PACIFIC ENERGY SUMMIT

2012 Summit Papers

Taking Renewable Energy to Scale in Asia

Letha Tawney

All 2012 Summit Papers are available for download from www.nbr.org.

LETHA TAWNEY is a Senior Associate at The World Resources Institute and works on innovation-led economic development in clean technologies. She can be reached at <letha.tawney@wri.org>.

EXECUTIVE SUMMARY

This paper argues that the renewable energy sector is significant and growing quickly, and that seizing the benefits and opportunities in this trend for economic development will require developing strategies that harness innovation to compete.

Main Argument

Electricity from renewable sources is becoming a mainstream option in the Asia-Pacific for many reasons, ranging from a tremendous growth in energy demand to concerns about energy security, improvements in renewable technologies, and efforts to limit pollution. Although this trend presents opportunities for economic growth, in this fast-moving sector developing and maintaining an internationally competitive domestic industry will require a strong capacity for innovation.

Policy Implications

- Successful innovations and market changes are converging in ways that both enhance the economic and environmental benefits of integrating renewables into the grid while lowering the costs of doing so. Moreover, it is now widely expected that solar photovoltaic projects and onshore wind projects will be competitive with fossil-fuel power around the globe by 2016, making the sector increasingly competitive with other traditional fuel sources.
- Efforts to seize the benefits of this growing sector can be assisted by building a market for renewables, which can be done through a mix of support for renewables demand, such as through mandates or feed-in-tariffs, and through promoting fossil-fuel subsidy reform or internalizing the cost of pollution damage in fossil-fuel prices.
- For those seeking to maximize potential gains from entering the renewables sector, even if a country can create a very large domestic market, international markets are still larger. Thus, building an internationally competitive sector is crucial to making the most of economic opportunities.
- Policymakers should focus on developing a renewables industry through building innovative capacity in the segments of the value chain they can compete for rather than through supporting local-content requirements and other infant industry protections. The latter risk creating a domestic sector that cannot compete for the international market and may keep domestic costs high. Building innovative capacity requires creating a healthy innovation system that improves the innovators’ chances of success. That system should do the following: create and share new knowledge, build competence, create collaborative networks, develop infrastructure, provide finance, establish governance and regulatory frameworks, and create markets.

Countries across the Asia-Pacific face unprecedented growth in demand for electricity and are looking to renewable power to help stabilize electricity prices, provide energy security, and reduce the impacts of power generation on public health and the environment. Additionally, as the sector grows, economic development opportunities are becoming readily apparent.

However, protecting and supporting a domestic industry can sometimes be at odds with providing abundant, low-cost clean energy, and both goals can strain public budgets or electricity consumers' wallets. The first deployment efforts for a new technology in a market can be more costly than incumbent technologies, and supporting a domestic industry can potentially keep those costs above the international average for some time. This paper suggests an approach to balancing potentially competing policy goals for power generation—domestic jobs and low-cost clean energy—while contributing to creating a growing, vibrant, low-carbon power sector globally.

The first section explores how renewable power has evolved from an expensive solution to electricity demand for a niche market into a mainstream and growing contributor to countries' energy mix. The implications of these trends suggest a tremendous opportunity for those countries that have products or services to sell in the sector. The second section examines how countries can realize these opportunities and discusses the weaknesses of an informal formula for building domestic industry that emphasizes requiring large swaths of the supply chain to be domestic. It then proposes an innovation-based strategy, designed to continue the current price declines in renewable power while building a country's long-lasting competitive advantage in portions of the global sector.

Renewable Energy Is a Rapidly Growing Sector

Globally, the renewable energy sector has been growing dramatically. In 2010, the sector reached $211 billion in investment and resumed the double-digit growth in investment that had slowed during the recession.[1] The Asia-Pacific, including Australia,

[1] United Nations Environment Programme and Bloomberg New Energy Finance, *Global Trends in Renewable Energy Investment 2011* (Frankfurt: UNEP and Bloomberg New Energy Finance, 2011), 12.

saw $59.2 billion of this new investment.[2] Globally, new renewable-electricity capacity outstripped new fossil-fuel capacity in 2010, and growth in Asia has been critical to this shift, with both China and India among the top five countries globally for total renewable power capacity.[3]

Looking forward, the International Energy Agency (IEA) projects that renewable energy electricity production will nearly triple and will attract $5.9 trillion in investment between 2011 and 2035.[4] Growth in Asia will account for 44% of the increase in global renewable-energy capacity.[5]

The sector is drawing increasing levels of new investment for several reasons. The tremendous growth in energy demand in developing economies, the increased instability of fossil-fuel prices and concerns about energy security, the growing body of evidence that integrating variable resources like wind power is technically feasible, and the rapidly falling cost of renewable power technologies all contribute to growing the sector. Commitments to slow the growth of carbon dioxide and other fossil-fuel pollutants have also played a role in expanding the sector.

Rapid Demand Growth

Electricity demand growth in Asia has been voracious and is expected to continue.[6] China has led with an average growth in electricity generation of 11.6% per year between 2000 and 2009, accounting for 51% of the global increase in electricity demand.[7] But China was by no means alone. Vietnam's total generation capacity grew at an average of

[2] This figure excludes small-scale projects, which are very difficult to track. *Global Trends in Renewable Energy Investment 2011*, Figure 13.

[3] Renewable Energy Policy Network for the 21st Century (REN21), *Renewables 2010 Global Status Report* (Paris: REN21 Secretariat, 2010), 18.

[4] International Energy Agency (IEA), *World Energy Outlook 2011* (Paris: IEA, 2011), 176, 193.

[5] Ibid., 189.

[6] Ibid., 81.

[7] Simon Müller, Ada Marmion, and Milou Beerepoot, "Renewable Energy: Markets and Prospects by Region," IEA, Information Paper, November 2011, 48.

13.5% per year over the same time frame.[8] With relatively slow growth for the region, even the Philippines added generation at an average of 3.5% per year.[9] This dramatic growth compares to essentially flat growth in generation across the 30 members of the Organisation for Economic Co-operation and Development (OECD), including Japan and South Korea. In 2009, OECD countries fell back to 2005 levels of generation as the global downturn bit into electricity demand.[10] While OECD countries may replace fossil-fuel generation with renewables in coming years, as has been the case for Germany in recent years, the Asian market for generation equipment of all sorts, including renewables, will be significant.

In the face of this enormous growth, countries are pursuing many generation technologies, racing to meet their electricity capacity shortfalls. Beyond wind and solar, countries are turning to domestic gas, hydro, and geothermal resources as well as imported coal, gas, and oil to meet the demand.[11] For example, China (wind), Thailand (biomass), and Indonesia (geothermal) all made major investments to add renewable capacity between 2000 and 2009. China, India, and Thailand were able to increase the proportion of renewables in their overall mix slightly, but in most other developing Asian countries, the growth of renewables did not keep pace with overall growth in power-generation capacity, and the proportion of renewables in total kilowatt-hours generated dropped between 2000 and 2009. Moreover, despite rapid increases in both capacity and generation of all sorts, many countries still face significant demand shortfalls. For example, despite annually adding capacity at an average rate of 5.2% between 1997 and 2010,[12] India faces a projected 8.5% average shortfall between demand and generation capacity in 2012.[13]

---

[8] Müller et al., "Renewable Energy," 81.

[9] Ibid.

[10] Ibid., 21.

[11] Ibid.

[12] D.S. Arora et al., "Indian Renewable Energy Status Report," National Renewable Energy Laboratory (NREL), October 2010, 13. Calculations are the authors' own.

[13] Central Electricity Authority of India, *Load Generation Balance Report 2011–12* (New Delhi, May 2011), 1.

Fossil-Fuel Volatility

Fossil-fuel prices have faced unprecedented volatility in the last decade. A rapid increase in oil prices in 2007 and 2008 was followed by an even faster collapse in 2009 that brought prices back to mid-2004 levels.[14] This volatility has contributed to pushing oil out of the power-generation sector globally, though some fast-growing Asian countries such as Indonesia still use oil in power generation.[15] Coal and natural gas, while still not traded as widely as oil, have also seen an increase in international trade and price volatility. Asia in particular is home to several coal-importing nations, including Japan, India, and China. China alone is such a large coal market that any domestic imbalance has the potential to destabilize the international coal trade.[16]

Import dependency exposes an economy to several risks, including balance of payments risk, amplified economic impacts when prices rise, tremendous pressure on public budgets to blunt the impact of price increases on consumers, and the potential to lose access to fuel altogether—either by being priced out of the market by other bidders or by supply lines being physically cut.[17] Diversification of sources is one strategy to manage this risk, and countries are looking to both fossil and renewable domestic sources. India, for example, is embracing solar energy as an imperative to protect itself from higher dependency on imported coal and the related cost of developing import infrastructure.[18] As the price of coal has risen in India, wind energy has also become an attractive option and has now reached grid parity with new thermal coal power in some cases.[19] The Philippines is similarly using renewable-energy investments to hedge against

[14] Masami Kojima, "Government Response to Oil Price Volatility: Experience of 49 Developing Countries," World Bank, Extractive Industries for Development Series, no. 10, July 2009, 49.

[15] IEA et al., "Extending the G20 Work on Oil Price Volatility to Coal and Gas," October 2011; and Müller et al., "Renewable Energy."

[16] IEA et al., "Extending the G20 Work," 25.

[17] Ibid.; and Kojima, "Government Response to Oil Price Volatility."

[18] "Jawaharlal Nehru National Solar Mission: Towards Building SOLAR INDIA," Government of India, 2.

[19] Sally Bakewell, "BlackRock's Mytrah Says Able to Produce Wind Power Cheap as Coal," Bloomberg, January 15, 2012.

rising fossil-fuel prices.[20] As an importer, they project that the price of coal will steadily rise, so the value of a renewable-energy solution is in part the way it protects against that rise.

Improved Integration of Variable Renewable Power

There have been concerns about how much variable renewable-energy sources like solar photovoltaics and wind can be safely integrated into the grid. These sources only generate power when the wind is blowing or the sun is shining. Grid operators are accustomed to power generation that runs when they require it to and that they can "dispatch" or use to meet the constantly fluctuating demand. In Europe, the United States, and China, grid operators have had opportunities to learn on the job as the proportion of variable renewables has increased substantially. There have been days in Denmark and the northwest United States where wind alone provides 100% of the power needed.[21] Characteristics of the grid, such as how well it is integrated over a wide area and which other electricity fuels also play major roles in the mix, determine the specific level of variable renewable-power penetration that is feasible.[22] However, several studies, including an evaluation of the large population centers in the United States by the National Renewable Energy Laboratory (NREL), show a 20% capacity penetration is manageable without significant storage or new backup generation.[23] This is well below

[20] Pedro H. Maniego, Jr., "Best Practices in FIT Design: Technology, Cost and Consumer Impact," (presentation at Asia Clean Energy Forum 2011, Manila, June 20–24, 2011).

[21] "Large Scale Integration of Wind Energy into Electricity Grids," Global Wind Energy Council (GWEC) website; and Matthew Wald, "As Wind Energy Use Grows, Utilities Seek to Stabilize Power Grid," *New York Times*, November 4, 2011.

[22] If the grid integrates a wide geographic area, it can balance areas of oversupply with areas of low demand. If the wind is not blowing in the north of Spain, it may still be blowing in the south of Spain, and an integrated grid allows the two areas to support each other. The fuel mix impacts how easily the grid operator can balance supply as renewables vary. Hydropower is easy to ramp up quickly so it can easily back up variable renewable power; nuclear and coal-fired power take days to come up to temperature and cannot easily step in to compensate for hour-by-hour changes in renewable electricity production.

[23] "Large scale integration of wind energy," GWEC website; and M. Milligan et al., "Large-Scale Wind Integration Studies in the United States: Preliminary Results" (paper presented at 8th International Workshop on Large Scale Integration of Wind Power and on Transmission Networks for Offshore Wind Farms, Bremen, Germany, October 14–15, 2009).

the current levels of penetration throughout Asia, though equipping the grid and grid operators is an important step in absorbing variable renewables, even in small quantities. In 2010, India made progress in this regard by adopting the Indian Electricity Grid Code (IEGC). The code provides detailed guidelines on the role of grid operators and mandates forecasting and scheduling of wind and solar power.[24]

Falling Technology Costs

The cost of renewable electricity technology has been falling dramatically, particularly since 2008. Policymakers and academics have both assumed that the less-mature renewable-power technologies, such as solar photovoltaic (PV), will continue a steady price decline as deployment provides opportunities to learn and find economies of scale. For example, one of the explicit goals of the Indian solar mission is to drive down solar-power prices so they reach parity with fossil-fuel power by 2030.[25] However, the actual decline in prices is a much less steady process. Sometimes supply constraints, rising commodity prices, or the cost of capital drive project costs up; other times, oversupply or innovation push costs down.[26]

Successful innovations and market changes are converging, and it is now widely expected that solar PV projects and onshore wind projects will be competitive with fossil-fuel power in several regions by the end of 2012 and around the globe by 2016.[27] A leading Chinese government think tank predicts solar PV will be competitive with coal power in China by 2015.[28] Prices for solar panels have fallen dramatically, driven in part by China’s expanding manufacturing sector. For example, cell prices dropped 59% in just

---

[24] GWEC et al., “Indian Wind Energy Outlook 2011,” April 2011.

[25] “Government Announces Jawaharlal Nehru National Solar Mission,” Ministry of New and Renewable Energy (India), November 23, 2009.

[26] Mark Bolinger and Ryan Wiser, “Understanding Trends in Wind Turbine Prices Over the Past Decade,” Lawrence Berkeley National Laboratory, October 2011.

[27] “Onshore wind energy to reach parity with fossil-fuel electricity by 2016” Bloomberg New Energy Finance, Press Release, November 10, 2011; and Henning Gloystein, “Renewable energy becoming cost competitive, IEA says,” Reuters, November 23, 2011.

[28] Fayen Wong and Ruby Lian, “China to double solar capacity by year end: report,” Reuters, August 12, 2011.

2011.[29] However, years of innovation in financing models, installation techniques, and manufacturing processes are also contributing to the very strong price declines seen in the United States and Europe. While the first installations in a market always involve learning and thus can be more expensive, several renewable power technologies will likely be competitive with coal and natural gas within the next five years, dramatically changing the options energy regulators can consider while affordably meeting energy demand.[30]

Climate Mitigation Pledges

The environmental impacts of other electricity sources also make renewable energy attractive. Whether due to the chill on nuclear power that the Fukushima disaster has created or local concerns about the health impacts of air pollution from coal burning, renewable energy has moved up in the agenda of many countries. However, international discussions on climate change mitigation, both within the United Nations Framework Convention on Climate Change (UNFCCC) and outside it in forums such as the group of twenty (G-20) and the Major Economies Forum on Energy and Climate, have also produced significant pledges from countries to slow the growth of their carbon emissions. Under the Cancun Agreements reached under the UNFCCC, China and India have pledged to reduce their carbon intensity (emissions per unit of GDP) and Indonesia, Singapore, and South Korea have pledged cuts in emissions from "business as usual."[31] In part to meet these goals, China is experimenting with carbon markets under the 12th

[29] Christopher Martin and Zachary Tracer, "China Solar Makers Face 'Suicidal' Prices on Excess Output," Bloomberg, November 25, 2011.

[30] Project costs do not currently include the cost to the larger system of absorbing variable renewable energy sources, the "system costs." Investments in increased transmission or interconnections between regions, dispatchable backup generation, and energy storage are not typically paid by the individual solar or wind project that is selling power to the grid. As discussed above, each grid will have its own strengths and weaknesses in absorbing these resources and so system costs will differ. However, as the proportion of variable resources increases, the issue of who pays system costs—and what constitutes reasonable system costs—will become more pressing.

[31] Ad Hoc Working Group on Long-Term Cooperative Action under the Convention, "Compilation of Information on Nationally Appropriate Mitigation Actions to be Implemented by Parties not Included in Annex I to the Convention," UN Framework Convention on Climate Change (UNFCCC), March 18, 2011.

five-year plan and India has implemented a tax on coal.[32] Australia recently adopted a carbon tax in an effort to meet their commitments under the Kyoto Protocol.[33] These pledges, which are a blend of voluntary efforts under the convention and reduction commitments under the Kyoto Protocol, create a significant market for low-carbon power options. While they may fall short of the action needed to meet the goal of limiting warming to less than two degrees Celsius above pre-industrial levels, they help shape energy policymaking in favor of low-carbon options, where the energy security pressures may give preference to domestic sources, regardless of the pollution profile.

Seizing the Development Opportunity

The trends described above are converging to support the IEA's projected growth in demand for renewable power globally. While policymakers grappling with growing energy demand and energy security have been engaged in how the renewable-energy sector is growing, it is now beginning to also capture the attention of economic development practitioners. The "green economy" argument is compelling. A November 2011 report by a Chinese government advisory agency estimated that China could net 9.5 million jobs in the next five years by transitioning from polluting industries to "green" businesses, including the renewable-energy sector.[34] A recent report by the Brookings Institution found that the United States already had 2.7 million green jobs as of mid-2011, more than the number of jobs in the fossil-fuel industry or biosciences.[35] While these jobs span several sectors from energy-efficient construction to waste management, the report also found that clean technology in particular included high-value jobs that were manufacturing-based and export-intensive. Germany's trade and investment agency also

[32] Wei Tian, "Chinese Carbon Market has 'Potential,'" *China Daily*, November 17, 2011; and Natalie Obiko Pearson, "India Lagging on Channeling Coal Tax for Clean Energy, Solar Lobby Says," Bloomberg, March 3, 2011.

[33] James Grubel, "Australia Passes Landmark Carbon Price Laws," Reuters, November 8, 2011.

[34] Jonathan Watts, "China's Green Growth Potential 'Could Create 9.5m New Jobs,'" *Guardian*, November 18, 2011.

[35] Mark Muro et al., "Sizing the Clean Economy: A Green Jobs Assessment," Brookings Institution, 2011.

recently boasted of 100,000 jobs in its well-established solar PV industry alone.[36] An assessment of independent reports and studies on trends in the clean-energy industry has found that the renewable energy sector also generates more jobs per unit of energy delivered than the fossil fuel–based energy sector.[37] These success stories are powerful to any policymaker trying to generate jobs and economic growth in the midst of globally slow growth, regardless of whether they are particularly concerned with pursuing environmental or energy goals.

Asia has been an epicenter of experiments with the green economy. South Korea has been a global leader, allocating 80% of its economic stimulus package for "green growth" and launching the Global Green Growth Institute, an international collaboration created to pioneer and diffuse green growth models.[38] China has embedded green growth concepts into its 12th five-year plan, building a range of experiments in urban development, innovation clusters like the Baoding Development Zone, and carbon markets.[39]

However, it is China's explosion into the wind-power sector that gets the most notice by both potential emulators and competitors. The perceived story of China's advance in this sector has led to an informal and often problematic formula for building a domestic industry in the low-carbon power sector that emphasizes promoting domestic jobs at the potential expense of the lowest costs or the best performing technology. This roughly dictates that policymakers should:

- Create domestic demand for renewable power, using a policy tool like mandates, targets, or feed-in-tariffs

[36] "Record-Breaking German Solar Demand Fuels Green Job Growth" Germany Trade and Invest, Press Release, June 7, 2011.

[37] M. Wei et al., "Putting Renewables and Energy Efficiency to Work: How Many Jobs Can The Clean Energy Industry Generate in the US?" *Energy Policy* 38 (2010): 919–31.

[38] Stacy Feldman, "Green Growth, South Korea's National Policy, Gaining Global Attention," Reuters, January 26, 2011.

[39] Deborah Seligsohn and Angel Hsu, "Looking to Durban: China's Climate Change Policy Progress Since Cancun" ChinaFAQs web log, November 23, 2011; and Ambuj Sagar et al., "Climate Innovation Centres: A Partnership Approach to Meeting Energy and Climate Challenges," *Natural Resources Forum* 33 (2009): 274–84.

- Add a local-content requirement or some similar regulation to the requirements for project developers
- Provide the domestic industry with a protective tariff regime or another form of infant industry protection

This formula has some roots in fact. Globally, large and reasonably stable wind markets have drawn parts of the value chains to domestic shores.[40] When the market seems too unstable or small, efforts to develop the wind-power sector can be slowed or even halted. In the early 2000s, uncertain and stop-start policy drove markets in both the United States and India to below 200 megawatts (MW) of wind capacity a year or fewer than 150 individual turbines—which in turn complicated investment in manufacturing.[41] Alternatively, China has seen an explosion in wind companies, and a rapid appearance among the global top ten companies, growth that is often attributed both the large domestic market and the local-content requirement that was in place until 2009. Whether it was the local content requirement or the large and stable market that created a domestic manufacturing sector is unclear. Since U.S. federal policy on wind power stabilized, domestic content grew from 25% in 2006 to over 60% in 2011, without a local-content requirement.[42] Despite this uncertainty about effectiveness, and the fact that local-content requirements that deter imports are counter to World Trade Organization rules, these requirements are still relatively common.[43] Regions as diverse as the Canadian province of Ontario, Italy, and India have used local-content requirements for wind, with varied success.

While this formula—create a large market, put in a local-content requirement, and protect the domestic industry—is a gross oversimplification of the varied approaches

[40] Jacob Kirkegaard et al., “It Should Be a Breeze: Harnessing the Potential of Open Trade and Investment Flows in the Wind Energy Industry, “ World Resources Institute, Working Paper, December 2009.

[41] Joanna Lewis and Ryan Wiser, “Fostering a Renewable Energy Technology Industry: An International Comparison of Wind Industry Policy Support Mechanisms,” Lawrence Berkeley National Laboratory, November 2005, 10.

[42] “Governor, Interior Secretary Show Commitment to Offshore Wind Power Movement,” American Wind Energy Association, Press Release, October 12, 2011.

[43] May Hao et al., “Local Content Requirements in British Columbia’s Wind Power Industry,” Pacific Institute for Climate Solutions, 2010.

countries have taken to reaping the benefits of the growing wind-power sector, variants of it are often repeated in the press, in political circles, and among policymakers. The formula, however, has several potential pitfalls:

1. The formula calls for countries to create significant domestic demand, but it can be difficult for a country or subnational region to muster a large and stable enough market to support a domestic manufacturing industry (at a minimum, a market of between 200 to 300 MW annually for at least three years).[44] As a result, many countries will have to consider participating in regional or international markets if they want to pursue manufacturing portions of the value chain. Infant industry protection can undermine this effort by creating industries that struggle to compete on cost or quality in the international market.
2. Regardless of whether a country can create a large domestic market, the international markets are expected to accumulate $2.1 trillion in investment between 2011 and 2020.[45] For example, while Canada can support a large wind market on its own, its market is only 25% of the size of the U.S. market, and thus policymakers have noted the potential for significant gains from promoting international competitiveness with U.S. suppliers rather than focusing solely on domestic growth.[46] Competing effectively in international markets is crucial to achieving the full economic development promise of "green growth."
3. The local content–requirement approach overemphasizes the manufacturing portions of the value chain. In 2010, over 50% of the solar PV value chain for installations in the United States was made up of non-tangible and services costs such as engineering, logistics, labor, and overhead.[47] Creating even a small but stable market creates opportunities for this part of the domestic industry to

[44] Lewis and Wiser, "Fostering a Renewable Energy Technology Industry"; and Industry Canada, Government of Canada, *Opportunities for Canadian Stakeholders in the North American Large Wind Turbine Supply Chain* (Ottawa, October 2011).

[45] IEA, *World Energy Outlook 2011*, 193.

[46] Industry Canada, *Opportunities for Canadian Stakeholders*.

[47] Greentech Media (GTM) Research, "U.S. Solar Energy Trade Assessment 2010: Trade Flows and Domestic Content for Solar Energy-Related Goods and Services in the United States," November 2010, 42.

develop, which may be missed altogether in an approach that enacts a manufacturing-focused local-content requirement.

4. Trying to force a large proportion of the value chain into a country risks losing access to both the technical and economic benefits of being connected to the global sector. It can result in expensive, lower-quality low-carbon power, which will do little to meet policy goals such as energy security or climate change mitigation, or a financially sustainable power industry.[48] For example, in Brazil, local-content requirements by weight are a prerequisite for access to subsidized loans for project developers. This means in practice that the steel towers are locally produced. However, because of local supply-chain constraints, domestic steel is nearly 70% more expensive than imported steel. Thus domestic turbine towers are more expensive than imported towers—a cost financed by the subsidized loans and delivered to the Brazilian steel industry.[49] While wind power has recently been very competitive in electricity auctions in Brazil, would imported towers reduce wind costs even further? A local-content requirement is an industrial policy, not a policy for low-cost power.

A more sustainable approach, in terms of public budgets, and an approach more likely to produce low-cost, high-performance, low-carbon power is one that engages fully with the global sector and competes based on existing strengths and innovation. This approach involves:

- Building a domestic (or regional, if possible) market that supports new technology, but maintains pressure on companies to reduce prices over time and build a competitive sector
- Investing in innovative capacity in the segments of the value chain in which the country may be competitive, globally or regionally

[48] Hao et al., "Local Content Requirements in British Columbia."

[49] Bruce Douglas and Sarah Azau, "Brazil: Taking the Bull by the Horns," *Wind Directions* 30, no. 1 (2011): 30–35.

Building a Domestic Market

The formula described above begins on the right foot—creating a domestic market. Stability is likely more important than overall size because each technology will have its own value-chain dynamics. While a sizable and stable domestic market has historically been important for the development of a domestic wind industry,[50] the link between a large domestic solar-PV market and a domestic manufacturing sector is less clear. By 2010, China had built over 17 gigawatts (GW) of solar-PV panel manufacturing capacity and only 900 MW of total domestic installed capacity.[51] Since nearly 50% of the solar-PV value chain is outside the physical components, a regional market could hold opportunities for countries to export services and expertise—rather than parts—to neighbors.[52] Countries could develop maintenance expertise and stage spare parts like inverters for a regional market. Alternatively, they could develop engineering expertise for solar installations in their region and provide services to more than one national market. Other, less mature renewable-energy technologies, such as offshore wind and ocean energy will have their own value-chain dynamics, but a domestic industry that can provide a learning laboratory and a buffer from international fluctuations in demand could be important to young technology companies.

The cost of energy is a very difficult political topic in most countries. There are often concerns that high power costs will hurt international competitiveness and constrain economic growth. High energy prices can also impact poor households and efforts to extend energy access. Policymakers can keep the consumer costs of renewable-energy subsidies to a minimum by encouraging renewable technologies to be more cost-competitive with fossil-fuel options, much as India aims to do in its solar mission, and by reforming subsidies for fossil-fuel options. Finally, if it is politically possible, it is economically most efficient to incorporate the environmental impacts of fossil-fuel power

---

[50] Kirkegaard et al., "It Should Be a Breeze"; and Lewis and Wiser, "Fostering a Renewable Energy Technology Industry."

[51] Leslie Hook, "China Reflects on Solar Panel Growth" *Financial Times*, May 5, 2011; and Wong and Lian, "China to Double Solar Capacity."

[52] GTM Research, "U.S. Solar Energy Trade Assessment 2011."

generation into the cost of that power. This can be accomplished through a carbon market or through a carbon or fuel tax, as Australia, India, and China are all pursuing.

While renewable-energy technologies still require price support in many markets, it is important to avoid creating an investment bubble and speculation through overly generous subsidies. The steady emergence of a domestic market is more effective for developing a supply chain and avoiding bottlenecks, quality issues, unplanned public costs through unexpectedly large subsidy commitments, and popular backlash. The emerging best practice is implementing steadily and predictably declining production-based subsidies that allow for sharper or slower declines in response to evolving economics, to avoid creating investment bubbles and artificial supply-chain constraints; this should be done via methodical and transparent public processes.[53] It is critical to encourage renewable-power technologies to continue to mature, reduce their costs, and improve their performance, both for the sake of domestic energy costs and for success in the international competitive landscape. This is an area where the principles of good governance, including transparency and allowing space for regulators to operate independently of politicians, are particularly powerful tools to prevent incumbents from capturing subsidies or inflating them at the expense of the consumer.

India has used some of these ideas in their solar mission, which aims to make solar power competitive with fossil fuel–generated power by 2020.[54] The mission calls for slowly increasing the mandated solar-power purchase by utilities in order to build the market steadily. In order to cap the cost to public budgets, India has developed a unique blend of feed-in tariffs (FIT), tradable renewable-energy certificates, and competitive bidding—but all are production-based. Once the solar FIT reaches a generation-capacity cap, procurement is shifted to competitive bidding. The national grid has recently

[53] There are a number of "best practice" guides for developing renewable-energy policy that draw on research over the last decade, particularly from the World Bank's Energy Sector Management Assistance Program (ESMAP), the International Energy Agency, the Renewable Energy Policy Network for the 21st Century (REN21), and research institutions such as the U.S. National Renewable Energy Laboratory. Lutz Weischer et al., "Grounding Green Power: Bottom-Up Perspectives in Smart Renewable Energy Policies in Developing Countries," World Resources Institute, Working Paper, May 2011.

[54] Government of India, "Towards Building SOLAR INDIA."

completed its second auction to buy solar power for the grid, and prices have declined 27% since the first auction a year ago.[55]

At the same time, raising the cost of electricity generated from fossil fuel through reformed subsidies or putting a price on carbon emissions can be perceived as hurting poor consumers or economic competitiveness. However, exposure to the price volatility and supply constraints that importing fossil fuels brings also can have dramatic impacts on an economy.[56] Similarly, the public health impacts of fossil-fuel burning can seriously and negatively impact a country's GDP. For example, in 2007, the World Bank estimated that air pollution cost China 3.8% of its GDP.[57] These costs may warrant higher electricity rates or lower subsidies for fossil-fuel power in order to limit the damage created by it. China, for example, will experiment with carbon-trading schemes under its 12th five-year plan.[58]

Fossil-fuel subsidy reform does not have to hurt poor consumers. It is a rare case today where subsidies even reach the poorest consumer, with only 2% of the subsidy reaching low-income consumers in some countries.[59] One option is targeting subsidies more efficiently, rather than removing them altogether. In addition to encouraging an efficient use of power—and thus slowing the growth of demand and taking pressure off public budgets—removing or more carefully targeting subsidies for fossil fuels means renewable-power technologies require a lower level of subsidy to compete with the existing technologies. As an example of this, Thailand subsidizes electricity for the very poorest households as opposed to all consumers, limiting the total subsidy needed substantially and encouraging efficiency among higher-income consumers.[60] Since it is a consumer-focused subsidy rather than, for instance, a subsidy on the cost of coal for

---

[55] Vikas Bajaj, "A Sunny Land's Ambitious Push for Solar Power; Indian Government Uses Subsidies to Cut Coal Use and Bolster Electrical Grid," *International Herald Tribune,* December 29, 2011.

[56] IEA et al., "Extending the G20 Work."

[57] "WB: Air Pollution Costs 3.8% of China's GDP," Xinhua, November 19, 2007.

[58] Seligsohn and Hsu, "Looking to Durban."

[59] IEA, *World Energy Outlook 2011*, 519.

[60] Association of Southeast Asian Nations (ASEAN), *Country Report of the ASEAN Assessment on the Social Impact of the Global Financial Crisis: Thailand*, 10.

electricity generators, it does not make cost-competitiveness harder for renewable energy to reach.

When implementing any of these strategies, the electricity sector should also follow the principles of good governance. This includes promoting transparency and access to information, encouraging accountability, and adopting procedures for redress, the effective participation of stakeholders, and the capacity for regulators to make decisions independent of political bias.[61] Subsidies—in terms of both who receives them and who pays for them—innately carry the risks of corruption, bias toward one party or another, and regulatory capture. Good governance can help ensure that the support package for the domestic industry is fiscally sound, meets a broad range of social goals like energy access for the poor, and is accountable to those paying for the subsidy (often the household rate-payers).

Investing in Innovative Capacity

As discussed above, many domestic markets cannot be large enough to support a cost-effective domestic industry alone, and export opportunities are a key reason to pursue this sector regardless. This need to look to global markets to maximize opportunities requires building a domestic industry that can compete effectively.

In order to develop a competitive domestic industry, it is important to consider which segments of which value chain it might be possible to compete for. There may be a range of barriers to entry in each technology that make competition particularly difficult—for example, the economies of scale that established silicon PV-module manufacturers have already achieved. However, there may also be existing domestic industries that provide a foundation for new entrants to expand into clean energy. A country with a strong logistics infrastructure could act as a spare-parts hub for regional renewable-energy installations. A domestic financial sector could service projects regionally. Capabilities in power electronics could be parlayed into components manufacturing. South Korea's shipping industry has provided an opportunity to enter the offshore wind market. South Korean companies such as Hyundai Heavy Industries

[61] Weischer et al., "Grounding Green Power," 12.

believe they have a competitive advantage in offshore wind power because of their extensive experience in shipbuilding and marine engineering.[62] Hyundai focuses on the construction and installation of turbines and outsources the making of electronic components to the American Superconductor Corporation (AMSC), a global power technologies company.[63] In another example, an analysis by the Canadian government found seventeen different gaps in the supply chain of large wind turbines that Canadian companies could compete for, as well as thirteen areas of technical innovation.[64] This sort of value chain–based analysis is potentially effective for generating local jobs without the economic inefficiencies and costs of a local-content requirement.

Yet, competing internationally in such a fast-moving sector relies on more than encouraging existing strengths in related industries. Innovative capacity—the ability to successfully introduce market-destabilizing improvements in cost or performance—is a key, long-lasting competitive advantage. Other countries with low-cost labor can undercut a domestic pool of low-cost labor. Advantages based on government subsidies such as low-cost loans, tax abatements, and inexpensive land have an impact on public budgets and may be difficult to maintain over time. Only innovative capacity is sustainable and will continuously adapt to the evolving competitive landscape

Investing in innovative capacity involves building an innovation system that supports local entrepreneurs, increasing their chances of success when they experiment with new technologies, processes, and business models. This is the enabling environment that makes it possible for innovators to be successful. This environment is also highly attractive to private sector capital because many of the risks inherent in new technologies and industries have been reduced. When an innovator or entrepreneur tries to do something new, they face a range of risks and uncertainties. Will the idea work at all? How will they solve the technical problems that come up? If the innovation system is weak, they also face questions such as, is there a market, are there regulations in place

---

[62] "AMSC and Hyundai Expand Wind Power Strategic Alliance," American Superconductor Corporation, Press Release, June 9, 2010.

[63] Kyunghee Park and Natalie Obiko Pearson, "Korean Wind Farm Helps Shipyards Challenge Siemens," Bloomberg, September 28, 2011.

[64] Industry Canada, *Opportunities for Canadian Stakeholders*.

that allow the innovation, and will they be able to connect to the grid or use the existing road infrastructure? A healthy innovation system means that many of these questions are already answered affirmatively and helps shift a risk analysis to the technical details of an innovation. Private sector capital weighs risk carefully. If many of the potential uncertainties are already settled by the innovation system—the enabling environment is healthy and does not block the innovator—then the innovation faces reduced risk and is more attractive to financiers.

Developing a strong innovative capacity means creating an innovation system that does seven things well, which are outlined in **Table 1**. This includes well-known activities such as research and development and training a high-caliber workforce, but for the energy sector in particular this also includes building necessary infrastructure (such as the grid) and setting up a regulatory environment to support innovation. See Table 1 for a detailed list. Each of these functions can be accomplished through a range of policy tools, from creating incentives for education to protecting intellectual property rights to promoting public-private partnerships.[65] The public sector does not have to deliver all of these services, but policymakers supporting domestic industry will want to consider how to encourage all of the functions.

Table 1: Innovation system functions in the low-carbon power sector

Function	Definition	Tools
Creating and sharing new knowledge	Some of the innovations in the renewables sector are based on scientific discovery, but many find their source of inspiration in other areas. As a result, this function is broadly defined as bringing new knowledge to the sector from all sources. Ensuring that knowledge spreads effectively through the sector is also critical.	Subsidies and incentives for new research, contests and prizes, intellectual-property protection and enforcement measures

[65] Letha Tawney et al., "Two Degrees of Innovation—How to Seize the Opportunities in Low-Carbon Power," World Resources Institute, Working Paper, September 2011.

Table 1 (continued)

Function	**Definition**	**Tools**
Building competence	A basic education is critical yet insufficient by itself. Skills in this sector are not easily learned from books and academic articles, but they are critical to the innovation process. As a result, competence-building—the provisioning of skilled human resources—is fundamental to successful innovation processes.	Subsidies and incentives for education and training, fellowships, scholarships, visas for advanced-degree candidates
Creating collaborative networks	Networks are a fundamental tool for knowledge dissemination and creating the contacts that innovators need to be successful. Networks can be market-based, such as with suppliers, but innovators also find mentors and other non-market network support crucial. Networks may be local, regional, national, or international in nature.	Joining or initiating international cooperation, supporting industry associations, intellectual-property protection and enforcement measures that promote network participants' confidence
Developing infrastructure	Innovation in this sector requires significant public infrastructure. Because individual technologies are part of a larger electricity system and often large pieces of infrastructure themselves, successful innovation activities rely on a significant physical infrastructure such as transmission.	Public-private partnerships, incentivizing private development, planning for public development, investment in public infrastructure
Providing finance	Innovators often need access to capital in order to realize their solutions, whether they are a new manufacturing process or a different wind-farm configuration. A range of financial actors—public or private, domestic or international—with differing appetites for risk must participate in order to serve different needs throughout the innovation process.	Loan guarantees, "green" banks, public venture capital–style funds
Establishing governance and the regulatory environment	An innovation process is more likely to succeed when the rules of the game are clear and consistent. These rules tell the innovator the bounds within which he must work and the characteristics his solution must include. Unclear standards add to the uncertainty that already complicates any innovation process.	Establishing environmental standards for new technologies, setting a stable trade regime, setting land-use rules, establishing redress procedures, updating grid codes for variable resources

Table 1 (continued)

Function	Definition	Tools
Creating markets	Policymakers have a strong hand in creating the power market and have a wide range of tools, from public awareness to mandates to government procurement, which can help ensure the ecosystem is creating a market that enables adoption of innovations. Creating supranational markets through international agreements is also a possibility.	Price, performance, or capacity targets; feed-in tariffs; renewable portfolio standards; government/public procurement; media campaigns; government requirements; taxes on negative externalities; subsidies for positive externalities; eco-labeling and other voluntary approaches

Source: Tawney et al., "Two Degrees of Innovation," 7, 47.

With this in mind, Asia is well-placed to dominate the low-carbon value chain because of investments in innovative capacity that countries are making today. Several examples are outlined in **Table 2**. These include India's plans under its solar mission, China's investments in transmission infrastructure, and Vietnam's and Thailand's feed-in tariffs. In fact, Asia pioneered the innovation-led economic development model, first in Japan, and then in South Korea and China.[66] Adapting this approach to a new sector that is far more heavily regulated than electronics or information technology is challenging. However, successfully competing in the rapidly maturing renewable-energy sector will require continuing and expanding investments in innovative capacity.

[66] Jorge Niosi, *Building National and Regional Innovation Systems: Institutions for Economic Development* (Northampton: Edward Elgar, 2010).

Table 2: Investments in innovative capacity in Asia

Function	Example
Creating and sharing new knowledge	India's solar mission:[67] • Establishing a National Centre of Excellence (NCE) to implement the technology development plan formulated by the Solar Research Council • Setting up of a network of Centers of Excellence—located in research institutes, academic institutions, or even private-sector companies—each focusing on a research and development area of its proven competence and capability Singapore: • Investing heavily in research and development in renewable energy, particularly solar energy • Emphasizing developing their ability to be a demonstration site and test-bed for early technologies[68] South Korea is already the world's fourth-largest investor in clean-energy research and development, and plans to expand its R&D investment in renewable energy from $1.8 billion in 2009 to $3.1 billion by 2013.[69]

[67] In 2009, India's Ministry of New and Renewable Energy announced the Jawaharlal Nehru National Solar Mission, a mission to install 20 GW of solar-powered electricity-generation capacity by 2022. The long-term objective of the National Solar Mission is to establish India as a global leader in solar energy. The immediate aim of the mission is to set up an enabling environment for solar technology penetration in the country. It is envisioned that as a result of the mission the price of solar electricity will attain grid parity by 2022. While it is perhaps too soon to evaluate success, the National Solar Mission addresses each function of the innovation system in turn. While the solar mission has included a local-content requirement for silicon PV (though not thin-film PV), it has had a limited impact on the development of the solar PV supply chains as it touches only a minority of the targeted growth in solar capacity and has no impact on state-level goals and programs. See Indian Ministry of New and Renewable Energy, "Government Announces Jawaharlal Nehru National Solar Mission"; and Government of India, "Towards Building SOLAR INDIA."

[68] "Strategic Research Programmes" National Research Foundation, Prime Minister's Office, Republic of Singapore website, http://www.nrf.gov.sg/nrf/strategic.aspx?id=134.

[69] Randall Jones and Byungseo Yoo, "Korea's Green Growth Strategy: Mitigating Climate Change and Developing New Growth Engines," Organisation for Economic Co-operation and Development (OECD), Economics Department Working Paper, August 29, 2011.

Table 2 (continued)

Function	**Example**
Building competence	India's solar mission: • Developing specialized courses in solar energy through collaboration with the Indian Institute of Technology (IIT) and premier engineering colleges • Adopting a government fellowship program to train 100 selected engineers and scientists in solar energy in world-class institutions abroad Between 2008 and 2011, the Australian government awarded $5.2 million to train students from India, China, and South Korea in photovoltaic engineering. As part of Australia's commitment to the Asia-Pacific Partnership on Clean Development and Climate, the students studied in the world-class solar-power program at the University of New South Wales.[70]
Creating collaborative networks	India's solar mission: • Providing through the National Center of Excellence a national platform for networking among different centers of excellence and research institutions, including foreign R&D institutions, high-tech companies, and multilateral programs. • Considering the creation of linkages with institutions such as the Centre for Innovation, Incubation and Entrepreneurship, which would incubate solar energy start-ups, and small and medium enterprises in India through mentoring, networking, and financial support.
Developing infrastructure	India's solar mission: • Encouraging state governments to establish solar-generation parks with dedicated infrastructure. These would have power and water supply 24/7 and ensure rapid access to imported raw materials and high-quality engineering talent. China: • Investing heavily in building new transmission between wind-rich regions and cities along the coast[71] • Encouraging development of ultra–high voltage transmission lines in part to provide access to electricity markets for gigawatt-scale wind-power bases[72]

[70] "UNSW to Train Indian Solar Engineers," University of New South Wales, Press Release, September 17, 2007.

[71] Letha Tawney, Ruth Greenspan Bell, and Micah Ziegler, "High Wire Act: Electricity Transmission Infrastructure and Its Impact on the Renewable Energy Market," World Resources Institute, April 2011.

[72] Li Junfeng et al., "2010 China Wind Power Outlook," GWEC, October 2010.

Table 2 (continued)

<table>
<tr><th>Function</th><th>Example</th></tr>
<tr><td>Providing finance</td><td>India’s solar mission:
Proposing to provide a soft refinance facility to create sustained interest within the banking community, for which the government will provide budgetary support
Considering establishment of a fund to support at least 50 start-ups in solar technologies across India over the next five years. The fund would provide financial (equity/debt) support to start-ups, entrepreneurs, and innovators for R&D and piloting of new solar technologies, and support for creating new and unique business models.</td></tr>
<tr><td>Establishing governance and the regulatory environment</td><td>India’s solar mission:
Creating, in consultation with states, a single-window clearance mechanism for all related permissions for doing business
Ensuring the introduction of effective mechanisms for certification and rating of solar-technology manufacturers
Proactively implementing special incentive package policies to promote PV manufacturing plants
Recommending that solar components be covered under the Bureau of Energy Efficiency’s star rating program to ensure high standards
Considering custom and excise duties concessions or exemptions on specific capital equipment, critical materials, components, and project imports
Vietnam’s Decision 37 established special priority for wind-energy projects. This provides corporate income-tax exemptions and reductions in land-use fees for wind-energy operators.[73]

In Thailand, the government loaned $133 million to thirteen commercial banks at an interest rate of 0.5% with the condition that the capital be loaned to small power projects at an interest rate of 4.0%.[74]</td></tr>
</table>

[73] Oliver Massmann and Phan Thi Mai, “New Wind Energy Tariff Not Enough to Entice Investors,” Duane Morris LLP, Legal Alert, July 14, 2011.

[74] Weischer et al., “Grounding Green Power,” 38.

Table 2 (continued)

Function	Example
Creating markets	The APEC parties' 2011 Leaders' Declaration committed to reducing trade tariffs on environmental goods and services to just 5% by 2015 to help create a market for products and services in the low-carbon power sector.[75] India's solar mission: • Emphasizing the mission's publicity and awareness campaigns • Establishing a single-window, investor-friendly mechanism for the purchase of solar power for the grid, one that reduces risk and provides an attractive, predictable, and sufficiently extended tariff • Making solar heaters mandatory, through building bylaws and incorporation into the National Building Code • Announcing solar tariffs for rooftop PV applications • Requiring a renewable purchase obligation mandate, where power utilities must include a specific proportion of solar energy Both Vietnam and Thailand have implemented feed-in tariffs for wind power. Thailand's guarantee of $0.18 per kilowatt-hour (kWh) has been sufficient to establish a domestic market. However, Vietnam's tariff of $0.078/kWh has so far been too low to attract significant investment in wind power.[76] In Thailand, the government established special regulations for small and very small power producers. The program includes provisions for grid connection and power purchase agreements and has led to the installation of 1,300 MW of renewable-energy generation capacity.[77]

Conclusion

The trends pushing renewable power forward are reinforcing each other to add momentum to the sector. Whether driven by the falling price of renewable energy technology, the price volatility and public health impacts of fossil-fuel energy, or the dramatic growth in energy demand in Asia, renewables promise to become a significant industry in Asia. The IEA reports that renewables are on track to play their part in

[75] Doug Palmer, "APEC Leaders Commit to Green Trade Liberalization," Reuters, Nov. 4, 2011.

[76] Massmann and Mai, "New Wind Energy Tariff Not Enough."

[77] Weischer et al., "Grounding Green Power," 15, 27.

limiting greenhouse gas emissions to 450 parts per million carbon-dioxide equivalent (CO_2eq). However, continued government policy, including financial support, will be crucial to achieving these goals.[78] The highly regulated nature of the power sector means that policymakers play a uniquely influential role in encouraging innovation by shaping the market entrepreneurs participate in and creating price pressures.

There are opportunities to create economic growth through participation in the sector, but it is not always clear how to best meet domestic energy demand and build an internationally competitive industry. Policymakers hoping to meet all of these objectives with limited public dollars should consider an innovation-based approach. By first identifying which segments of the value chain that they can compete for and then investing in supporting their entrepreneurs with a healthy innovation system, they can take advantage of the global energy transformation underway today.

[78] Henning Gloystein, "Renewable Energy Becoming Cost Competitive, IEA Says," Reuters, Nov. 23, 2011.