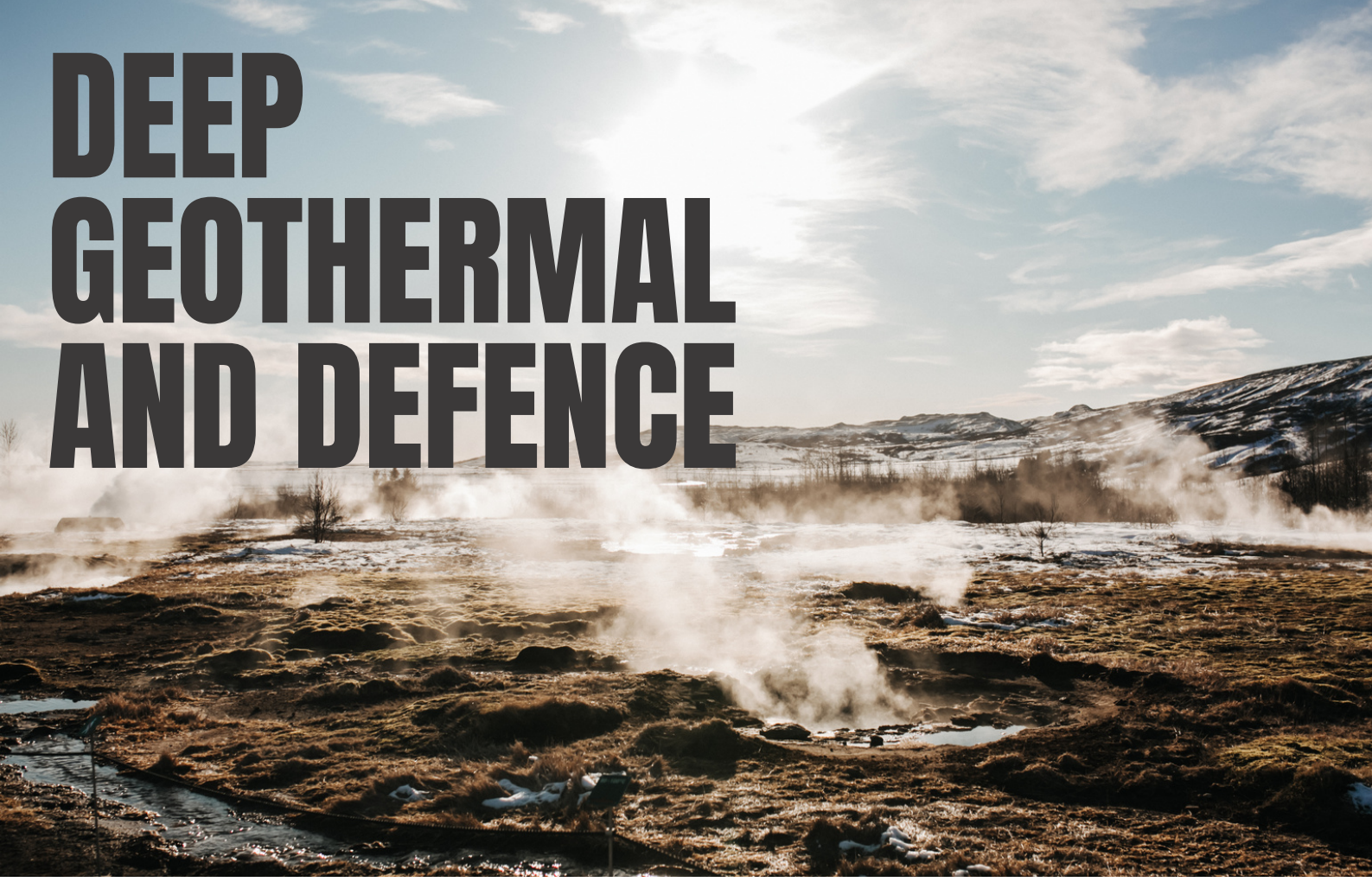
DEEP GEOTHERMAL AND DEFENCE



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We must learn lessons from Ukraine, that bitter, brutal war on European soil. Lessons about tactics, about how to operate in an environment where drones, intelligence, and social media watch everything you do. Lessons about equipment, about the vulnerability of tanks to modern anti-tank weapons, aircraft to modern air defence, and all to cyber-attack. The mechanics of warfare, and how to conduct it, will develop substantially as a result of the brave fight the Ukrainians have put up despite overwhelming odds.

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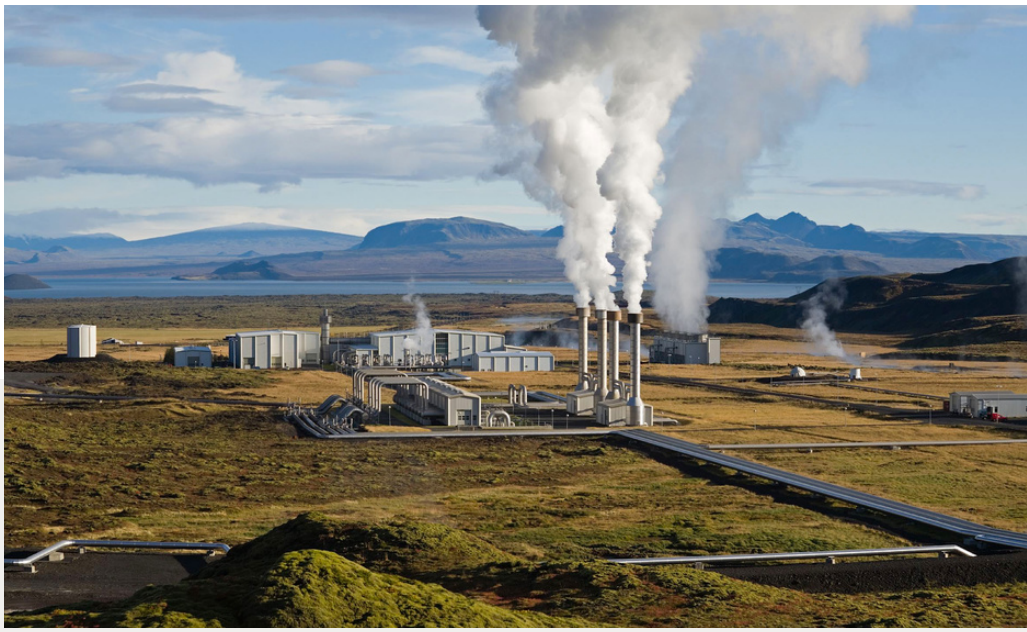
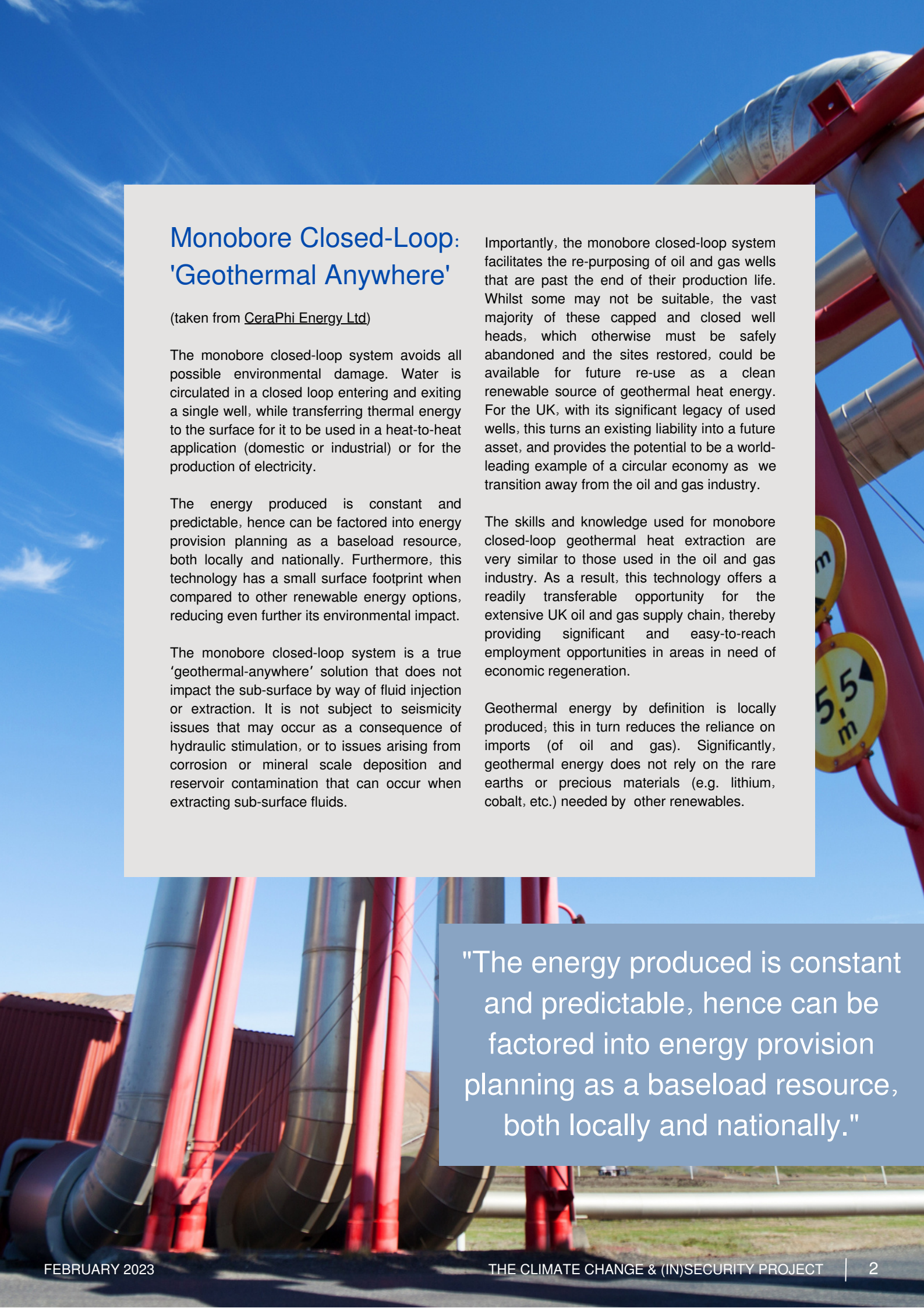
The mechanics of (inter)national governance, and how to exercise it, have developed substantially as a result of the unprovoked attack the Russians have escalated in spite of near universal condemnation. President Putin has cynically and deliberately weaponised energy, and made the supply of energy a key factor in this war. He has turned the provision of energy to Europe from an opportunity for democratisation and development into a vector of coercion and control. From allegedly destroying the Nord Stream 2 pipeline (causing the largest single release event of methane the world has ever seen), to deliberately targeting Ukrainian power plants (including nuclear providers), the Russians have made energy a weapon that compromises socio-economic stability, supply chains, and public morale.





Monobore Closed-Loop: 'Geothermal Anywhere'

(taken from CeraPhi Energy Ltd)

The monobore closed-loop system avoids all possible environmental damage. Water is circulated in a closed loop entering and exiting a single well, while transferring thermal energy to the surface for it to be used in a heat-to-heat application (domestic or industrial) or for the production of electricity.

The energy produced is constant and predictable, hence can be factored into energy provision planning as a baseload resource, both locally and nationally. Furthermore, this technology has a small surface footprint when compared to other renewable energy options, reducing even further its environmental impact.

The monobore closed-loop system is a true 'geothermal-anywhere' solution that does not impact the sub-surface by way of fluid injection or extraction. It is not subject to seismicity issues that may occur as a consequence of hydraulic stimulation, or to issues arising from corrosion or mineral scale deposition and reservoir contamination that can occur when extracting sub-surface fluids.

Importantly, the monobore closed-loop system facilitates the re-purposing of oil and gas wells that are past the end of their production life. Whilst some may not be suitable, the vast majority of these capped and closed well heads, which otherwise must be safely abandoned and the sites restored, could be available for future re-use as a clean renewable source of geothermal heat energy. For the UK, with its significant legacy of used wells, this turns an existing liability into a future asset, and provides the potential to be a world-leading example of a circular economy as we transition away from the oil and gas industry.

The skills and knowledge used for monobore closed-loop geothermal heat extraction are very similar to those used in the oil and gas industry. As a result, this technology offers a readily transferable opportunity for the extensive UK oil and gas supply chain, thereby providing significant and easy-to-reach employment opportunities in areas in need of economic regeneration.

Geothermal energy by definition is locally produced, this in turn reduces the reliance on imports (of oil and gas). Significantly, geothermal energy does not rely on the rare earths or precious materials (e.g. lithium, cobalt, etc.) needed by other renewables.

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Energy has always been an important factor in both war and peace. Against the backdrop of climate and security, energy is now a critical consideration: how we produce it and how we protect our supply.

Permanent long-term (5 years plus) military bases, at home or abroad, can now utilise new technology that facilitates solar, wind, micro-nuclear and deep geothermal (as geographically appropriate) in order to build self-sufficiency of supply. Self-sufficiency on permanent bases is essential as it provides deep resilience for the creation of electricity and heat. Any excess energy supply can also be directed into alternative fuels (hydrogen, synthetic aviation, and land vehicle).

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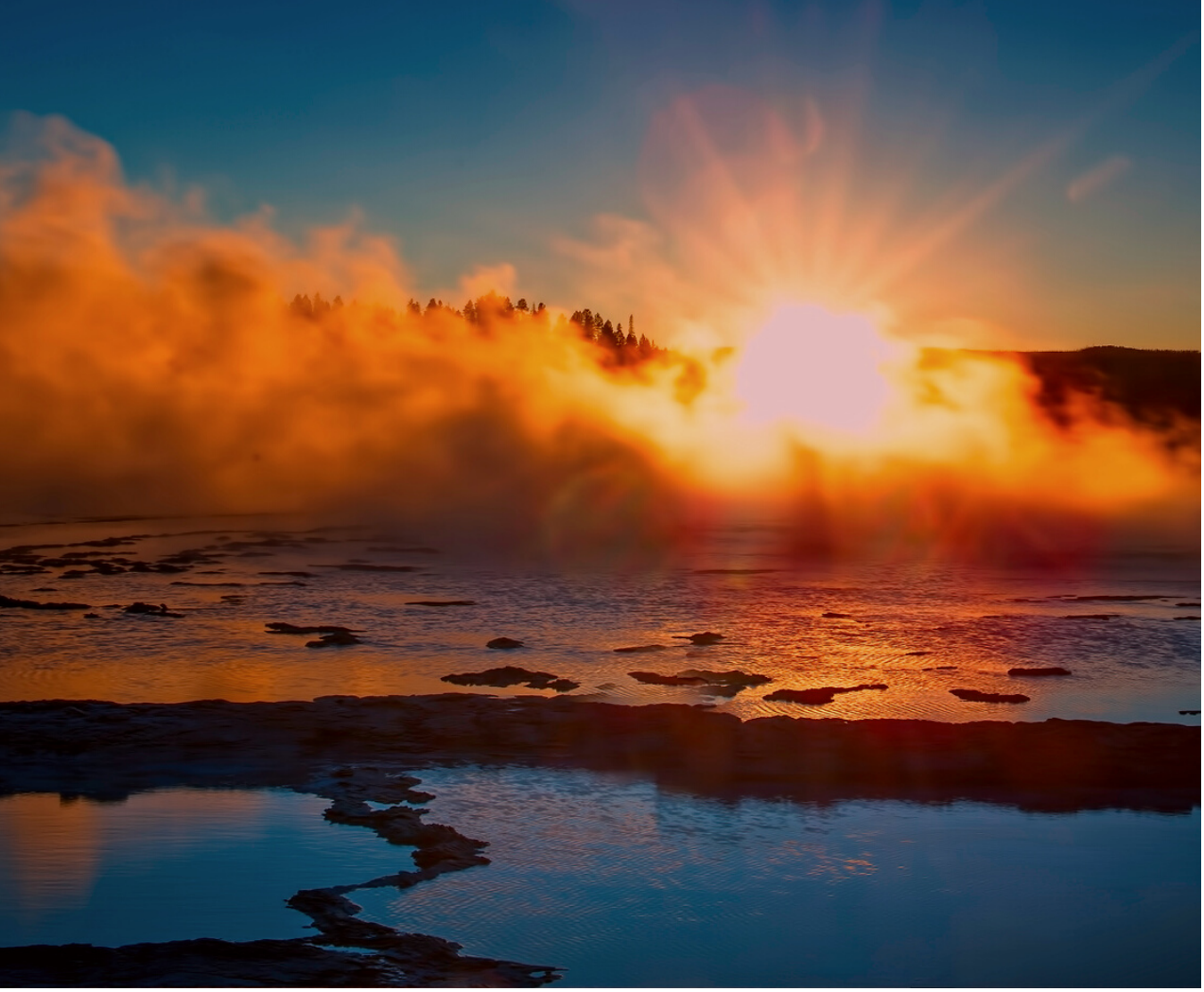
As regards both military and civil planning, it's important to analyse and respond to what self-sufficiency (and sustainability) means in practical terms. This requires balancing the imperative of Net Zero by 2050 against the predicted increase in demand for electricity to more than 150%. The International Energy Agency estimates that this would require a near three-fold increase in zero-carbon sourced electricity.



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In terms of this future sourcing, the impact of climate change on existing weather pattern predictability must be considered – solar and wind energy are weather dependant, geothermal is not. Likewise, climate change is set to reduce the amount of habitable land, with particular impacts on agricultural capacity. Land resources will therefore need to be prioritised for food production and living space. In terms of energy production per square metre, geothermal outperforms solar and wind.

A further risk to be factored is the dependence on competitors, or the inadvertent encouragement of adversaries in relation to rare earth mineral supply, extraction, and control. Rare earth minerals constitute essential components in storage batteries for solar and wind energy. Experts such as Olivia Lazard are concerned by this issue, highlighting potential links between rare earth minerals and the strategic planning of the Russian occupation of Ukrainian territory and the remit of the Russian sponsored Wagner Group in spaces such as the Central African Republic and Madagascar. Again, geothermal provides a more secure option as it does not rely on storage batteries like solar and wind.

Where geographically possible, deep geothermal should be prioritised as it provides the most reliable, easily protected, cost effective energy solution. Geothermal technology provides an affordable source for heat and electricity that is more resilient in terms of an attack on national power infrastructure or military bases at home or abroad. It also offers a carbon free solution that is less vulnerable to enemy and competitor intervention and influence. For long term bases (such as we had in Afghanistan), geothermal provides the optimal energy solution. Defence needs to embrace this new technology now to maximise its effectiveness.