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Energy Security:

The term "Energy Security" makes me a little suspicious. The term was born from the 1970s supply shocks, as a slogan to capture then widespread concern about the risks of disruption from sudden supply cutoffs. But since then, it has mostly been deployed to serve the interests either of the US domestic production lobby – as grounds for overturning whatever environmental or other regulations where hindering expanded operations somewhere they wanted to go – or as a basis for foreign policy pressure against particular foreign suppliers. The recent adoption of the term by environmentalists, hoping to link energy security to climate change and consequently gain more standing for climate at the high table of policy represents an added theme, but does not alter these underlying configurations of interest using the term.

This concern about the political economy of the term does not, however, imply that there are not real and serious security issues associated with the production, conversion, transport, and use of energy. There are, of three broad types:

Energy Security Issues: Three Types

1. Economic vulnerability to supply disruptions:

Economies are vulnerable to energy supply disruptions because of the central importance of energy as an economic input – essentially as widespread and essential as labor or capital – and, crucially, because energy systems tend to be sticky, characterized by limited and slow substitution. Price elasticities for energy inputs are relatively low, particularly in the short run – granted, not as low as people believed them to be in the 1970s, when conventional wisdom had them essentially zero, but low nonetheless. There are many specific, technical characteristics of energy systems that contribute to limited substitutability throughout the system, such as a capital structure with large, long-lived capital investments depending on specific fuel inputs (refineries, gas stations, and automobiles need petroleum; gas-fired electrical generating stations need natural gas); and networks of infrastructure for supply, conversion, distribution, and use of specific energy products that create substantial lock-ins. There are specific opportunities at many points in the system to increase, flexibility, of course – e.g., dual-fired boilers and flex-fuel cars – but the technical opportunities to increase flexibility are not uniformly distributed throughout the system, and introducing flexibility usually implies higher costs as well as advance planning.

In addition, many elements of energy systems involve concentration – of supply resources, or of crucial infrastructure. There are many points in the system where one or a few actors have substantial influence over markets – whether this means Saudi excess production capacity, Russian control of natural gas pipelines feeding Europe, or bottlenecks in refining capacity in the American Midwest.

Different primary energy sources imply different specific configurations of suppliers and potential choke points, with different particular types of vulnerability. The original 1970s concerns about oil arose because so few suppliers dominated the world market of the time – a consequence, in turn, of the artificially low prices that had prevailed in prior years – so consumers were vulnerable to the decisions of even one major producer. Since that time, world oil markets have been characterized by increasing diversification of supply and increasing market integration. But while this trend has meant that consumers need no longer worry about a particular supplier cutting them off, the vulnerability to supply disruption is now integrated and spread worldwide, via fluctuations in the world oil price. This is not necessarily a greater vulnerability, it is just a different one: in the absence of state control of production, even net exporter nations are now vulnerable to spikes in the world oil price caused by decisions of suppliers whose oil they do not buy, so long as their own domestic producers are selling in, and pricing to, the world market.

For natural gas, the movement toward integration of world markets is real, but slower. Consequently, there still exist more specific choke points – usually as a result of infrastructure bottlenecks such as LNG terminals or pipelines – that give particular actors stronger market power over their customers, the most prominent example being Russian control of pipelines to Europe. Uranium is quite highly concentrated, with a dozen-odd countries holding the bulk of world terrestrial resources (vast supplies are available, but at low concentration and high extraction cost, in seawater). Coal has the widest worldwide distribution of the fossil fuels, and so is the least subject to supply vulnerability of this type.

2. Danger: High Energy Densities and Dual-Use Technologies.

Throughout the history of development of modern energy systems, high energy and power densities have been one of the criteria of desirable systems: energy sources and carriers that provide a large amount of energy per unit volume, and transmission systems that provide a large flow of power per unit area. An inevitable consequence of the pursuit of high energy and power densities is that energy systems are dangerous. My parents knew this when they witnessed the high frequency of explosions in the early days of natural gas distribution systems through cities. The residents of Oklahoma City learned this when they suffered a terrorist attack with a truck bomb made of diesel fuel and ammonium nitrate fertilizer. (One might have imagined the response to this attack as tightening controls on the distribution of diesel fuel, but the more sensible response of paying closer attention to large purchasers of ammonium nitrate – a far smaller supply chain in which buyers and sellers more often know each other – was taken.) Energy systems with high energy or power densities are dangerous. They are subject to deadly accidents, and to deadly events created on purpose through vandalism or attack.

The highest energy densities are associated with nuclear power, and consequently the greatest risks. Nuclear systems can also be vulnerable not just to attacks or accidents at the power system, but to theft or diversion of fissile materials to build nuclear weapons. Because of specific technical characteristics of civilian nuclear power systems, the two points of most acute vulnerability to diversion and weapons proliferation are the isotopic enrichment of Uranium fuel (which can be continued to produce highly enriched uranium suitable for bombs), and the reprocessing of spent fuel (which can allow separation of Plutonium suitable for bombs).

3. Environmental Risks:

The extraction, conversion, transport, and use of various energy sources has specific environmental consequences, some of them local, some regional, and some global. The most grave and prominent of these at present is global climate change from the CO_2 and other greenhouse-gases associated with all fossil fuels.

Managing Energy Security Risks, and the Link to Climate Change:

All energy sources pose security issues, of one or more of these three types. The choice of a specific energy-supply mix, whether this choice is made through private markets or public policies and investments, implies a choice of a particular set of associated security risks. In most cases, the magnitude of risks posed by a particular energy source or technology increases with the scale of use of the source or technology. Particular risks may be characterized by various spatial scales, from local to global.

None of these categories of energy-related security risk is adequately controlled by private energy markets. Responding to all of them requires policy interventions, at a scale that depends on the scale of the risk. Some of the most important current energy-related security risks, however, operate at global scale. These include supply disruptions flowing through price spikes in globally integrated markets; threats of aggressive actions by hostile states or other actors who have been enriched by their control of high-value resource revenue streams, or who control key infrastructure; risks of nuclear attack, whether by states or non-state actors, following diversion of fissile materials and technology from civilian nuclear power systems; and global climate change and other potential global-scale environmental problems.

All these types of energy-related security risks can be reduced, at a cost. But for the global-scale risks, nations do not generally have the option of eliminating their risks from a particular energy source simply by not using that source. Avoiding particular sources, or even achieving “energy self-sufficiency”, does not necessary help you, because you can be vulnerable to risks associated with particular energy sources you do not use. You can be vulnerable to oil price spikes from Iranian production cutbacks even if you buy no Iranian oil; to nuclear weapons created by diverting fuel from other nations’ nuclear power programs; and to global climate change from other nations' fossil-fuel combustion. Consequently, addressing any of these risks – and increasing the safety of any state, regardless of their mix of energy sources – requires international policy, on which it is not necessarily easy to reach agreement. Managing these risks requires some combination of internationally coordinated actions, on whose specifics relevant parties might not agree; and international cost-sharing, when many nations may prefer to free-ride.

The essential problem of energy security is that focusing exclusively or predominantly on any one of these types of risks is likely to push choices that exacerbate the other risks. This is the reason that there is danger as well as opportunity in the recent tendency to link the issues of global climate change and energy security. A predominant focus on energy security framed as security of energy supply is likely to imply a strong push to develop alternative sources of liquid fuels from unconventional hydrocarbons – including heavy oils, oil sands, oil shales, and coal. These sources have the capability to reduce vulnerability to supply disruption in oil markets, but at the cost of greatly accelerating global climate change. Getting liquid fuels from any of these requires upstream processing of the primary fuel source that is highly emissions-intensive, such that the total greenhouse emissions associated with a unit of delivered energy in your gas tank may more than double relative to the present system.

There are other ways to address energy security as energy supply that can be neutral for global climate change, or even favorable – basically, any strategy that relies principally on increasing energy efficiency plus shifting to non-fossil primary energy sources (renewable sources and nuclear), as well as exploiting new technologies of carbon capture and sequestration that allow use of fossil fuels without emitting CO_2 to the atmosphere. These are probably not the cheapest, easiest, or most incremental ways to address supply shortages and producer market power in conventional hydrocarbons, however: the cheapest and easiest path is likely to be toward unconventional, higher-emitting sources of hydrocarbons.

Incidentally, this observation provides the answer to a long-standing puzzle I have had about the politics of global climate change. Why have the major oil companies (with a couple of notable exceptions) been so hostile to concerns about global climate change and the need to reduce emissions? Since climate change is to first order a problem about coal, one might expect that all the cheaply exploitable, conventional petroleum will be pumped and burned, no matter what we do to limit greenhouse-gas emission: the only difference will be how fast it is pumped, at what price, and who gets the rents. It would seem obvious that a deal could be cut in which incumbent oil producers get enough of the rents associated with the slower pumping that they are content not to resist. This reasoning, however, fails to consider the prospect of shifting to non-conventional hydrocarbon sources. To the extent that the oil majors regard themselves as being in the "liquid fuels" business, rather than the "energy" business (which it would appear that most of them do), their obvious strategy is so shift smoothly toward heavier hydrocarbon sources with more intensive upstream processing as conventional supplies decline and price rises. And this path – unless accompanied by a large-scale commitment to carbon capture and sequestration – would be foreclosed by any serious effort to limit greenhouse-gas emissions.

So policies to address the energy supply security problem, if they fail to consider climate change at the same time, are liable to make climate change worse. What about the reverse? Are policies to address global climate change likely to exacerbate other energy security problems, including security of supply? Here, the picture is more mixed. To the extent that the core policies to address climate change involve economy-wide measures that put a price on emissions, either through a carbon tax or a cap-and-trade system, these are likely to reduce overall demand and provide incentives to innovate, develop, and increase supply of all manner of non-emitting sources. In this regard, climate-change policies are likely to have the incidental effect of making energy supply security better, even if they are not designed to pursue this explicitly: any increase in diversification of energy supply, particularly in the transport sector, is likely to enhance energy supply security.

There are two respects, however, in which climate-change policies may worsen other dimensions of energy security. First, policies to promote large-scale expansion of nuclear expansion must be designed to address the other risks it poses, principally proliferation of weapons and weapons materials. Second, climate-change policies that gamble on rapid supply increases from particular preferred sources – e.g., a policy that gambles on getting most of future energy from dirt-cheap solar photovoltaics – may increase risks of shortages or price spikes, particularly if the policies to pursue these preferred technologies intentionally or inadvertently foreclose other options. Absent these two caveats, policies to limit global climate change – including economy-wide measures to put a price on emissions, focused sectoral regulations to promote efficiency improvements and other innovations in particular high-leverage sectors, and public support for climate-safe energy R&D – are likely to make positive contributions to the other major dimensions of energy security risks as they address climate change.