Will Deep Hot Dry Rock Geothermal (DHDRG) Displace Solar and Wind?

California’s 2050 Energy Dilemma:

- Hardened Smart Grid, or Hydrogen Pipelines, or Distributed Deep Hot Dry Rock Geothermal (DHDRG)? Think Beyond Electricity
- Should California and USA invest $ billions in a bigger, smarter, harder Grid? How better to achieve humanity’s total de-GHG-emissions?

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Carbon-neutral economy by 2050: All energy plus industrial feedstocks, from CO2-emission-free sources, firm and dispatchable

- Electricity Grid: Large CAPEX required to harden against fires and storms, expand to “electrify everything”, NIMBY opposition. Undergrounding very expensive.
- Avoid over-dependence upon, and over-investment in, the Grid. Technically and economically suboptimal in 2030? 2050?
- DHDRG: Deep (6 – 10 km) Hot Dry Rock Geothermal systems: Benign, inexhaustible, indigenous, baseload, firm and dispatchable, nearly ubiquitous on Earth, equitable
- The ultimate in Distributed Energy Resources (DER): All electric and thermal energy by loosely-connected micro- and mini-grids PLUS industrial feedstocks. Local and autonomous.
- No transmission nor storage needed: Nearly ubiquitous on Earth. Leave the heat in the ground until needed. Needs gathering and distribution, not transmission.
- Obsoletes wind, solar, other Variable Energy Resources (VER’s)? No large, distant plants requiring transmission? Lower delivered long-term COE, almost anywhere in California, on Earth?
- Should California invest now in nascent boring technologies to accelerate installation of profitable DHDRG access, harvest, and delivery systems? Build a novel industry?

Gaseous Hydrogen (GH2) pipelines vis-à-vis Grid: Underground, lower cost, gathering + transmission + distribution “free storage” by “packing” pipelines to Maximum Allowed Operating Pressure (MAOP); un pack to ~ 1/3 MAOP, for Variable Energy Resources (VER’s)

- ~ $ 30 million: proof
- Electro Pulse Boring: EPB for DHDRG
  - 8,000 MW alternatives: HVAC vs HVDC superconductor
- "H2@Scale" Hydrogen needs regional-to-continental optimized transmission-plus-cavern-storage systems

DHDRG critical path to commercialization from ~ TRL 3 today: Should California risk investment, to invent and deploy?
- Design, build, test Down Hole Pulse Generator (DHPG) to operate at full depth T and P, at 6 – 10 km
- ~ $ 30 million: proof-of-concept test borings to 3 km
- ~ $ 150 million: test borings to 5 – 10 km; design revisions for commercialization; pre-production EPB components: achieve TRL 8

Goals: EPB technology, to enable California’s 2050 goals, without new Grid or pipeline transmission, storage, or fracking
- $ 150 per meter depth, constant, to 5 – 10 km: ~ $ 2 million @ 10 km marginal cost
- Rate Of Penetration (ROP) = 1 m / minute @ 10 – 20 pulses per second (pps)
- $ 0.02 / kWh (thermal) wellhead @ 200 + C: Organic Rankine Cycle (ORC) electricity + District Heating & Cooling System (DHCS)
- $ 0.04 / kWh (electric) at Organic Rankine Cycle (ORC) generator, baseload, dispatchable; micro- and mini-grid proliferation

Affordable, inexhaustible, baseload, benign, equitable, energy almost anywhere in California, and on Earth: limited by topsoil, aquifers