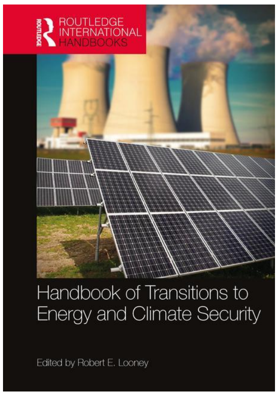

Handbook of Transitions to Energy and Climate Security

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Climate change and energy security policies

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Climate change and energy security policies

Are they really two sides of the same coin?[1]

Peter R. Hartley

It has been claimed that energy security and climate policy should be considered "two sides of the same coin." For example, on a visit to the United States in October 2006, former UK Prime Minister Tony Blair said, "We must treat energy security and climate security as two sides of the same coin." Other leaders in Europe, members of the United States Congress and many commentators echoed Blair's statement.

Blair was addressing the claim that the Iraq War was at least partly motivated by concerns about the security of supply of crude oil. His point was that the industrialized world would not be so concerned about Middle East politics if it were not so dependent on Middle East oil supplies. For ensuring energy security, reducing oil consumption is a substitute for a military presence and military action in the Middle East.

At the same time, fossil fuel combustion adds carbon dioxide to the atmosphere. Since CO_2 is a greenhouse gas, increasing its concentration in the atmosphere should impede the outgoing transmission of infrared radiation. This could, in turn, have harmful effects by triggering changes in climate, especially a rise in global surface temperatures. Reducing these possibly harmful effects from climate change is the goal of climate policy.

Hence, reducing fossil fuel combustion should increase energy security while also reducing potentially harmful climate change. Although we have two policy goals, they should be treated as one, since one policy instrument can simultaneously further both goals.

To examine this argument more carefully we need to discuss what we mean by energy security and climate policy. We also need to investigate the range of policies that could address the two policy goals. Only then can we assess whether both goals are best addressed by the same policies, or whether policies that are best to further one goal might compromise attainment of the other goal.

Possible meanings of energy security

The above argument identifies energy security with national security. We can associate increased energy security with a reduced need to maintain influence in countries, such as those of the Middle East, that possess substantial energy resources but may be politically unstable or hostile to the West.

Another connection between national security and energy security is the fact that modern military forces require substantial refined oil products. The United States military, for example, consumes about 130 million barrels (about 20 billion liters) of oil products a year.

The notion of energy security also has economic dimensions. Sudden, large increases in energy prices have preceded most of the post-World War II recessions. Large energy price increases are thought to retard economic growth via a number of mechanisms. The need to spend more on energy commodities constrains household consumption of non-energy goods and services. Similarly, to save on non-energy related costs, firms reduce employment and investments in non-energy related capital. Productivity also declines as resources are reallocated in response to the energy price changes.

Higher energy prices also increase financial flows from net importers to net exporters of energy commodities. Many net exporters are smaller economies with limited capacity to absorb additional investment funds. The funds therefore have to be recycled by international capital markets and the resulting financial flows can disrupt exchange rates and international financial markets more generally.

Energy price variability also increases uncertainty about future energy prices, which in turn deters investments in competing types of energy or competing high cost locations such as the deep water Gulf of Mexico. Such investments typically are large and long-lived and thus made much more risky if energy prices are more uncertain. In so far as volatile energy prices reduce investments in domestic alternatives, they exacerbate the initial instabilities by concentrating production in less stable regions.

Several policies have been proposed to deal with energy insecurity. Strategic petroleum reserves can reduce the effects of supply shortages, and especially provide emergency supplies in case they are needed for military purposes. It is arguable whether such reserves increase security of supply on net, since they likely reduce the incentives for private firms to store energy commodities. Regardless of one's view on that issue, however, resource stockpiles are designed to contend with short term emergencies.

Longer term energy security for the world can be increased most effectively by diversifying energy sources and the range of regions from which they come, and especially by increasing supply from more stable countries. Increased substitutability among energy sources also increases resilience to supply disruptions. *National* energy security is also enhanced by a greater variety of *domestic* energy supply sources.

CO_2 emissions and climate policy

Almost all scientists who have investigated anthropogenic CO_2 emissions agree that they will change climates. However, far fewer scientists claim that the *overall* effects of such emissions under a so-called "business as usual" scenario, where no specific policies are taken to artificially constrain fossil fuel use, are likely to be significantly harmful. I will return to this proposition shortly. Before I do so, however, I want to discuss another issue. Even if we conclude that CO_2 emissions are likely to be significantly harmful on net, limiting CO_2 emissions is not the only possible policy response.

I will classify climate policy actions into five categories. The first is reducing the emissions of greenhouse gases, particularly CO_2. Other components of the atmosphere have stronger greenhouse effects than CO_2. In particular, water vapor absorbs a far wider range of outgoing radiation, and therefore has a more significant warming effect. However, the concentration of water vapor in the atmosphere is not thought to be *directly and significantly* influenced by human activity and therefore is not considered to be *directly* amenable to policy. Indeed, the main global computer climate models assume that a trend in CO_2 concentration in the atmosphere is the main determinant of trend changes in water vapor content so that controlling CO_2 also indirectly controls water vapor. Apart from water vapor, other greenhouse gases, including methane and hydrofluorocarbons, also have much stronger radiation trapping effects than CO_2. The main argument for focusing on CO_2 is that, since we release more of it, it could provide a more significant policy lever for reducing the total greenhouse effect.

A second category of responses to the threat of climate change from CO_2 emissions involves an offsetting sequestration of greenhouse gases, particularly CO_2. Already CO_2 is used for enhanced oil recovery. This involves extracting additional oil from a mature well by injecting CO_2 to increase the pressure and, with suitable additives, also alter the geochemistry. The permanence of such sequestration has been questioned, however, since some of the injected CO_2 may be produced along with the oil.

Another proposal under investigation involves injecting CO_2 into so-called methane hydrates. These are a form of solidified methane, or natural gas, found under great pressure and low temperatures on many continental shelves. Methane hydrates are thought to contain more energy than all other known remaining sources of fossil fuel combined. Laboratory experiments have shown that CO_2 can displace the methane in the hydrate structure both sequestering the CO_2 and liberating the methane to be used as a fuel.

There are also a few demonstration projects that bury CO_2 in underground reservoirs such as abandoned natural gas wells or salt domes, or in the deep ocean. Unlike the examples just discussed, these projects do not produce anything worthwhile in exchange. As a result, they are very expensive and unlikely to be used on a large scale without further technological innovations.

Another set of sequestration proposals relies on the fact that CO_2 is an input into photosynthesis, whereby plants use CO_2, water and the energy of sunlight to produce carbohydrates and then other organic compounds. Those organic compounds in turn, of course, sustain most of the rest of the life on earth, including us. When we oxidize the carbohydrates we not only get energy but also produce CO_2 (and water) that we return to the atmosphere in our breath. Planting forests, or reducing deforestation, sequesters some CO_2 until the wood decays. A related idea involves partially oxidizing plant material to produce charcoal, which is then buried. Since the charcoal is slow to decompose, this sequesters the carbon for a long time. It also can improve soil quality. It is unclear, however, whether it could be done on a large scale at a sufficiently low cost.

Other firms are working on using CO_2-enriched greenhouses to grow algae that have been genetically engineered to produce compounds that can be turned into synthetic liquid fuels as substitutes for oil-based fuels. Although those fuels also release CO_2 when they are burned, it is recycled CO_2 previously taken from the atmosphere by the algae. The same idea underlies producing ethanol and other biofuels from sugars produced by plants.

Proposals to seed the oceans with iron also aim to enhance the absorption of CO_2 by plants, in this case, phytoplankton. In the middle of the ocean, insufficient iron limits the growth of phytoplankton. Increasing the amount of iron would promote plankton growth and increase photosynthesis. Some of the additional carbon compounds so produced would fall to the ocean floor to be sequestered for a long time.

A third category of responses to the threat of climate change involves various geo-engineering projects aimed at offsetting the radiation trapping effect of greenhouse gases by increasing the direct reflection of incoming solar radiation. One way to do this is by increasing the amount of low cloud cover, which in turn reflects incoming solar radiation. A change in cloud cover of just a few% could completely offset the predicted warming effect from a doubling of CO_2 concentration in the atmosphere.

The above proposals try in some way to limit the ability of CO_2 emissions to change climate. The last two categories of response take a different tack altogether.

The fourth category of responses involves limiting the chance or magnitude of harmful consequences from future climate change. For example, levees or dykes can help reduce the costs of flooding, as can depopulating low lying areas. Improved building materials, and more stringent building codes, can lessen the damage and loss of life from strong winds. Better weather forecasts can help people get out of harm's way. Crops can be bred to be more resistant to droughts or wet weather. Farmers can be given better advice on which crops are best to plant under different seasonal weather forecasts.

The fifth category of responses involves taking better measures to deal with damaging weather events *after* they occur. Primarily, this would involve improving disaster relief measures. For example, very poor civil defense response, including the lack of effective co-operation between different levels of government, was a major cause of the loss of life from Hurricane Katrina in New Orleans in 2005, which was only the sixth strongest recorded in the United States. Other examples of policies that would fit into this category include having stockpiles of emergency medical and food supplies, faster ways of providing temporary housing, and better planning of evacuation routes, including contra-flow lanes.

When many policies could potentially address an issue, most people are likely to conclude that we should use all of them. The economic approach, however, argues that we should compare costs and benefits and implement first those policies with the lowest expected costs for a given level of expected benefits. In making these cost/benefit assessments we need to include in the costs and benefits the indirect effects as well as the direct ones. In particular, if a policy would also eliminate benefits that would otherwise have been obtained, those foregone benefits should be counted as additional costs of the policy.

Revisiting climate policy and energy security

Having discussed energy security and climate policy separately, we return to discuss the relationship between them. The two objectives will be related only if reducing fossil fuel use is part of the efficient response to energy insecurity or reducing CO_2 emissions is part of the efficient response to the threat of climate change. In both cases, the policies will be efficient only if their cost per unit of benefit delivered is lower than the cost/benefit ratio for all the competing policies. If other policies are less costly, restrictions on CO_2 emissions should be used only after further exploitation of those other actions has become just as costly as restricting emissions.

It has been suggested that many unexploited low cost options for increasing energy efficiency could be used to further both the energy security and climate goals. Energy efficiency is the primary energy or electricity input needed to perform a certain task, such as the amount of fuel needed to drive a vehicle a given distance, or the amount of electricity needed to run a light bulb of given luminosity.

If people are ignoring cost-effective measures to improve energy efficiency, however, it is reasonable to ask why. Part of the answer is that electricity prices often do not reflect the real cost of supply – especially the way those costs vary over time. People then do not have appropriate incentives to conserve. Another answer is that consumers may not be aware of new technologies that can more than repay a higher upfront cost through lower energy needs. Some consumers, especially those who face borrowing constraints, might also have a high discount rate and hence devalue future energy savings relative to the upfront capital costs. Landlords may also undervalue the benefits of increased energy efficiency for renters, although that raises the question of why the lower energy costs are not reflected in higher rental payments. A final explanation is that consumers may reject cost-effective energy efficient options because they have other drawbacks. For example, more energy efficient light bulbs may produce a worse quality of light, or more fuel efficient vehicles might be lighter and less safe. If so, implementing policies to force more energy-efficient choices might not be an economically efficient policy option.

Some have suggested that forcing, or using subsidies to encourage, an *immediate* shift to non-fossil fuel sources could be an efficient policy to further both climate and energy security goals. The main problem with this approach is that it would be enormously expensive.

Large amounts of capital invested in the current system for producing, delivering and using energy will have to be replaced if fossil fuels are eliminated. This would be very expensive to do over a short period. Since the investment funds could instead be used for other purposes, replacing otherwise productive capital would come at the cost of reduced prosperity and economic growth.

In addition, alternative sources of energy currently are much less efficient than fossil fuels, especially when one takes account of limitations such as their frequent unavailability and extreme short term variability, the inability to schedule their time of supply, their remoteness from markets, their low energy density, and their non-CO_2 related environmental costs. Some of these problems no doubt could be ameliorated through suitable R&D. For example, better energy storage technologies would greatly enhance the competitiveness of wind and solar energy and electric vehicles. Some subsidization of *basic* research into energy technologies could be justified as part of an efficient energy policy, but it will take time to solve the problems. Meanwhile, the very high cost of non-fossil sources of energy makes it unlikely that restricting the use of fossil fuels through taxes or direct controls is the most efficient response to the threat of climate change from CO_2 emissions.

Another fortunate turn of events is lessening the need to force the premature adoption of non-fossil sources of energy. The energy system is evolving toward much greater reliance on natural gas, which is the least carbon-intensive fossil fuel. Technological developments in the production of natural gas from shale have substantially increased estimated economically recoverable reserves. The consequent reduction in expected future natural gas prices is encouraging firms to invest in natural gas fired power plants. Efficiency gains in combined cycle gas turbine generating plants, and restrictions on emissions of sulphur dioxide, nitrous oxides, particulate matter and mercury from coal-fired plants, have increased this tendency. The result will be a slowing in the growth in CO_2 emissions in a way that does not raise energy costs and therefore is consistent with continued growth in economic prosperity.

Ultimately, the finite supply of fossil fuels means that we are not talking about unbridled emissions of CO_2 forever. Even in the absence of policies to restrict fossil fuels, they will continue to be burned only until their costs rise above the cost of alternatives, as someday they surely will. In addition, the physics underlying the greenhouse effect implies that the marginal effect of additional CO_2 emissions will decline as more accumulates. Adding paint to a pane of glass provides an analogy. As extra coats are added, each new coat reduces the transmitted light by a smaller amount.

More fundamentally, continuing CO_2 emissions until non-fossil energy sources take over will have some beneficial effects that offset costs from the climate change they produce. As noted above, CO_2 is not a pollutant in the sense that it directly harms people or other life on earth. On the contrary, CO_2 is food for plants and hence the foundation of the food chain. Experiments have shown that increased CO_2 in the air increases plant growth, makes plants more resistant to drought, disease, pollutants such as ozone and low light conditions, and increases yields of seeds or fruit. These beneficial effects have also been observed around natural CO_2

seeps. Their commercial value has been demonstrated by the addition of CO_2 to greenhouses to increase plant yields. The experimental evidence suggests that at least 10 percentage points of the increase in wheat and rice yields since 1750 is the result of the roughly 35% increase in CO_2 in the atmosphere that has occurred over the same period. The free fertilizer provided to farmers by continued CO_2 emissions over the next few decades could be essential for feeding the expected world population in 2050.

In addition, while increased CO_2 in the atmosphere will affect climates, the effects will vary quite a bit geographically and not all the changes will be harmful. In particular, while it has been claimed that a warmer climate will be associated with more extreme weather events, some scientists have made theoretical arguments and presented empirical evidence that warming is more likely to *reduce* the frequency of such events. As with changes in mean temperatures, however, the effects of CO_2 on weather variability also are likely to vary geographically.

With regard to direct impacts on human health, numerous studies in many countries, and therefore for a range of climates, have shown that abnormal cold snaps have more adverse direct effects on health than do abnormal heat waves. Consistent with this finding, significantly more people die on average in the winter than in the summer.

Climate models predict that the largest temperature increases from CO_2 will occur in the coldest air masses in the middle of winter. Since such air masses have temperatures far below zero degrees centigrade, an increase of even five degrees centigrade is likely to be more beneficial than harmful. Furthermore, insofar as high latitude air masses warm also in autumn and spring, high latitude grain producing areas in Canada, Northern Europe and Russia could be expected to benefit considerably from the longer growing seasons.

A recent article in the *American Economic Review* examined the effect of past weather fluctuations on United States agricultural output. It then asked what would happen to the value of US agricultural output if the climate changed from what it is now to what it is predicted to become according to several climate models. The answer was that, overall, the value likely would rise. Furthermore, this calculation did not take account of the fact that in a changed climate farmers would re-optimize the crops they plant to take better advantage of the new conditions. The calculation also did not take into account the increased agricultural productivity from the direct fertilizer effects of CO_2.

Throughout European history at least, more rapid economic and social progress has tended to be associated more with warm climatic phases, such as the Minoan, Roman and Medieval warm periods, than with cold periods, such as the Dark Ages. A possible reason is that agriculture in Europe was more productive in warmer periods. The period of maximum average global temperatures since the last ice age used to be called the "Holocene climate *optimum*" until it became unfashionable to think of warmth as being associated with "good times."

The latter discussion raises another point. Climate is always changing. Controlling the concentration of greenhouse gases in the atmosphere at best does something about just *one* source of climate change. Climate will still change regardless of what happens to CO_2. This reduces the certainty with which we can claim benefits from controlling CO_2. For example, we might incur costs to reduce temperature increases only to discover that we are heading into a natural cooling cycle that could make temperature rises more beneficial. Uncertainty about the benefits of controlling CO_2 in turn raises the risk and therefore reduces the value of investing in technologies aimed at reducing CO_2 emissions.

The ample historical and natural evidence of past natural climate changes raises another issue. How much of the recent temperature change is natural, how much is attributable to anthropogenic sources other than CO_2, such as land clearing, large scale irrigation, and urbanization, and how much results from the accumulation of CO_2? For example, cooling forces evidently have been offsetting sources of warming, including CO_2, for at least the last decade.[2] As another example, half of the recovery in average temperatures from the Little Ice Age cold period, which occurred from the mid-1600s to the early 1800s, took place before 1930, and therefore could not have been due to CO_2 accumulation in the atmosphere. More generally, there have been many previous periods of warming and cooling of natural origin and comparable magnitude to late twentieth century warming.

The larger the non-CO_2 components of climate change, and the more variable the effects geographically, the stronger the case for limiting the chance or magnitude of harmful consequences from climate change, or taking measures that improve recovery from damaging weather events. These types of measures will help protect against climate change *regardless* of its source, while limiting CO_2 addresses only one source. In addition, such measures would enable us to retain the benefits of increased CO_2 in the atmosphere, such as the stimulus to plant growth and any induced climate changes that are beneficial, while limiting the costs associated with climate changes that are harmful. Furthermore, many policies for handling damaging weather events would also be useful for events that have nothing to do with climate change, such as earthquakes or terrorist attacks. This further reduces their cost/benefit ratio compared to constraining fossil fuel use.

Even if we decided that restricting fossil fuel use is part of the best climate policy for the world as a whole, we have to ask how effective it would be to limit fossil fuel use in only part of the world. Developing countries are not going to slow their economic growth by avoiding low cost fossil fuels. As those with large populations, such as China, India, Brazil and Indonesia, increase their standard of living, their increased CO_2 emissions already are swamping reductions made elsewhere. For example, CO_2 emissions from energy consumption in China increased by more than 167% over the decade 1999–2009, while the absolute *increase* in India over the same period was around two and a half times the *decrease* in the United States. Only at later stages of development does energy use per unit of GDP begin to decline as economies shift into services and use more energy efficient, but also more expensive, production technologies.

With continuing growth in CO_2 emissions from developing countries, any reduction in emissions in the *developed* world will have lower marginal benefits. Restricting fossil fuel use in the developed world alone might even be counterproductive from the perspective of reducing global CO_2 emissions. Raising the cost of energy in developed economies alone will drive industry to the developing countries, more than likely resulting in a net increase, not a decrease, in world energy use and world CO_2 emissions. There are two reasons for this. Energy efficiency tends to be lower in developing economies than in developed ones, while industry relocation probably would raise energy used for transportation of manufactured goods.

Finally, we need to consider that the *cost*, including the energy security cost, of forgoing the use of fossil fuels is likely to vary geographically. For example, the United States and Canada together have very large deposits of coal, tar sands, oil shale, shale oil, shale gas and methane hydrates. The World Energy Council estimates that the United States has around 30% of the world's known coal resources, which is more than any other country. They also estimate that Canada has more than 70% of the world's known bituminous oil, and the United States has more than 70% of the world's known oil shale resources. While oil imports are currently an energy security issue for the United States, absent concern about CO_2 emissions the United States and Canada could together produce, at costs competitive with the current price of crude oil, all the petroleum products they need until alternative energy technologies become competitive. However, producing liquid fuels from unconventional oil resources, or from coal, releases additional CO_2 before the fuels are burned. For the United States and Canada, therefore, energy security and restrictions on CO_2 emissions are in conflict. For western Europe and

Japan, where there are far fewer remaining indigenous supplies of fossil fuels, restricting the use of fossil fuels is of much lesser consequence.

While Australia is not as well endowed with fossil fuel resources as is North America, it has very large per capita endowments of coal and natural gas. As a result, cheap energy is a major source of comparative advantage for the Australian economy and energy is a relatively large part of its exports either directly or embedded in other products. Furthermore, econometric studies, such as those done by the Center for Global Trade Analysis at Purdue University, suggest that countries in Asia and the Middle East that would not impose taxes or controls on fossil energy would be close substitute locations for many energy-intensive industries currently located in Australia. Given the high costs to Australia of restricting fossil fuel use, it is quite reasonable for Australia to insist on *very* strong evidence that the sacrifice will yield comparably high benefits before it agrees to incur the costs.

When I first started writing on energy economics issues in Australia in the early 1980s I wrote a paper titled "Cheap Resources into Expensive Energy." At the time, I was writing about how inefficient state-owned monopolies in the electricity industry were turning Australia's abundant, and often non-tradable and therefore cheap, coal into expensive electricity. This was hampering Australia from obtaining maximum benefit from its resource endowment. From a purely domestic perspective, the proposition that Australia should tax or otherwise constrain the use of its fossil fuels could be seen as "Cheap Resources into Expensive Energy Revisited." For Australia, as for the United States and Canada, energy security and climate change are not "two sides of the same coin."

Of particular relevance for current policy discussions, it would be an expensive but futile exercise for Australia to restrict CO_2 emissions *unilaterally*. Since Australia currently produces less than 1.4% of total anthropogenic CO_2 emissions, if the Australian economy were *completely shut down*, the resulting effect on global surface temperatures would not be measurable even if the climate models predicting the largest effect from CO_2 accumulation turn out to be accurate.

Nor is it likely that substantial reductions in emissions from Australia would have any effect on policies adopted by others. Even in the extremely unlikely event that all OECD nations implemented controls on CO_2 emissions to the level specified in the Kyoto Protocol it would amount to little in the face of continuing strong growth in emissions from high population developing countries. As a result, the marginal effects of such aggregate OECD reductions on surface temperatures would be tiny. The *proponents* always acknowledged that the controls in the Kyoto Protocol were only a *first step* toward limiting climate change from CO_2 accumulation.

In summary, the costs of reducing CO_2 emissions are currently so high, especially for developing countries, that it is most unlikely that meaningful controls on CO_2 emissions could be instituted at the global level before alternatives to fossil energy become competitive. At that time, policies to force reduced fossil energy consumption would be unnecessary. In the interim, policies aimed at encouraging basic research to lower the cost of new energy technologies, limiting the harmful consequences from climate change, or contending better with damaging weather events would yield far greater expected benefits for a comparable level of expected costs.

Notes

1 A previous version of this paper was presented as the 2011 Reid Oration at the University of Western Australia. It has been lightly edited mainly to convert a paper that was initially delivered orally into written form.

2 Recall that this was written in 2011. What is now known as "the pause" has continued for another four years.