A New Energy Security Paradigm for the Twenty-First Century

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Abstract

This paper considers three timescales facing energy policy makers: the timescale of technological innovation, the timescale of fossil fuel resource depletion and the timescale of harmful climate change. The paper posits a future of rapid climate change in which technological innovation struggles to match the demands placed upon it. In this scenario resource depletion recedes as a driver of energy policy. The paper considers a possible accompanying evolution in foreign and military policy over such a period. A future is described in which naval power is redeployed within a generation away from today's mission of supporting unfettered free trade through international choke points to a role of interdiction and control by which the leading industrial powers, and their allies in the developing world, seek to prevent high carbon dioxide emissions from a few recalcitrant sovereign states. Historical parallels are drawn with the similarly rapid paced end to the Trans-Atlantic slave trade in the early Nineteenth Century.

Keywords

Energy Security, Climate Change, Decarbonisation, Energy Alliance

Summary

Conventional energy security has been focused on the depletion of natural resources, particularly oil, natural gas and coal. More recently, the link between energy security and the military has been made, focused on the defence of international oil tanker chokepoints and the free flow of oil through these trade routes. This paper considers a possible future in which, the impacts of climate change have been realized far earlier than most experts have previously expected. This has promoted a transition to cleaner energy technologies long before the depletion of fossil fuel resources. In this scenario, the peak in demand for fossil fuels occurs before the peak in supply and some nations are strongly promoting the development and deployment of clean energy technologies. Some private companies developing and deploying these technologies benefit from sudden market expansion, fueled largely by the world's richest nations struggling to reduce their carbon footprint.

In this scenario the countries of the world would fall into one of the three categories: (1) the countries willing and readily able to adjust in response to rapid and serious climate change, (2) countries willing to adjust, but facing significant economic hardship without external assistance and protection, (3) and those countries unwilling and, perhaps to their perception at least, unable to play a part in combatting climate change. In this scenario, the Western Economies will likely fall under the first category while the BRIC countries (Brazil, Russia, India, China) might fall into the second category. These nations are needed to achieve a viable, powerful, and effective formal or informal "Clean Energy Alliance". Some countries however will probably fall into the third category. This paper considers how countries in the first two categories could, and perhaps should, respond by adjusting their foreign, trade and even military policies.

If climate change is as severe and as pressing as some fear, leadership will be needed from those nations who are most capable of responding to the crisis. Within a generation, the great powers might find themselves shifting from keeping trade routes open to constraining the same trade. Severe climate change impacts could even approach the timescale of technological innovation needed to respond to this crisis. This paper proposes that our world may need new military and foreign policy options as well as new energy technology options in the years to come. Parallels are drawn between the challenge of decarbonising the global energy systems in the early twenty-first century and the ethical imperative of ending slavery in the early nineteenth century.

Introduction

Energy Security has returned to the top of the international agenda in ways not seen since the oil embargoes of the 1970s. The Russian government, when for the first time hosting the G8 in St. Petersburg in July 2006, put energy security centre stage giving it an international prominence not seen in recent years. Ironically, leading up to the Summit, the country posing the paramount energy security risk to the EU was the one putting the issues at centre state. Rising global energy prices, growing demands for energy in China, conflicts in Africa and the Middle East, and natural disasters constraining an already tight oil supply are making it difficult to avoid the issue of energy security. Such thinking prompted President Bush, in his 2006 State of the Union address, to highlight the obvious by saying that "America is addicted to oil" [1].

Energy security has been framed primarily around availability and access to fossil fuels. Interruption of the energy supply has been identified by many as the primary threat that faces global energy security. In an era of global terrorism, Daniel Yergin revealed that al Qaeda has openly committed to attacking "the provision line and feeding artery of the crusader nation" [2]. This example is representative of one driver for a fresh perspective on energy security – the perspective of energy and security; both national security and military policy. This is the nexus explored in this paper.

Oil literally fuels the global economy. Both the United States and Japan, as examples, can be used to highlight the potential risks of energy dependence. With only $1/20^{th}$ of the world's population, the US consumes almost 1/4 of the world's oil and has less than 3% of the world's proven oil reserves [3]. Sudden supply fluctuations impact all countries that rely on this commodity and disruptions in the supply pose a further risk. Although the US imports more than 60% of the oil it consumes [4], Japan is even more vulnerable to disruptions in the transport of oil to its shores because it imports more than 90% of the oil it consumes [5]. This situation is further complicated by the artificially low cost of energy in some countries, such as the United States, where the government has not properly reflected the true cost of energy in its price. These are the so-called negative externalities, such as environmental impact and costs associated with securing and maintaining access to energy supplies.

At the end of 2005, British Petroleum placed proven world oil reserves at 1.2 trillion barrels [4]. Even if no further probable reserves are classified as proven, which is extremely unlikely, and even if an increase in energy efficiency offsets some of the increase in consumption associated with an expanding global economy, the proven reserves can be expected to meet our needs (80 million barrels per day, rising to 119 million barrels per day by 2025 [6]) for the next 30 or more years without any transition to alternative feedstocks. This conventional thinking, whereby the peak in supply will come before the peak in demand, was postulated by M. King Hubbert in the 1950's [7]. Such thinking posits that 'peak oil' exists and that once past the peak, oil supply will decrease, prices will rise, demand will fall and innovation into alternatives will occur. Others, such as M.A. Adelman, suggest that the peak oil hypothesis and the notion that the world faces a serious reduction in oil reserves is flawed [8]. The peak oil hypothesis, neglects, among many things, the vast reserves of unconventional oil available in the form of tar sands and shale oil. For example, bitumen (mined from tar sands) in Alberta, Canada is technically challenging to convert, but these unconventional reserves are huge, estimated to be on the order of ¼ trillion barrels [9]. In addition, these reserves are highly profitable. In 2006 Shell reported that synthetic crude, made from bitumen, generated a post-tax profit of nearly $22/barrel, approximately $10/barrel more than Shell's average profit

per barrel of crude [10]. Sustained high oil prices will continue to drive exploration and development in oil from tar sands. The authors of this paper share this scepticism of the "peak oil" hypothesis.

Rather than face a peak in supply, it appears that we will always have access to oil, if we want it. Prices to extract, refine and transport fossil fuels are likely to remain affordable by advanced industrialised economies for the very long term. A more sophisticated assessment than "peak oil" leads one to the notion that there could be a peak, but that it will be a peak in demand not supply, or to be more precise the peak in demand will occur before the peak in supply. This position has been popularised via the aphorism attributed to the former Saudi Oil Minister Sheikh Zaki Yamani when he reportedly said "the stone age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil" [11]. This assessment lies behind the ideas presented in this paper.

Much of our international geopolitical energy security is locked in the orthodox mindset that tells us that our efforts in commerce, diplomacy and military power must be devoted to keeping open the global trade in fossil fuels [12]. The timescale of the collapse of this endeavour being measured in terms of the depletion of fossil fuel energy reserves, on a timescale of the next 30 or more years.

The 2006 UK Energy Review summarised this current prevailing attitude to the challenge of global energy security when it said on page 19: *"We need …a strong international agenda to promote more open and competitive markets"* [13]. The UK DTI Energy White Paper 2007 continues the sentiment of the 2006 Energy Review stating [14]:

> *1.22 Our international strategy is built [on …]:*
> ***1. Promoting open, competitive energy markets*** *which provide fair access to energy supplies, foster investment throughout the energy supply chain and deliver diverse, reliable supplies at competitive prices. Governments are responsible for establishing the market framework, based on clear, stable and non-discriminatory rules, and for the effective regulation of the market. Effective markets will ensure that the world's finite natural resources are used in the most efficient way and ensure that we make the transition to a low carbon economy at least cost. Governments also have a role in planning for contingencies (such as major disruption to supplies), where markets alone would be unable to manage the impact.*

The markets for companies that develop energy technologies are greatly influenced by evolving government regulations (US sulfur emissions cap-and-trade, EU Emission Trading Scheme, etc). Early technology development sometimes occurs in advance of regulatory measures to secure intellectual property and hedge against changes in the marketplace. However, technology development and deployment in the marketplace may also lag government policy.

Consideration of energy security in the context of global climate change has until recently been somewhat naïve and uncritical, overshadowed in the EU by pipeline politics with Russia and overshadowed in the US by rising oil prices and tense relations with some countries in the Middle East. Perhaps, in part, this is because those concerned for ecological stability and those concerned for geopolitics and defence are sometimes not amiable acquaintances and generally operate in different spheres. However, circumstances are changing and influential reports are appearing concerning the impact of fossil fuel combustion (via climate change) on energy security. For instance one such example is the International Energy Agency's recently published report entitled *Energy Security and Climate Policy – Assessing Interactions* [15]. Also, and as mentioned previously, the new *energy and security* approach leads one to

consider the relationship between energy security and national security. One example is the suggestion from a recent US Council on Foreign Relations independent task force chaired by John Deutch and James Schlesinger that the United States must "integrate energy issues with its foreign policy" and that the US must "transition to an economy that relies less on petroleum" [16]. This paper explores the further notion that in the decades to come foreign policy backed by military force might, for reasons of a climate change crisis, be used to militate against unconstrained fossil fuel combustion. Today, there are few voices of leadership in this new space of ideas, but the recent words of Governor Schwarzenegger of California are noted with interest:

> *I believe in free trade, and I believe that it lifts everyone's standard of living. But eventually we will look at those countries that produce goods without regard to the environment the same way as we look at countries that produce goods without regard to human rights …such as those who allow sweatshops. My guess is that within the next decade or so, if an economy ignores the damages that it's doing to the environment, the civilized world will impose environmental tariffs, duties and other trade restrictions on those countries. This is a matter of fair trade. Nations cannot dump their products, and one day in the near future, they will not be able to be allowed to dump their carbon or their greenhouse gases either. It gives them an unfair advantage*
>
> 12 April 2007 meeting of the Council on Foreign Relations [17]

New Technologies Are Essential

Advancements in technology will be the only way the human race will discover sustainable, renewable, safe, low-cost, and secure energy sources. There will be no single technology, but rather a combination of many technologies that collectively meet the globe's energy needs. Much of this innovation will originate in the most developed economies. The development and deployment of these technologies will be driven by both naturally emerging market conditions and markets created by government policy.

One example of such an innovation will be the path to commercial deployment for Integrated Coal Gasification Combined Cycle (IGCC) electricity generating plant. This is an advanced technology, driven not only by US government policy, but also by the prospect of higher thermal efficiencies and lower emissions of conventional air pollutants as compared to conventional Pulverised Coal (PC) plants. IGCC is well suited to the later deployment of carbon capture and storage (CCS), providing the possibility of continued coal combustion consistent with climate-friendly action. Despite the expected higher thermal efficiencies, IGCC with CCS will be a significantly more expensive way to generate electricity than simple and conventional PC plant in those jurisdictions where there is little or no value for greenhouse gas emissions.

In a climate change constrained economy, CCS offers a unique opportunity to reduce carbon emissions drastically and enable many coal-rich countries to consume their vast endowments; estimated in the US to last 250 years at the current level of consumption [18]. Electricity generated from coal represents the largest share of US power generation and is a fuel with strong energy security benefits, sourced from many States.

Another technology that offers increased energy security in the United States is the plug-in hybrid vehicle (PHEV). In the US, the PHEV creates an opportunity to "fuel switch" from gasoline, refined largely from imported petroleum, to electricity, generated largely from domestically sourced coal.

In a world unable and/or unwilling to reduce its carbon footprint, the energy security benefits of increased coal use could be outweighed by a catastrophic climate tragedy: rising sea levels, hurricanes and drought; and the death and destruction caused by these events. Pulverized coal plants are popping up in China at a rate of two 500MW coal-fired power plants each week [19]. The availability of IGCC and CCS technology will not only offer China a solution for improving its dreadful air quality, but also allow China to constrain its carbon emissions. IGCC demonstration projects are already in operation in Europe and the United States [20]. Favourable policies and market trends could lead to adoption of this technology within the next decade. Since CCS technologies are in an earlier stage of development. The development of CCS technologies could be accelerated by policies that promote cleaner coal technologies. In the case of Plug-in hybrid vehicles, technology development is underway and the first models are expected to be available in 2010 [21]. Again, the rate of adoption will depend on market conditions and the policy landscape once the technology is widely available.

In some cases, the timescale of technology development and widespread deployment can be longer than 10 years, even with significant government incentives and market demand. The shift in public opinion about the severity of climate change, needed to enable greater government support of clean energy technologies, could occur months or even years into the future. The shift in perception and government action could occur sooner than the timescale of technological innovation. In the event of rapid and serious climate change the world could find itself scrambling for a solution.

Three Timescales

The three timescales critical to the paradigm shift described in this paper are: (1) natural resource depletion, (2) climate change, and (3) technology development, demonstration and deployment. The idea of timescales will be referred to throughout this work. Generally speaking, these timescales refer to an approximate timeframe or duration for technology development, change in perceptions about climate change and resource depletion. Technology improvements, government incentives, market conditions, and many other factors will affect these timescales. For the purposes of this work the timescales are estimates.

The first timescale is the slow timescale of resource depletion (given current emphasis on oil and gas this is conventionally expected to be somewhere in the second half of the twenty-first century: greater than 40 years). The other two timescales to be considered are the timescales of climate change policy (usually estimated as somewhat more than 50 years), and the timescale associated with technological innovation and substitution (estimated to be around 20 years). While, of course, the timescale for technology development is spurred by external drivers such as rising oil prices or changes in regulation, there are certain factors, for instance the productivity of skilled labour that can only enable technology development and deployment within a certain timeframe.

Generally speaking, the resource depletion and climate change timescales has generally been thought to be broadly similar, and both have been regarded as occurring many years into the future. As such, there has generally been no incentive to examine the details or to adjust consideration of energy security policy from that which would be arrived at from a consideration of resource depletion alone. We assert that much policy for energy security, perhaps incorrectly, relies on resource depletion as the pacesetter rather than climate change.

The energy security paradigm considered in this paper differs from the conventional "energy and security" paradigm presented earlier and as highlighted in the recent eponymous book edited by Kalicki and Goldwyn [22]. The purpose of this paper is to propose an alternative and perhaps somewhat disconcerting vision for the future of global energy and security. The proposition described here is not a prediction of the future, it is merely one possible future in a world trajectory popularised by James Lovelock in his polemical but stimulating book, *The Revenge of Gaia* [23]. One could imagine this future emerging in a world that is initially slow to address climate change, and which is then triggered to act by a growing awareness of a crisis far more serious than has previously been expected. In such a scenario it will be the onset of observable impacts from climate change, and the associated change in public perception of the severity of climate change that will drive innovation and technological substitution not the timescale of fossil fuel resource depletion. Climate change might eventually be sufficiently pressing that innovation may not be able to occur easily and with sufficient speed to allow our society to transition away from dirty fossil fuel combustion to cleaner, more sustainable energy production. There will be no shortage of fossil fuels, but the way in which society uses these fuels will be very different than today.

The paradigm differentiates between those countries that are ready, willing and able to shift away from dirty fossil fuel combustion in the absence of the threat of resource depletion, and those countries that are not ready, willing or able. In this paradigm, some private companies will be able to deliver the energy technologies that are needed in a carbon-constrained economy. Some companies are already committed to and making significant returns on clean energy ventures, such as wind and solar power, though this type of response from private industry is visionary in today's business world. It is these types of companies that will benefit if the scenario presented here emerges. These companies will meet the energy demands of countries that have accepted the need to constrain their carbon emissions and are willing to pay to do so. Clearly the list of countries must include the European Union, the United States, Canada, Japan and Australia.

In the United States there has been a refusal to enact federal requirements to reduce greenhouse gas emissions, however the Administration is slowly recognizing the need to act. The timescale of such a transition in attitude at the national level could be shorter than any of the three timescales referred to earlier. The Presidential election in 2008 will be an important step in the anticipated process of transition, though challenges remain: the US relies heavily on coal-fired electricity generation and has a history of favouring domestic policies, such as sulphur emissions trading, over international agreements, such as the Kyoto Protocol. The countries referred to thus far are needed in the scenario presented here, though their efforts alone are not sufficient.

The countries of central concern are another bloc of nations, called the "BRIC" – Brazil, Russia, India and China. These powerful, rapidly developing geopolitical powerhouses must be advocates of action against climate change if the planet's climate is to be stabilised. These countries must be persuaded to adopt the clean technologies urgently developed by the richer countries in the former group. Favourable economics, national participation in the investment and a desire to address poor air quality should help motivate these countries to adopt clean energy technologies. The rest of the world needs these countries to subscribe to international best practice. This paper considers a future shaped by this optimistic assumption.

BRIC; the Critical Nations

Global energy consumption is being driven by soaring demand in Asia. In 1970, Asia accounted for 15% of the total global energy consumption. In 2000, Asia consumed 27%, and it is expected that Asia will consume 35% by 2030 [5]. Since 1995, the number of cars in China has almost tripled and it is expected that there will be more than 50 million cars in China by 2010 [24]. Soaring consumption is leading China to pursue oil production beyond its borders in the Middle East, Russia and Africa [25]. In Russia, the story is somewhat different. Russia is the world's second largest exporter of crude oil and holds the world's largest reserves of natural gas [25]. This gives Russia enormous political influence through its state-owned pipelines, oil companies, and gas companies. Competition for Russian energy supplies is fierce. Russia is acutely aware of the opportunity provided by China and other Asian economies for its gas exports. In India and Brazil, rapid economic growth is fuelling demand for energy, however these two countries hold greater potential for different models of energy production. Brazil is widely known for the sugarcane ethanol industry that emerged after significant government investment over the past decades [26]. Though reliant on coal for power, India is increasingly becoming dependent on distributed renewable energy systems, such as biogas produced from the anaerobic digestion of animal waste, solar PV for electricity and solar thermal for hot water heating [27]. As Brazil and India's energy demand soars—to meet the growth of their economies—early adoption of renewable energy alternatives will initiate best practices in these nations. These four nations not only represent a large proportion of the human race, but also the future centres of energy demand.

In a world where the peak in fossil fuel demand occurs before the peak in supply, the price of fossil fuels may fall to the point where one of two things may happen: (1) BRIC countries may opt for the same cheap fossil fuels that rapidly grew Western economies over the past century, or, as is considered in this paper, (2) BRIC countries may be persuaded to join the group of clean consumer nations, using technologies from the US, Europe and Japan issued under favourable licensing terms. It is even possible that a decrease in demand from the Western economies (plus the BRIC states) might hurt the economies of producer regions, fueling further political instability and potentially even undermining OPEC, where six of the eleven OPEC countries (Saudi Arabia, Iraq, United Arab Emirates (UAE), Kuwait, Venezuela, and Iran) hold two-thirds of the total world oil reserves [5].

Even if the BRIC countries were on-board, the future would not be assured. There are many countries not named above whose actions will also be important. The participation of these countries is not directly vital to global climate stability, as is the case for the BRIC nations, but nevertheless the contribution of countries in this third group is important to global climate stability. More importantly still, international action must protect the BRIC states against actions of other states keen to achieve economic advantage as a result of relatively low cost fossil fuels and dirty practices in energy use. This is the future hinted at by Governor Schwarzenegger [17]. All countries making the shift to a low carbon future need to be protected against such threats and the poorer the progressive state in question, the greater its need for protection.

For the sake of argument, Indonesia can be taken as an example of a country that might find itself in this third group. In 2002 Indonesia created 40% of all anthropogenic carbon dioxide emissions through deforestation [23]. Indonesia is, and of course will continue to be a sovereign state. Today it has the right to combust domestic and imported fossil fuels in any way it chooses. Some such nations may opt not to follow the clean consumer nations. These

countries will benefit from the low cost fossil fuels brought about by falling demand. For these nations to join the clean consumer nations, clean energy technology solutions will have to be cost competitive with current energy production. It is our hope that Indonesia, and States like it, would choose voluntarily to join the group discussed earlier, but it will be inevitable that some states choose not to join others in adopting the best practice. The decision to join will rely on many factors, including the political climate, the severity of the climate crisis, and the foreign policies and trade policies of other countries.

The Clean Energy Alliance

In the paradigm presented in this paper the 2030s will see a world very different from the world we enjoy today, and that will not be simply as a consequence of the eroding climate. Globalisation will have led to an increased internationalisation. Intervention by the great powers in the affairs of lesser powers might be commonplace with, or without, the gloss provided by endorsement from the United Nations. Intervention might occur to prevent genocide, to protect the rights of women and children, and even to prevent 'climate crime'. Those recalcitrant states that obstinately refuse to transition from dirty fossil fuel burning technologies to cleaner technologies will risk facing military-backed embargoes. The great powers at the heart of the collective action will protect their own economic and environmental security and that of less powerful allies, by constraining the energy policies of others via foreign policy and military action. In such a scenario, international fossil fuel trade will require a robust system of permits with, for instance, end-user certificates (perhaps not unlike those used for munitions shipments today) indicating that the cargo carried is indeed to be used in a qualified clean combustion system such as the named IGCC power plant with CCS. Somewhat different tactics would be required to constrain pipeline shipments and most difficult of all would be attempts to constrain domestic fossil fuel use in local power plants. Nevertheless international permitting would send a powerful signal of the international community's attitude to recalcitrant states that persist in irresponsible behaviours. The countries that subscribe to the principle of a prompt transition from fossil fuels to cleaner technologies and favour fossil fuel trade constraints would form the membership of the proposed Clean Energy Alliance.

A Clean Energy Alliance conjures up ideas of a NATO-style military alliance to ensure the stable flow of energy resources around the globe and/or an OPEC-style consumer alliance that operates as a "counter-cartel of consumer nations." [28] An energy alliance that brings some of the principles of both alliances could open a dialogue between counties to identify common energy security interests and to develop joint military planning in order to secure energy supplies. The Clean Energy Alliance could share the burden of military costs and provide a common voice for members of the Alliance. The mechanism for engagement (i.e., the United Nations, the G8, NATO, OECD, etc) and the degree in which nations are committed will emerge based on the severity of the climate crisis. In the case of a severe threat, one could envision a world in which nearly all citizens share a common desire to accept relatively slight economic penalties (higher taxes, higher fuel costs, etc) to address climate change.

Such an alliance could also be responsible for defending global fossil fuel tanker chokepoints (Straits of Hormuz between Oman and Iran, through which most Gulf oil is exported, and the Straits of Malacca between Malaysia and Indonesia, through which 80% of Japan and South Korea's oil imports are transported) (see [29] in [12]), monitoring critical energy infrastructure, training local soldiers, co-ordinating energy terrorism intelligence, protecting international companies and their employees, and managing the response to energy crises.

Thus far the cost of securing the energy supply has largely been borne by the US military; one of the few organizations capable of completing such a task from an operations and cost standpoint [12].

The Institute for the Analysis of Global Security reports that the cost to the US of defending the sea lanes of communication and providing military assistance to partners in oil supplying nations is $50 billion per year [30]. The contribution of the US military to securing global oil supplies is clearly substantial, but equally important may be the opportunity cost of these military efforts. While a move to constraints on fossil fuel shipments might appear burdensome it should be remembered that the vast majority of shipments would proceed unimpeded. The cost of such a scenario would be substantial, however this cost should be compared to today's substantial cost of military and foreign policy support.

An Historical Parallel

From the supply side, transitioning to cleaner energy technologies such as IGCC with CCS, wind power, solar power, plug-in hybrid electric vehicles, and sustainably produced biofuels will be a gradual process. Similarly, from the demand side, increasing vehicle fuel economy, energy efficiency and energy conservation will also be a gradual process. The rate at which we transition away from fossil fuels will be driven by the economics of these, and other, cleaner technology options. However, the process of weaning ourselves off fossil fuels will be accelerated by any identifiable environmental impact that can be unequivocally attributed to climate change. Drought, flooding, and hurricanes could prompt recessions. Death and destruction will know not differentiate between members and non-members of the Clean Energy Alliance. Private companies and governments who are accepting of this paradigm, and who are prepared for this transition, will fare better than those who are unprepared. The aftermath of a climate change catastrophe will have two routes. If BRIC countries were to join the alliance of cleaner consuming nations, more effective progress will be made. If BRIC countries do not join the alliance then the future is dismal for all.

The scenario described here is presented from the fear that perhaps it may unfold. Some will counter that such a strategy is impossible because of its political implausibility. How can these great powers that currently use their navies to keep open fossil fuel trade routes, re-deploy their forces within a generation to enforce a constrained fossil fuel economy? How can we imagine such a volte-face in good conscience? History may offer a possible parallel. One such possibility comes from the late eighteenth and early nineteenth century when, arguably, Britain was the world's only superpower.

In the late eighteenth century the Royal Navy had many functions including keeping open the trade routes for what was to become the British Empire. An awful truth is that much of this power and finery was deployed to maintain the unconscionable trade in African slaves – innocent individuals ripped from their homelands, demeaned and sold into the hands Caribbean planters who treated them most cruelly. Within a generation, however, this trade was gone. Britain closed down its transatlantic slave trade first with a domestic ban on slavery and finally and much more importantly across all British dominions. Slavery had made Britain rich and indeed it exhibits a certain hypocrisy that the UK then pressured others to leave the trade. Despite the hypocrisy it was most definitely the only right thing to do.

The British slave trade of the late Eighteenth Century had made many people very rich [31]. Whole cities in the UK such as Liverpool had developed on the back of the trade. Western

powers did not conquer or colonise the African supplier states, instead they negotiated and bribed intermediaries in order to access the scarce resource. Generally, there were only modest European investments in direct infrastructure, for instance in African forts. Naval protection, however, was of key importance for the viability of the British Slave trade. In particular Royal African Company forts and other assets had been protected by Royal Navy warships.

In considering this possible historical parallel it is important to note that the abolition of slavery was accompanied by redefinition of British identity as a free civilised society [32]. As Linda Colley puts it "Anti-slavery became an emblem of national virtue" [33]. Key parts of the history of abolition include the acts and battles leading up to 1811, when it was made a felony to participate in the slave trade [34]. Importantly, in the period 1807-66 the Royal Navy intercepted more than 500 slaving vessels. Enforcing the shutting-down of the Atlantic slave trade was costly and tied up significant naval resources, although British pressure tended to stop short of full blockades and suppression of the slave trade never became a driver for the growth of British naval power [35]. Despite Britain's efforts the slave trade continued beyond Britain's borders legally and illegally for several decades. The United States finally completely abolished slavery following its Civil War, in 1865.

The story of Britain's *volte-face* on slavery serves, perhaps, as a helpful analogy for the severe climate change-initiated paradigm described in this paper. The world's largest economies have become rich from the unsustainable use of fossil fuels. It will be the duty of these same countries not only to alter their own behaviour, but also to stop others from continuing with the same unsustainable actions. A move to such a future must be built upon consensus and persuasion, but as is explained here, for the recalcitrant few, coercion may be an unfortunate necessity.

Concluding Remarks

If climate change is as severe and as pressing as some fear, leadership will be needed from those nations who are most capable of responding to the crisis. Within a generation, the great powers might find themselves shifting from keeping trade routes open to constraining the same trade. Severe climate change impacts could even approach the timescale of technological innovation needed to respond to this crisis. Short timescales of twenty years not only apply to the invention, development, and deployment of new energy technologies, but also to the time it takes to plan and build up new military technologies and infrastructures. The purpose of the preceding description is to remind the reader that our world may need new military and foreign policy options as well as new energy technology options in the years to come.

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