerable, as HDD.

Ubiquitous HDR geothermal could obsolete [wind and PV + transmission + storage] systems, as we know them:

- Minimizing investment in electricity transmission and energy storage subsystems;
- Accelerating near-total decarbonization and de-GHG-emission of the entire human enterprise, well beyond electricity and energy.

But, the essential boring technology will probably not be ready in time to couple with urgent COVID recovery investments.

Deep HDR geothermal is the safest form of nuclear energy: the heat emanates from fission of Uranium and Thorium atoms deep in Earth's crust and shallow mantle, where the fission byproducts remain sequestered.

NREL contact and event co-organizer: Geothermal program manager Kate Young "Young, Katherine" <Katherine.Young@nrel.gov>

See attached: my presentation and poster from a 2018 IEEE conference, based on European

"Electro Pulse Boring" (EPB) R&D from 2005 - 2012. The technical challenges are significant, but probably tractable; the solutions worth protecting as IP.

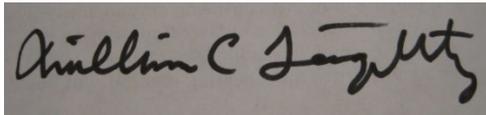
See also: GRC (Geothermal Resources Council) Virtual Annual Meeting & Expo, October 18-23, 2020 <https://geothermal.org/> <https://grc2020.mygeoenergynow.org/>

My most recent conference presentation videos:

- <https://vimeo.com/301111544> " Deep Decarbonization of Total Global Energy: Hydrogen and Ammonia C-free Fuels as Integrated Energy Systems "
- <https://vimeo.com/373679728> " Designing CarFree Cities to Welcome Millions Fleeing Rapid Sea Level Rise, Within a Few Decades "

Thank you for your consideration. Please FWD as you wish.

I'm sorry I was unable to attend your 9 July 20 workshop on this subject.

A handwritten signature in black ink on a light-colored background. The signature appears to read "William C. Leighty".

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