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DISCUSSION NOTE 7

Improving the affordability of renewable energy

Moderator: Roger K Raufer, University of Pennsylvania
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1. The affordability of renewable energy

In recent years, there has been an increasing recognition that stabilizing greenhouse gas concentrations in the atmosphere is not simply a matter of constraining anthropogenic emissions — the focus of the Kyoto Protocol — but also requires a technological transformation of the world's energy infrastructure. The two factors principally associated with such a transformation — energy economics and technology — are closely interlinked. In fact, just such a technological transformation will be required in order to make stabilization economically feasible.

Perhaps the most popular evidence of such a view is Google's recent adoption of the slogan "RE<C," which suggests that it will be necessary to drive the cost of renewable energy below that of coal in order to accomplish environmental goals. Google has now invested over $700 million in clean energy technologies in an attempt to help make that happen.

Asia and the Pacific faces a future which is dominated by coal under business as usual scenarios. BP's 2010 Statistical Review of World Energy notes that the region already leads the world in terms of energy consumption with 38.1% of the world's total — but it is heavily affected by coal, using fully two thirds (67.1%) of that fuel's worldwide consumption. The US Department of Energy sees 95% of the world's increase in coal consumption through 2035 happening in non-OECD Asia. OECD demand for this fuel is likely to significantly decrease over that period according to the IEA projections, but China's new power generating capacity alone during that period will be greater than the combined US, EU and Japanese coal-fired capacity.

Further, developing Asia has more than half of the world's population without access to electricity. The almost 800 million Asians falling into this category represent a significant latent demand which governments across the region are striving to fulfill, to further economic and social development. Whether such energy access is ultimately provided through coal or renewable energy resources will obviously have a significant impact upon the region's local environment as well as the world's greenhouse gas concerns.

The BP report suggests that there is considerable work to be done. While Asia and the Pacific is reasonably well represented with hydroelectricity (31.8%), it does much less well with other renewables, consuming only 20.5% of the world's renewable energy, well below its overall proportional energy consumption figure of 38.1%. Projections suggest that while coal will increase, the contribution of renewables within the region will continue to be below that of other regions.

A question of considerable interest, then, is how Asia and the Pacific might make renewable energy more affordable.

2. Factors affecting renewable energy affordability

Any new technology faces a difficult transition period for acceptance and market penetration, even when it has favorable attributes. Fossil fuels represent an entrenched competitor with favorable energy density characteristics (as described in Discussion Note 1), and most renewable energy resources (other than biomass and large hydropower) suffer another significant disadvantage in one-on-one comparisons: they are intermittent in nature, and cannot be dispatched in power generation systems. Electricity storage systems are not sufficiently well developed to overcome this disadvantage.

Despite such problems, they represent a free and non-depletable source of energy, with extremely positive environmental attributes — and hence they have received considerable attention (and technological development) over recent decades.

There have been significant price drops, particularly in wind and solar, in recent years, due to a confluence of factors including the economic recession, overcapacity in production, technological improvements and fierce pricing competition within the industry. GE Energy Financial Services has estimated that wind power costs have dropped by approximately forty percent in just the past three years, citing bigger and better blades as a significant factor. Solar panel prices have also plummeted, after the first half of 2011 saw shipment declines after years of robust growth. Germany, Spain and Italy all reduced subsidies, and the corresponding drop in demand led to price declines, and some industry consolidation.

These are short-term industry changes, however, and the energy transition noted above will require a long term commitment to that transformation. Gregory Nemet in the Energy and Resource Group at the University of California at Berkeley studied the long term trend of photovoltaic technology over the period 1975-2001, and found four major factors leading to a 20-fold drop in prices over that period:

- *Economies of scale*. The size of manufacturing plants and similar factors associated with economies of scale were the most important factors, responsible for approximately 43% of the price reductions;
- *R&D breakthroughs*. Improved PV cell efficiency and new cell manufacturing processes were responsible for 32% of the price reductions;
- *Learning by doing effects*. Reduced silicon usage, higher yields, etc. contributed to a variety of factors responsible for about 10% of the price reductions;

- *Spill-over from other industries*. Technological advances pioneered in other industries (e.g. lower silicon supply costs due to advances spurred by the microchip industry) contributed to factors responsible for about 15% of the price reductions.

Countries around the world obviously want to replicate (and continue) such progress in the renewable energy area, and many do so in multiple ways. The most obvious approach towards encouraging the first factor (i.e., increasing economies of scale) is by developing and implementing support policies which increase the size of the renewable energy market. This has been done in many countries around the world, typically utilizing one of two types of support programs: (a) price-based feed-in tariffs (FiT) or (b) quantity-based markets in renewable energy certificates (RECs). By encouraging the development of large-scale renewable energy systems in the power sector, governments hope to increase the affordability of renewable technologies and small-scale applications as well. In the developed world, there has been a fundamental split, with Europe (and many other countries) favoring price-based approaches, while the US and a number of other countries (e.g., the UK) have favored quota-based approaches.

The former have a strong record of encouraging renewable energy development, as Germany, Denmark and Spain, three early and notable FiT adopters, have demonstrated. The approach has the advantage that it can be technology- and location-specific; can incorporate the third factor, learning by doing, in tariff degressions over time; and can be structured in different ways (e.g., fixed tariff, premium add-on, etc.). The disadvantage, of course, is that these policies tend to be very costly. The statement above about governments reducing subsidies reflect this fact, and Spain's recent solar FiT — which attracted renewable energy development far beyond the levels envisioned, leading the government to eventually renege on commitments, provides a cautionary tale about both advantages and disadvantages of such an approach. Other critics also point to the strong 'industrial policy' elements of FiT. It is perhaps not surprising that the European countries with the strongest FiT policies also had the most significant wind turbine vendors in the world. (Today, however, four of the top ten are Chinese.)

Quota-based systems have worked well in the US, with Texas being the prime example. That state surpassed California as being the state with the most wind power in 2006, and currently has more than three times as much (more than 9 GW). Twenty-nine states in the US now have Renewable Portfolio Standards (RPS) quotas, and most allow trading to meet that goal. While such an approach can be successful in providing support, the US approach has led to a 'balkanized' effort, with lots of small-scale RECs markets, with different goals, trading instruments, etc. Not all of these markets have proven successful. Efforts to develop a broader national — rather than state-by-state — RECs market have not been able to garner sufficient political support.

Countries in Asia have undertaken significant support programs as well, covering both a wide range of technologies and policy mechanisms. For example, India recognizes that the availability and intensity of solar energy within the tropical country represents a particularly appropriate renewable resource, and it has developed a National Solar Mission whose goal is to increase affordability through a rapid scale-up of capacity as well as encouraging technological innovation. It hopes to achieve grid parity by 2022, and parity with coal-thermal plants by 2030. Its new RECs program — developed in conjunction with its new energy efficiency (white certificate) market — is receiving

considerable attention worldwide. China, too, has used both regional FiTs for wind power development, after early experiments with wind resource concessions and tendering arrangements. It also explored the application of Mandatory Market Share (MMS) regulations, a quota-based system similar to an RPS. China already has almost 60% of the worldwide installed capacity of solar hot water systems, and it has deployed a range of support mechanism to encourage development of micro-hydro, biogas, and other renewable technologies as well. Other countries in the region have also developed a range of programs designed to increase overall capacity, often relying upon price supports, subsidies, tax credits, concessions, and other policy mechanisms. Most of these are targeted at that first (and primary) affordability factor, economies of scale.

A second major area of governmental support can come from R&D. Nemet has documented a broad-based decline in energy R&D in the US since the mid-1980s, and he notes that this has occurred across almost every energy technology category, in both the public and private sectors, and at multiple stages in the innovation process. A 2009 analysis found that Asian R&D in this area is faring considerably better: South Korea and Japan's energy R&D was at least twice as high (on a %of GDP basis) as that of the US, and combined clean energy investment in these countries and China over the 2009-2013 period was expected to be three times higher.

The third factor (learning by doing) will receive support from the same policies addressing the first (economies of scale), namely, through price or quantity market support; and the fourth factor (spillover from other industries) is similarly likely to be increased by additional R&D.

All of these factors together might also fall under the policy research area known as "induced technological change" (ITC). Many economists do not believe that carbon pricing or renewable price/quantity support mechanisms will be sufficient to tackle the climate change problem, and have begun to incorporate ITC components into their models in an attempt to see if it is possible to drive technological change through specific policy actions. These typically see the economy's stock of skills, experience, ideas and blueprints — what is sometimes collectively called "knowledge capital"— as being crucially important in accomplishing such goals. Obviously, such a premise has important implications for a developing region like Asia and the Pacific.

Asia-Pacific governments clearly believe that by increasing economies of scale, increasing learning-by-doing, and supporting R&D in both energy and related industries, they will be able to drive costs down, and make it more affordable for the poor. To the extent these policies are not sufficient, or take too long to accomplish such goals, it might also be necessary to examine additional policy mechanisms that focus on distributive effects, e.g., cross-subsidies for the poor, targeted concession programmes, etc.

3. Questions for participants

a) Should Asia-Pacific countries support price or quantity-based mechanisms to encourage renewable energy development within the region?

b) Given the importance of economies of scale in reducing renewable energy costs, is it appropriate that governments initially target large-scale centralized utility applications, or should they instead target smaller-scale consumer ones?

c) What is the likely role of "knowledge capital" in driving down renewable energy costs, and increasing its affordability?