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Interview with Peter Maas

Chinese Oil Investment in Angola and the Quest to Evade the Resource Curse

Why We Can't Kill Carbon

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In This Issue

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Letter from the Editors

Increasing concern over climate change and energy use as well as mounting evidence highlighting the unsustainable nature of current practices have propelled the topics of energy and the environment to the forefront of the global agenda. In the early 21st century, we find ourselves at an important crossroads, grappling with daunting questions that will determine the future of the entire globe. How can we further the economic growth that has pulled millions out of poverty, and at the same time develop clean and affordable technologies that will not damage the environment or slow the emergence of developing countries? How can the world wean itself off its dependence on oil, a resource needed by almost every society to heat homes, run machinery, and facilitate commerce? How do we maintain energy security and offset the possibility that some oil-producing countries may use their control over the world's energy supply to influence others? As this issue is being launched, the United Nations Climate Change Conference in Copenhagen is drawing to a close. This conference, in which "the future of humanity is at stake," has convened the most powerful leaders and decision-makers in the world. Many observers are no doubt disappointed by the political impasse and lack of agreement between developed and developing countries that is urgently needed in order to move forward. Yet at the same time, it is important to be mindful of what lies beyond Copenhagen. The idea that progress must be in the form of an international binding agreement can be rather limiting. Beyond Copenhagen, there is still hope and ample opportunity for the global community to pursue sustainable growth and development. The editorial board has selected the theme of Energy and the Environment for our Fall 2009 issue to not only reflect the broad range of perspectives in this crucial, ongoing debate, but also to press on the pursuit of viable solutions.

In response to our call for papers, PGI was honored to receive many submissions, which clearly reflects the international affairs community's passion for and knowledge of this pertinent subject. The editorial team is proud to showcase the exceptional talents of our colleagues here at the Center for Global Affairs, which encompass multidisciplinary perspectives into the topic of Energy and the Environment.

The issue opens with an in-depth interview with writer and journalist Peter Maass, the author of Crude World: The Violent Twilight of Oil. PGI editors Jhelum Bagchi and Karishma Thakkar kick off the interview with questions about the author's new book, and then delve into an insightful discussion of the future of oil supply and what that portends for the U.S. and other oil-producing nations.

The issue then turns to the analysis of proposed environmental policies, beginning with "Why We Can't Kill Carbon," an article by CGA student Russel Karas on the political roadblocks to carbon emissions trading. Next, another CGA student, Sonia Gupta, argues that there is a viable legal basis for climate change policies to be mandated at the highest level of multi-lateral institutions because of its implications for international peace and security.

Using China and Angola as a case study, CGA alumna Ethan Cramer-Flood explores the political economy of China's resource-based direct investment in "Chinese Oil Investment in Angola and the Quest to Evade the Resource Curse." This is followed by two articles that center on energy mix and the impact of climate change at the country level. CGA alumna Maia Dimitrova then explores the environmental consequences of nuclear energy in France, and fellow student Henry Kwong describes his research on the scientific evidence of climate change on the small-island state of Hawaii. The next article, written by three CGA students, Samuel Lissner, Kelly Nelson and Orlee Zorbaron, takes a multidisciplinary approach to examine how the discovery of shale gas deposits in the U.S. will affect the country's appetite for imported natural gas.

Of course, the theme of Energy and the Environment cannot be complete without a pragmatic and technical examination of the potential of renewable energy sources, as synthesized by CGA alumna Fathali Ghahremani in "The Possibility of Large-Scale Geothermal Power Plants." This is followed by a piece by two CGA students, Marianne Nemecek and Orlee Zorbaron, which promises to elucidate the pervading myths and realities of carbon sequestration technology. The Fall 2009 issue concludes with a book review by PGI editor Linda Bouzembrak of the New York Times bestseller, Earth the Sequel, by Fred Krupp and Miriam Horn.

The editorial board of Perspectives on Global Issues would like to thank the contributing authors for their insights on the subject of Energy and the Environment which, without a doubt, enriches the substance and breadth of this issue. Readers' thoughts and suggestions are always welcome.

Thank you, Florence Au, Editor-in-Chief and the PGI Editorial Team

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Interview with Peter Maass, Author of *Crude World: The Violent Twilight of Oil*

Interview by Jhelum Bagchi and
Karishma Thakkar

Peter Maass is the author of Love Thy Neighbor: A Story of War*, a book about the war in Bosnia published in 1996 by Alfred A. Knopf. More recently, Maass authored* Crude World: The Violent Twilight of Oil. *He has won The Los Angeles Times Book Prize (for nonfiction) and the Overseas Press Club Book Prize for* Love Thy Neighbor*, and was a finalist for several other literary awards. In 1997, after working for a year in Washington as a staff writer for the* Post*, he left the paper and moved to New York City, where he is a contributing writer at* The New York Times Magazine. *He spoke to PGI about his experiences while writing about the global oil industry in* Crude World.

PGI: What prompted you to write this book? What was the point you thought this book needed to be written about?

PETER MAASS: Well, I 'd written a book about the war in Bosnia in 1996, and that was very much a book about war itself, or a particular war. What [being in a war] felt like sounded like being shot at – seeing people shot at. And so after that, I wanted to write a book that would not be about a particular war or conflict, [but] one of the reasons for conflict, one of the reasons for war, one of the reasons for poverty or wealth – because I wanted to go deeper. So, while reporting and writing for magazine stories, I realized that oil was it.

When I was in Bosnia, people had said the city was surrounded by Serbs, but what they were saying to me was that "If only we had oil, America would care." Then, as I went out into the world and other places, especially in the Middle East: "If we didn't have oil, we wouldn't have so much trouble." But of course, oil is absolutely essential to the economy and to politics. But there were all these unanswered questions about it: Do we fight wars over it? What wars do we fight over it? Does it make people richer, particularly in the countries that have oil? Or perhaps, does it not make them richer? What role does oil play in poverty and wealth across the globe? So I had all these big questions that I wanted to answer and then I realized that there was no book out there, the type that I wanted to read. [There were] a lot of books that were political and economic, but there were none that were narrative, that had stories in them, that told the story of oil through the story of the people and through interesting stories of countries. And so I decided that this is what I would do.

PGI: Did you know you were addressing the issue of the "twilight of oil," or was it something that came upon you as you dug deeper into the subject?

PM: I think it came upon me gradually, because I started doing this book in 2001, and at that time there wasn't nearly as much tension towards oil, towards the question of supplies of oil, or global warming, as there are now. So at the time that I started the book, I just wanted to throw a spotlight at something that I thought was important.
As time went on, it became clear first that global warming was indeed an issue; in 2001 it was pretty much being discussed about but still wasn't as essential an issue as it is today. Global warming is very real in that burning a fossil fuel creates essential problems for the global economy and the society. And then came this question of how much oil there really is that can be extracted – that is the peak oil discussion.

I also came to realize that we are at the peak of global production of oil, that at some point we won't be able to go beyond the 85 million barrels per day of oil that is being produced. Oil became central to the global economy just before World War I, when Winston Churchill switched the British Navy from coal burning to oil. And now, almost 100 years later, even the most optimistic estimates say that oil supplies will remain for a maximum of 20-30 years. Hence, if you have only 20-30 years left where oil can be central, after a century of oil being central and when also a lot of efforts [have] started to get us out of the century of oil, I think if you think very clearly, this is a twilight era.

And also, given the violence that existed in the pre-twilight period, it would continue to be violent. Violence as I define it is not just in terms of wars, but also in pollution, in corruption – these are things that also cost lives.

PGI: What is the typical reaction of oil producers to the concept of *Twilight of Oil*?

PM: I've been to a lot of different countries and investigated or looked into different issues, but there was no bigger [or] firmer door that was kept shut in front of me than the one about supply, particularly in the OPEC countries. I went to Saudi Arabia, the highest oil-producing country at 264 billion barrels, which is kind of the center of these questions of peak oil. Not that anybody thinks Saudi Arabia is going to run out of oil, it's just everybody keeps wondering if Saudi Arabia can keep increasing the amount of oil it keeps extracting. So I went to Saudi Arabia, but the Oil Minister refused to see me. He would not even let me into the ministry of oil. The spokesman refused to see me until the last day that I was in Saudi Arabia in the lobby of my hotel for around 20 minutes, where he basically told me to get lost.

The problem is these producers of oil, like Saudi Arabia, Russia, Iraq, and Iran, do not believe in independently verifying data. Particularly, they are reluctant to discuss the processes employed in getting the oil out – what secondary methods are used, how much water is coming out with the oil. These are the key indicators of how healthy reservoirs are – how much oil they will be able to continue to produce. In general I tend to skeptical of governments when they tend to tell me something without providing me with any evidence. And this was a case where the governments and the state-owned oil companies were refusing to give information to anybody that could support their claims. Above all, it's in their interest to provide us with untruthful information because they would like to have us believe that they can provide us with as much oil as we will ever need. If that were actually the truth then they would provide independent evidence, but since they don't, it seems very fishy to me.

PGI: What is the influence of the United States and the dollar on the oil-producing countries?

PM: Well, if it's done abruptly, then the impact would be huge – but I don't think it would be done abruptly. The oil-producing countries don't want to do something that is going to significantly damage the U.S. economy because that damages their assets, their reserves, which are dominated in the dollar to a great extent – except for countries like Iran and Venezuela, which, for political reasons, would like to damage or at least threaten to damage the U.S. economy. These countries realize that if they move too fast, they hurt themselves. But there is this move, because frankly it makes sense to the exporters – they are tied into the dollar, which is a currency that is beyond their control and is depreciating partly because the U.S. government is issuing so much debt. If they continue to have their main product denominated in dollars when the dollar is depreciating, then the value of their main asset, oil, is also depreciating. So it makes sense for them to have a basket. I can see the logic on their side, and I can also see the logic in the senses of the global systems. Do we have to have the dollar forever as the only reserve currency? How do you get from here to there without much damage not just to the United States, but to the whole global system? The global system requires a healthy USA. And that process is going on. I mean, I think everybody is aware of the risks involved [in] moving too fast, even though it's not moving too fast right now. But it's definitely moving, and to me, that's not troubling because I can see why it makes sense for the countries that have oil and lead to a transition to a more balanced world economy.

PGI: It's interesting that you say that "the global system requires a healthy USA." Does the U.S. still hold enough sway on demand dynamics, especially with oil?

PM: The United States is still by far the most powerful economy in the world – maybe not as powerful as it was 3 years ago. And one of the reasons why it is powerful is because a lot of other countries count on us. If our economy does badly or if our government issues ridiculous amounts of new currency, their assets would suffer because they are denominated in U.S. bonds. And so that gives us certain leverage over them, even though they also have certain leverage over us.

The main question about the U.S. is: Would an American transition to non-oil energy affect the suppliers? Well first off, the transition is not going to happen immediately. There is very little prospect of oil being replaced as the main fuel, especially in the transport sector, within a year. I mean, it's going to be a process of many years and definitely not abrupt. Signals, of course, could be very important. If the government of the United States decides very seriously – much more seriously than it was able to so far – to marshal a path to a "post-oil" future, that can send a signal that oil is not the future, and hence, we are not going to need in 20 years nearly as much oil as we need now. I think things like this can sure impact the producers of oil because part of the price of oil is speculative, and we think we're going to need it for a while to come. So if we send a signal out that we are not going to need as much in the future as we need now, that can help in effect. And also, if our consumption is indeed

reduced, given that we consume nearly 20 million barrels a day (which is about 20-25 percent), a small reduction in our consumption would free up an interesting amount of supply, which would have an effect on oil price.

In addition…given that the United States is the world's largest economy, where do we actually cut off? Because whatever technologies we find, whatever directions we take are ones that other countries will take very close notice of, and if these are kind of good shifts, they will follow them. It's not just the United States embarking alone without anybody going in the same direction. I would add a caveat to that, which is actually that the directions we need to go into are ones that other countries are already ahead of us in; they are much more fuel efficient than we are. So if we just go in the direct of Europe, then Western Europe per-capita carbon emissions are about 1/3 below the United States. If we just go in that direction seriously, that can have a big effect.

PGI: In your experience, while writing the book, did the oil-producing countries come across as concerned about Obama's new policies?

PM: Well not really. Most of my reporting was done before Obama came into office. I wasn't in Saudi Arabia or Nigeria when Obama was president or had even been elected president.

PGI: But he did speak about his policies during his campaign. Did any of that seem to stir concern amongst the producers?

PM: Well I didn't feel it because I think that in one way, the Obama rhetoric was a statement of the inevitable. A lot of people in the world looked [at] the policies of the Bush administration as really an ostrich sticking its head in the sand – policies about climate, developing renewable energy and conservation [were] really primitive. And therefore, what Obama was saying as a candidate was not of the order of "Oh my God, this man is going to just implement this strategy that we had not envisioned and this is going to send the world in a direction we don't want to go in." I think the world was waiting for this. So it's not a total shock, and to much of the world it's welcome. [I]t's really not something that's taken people by surprise.

As for the producer countries [and] the worry that they may lose their biggest customer, there is always that relationship between suppliers and consumers where the suppliers worry about losing their customers. In 1973, when the OPEC oil embargo took place – although we here in America tend to regard it as a sign of how powerful the OPEC countries are, and that was indeed a frightening experience for us where all of a sudden we didn't have the oil we needed – the oil prices shot up. We had to wait for hours at the gas stations. Actually, on the other side of the equation, it was kind of a failure of an embargo, because what happened in the United States is we became much more efficient in our use of oil. We stopped using oil to a great extent. Not completely – home heating, for example. Particularly countries like Japan, which became ruthlessly efficient in its usage of energy. From the point of view of the supplier countries, they realized within a couple of years that by having this embargo they had actually scared some of their customers away and made some of their customers [find] alternatives to oil in the sense of using more natural gas, more conservation, et cetera. They had known the supplier countries for a long time, but there is a kind of a fragile relationship that exists between them and the consumer countries – that if the prices go to high, that will draw the consumers away for a very long, if not permanent, period of time. So I don't think they had a new concern as a result of the Obama administration's policy or the Obama rhetoric. I think they have always had those concerns. It's probably just a little closer to the surface now, but they realize they can't control it. They can get as much oil out of the ground as possible, and they can say "Don't worry, there will be enough oil," but I do think over there in those countries, they realize that they are not in the driver's seat.

PGI: Finally, what do you think of the concept of independence from foreign oil, which has been part of the rhetoric since 1975?

PM: It's a diversion, I think, because independence from foreign oil implies dependence on domestic oil, but we simply do not have enough domestic oil to supply the energy we need. So [to] the people who say we should be independent of foreign oil, that sounds very nice, but the fact is [that] it's simply impossible unless you reduce considerably our energy consumption. Which would be a nice thing, but I don't think the people who are saying we should not be dependent on foreign oil mean that we should consume 50 percent less oil. The real question is dependence on oil, not dependence on foreign oil, because we can't become independent of foreign oil. The other aspect of that slogan is that it tends to be directed at Middle Eastern oil producers who are not really our largest supplier of oil – it's Canada. The Middle East is crucial in terms of global supply of oil, [and] therefore crucial in terms of the price of oil.

Environmental Law and Policy: Climate Change as a Threat to International Peace and Security

By Sonia Gupta

Introduction

AWARDING the 2007 Nobel Peace Prize to Al Gore and the Intergovernmental Panel on Climate Change signaled, among other things, that climate change is a very real process that is causing an incredible amount of global change and even conflict. It also recognized that climate change will perhaps constitute one of the more dire environmental threats that this generation will face. The threat, however, is not just environmental; climate change effects have been seen in social, political, and even economic contexts. In this paper, I argue that climate change and its accompanying environmental degradation contribute to creating conflicts that rise to the level of implicating global peace. I will first begin my discussion with an examination of the notion of "international peace and security" generally. I will then look at the causal effects of climate change and its ability to exacerbate state vulnerabilities. Next, I will show that the existing means of enforcement are inadequate, and that the enforcement power of the Security Council offers a better alternative. Lastly, I will examine the competency of the Security Council to even address climate change and the arguments posed against it.

Thus, I endeavor to show that there exists a viable legal basis for the Security Council to declare climate change a threat to international peace and security to be included on their agenda.

What is International Peace and Security?

The Security Council is the organ of the United Nations entrusted to maintain international peace and security. The following discussion, however, will center primarily on the concept of international peace and security generally. It will focus on how the concept was first thought of and the evolution into its current meaning. The discussion of security within the context of the Security Council will be addressed in a later section of the paper.

Security was on the minds of global leaders when they convened in San Francisco in 1945 to create the United Nations ("UN"). In fact, the first line in the UN Charter's preamble outlines the need to protect "succeeding generations from the scourges of war."[1]

In order to achieve that goal, the UN founders appreciated the power of creating a collective security organization to maintain international peace and security. At that time, with the recent occurrences of two world wars, the notion of what constituted an international threat to peace and security primarily involved interstate armed conflict in the traditional military sense. The UN system was to comprise a unity of states that would act collectively to condemn acts of state violence, where "aggression against one is aggression against all."[2] Today, the idea of security has expanded from the traditional understanding of interstate armed conflict. Many threats are not so obvious and may not even originate from countries themselves, but from non-state actors. Today's threats are globally created and necessitate the kind of multilateral cooperation first envisioned by the UN founders.

Recognizing the evolved and changed nature of the threats we now face in the 21st century, former Secretary General Kofi Annan convened a panel of experts in September 2003 – the High Level Panel on Threats, Challenges and Change ("High Level Panel") – to ascertain the current threats to international peace and security.[3] In their report, the High Level Panel defined international peace and security as "any event or process that leads to large-scale death or lessening of life chances and undermines States as the basic unit of the international system."[4] Following from that definition, the panel identified six groups that constitute threats: interstate conflict; internal conflict; terrorism; nuclear, chemical and biological weapons; transnational organized crime; and economic and social threats including disease, extreme poverty, and environmental degradation.[5] Kofi Annan included climate change and its accompanying environmental degradation in his characterization of the above-mentioned groups as "soft threats." He further stressed that the United Nations does not have the luxury of dividing its attention between the traditional "hard threats," such as weapons of mass destruction, and the "soft" ones. To that end, he noted, "in truth, we do not have to choose. The United Nations must confront all these threats and challenges – new and old, 'hard' and 'soft'."[6] Reaffirming the expanded definition of international peace and security proffered by the High Level Panel, the former Secretary General labeled climate change and environmental degradation, among other things, as having the potential to produce "catastrophic consequences," and thus were viable threats to international peace and security.[7]

Including climate change in the expanded 21st century definition of what constitutes a threat to international peace and security reorients the issue into a security context, rather than just a negative environmental process. This critical reframing of the issue has resulted in the possibility that climate change could be included on the Security Council's agenda. However, although it may be considered a threat to international peace and security, the question of whether it

belongs on the Council's agenda is another issue entirely. Before a conclusion can be reached either way, the causal effects of climate change must first be examined. This is necessary in order to discern whether the effects of climate change and its accompanying environmental degradation are severe enough to equal the level of threat posed by issues currently on the Council's agenda.

"...the former Secretary General labeled climate change and environmental degradation, among other things, as having the potential to produce 'catastrophic consequences,' and thus were viable threats to international peace and security."

Causal Effects of Climate Change

A discussion concerning what causes anthropogenic and naturally-occurring climate change is beyond the scope of this paper.[8] For the purposes of my discussion, I will primarily be focusing on the causal effects brought on by climate change and its accompanying environmental degradation on human security. The process of climate change is defined as:

> a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.[9]

According to the Intergovernmental Panel on Climate Change (IPCC), the years between 1995 and 2006 represented the world's warmest temperatures.[10] The overall warming of the earth's temperature has the potential to produce adverse effects. Adverse effects as defined in the UNFCCC means "changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare."[11]

Already, these effects have manifested in several ways, resulting in negative causal connections between climate change and conflict. It is important to note however, that climate change is not just a threat in and of itself. The United States Center for Naval Analysis (CNA) assembled a panel of retired army generals to study the issue of climate change with respect to its impact on American national security. In their 2007 report, the military panel identified climate change as having the capacity to act as a threat multiplier.[12] Climate change acts as a threat multiplier in that it exacerbates already fragile situations and creates even more political instability.[13] Current UN Secretary General Ban Ki-Moon also agreed with the CNA's assessment of climate change in his speech before the Security Council in 2007, where he stated that this concept was "especially true in vulnerable regions that face multiple stresses at the same time — pre-existing conflict, poverty and unequal access to resources, weak institutions, food insecurity, and the incidence of diseases such as HIV/AIDS."[14]

Climate change and its accompanying environmental degradation have been responsible for contributing to, among other things, increasing infectious disease vectors, mass migration, glacial melting, extreme weather occurrences, salination of the water supply, and an increase in floods and droughts.[15] Admittedly, a whole other paper could be written evaluating the direct and multiplier effects of climate change. However, for the sake of brevity, I will discuss two different cases that represent clear and convincing evidence that climate change does in fact implicate international peace and security.

Rising Sea Levels

According to the IPCC, rising sea levels and global warming due to climate change go hand in hand.[16] One of the more dramatic effects of this sea rise is the possible flooding and eventual sinking of low-lying coastal areas. This is especially true in states located in the South Pacific and along the coastal areas of Asia. The very real possibility of the existential threat that climate change poses to these nations creates a devastating situation where "UN member states cease to exist geographically."[17]

The resulting loss of land mass inevitably leads to an increase in forced migration of environmental refugees. Residents of the Solomon Islands have already begun moving to Papua New Guinea due to the flooding that has made parts of their island uninhabitable. It is reported that by 2015, the Solomon Islands are expected to be completely submerged under water due to the effects of climate change.[18] Estimates suggest that there could be between 150-200 million environmental refugees by 2050.[19] There are as many as 5.5 million people living in the coastal region of Bangladesh. A mere 45-centimeter rise in sea level will force their relocation. Although some of those residents may choose to move more inland, some may still seek to move to India or Pakistan. A similar past instance of forced Bangladeshi migration in the region had been the cause of violent conflict.[20] Furthermore, future predictions of violent conflict in the region are being made in a report requested by the United States Pentagon outlining the "worst-case scenario" situations that could be induced by climate change. The report predicted that by 2010, there will be an increase in "border skirmishes and conflict in Bangladesh, India and China, as mass migration occurs toward Burma."[21]

Unless the massive amounts of migration can be properly managed, violence, it seems, will be inevitable. The Security Council has already recognized that mass migration movements may constitute a threat to international peace and security.[22] The potential for conflict is even greater in developing countries where the infrastructure, governance, and carrying capacity to absorb such a large population are weak.

Water Scarcity

Climate change has been shown to cause a decrease in precipitation and an increase in desertification.[23] The decrease in rainfall reduces the availability of water, decreasing the amount of agricultural output, which ultimately results in food shortages.[24] This is particularly true in Egypt, where a projected increase in "evapotranspiration"[25] will increase the water required by agricultural production, thus limiting yields. The search for more water could result in greater international tensions and conflicts.

An example of a negative effect of water scarcity is found in the current Darfur conflict. The United Nations Environment Programme (UNEP) issued a "Post-Conflict Environmental Assessment on Sudan." In their report, UNEP found that the cause for conflict in Darfur could be in part attributed to climate change and its accompanying environmental degradation. Rainfall in the region had decreased by 30 percent.[26] The decrease in rainfall resulted in the desertification of millions of hectares of land. This forced many of the pastoralist societies to move south in search of a more arable area.[27] According to the report, climate change and its resulting desertification and drought are "clearly linked to conflict, as there are strong indications that the hardship caused to pastoralist societies by desertification is one of the underlying causes of the current war in Darfur."[28] The report warns that unless the negative effects of climate change can be contained, the potential for new and successive conflicts in Africa, especially in the countries surrounding the Sahel belt, will be very high.[29]

The example of the Darfur conflict demonstrates that water scarcity can act as a catalyst for civil unrest, especially in areas already pressured by high population numbers. In 2005, former UN Secretary General Boutros Boutros-Ghali warned of the inevitability of "water wars" between the countries surrounding the Nile basin.[30] The overall effect is that climate change will exacerbate already existing tensions over scarce resources.[31]

Acting as a threat multiplier by contributing to droughts, desertification, food shortages and potential resource wars, climate change and its accompanying environmental degradation can clearly be shown to catalyze violent conflict, which can in turn ultimately threaten international peace and security.

Existing Enforcement Mechanisms

Before the Security Council's enforcement mechanisms can be discussed, the existing means of enforcement must first be examined.

Initially, the means by which climate change and its resulting environmental degradation can be addressed is through diplomacy and negotiation in order to create a new environmental framework. However, this process is quite political in nature. Because of this, diplomacy and negotiation can often take a very long time to produce a document of substantial force.[32] The Kyoto Protocol (Kyoto), which creates targets for its state parties to reduce the amount of green house gases they produce,[33] is a telling example of just how lengthy the process can be. Kyoto was first opened for signatures in March of 1998. However, the protocol finally came into force eight years later, in February of 2005, when it received the requisite number of ratifications.[34]

Many of the effects of climate change discussed in the prior section have contributed to creating problems where time is of the essence. In such a situation, the many years it could potentially take to negotiate a new climate change instrument cannot be afforded, and a more expedient enforcement mechanism is needed. Another drawback with Kyoto and other environmentally-focused treaties is that the choice to engage in the negotiation process of the treaty in the first place is entirely voluntary.

The second means by which climate change can be addressed is through the environmental treaties themselves. Although they embody the spirit of international cooperation, these treaties are only enforceable against those states that sign and ratify them. However, even a high member rate may not be enough. In their report, the High Level Panel found that most environmental treaties are "undermined by inadequate implementation and enforcement by the Member States."[35]

There are two relevant instruments addressing climate change: the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The UNFCCC is a framework of guiding principles. Although the framework is significant for being the first attempt at trying to deal with the problem of climate change, it lacks any sort of significant enforcement power.

In contrast, the Kyoto Protocol does have specific emission targets and commits state parties to reaching those targets. Unfortunately, the obligations and the corresponding commitment period expire in 2012.[36] Another source of impotence is the fact that the United States, China and India — arguably some of the world's largest green house gas polluters — have not acceded to the treaty.

The last existing means by which climate change can potentially be addressed is through bringing a suit before the International Court of Justice (ICJ). Using the ICJ may be problematic because of issues of standing, jurisdiction, and a limited remedy scheme. With regard to standing, the Court can only hear cases brought by a state who has suffered an actual injury by another state. However, this presents complications with the issue of causation, and a state may lack standing if a direct injury cannot be shown.[37]
Without delving into the various ways by which the ICJ could exert jurisdiction over a particular state, it is primarily based upon the consent of a state to be subject to the ICJ's ruling in a particular type of case. Thus, the Court could potentially lack the competency to render a ruling in an environmental dispute.[38] Another limitation with bringing a suit before the ICJ is the fact that the court is restricted in the types of remedies it can create. Since it is limited to providing a

remedy for an actual breach that caused an injury, future threats may not be addressed. The Court may issue advisory opinions or fashion some sort of provisional remedy in order to prevent future harm. However, advisory opinions are non-binding and provisional remedies are only applicable to the parties of the suit.[39]

While they offer legitimate forms of recourse for many environmental disputes, the existing mechanisms discussed above all rely on the voluntary consent by states.
Time can also be an issue, as is the case with negotiation, and the solutions may not even begin to address future threats, as is the case with the ICJ. Therefore, although these forms of enforcement should continue to be utilized, the Security Council's Chapter VII authority is still needed to address the issue of climate change, if for nothing more than to act as a necessary last resort of protection and enforcement.

Security Council's enforcement mechanisms

As explained in an earlier section of this paper, although the UN as a whole is concerned with global peace and security, the primary responsibility of maintaining international peace and security has been conferred upon the Security Council.[40] Moreover, in addition to maintenance, the Security Council is vested with the further role of identifying potential threats and deciding what measures should be taken to restore and ultimately maintain international peace and security. According to Article 39 of the UN Charter:

> The Security Council shall determine the existence of any threat to the peace, breach of the peace, or act of aggression and shall make recommendations, or decide what measures shall be taken in accordance with Articles 41 and 42, to maintain or restore international peace and security.[41]

The various means afforded to the Security Council are detailed in Chapters VI and VII of the Charter. Although the focus of this paper revolves on the Security Council's use of their Chapter VII authority to address climate change, Chapter VI will be briefly examined.

Chapter VI encompasses peaceful dispute settlement mechanisms to help members resolve conflicts that can endanger international peace and security. Under Chapter VI, the Security Council may recommend a number of dispute settlement procedures such as "solution by negotiation, enquiry, mediation, conciliation, arbitration, judicial settlement, resort to regional agencies or arrangements, or other peaceful means."[42] Without any doubt, the use of the peaceful means of settlement of disputes and conflicts is the most desired method by which to address threats to international peace and security. However, similar to the problems posed with the existing mechanisms of enforcement, the Security Council's Chapter VI authority is completely subject to the consent of the relevant member countries of the UN.

Chapter VII of the charter however, provides the Security Council with binding enforcement power. Express consent by member states is not needed once the Security Council invokes their Chapter VII authority based on the implicit consent provided by member states' ratification of the UN charter. Additionally, Article 25 states that the "Members of the United Nations agree to accept and carry out the decisions of the Security Council in accordance with the present Charter."[43] Further reinforcing the Council's binding authority of their Chapter VII decisions, Article 48 of Chapter VII dictates that the "action required to carry out the decisions of the Security Council for the maintenance of international peace and security shall be taken by all the members of the United Nations" (emphasis added).[44]

The various types of enforcement mechanisms available to the Council under Chapter VII are listed in Articles 41 and 42, respectively. Article 41 mandates a variety of non-forceful measures, whereas Article 42 allows for coercive military force. Both articles will be discussed in turn. It is important to note that although I argue for climate change to be included on the Security Council's agenda as a threat to international peace and security, I also argue (as will be discussed below) that it would be inappropriate to subject the issue of climate change to Article 42 measures. Article 41 states:

> The Security Council may decide what measures not involving the use of armed force are to be employed to give effect to its decisions, and it may call upon the Members of the United Nations to apply such measures. These m ay include complete or partial interruption of economic relations and of rail, sea, air, postal, telegraphic, radio, and other means of communication, and the severance of diplomatic relations.[45]

In the past, Article 41 has been used to freeze funds and impose economic sanctions, restrict the ability of government officials to travel, deteriorate diplomatic relations and effectively interrupt communications over land, air, water, post, and radio.[46] It is important to note, however, that these measures do not represent an exhaustive list of what is available. In fact, the International Criminal Tribunal for the former Yugoslavia (ICTY) opined in its ruling on the *Tadic* case: "It is evident that the measures set out in Article 41 are merely illustrative examples which obviously do not exclude other measures. All the Article requires is that they do not involve 'the use of force.' It is a negative definition."[47]

Thus, the Security Council would be able to fashion an enforcement measure appropriate to the security issue of climate change that could go above and beyond those already delineated in Article 41. Furthermore, under Chapter VII, the problems described concerning the existing enforcement mechanisms are alleviated. Unlike the ICJ and international environmental treaties, jurisdiction does not present any sort of challenges for the Security Council, as all members of the UN have provided consent through ratification of the charter itself. Additionally, standing is not an issue, as the Security Council has the power to investigate possible threats to international peace and security, and according to Articles

11(3) and 99 respectively, both the General Assembly and the Secretary General can refer situations to the Security Council which may implicate international peace and security.[48]
Unlike the diplomatic/negotiation process, the Security Council also has the capacity to make their decisions and implement enforcement mechanisms with expediency — a point of significance in situations like rising sea levels, where time is of the essence. Another benefit of subjecting climate change to Article 41 measures is that the binding nature of Chapter VII could translate into creating a deterrent for many states who would not want to be subject to the "wrath" of the Security Council. The fact that the Council is such a powerful organ within the UN system also brings a certain gravitas to the issue by providing more of a publicized forum than any of the other mechanisms ever could.

In terms of remedies, the Security Council also provides a more effective platform than the ICJ. As mentioned earlier, the ICJ can only fashion remedies that are binding on the parties to the suit. However, the Security Council's Article 41 measures can be binding on all states.[49] Thus, the Security Council's Article 41 enforcement power would provide a quick and effective tool in dealing with the issue of climate change.

"...the Security Council would be able to fashion an enforcement measure appropriate to the security issue of climate change that could go above and beyond those already delineated in Article 41."

Article 42 allows for the Security Council to use military force in order to maintain international peace and security.[50] Although it is one of the two enforcement measures the Security Council can employ under their Chapter VII authority, I argue that the issue of climate change should not be subject to the measures provided in Article 42.

First, a major driver of international law is international cooperation. According to the preamble in the UNFCCC, "[t]he global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response."[51] Engaging in military action pits states against each other and goes against the spirit of cooperation espoused in the UNFCCC and against International Environmental Law in general.

Secondly, war by nature is a very damaging act. This notion was recognized and condemned in the Rio Declaration, which states that "warfare is inherently destructive...and peace, development and environmental protection are interdependent and indivisible."[52] Thus, to employ military measures in order to combat climate change and protect against the accompanying environmental degradation would, again, be contrary to the principles espoused in international environmental treaties.

Lastly, Article 42 enforcement mechanisms should not be used to address the issue of climate change, as the military itself represents a major source of pollution. The resulting environmental degradation can manifest in the form of land and water pollution and higher carbon emissions. In fact, the activities of the United States military accounts for more than 10% of the country's total carbon emissions.[53] In addition to the high emissions they produce, using military measures under Article 42 would divert important resources away from achieving possible social, political and environmental alternatives.[54]

Therefore, Chapter VII, Article 42 measures should not be applied by the Security Council in addressing climate change as a threat to international peace and security.

Competency of the Security Council to include climate change on its agenda

The following section will discuss whether climate change can legally fall within the ambit of the Security Council's purview.

Beginning with the end of the cold war, the Security Council's agenda has significantly expanded to include a wide range of issues.[55] An explanation, in part, is found with the Security Council's acknowledgment in 1992 that environmental and social issues could become threats to international peace and security. The council reiterated their recognition with the following statement:

> The absence of war and military conflicts amongst states does not in itself ensure international peace and security. The non-military sources of instability in the economic, social, humanitarian and ecological fields have become threats to peace and security.[56]

With respect to environmental impact, the Security Council first addressed this issue when it censured Saddam Hussein's burning of Kuwaiti oil wells during the first Iraq war. The council, cognizant of the environmental impact, found Iraq liable for the environmental damage caused by its unlawful invasion.[57]

The Security Council also acted in an environmental context with their resolution in 2001 that condemned the exploitation of natural resources to finance the conflict and war occurring in the Congo at the time.[58]

These two resolutions are examples of the fact that the Security Council has dealt with environmentally related conflict issues in the past. It is important to note that the above-mentioned statements on environmental damage and exploitation were both made within the context of an already existing state conflict. Nevertheless, the following examples show how the Security Council still expanded their agenda and dealt with issues that went beyond the traditional definition of international peace and security.

Following the attacks on September 11, 2001, the Security Council declared terrorism to be a threat to international

peace and security. This marked a departure from past resolutions, which were usually limited to geographic locations and limited in time and scope. Generally, resolutions made pursuant to the Council's Chapter VII authority were directed at named states or identified organizations with the purpose of extinguishing a particular threat.[59] Usually, the Chapter VII resolutions were strictly defined because "by their nature these restrictions are imposed for a limited purpose — to secure compliance by a target state — and explicitly or implicitly are limited in time until that purpose is accomplished."[60] However, identifying terrorism as a threat to international peace and security marks a departure from that process as it deals with a conflict generally.[61]

Similar to terrorism, the Security Council has passed resolutions in relation to other conflict-fueling issues, not defined by any geographic or temporal scope. These include approving the Kimberly process, which works to prohibit the sale of conflict diamonds,[62] concerns with the humanitarian conditions, and safety of refugee camps[63] and the prohibition against using children in armed conflict.[64]

In 2004, the Security Council again broadened the scope of its agenda to include the declaration that weapons of mass destruction (WMD) constitute a threat to international peace and security.[65] Although the security threat posed by WMD seems rather obvious, the resolution still enlarged the Security Council's Chapter VII authority because it was a "broad and open-ended characterization"[66] of the problem.

A not-so-obvious security threat, however, was the declaration recognizing that the HIV/AIDS epidemic posed a threat to international peace and security.[67] With regard to geographical scope, although there is a focus on Africa, the resolution is meant to address cases of HIV/AIDS globally. Additionally, there is no delineated temporal scope.[68] Although HIV/AIDS may not present a direct risk to international peace and security, similar to climate change, it can act as a threat multiplier. According to the UNAIDS 2008 report on the global AIDS epidemic, the impact of HIV/AIDS can result in various deleterious societal impacts including disrupting traditional family structures, inhibiting economic development, and adding stress to an already weakened social infrastructure.[69] Additionally, HIV infection rates amongst soldiers in various African countries are between 30-40%, thus threatening the integrity of the very defense and security forces of those nations.

The persistence of HIV/AIDS in these states acts to multiply the factors contributing to an increasingly vulnerable situation. All of these threats, when aggregated, result in creating a destabilizing force. The compromise on domestic stability can easily spill over into other states, ultimately causing regional instability and conflict.[70]

The prior examples demonstrate how issues that were traditionally thought of as being "soft threats" were reoriented into threats to international peace and security. The inclusion of those threats on the Security Council's agenda has paved the way for climate change to be considered as well.

The only limitation that the Security Council would have to adhere to is to stay within the confines of the conditions of Article 39. In order to determine whether something is a threat to international peace and security, the Council must first assess that the issue at hand is "international" in nature.[71]

This first requirement is limited by Article 2 of the UN Charter, which states that "nothing contained in the present Charter shall authorize the United Nations to intervene in matters which are essentially within the domestic jurisdiction of any state."[72]

"...Issues that were traditionally thought of as being 'soft threats' were reoriented into threats to international peace and security. The inclusion of those threats on the Security Council's agenda has paved the way for climate change to be considered as well."

Secondly, the Security Council must determine that an actual threat to peace and security is posed by the issue at hand. Unlike the first prong of the test, determining what constitutes a threat is not as easily discernible. There is no guidance provided by Article 39 itself; however, most scholars agree that the Security Council has wide discretion in what they constitute as a threat to international peace and security.[73] Nevertheless, Article 24 of the UN Charter dictates that "In discharging these duties the Security Council shall act in accordance with the Purposes and Principles of the United Nations."[74] Furthermore, the Council is guided by the Court in *Tadic*, which held that within the Security Council's Article 39 power, "the determination that there exists such a threat is not a totally unfettered discretion, as it has to remain, at the very least, within the limits of the Purposes and Principles of the Charter."[75]

The threats posed by climate change sufficiently meet the first prong of the test. The origins, occurrences and impacts of climate change exist on a global scale. As for the second prong, it is evident that the threats being posed are creating a situation in which states are facing an existential threat where time is truly of the essence. Additionally, the multiplier effect of climate change is evidenced by the devastating conflict in Sudan.

Therefore, it would be difficult for the Security Council not to accept climate change as a threat to international peace and security. Additionally, as explained in the above examples of other threats, geographic and temporal restriction of the issue is no longer a constraining factor when declaring what constitutes a threat. Furthermore, as climate-change-related effects are becoming more severe in their impact, the Security Council's authority is needed, at the very least, to provide a safety net and gap-filling role when the existing

enforcement mechanisms fail. Consequently, climate change does constitute a threat to international peace and security, falling within the ambit of the Security Council's Chapter VII enforcement power and overall agenda.

Opposition: The Usual Suspects

Climate change in general represents a polarizing issue between developed and developing states. To be sure, the UNFCCC contains many provisions that recognize the common but differentiated responsibilities between developed and developing nations.[76] As such, most of the opposition to the idea that climate change should be included on the Security Council's agenda as a threat to international peace and security comes from the developing nations.

It should be noted, however, that a number of developing states, especially the small island developing states, are in favor of including climate change on the Security Council's agenda.[77]

"...It would be difficult for the Security Council not to accept climate change as a threat to international peace and security."

A summary of arguments against including climate change on the Council's agenda will be discussed in the context of the first-ever Security Council debate that occurred on April 17, 2007. Initiated by the United Kingdom, who held the presidency position at that time, the debate included 55 countries and Secretary General Ban Ki Moon. The following represents the major arguments representing the crux of many developing nations' opposition.

Climate change is beyond the mandate of the Security Council

Many of the developing states who spoke at the debate reiterated their belief that the Security Council was not the appropriate forum in which to manage climate change. Their argument hinged on the composition and function of the Security Council. Because of these institutional concerns, the Council is seen as very undemocratic and unrepresentative of the rest of the UN membership.[78] Furthermore, there is a concern amongst developing states that the permanent veto members of the Council are trying to "disguise imperialistic or paternalistic motives as humanitarian or environmental concerns."[79]

Representing the African States during the debate, the representative from Sudan argued that by putting climate change onto the Security Council's agenda, the Council is actually encroaching on the functions of the other UN organs, namely the General Assembly and the Economic and Social Council ("ECOSOC").[80] Related to this encroachment and the accusation of paternalistic motives, the Sudanese representative further argued that the "Security Council tries to justify by linking all issues to the question of security — compromises the principles and purposes of the United Nations Charter and is also undermining the relevant bodies."

Some may argue that it is interesting that this argument would be proffered by developing nations, much less Sudan, considering that developing countries are more affected by climate change. However, it appears that even though the threats to peace and security brought on by climate change may be an important issue, even more concerning to many of these nations is the right to participate in the decision-making process of how those threats will be dealt with.[81]

Although this argument has validity, the problem really implicates the underlying institutional concerns with the composition and overall functioning of the Security Council. Given the fact that many of the permanent five members would be remiss to give up their power, Security Council reform seems to be nowhere in sight. Climate change and its accompanying degradation are too critical to wait for the necessary enlargement of the Council's permanent members in order to ensure a measured level of democratic legitimacy.

Climate change is not a security issue

Another common argument made by the developing states was that climate change is more appropriately framed as a sustainable development issue, not a security one. As the representative from Pakistan who was speaking on behalf of the Group of 77 and China, stated, the issue of sustainable development is within the ambit of the General Assembly and the ECOSOC.[82] Moreover, with respect to dealing with climate change, the UNFCCC and the Kyoto Protocol are more appropriate forums.[83]

In response to this argument, states are more likely to pour financial, political and technological resources into the issue of climate change if it is framed as a security issue, instead of a development or human rights issue.[84] With respect to relying on multilateral environmental treaties, the problematic enforcement issues discussed earlier still remain. Thus, including climate change on the Security Council's agenda is still required.

Climate change is being used to alter the common but differentiated responsibilities

Lastly, an accusation was made by many developing states that the Security Council debate on climate change was an attempt by developed countries to "shirk" their responsibilities under UNFCCC and Kyoto. According to the representative from Egypt, it is the developed states that have caused the current climate crisis because they have "continued to pour emissions into the upper atmosphere and have failed to fulfill their obligation...according to the provisions of the UNFCCC and the Kyoto Protocol."[85] He further stated that the way to a solution involves the fulfillment of treaty commitments based on the principle of common but differential responsibilities "and not according to the principle of shared responsibilities which some

countries are seeking to promote."[86] Central to this argument is the developing states' fear that the Security Council would issue opinions and make decisions without fully recognizing the responsibilities and contribution made by developed states in creating the problem of climate change.[87]

This argument is not very strong. During the debate, a number of developed states reinforced their commitment to the notion of common but differentiated responsibilities.[88] Additionally, the United Kingdom, whose concept paper promulgated the debate on climate change, acknowledged the importance of the principle when it stated that parties to the UNFCCC should try to reduce and stabilize "greenhouse gas concentrations in the atmosphere at a safe level, based on the principle of common but differentiated responsibilities and respective capabilities."[89] Furthermore, in the interest of attaining a globally applicable solution, it is doubtful that the developed countries would risk alienating the participation of developing nations by trying to absolve themselves of their common but differentiated responsibilities.

Conclusion

In this paper I have attempted to argue that climate change should be considered a threat to international peace and security to be included on the Security Council's agenda. An examination of the existing enforcement mechanisms reveals their inadequacy when states are facing the very real existential threat posed by climate change. Additionally, the fact that they also act as very potent threat multipliers suggests that climate change and its accompanying environmental degradation can create the level and severity of conflict on par with the issues that are already on the Security Council's agenda. Therefore, the evidence is clear that climate change and the kinds of conflicts it can create meet the requirements espoused in Article 39 of the Charter.

Making climate change potentially subject to the Council's Chapter VII powers helps to increase the publicity surrounding the issue and provides a fail-safe enforcement mechanism, should binding authority on the issue ever be needed. Despite the protestations put forth by many developing nations, the Security Council is still the most viable platform in the face of severe global environmental degradation caused by climate change. As such, climate change should be recognized as a threat to international peace and security and should accordingly be included on the Security Council's agenda.

**The author notes that this article was written during the fall of 2008. Subsequent events that may have occurred since then are therefore not reflected in this essay.*

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Chinese Oil Investment in Angola and The Quest to Evade the Resource Curse

By Ethan Cramer-Flood

The Context

ANGOLA is the second largest producer of oil on the continent of Africa, after Nigeria.[1] In January of 2007, Angola joined the Organization of Petroleum Exporting Countries (OPEC),[2] reflecting its status as the 13th highest net exporter of oil globally.[3] According to the U.S. Energy Information Administration (EIA), Angola exported 1.36 million barrels per day in 2006.[4] Although it is not among the top 15 overall producers,[5] its limited domestic oil use allows it to export the vast majority of its production.[6] OPEC reported a slightly lower output for Angola in 2007, but both OPEC and the EIA agree that Angola's proven reserves are in the range of nine billion barrels.[7]

Logically, this makes Angola one of the primary targets of energy-hungry China's multinational search for fuel to feed its bustling economic development. Periodically over the past several years, Angola has been the number one supplier of foreign oil to China, eclipsing even Saudi Arabia on occasion.[8] According to the EIA, "in May 2006 China imported 750,000 bbl/d of crude oil from Angola, a 70 percent increase from the same month in 2005."[9]

The purpose of this brief is to look at the economic tactics China is using to acquire Angolan oil, and suggest a strategy for the Angolan government to ensure that Chinese-created oil largesse is used to the advantage of the Angolan people. As China's relationship with — and reliance on — Angola grows deeper, Angola has an opportunity to use its oil profits to boost its own economic development; but only if it can defeat the so-called "resource curse" that has bedeviled it and other poor countries for so many years.

The China Factor

If Angola produces 1.34 million barrels per day, and China imports up to 750,000 of those barrels every day, it is not hard to discern the depth of the two countries' relationship. China has successfully ingratiated itself on the Angolan oil industry using the same strategy it has applied all over Africa: a whirlwind of spending, investment, and preferential loans with no strings attached other than oil rights.[10] In 2007, China pledged no less than $20 billion "to finance trade and infrastructure across the continent over the next three years," according to published reports.[11]

"If Angola produces 1.34 million barrels per day, and China imports up to 750,000 of those barrels every day, it's not hard to discern the depth of the two countries' relationship…"

Government-backed Chinese companies — and often the Chinese government itself — have thrown aid money at the Angolan leadership in amounts that dwarf the assistance provided by western international NGOs and aid organizations such as the World Bank. The Chinese finance enormous oil-backed loans for Angolan development, providing immediate liquidity for the government and a guarantee that the loan will pay itself back once the oil is produced.[12] Angola reports it has "taken out between $8 billion and $9 billion in loans from China since 2004, exchanging guarantees of oil supply for reconstruction work." The World Bank puts that number at $12 billion.[13]

Chinese construction firms work directly on Angolan infrastructure, which facilitates both development and the Chinese capacity to efficiently extract resources. They have built a new airport, repaired the Benguela railroad, and constructed countless hospitals, schools, and roads.[14] All of this is designed to curry favor and gain exclusive future rights to Angolan oil deposits. It also provides convenient business opportunities for Chinese firms and employment for Chinese workers.[15]

Journalists Lydia Polgreen and Howard French of the *New York Times* provided an excellent summary of the Chinese and African views of one another in a summer 2007 article: "Chinese officials and their African allies like to call their growing relationship a win-win proposition, a rising tide that lifts all boats in China's ever-widening sea of influence… Many African scholars and political leaders say Africa has no need for the colonial baggage and paternalism of the West, and they welcome the Chinese approach of cowboy capitalism."[16] Meaning, many African governments prefer to be funded by the Chinese because unlike with the West, there is no conditionality on the financing – the money comes with no requirements about human rights, transparency, or democratization. The Chinese narrative in Africa paints an optimistic picture, but history tells us there is a serious danger for the Angolans.

The Problem and the Consequences

The "resource curse" has been extensively explored in the academic literature on development economics, but the basic premise is that underdeveloped countries blessed with extensive natural resources tend to fall into traps of internal conflict and economic stagnation, rather than find a way to exploit their gifts in the name of general prosperity. The natural resource creates a motive for rent-seeking, prevents economic diversification, and often results in political violence over control of profits. Empirical evidence has shown a direct correlation between resource wealth in places like Angola (and Nigeria, Sudan, etc.) and "systemic corruption and the weakness of state institutions."[17]

Internal instability caused by the resource curse can result not just from *greed* but also from *grievance*, according to prevailing theories.[18] Matthias Basedau of the German Institute of African Affairs explains the grievance hypothesis as such:

> Segments of the population or regions might feel deprived of the benefits of resource-related income (while possibly carrying the ecological burden of production) and therefore take up arms. Typically, grievance is associated with secessionist upsurges: When central governments (tend to) monopolize resource income, the resource producing regions might develop feelings of deprivation and grievances that, in turn, trigger violent secessionist movements such as in the oil-rich regions of Cabinda in Angola.[19]

Angola's civil war lasted for 27 years and was only recently resolved, thanks to the death of rebel leader Jonas Savimbi in 2002.[20] While Angola's peace appears durable, the resource curse need not produce violence to have an impact. Exploitation of oil wealth at the elite level impedes economic development just as efficiently as civil war. The Cato Institute's Moeletsi Mbeki describes a typical African experience:

Oil revenues make it possible for the political elite to become detached from the local population and economy. When that happens, there is no need for the political elite and the state it controls to invest in public goods enjoyed by the population at large. Worse, oil revenue provides the political elite with the funds to repress the local population.[21]

Under this scenario, the country remains peaceful, but the population remains in misery. The government need not rely on taxation in order to function, and thus has no reason to feel answerable to the people. A vicious dichotomy develops.

An Angolan's life expectancy, according to the World Bank, is a meager 41.4 years. The mortality rate in 2005 for those five years of age and under was 260 per 1,000. The GNI per capita in 2006 was just US$1,980.[22] According to the United Nations, Angola is the 17th least developed country on earth, and some analysts believe that two-thirds of all Angolans live on less than $2 a day (though the Angolan government claims the numbers are slightly less grim).[23] Few countries on earth have as desperate a need as Angola for a major injection of export profits to fund economic development projects, and circumstances generated largely by China are providing just such an opportunity. But how can they be sure it won't all be for naught?

What's Happening Now and What Needs to Happen

On the surface, the trend for Angola is positive, especially with regard to pure economic growth. According to the Council on Foreign Relations, "the combination of record-high oil prices, increased oil production, and Chinese loans have jump-started Angola's development."[24] The World Bank reports that Angola grew at a remarkable 18.6 percent in 2006, with positive signs in both the oil and non-oil sectors[25] (this after growth rates of 12 percent in 2004 and 19 percent in 2005[26]). The IMF estimated that Angola grew at an astounding 24 percent clip in 2007,[27] a dizzying number that reflected both the historic high price of oil that year and the economic depths from which Angola started. Concurrently, government revenue was up 250 percent that year.[28]

The key driver for Angola has been its oil industry and the investment by China and others that has allowed oil exports to become a robust and dependable revenue source. Oil profits can also be considered part of the peace dividend, as development of Angola's extractive industries was on hold for a generation thanks to its civil war.[29] Oil money represents about half of Angola's GDP, 90 percent of exports,[30] and 80 percent of the national budget[31] (about half of all oil revenue in Angola goes to the government).[32] In 2006, oil production was up 13 percent, thanks largely to new deepwater oilfields coming online,[33] an expensive and difficult process that requires international investment for a country like Angola.

As money flows into Angola like never before, the need to rigorously apply policies that will protect it against the resource curse is of paramount importance. This goes beyond mere energy policy, as the issues of corruption, poor government management, haphazard budgeting, lack of transparency, etc., cross all public sectors and represent the main threat to sustained Angolan growth. It is vital that Angolan leadership acknowledge that these pitfalls rank as a higher priority than ramping up oil production. A major

"…The need to rigorously apply policies that will protect it against the resource curse is of paramount importance…"

report by the International Energy Agency (IEA) and the Organization for Economic Cooperation and Development (OECD) declared that although "a well-formulated upstream oil development policy can help improve the sustainability of revenue flows…the main bottleneck in the flow of benefits from this sub-sector to the population in Angola's case does not appear to be the size or sustainability of such revenues."[34]

According to the IEA report, the main bottleneck is the issue of corruption and revenue management.

The IEA credits Angola with making some tentative positive steps in this regard, especially in the realm of transparency, thanks to a government sponsored "diagnostic of oil revenues" produced by consulting firm KPMG.[35] Since then, Angola has produced a more "unified" oil-related budget and has "incorporated spending that was previously off-budget."[36] Other analysts are less sanguine on the matter, however.[37]

There are also major transparency concerns relating to Angola's relationship with China. A comprehensive picture of China's total involvement is not publicly available, and can only be guessed at by piecing together various reports, statements, and anecdotes. No one knows exactly how much money China is providing, how many contracts exist, how they are awarded, or how many Chinese firms and workers are currently in the country.[38] Vast sums of Chinese money could be disappearing into the private accounts of the elites, and no one would know. Also, Angola should be more concerned with tracking Angolan employment rates at Chinese firms. These statistics are unknown, but there is reason to suspect Chinese infrastructure projects mostly employ Chinese workers. As the Council on Foreign Relations puts it, "Angola should be wary of outsourcing jobs Angolans could do themselves; importing labor may be sowing the seeds of future resentment."[39]
Transparency International ranks Angola as the 10th most corrupt nation on earth.[40] They claim that up to 12 percent of GDP disappears every year,[41] a devastating total for a country as poor as Angola. According to a 2003 Angolan newspaper report on the wealthiest citizens in the country, "Twelve of the top 20 [richest people] were government officials; five were former government officials."[42] As Chinese oil money flows in unabated, well-intentioned government ministers must find a way to prevent it from disappearing. Instead, it must be directed towards Angola's desperate needs in health, education, and economic development.

Beyond issues of corruption and lack of transparency in Angola's oil dealings with China, there are also tactical issues that the country needs to consider. First off, Angola is quickly becoming too dependent on China as its primary customer, a situation which could come back to haunt them in the event of an economic reversal in China or a geopolitical situation that strains their relations. Second, the Angolan government's policy of relying on oil-backed loans is mortgaging future oil revenue flows.[43] Although Angola has a great need for financing at the moment, they are putting tremendous pressure on themselves to use the money wisely on the first go. As their oil industry matures into an even more powerful export machine, they will see little benefit as profits are diverted for years into paying back loans. Payments will go mostly to China, who will be monopolizing much of the new crude oil product as well. Given how well the relationship with China is working for Angola in the short term — and how dramatically the economy is currently growing — it is difficult to recommend the government ease off from the courtship. But over the long run, Angola might do well to not accept every single Chinese loan offer and to work on diversifying its customer base.

On a broader strategic scale with respect to oil production and national development, there are valuable lessons to learn regarding Angola's national oil company (NOC), Sonangol. Sonangol was founded in the late 1970s and was quickly designated as "the sole concessionaire for oil exploration and production in Angola."[44] It is vital for Angola that Sonangol emulate the behavior of the world's most effective NOCs, such as Saudi Arabia's ARAMCO or Norway's Statoil; and avoid the deterioration of overburdened and mismanaged NOCs, such as Venezuela's PDVSA or Iran's NIOC. A well-run NOC can fund vital government programs, provide budgetary flexibility, be a force for modernization and technological development, and otherwise assist in all manner of poverty reduction and state-strengthening. But if a NOC falls under the ideological sway of politicized state leaders, it can easily become an inefficient albatross. In the wrong hands, NOCs can become geopolitical foreign policy tools, sources of political patronage, and saddled with over employment – all of which will impede the NOC's ability to efficiently run an oil industry and produce extra revenue.

Angola must follow the conventional wisdom on how to keep a NOC tightly leashed to the business of oil extraction and sales. Sonangol should maintain an independent board of advisors, offer limited ownership to international shareholders, seek international financing (and the transparency that it would require), and be given limited authority of its own revenues (in order to ensure sufficient reinvestment). Additionally, the Angolan government should create another NOC to foster competition between the two, and should allow limited competition with International Oil Companies (IOCs). According to the United States' EIA, Sonangol currently "works with foreign companies through joint ventures and production-sharing agreements, while funding its share of production through oil-backed borrowing."[45] Most of the world's major IOCs had at least some limited operations inside Angola as of 2007,[46] which means there is plenty of opportunity for Sonangol to learn and grow from partnerships and competition. Eventually Angola must develop domestic expertise at all forms of oil extraction in order to maximize national revenues in the future.

Privatization?

While no one would argue with the policy objective of increasing transparency, reducing corruption, and improving management and budgetary competence, some analysts would offer opposing policy advice on Angola's NOC. Specifically, they would do away with it entirely and leave the oil industry to the private sector. This pro-market prejudice is reflected between the lines of the IEA's advice to Angola. For instance, they encourage Angola to improve its transparency for the purposes of attracting more private investment in the oil sector, rather than to ensure that oil revenues are appropriately directed at economic

development.[47] A common theme among neoliberal economists is the absolute superiority of market forces over government decision-making. Specifically, many oil analysts believe that NOCs are incapable of performing efficiently, and thus are automatically inferior to private firms. By using NOCs, according to this point of view, maximizing revenue is impossible, oil extraction is slowed, and resources are wasted. From this perspective, Angola would be doing its economy a favor by disbanding Sonangol and leaving it up to private firms (national or international) to run the industry according to traditional economic principles of supply and demand, comparative advantage, and so on.

The problem with privatization and the philosophy of market fundamentalism is that it treats *efficiency* as an end in and of itself. This perspective believes that maximizing the efficient extraction of oil and getting it to the market with the highest possible profit margins is the only goal. In reality, for a place like Angola, selling oil is a means to an end that is utterly detached from the global oil markets. The point of oil profits for a country like Angola is to assist with national

"In reality, for a place like Angola, selling oil is a means to an end that is utterly detached from the global oil markets…"

development, and if oil profits were streaming to private companies, the government would be unable to pursue that goal. Angola is better off with its NOC than with IOCs because it keeps oil revenues inside the country and provides a constant financial stream for a government that would otherwise be unable to provide the slightest public service to its people.

According to the Angolan government (via the *New York Times*), since 2002, "it has rebuilt 2,400 miles of crumbled roads — more than half of the nation's system — and renovated airports in Luanda and three other cities. More than 430 miles of new rail track have been laid."[48] All of this has been possible thanks to oil revenues that might otherwise have gone into private hands – hands that would have made no effort to repair public roads and train tracks. IOCs are tremendous profit machines, but they are only appropriate for developed economies. Poor countries need their NOCs to help with development and to avoid any destabilizing public perception that national resources are being stolen by foreign elements. Additionally, NOCs can be a valuable tool for providing cheap and subsidized fuel to a population that otherwise would not be able to afford gasoline and heating oil at international prices. In the long run, fuel subsidies can wreak havoc on supply and demand curves inside a country and can become a debilitating burden on national budgets. But in the short run, when a country is as poor as Angola, it is a great boon for impoverished citizens to be able to afford vital fuels. As the country's per capita income grows, subsidies should be indexed to GDP growth in order to avoid long-term traps.

Conclusion

Most of the advice Angola must follow is nothing new to oil-rich undeveloped countries. This issue has been studied, and the proper course of action has been laid out by an army of development economists and extractive industry analysts. The country needs a strong regulatory framework to provide "sufficient stability for existing contracts and for continued attraction of foreign investment."[49] The government must, "enhance coordination between the Ministries of Finance and Petroleum, Central Bank and other financial, governmental and international institutions in its efforts to improve transparency in the management of oil revenues,"[50] etc. The list of advice that would also apply to any other country in Angola's position goes on and on. Nonetheless, it is vital that the Angolan government find a way to operationalize this advice and buck the trend of corruption and waste that has buried so many of their peers in Africa.

According to journalist Stephen Kotkin, "every recalibrated program to finally enable the African masses to share in a hydrocarbon mother lode has crashed and burned."[51] Angola is the latest to try to reverse this unfortunate history, and on the surface they are off to a good start. Here's hoping that an enlightened leadership, chastened by years of brutal warfare, will find a way to do the right thing; and that China will stay out of the way.

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French Nuclear Energy and Its Environmental Impact

By Maia Dimitrova

THIS article will study some essential aspects of nuclear energy in France and challenge the notion that nuclear energy is a fully carbon-dioxide-free, radioactively safe, energy source. Currently, 79 percent of France's electricity is derived from nuclear energy.[1] France has 58 active nuclear plants that produced 450 billion nuclear kilowatt-hours in 2006. The country is the world's largest net exporter of electricity, as it generates an excessive amount at a very low cost. We will look at the political, social, economic, and environmental considerations that placed France ahead of most of the developed world in the arena of nuclear energy. Despite the fact that France is a nuclear energy leader, the serious issue of completely safe disposal of nuclear waste has not been resolved. While France is considered a country with lower CO_2 emissions, and may emit less carbon than the countries dependent on fossil fuels, nuclear energy is not free of greenhouse gasses (GHG), as many nuclear energy proponents portray. Yet compared with the size of its economy and GDP, France is a nominal CO_2 emitter. Clearly, the reduced level of CO_2 is attributable to its dependence on nuclear energy.

The topic of nuclear energy is a controversial one. Many countries have shied away from replacing coal and natural gas with nuclear energy. In spite of the successful French example, nuclear energy does not resonate well in Germany, Austria, Sweden, the US, etc. Nevertheless, France's example is interesting. The country lacked enough domestic energy resources and would have been destined to depend on importing its energy needs, had it not been for its reliance on nuclear energy. By combining political will and determination with public education, an effective advertising campaign, and highly skilled human capital, France managed to escape a precarious situation of being overly energy dependent on CO_2 pollution-emitting processes, and transformed itself into a relatively clean energy exporter.

The Development of Nuclear Energy

Although it had been on the state agenda since the 1950s, nuclear energy was relatively unpopular in France until 1973. It was the trauma of the oil shock in 1973 that compelled the French government to look for alternative energy sources. At that time, most of the electricity in France came from plants that burned oil, and the oil was imported mostly from the Middle East. France has not been graced with an abundant natural resource base. It does not have oil or gas on which to fall back and its coal fields are already exhausted. The only way to maintain a reliable and sustainable source of energy was by launching a large-scale nuclear energy program. It was this recourse that forged a national consensus among major political parties towards the need to maintain a powerful, nuclear industry which still exists today.

During the course of the next 15 years, France introduced 56 nuclear reactors and managed to transform itself from a net importer to a net exporter of electricity.[2] And yet, well before the Chernobyl disaster, nuclear power as a source of energy for peaceful purposes had powerful foes in France. In the 1970s and 1980s, Green activists protested nuclear power as a source of national energy, culminating with the dramatic protests opposing the building of Superphénix, a nuclear power station. Nonetheless, a majority of the French are now comfortable with the nation's reliance on nuclear plants for most of its energy needs. Indeed, 70 percent of the French approve of the nation's incorporation of nuclear power into its energy portfolio.[3] Energy experts opine that the country's comfort with nuclear energy comes from French mentality and culture. Since the French prefer to be fiercely independent, they were publicly given a choice between dependency on unstable, unfriendly foreign sources and independent, reliable, nuclear energy. The argument for a nearly inexhaustible domestic source of power was made especially compelling by policymakers, who claimed that nuclear energy could be hazardous only in rare occasions. France holds its researchers and engineers in high esteem. They are considered to be part of an unusual elite whom the French not only appreciate, but trust. So it was easy for the population to be persuaded of the merits of nuclear energy. However, French policymakers hardly ever emphasized the dark side of this energy panacea: the fact that it uses uranium, a non-renewable resource, and that the country has still to resolve its nuclear waste disposal challenges. Also, very little acknowledgement has been given to the fact that nuclear energy is not completely CO_2 free.

The Advantages of Nuclear Energy

Extensive reliance on nuclear power has some advantages. Here are some:

1) Relative energy independence: Having an extensive nuclear energy network secures relative independence for France, which lacks natural resources of its own. Since 2003, France has not had any uranium production; its nuclear energy depends entirely on imports. However, dependency on supplier nations is not considered a risk since supplies are not in the hands of foreign hostile regimes.

2) Nuclear energy is regarded as clean energy. Compared to coal, petroleum and natural gas, it emits much lower levels of CO_2. Since nuclear plants generate energy through the fission of uranium, their emissions of nitrogen oxides (NOx), sulfur oxides (SO_2), dust, or greenhouse gases (such as carbon dioxide) are negligible compared to the fossil-burning methods of energy production. In a span of only 6 years from 1980 to 1986, France was able to reduce its SO_2 emissions by 56 percent and NOx by 9 percent. There is little doubt that nuclear power generation is a relatively clean process, especially when compared to electricity produced by coal. Coal plants emit dangerous levels of toxic, heavy, carcinogenic metals such as arsenic, cadmium, lead, and mercury, as well as CO_2, SO_2, and NOx. Finally, coal as a source of energy has increased the level of CO_2 in the Earth's atmosphere, contributing to the greenhouse effect of global warming. Comparatively, France's output of CO_2 emissions has dropped by 80-90 percent.[4]

3) The technology for building nuclear plants is widely available and consequently does not need to be developed. Also, because of the vastness of its nuclear energy sector, France is one of the biggest exporters of nuclear reactors and nuclear technology, which bring additional export revenue.

4) Nuclear plants are much more energy efficient than coal plants. One nuclear plant can generate electricity for an entire region, which can only otherwise be achieved by numerous coal plants. Indeed, 79 percent of electricity in France is generated by 58 nuclear plants.

Drawbacks of Nuclear Energy

France started its nuclear program under French President General de Gaulle in the 1950s. At that time, the country's leadership was more concerned with energy independence than with the portent of nuclear waste. However, in the 1960s and 1970s, the state and the French energy industry had to heed the urgency to deal with nuclear waste in the least harmful manner. "The 58 nuclear reactors in France generate 1 kilogram of radioactive waste per inhabitant per year (about 65 tons), about 900 grams of which are short-lived, low-active or medium-active waste, 90 grams are long-lived medium-active waste, and 10 grams are high-active waste. Ninety-six percent of radioactivity is contained in less than one percent of waste."[5] Nuclear waste management is now considered a topic of national security, and thus, not all information is readily available. The agencies in charge of nuclear waste management are all state organizations, which has led many environmental activists to accuse the French authorities of inordinate secrecy. Agence nationale pour la gestion des déchets radioactifs (ANDRA) manages nuclear waste and its scope of activities includes:

Low-Level Radioactive Waste Management: Low-level nuclear waste's radioactivity reaches non-hazardous levels in less than 300 years. There are two facilities where the low-level radioactive waste is stored: Centre de la Manche and Centre de l'Aube. La Manche is an old facility that has reached its operational limit and has not accepted any waste since 1994. The L'Aube site, opened in 1992, is expected to operate until 2035. Both sites are not considered to be very deep in the ground.

"...French policymakers hardly ever emphasized the dark side of this energy panacea: the fact that it uses uranium, a non-renewable resource, and that the country has still to resolve its nuclear waste disposal challenges."

High-Level Radioactive Waste Management: Waste which requires more than 300 years to reduce its radioactivity to non-dangerous levels is designated as high-level radioactive waste (HLW). HLW is retained at each plant for one year. After that, it is transported to La Hague and Marcoule and stored there for two to three years.

Reprocessing spent nuclear fuel: Along with reprocessing its waste, France recycles fuel from Belgium, Germany, the Netherlands, Switzerland, and Japan. The remaining waste, after recycling, is HLW. It is hardened and kept for decades at the La Hague site. Eventually, the hardened waste will be buried deep in the ground.

Transporting radioactive waste: France has over 30 years of experience transporting radioactive waste. For long distance transport, the waste is transported by rail in special rail wagons. Trucks are used for shorter distances. If there is an intercoastal connection, five specially designed ships are used to transport the waste. The used fuel's final destination is the waste radioactive depot – La Hague.

Deep geologic disposal plans

A site in Bure, Meuse, in the region of Champagne, has been selected as a deep geological repository for the high-level radioactive waste. The site is expected to be ready by 2025. The storage's depth will be 500 meters beneath ground level. Currently, disposal in natural clay and granite formations are being considered. French officials go to great lengths to project the impression that the disposal of waste management is under control, and the skillful handling of waste by nuclear disposal experts does not pose any threat to the environment. However, many disagree with this reassuring image. Almost all matters concerning nuclear energy and especially radioactive waste are treated as classified in France.

Greenpeace reports that Russia is a recipient of tens of tons of nuclear waste every year. For instance, each year the French nuclear plant Eurodif, located 700 km south of Paris, sends about 4,000 to 5,000 tons of its waste to Russia. Greenpeace critics claim the waste travels without the necessary safety measures in place via several Western European countries, and that it passes through cities in Russia such as St. Petersburg and Tomsk with only sporadic supervision. They assert that the used fuel is enriched in Russia, and only a fraction of it is returned back to France. The rest remains stored in Siberia in unsafe and unsecure conditions. Greenpeace says that France has over 1,000 temporary nuclear waste sites, some of which are not protected. As its nuclear energy network grows, so does the amount of nuclear waste it produces. It is estimated that each year, radioactive waste increases by 1,200 tons.

These opponents of nuclear energy, such as Greenpeace, accuse the nuclear reprocessing industry of storing nuclear waste in unsafe conditions. Once the used fuel is disposed of, there is no way to retrieve it from the contaminated site. The impact of the waste is not yet fully known. However, one thing is certain: with our current level of scientific knowledge, the environmental damage resulting from modern disposal methods will be felt by this generation and passed onto future ones. Both low- and high-level radiation sites have been leaking radioactive elements into underground water. The Centre de la Manche, one of the largest nuclear waste sites in the world, which has been closed since 1994, still has a high level of contamination. The water from La Manche seeps into the underground aquifer, from where it flows to the rivers and wells. There are concerns by the farmers who use this water to feed cattle. The level of radioactivity in the area is 750 Becquerels per liter of water, which is seven times higher than European safety requirements. The contaminated water may contain plutonium and strontium, which can cause cancer and genetic defects.

In addition, tritium has been found in the aquifer near the Centre de l'Aube, which opened in 1994. Since the plant does not have a license to release any of its radioactive elements, radioactive alpha-emitters have been detected in the area. They remain radioactive for thousands of years and are linked to lung and bladder cancer. The Centre de l'Aube is designed to store low-radiation waste, whose radiation lasts for less than 300 years. It is not equipped to handle high-radiation waste. Ominously, the Centre de l'Aube is located in Champagne, famous for its production of sparkling wine. If the water is contaminated, as Greenpeace claims, its effects will be felt for decades, and possibly for centuries. If this is not bad enough, France's nuclear authorities are compounding the problem with nuclear pollution in the area by reprocessing the waste for other countries. In fact, ten percent of the reprocessed waste comes from Areva/Cogema and its foreign clients from Germany, Belgium, Holland, Japan, and Australia. And since French law does not allow discharging of foreign nuclear waste in France, it is clear that Areva/Cogema[6] are responsible for the region's increasing contamination.

If the plan to open a deep geological repository in Bure, Champagne materializes, a huge quantity of radioactive waste

will be deposited for an undetermined period of time. The problem with such a depository is that radioactive pollution might remain active for hundreds or even thousands of years. Although its building has been carefully planned and supervised, there is no guarantee that tectonic changes will not disrupt the depository and release radioactive pollution into the area. Climate change's effects on the site might cause damage and leak radioactive waste into underground waters. However, strong opposition from residents, such as the famers from Rhone Valley (another strong wine producing region) has prompted cancellation of a second high level waste depository.

Proponents of nuclear energy praise it as the least expensive of all energy generation options. However, this does not take into consideration the costs for disposal of the waste. Invariably, when these costs have been called into question, the figures have been underestimated. For instance, in 1996, ANDRA projected that the cost for a deep geological repository would be 14 billion euros. In 2003, it revised its budget based on estimates that it would cost between 16 and 58 billion euros. Since the EDF, which generates and distributes the electricity nationwide, is a limited-liability company, the costs for a repository are passed on to its customers. Operating and maintaining the repository depends on the financial health of EDF. If at some point EDF's financial stability is compromised, it will be up to the state to take over the security of the depositary and eventually the cost for running it.[7]

Is Nuclear Energy CO_2 free?

Since precise data on France's nuclear plant emissions of CO_2 is not available, we'll use data of CO_2 emissions garnered from research of nuclear power plants in different parts of the world. This will be the basis for our conclusions regarding France's CO_2 emissions.

As previously noted, many proponents would like to promote nuclear energy as CO_2 free. However, examining the life cycle of a nuclear power plant from the first phase of uranium mining to its final, permanent nuclear waste storage clearly shows that nuclear energy generation does produce carbon. While nuclear power itself does not emit CO_2, there are numerous externalities which contribute to GHG (greenhouse gas) emissions. Since these externalities vary, there is no agreement in the scientific community over how much CO_2 one nuclear plant emits. There is, however, a consensus that on the low end of the scale, it contributes 1.4g CO_2 e/kWh and on the high end of the scale it emits 288g CO_2 e/ kWh. There is a semi-consensus that on average, a nuclear plant emits around 66g CO2 e/ kWh.[8]

The emissions start with the mining of uranium. Depending on the quality of the uranium ore, emissions from mining and milling lie between 0.4g CO2 e/kWh and 67g CO_2 e/kWh. Different mining techniques will release different amounts of CO_2. The energy used to extract the metal also plays into how much a plant emits. Using energy efficient mining techniques will produce less CO_2 emissions. Conversely, mining in remote areas using diesel powered generators for mining energy will increase CO_2 emissions.

CO_2 emission during the uranium enrichment phase varies according to the technology being used. A gaseous diffusion approach requires much more energy, especially if powered by a fossil fuel generator, which can give off as much as 80g CO2 e/kWh. Enrichment by centrifuge brings the CO_2 emissions down to 9g CO_2 e/kWh. France uses gaseous diffusion processes[9] [10], and thus, this cycle emits more CO_2.
Even boiling water in the nuclear reactors is a source of GHG. There is no agreement as to how much these emissions amount to, but some scientists see them in the range of 5-12g CO_2 e/ kWh. Others claim that they are ten times higher. There are more than 30 different reactor designs, and each of them has a different fuel cycle, level of efficiency, and cooling procedure. On average, the amount of CO_2 from a commercial reactor is 66g CO_2 e/kWh. At this time, the reactors considered the most efficient are the CANDU reactors, produced in Canada. Their level of greenhouse emissions is a quarter of the commonly used medium – 15g CO2 e/kWh.

The construction of the plant is another factor in the CO_2 emission bouquet. It may vary according to building techniques; materials, which are often imported (copper, concrete, steel); transportation; the energy supplied from the local companies (renewable or fossil fuel); and commute to and from the construction site for laborers and experts who do not live in the area. A plant built in Canada using a CANDU reactor with highly energy efficient technology, domestic uranium, and located close to the construction site would, at minimum, emit 15g CO_2 e/kWh. On the other hand, a plant built in a developing country that uses imported uranium, low energy efficiency, workers that need to be brought in from elsewhere, and lacks advanced technologies or skilled labor can raise CO_2 emissions to 80g e/kWh.[11]

During the operational cycle, which is usually 30 to 40 years, the amount of GHG depends on the load factor. On average, the CO_2 emissions during this phase stay at 11.58g CO_2 e/ kWh.[12]

At the back end of the plant's life cycle, which includes fuel processing, temporary and permanent storage, and transportation to the sites, the amount of CO_2 is 9.2g CO_2 e/ kWh.[13]
The decommissioning of the reactor can last as long as 60 years; hence, the energy required to complete this cycle can be quite substantial. Studies attribute from 12.01g CO_2 e/ kWh to as much as 49.1g CO_2 e/kWh to this final phase of a plant's cycle.[14] Nuclear energy is not carbon free. Yes, it emits much less CO_2 than coal, oil, diesel, fuel cell, and natural gas. However, can it truly be called "clean energy"? It contributes to the greenhouse effect and also leaves radioactive waste with dangerous consequences that are not yet fully understood.

While the data may vary slightly, there is no doubt that France's nuclear-produced energy is no less carbon free than in other parts of the world where the study was conducted. France imports the required uranium and the mining and milling take place outside its borders. Yet, the remaining parts of the life cycle – conversion, enrichment, fabrication, reprocessing and recycling of nuclear materials – are all taking place in France.[15] And since France is the recipient of the uranium, the CO_2 emissions should go on its account even as it fails to use the most efficient nuclear reactors. French nuclear reactor emissions are higher than those utilizing a CANDU reactor, and there are currently no plants in France that use them. The country has a highly skilled non-commuting labor force that helps lower CO_2 emissions. If we use the above data, we can conclude that France's CO_2 emissions are in the range of 100-140g CO_2 e/kWh. The exact emission depends on the method used to mine the uranium, the type of reactor used, and the plant's proximity to waste storage site.

"Nuclear energy is not carbon free. Yes, it emits much less CO_2 than coal, oil, diesel, fuel cell, and natural gas. However, can it truly be called "clean energy"? It contributes to the greenhouse effect and also leaves radioactive waste with dangerous consequences that are not yet fully understood."

Conclusion

We took France as a case study for the nuclear energy industry because it is considered to be at the forefront of nuclear energy technology. Seventy-nine percent of the electricity in France comes from nuclear plants. France's love affair with nuclear energy began in 1950s but went into full swing only after the country's sense of security was shaken by the shocks of the first OPEC oil crisis. France was not endowed with a bountiful, rich natural resource base, and so it sought to cut its dependence on foreign energy supplies. Above all, what spurred its headlong jump into building a vast network of nuclear plants was the drive to secure France's energy independence. The second reason France took the nuclear route for its energy needs was environmental concerns. Many place nuclear energy in the camp of GHG-free energy sources. There is almost a knee-jerk response to nuclear energy proponents' claims that nuclear energy is less harmful than coal, natural gas, or oil. Yet as we have seen, while the process of generating nuclear energy is CO_2 free, the life cycle of the nuclear process still contributes CO_2 emissions. The more pressing issue, however, is how to effectively and safely dispose of nuclear waste so that future generations do not pay a terrible price for the possible disposal mistakes which may have already been committed and are beyond recall. Nuclear technology is constantly evolving and there is always the possibility that uranium might one day be replaced by a less lethal fuel. Scientists may find a way to dispose of nuclear waste in a safe way with no dangerous consequences to humans, animals, or the environment. Nevertheless, until we reach that point, nuclear waste's toxic effects threaten to contaminate water and land with far-reaching effects that may last for generations to come. Brisk and crisp champagne will continue to be poured into our glasses and French cheese will be served on ornate trays while the majority of us remain unaware that they could be blended with particles of nuclear waste coming from the radioactively polluted areas of Champagne and Normandy.

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1 The nuclear reactors are operated by Electricite de France (EDF). They have a total capacity of about 63 GWe, supplying annually approximately 430 billion kWh of electricity. France's total generating capacity is 116 GWe, of which 63 GWe is nuclear, 25 GWe is hydro and 26 GWe is fossil fuel.

2 Currently, France imports less than 50% of its energy resources.

3 Joe Palfreman, "Why the French like nuclear energy." <http://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/french.html> (March 31, 2009)

4 Ilan Lipper & Jon Stone, "Nuclear Energy &Society," at http://www.umich.edu/~gs265/society/nuclear.htm (March 26, 2009).

5 French Ministry of Foreign and European Affairs, 2007, "La France a la loupe" (March 31, 2009) at http://ambafrance-us.org/IMG/pdf/nuclear_power.pdf

6 AREVA is state-owned. The French state owns 90 percent of AREVA.

7 As of 2004, EDF is a private company; however, through complex stocks, the French government retains almost 85 percent share in it.

8 Bejamin Savacool," Valuing the greenhouse gas emissions from nuclear power : A critical survey:," *Science Direct* (June 2, 2008) at http://www.nirs.org/climate/background/sovacool_nuclear_ghg.pdf, pp. 29-49.

9 The Encyclopedia of Earth, "Uranium enrichment" (April 1, 2009) at http://www.eoearth.org/article/Uranium_enrichment#Gaseous_diffusion_process

10 France is developing third-generation EPR reactor with high environmental standards, which is expected to be in operation by 2012. The country is also researching a forth generation reactors, which may not come in line until 2040.

11 Bejamin Savacool," Valuing the greenhouse gas emissions from nuclear power : A critical survey," *Science Direct* (June 2, 2008) at http://www.nirs.org/climate/background/sovacool_nuclear_ghg.pdf, p. 2,950 (March 28, 2009)

12 Ibid. p. 2,949

13 Idem.

14 Idem.

15 French Ministry of Foreign and European Affairs, 2007, "La France a la loupe," (March 31, 2009) at http://ambafrance-us.org/IMG/pdf/nuclear_power.pdf

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Climate Change Impacts on Hawaii

By Henry Kwong

THE ALOHA state of Hawaii is located in the middle of the Pacific Ocean, approximately 2,600 miles west of California. As the only state in the United States that is an island, Hawaii is unquestionably vulnerable to changes in climate. Like many islands across the world, Hawaii is susceptible to sea level rises, coastal flooding and a whole host of other impacts caused by climate change. According to the global climate change report on the United States (U.S. climate change report), islands have been experiencing rising air temperatures and sea levels in recent decades. Scientific evidence strongly suggests that these trends are very likely to continue into the foreseeable future.

According to the U.S. climate change report, small islands are considered among the most vulnerable to climate change because extreme events have major impacts on them. Changes in weather patterns and the frequency and intensity of extreme events, sea-level rise, coastal erosion, coral reef bleaching, ocean acidification, and contamination of freshwater resources by salt water are among the impacts small islands face. In addition, the availability of freshwater is likely to be reduced, with significant implications for island communities, economies, and resources.

Climate change and global warming are likely to have adverse potential impacts on Hawaii's environment, health, economy and natural resources. Sea-level rise explains the disappearance of Whale Skate Island, a small island formerly located in Hawaii's northwest region.[1] Its disappearance wiped out habitats for birds, turtles and other fish and wildlife. In general, the Northwestern Hawaiian Islands, which are low-lying and therefore at great risk from increasing sea levels, have a high concentration of endangered and threatened species, some of which exist nowhere else. The loss of nesting and nursing habitats is expected to threaten the survival of already vulnerable species, and unusually high temperatures and increased frequency of heat waves could very likely lead to a rise in heat-related deaths, particularly among the elderly, in a situation similar to what befell Europe in 2003, when several thousands more died above normal death rates.[2]

The scientific evidence for sea-level rise is strong and unequivocal. As the U.S. climate change report indicates, "Recent global sea-level rise has been caused by the warming-induced expansion of the oceans, accelerated melting of most of the world's glaciers, and loss of ice on the Greenland and Antarctic ice sheets. A warming global climate will cause further sea-level rise over this century and beyond."[3] Based upon data furnished at a presentation given at a National Oceanic and Atmospheric Administration (NOAA) meeting in San Francisco, sea levels are projected to rise three feet along the coast of Oahu during the rest of this century due to global warming.[4] Clearly, islands and other low-lying coastal areas will face increased risk from coastal inundation due to sea-level rise and storm surge, with major consequences for coastal communities, infrastructure, natural habitats, and resources.

"...unusually high temperatures and increased frequency of heat waves could very likely lead to a rise in heat-related deaths, particularly among the elderly, in a situation similar to what befell Europe in 2003, when several thousands more died above normal death rates."

Generally, Hawaii's beaches are not subject to any significant erosion thanks to coral reefs, which act as barriers to incoming waves. With documented warming of the seas, coral reefs will be subject to adverse environmental conditions which are harming their ecosystems, growth and sustainability. Without the protective quality of these coral reefs, which are the source of the island's white, sandy beaches, Hawaii's coastline will very likely undergo erosion over time. According to Next Generation Earth, a group associated with the Earth Institute at Columbia University, the cost of replenishing these beaches to prevent sea-level rise will range anywhere from $350 million to $6 billion.[5] Based upon a study issued by NOAA along with several other government and research agencies, ocean water temperature increases are expected to amplify the frequency and severity of coral-bleaching events.[6] Most of Hawaii's coral reefs are in fair to good condition, but this status will change for the worse if effective ecosystem management measures are not taken.

According to a United States Geological Survey report, warmer temperatures in Hawaii are having adverse affects on native bird species.[7] Warmer temperatures expand the range of mosquitoes into higher mountain elevations. For birds such as the honeycreeper that live in higher, cooler mountain refuges, this will introduce new stresses and disease vectors into their environment. Without resistance to malaria, honeycreeper birds in their current habitats may face extinction as a result of the spread of mosquitoes and mosquito bites. As ecosystems move and change, other diseases are likely to migrate into regions of warmer temperature. Saving the honeycreepers and other bird species will require active environmental management of those areas they currently inhabit and the elimination or containment of mosquito populations.

Climate change impacts in Hawaii have an economic dimension with effects felt in the tourism industry and fisheries trade. As the U.S. climate change report notes, "coral reefs sustain fisheries and tourism, have biodiversity value, scientific and educational value, and form natural protection against wave erosion. For Hawaii alone, net benefits of reefs to the economy are estimated at $360 million annually, and the overall asset value is conservatively estimated to be nearly $10 billion."[8] Although further evidence is necessary, warmer seas may also promote toxic algae, leading to harmful algae blooms known as red tides. These blooms are toxic to habitat and shellfish nurseries as well as humans. In addition, clean-up costs must be taken into consideration.

Any environmental problems or disasters may have a net negative effect on Hawaii's tourism industry, as tourists will be dissuaded from visiting an unstable, environmentally risky destination. In 2008, over 6.8 million visitors came to Hawaii and spent $11.4 billion,[9] which accounted for 18% of Hawaii's gross domestic product.[10] Sea-level rises and flooding contribute to submergence of beaches, and that will be a factor Hawaii policymakers must grapple with in planning the future of Hawaiian tourism. In recent decades, as sea levels have risen and more beaches have overflowed with seawater, more sea walls have been built along the famous Waikiki beachfront to stem the rise in ocean levels. As a possible consequence, many affected parts of the islands may experience declines in real estate values.

Unlike many small, developing island nations, as part of the United States, Hawaii has the capacity and resources to mount a credible defense against environmental impacts caused by climate change. Hawaii has exhibited foresight in anticipating climate change impacts. In 1998, the state issued a lengthy report on the effects of climate change on the islands. Recommendations and action plans to improve energy efficiency and reduce greenhouse gas emissions over a broad range of industries were included in the report.[11] Hawaii is proactive and has positioned itself to combat climate change and reduce greenhouse gas emissions.

In 2007, Hawaii enacted "A Global Warming Solutions Act 234" to cap greenhouse gas emissions to the 1990 level by 2020.[12] In 2008, Hawaii launched a Clean Energy Initiative with the goal of creating a 70 percent clean-energy economy within a generation.[13] As a result of its location and lack of fossil fuel resources, Hawaii is the most oil-dependent state in the nation, getting 90 percent of its energy needs from imported oil.[14] In a memorandum of understanding signed in 2008, the Department of Energy (DOE) will assist Hawaii to achieve the goal of reducing its dependence on oil for electricity generation.[15]

"Hawaii is proactive and has positioned itself to combat climate change and reduce greenhouse gas emissions."

Hawaii has at its disposal a plethora of renewable energy options to transition to a renewable energy economy including biomass, hydro, wind, geothermal, ocean waves and, of course, solar. In its favor, Hawaii emits only 0.4 percent of the total U.S. greenhouse gas emissions and is therefore one of the lowest state emitters in the country.[16] Hawaii is also part of the EPA's Clean Energy State Partnership Initiative to support the introduction and use of clean, renewable energy. The Sierra Club reports that Hawaii also recently imposed a $1 surcharge on each barrel of oil imported into the state. Funds collected here will be earmarked for the development of clean, renewable energy. Last but not least, the Governor of Hawaii, Linda Lingle, recently signed an energy bill into law mandating that 25 percent of Hawaii's electricity must come from renewable energy sources by 2020 and 40 percent by 2030.[17]

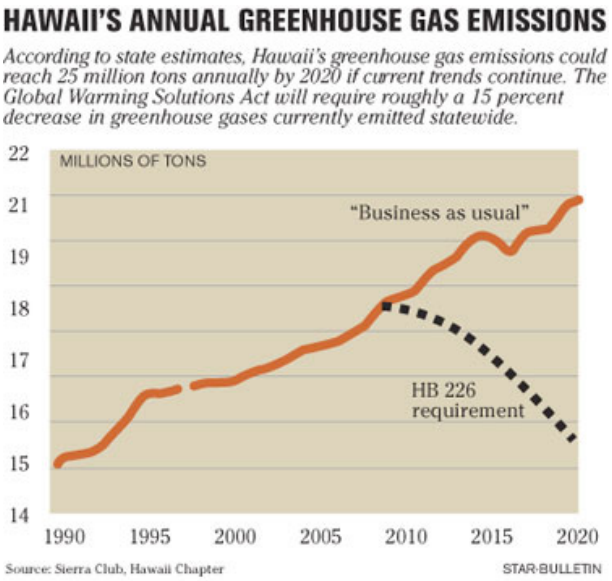
The scientific evidence for climate change in Hawaii is strong. Rising sea levels and temperatures are increasingly affecting coastal areas, natural habitats, and will potentially have harmful effects on human health and the economy. To spotlight the severity of the problem with climate change and rising sea levels, the President of the Maldives, Mohamed Nasheen, recently conducted an underwater cabinet meeting to point out one possible future scenario for island nations if little or no action is taken to deal with climate change.[18] With foresight and planning, Hawaii is taking appropriate steps to adapt to changing conditions, strengthen its natural defenses and mitigate future climate troubles. It is highly unlikely that Hawaii would have to take the astonishing step of performing an instance of official government business underwater like the Maldives to bring awareness of the issue to a wider global audience. Given its global impact, the warming of the oceans and other climate changes are obviously beyond the sole control of the state and will present continuous challenges well into the foreseeable future. In this sense, Hawaii shares vulnerability with other small island nations in that its environmental resilience and destiny is as much determined by its own actions as it is dependent upon the actions of others in other parts of the world.

Henry Kwong grew up in Queens and has lived in New York City most of his life. A graduate of Brown University, he has lived and traveled in Britain, Canada and China. Henry has worked at the U.S. Attorney's Office where he assisted on several successful criminal cases and trials. Before attending NYU, Henry worked at Prudential, where he managed a portfolio of the company's domestic and international trademarks, domain names and intellectual property matters.

Through New York Cares and other organizations, Henry has volunteered on many projects to improve the lives and communities of New York City residents. Henry's academic interests are in energy and the environment and the private sector.

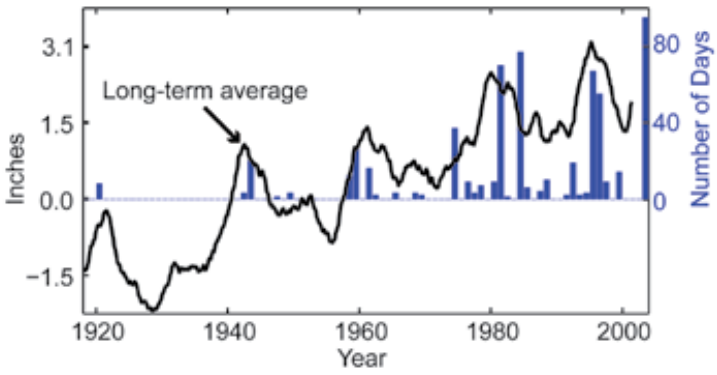
An enthusiastic sports participant, Henry can often be found on softball fields having fun and enjoying the sun during warmer months.

Appendix 1



Appendix 2

Severe Sea Level Days – Honolulu, Hawaii



Source: Global Climate Change Impacts in the United States

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Emissions Arbitrage in the Natural Gas Market

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Co-Authors: Orlee Zorbaron & Kelly Nelson

Abstract

Analysts have long-expected Liquefied Natural Gas (LNG) imports to provide a steady, dependable source of natural gas feedstock for end-use in the United States. However, climate change legislation and the availability of domestic unconventional gas supplies are recasting the long-term relevance of LNG in the United States. "Emissions arbitrage" opportunities that result from competition between LNG and shale gas providers will reorient the U.S. market for imported natural gas, causing it to increasingly be supplied by domestic sources.

Although it currently accounts for one percent of natural gas that is consumed in the United States, analysts have consistently forecasted that Liquefied Natural Gas (LNG) imports would provide a steady, dependable source of natural gas feedstock in the decades to come. However, climate change legislation that levies a price on greenhouse gas emissions and the availability of domestic unconventional gas supplies will limit the long-term relevance of LNG in the U.S.

The cap-and-trade system envisaged by the U.S. House of Representatives requires foreign suppliers of fossil fuels to surrender "emissions allowances" to the government for each unit of carbon dioxide (CO_2) or methane (CH_4) that is emitted in the process of making a shipment of fuel to the United States. LNG is especially impacted by this provision, because 20 percent of the gas that is extracted abroad gets consumed in the process of delivering a shipment of LNG to a distribution company (LDC) in the United States. The cost of upstream emissions that results from liquefying, shipping and regasifying natural gas will significantly increase the price of LNG in the U.S. and limit the market for imports.

Concurrent to the forthcoming carbon price regime is an ongoing renaissance in the U.S. natural gas industry. In the last century, it was considered uneconomical to extract hydrocarbons locked in shale rock formations. However, advanced drilling techniques have made the development of shale natural gas reserves in Texas and Louisiana economically viable, and the successes in the South have spurred investment in shale gas plays across the country. There is estimated to be enough shale gas to supply 100 years' worth of U.S. domestic demand (at current rates), and gas from shale is projected to supply more than 50 percent of the U.S. market by 2020.

The added carbon cost of importing LNG, in addition to the increasingly favorable economics of shale gas extraction, stand to limit long-term demand for LNG in the United States. To the extent that these two sources of natural gas compete with one another,

"There is estimated to be enough shale gas to supply 100 years' worth of U.S. domestic demand."

emissions arbitrage opportunities that arise by purchasing domestic shale gas, as opposed to LNG, will encourage further development of shale reserves and limit the relevance of LNG.

Liquefied Natural Gas

The Liquefied Natural Gas supply train to the United States starts when methane gas is extracted from foreign reserves (predominantly located in Trinidad and Tobago). The gas is piped to processing facilities that remove water, sulfur and certain distillates, and then to liquefaction plants, where the gas is cooled, pressurized, and transformed into a liquid. In liquid form, the LNG is loaded onto tankers, which travel to their U.S. ports of call. Tankers offload their cargo at regasification terminals, where LNG is heated until it returns to its gaseous phase. The gas is then pumped into a pipeline system that leads to distribution hubs, and is finally routed to end-users.

Liquefaction facilities use fans and refrigerants to cool methane gas to -163 degrees Celsius. They are energy intensive, and consume eight to ten percent of the initial volume of extracted natural gas to power various processes.[1] The actual amount of CO_2 that is emitted depends on the energy intensity of the gas (in British Thermal Units) and the efficiency of the liquefaction plant itself.

After it has been liquefied, the LNG is stored until a shipment order is filled. Any type of container used to store LNG has an inflow of heat that results in evaporation. This is generally

referred to as "boil-off." For typical storage containers the boil-off varies between 0.04-0.20 percent of the total storage volume per day, which is released into the atmosphere in the form of methane gas.[2]

When there is enough LNG to fill an order, the product is loaded onto a ship and transported across the ocean in specially insulated tankers. The insulation maintains the temperature of the cargo, thereby limiting boil-off, but on a typical voyage, 0.1-0.25 percent of the methane is released into to atmosphere.[3]

LNG carriers are traditionally powered by steam turbines burning marine diesel or heavy fuel oil.[4] The new generation of LNG carriers is increasingly powered by diesel-electric propulsion systems in which two to four large engines generate electricity that power electric drives. Some ships use the LNG boil-off as fuel for the journey, but over a typical 20-day return voyage from a liquefaction facility to a regasification terminal, the total net loss is two to six percent of the volume.[5] [6]

There is limited capacity for transporting LNG over land; once it reaches the port, LNG is returned to its gaseous state and transported via pipeline. More natural gas is needed to provide the energy for regasification, which uses vaporizers that convert the liquefied cryogenic methane back into gas. Regasification terminals run heated seawater through heat exchangers inside the vaporizers. All told, between 1.5-3 percent of the throughput gas is used to fuel the water heater system.[7]

After unloading their cargo, tanker ships steam home to reload. The return voyage incurs additional boil-off. The "heel" refers to five percent of the cargo, which remains on board to keep LNG transport containers at the right temperature and pressure. The boil-off losses can be 10-50 percent of the heel on a return voyage, or the equivalent of .5-2.5 percent of the total load.[8]

All told, 20 percent of the initial volume of extracted gas is consumed during the LNG train, which in and of itself makes LNG very expensive. But the carbon cost of gases that are lost or used as fuel will significantly increase the price of importing LNG to the United States.

Shale Natural Gas

In the last ten years, innovative drilling techniques have economized the production of natural gas from shale rock formations. These formerly untapped reservoirs of methane gas are now producing large quantities of gas. Due to the enormous shale formations that underlie the continental United States, analysts expect that shale gas will be an increasingly reliable supply of natural gas.

Traditional natural gas wells are drilled down vertically to the depth of a subsurface layer that contains a gas reservoir. The pressure and weight of overlying rock forces hydrocarbons up through the depressurized well, which essentially acts as a straw. However, due to the impermeability of shale rock formations, gas trapped in subsurface shale reservoirs does not move to the surface in large quantities. As a result, the economic viability of vertical shale wells has been marginal.

"All told, 20 percent of the initial volume of extracted gas is consumed during the LNG train, which in and of itself makes LNG very expensive."

Advances in horizontal drilling and hydraulic fracturing techniques have made shale gas wells more economical. In the last decade, shale formations in Texas, Louisiana, and Arkansas have seen major development. As the drilling techniques are refined, companies are becoming eager to expand operations to Pennsylvania, Ohio, New York, West Virginia and other areas of the country that overlie shale formations.

The process of developing a shale gas well begins by securing mineral rights and permits to drill on land that is close to existing pipeline infrastructure and a source of water. Operators get a sense of the subsurface hydrocarbon density by using seismic monitors and four-dimensional modeling, and by drilling test wells.

A vertical well is drilled down to the subsurface layer of shale, and a specially curved bit is used to turn the well so that it bores horizontally through the formation. After the well is capped and cemented, small explosive charges are detonated in the horizontal section of the well to create spider web-like fissures in the surrounding rock. Water mixed with sand and chemicals is pumped into the well at high pressures to force sand particles into the fissures, artificially creating porosity that enables gas to flow into the well bore more easily. The hydraulic fracturing process exposes vast volumes of hydrocarbons to the depressurized bore, and is a key element in the increased efficiency of drilling shale gas wells.

In the oil and gas industry, excitement about the prospects for shale natural gas development is palpable around the world. European nations that are dependent on imports of gas from Russia are now commencing studies of their domestic shale reserves. And although stratigraphy of the countryside is not easily accessible, further study may reveal that mainland China is also home to vast reserves of shale natural gas.

"...Cost of carbon allowances for a shale gas well will be significantly less impactful than for the LNG train."

Recent analysis has suggested that there is enough recoverable shale gas to satisfy U.S. domestic demand for 100 years. Although the price point at which shale gas development will be economical has yet to be determined, experts generally agree that the U.S. shale gas resource is vast, that operators in certain shale plays are already profitable, and that cost of carbon allowances for a shale gas well will be significantly less impactful than for the LNG train.

Conclusion

It is impossible to be sure what share of the gas market will be supplied by LNG in the long run. But to the extent that there is competition between shale and LNG, the emissions arbitrage that arises from purchasing local shale supply as opposed to imported-LNG is reshaping projections about the U.S. market. Only 12-13 percent of the US regasification capacity is currently being utilized, and financing has been withdrawn from projects to develop additional regasification terminals.

We contend that climate change legislation and economical shale gas extraction will limit the long-term demand for imports of LNG to the United States, and that emissions arbitrage opportunities will arise for LDCs purchasing feedstock from shale reserves as opposed to LNG.

Samuel Jurek Urbach Lissner received his bachelor's degree from Harvard University in Near Eastern Languages & Civilizations and Government. He studied abroad at the Hebrew University in Jerusalem, and is now concentrating in Energy & Environment at the NYU Center for Global Affairs. Sam has worked at The Network for New Energy Choices, the United States Environmental Protection Agency, and at the United States Department of Energy. He is currently researching sustainable transportation initiatives in Tel-Aviv, Abu Dhabi, and Pamplona, and will co-produce a documentary film that presents the findings of his investigation.

Orlee D. Zorbaron spent her freshman year of college at Bar Ilan University in Israel, and earned her undergraduate degree in a double major of Philosophy, Politics & Law and Judaic Studies from SUNY Binghamton. Her concentration in the Global Affairs program is Energy & the Environment. She is currently working on a thesis about Israel and Energy Independence.

Kelly Nelson's concentration is international business, economics and development. His interests are the political economy of violent conflict, international health, and environmental issues. He is currently an intern in the operations department at the Tanenbaum Center for Interreligious Understanding. Prior to studying at NYU, he was a laboratory assistant at Clarke Mosquito Control in Sterling, VA. Previous experience includes an internship in the programs department at Citizens for Global Solutions in Washington, D.C. and a research assistant position at the Center for International Development and Conflict Management. Kelly holds a BA in history from the University of Maryland-College Park.

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Acknowledgement

Thanks to Chris Gadomski for encouraging this article.

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The Possibility of Large-Scale Geothermal Power Plants

By Fathali Ghahremani

Abstract

It is conceptually possible to extract one thousand megawatts of thermal power from a single geothermal site. This paper presents a new model to extract such energy by concentrating on heat mining without the requirement of using *in situ* (in-place) or injected fluids, thereby avoiding the problems inherent in the current paradigms.

Most current geothermal power plants are water/vapor driven and dependent on subterranean fluid reservoirs. These reservoirs are characterized by subterranean rock formations with enough fluid volume and pressure, adequate porosity and permeability, and sufficient temperature to allow viable energy extraction. These unalterable geologic conditions (heat, fluid content, pressure, porosity and permeability) seldom occur simultaneously, thereby restricting both the size and location of power plants.
Enhanced Geothermal Systems (EGS) are a slight modification of these requirements. The permeability of the rock is increased by hydraulically fracturing – that is, shattering – the subterranean rock formation, thereby facilitating the flow of fluid through it. This allows for heat mining by circulating fluid between the surface and the hot dry rock (HDR). Similar to other vapor-driven systems, this method depends on direct fluid to rock contact. However, the EGS system does not require *in situ* fluids. The plant supplies the fluid necessary for heat transport.

A new model is proposed that is independent of the flow characteristics of the subterranean lithology. It concentrates on energy extraction, requiring only a high-temperature conductive rock formation. The technique does not need direct fluid to rock contact, thus avoiding the problems associated with hydraulic fracturing or chemical alteration of the formations. Since HDR formations are readily accessible and widely distributed, this method would allow the development of high megawatt geothermal plants.

Introduction

Energy consumption has been a determinant of human development and, in fact, may be the best measure of human activity.[1] It is a force multiplier that gives humans the tools necessary for modifying their environment, building their massive nfrastructures and communicating over global distances. Its availability is the one requirement, *sine qua non,* without which all human civilization, as it is known today, would cease to exist.

The use of energy in ever-increasing amounts is no longer a luxury for the elite. It is an essential component for the continued development of the human population. This rapid population growth necessitates efficient utilization of existing sources and development of new ones.[2] The availability of concentrated and transportable forms of energy is required to assure the advancement of our technology-based society.

The basic sources of energy in the world are twofold: the radiant energy from the sun, solar; and the latent energy trapped in the earth, geothermal. The preponderance of our current paradigm is based on fossilized energy from the sun – solar energy that was trapped by photosynthesis in the earth's flora. Upon their death, plants formed the strata of coal,[3] while the bodies of animals that fed on them formed the reservoirs of petroleum. In today's world, 86 percent of available energy is from fossilized biological sources (coal, petroleum and natural gas).[4]

The biologically stored solar energy can only be released by combustion. Carbon dioxide (CO_2) molecules, transform into carbon products by photosynthesis and/or geological activity, and revert back to CO_2 when burned. Thus, the inevitable byproduct of biological energy sources, fossil or current, is CO_2, which is now considered a greenhouse gas.

Other low CO_2-emitting sources are hydro, tide, wind, etc. The driving force of these natural phenomena is the sun; hence, they are solar based. However, they may pose other environmental problems – for example, a large geographic footprint, since they need large tracts of real estate to be effective.

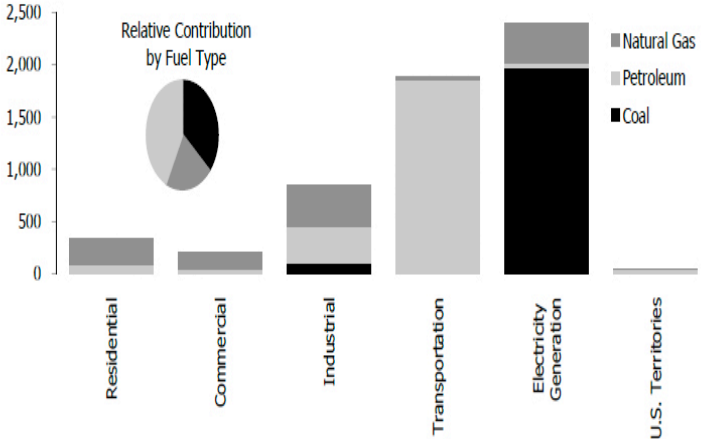
The only non-solar-based sources of energy are nuclear and geothermal. These sources are part of the makeup of the planet and do not depend on inputs from the sun. It is interesting that, similar to fossil fuels, the most polluting of these sources, nuclear, is also the most developed. While non-polluting solar sources such as wind, photovoltaic, tide, etc. are developing rapidly, geothermal, also a non-polluting energy source, has attracted little interest.

Concept Background

The Energy Information Administration (EIA) reported total electric production to be just over four quadrillion watt-hours from fossil and all non-fossil sources in the United States.[5] Of this, about 72 percent – some three quadrillion watt-hours (2.98 billion megawatt hours) – was from fossil sources, i.e., coal, oil and natural gas. By comparison, only about 2.5 percent, about 0.1 quadrillion watt-hours, was from "other renewable" non-polluting electric generation, i.e., wind, solar, geothermal, biomass, etc. The balance,

about one quadrillion watt-hours, was from nuclear and hydroelectric. It should be noted that as the U.S. moves toward a fleet consisting of hybrid and/or electric vehicles, recharging batteries would impose additional load on electric power generation facilities.

Figure 1[6]



2007 US CO_2 Emissions from Fossil Fuel Combustion by Sector and Fuel Type

Note: Electricity generation also includes emissions of less than 0.5 Tg CO_2 Eq. from geothermal-based electricity generation.

Tg (teragram) = 1,000,000,000 kilograms

An adverse consequence of this massive use of fossil fuels (Figure 1) is the release of 7.15 billion metric tons of CO_2 into the atmosphere annually.[7] The speed with which this enormous volume of pollutants is dumped into the atmosphere is beyond nature's ability to act as a sink, accelerating the rate of global warming.

The general public is increasingly sensitive to energy usage and has become aware of the relation between fossil energy and pollution. Consequently, there is an increasing demand for non-fossil, less environmentally destructive energy sources. The demand for non-polluting energy requires a major shift in production and consumption of various fuels. It belittles the scope of the problem to assume that replacing fossil fuels will be easy. It is critical not to endanger the future of society by presenting the public with the false hope of a rapid, painless, and cheap move to new energy regimes.

Engineers and scientists have considered various energy schemes such as wind, solar (both solar thermal and photovoltaic), tide, etc. The question, however, remains: Can such "renewable sources" easily, cost-effectively, and rapidly replace fossil fuels? Engineers, when asked this question, consider the energy of the future to most probably be "wind, solar and other renewable energy" (Figure 2). Most engineers, apparently, did not consider geothermal energy a serious "renewable resource."

Yet of all the renewable energy sources, geothermal has the highest capacity factor, is the most reliable, has the least environmental impact, and is the best source for electric generation (Table 1). The lack of interest on the part of a majority of engineers may be a reflection of the perception that geothermal sources are small or un-exploitable. In addition, it is known that most geothermal plants in the world are relatively small (in the range of tens rather than the hundreds of megawatts).[8]

Concept

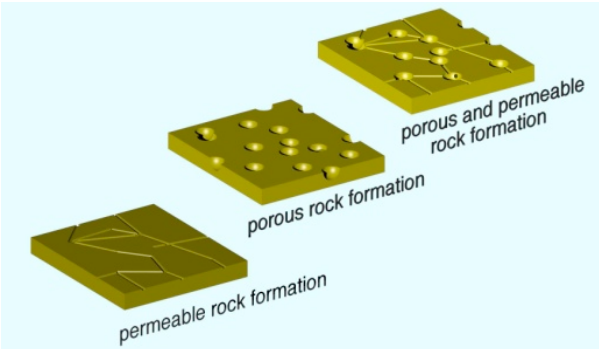
The miniscule role of geothermal generation in the overall national power paradigm can be attributed to its dependence on specific geological structures. The characteristics of these geologic structures can be summarized as follows:

1. A subterranean heat source at an accessible depth

2. A lithology above the heat source that has sufficient porosity and permeability (Figure 3) to allow fluid accumulation and flow

3. A rock structure with enough volume, pressure and temperature to force the useful fluids to the surface.[9]

Figure 3



The simultaneous occurrence of these geologic events is rare. Most of these sources are incapable of providing the energy to power large power plants, thus restricting the average size to 30 megawatts. Even the Geysers in California, the largest facility in the world with a rated output of about 1500 megawatts, is composed of 25 power plants, the largest being 113 and the smallest 20 megawatts.[10] These plants are distributed over an area of about 30 square miles.[11]

"Of all the renewable energy sources, geothermal has the highest capacity factor, is the most reliable, has the least environmental impact, and is the best source for electric generation."

Previously, geothermal reservoirs were identified with hot water sources. This is no longer the case since technology provides access to more varied sources. Geothermal systems are now classified into five basic categories:

1. vapor dominated
2. hot water
3. hot dry rock (HDR)
4. geo-pressured
5. magma[12]

Historically, "geo-pressured" and "magma" geothermal energy have been marginally exploited due to their complexity, geologically and technically. Geo-pressure systems pose the question of how and at what cost the reservoir pressure can be maintained. Magma sources because of its volcanic flows have major corrosion and stress problems.[13]

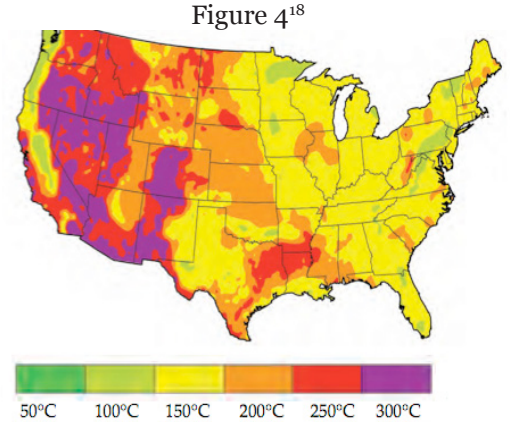
Current geothermal energy production has been centered on hydrothermal systems, i.e., "vapor-dominated" and "hot water."[14] These sources are the easiest to exploit, even if the confluence of previously mentioned geologic parameters are rare and limited in productivity.

A limit to hydrothermal systems is the need to re-inject fluid into the reservoir for volume and pressure maintenance. Generally, hydrothermal systems need one well to extract hot fluid – a production well – and another well (or wells) to re-inject the cold fluid – an injection well. This system of fluid circulation avoids the necessity for additional "make-up" fluids, but the injected fluid can cause chemical and physical damage to the reservoir. Such damage can reduce the effective life of geothermal wells.[15]

This dependence on the productivity of subterranean reservoirs has limited the size of geothermal plants. To date, only two large-scale geothermal plants exist: one in Larderello, Italy – approximately 900 megawatts – and the second at Geysers, California – about 1,000 megawatts.[16] Even these facilities are made up of multiple small plants, each less than 110 megawatts, spread out over a large area.

The third model, "hot-dry-rock" (HDR), is the most geologically extensive. HDR, as the name implies, is a hot dry formation, that is, no in situ fluid. These sources were defined as: "a completely impermeable homogeneous crystalline rock at a temperature that can provide useful amounts of energy" by the 1993 Congressional Report 93-377.[17] HDR formations (300°C - 572°F), at accessible depths of up to 35,000 feet, cover most of the Western United States (Figure 4).

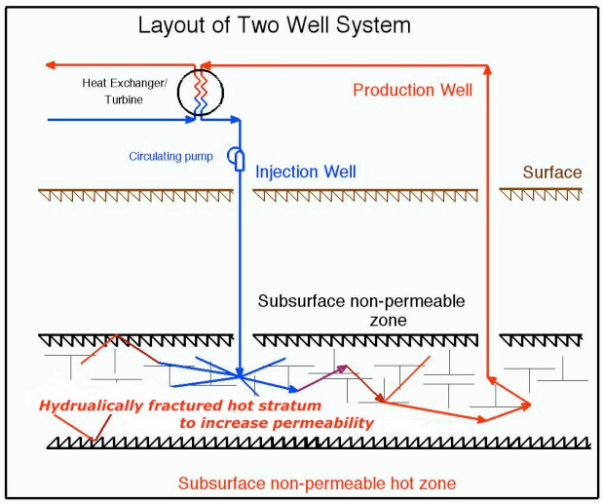
Figure 4[18]



Source: MIT 2006 The Future of Geothermal Energy. 2-17 & 2-18

These HDR strata are the targets of the Enhanced Geothermal System, EGS (also called Engineered Geothermal System) for energy extraction.[19] Most of these rock formations are considered "tight," i.e., impervious to fluid flow, and must be "enhanced" by hydraulically fracturing to increase their permeability (Figure 5).[20] Once the formation is shattered with hydraulic pressure, fluid can flow through the interconnected fractures, allowing heat extraction.

Figure 5

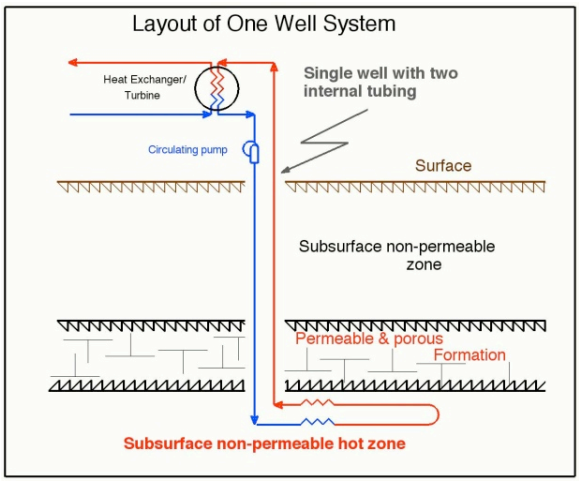


Hydraulic fracturing *can* cause earthquakes. The possibility of earthquakes is controversial. It was considered in Congressional Report 93-377, but the MIT report on EGS systems discounted the matter.[21] Subsequent reports suggest that heavy fracturing may cause local earthquakes. Earthquakes, supposedly induced by hydraulic fracturing, have raised concerns about two EGS projects (one in Basel, Switzerland[22] and another in Landau in der Pzalz, Germany[23]).

The need for "clean" energy means that geothermal resources, in spite of the technical difficulties, cannot be ignored. A possible new model that avoids some of the previously mentioned problems is shown in Figure 6. Here, heat extraction is independent of heat reservoir's lithology, fluid content, permeability, or porosity. In this scenario, high-pressure fluid is circulated between the surface and the HDR through a totally closed tube. The fluid, sealed from all direct contact, would acquire heat by conducting it from the hot sub-subterranean rock and releasing it to a working medium on the surface. Such a geothermal facility could produce 1,000 megawatts of thermal power plant and would have a physical footprint similar to an equivalent fossil fuel plant.

"The need for 'clean' energy means that geothermal resources, in spite of the technical difficulties, cannot be ignored."

Figure 6



Similar models have been presented; for example, Warren and Whitelaw in 1975 suggested a heat extraction method that was similar but required depths of 50,000 feet.[24] Also, Schulman and Whitelaw (Patent Numbers 5,515,679 dated 1996 and 6,247,313 dated 2001) presented a two-well system of heat mining, where the injection and the production wells were linked by an underground pipe.

The availability of shallow HDR is important for this model of heat mining. There are many sources available at depths of 6-8,000 ft at 300°C (572°F),[25] and even sources at the depth of 33,000 ft are highly accessible. This makes it unnecessary to drill to the depth of 50,000 feet suggested by Warren to obtain reasonable energy sources.

Furthermore, drilling technology, both directional and straight, has advanced considerably. Presently, the deepest well in the world is on the Kola Peninsula in Russia (40,233 ft deep).[26] The longest oil well is in Qatar (40,320 ft in length including a 35,770 ft horizontal section).[27] Thus, the technology for creating a single well with sufficient subsurface area for high volume heat extraction is available. However, it should be noted that the subterranean interconnection of two wells (as required by Schulman) has yet to be implemented.

Test program considerations

Once the test site has been selected, the availability of technical resources must be considered. Primary technical issues involve the drilling and completing the geothermal well and can be summarized below:

Drilling

1. The target rock formation need not have any *in situ* liquid but fluids may be encountered. High-density and non-permeable formations have better coefficients of heat transfer and are well suited to this model. Formation fluids that are encountered could pose significant problems for the drilling fluid, both in terms of dilution and potential toxic components.

2. Extended drilling in a hot zone will be required. The cooling of tens of megawatts of thermal energy will pose significant problems for the drilling rig and its operations. The equipment and drilling protocols must be modified for temperatures of 600°F. Drill bits and cooling systems capable of working in these conditions must be designed.

3. Drilling equipment must be modified to drill large diameter holes in hard rock formations. Such large holes will be necessary to provide the required surface area and flow rates.

4. Sealing the well casing into the formation will pose special problems. This is normally done with cement; however, most cement will fail at high temperatures. In order to assure adhesion to the formation, current cements must be modified for high temperature applications.

Completion

1. The conceptual design calls for a totally enclosed fluid circulation at high temperatures, pressures and flow rates. The well piping must be designed for the maximum physical and temperature stresses expected under these conditions.

2. Thermal expansion and contraction will impose stresses on the pipe that must be resolved with high pressure, high temperature expansion joints.

3. Tubing insulation in the bore-hole to minimize heat loss is critical. Insulation systems must be robust enough to withstand the abuse of being installed and removed from the casing. The stress imposed on the suspended insulation must be considered. Development of new types of insulation could be required.

This is a short list of issues that must be addressed. Others will arise during the testing. It is not foreseen that technical issues will be "game changers," but the rewards for achieving a breakthrough in major geothermal energy production are significant.

Conclusion

The lack of development of geothermal resources has much to do with the two-well energy extraction model. This model consists of production and injection wells fluid linked by a subterranean rock formation. It is ill-suited for extracting large volumes of heat because of its dependence on subterranean lithology. The fluid flow between the injection and production well is totally dependent of the flow characteristics of subterranean rock formations. This limits the availability of sources as well as potential energy available for extraction.

While fracturing may enhance the permeability of the underground rock formations, there is no guarantee that these fractures will actually increase the flow between

injection and production wells. Furthermore, there is a possibility that such fracturing could result in detrimental local earthquakes.

Furthermore, the intimate contact between the fluid and rock can cause problems. The contact inevitably results in the absorption of minerals, pollutants and particulate matter by the fluid complicating its treatment. The movement of dissolved material throughout the formation adversely affects the reservoir, reducing the functional life of the production and injection wells.

An alternate one-well system is proposed. In this paradigm, a fluid is circulated between the surface and the hot zone in a closed loop. The fluid, volume and pressure are entirely controlled from the surface thus assuring optimal heat recovery. Simple energy calculations indicate that there is high likelihood that up to 1,000 megawatts can be extracted with this method. Furthermore, unlike the two-well model, the fluid in this paradigm never makes contact with the formation, thereby avoiding any potential contamination.

This method depends on the development of equipment and techniques for high-temperature drilling – an engineering challenge. Yet, the viability of safely extracting large megawatts of thermal power from a high-temperature geothermal zone independent of the rock permeability and porosity makes this an attractive prospect. The earth's energy is a 24/7, large-volume, pollution-free, zero-carbon-footprint energy source. It has the potential to replace fossil fuels for electricity generation in the United States and throughout the world.

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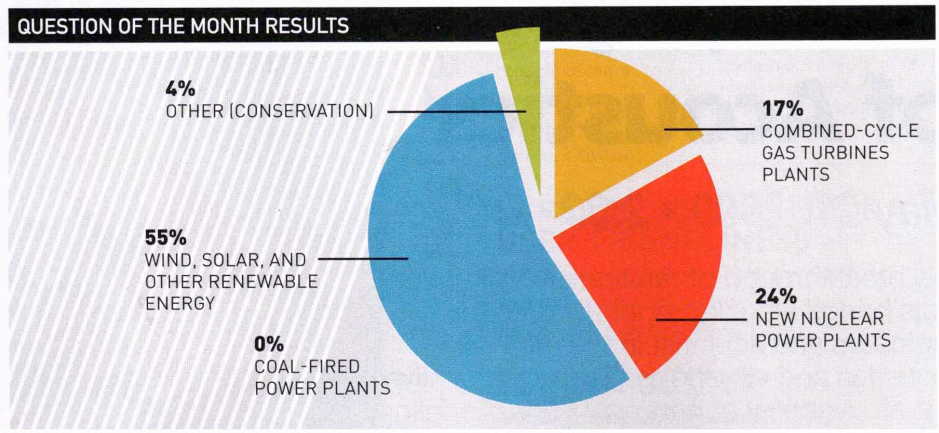
Table 1[28]

Renewable Energy Sources	***Capacity Factor (%)***	***Reliability of Supply***	***Environmental Impact***	***Main Application***
Geothermal	85-95	Continuous & reliable	Minimal land usage	Electricity generation
Bio-mass	83	Reliable	Minimal (non-combustible material handling)	Transportation, heating
Hydro	30-35	Intermittent dependent on weather	Impacts due to dam construction	Electricity generation
Wind	25-40		Unsightly for large-scale generation	Electricity generation (limited)
Solar	24-33			

Note: Capacity Factor = Total Energy Produced/ Energy Produced at Full Capacity
Source: Geothermal Energy Organization

Figure 2[29]

QUESTION OF THE MONTH: What is the best technology for electric utilities to invest in to meet demand over the next 10 years?



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Why We Can't Kill Carbon: The Political Roadblocks of Progressing Carbon Emissions Trading

By Russell Karas

Introduction

IT WAS supposed to be the perfect marriage between the free-market-wielding right-wingers and the liberal left. Carbon emissions trading, or "cap and trade," is the ideal market-based solution to finance a global reduction in carbon emissions. The European Union is at least trying it, so why has cap and trade recently stalled in the United States and abroad? If correctly designed and implemented, jobs are created, economies are boosted and the carbon emissions that are fueling future climate disasters are reduced. Have Obama and the Senate Democrats already run out of political capital? Can the U.S. coal and oil lobbies crush the hopes and dreams of the recent "green movement"? Other countries have made promises and official statements about action to reduce carbon emissions, but even these ambitious statements fall short of what needs to be done.

The problem is not the effectiveness of a cap-and-trade-system, but the political and economic fears that have stalled domestic actions and could prevent a global solution. Throwing another wrench in the system is the continuing debate between developing and developed nations about who needs to accept responsibility for reducing carbon emissions. These hurdles need to be overcome in order to implement the most realistic solution to climate change – a mandatory global cap-and-trade system. Before getting into the political roadblocks and snafus associated with establishing carbon trading, it is best first to outline the basics of carbon trading.

The Basics of Cap and Trade

If designed correctly and strictly implemented, the carbon cap-and-trade system is brilliant. The final product should act as a cycle, with money generated from the sale of permits and offset credits being reinvested into the economy of the respective country to create more clean energy or carbon-reducing projects. The first part, the cap, is a legal limit on the quantity of greenhouse gases an economy can emit each year.[1] This cap is an important part of the process as it sets the precedent to reach the total emissions reduction goal. Each carbon-emitting entity, e.g. power plants, transportation fleets, and manufacturing plants, have individual emissions limits. These limits are based on the total amount of emissions reductions that their respective host country is looking to achieve.

There are several ways to meet the set emissions cap. One is through the quantity of emissions permits that are provided by countries to companies either for free, through an auction, or both.[2] If a country decides to sell the permits at auction, it can use the profits to implement more clean energy state programs and incentives. These permits, also known as allowances, can be sold by the emitting entity if their emissions levels fall below the cap. These excess permits are sold at market-determined prices and provide a financial reward to companies that reduce their carbon emissions. With permits, stakeholders feel financial pressure from the government and the private sector to develop and implement better energy practices.

The second way provides even more incentive for private sector innovation. A company can meet its emissions cap through the purchase of offset credits. Instead of buying permits from another participant in the cap-and-trade program, companies can also purchase carbon credits from carbon-reducing or carbon-offsetting projects. Examples of offset projects include: increasing CO_2 sequestration potential by protecting or planting trees, capturing methane from landfills, and implementing energy efficient technologies.[3] This is beneficial to members and non-members of a cap-and-trade system. For members, there is the potential to stay within the cap at lower costs than making improvements on their facility. This also helps to increase carbon reduction in countries that are not part of the cap-and-trade system. One of the most important issues surrounding offsets is the verification of the quality of the offset. Regulations must be upheld that ensure "offsets produce measurable, real and additional emissions reductions."[4] Offset projects also lead to increased job creation and technology transfers between developing and developed nations. Fortunately, one group of countries has banded together to develop an effective carbon-trading system.

The European Union

The most important cap-and-trade system to analyze is the European Union Greenhouse Gas Emission Trading System (EU ETS). In January 2005, the EU ETS was launched as the "largest multi-country, multi-sector Greenhouse Gas emission trading scheme world-wide."[5] The system initially covered 11,500 energy installations throughout the

EU, including combustion plants, oil refineries, iron and steel plants, and factories making cement, brick, glass, and paper, to name a few. The system only accounted for carbon emissions in the power sector, specified industrial sectors and all combustion facilities with a thermal input of greater than 20 MW.[6] There have been some delays in expanding industries covered by emissions caps in the EU ETS. In 2007, the EU's Environment Commissioner, Stavros Dimas, announced that expanding the carbon cap to the aviation industry would have to wait until 2012, instead of 2011.[7]

The emissions caps in the EU ETS are set by individual member countries, but are subject to review and approval by the European Commission. Tradable allowances, known as European Union Allowances (EUAs), were distributed in amounts equal to the cap.[8] The facilities had to report their CO_2 emissions annually and produce an allowance for every ton of CO_2 emitted. Following the basic concept of cap and trade, the facilities would have to improve their energy efficiency or purchase outside allowances if they emitted beyond the cap. The European Climate Exchange (ECX) was created in order to have a market where tons of carbon could be bought and sold.[9]

There have been mixed results for the EU ETS, but it is the best effort towards an improved cap-and-trade system to date. One negative aspect of the initial phase was that a lot of the allowances were given to the facilities, rather than sold at auction. This over-allocation of CO_2 credits meant that some companies were paying close to nothing to offset carbon.[10] To make matters worse, "power supply bids 'improperly' included the market value of freely allocated allowances, instead of their zero cost, thereby causing higher wholesale power prices and significantly higher profits for some generators."[11] This lesson shows the importance of auctioning off carbon allowances instead of giving them away.

One of the largest initial concerns with the EU ETS was that the trading system was going to hinder large carbon-emitting facilities and raise prices for electric consumers, thus hurting the overall economy of the EU. A 2008 MIT report concluded that there were minimal macroeconomic impacts from the first phase of the EU ETS and carbon reductions were achieved.[12] So far in the second phase, the EU has seen more

"…there were minimal macroeconomic impacts from the first phase of the EU ETS and carbon reductions were achieved."

progress as emissions in 2008 declined between 4-6 percent.[13] These numbers would put the EU on track to meets its target of reducing emissions by 20 percent by 2020. There have also been signs of market activity increasing. From 2007-2008 there was an 83 percent increase in tons of carbon traded on the ECX, resulting in a 2008 total market value of $125 billion.[14] The EU ETS should not be duplicated to create a global cap-and-trade system, but instead, its best components should be utilized and its mistakes learned from. So now that this pilot program has been running for a few years, are other countries jumping on the carbon trading bandwagon?

The Tentative Leader

The United States still remains the most important country in finding a global climate change solution, but the domestic political capital needed to pass climate change legislation may be running low. Political capital seems to have become a finite resource, only refilled during times of catastrophe. Unfortunately, even Nobel Prize Laureate President Obama has to worry about re-election in a few years. If he gets key Democrats and Republicans to bend towards accepting health care legislation, it is unlikely that he will have enough left in the tank to convince them to compromise on cutting carbon. Cutting carbon emissions is already hard enough to push on Democratic representatives that represent manufacturing-heavy and coal-producing states.[15] So who would the public choose in a health-care-versus-climate-change-bill battle?

According to public opinion, the United States population would choose health care over climate change. Public opinion is important when examining political issues, as it helps determine how much political capital the President or a representative of Congress has on specific issues. Climate change legislation lacks support in part due to a lack of belief that global warming is a true threat to the American people. According to a Gallup poll conducted in March 2009, 41 percent of Americans believe the seriousness of global warming is exaggerated.[16] Another poll conducted by WorldPublicOpinion.org, an organization managed by the University of Maryland's Programme on International Policy Attitudes, found that the United States ranked last in how high a priority it should be for their government to deal with climate change. The United States ranked addressing climate change as a high priority only 4.71 out of 10 (10 being most important), preceded by the Palestinian territories at 4.91 and Iraq at 5.14.[17] When the Iraqi public shows more interest in combating climate change, it may be time to take bets away from a stringent climate change bill.

It is not just the United States' lack of concern of global warming that reduces efforts by politicians to pass climate change legislation, but also the stronger public desire to put through health care legislation. A recent Gallup poll puts Americans who support passage of a new health care bill at 51 percent, while 41 percent oppose it or lean toward opposition.[18] While the previously mentioned Gallup poll regarding the severity of climate change showed a decrease

in attitude towards addressing global warming, there has been a 5 percent increase in support for health care legislation from April 2009 to October 2009.[19] Political representatives do not ignore these numbers and are more likely to risk political capital on a bill that garners the higher level of public support.

Another roadblock in recent climate change proposals is the fear of losing blue collar jobs such as coal mining. It should be noted that mining coal is a noble profession, but since 1900 it has also accounted for 100,000 accident-related deaths and at least 200,000 deaths from black lung.[20] The fact that jobs would be shifted from energy-intensive jobs such as mining coal scares people. Some job loss could occur as the

"The coal and oil lobbies have not been shy in promoting this fear."

Congressional Budget Office report on the House-passed climate bill, the Waxman-Markey Bill, found that there would be a reduction in total supply of labor.[21] It should be noted that there have been other predictions and reports on the Waxman-Markey Bill, but this is the one that Congress has to take into account when debating final climate change legislation. This fear of job transitions is similar to how many people feared losing their jobs on farmlands during the agricultural and industrial revolutions of the 19th century. The coal and oil lobbies have not been shy in promoting this fear. The coal and oil industries have the money to throw around, spending over $400 million just in the first half of 2008 on marketing and lobbying efforts.[22] Domestically, the coal and oil industry have already set roadblocks and received concessions; a global solution will most certainly run into this issue as well.

The Coal-Powered Dragon

Some scholars would argue that China is equal to or even more important than the United States in fighting global climate change. China overtook the United States as the leader in carbon emissions in 2007.[23] There is no sign that China will slow down, as a recent Energy Information Administration report predicts that China will account for 29 per cent of the world carbon emissions by 2030.[24] The good news for climate change advocates is that China is taking some steps towards reducing these emissions. China plans to continue to outshine the United States as far as fuel economy standards are concerned. While the United States praised President Obama's recent announcement to reach a corporate average of 35.5 miles per gallon by 2016, China set in motion plans to reach a corporate average of 42.2 miles a gallon by 2015.[25] Chinese President Hu Jintao has also promised 15 percent renewable energy within the next 10 years.[26]

"China plans to continue to outshine the United States as far as fuel economy standards are concerned."

Even though under a one-party system, Chinese political leaders do not need to worry about wasting political capital nearly as much as the United States, Chinese leaders would have more support based on public opinion. China ranked 2nd, 8.86 out of 10, on the recent WorldPublicOpinion.org poll that addressed the priority of government action on climate change.[27] This was the same WorldPublicOpinion.org poll mentioned previously, in which the United States came in last place.

Despite these positives signs that the Chinese government and population have shown, they still do not deserve to be put on the level of the European Union. In September of 2009, the China Beijing Environmental Exchange (CBEEX) announced the creation of China's first voluntary offset standard, dubbed the "Panda Standard."[28] While this appears to be a positive step towards reducing carbon emissions, the executives of the CBEEX have "taken pains to avoid any indication that the move marks the nation's first baby steps toward a national cap-and-trade program."[29] This will basically just allow projects to be developed to create offsets for purchase or trade in external carbon offset programs or for companies looking to voluntarily offset their carbon emissions. This is not a bad thing, but it does highlight the fact that China is not taking major steps toward establishing a carbon-trading system. The United States, on the other hand, at least has the Chicago Climate Exchange and the Regional Green House Gas Initiative as pilot projects.

The Rest of the World

The European Union, the United States and China are not the only important actors in the fight against climate change. The rest of the world has just as many mixed signs of hope and despair as the three actors already discussed. Japan represents a country that has recently taken a turn for the better.

Newly elected Japanese Prime Minister Yukio Hatoyama has already made ambitious statements to reduce greenhouse gas emissions. Hatoyama has pledged a 25 percent reduction of greenhouse gasses from 1990 levels by 2020, which is the greatest pledge by an industrialized nation thus far.[30] According to Japan's environment minister, Sakihito Ozawa, this new plan could involve carbon offset projects.[31] This would demonstrate that Japan is preparing for and could endorse a more comprehensive global cap-and-trade system. These ambitious plans need to be met with caution, as Hatoyama and his Democratic Party still need to worry about their next election.

Making bold promises after a major political upset is one thing; implementing them is another. Japan's manufacturing sector, specifically its automobile industry, will not exactly help get to the 25 percent reduction goal. Hatoyama will have to be careful with his political capital, as it could run thin if Japanese jobs are put on the line in the name of carbon. It is also important to note that Hatoyama has an estimated $70 million of shares in Bridgestone, a company that prospers when more cars and their rubber tires are on the road.[32] On the other hand, Japan's innovative industries could prove helpful in introducing new clean energy technologies. An example can already be seen with Toshiba testing its newly constructed post-combustion carbon capture plant. This technology removes 10 tons of carbon a day, utilizing an amine-based chemical absorption system that uses less energy than comparable systems in the industry.[33] Japan must continue to innovate to keep high-tech and manufacturing jobs alive, while at the same time combating carbon emissions.

Besides domestic political struggles, a global carbon solution has also highlighted the conflict between developed and developing nations. The million-dollar question is whether the past carbon producers, i.e. developed nations, should be held responsible or the future culprits. Realists around the world are nodding their heads, saying "I told you so," as developing countries focus on relative gains looking for handouts and exceptions. India is in an interesting position, as it ranked 5th in GDP but 166th in GDP per capita in 2008.[34] This means they will be emitting like a developed nation, but still have rural poverty resembling a developing nation. Recently, India took the stand as a developing nation when Prime Minister Manmohan Singh stated that "developed countries must bear 'historic responsibility' for industrial emissions of greenhouse gases they have produced."[35] It is interesting that India demands an equal standing in international affairs and at the same time wants handouts for reducing carbon emissions. This hybrid country needs to either take the responsibility of a developed nation and lead by example, or back off the global stage and receive more "aid" from developed nations.

Although India has not shone as a climate change star in international affairs, it is correct to point out inaction by developed nations. Australia is an unfortunate example of a developed country backing off the carbon fight. The proposed Australian system appeared to improve on the EU ETS in that it would also cover transportation and allow the forestry sector to opt in voluntarily.[36] Another improvement was the government's plan to implement a first year fixed price of A$10 a carbon ton. Following the first year, there would be a transition to a market set price.[37] This would help avoid the EU ETS mistake of giving away free carbon allowances during the initial phase. Unfortunately, the bill advocating this system was defeated this past August. The clash between environmentalists and Australia's natural gas industry could cause a second defeat of climate legislation and perhaps an early election to be called.[38] What at first looked like an example of a developed nation taking strong action has turned into another ambitious plan falling short.

Conclusion

The bottom line of this report is that there are efforts being made toward curbing carbon emissions, but a comprehensive global solution is needed. A global cap-and-trade system offers this possibility, but not if it is a watered-down version. It is hard to see this solution in the near future, as countries are struggling to create domestic carbon-trading schemes. Countries have to overcome limited political capital and economic fears in order to implement national and/or international carbon emissions trading schemes. As more and more countries increase their efforts, it will be harder for the remaining countries to sit idle.

"It is not politically plausible that a carbon tax will ever be passed in the United States, never mind globally."

So with hope, the debate continues. Will a global carbon-trading scheme ever come into effect? It appears to be the best global solution at this point. It is not politically plausible that a carbon tax will ever be passed in the United States, never mind globally. Like any political or economic system, corruption and misuse could reduce a carbon emission trading system's effectiveness. Regardless, this is a large-scale global problem, which requires an educated leap of faith. Hopefully, something will snap in place in the near future. If not, the solution to future global climate disasters, a global carbon-trading system, will remain a dream. The next generation will deal with the nightmares that result.

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Carbon Capture and Sequestration: Possibility or Myth?

By Marianne N. Nemecek and Orlee D. Zorbaron

Abstract

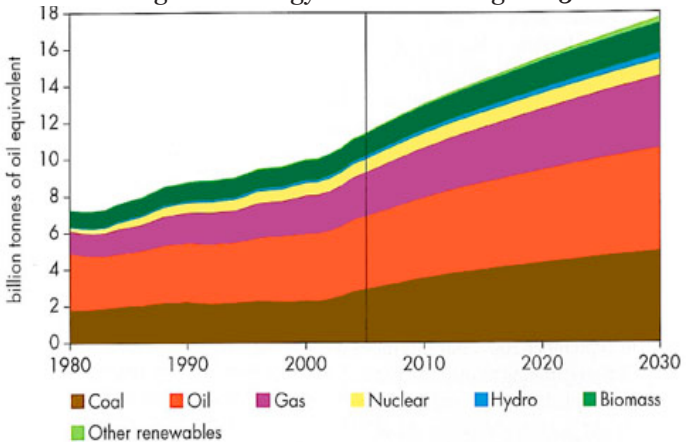
GLOBAL carbon dioxide (CO_2) emissions are rising at levels higher than can be contained by the natural sequestering system, thus leading to climate change. Carbon Capture and Sequestration (CCS) has become a widely talked-about and speculated venture on behalf of cleaning up CO_2 generated from energy and industrial processes. As the amount of CO_2 in the atmosphere continues to increase each year, carbon sequestration projects have grown, but at a high cost. The viability of carbon sequestration is questioned due to its high cost, little research and development, and the inherent storage safety risks, primarily the threat of geological change in the rock formations once CO_2 is injected into the storage site. In order to attain greater energy output efficiency, it is necessary to create further carbon sink and sequestration sites. The following is a detailed analysis of the viability of carbon sequestration and some existing and pending projects.

What is sequestration and is there a need for it?

At present, 50 percent of the United States' energy output is produced from coal, since it is abundant and a seemingly cheap fuel source, given that environmental and health costs are not included in the price of coal, but are borne by society at large.[1] When burned, fossil fuels emit large quantities of CO_2, a leading greenhouse gas, as well as other noxious or toxic gases. Currently, coal and other fossil fuels, which produce vast amounts of carbon, continue to be used as the primary source of energy. As such, carbon capture and geologic sequestration is thought to be the way of the future. The idea calls for on-site capture of carbon, followed by geologic sequestration of that carbon into "unminable coal seams, abandoned natural gas reservoirs, deep saline reservoirs and depleted and marginal oil fields."[2] In the United States, there are approximately 3,000 miles of pipeline dedicated to CO_2, which are controlled and regulated to watch for CO_2 loss.[3] Common sources of CO_2 emissions are fossil fuel power plant stations, oil and natural gas processing plants,

"cement manufacture, iron and steel manufacture, and the petrochemical industry."[4] See Diagram 1 for an overview of geological storage options and Diagram 2 for an illustration of the carbon sequestration process.

There is a vital need for geological sequestration of carbon due to the amount of carbon currently in the atmosphere, and because of future growth in demand for energy. The International Energy Agency states that by 2030, global energy demand will increase by 50 percent (70 percent of that coming from developing countries, a third of which is China).[5] The following chart shows the projected growth in fossil fuel usage and energy demand through 2030:



CCS is vital as the Earth reaches the point of no return with regard to atmospheric CO_2 saturation. The Intergovernmental Panel on Climate Change concluded in 2001 that countries "must reduce global greenhouse gas emissions to 25 percent below 1990 emissions by 2050 to reach climate stabilization at 450 parts per million (ppm), or 45 percent above 1990 emissions to reach 550 ppm."[6] Specifically for the United States, this means an 80 percent reduction of 1990 levels by 2050 to achieve 450 ppm or 60 percent reduction of 1990 to achieve 550 ppm.[7] However, CCS has faced challenges in getting off the ground because of the high cost of projects and their failure rates. Thus, to reduce carbon in the atmosphere, a generalized plan needs to be developed to include an increase in energy efficiency, using less carbon-emitting fuels, maintaining and broadening carbon sinks through vegetation, and through improving energy extraction and storage from renewables, which is beyond the scope of this paper.[8]

What is carbon capture?

As the second diagram shows, carbon capture is most easily attained from a stationary source such as a power or manufacturing plant. Three types of carbon capture exist: pre-combustion, post-combustion, and oxy-firing; however, improved technology needs to be developed to make the cost of carbon capture competitive.[9]

Pre-combustion capture involves a process through which coal is brought into contact with steam and oxygen, producing a synthetic gas called syngas (formed mostly of carbon monoxide, CO_2, and hydrogen).[10] This syngas is then used to create electricity in a turbine; the CO_2 is removed before electricity generation.[11] In post-combustion

capture, the CO_2 is separated from the flue gas after the coal is burned.[12] Lastly, oxy-firing involves fuel combusted in pure oxygen, thus producing less flue gas and reducing the noxious gaseous emissions (75 percent less than air-fueled combustion, which is used by most major power plants and exhausts CO_2 diluted with nitrogen. The exhaust is made up of 80 to 90 percent water vapor, which eases the CO_2 capture process).[13] Diagram 3 shows the different methods of carbon capture and their chain: pre-combustion, post-combustion and oxy-firing.

The current cost of CO_2 capture is far too expensive for actual "carbon emission reduction applications" at $150 per ton of carbon.[14] SFA Pacific, Inc. also surmised that adding additional carbon capture technology could increase the cost of electricity from 2.5 cents to 4 cents/kWh.[15] The capture portion of the carbon capture, storage, transport and sequestration storage process account for approximately 75 percent of the cost of the process.[16] This is due to the extreme supercritical phase that the CO_2 must reach in order to be liquefied and put into the transit means. The cost of CO_2 capture as depicted in the following chart varies according to the type of plant and technology being used.[17] Carbon capture ultimately appears fruitless given the lack of R&D invested in developing more economical methods of carbon capture. Several types of programming can be developed to relieve the cost of carbon capture, such as: technology that separates the carbon and then stores it, such as chemical absorbents and membranes; and retrofittable CO_2 capture options for plants that are already in existence, such as ammonium carbonate slurry, which could be scalable and less energy intensive, thereby keeping the costs lowered.[18]

THE COST OF CO_2 CAPTURE FOR VARIOUS INDUSTRIAL PROCESSES
(see appendix for sources and assumptions)

Plant Type	Capture Process(es)	Cost Estimates for Capture & Compression	Factor(s) Driving Cost of Capture and Compression
Steam Rankine Power	Chemical Absorption (amines)	$25–$60/tCO_2	CO_2 content in flue gas stream, capital cost and energy requirements for solvent cycling
IGCC Power	Physical Absorption	$25–$40/tCO_2	CO_2 content in flue gas stream, capital cost
Refinery Flue Gas	Chemical Absorption/ Flue Gas Recycling	$35–$55/tCO_2	CO_2 content in flue gas stream and capital cost, energy requirements for solvent cycling (if applicable)
Steel	Flue Gas Recycling/ Chemical Absorption	$20–$35/tCO_2	CO_2 content in flue gas stream and capital cost, energy requirements for solvent cycling (if applicable)
Cement	Flue Gas Recycling/ Chemical Absorption	$35–$55/tCO_2	CO_2 content in flue gas stream and capital cost, energy requirements for solvent cycling (if applicable)

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CCS Projects: How viable are they?

There have been various technologies and projects attributed to CCS. Firstly, with regard to energy extraction from coal technologies, two specific technologies yield greater efficiency than the traditional pulverized coal plants: the supercritical pulverized coal (SPC) and the integrated gasification combined cycle (IGCC). The latter offers higher efficiency than the former.

IGCC technology is complex. It involves four major steps: gasification, syngas cleanup, power generation through a gas turbine combined cycle, and finally, a cryogenic air separation.[20] IGCC is proven to remove 90 percent of the carbon from its emissions, and does so pre-combustion. However, the process has not been commercialized. Thus, anyone who ventures to build an IGCC plant faces the possibility that the technology may not be what it seems and the costs may be much higher than the estimates.[21]

IGCC has been found to be more efficient than SPC. According to the EPA, at a cost of $7 or more per ton of CO_2, by 2012, IGCC CCS will emit lower levels of CO_2 than SPC. Also, adding CCS capabilities to IGCC is much cheaper than adding them to SPC (because capturing CO_2 in IGCC is much less energy-intensive than SPC).[22]

"...anyone who ventures to build an IGCC plant faces the possibility that the technology may not be what it seems and the costs may be much higher than the estimates."

An example of IGCC in action is the FutureGen project, which started in 2003 under President George W. Bush and was promoted as a zero-emissions coal-fired power plant. In January 2008, after selecting a site in Illinois due to the presence of deep saline rock formations and the lack of faults cutting through those formations to accommodate CO_2 storage,[23] the Department of Energy (DOE) announced that it would restructure the proposal and call for commercial involvement due to the high costs of the project for the government (the FutureGen alliance was also covering a share of the cost). The cost of the project is estimated to be 1.5 billion dollars, mostly concentrated in CCS.[24]

The longest-running carbon sequestration project in North America is in Saskatchewan, Canada: the Weyburn Enhanced Oil Recovery Project. The project, which started in 2001,[25] has stored five million tons of CO_2 and has a capacity of 30 million tons. As of 2005, there had been no reported CO_2 leaks.[26]

Another successful project is in Algeria: the In Salah project. Since 2004, it has injected 1.2 million tons of CO_2 per year into a sandstone reservoir 1,800 meters deep, and it has a capacity of 17 million tons.[27]

Another notable venture is the Otway Project. CO2CRC's Australian Otway Basin Project has successfully stored 10,000 tons of CO_2 greenhouse gas underground.[28] The gas was converted into liquid and then stored about two kilometers away in a depleted natural gas reservoir, where it is monitored by a geosequestration monitoring system.[29] Thus far, the liquefied CO_2 has behaved as predicted.[30] The cost of the Otway Basin has been approximately 30 million dollars.[31] The technology behind the project involves extracting the CO_2 and compressing it into a supercritical state in a compressor/refrigerator.[32] Diagram 4 shows two wells 300 meters apart. CRC 1 injects the CO_2 into the reservoir while Naylor-1 monitors the gas and fluids coming from the formation.[33] The project is expected to sequester 100,000 tons of CO_2 deep underground.

Looking at these projects, it would appear there is a large amount of CO_2 storage space even when the annual global

CO_2 emissions rate is measured at about 23 to 28 billion tons. Last but not least is the offshore and ocean storage of CO_2. The CO_2 from the stationary source is compressed and then transported via ocean or pipeline.[34] The major difference between offshore sequestration and ocean storage is that with offshore storage, the CO_2 is injected deep into a formation under the ocean seabed away from the water, while in ocean storage, CO_2 is injected into the water column at 1,500 to 3,000 meters to be dissolved, or below 3,000 meters to form a CO_2 lake.[35] An example of successful offshore sequestration is at Statoil's Sleipner Field in the North Sea, located 250 kilometers off Norway. The project has been ongoing since 1996. The CO_2 is separated from natural gas and then stored in a "deep saline formation" at 1,000 meters under the seabed.[36] Presently, there are no projects on ocean sequestration.

Is CCS an actual option?

CCS faces many obstacles. There are questions of monitoring and safety, of the susceptibility of rock formations to faults, and of course, the cost. Despite these concerns, there is a customer base for CCS. In Europe, 12 CCS plants using various technologies are in the works.[37] In Spremberg, Germany, a privately funded coal-burning power plant captures 95 percent of the CO_2 it emits.[38] The plant, which cost $100 million, liquefies the CO_2 and then transports it 220 miles to a depleted gas field in Northern Germany. Eventually, it will be transported by pipeline to improve efficiency.[39] German environmental groups have protested the building of the plant, stating that the building of any coal plant is not part of a sustainable future.[40] As far as customers in the United States, there is a viable market. For example, 95 percent of the 500 largest CO_2 emitting plants are within 50 miles of a "candidate CO2 reservoir."[41]

Another major viability issue is cost and research, which are ultimately related to the development of more efficient technology. The U.S. DOE's National Energy Technology Laboratory has a Carbon Sequestration Program, whose ultimate goal to decrease the cost of CO_2 capture from industrial sources and create knowledge on carbon storage, capacity, and safety.[42] One stage of the program is core R&D, working on the development of new technology for minimizing greenhouse gas emissions from industrial processes. This has ultimately resulted in computer programs modeling carbon sequestration and storage space.[43] Another stage is Demonstration and Deployment, which aids in the development of technologies through initiatives such as the DOE's Regional Carbon Sequestration Partnerships.[44] These are collaborations funded by the DOE among "government, industry, universities, and international organizations" to create regulations and infrastructure for carbon sequestration.[45] It would appear that the United States is betting on carbon sequestration; the amount of money and development being put into carbon sequestration at the DOE is impressive. The United States is attempting greater energy independence, which involves using more domestic resources. The most developed and abundant at present are fossil fuels.

"... who would want to live near a rock formation injected with liquefied CO_2?"

Carbon sequestration does have many obstacles. Of note are the cost of technology and pipelines, the lack of technological advances, and the safety of storing pressurized CO_2, a poisonous gas, anywhere near communities. IGCC has shown promise, but has ultimately failed in FutureGen. Additionally, who would want to live near a rock formation injected with liquefied CO_2?

Recommendations and Conclusion

CO_2 is a problem, and carbon sequestration is only a part of the solution. Ultimately, a future dependent on more coal plants is unsustainable specifically because there are available technologies today that can produce coal's energy output with less environmentally damaging results, particularly with much lower CO_2 emissions. Current coal plants must be retrofitted with scrubbers, and when they are to be decommissioned, the land should be reforested, thereby returning to carbon sinks rather than carbon producers. We advocate a future in efficiency, renewable energy, nuclear plants and, if necessary, hybrid natural gas-coal plants.

The recent March 2009 Waxman-Markey bill, otherwise known as the American Clean Energy and Security Act, puts a strong emphasis on U.S. energy independence. The bill calls for additional investment in energy technology and greater usage of renewables. Chairman Waxman said that "this legislation will create millions of clean energy jobs, put America on the path to energy independence, and cut global warming pollution...Our goal is to strengthen our economy by making America the world leader in new clean energy and energy efficiency technologies."[46] The new bill will require a renewable electricity standard that six percent of electricity must come from renewables by 2012, and 20 percent by 2020, of which five percent can be achieved through efficiency improvements. The types of renewables that can be used are solar, wind, geothermal, biomass, "marine and hydrokinetic energy, biogas and biofuels derived exclusively from eligible biomass, landfill gas, wastewater-treatment gas, coal-mine methane, hydropower projects built after 1992, and some waste-to-energy projects."[47] We recommend that R&D funds be put towards finding a way to store renewably-produced energy for longer periods of time so that they are more easily dispatched. In addition to major storage issues, R&D funding should support renewable technologies such as solar-thermal energy in order to replace coal's baseload capability.

"We recommend, as a hedge against CCS failure, that hybrid plants using natural gas and coal become the default in place of coal plants."

The bill also requires emission cuts that would start in 2012 and a cap-and-trade program to be implemented by 2016. This program would phase in energy permits, of which only five percent would go to merchant coal generators

that have long-term contracts with electricity generators (which would evetually be phased out from 2026-2030).

Another two percent would go to electric utility companies from 2014-2017, with another five percent coming in once CCS technologies are developed and implemented (if that ever comes to fruition).

The bill directs 60 billion dollars to CCS technology by the year 2025. New coal plants would be built up to the year 2020, although they are expected to have CCS technology. By 2025, the coal plants would be required to capture 50 percent of their emissions (coal plants built after 2020 would have to capture 65 percent of their emissions). This bill places a heavy bet on the outcome that CCS will become a likely technology; however, it is neither viable nor feasible. We recommend, as a hedge against CCS failure, that hybrid plants using natural gas and coal become the default in place of coal plants. Natural gas burns more cleanly than coal and is a much more efficient producer of electricity. If fossil fuels must continue to be used, then natural gas is the cleanest route. Furthermore, we advocate investment in improving energy efficiency output through nuclear energy and in the development of storage cells, so that renewable energy can increase its share of the energy market and help replace the use of coal.

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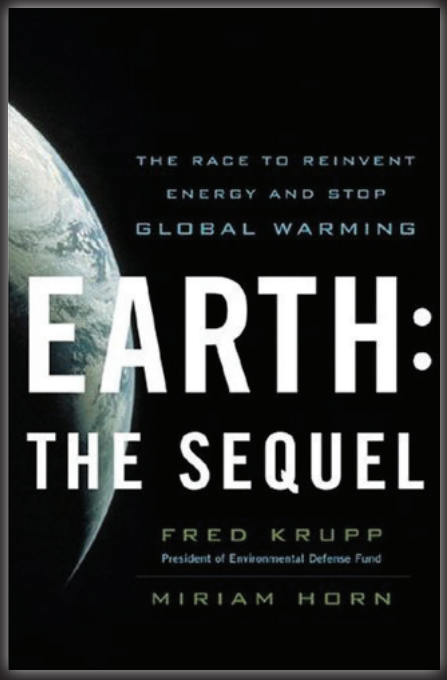
Book Review: *Earth the Sequel*

Authors: Fred Krupp and Miriam Horn
Edition: W.W. Norton & Company, Inc, New York, 2008
Reviewer: Linda Bouzembrak



THE NEW YORK TIMES bestseller book, Earth the Sequel, by Fred Krupp and Miriam Horn, is a fascinating book. Fred Krupp, president of the Environmental Defense Fund, and Miriam Horn, staff member of the Environmental Defense Fund, explore how inventors and entrepreneurs are creating industrial solutions that could stabilize our climate and save our planet. The authors followed numerous entrepreneurs in their adventures to develop clean energy solutions.

Based on their research and observations, Fred Krupp and Miriam Horn argue that the world needs a second industrial revolution in order to save the planet. By examining in depth several companies and their research towards a clean environment – from harnessing the sun to new sources of biofuels, ocean energy, and power from the earth, the authors realized that entrepreneurs are facing significant barriers.

For instance, lack of incentives from financial institutions and challenges in engaging carbon dioxide heavy industries in their projects are key obstacles. Therefore, in order to provide American green-innovators a fair chance to develop, the authors of Earth the Sequel strongly advocate for a cap and trade system on carbon dioxide and greenhouse gas emissions. According to Fred Krupp and Miriam Horn, this system, if implemented properly, would ensure the health of our planet's future.

Moreover, according to a report published in November 2007 by McKinsey & Company, the United States can reduce its projected 2030 greenhouse gas emissions by half by simply implementing the right policy tool soon enough.

To achieve such a level, the authors highlight the need to implement a high enough tax system that would provide strong incentives for industries to significantly reduce their carbon dioxide and greenhouse gas emissions. Furthermore, this system would induce entrepreneurs to search for new green technologies. However, paralysis in Washington seems to be the biggest obstruction to a cap and trade system in the United States. Thus, American innovators developing green technologies are facing a competitive disadvantage compared to their counterparts in Europe or Japan, who have already imposed this system on their economies.
Fred Krupp and Miriam Horn are pressing the need for the United States to pass laws that will impose a hard cap on global warming pollution emissions. Thanks to such laws, the United States of America could become the leader in green technologies, creating a new multi-billion-dollar market and saving our planet at the same time.