The AMBACHTSHEER Letter
Sustainable Pension Design • Effective Pension Management

August 2022

FIXING GLOBAL WARMING:

A POSSIBLE SOLUTION GETTING TOO LITTLE ATTENTION FROM PENSION FUNDS

"Britain breaks its record for highest temperature ever registered as Europe sizzles under heat wave."

Globe & Mail
July 19, 2022

"A big bet on ultra deep geothermal could help prevent a climate catastrophe."

Globe & Mail
May 27, 2022

Mediums and Messages

Marshall McLuhan's mantra that 'the medium is the message' fits a surprising number of contexts. Global warming is one of them. The July heatwaves are the medium, and the message is that the best way to reduce their severity and frequency is to convert heat into zero-emission electricity to power Planet Earth. How do I know this? Because I read an **article** in the May 27 edition of the Globe&Mail telling me so. A week later, I spoke at a pensions conference in Banff AB and asked attendees what they thought of the G&M article claiming that "*a big bet on ultra deep geothermal could help prevent a climate catastrophe*". Out of a dozen queries, only one person acknowledged reading the article…..although admittedly, not very carefully.

The goal of this *Letter* is to address the article message's 'too little attention' problem. To repeat the message: the May 27 G&M article outlined a possible plan for addressing the emerging climate catastrophe already visible all around us. Based on some further digging, I believe the plan has promise, subject to further technical research and validation. Some of this research is already underway in the USA, Europe, Australia, and Canada. This *Letter* sets out a plan to expand that research, and also makes the case that pension funds have much to gain from staying abreast of these developments, and possibly even get involved some direct way.

Generating Zero-Carbon Emission Electricity for the World

The May 27 G&M article was based on a much deeper-dive *Cascade Institute* research paper titled "**Deep Geothermal Superpower: Canada's potential for a breakthrough in enhanced geothermal systems**", authored by Ian Graham, Ellen Quigley, Scott Janzwood, and Thomas Homer-Dixon. In point form, here is the essence of their story:

- There is enough heat emanating from the earth's core to satisfy humanity's zero-carbon electricity needs many times over into the indefinite future.
- The essence of the generation process is to convert the heat to geothermal power which in turn would drive electricity-producing turbines.
- This conversion process is already producing electricity in the few locations where the earth's heat is close to the surface (e.g., Iceland).

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- However, current drilling technologies cannot go down deep enough (i.e. at least 10kms) to access the earth's heat on a much wider, cost-effective, continuous basis. Increasing drilling speed is critical.
- New 'ultra-deep geothermal drilling' technologies are needed to access this heat to feed the already-existing electricity-generation infrastructure around the world currently being powered by fossil fuels.[i]
- Why bother when we are already generating electricity from zero emission power sources such as wind, solar, and nuclear? Because all three have material shortcomings (e.g., weather variability, energy storage systems, power density, nuclear disposal, rare earths access).
- Equally importantly, we are not at 'ground-zero' with the R&D status of new 'ultra-deep geothermal drilling' technologies. Three promising technologies termed 'microwave', 'plasma', and 'percussive' are already under development.

Given we seem to have reached the record-setting stage of global warming in many parts of the world, this *Cascade Institute* story surely deserves more attention than it currently seems to be getting.[ii]

Some 'Further Digging' Findings

With the critical role that the new 'ultra-deep geothermal power' technologies will play in taking this geothermal story to the next level, it seemed logical to see what a google search would turn up. Again, in point form, this is what I learned:

- Three promising deep drilling technologies have been identified: Microwave, Plasma, and Percussive.
- Microwave is being developed by *Quaise Energy*, in collaboration with *AltaRock Energy* in the USA.
- Plasma is being developed by *GA Drilling* in Slovakia.
- Percussive is being developed by *Strada Global* in Australia.
- *Eavor Technologies* in Canada has developed a closed-loop circulation technology, but has not focused on ultra deep drilling this far.

Here is some publicly-available information on each of these five organizations:

Quaise Energy - USA

- Their gyrotron-powered drilling platform vaporizes boreholes through rock and provides access to deep geothermal heat without complex downhole equipment. First, they use conventional rotary drilling to get to basement rock. Then they switch to high-power millimeter waves to reach 20km depths and 500C heat..
- Implementation timeline: 2024…first full-scale hybrid drilling rig combining conventional rotary and millimeter wave drilling -> 2026…..first Enhanced Geothermal System rated to 100MW from a number of wells -> 2028….first fossil fired power plant repowered with clean geothermal steam….
- The company was spun out of *MIT Science Center* in 2018, and has raised a material $75M in funding thus far from multiple sources, including from *VC Funds*.

AltaRock Energy - USA

- Founded in 2007 and has raised $10M in funding.
- Developed the world's first Super Hot Rock Geothermal site in Oregon.
- Specialist in integrating drilling, well-completion, and reservoir development technologies.
- Partnering with *Quaise* to implement its Microwave drilling technology.

GA Drilling - Slovakia

- Founded in 2008…..100+ employees…..20 patents…..R&D funding from the EU.
- With their unique PLASMABIT drilling platform they can provide geothermal energy at 10km depths.
- PLASMABIT has four subsystems: 1. Pulse plasma drilling head, 2. Bottom hole assembly modules, 3. Transfer line subsystem, 4. Surface equipment with control system.
- System has been vetted by major industry players.
- Open to partnerships and investments.

Strada Global - Australia

- 4th generation drilling family…current firm founded in 2014.
- Key piece of technology is the 'Fluid Hammer Operating System"……70% cost/time reduction from current drilling technologies. Its performance improves even more when combined with high-speed water jets.
- Highly unique, innovative, dual circulation, water-hammer percussive drilling technology.
- Timeline is 2yrs to demonstrate the capabilities of the System….and then to bring it to market.
- There is also a custom drilling rig co-developed with *Herreknecht*.

Eavor Technologies - Canada

- Founded in 2017 to exploit its closed-loop circulation technology (3 patents, 5 more pending).
- $40M in funding, including from Chevron, BP, Temasek, BDC Capital.
- The technology circulates a fluid (e.g., water) to extract heat underground in a closed-loop configuration.
- However, a 3rd party expert study observed "relatively high levelized cost of energy for electricity generation unless significant reductions can be obtained in drilling costs".

What can we conclude from this technology/organizational information? Some strategic thoughts:

- The Millimeter Waves technology seems to have the most explicit scientific validation and financial backing of the three technologies.
- It has the most explicit 3-stage development plan from here to 2028.
- *Quaise* seems OK being the technology provider, collaborating with organizations like *AltaRock* and *Eavor* who would do site selection, reservoir building, repowering fossil-based utilities with geothermal steam.
- So one possible scenario is to, subject to further validation of the technology, create additional implementation organizations like *AltaRock* and *Eavor* around the world (e.g., on a geographic or national basis).
- However, it is far too early to be definitive at this stage. The *GA* or the *Strada* option may turn out to be technically superior as an ultra deep drilling technology. Though unlikely, in a worst case outcome all of the current technologies fail to make the grade in the required critical cost-effectiveness tests. This is an unavoidable risk.

Further Validation of the Deep Drilling Technologies and Possible Next Steps

Thus at this point, much rides on the validation of one or more of the three deep drilling technologies summarized above, and that takes us back to the role of the *Cascade Institute*. Having brought the project this far, the *Institute* is the logical agent to oversee the assessment of these critical technologies, which will significantly clarify the decision landscape for investors, policy makers, and firms.

Its Ultradeep Geothermal Project would assess the effectiveness of hard rock drilling technologies, identify what is needed to achieve the required deep, hard rock drilling cost reductions, and engage key industry, financial, and governmental stakeholders to shape its findings and recommendations. To that end, it foresees three project components:

Component 1. Assess the current state of ultradeep geothermal drilling technologies

- Assess the feasibility of major, near-term advances of various ultradeep drilling and well completion technologies and their potential to provide the cost reductions necessary to make ultradeep geothermal cost competitive with other sources of net-zero electricity.
- Identify key levers for achieving the needed speed increases/cost reductions, and high-level strategies for achieving those.

Component 2. Build a "Community of Intent" around ultradeep geothermal in Canada

- Coordinate and engage with the fragmented landscape of Canadian stakeholders with interest in ultradeep geothermal (and the energy transition more broadly).
- Develop a rough consensus within this community of common goals and create a shared understanding of opportunities, obstacles, and potential strategies for accelerating R&D and investment.

Component 3. Create an R&D and Investment Roadmap

- Build, with stakeholders, a strategy outlining next steps for R&D and investment.
- Clarify the target state for cost-effective deep hard rock drilling (key cost/financial aspects, technical attributes, organizational structure, etc.).
- Identify the key technology, R&D, organizational, and other gaps that need to be filled to achieve this target state. Other gaps will likely include regulatory, governmental and financial support.
- Develop a prioritized list of R&D and uncertainty-reduction activities associated with filling these gaps and identify the resources requirements and next steps for each.

Possible Roles for Pension Funds

A stated goal for this *Letter* was to address the 'too little attention' problem for an idea that could have a material impact in addressing the very real global warming catastrophe facing the entire population of Planet Earth. Readers who made it this far in the *Letter* can no longer claim ignorance. But that is not all. You and your organization can also choose to become involved in taking this project to the next level in some way. The *Cascade Institute* and *KPA Advisory Services* encourage you to consider the possibility.[iii]

Keith Ambachtsheer

Endnotes:

i. *Although new adaption technologies will have to be developed.*
ii. *The Cascade Institute at Royal Roads University is a Canadian research centre addressing critical economic, political, technological, health, and environmental issues. Thomas Homer-Dixon is its Executive Director, Scott Janzwood its Research Director, and Ellen Quigley and Ian Graham are Senior Fellows at the Institute.*
iii. *Earlier drafts of the Letter generated much valuable feedback from both investment and geothermal technology perspectives. Thank you!*

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