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Global Agenda Council on Energy Security

White Paper on Energy Security and Global Warming

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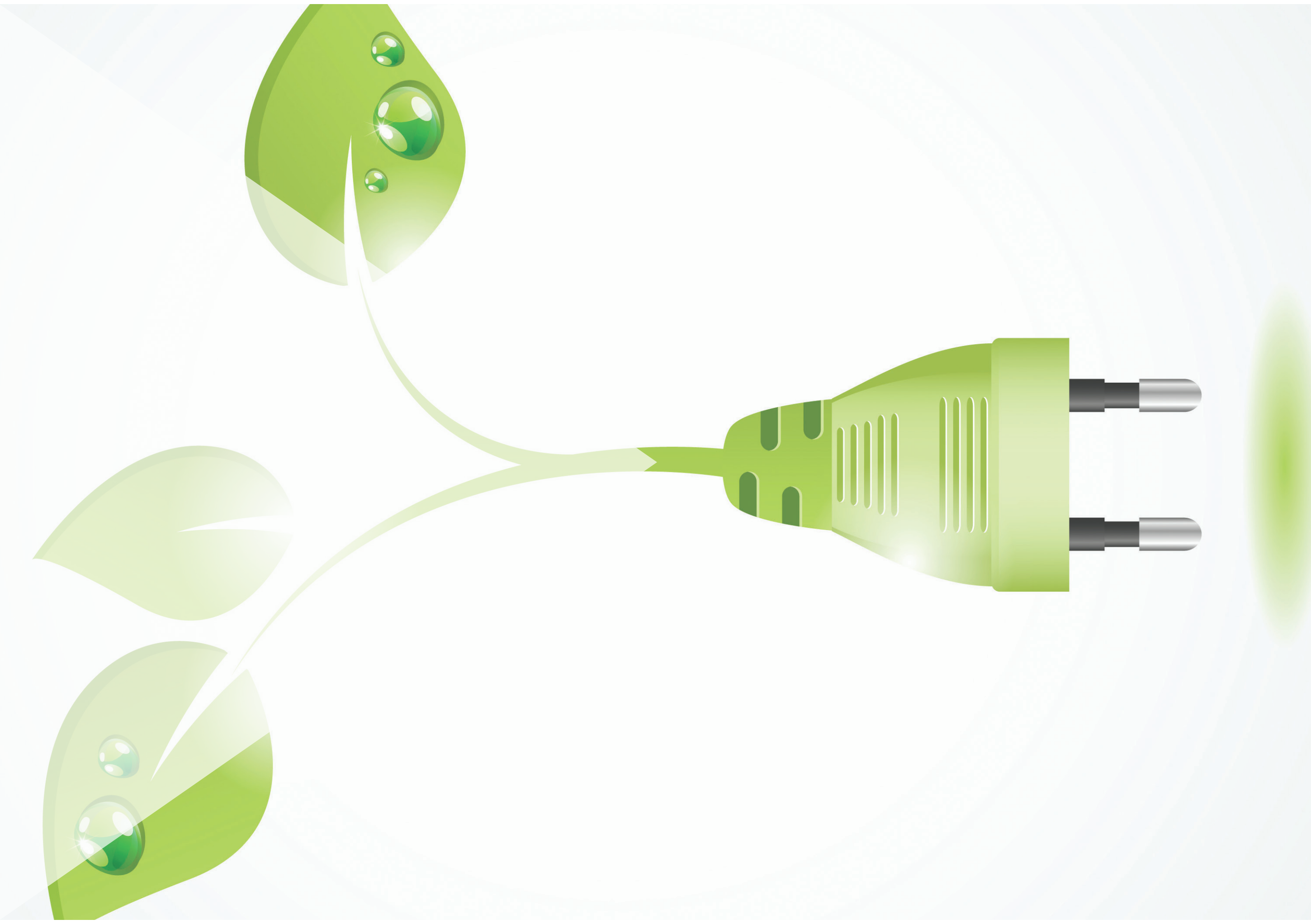

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Chairman's White Paper

The last few decades have seen massive changes in the challenges that confront the world's energy system. Some of these challenges reflect that the energy system must address new goals, notably protection of the planet from global warming.

This year marks the 20th anniversary of the United Nations Framework Convention on Climate Change (UNFCCC). Despite 20 years of diplomacy on this important topic, there has so far been little real impact on global energy trends. However, a few countries, particularly in Europe and Japan, have undertaken large emission control programmes at least partly inspired by the UNFCCC and the Kyoto Protocol. Most other countries have been more sceptical or wary of signing strict limits on their emissions.

These last two decades of climate diplomacy have been filled with ambitious goals – such as limiting the increase in the average global surface temperature to 2ºC above pre-industrial levels – but not many bold actions. Since most of long-term global warming is due to emissions of carbon dioxide from burning fossil fuels, as a practical matter the search for bold actions has focused on energy.

The last 20 years have also seen massive changes in the world's energy system and markets, with large impacts on energy security. New technologies – such as new supplies of shale gas and a surge in the deployment of various forms of renewable energy – could, with the right policies, lead to more reliable and affordable energy supplies.

Experience strongly suggests that reliability and affordability – that is to say "energy security" – comes mainly from competitive, global energy markets that allow each country to pursue a mix of energy sources that best meets its local circumstances. Yet, in reality, the policies needed to boost energy security are fragmented and often missing. Moreover, the supply of primary fuels and technologies has struggled to keep up with a tectonic shift in the global economy. Demand for energy supplies has slowed in the mature, highly industrialized countries, but it is booming in the emerging economies, especially in Asia.

Linking Energy Security and Climate Change

In recent years, it has become popular to link climate change and energy security. The linkage, it is thought, will raise the political prospects for serious action on climate change.

In most countries, public and government concern about climate change ebbs and flows. By contrast, energy security is a more timeless and compelling goal that nearly always commands the highest levels of government attention and significant resources. In addition to the supposed political opportunities from linkage, substantively the two topics are tightly intertwined; many of the actions that make for a more secure energy system also reduce the warming emissions that come from energy supplies. Much greater energy efficiency efforts, for example, can serve both goals.

This paper explores the linkage between energy security and climate change. It reflects the deliberations of a team of experts who work in business, government and academia, and have extensive experience on matters of energy security. Our analysis suggests that the growing popularity of linking energy security and climate change is rooted more in tactical political goals than in a real understanding of exactly how and where these two issues are linked. Getting serious about linking these two issues requires rethinking policy in both spheres, especially in climate change.

While this is a large and complex topic, we make five central points:

1. *Climate change and energy security share the need for policy to encourage "all of the above" choices of technology.* There are no silver bullets in either domain. Instead, efforts must push on many fronts – energy efficiency, natural gas, advanced nuclear, renewables and others. This point is hardly controversial and widely made, but in reality its implications are rarely grappled with. An "all of the above" approach requires policies that encourage market competition and select technologies based on real performance. As a strategy, "all of the above" only works if policies are adopted that force markets to internalize the energy security and environmental consequences of each fuel.

2. *"Smart globalization" is essential.* Since all major fuels are now traded in global markets, all major users have a strong stake in making those markets work reliably. In addition, all major energy technologies – especially the most advanced technologies that are needed for deep cuts in emissions and for transforming energy supplies to make them more secure – are also globalized. Thus, any kind of serious programme for linking energy security and decarbonization must start with the huge opportunities afforded by globalization. Today, those opportunities are already apparent in fuels and technology. In the future, there are also large gains to be made through globalization in the engineering and construction of large systems. Nearly all the promising technologies for deep cuts in carbon require large-scale engineering such as advanced nuclear reactors or integrated renewable power systems. Globalizing the engineering and perhaps even construction of these systems offers huge potential for lowering cost and raising performance.

3. *Scale and speed are important.* In politics, there are strong premiums to promise that changes will appear much faster than reality can produce. This helps explain the long string of bold promised visions such as "energy independence" or halting global warming at 2ºC, which have little bearing on how energy markets actually function. Globally, the energy system changes slowly; transformations that could lead to a much more secure energy supply and much lower emissions of warming gases will require three to five decades. While energy security might arrive faster – the world's energy system is probably more secure today than it was a few decades ago because supplies are more diverse and markets are more robust – a radical change to decarbonize the energy system will not happen overnight. Promises of swifter action would be irresponsible. The long-time horizon for change means that policy-makers must get serious about the policies that will be needed to cope with the transition. Those policies include many topics outside the scope of this essay, such as better mechanisms for large oil consumers to coordinate their stockpiles, which are essential for oil security, as well as important transitional issues at the intersection of climate change and energy security. Chief among those is the inevitability of large changes in climate, which will require adaptation, including in the energy system. There are many ways that a changing climate will affect energy security, but among the most important relates to water.

4. *Innovation is required.* It is hard to get serious about the twin challenges of energy security and climate change without radical new technologies. It is popular to claim that all the technologies needed to address these challenges are already "on the shelf" and what is needed is just deployment. We disagree. A serious programme on energy security and climate change requires that new energy sources be affordable and highly reliable, something that is not achievable without radical

innovation. Yet real investment in innovation has lagged. A sharp rise in public spending on energy RD&D is needed, along with policies that spend those new resources wisely. What is missing, however, are practical visions for how to finance this RD&D in an era of fiscal austerity along with a vision for how these new funds would be spent wisely. We suggest that some of the funds can come from redirection of subsidies along with tax reforms, but we note that subsidy reform is politically difficult and unlikely, by itself, to generate the needed extra funds. Governments must be prepared to increase what they spend on energy innovation, and those new funds probably must come from general revenues. Historically, energy innovation (like almost every area of government innovation policy) has been managed at the national level. Given the changes in energy technology markets and the global nature of the firms that do much of the innovation and deployment of new technology, a more global approach to innovation policy is needed.

5. *Having a perspective about what is achievable.* Much of the interest in linking energy security and climate change has come from political expedience. People who care about climate change want more attention and action on their issue, and they rightly are looking at ways that topic is linked to other matters that command more public attention. This paper is an effort to show how the topics are (and could be) linked more fundamentally. But, it is equally important to focus on areas where the linkages point in opposite directions. We focus on two: one is the future for high-carbon fuels, notably coal and heavy oil, and the other is reliability, notably for the electric power sector. Many of the technologies envisioned for decarbonization of the electric supply imply big shifts in the entire electric infrastructure and systems for pricing of electricity. This is particularly notable in the possibility of electric grids that depend much more heavily on natural gas and on renewables. Such technologies may have a central role to play in decarbonizing the electric system, but only if their widespread deployment is done at a pace consistent with also assuring reliable electric power.

We develop these five themes throughout the piece, which is structured around three main topics: scale and pace; making energy markets work better; and globalization and innovation.

Scale and Pace

Achieving energy security and decarbonization will require large-scale changes in energy systems. This will not come quickly. For example, if security and decarbonization are to be attained with a very large role for renewable energy, such as wind, then electric systems must be adapted for power supplies that are intermittent. While this is technically feasible, it will require much larger electric grids, widespread deployment of technologies for storage of electricity that probably have not yet been demonstrated at scale, and extensive use of real time pricing so that power users have incentives to respond to the real conditions of the grid.

Even in countries with massive deployment of intermittent renewables today – such as Denmark, where 27% (in 2009) of all electrons sold come from Danish renewable sources (mainly wind) – have not made the full transformation of the electric system that will be needed. In Germany, for example, on a Saturday during the summer, 50% of electrons on the grid come from solar panels. Yet, on other days with less sun and when total demand is higher, the role of solar is relatively minor. The German government envisions that as the country phases out nuclear power in the wake of the Fukushima disaster and long-standing public opposition to nuclear power, the country will become a lot more dependent on renewables. In reality, however, the short-term pattern has been to increase dependence on coal, the traditional backbone of the German grid. Moving quickly from traditional energy sources to new ones is a difficult and slow proposition, even when there is strong public policy support.

In highly industrialized economies, much of the thinking about decarbonization and security has focused on local supplies of renewable electricity such as wind and solar. But it is important to realize that there are many other options. It is conceivable that decarbonization could be achieved with massive use of coal through the use of large-scale carbon capture and storage (CCS). A few components of CCS systems have been deployed, but massive widespread use would require at least three decades of sustained investment.

Particularly interesting is the potential for massive deployment of nuclear power plants. The events of Three Mile Island, Chernobyl and Fukushima have darkened the prospects for building new nuclear plants in highly industrialized countries, but in other parts of the world, such as China, India and the Persian Gulf, the prospects for nuclear are brighter. About five dozen plants are at various stages of planning and construction in China; an initial project with four plants is now under construction in Abu Dhabi.

Done well, nuclear power already offers a relatively inexpensive way to generate bulk power with essentially zero emissions. The best Chinese and Korean engineering firms, for example, already build reactors at less than one-third the cost of a comparable unit built in Europe or the United States. Nonetheless, the pace of change in a nuclear world is slow. Today, China gets only 2% of its electricity from nuclear power. With its massive building programme and future plans it might, at best, raise that share to 10% in 2025. Change is slow.

While our examples here focus on electricity, similar comments apply to alternative sources of liquid fuels that might replace oil. Massive use of ethanol, for example, requires new fuelling infrastructure. Building such infrastructure took about two decades in Brazil, a country with strong policy incentives in place for widespread use of ethanol. In the United States, where policy signals have been more erratic and where use of motor vehicles is more diffused, total use of ethanol is unlikely to rise much above 10% to 15%. This is despite 20 years of active promotion of ethanol through policy at the federal level and in some states (the fact that the US ethanol policy has focused on corn, which is biologically a very inefficient way to make ethanol but politically attractive since there are many well-organized corn suppliers in America, has not helped the long-term viability of the US ethanol strategy). The fraction of ethanol that can be readily blended and used in the existing gasoline network is due to the continued lack of a dedicated ethanol fuel network and sufficient numbers of dual fuel vehicles that can burn larger fractions of alcohol fuel.

Looking to history, experience suggests that large-scale changes in energy infrastructure require 20-70 years. Changes that require the invention, testing and diffusion of a new technology within a compatible, existing network (for example, the spread of alcohol liquid fuels as rivals to oil-based fuel) can occur over a period of about 20 years.

Fundamental changes that require recrafting of infrastructure, such as the need to add large amounts of storage to an electric grid along with new real-time pricing systems and, crucially, new business models, require much longer time periods, perhaps about 50 years. Technologies differ in the extent to which this recrafting might be needed. Nuclear power, for example, probably requires little redesign of electric grids and markets, but it will require design of new infrastructure for supply and disposal of fissile material.

When energy systems must transform so massively that the major uses of energy are fundamentally altered as well (e.g. the shift from transportation networks based on coal and steam power to roads and vehicles powered with oil), the changes require 70 or more years. For first movers, the time required to scale and change is almost always longer than for latecomers who can take advantage of what first movers learn.

These points, rooted in the history of energy technology, suggest two major points for policy-makers who are trying to advance energy security and decarbonization.

1. *Policy goals need to be anchored in the realities of how quickly the energy system can change.*

   The policy process creates strong incentives for politicians and diplomats to make bold promises and weak incentives to put into place the policies actually needed to deliver, especially when promises come due several electoral cycles in the future.

   On matters of energy security, the gravitational effects of boldness are seen, for example, in the often cited goal of "energy independence". In fact, independence – when combined with lack of infrastructural access to the global markets – can undermine energy security because well-functioning global markets for fuels and technology are a source of security and flexibility. For most large energy consumers, independence (even self-sufficiency) is not likely to be achieved. From the perspective of low-cost, reliable suppliers, the incentives to invest in larger and even more secure supply systems are undermined when consumers claim they are seeking autarky.

   Similarly, in climate change, bold but unrealistic goals have perverse effects. The goal of stopping climate change at 2ºC, for example, has been widely espoused by governments and analysts who have focused on overly optimistic projections for the changes in energy systems – away from high-carbon fuels and towards a much larger role for efficiency and low- and zero-carbon energy supplies that are technically feasible only under ideal conditions.

For the last decade, governments have been reinforcing their claims that the goal for climate diplomacy is to stop warming at 2ºC above pre-industrial levels, yet have done little about the reality that the energy system is not changing at the speed needed to achieve that goal. Not surprisingly, in the last few years a spate of new studies has appeared showing that the 2ºC goal is all but impossible to achieve. By focusing on unrealistic goals, climate diplomats have undermined the credibility of international climate talks and probably also delayed the day when diplomats have needed to face the inevitable: that a large and growing element of climate diplomacy must focus on adaptation to higher sea levels and other likely effects of climate change in addition to controlling emissions.

Getting serious about energy security and decarbonization requires setting goals that are rooted in sober assessments of what is achievable. Overly bold goals are not just idle chatter. They diminish the credibility of policy efforts, and when firms that account for most investment in energy systems see signs that policy efforts are not credible they are a lot less likely to invest.

2. *Almost all long-term challenges such as energy security and climate change are composed of many components with different timescales.*

   Policy-makers and firms need to be aware of the opportunities available at each timescale. The longest timescales describe the large-scale transformations of energy systems; political systems often face profound difficulties in pursuing these long-term transformations. The benefits from change are greatest in the distant future, but the costs are more apparent along the way; no political system does well in addressing problems that pose immediate costs and only distant, abstract benefits.

   Activities on shorter timescales are particularly interesting for policy because they allow for a closer coupling between actions (and their expense) and practical benefits. Over the short term (a decade or so) actions that can promote energy security and decarbonization include the many efforts to boost energy efficiency as well efforts to expand the production and use of natural gas.

   A particularly intriguing opportunity lies with efforts to control short-lived climate pollutants such as soot and methane. New science has shown that these pollutants have a much larger impact on the climate than originally thought. While it is crucial for governments to adopt policies that begin the long, slow process of decarbonization, there are large political opportunities in controlling short-lived pollutants to help "buy time" for the longer term policies to take full effect. And, if governments can demonstrate that they can make deep cuts in these short-lived pollutants, they can build credibility that will be needed for the harder, long-term challenge of decarbonization.

Making Energy Markets Work Better

Any serious plan for integrating energy security and climate change must begin with markets. Over the last four decades, every major economy has made substantial progress in empowering markets to allocate energy services. Quotas and price controls that were the norm across OECD countries in the 1970s are almost completely dismantled; restructuring of electric power systems to allow market forces to operate has unfolded more slowly, but there is decisive progress on that front.

Recently, Poland successfully restructured its wholesale energy market, shifting trade from highly regulated bilateral contracts (accounting for 99% of the market in 2009) to an energy exchange that just two years later accounted for 60% of the country's electric market. Some striking shifts to markets are observed also outside the OECD nations. Many of the former Soviet bloc economies, including Russia, have implemented massive reforms to liberalize energy prices. Russia has invited new entrants into its oil and electricity sectors, although much more progress is needed in gas where a state monopoly continues to dominate the industry. All the rapidly growing, emerging economies have made massive market-oriented reforms in recent decades. Brazil, China and India, for example, have dismantled nearly all price controls. In all the energy-related sectors of these countries, there are more opportunities for entry by competing firms and enterprises.

We see these changes as an important foundation for serious action on climate change and energy security. For action on these policy priorities to be politically viable and economically efficient over the long term, governments must rely on market forces to the extent possible. When enterprises are exposed to real prices – even in countries where state-owned companies account for a large share of energy-related activity such as in China, India, Russia and much of the Persian Gulf – they are more likely to make sensible decisions. The effects of high oil prices are familiar; they have encouraged efficiency as well as massive investment in new supplies.

This shift to markets is welcome, but far from complete. We see additional efforts needed on three fronts:

1. *Efforts at market-oriented reforms in energy must continue.*

While there has been enormous progress in relaxing price controls, countries have done less well in opening energy markets to entry by firms that offer competing services in both the supply and use of energy. The last 20 years have taught important lessons about some of the dangers and difficulties in allowing unfettered competition in some energy markets. For example, the California electricity crisis in the early 2000s underscored the need for governments to link electricity market reforms with smart regulation.

Yet, for every example of poorly executed market reforms there are many more examples where the failure to create competitive markets has undermined energy security and led to higher levels of pollution. Examples also range from the continued failure to allow market competition in Mexico's oil sector to shortages in electricity in India's state-dominated power system. The overall effect of market reforms has been positive and essential.

To explore all benefits of competitive energy markets, liberalization efforts should be comprehensive yet implemented cautiously. The need for caution and strategy is particularly acute in power markets, which have proved highly sensitive to poorly conceived reforms (e.g. in California). Making such reforms successful requires robust infrastructures such as transmission networks as well as alignment with complementary markets, including markets for natural gas and other sources of primary energy.

2. *Competitive markets require judicious use of subsidies.*

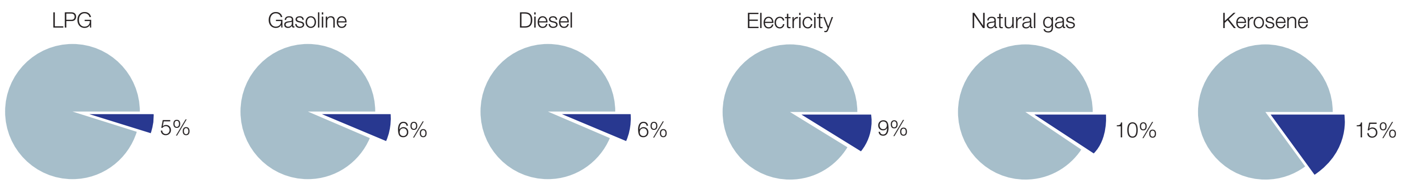
Historically, subsidies to the energy system have been massive. Many of those subsidies have been devoted to important and proper purposes, including funding for research and development, as well as support for infant technologies such as early-stage designs for nuclear plants and advanced coal technologies to renewable energy sources. Governments have also adopted subsidies with the goal of benefitting very low-income consumers, such as programmes to subsidize the extension of electric grids to rural areas. There are many well-grounded reasons to use subsidies in public policy.

In reality, however, most subsidies are not serving proper goals because the politics of removing subsidies are toxic and difficult to manage. Once created, subsidies attract political supporters; once created, they tend to flow to the groups that are politically best organized rather than the activities that actually deserve subsidy.

Figure 1 below shows that low-income consumers, who are usually the intended beneficiaries, often receive a very small fraction of total subsidies. The intended beneficiaries are less organized politically than the larger energy users who obtain most subsidies. At the same time, once subsidies are in place they are extremely difficult to remove, as policy-makers in Jordan and Nigeria learned when they faced street riots protesting economically sensible (but politically treacherous) reductions in energy subsidies. These problems are fundamental and unavoidable. New technologies for targeting subsidies (e.g. smart cards) can help governments manage the political challenges in such reforms because they make it easier to ensure that subsidies are directed mainly to the intended beneficiaries.

Figure 1. Share of fossil-fuel subsidies received by the lowest 20% income group by fuel in surveyed economies (2010)

Source: IEA, World Energy Outlook 2011 (countries surveyed were Angola, Bangladesh, China, India, Indonesia, Pakistan, Philippines, South Africa, Sri Lanka, Thailand and Vietnam)



We are encouraged by the progress that is being made on energy subsidies. In 2009, the leaders of the G20 countries agreed to phase out inefficient fossil fuel subsidies that encourage wasteful consumption. And while protests against subsidy reforms are often in the news, less reported are the places where governments have made substantial progress.

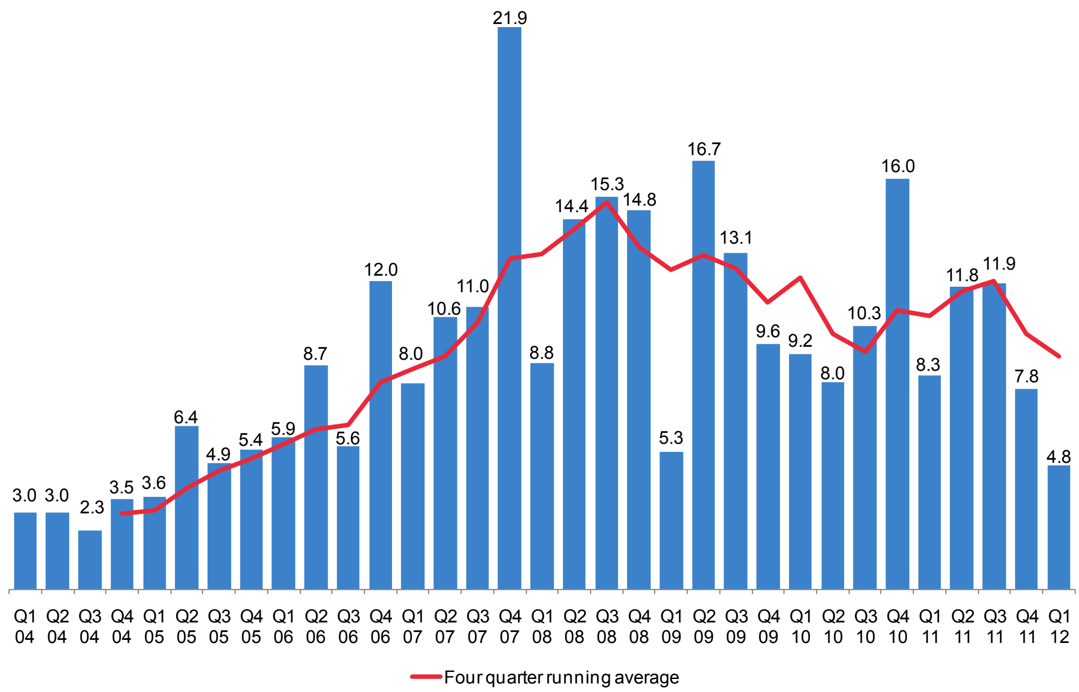
In mid-2011, the Indian government raised domestic prices for gas oil, LPG and kerosene (by 9%, 15% and 20%, respectively) and plans to eliminate subsidies for cooking gas and kerosene in the nearest future. In late 2010, Iran began a five-year programme of significant reductions in energy subsidies designed to bring domestic prices of oil products, natural gas and electricity to international levels. The United States has ended its subsidy for corn-based ethanol; that, along with other policy reforms will help make the supply of biofuels into the US market more competitive. Moreover, international organizations that help national governments plan fiscal policies have become much more engaged with the need for energy subsidy reform. The International Monetary Fund (IMF), World Bank and International Energy Agency (IEA), for example, all have active programmes on subsidy policy.

These trends need to be solidified. The G20 agreement is an aspiration that included the promise that governments would report on their progress and revise their commitments; very little progress is observed. The biggest subsidizers of energy – such as Venezuela and most other large energy exporters – are still known for their subsidies rather than reforms.

The looming question for subsidy policy is the strategy for reform of subsidies for renewable energy. Two decades ago, the largest use of energy subsidies were in fossil energy and nuclear. Today, in a growing number of countries, it is renewable energy. There are important roles for a subsidy in encouraging deployment and technological improvement in renewable energy. But, as renewable technologies mature and as the size of the total subsidy grows rapidly, we think reforms are essential. Subsidies must be redirected from mature renewable technologies to those technologies that are the earlier stages of development where subsidy has a proper role. Such reforms will be politically difficult yet are unavoidable, not least because nearly all of the countries that have the largest investments in renewable power also face fiscal austerity. Figure 2 shows that this uncertainty can already be seen in falling investment in green energy in Europe.

Figure 2. New financial investment in clean energy in Europe in US$ billions

Source: Bloomberg New Energy Finance, 2012



Smart subsidy reforms now will lower the odds of fiscal crises in the future. Crisis could prove politically helpful, but we caution against relying on fiscal crisis as a driver of smart subsidy reforms. Serious subsidy reform will require efforts on many fronts – it will require the creation of special funds that are earmarked for novel technologies, the setting of realistic goals and mechanisms to adjust where subsidies actually flow.

We think the EU vision for achieving 20% renewable energy supply by 2020 is a partial model. The primarily EU-level legal framework is rigid and focused only on select technologies, which has the unintended effect of undermining investments in new technologies that currently are not legally recognized as "renewables". Moreover, the actual EU support schemes are fragmented across more than two dozen countries and not well interconnected, which undercuts the important economies of scale and scope that are often crucial in innovation. Those national systems are often poorly tailored in relation to country conditions what makes them expensive and unsustainable.

We also implore governments to engage in more in-depth dialogue about their subsidy reforms – a process started in the G20, but not sustained. The failure to coordinate policy in this area is likely to waste resources while also raising the odds of trade conflicts over subsidies. At present, the US is planning retaliation against Chinese subsidies for renewable energy technology, a sign that such trade conflicts are likely to arise. Inevitably, the pressure for trade conflicts will also spread to Europe as many local renewable energy providers have moved to China where costs are lower. Scaling up renewable energy will require harnessing the power of the market, which includes global sourcing of technologies.

3. *Making markets work requires a market signal to decarbonize.*

Today, barely 15% of the world's emissions of global warming gases are exposed to any clear signal for reduction. Most of those are in Europe where the EU's Emission Trading Scheme (ETS) has become the world's largest pollution market (other markets for warming emissions exist in Australia and New Zealand and in a few other places, such as the north-eastern US and some individual provinces and states like California). The original vision in the Kyoto Protocol was that all countries, in time, would adopt limits on emissions and would link together in a global emission market. The reality, 15 years later, is that just a few countries are adhering to emission caps and emission trading is highly fragmented.

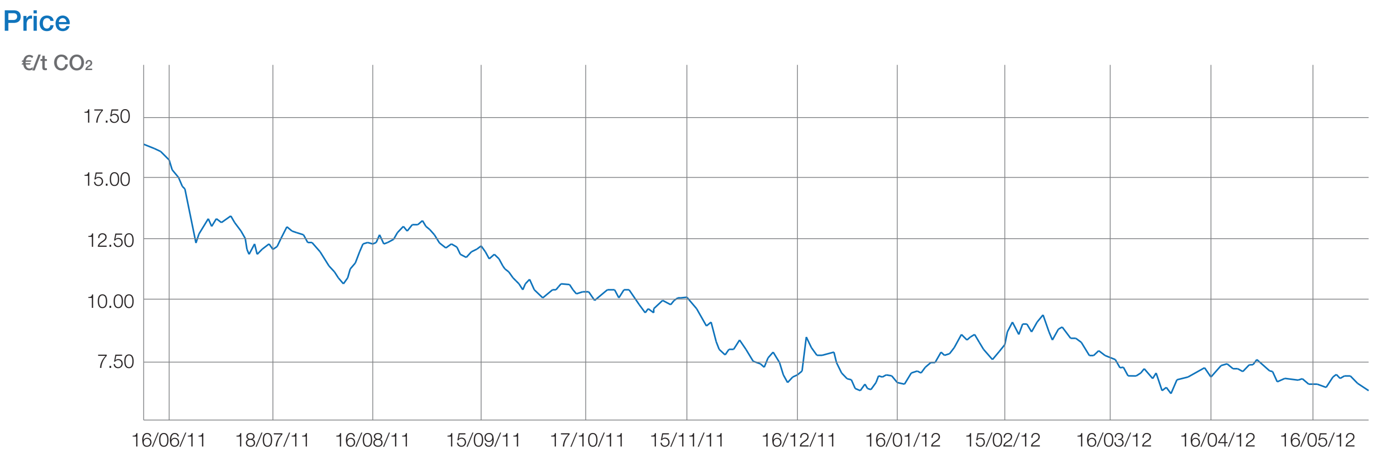
We do not think that emission prices alone will be sufficient to yield the deep cuts in emissions that experts say will be needed to stop global warming. But, they are an essential first step because prices signal that the efforts to cut emissions are credible. Thus, we are worried by two trends in today's emission markets:

One is high price volatility of emission allowances and the lack of a clear political vision for the level of prices that would be desired and thus the level of effort needed in control of emissions. The price of emission credits in Europe is one-third the level of just a year ago (see Figure 3). The price of emission credits in the market in the north-eastern US is now so low (less than US$ 2) that it has no impact on how emitters actually behave. Serious reforms are needed to align these emission markets with how companies actually make long-term investment plans. Those reforms could include price floors and ceilings so that prices are much less volatile (and thus more credible) – in effect, transforming these systems from simple cap and trade schemes that were politically expedient into proper price signals that behave more like taxes.

The other worrying trend is the slow progress in reforming emission offset schemes such as the Clean Development Mechanism (CDM). These systems are essential because they create an incentive for emission trading to expand and for investors to find the lowest cost way to control emissions globally. In practice, however, these systems have been plagued by poor accounting and oversight and by rules designed to reward special interests rather than the least-cost providers of emission credits. Some reforms are possible through the formal UN negotiating process (which created the CDM), but we think it is equally important to encourage the creation of many competing systems, such as the various efforts within the private sector and the emerging offset system in California. Competition creates risks of fragmentation, but more important is that it creates incentives for each offset system to improve its performance.

Figure 3. EU emission allowances – spot, EUR/t CO_2

Source: European Energy Exchange



Carbon pricing is long overdue in the rest of world, notably in the United States. We are not naive about the political barriers to such reforms. Getting more countries to adopt meaningful market incentives requires incentives – rewards for those that make the effort and punishments for those that skirt their responsibility. Better offset systems will create an incentive for more countries to adopt national emission pricing.

Strict border measures can create incentives for countries to "opt in". For example, we are encouraged by the EU's requirement that all airlines flying to EU airports cover their emissions with ETS credits. We are mindful that there are risks of abuse of these kinds of unilateral actions, but we think that the overall effect is positive because they create new political constituencies in favour of emission pricing.

Globalization and Innovation

We note that almost all major issues in energy security and decarbonization hinge on matters of investment and technology. Increasingly, those issues are settled in a global economy where firms have choices about where to invest. In this global economy, technologies are also highly migratory.

Twenty years ago, each of the major economies tended to rely almost exclusively on local innovations and production for their energy systems. Today, this is no longer the case. Best-in-class nameplates are found on power plants and other energy technologies around the world regardless of where the original innovation occurred. The net effect of this globalization has been extremely positive and has increased the ability of governments and firms to provide secure energy supplies. Globalization has also radically improved the prospects for decarbonization since international trade in energy technologies and associated intellectual property have tended to favour technologies that promote efficiency as well as those in renewable power, smart grids and the like.

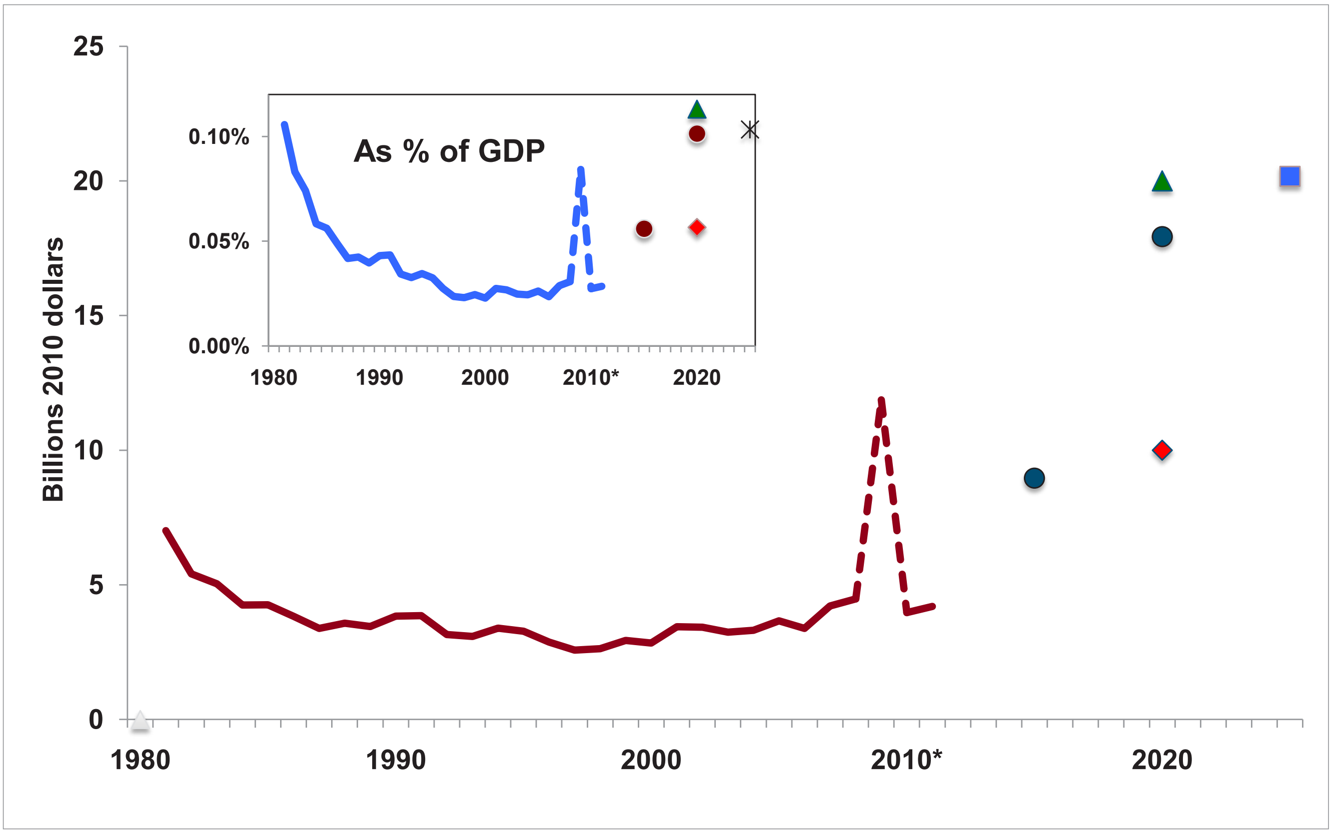
This globalization has not occurred autonomously. It has required that national governments adjust their policies, particularly to protect intellectual property and the sanctity of contracts. Progress in these areas must continue. At the same time, governments must be aware of the huge changes that have been required in other nations while also realizing that as energy issues rise in prominence so will the odds of unpleasant disputes over trade and investment. There are dangers that if such disputes are allowed to fester – such as those unfolding between the US and China over solar panels and other innovations in renewable energy technology – that their side effects will undermine the many beneficial effects of globalization.

So far, policy-makers have not adequately confronted what is perhaps the most central challenge in globalization. When markets for energy technology and investment were mainly national then policy efforts to address public goods were also oriented around national goals. In energy, the most important public goods are those linked to innovation. The new ideas that come from successful invention and demonstration of new technologies are difficult for any one firm to appropriate. Rather, they are “public goods” that benefit (to different degrees) the whole society.

While there are many different views on when and how governments should intervene in markets, one of the central rationales for government intervention is to provide public goods. In the area of energy, those policy interventions have included support for basic research, other subsidies and publicly demonstration projects. Absent public policy, societies are prone to underinvest in these public goods. A growing number of studies suggest that nations, in fact, are already massively underinvesting in energy-related technologies. For example, Figure 4 shows the history of energy-related RD&D spending in the US – the country that accounts for most spending and output (patents) in energy innovation – along with proposals for the level of effort that would be required to address major energy challenges.

Figure 4. US federal energy RD&D spending (1980 to 2010), major proposals to 2025

RD&D Proposals: Climate Group (circles); Gates/Immelt (diamond); Obama 2010 budget vision (triangle); IEA (square)
Source: Electric Power Research Institute; IEA; BEA; DOE Budget (2009-2011 estimates); UC San Diego/ILAR analysis



The message from Figure 4 is that from the perspective of just one country there has been a perilous decline in federal support for energy RD&D from the peak around 1980 to today's level, which is about half. There was a brief peak linked to the economic stimulus programme that began in 2009, a programme that is now winding down. The actual spending on energy RD&D is reverting to historical patterns with a modest amount of growth. It is hard to avoid the conclusion that the US underspends for energy RD&D, not just in total dollars but also as a fraction of GDP. Almost all other countries reveal the same pattern.

Individually, countries need to do more to boost energy-related RD&D. But the really big news is that the "public goods" of energy innovation are global. If countries do not work together on this issue then the whole planet will underspend on energy RD&D. If countries are already massively underspending in this area, which is the message from figures such as the one presented here, then the news is even more dire.

Getting serious about global innovation requires rethinking the forums in which countries coordinate policy. One of the reasons that coordinated action on climate change has been so difficult is that the forums where that topic is discussed are huge – they engage literally hundreds of countries. A serious programme on innovation should be easier to organize because only a handful of countries dominate all innovative activity.

Looking across most energy-related patents for example, just six countries account for about 95% of all the patenting activity. Historically, that shortlist has been dominated by OECD countries, especially the US, Japan and members of the EU (notably Germany and the United Kingdom). But emerging economies are rapidly rising in importance – those include Brazil and India, but especially China.

Over the last 15 years, China has been transforming its national system of innovation, and that transformation is particularly evident in energy. Vertically integrated state-owned enterprises have spun off some of their RD&D labs into separate and more competitive enterprises. Funding for fundamental RD&D has risen sharply. Incentives to deploy novel technologies have grown, which is evident across the energy system from transmission lines to advanced coal-fired power plants to renewables. China is no longer solely an importer of intellectual property; today (and even more so in the near future) it is a producer and exporter. This transformation is good news for the world since competition in intellectual property can flourish, if allowed to, and lead to a much more innovative and effective energy system.

Getting serious about energy innovation requires getting these big innovators together. Not only joint commitments to increase spending on RD&D are needed, but also coordination on projects that individual nations cannot (or will not) undertake on their own such as large-scale demonstration projects. And countries must develop mechanisms to "peer review" each other.

What matters, in the end, is not simply the total level of spending, but also the effectiveness with which those funds are spent. While this topic might seem controversial, we note that "peer review" of this type is already widely done on trade policy (through the WTO) and could build on many related efforts, such as a programme at the International Energy Agency on advanced energy technology and bilateral diplomacy such as between the US and China.

Conclusion

In theory, efforts to connect the goals of energy security and climate change could lead to more progress on both fronts. In practice, relatively little has been achieved by linking these two goals because the efforts have been driven by political expedience rather than a practical vision of what is achievable. Policy-makers have been inclined to set goals that are not achievable in light of the generally slow pace at which energy systems change. The lack of credibility, in turn, has undermined incentives for industry to invest in new technologies that will be needed because they know that policy goals will not be met.

Fixing these problems requires efforts along three fronts. One is setting more realistic goals. A second is focusing on market mechanisms that can allow all energy technologies to compete on fair terms. A third is embracing the effects of globalization.

The rise of global markets for energy technologies and fuels is potentially great news in the struggle to assure energy security while decarbonizing the energy system. Global markets will expand the supply of ideas and diversify energy systems.

David G. Victor
Chairman, Global Agenda Council on Energy Security (2011-2012)

Appendix

Members of the Global Agenda Council on Energy Security

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Global Agenda Council on Energy Security
Record-high oil price volatility, changing energy demand, concerns over supply and other economic and geopolitical factors have made energy security a global issue of fundamental importance. Exploring and implementing long-term sustainable solutions in the complex field of energy security is vitally important to promoting peace and economic growth. The Global Agenda Council on Energy Security strives to explore in depth the most crucial current issues in its field. It aims to generate long-term, flexible solutions for energy security, focusing on the development of technology in particular.

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