Arran Elcoate – Energy Security in a post-carbon world

'Power station boss warns against reliance on electricity imports' (The Guardian, May 2018), *'UK's energy system at risk of attack by Russian state'* (Telegraph, March 2018), *'Japan is nervous about its energy security'* (Financial Times, July 2018); the briefest scan of Anglophone headlines shows that energy security, understood as the avowed dependency of national security on reliable and affordable energy sources, is a perennially live topic. Concerns of this nature can be traced right back to the 19th century: Lord Kelvin speaking to the British Association for the Advancement of Science in Edinburgh warned that the Britain's dependence on dwindling supplies of coal was a recipe for complete disaster. For Kelvin, Britain's only hope was to harness the limitless power provided by wind via some form of 'windmills or wind-motors'.

Today, the popular imagination continues to fixate on the security risks posed by finite carbon-based energy sources. Increasing dependence on imports as national reserves dwindle; the geopolitical might wielded by states that possess a relative abundance of these fuels and the threat of instability in states whose economies are dependent on fossil fuel exports all feature heavily in both popular and academic security discourse. Less well rehearsed are discussions of what energy security might look like in a post-carbon society. Often the security dimensions of renewable energy sources can be obscured by a sunny utopianism; the sun, wind and tides are limitless, freely available and do not belong to any one national power. Conversely, discussions of nuclear power, which will likely form an important element of any post-carbon energy mix, can distort in the shadow of Chernobyl and Fukushima into unhelpful scaremongering, where images of terrorists packing nuclear weaponry and catastrophic nuclear meltdown abound. No energy source is without its security risks, just as few sources are irredeemably dangerous. From lithium to so-called 'rare earth metals' renewable energy technologies are also reliant on finite resources with their own security dimensions, whilst the nuclear industry works tirelessly to alleviate many common security concerns.

This article tentatively explores the prospective security dimension to these post-carbon energy sources something that, with a post-carbon revolution gathering pace, will soon need to be discussed. Ultimately, three general conclusions are reached. The first obvious point is that post-carbon energy generation contributes significantly less to global warming, itself a threat to energy security. The second is that whilst all forms of energy generation are reliant on finite and contested resources in the case of nuclear and renewable energy the geographical distribution of these resources and the possibility of recycling technologies make them more secure than fossil fuels. Currently recycling many of these resources is prohibitively expensive – similarly, many deposits of these resources lie untapped. It is the contention of this author that the 'securitization' of these energy sources, along with the general pressures of demand, which will bring these currently untapped resources 'on-line'. Finally, while the dangers of nuclear power are liable to bed overstated an energy mix with a greater nuclear power element would still likely present substantial inherent security challenges.

It is worth briefly rehearsing some discussions of energy security geared towards the current fossil-fuel dominated energy mix, so that we might examine their relevance to a prospective post-carbon energy environment. First is the waning abundance of fossil fuels. For many states whose own fossil fuel reserves are relatively limited, like the UK, this poses a risk of increased dependency on energy imports which in turn are likely to grow prohibitively expensive as resources dwindle. This waning abundance also poses an energy security risk by threatening to destabilize oil-exporting nations, like many Middle Eastern nations, whose wealth and stability depends on plentiful supplies of fossil fuels available for export. This instability turn impacts the importing nations who depend on the fuel-rich states to stably export their fossil fuel supplies. Indeed, related to the problem of declining abundance is this security risk posed by import dependence. As well as making energy-importers vulnerable to political instability in other states it raises the possibility that energy imports could be withheld in order to generate geopolitical leverage. The 1973 oil crisis, in which OPEC placed an oil embargo on

those nations perceived as supporting Isreal during the Yom Kippur War, is the classic example; European dependence on Russian gas, and the geopolitical risk this entails, is the most immediate in the popular mind today. More fundamentally, there is also the familiar concern that continued reliance on fossil fuels will lead to an increasingly warm planet. Rising temperatures are not only a security risk in themselves but, by increasing geopolitical instability and the prevalence of extreme weather events, threaten energy security.

Proponents of nuclear power argue it would meet many of these security concerns. Most obviously, although the construction and fuelling of nuclear power stations presently entails some carbon emissions, the core processes of nuclear power generation do not produce climate-changing greenhouse gases. Uranium too has the potential to be a more secure fuel source than fossil fuels. Uranium has an exceptionally high energy density; according to the World Nuclear Association only about 200 tonnes of natural uranium, or less than 30 tonnes of fabricated fuel, is required per year to power a 1000-Megawatt power plant.[1] This makes uranium easier to stockpile than fossil fuels. This, coupled with the fact that there is at present an abundance of uranium available from a diverse range of countries, means nuclear power is in part a more secure fuel source than traditional fossil fuels. The prospect of reprocessing and recycling uranium and fast breeder reactors (which generate more fissile material than they consume) would only serve to reduce the need to import uranium, thus increasing the security of nuclear power further.

Yet of all prospective post-carbon power sources nuclear is the most vociferously criticized in popular media. Fukushima is an emblematic example. For the uninitiated, in March 2011 a 9.0 magnitude earthquake and tsunami caused a meltdown and radiation leak in this Japanese nuclear plant. Whilst the actual damage from this event is often overstated, it did highlight the vulnerability of nuclear power stations to extreme weather events – the frequency of which will almost certainly increase as the planet gets warmer. The debatable risk posed by radiation leaks aside, from an energy security perspective the concentrated nature of nuclear power production in large plants like Fukushima makes the energy they supply particularly vulnerable to these kind of weather events. This contrasts with the more decentralised nature of renewable energy generation, discussed below, although a shift towards smaller modular nuclear reactors (a shift the UK is at least ostensibly committed to) could mitigate this risk.

The second branch of nuclear doomsaying focuses on the threat to nuclear power stations not from the environment but from intentional human malaise. Highly concentrated power sources with the potential, if damaged, to do great human and environmental harm are a natural target in both conventional warfare and within the evolving frontier of cyber warfare. In December 2014 a hacker leaked partial blueprints and operating manuals for three South Korean nuclear reactors with the threat that unless three specific reactor units were shutdown they would be destroyed, and further data leaked online. Measuring the actual severity of this threat is highly difficult and predicting the vulnerability of nuclear power stations to conventional and cyber attacks in the future is even more so. In this case South Korea not only raised the national threat level but drastically lowered its national nuclear energy capacity target. From other security angles South Korea should be inclined towards nuclear energy; much like the UK it has a paucity of domestic fossil fuels. The South Korean rollback then is a testament to the perceived threat of cyber attack on nuclear power.

The second human threat comes not from attacks on the plants themselves but from the security of their fuel and waste. Whilst not strictly an issue of energy security, the existence of uranium and radioactive waste does pose the risk that such radioactive materials might be re-purposed by states or individuals for violent and terroristic actions. There is also the risk that a proliferation of nuclear power globally might have the undesirable effect of inadvertently allowing more states the ability to

[1]http://www.world-nuclear.org/information-library/economic-aspects/energy-security.aspx

nuclear arm themselves – a worryingly destabilizing prospect, at least from the view of the currently hegemonic nuclear powers.

At first glance renewable energies, like wind and solar, seem to escape many of the security problems nuclear power is forced to address. Dams and geothermal plants exempted renewable energy generation has the potential to be significantly decentralized, thus avoiding the security vulnerabilities of a single large plant. More obviously, the fuel used in renewable technologies is limitless and exists in varying degrees of abundance. This is the central thrust of Lord Kelvin's argument – whilst coal will one day run out, or at least grow prohibitively expensive, wind is both limitless and free. Similarly, the global abundance of renewable 'fuels' means they have the potential to liberate states like South Korea and UK from their energy dependence on other variously stable powers. This is the argument recently put forward by the Oxford Research Group (a …), who present 'self-sufficiency in energy production' as the central security benefit of a shift toward renewable technologies.

Renewable technologies are however also reliant on insecure and finite resources. Whilst the fuel used in renewable power generation is limitless the materials used in the construction of the generators themselves are not. Materials like quartzite, used in the construction of solar panels, lithium, near ubiquitous in the batteries upon which renewable energy depends and the so-called 'rare earth metals' are all finite and present a growing security concern. Already, the actions of various global actors can be read as an attempt to secure supplies of these resources. Beijing's massive economic and diplomatic push into Africa, where there is great potential for rare earth production, coupled with investment into Latin America, where lithium is found in the greatest abundance, suggests an effort to secure these increasingly valuable resources.

The security of lithium reserves is a well-publicised example of this dimension to renewable energy generation, not least because lithium batteries are still for the most part an essential part of one of the most powerful symbols of a post-carbon world, electric cars. Currently, ¾ of the world's known lithium reserves are concentrated in the southern cone of Latin America, with other significant deposits being found in China and Australia. Although not an identical circumstance to the concentration of oil in the Middle East many aspects of the global distribution of lithium are analogous. Many Latin American nations have shown themselves to be vulnerable to political instability and they, along with the shipping lines that link them to the rest of the world, are as vulnerable as anywhere to the effects of global warming. Although currently found in relative abundance the ultimately finite nature of lithium also cannot be ignored; the possibly of future price spikes and lithium-motivated conflicts cannot be ignored. Yet, unlike the fuels used in non-renewable energy generation, generating renewable power does not require a constant throughput of lithium nor any other mineral. Other analysts have pointed to the ready possibility of recycling lithium, which is not consumed in the production of batteries, or of other sources of lithium, such as that extracted from seawater, coming 'on-line' as demand for increasingly scarce supplies makes the currently prohibitive cost more palatable. A similar discussion could be had with regards to materials like quartzite (currently concentrated in diverse nations including China, US, Russia, Brazil and Norway) and copper (again found in US and China, but increasingly mined in nations like Chile, Peru and the Congo).

Rare earth metals present a more interesting case. As Julie Michelle Klinger's seminal *Rare Earth Frontiers* argues contrary to the alarmist warnings in the anglophone press, rare earth metals are not actually all that rare. Currently, China absolutely dominates the extraction of rare earths, providing 85% of the global supply in 2015. The security dimensions of this dependence are well illustrated by the conflict between China and Japan in late September 2010. Following Japan's detention of Chinese fishing trawling captain Beijing blocked the exports of rare earth to Japan, immediately highlighting Japan's near-absolute dependence on its turbulent neighbour. However, unlike with fossil fuel production, the geographical distribution of rare earth production is not geologically determined.

Instead, as Klinger's work so compellingly argues, the pre-eminent factors are political. Firstly, mining rare earths is hazardous to humans and the biosphere. Rare earth mining has thus naturally shifted to frontier zones where human life is deemed less valuable. China's dominance today is in part the result of a massive migration of Euro-American production to China in the 1990s, following a series of environmental disasters. Secondly, rare earth exploitation is a way of asserting control over contested frontier areas. The Brazilian government's ongoing efforts to mine rare earths in Sao Gabriel de Cachoeira is a perfect example. The region in North West Brazil does contain sizeable rare earth deposits – but so does much of Brazil, much of it more accessible than this poorly connected Amazonian region. What makes Sao Gabriel de Cachoeria special is not its geology but its geopolitical position, on a contested border with Venezuela and Colombia.

There are alternatives to this bizarre geologically incongruous state of affairs. Rare earths can be produced more safely and sustainably, through recycling and extracting from existing waste sites, thus obviating the need for them to be produced in remote areas. As with lithium and the more novel nuclear technologies the cost of these methods is currently prohibitively expensive. However, it seems to this author that a combination of demand and, more importantly, the 'securitization' of rare earth production will be more than ample inducement to overcome this difficulty. Raising an issue to the status of a 'security concern' is a tried and tested method of galvanizing the public will and national purse, which have both proven responsive to the 'fundamental' nature of a security threat. It is precisely because these post-carbon methods of energy production have an energy security dimension that efforts will made to address it.

The shift to carbon-free energy production will not ameliorate energy security concerns entirely. Various finite resources will still have to be secured. If nuclear power remains in the energy mix this too presents security concerns, including the security of the plants themselves and the uranium which fuels them. Overall however these security concerns pale in comparison to those associated with fossil fuels. Not only is the existential threat of global warming reduced, but so is dependence on often unstable hydrocarbon-rich states. As alluded to, publics and their governments are often most susceptible to arguments framed as 'security' concerns. Perhaps it is this more immediately recognisable benefit carbon-free energy, rather than the overwhelming existential threat of global warming, that will catalyse a much-needed post-carbon revolution.