



LEADERSHIP PRACTITIONER BRIEF

Clean Energy in Perspective

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Clean energy is riding a wave of enthusiasm. Many business leaders, entrepreneurs, climate scientists, politicians, investors, and college students believe it promises strong investment returns, meaningful careers, and solutions to some of the world's most serious environmental and economic problems.

Although clean energy is likely to have a bright future, will it live up to the more extravagant predictions of its boosters? What are the current reality and future prospects of clean energy businesses in the US and abroad?

This paper provides an introduction to a wide range of clean energy businesses. It emphasizes the importance of understanding the great variation in those businesses, as well as in the economic and public policy contexts that influence clean energy development around the world. It warns against getting caught up in the hype about clean energy, while nevertheless suggesting that clean energy will play an increasingly important role in the global economy in the years to come. But for clean energy to reach its potential, leaders in business and government will need to act strategically and creatively.

The Shape of the Clean Energy Realm

“Clean energy” is a broad term, encompassing diverse industries and activities, which range from researching new technologies to replacing old light bulbs. Different clean energy businesses are therefore subject to different economic forces and trends. This complex, rapidly-changing realm offers myriad niche business opportunities that can be grouped into four distinct, but overlapping, categories:

1. Developing, manufacturing, and installing new technologies for electricity generation and transportation. When young people express a desire for a career in clean energy, they are generally thinking about new technologies for producing electricity or powering motor vehicles. Similarly, when the news media and politicians discuss clean energy, they usually focus on a few photogenic technologies in this category—wind turbines, solar panels, electric cars, fuel cells, and algae biofuel. Innovation in these areas has also been a primary focus for university researchers, stimulating start-up companies to transition many new technologies from the lab to the marketplace. At the same time, large multinational companies are playing increasingly important roles, such as Siemens and GE in wind, Mitsubishi Electric in solar, and Nissan in electric vehicles.

2. Using energy more efficiently. Although energy efficiency is not a new concept, there is tremendous potential to implement it much more widely. For example, a recent study estimated that a \$10 billion investment in energy efficiency in India could save 183 billion kilowatt hours of electricity annually, providing a quick and significant financial return.¹ Achieving these savings would require installing efficient motors, lighting, and appliances, as well as adding insulation and other improvements to buildings. Although many countries have an important, growing “energy-efficiency industry,” including energy service companies and weatherization contractors, much of the economic activity

1. Ella Aglipay Delio et al., *Powering Up: The Investment Potential of Energy Service Companies in India* (Washington, World Resources Institute, 2009), p.6.

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and many of the business opportunities related to energy efficiency can be found with firms not usually considered clean energy companies, such as manufacturers of front-loading clothes washing machines, fuel-efficient automobiles, and foam insulation.

3. Making fossil fuel use cleaner. Simply switching from coal to natural gas for electricity can cut greenhouse gas emissions by 50% or more. That has become more feasible as new gas drilling technologies have increased supplies while keeping prices flat. In addition, the process of extracting and using each of the fossil fuels—oil, coal, and natural gas—can be significantly improved. For example, Global Gas Flaring Reduction, a public-private partnership led by the World Bank, is working to reduce the burning and flaring of natural gas at oil fields around the world. Coal-fired power plants can reduce their greenhouse gas emissions by using state-of-the-art equipment that provides a 20% improvement over the average coal-fired electricity generator in OECD countries and an even greater improvement when compared to the facilities in many other places.¹

There is also strong interest in carbon capture and storage (CCS), which separates carbon dioxide from other emissions and stores it underground. Although 5 large demonstration projects are in place and 80 more are in various stages of development in 17 countries,² it is too soon to know whether CCS will turn out to be practical or widely implemented. (Nuclear power is similar to CCS in that a few next-generation nuclear plants need to be built before knowing the extent to which it can be a safe, affordable way to reduce greenhouse gas emissions.)

4. Improving infrastructure to enable efficient and renewable energy options. Energy storage methods, including battery banks and flywheels, would allow greater reliance on intermittent energy sources like wind and solar. Moving away from gasoline-dominated transportation requires new infrastructure, such as electric vehicle charging stations. However, much of the business activity and jobs related to infrastructure improvement will not come from self-defined clean energy companies, but from the information technology and communications sectors. Advanced meters, sensors, automatic controls, and other similar technologies are beginning to make the electricity transmission and distribution system more flexible and efficient. This move towards a so-called “smart grid” will provide better information to electric utilities and consumers, and make it easier to integrate intermittent power sources into the system. Similarly, adding information and communication technology to the transportation infrastructure can produce significant energy savings. Variable traffic-light timing, tolls that change with traffic density, and electronic toll collection can reduce congestion. Mass transit can be made more attractive with mobile phone apps that tell commuters when a bus or subway will approach a particular station.

Although all four areas offer appealing career and investment opportunities, excitement surrounding the sexy electricity generation technologies has sometimes overshadowed more familiar businesses and technologies, obscuring their economic importance. As an example, as of 2008, the energy efficiency sector in the United States accounted for more than 17 times as many jobs as the renewable energy industry, and most of the renewable energy jobs were connected to corn ethanol and wood-burning power plants rather than wind or solar.³ The study that produced those findings also made future projections and, even in its most optimistic scenario for renewables, energy efficiency would continue to be responsible for more than four times as many jobs in 2030.⁴

2. Brian Ricketts, *Focus on Clean Coal* (Paris: International Energy Agency, 2006), p. 3.

3. International Energy Agency, *Carbon Capture and Storage: Progress and Next Steps* (Paris: International Energy Agency, 2010), pp. 5, 30-34.

4. American Solar Energy Society and Management Information Services, Inc., *Defining, Estimating, and Forecasting the Renewable Energy and Energy Efficiency Industries in the US and in Colorado* (Boulder: American Solar Energy Society, 2008), p. xiii. If a similar study were conducted in 2010, the distribution of renewable energy jobs would likely be somewhat different, with fewer in ethanol refinery construction and more in solar installation.

5. *Ibid.*, p. xvii.

The Local Context is Key

The clean energy realm is complicated, not only because it is composed of so many different technologies and businesses, but because clean energy will inevitably be implemented and manufactured unequally around the world. For one thing, resources needed for clean power generation, such as sun, wind, and water, are not distributed evenly around the planet, nor is the need for additional energy. And clean energy is not immune to the general economic forces that have been causing much of the world's mass production of industrial goods to migrate to locations with low labor costs.

Several specifically energy-related economic factors contribute to clean energy being applied differently in different locations. For example:

- It is easier for clean energy technologies and practices to gain a foothold where the cost of conventional energy is high. In other words, there is more appeal to high-efficiency automobiles in the Netherlands where gasoline sells for \$5.60 per gallon than in Venezuela where it costs 40 cents. Even though there is more sunlight in Atlanta than New York, solar power is a more attractive economic proposition in the Big Apple, because the price of electricity is twice as high.
- Electric cars, natural gas buses, advanced rapid transit, and other alternatives to gasoline-powered vehicles are easier to implement in densely populated areas where the required new infrastructure will serve large numbers of users. Electric cars are most attractive in places, such as Israel and Hawaii, where vehicle owners do not normally take long trips far from home and other battery-charging locations.
- Countries, like China and India, with rapidly expanding electricity use but an incomplete electricity infrastructure, represent promising markets for new electricity generation technology.
- Some clean energy businesses and activities benefit from proximity to research universities and/or clusters of other industries, such as information technology or metallurgy.

The Role of Public Policy

Beyond such purely economic variables, government policy makes a tremendous difference. Government financial incentives and favorable regulations are necessary to make some clean energy technologies cost-competitive in the short run. Public policies can be relatively simple and economically efficient, such as a carbon tax, or they can be much more complicated and apply only to specific technologies, but in all cases they help shape how clean energy business develops in a particular location.

Concern about climate change is the most obvious motivator of policies to support clean energy and its impact on government action varies widely. In places such as Scandinavia and California, governments and the public have decided to take strong action to reduce greenhouse gas emissions.

Clean energy-related economic policy also varies considerably. Some governments have embraced clean energy as a solution to particular local economic development problems, as Germany did when it established generous subsidies for solar electricity in part to revive the industrial base in the former East Germany. Certain countries, such as Japan, are more inclined than others to make investments in infrastructure and technology that may initially cost more but will pay off in the long run by being more energy efficient.

Because of the great variations in government policy and economic attractiveness of clean energy, entrepreneurs and investors need to understand and respond to the local context. Not every clean energy business can or will thrive in every location. Certain clean energy products, such as large wind turbine blades, are costly and difficult to ship over long distances, so they are likely to be manufactured in multiple locations close to their markets. Businesses and government officials should consider which types of enterprises will most likely succeed in a particular setting.

But in other cases, as the Monitor Group points out, "Different regions offer a better environment for different industries. Companies in those industries tend to locate in the right regions, and over time

strength begets more strength.”⁶ Firms are most likely to prosper where the assets exist to support an internationally competitive industry cluster.

Unfortunately, enthusiasm for clean energy has spurred many recent attempts to plant or support particular clean energy businesses in locations where they are not likely to flourish. Rarely are there situations, as with China today, where an unusual confluence of circumstances (i.e., cheap capital, large government infrastructure investments, competitive labor costs, strong perceived need to reduce coal-based air pollution, and favorable government policies including ambitious national targets for energy efficiency and renewables) allows a large number of very different clean energy manufacturing sectors to succeed.⁷

Getting Past the Hype

The prospects for clean energy are sometimes overstated in four different ways:

1. Exaggerating the speed at which clean energy can or will replace fossil fuels. Trillions of dollars have been invested in existing fossil fuel energy infrastructure. An abrupt transition to clean energy would require all of the existing plants and facilities to be prematurely abandoned. Neither businesses nor governments would accept such a draconian financial sacrifice.⁸ Moreover, the energy sector, with its strong emphasis on stability and reliability, has historically been slow to embrace and adopt novel technologies. On a global basis, only 10% of energy sector investment has recently been going into efficiency and renewables, with the vast majority of the rest invested in the fossil fuel industry.⁹

Even if political will existed for an all-out effort to advance clean energy, change would still only come gradually. Large electricity generating projects inevitably take several years to site, design, permit, and build. And because each renewable energy facility only produces a modest amount of power compared to a large coal power plant, tens of thousands of such facilities would be needed to displace the entire fossil fuel infrastructure while also meeting increasing global energy demand.

In addition, renewable energy is ramping up from a low starting point. In the case of the United States, 10.5% of the electricity in 2009 was generated from renewables, but most of that (6.9%) came from large hydropower plants that will not be significantly expanded, with the remaining divided among wind (1.8%), wood and other biomass (1.4%), geothermal (0.4%), and solar (less than 0.1%).¹⁰ When transportation fuels and heating are added into the picture, just 8.2% of the total US energy supply came from renewables: 4.1% from biomass (mostly ethanol), 2.8% from hydro, 0.7% from wind, 0.4% from geothermal, and 0.1% from solar.¹¹

Despite these realities, some projections predict astoundingly rapid clean energy market penetration. Unsurprisingly, ambitious clean energy entrepreneurs and marketers, like their gung-ho counterparts in other growing industries, tend to release overly optimistic production and sales forecasts. But other dynamics unique to clean energy lead to overblown projections that sometimes receive too much attention from the media and the public. Some environmentalists set goals for near-term clean energy adoption based on what they believe to be necessary to address global warming, rather than on a hard-headed assessment of what is feasible. Some political leaders select targets that

6. Jeff Grogan et al., “Targeted Recruiting,” in Warren Leon et al., *An International Strategy for Massachusetts: A Report for the Executive Office of Housing and Economic Development* (Westborough, Mass.: Massachusetts Technology Collaborative, 2010), p. 36.

7. On clean energy in China, see Julian L. Wong, *China’s Clean Energy Push: Evaluating the Implications for American Competitiveness* (Washington: Center for American Progress, 2010) and Renewable Energy and Energy Efficiency Partnership, *Special Report on China and Chinese Provinces* (Vienna: Renewable Energy and Energy Efficiency Partnership, 2010).

8. A recent widely promoted book by Robert Bryce makes a convincing case for the likely persistence of the existing fossil fuel infrastructure, although it underestimates the potential for energy efficiency, certain renewable energy technologies, and government climate change action. See *Power Hungry: The Myths of “Green” Energy and the Real Fuels of the Future* (New York: Public Affairs, 2010), especially pp. 44-52.

9. Michael Liebreich, Bloomberg New Energy Finance presentation to the Clean Energy States Alliance, July 30, 2010.

10. US Energy Information Administration, *Electric Power Monthly* (July 2010 edition), tables on “Net Generation by Energy Source: Total (All Sectors)” and “Net Generation by Other Renewables”.

11. US Energy Information Administration, *Monthly Energy Review* (July 2010 edition), table on “Primary Energy Consumption by Source.”

sound catchy or will be popular politically. Such aspirational goals can inspire people but may also mislead them about what will or can change in the future. To take a notable example, Al Gore's wildly unrealistic claim that, "If we set our minds to it, we in this country could produce 100 percent of our electricity from renewable and carbon free sources in 10 years,"¹² has caused some people to expect much more than clean energy can possibly deliver.

2. Unrealistic expectations for investment returns in particular clean energy sectors.

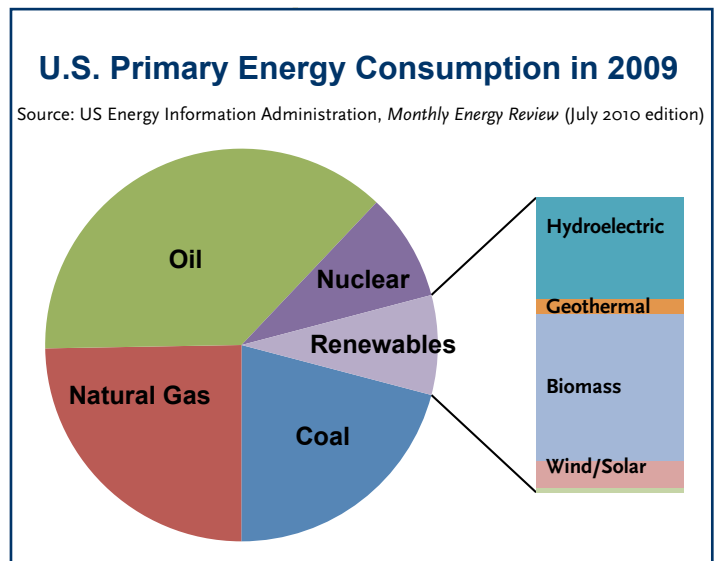
While many venture capital firms understand the clean energy industry well, others jumped on the bandwagon and made ill-advised investments. Some of them assumed it would be similar to investing in Internet companies and therefore overestimated how quickly clean energy firms could issue wildly successful IPOs. Although many companies will prosper, most clean energy business segments are not well positioned to generate quick, windfall financial returns. For example, companies developing new electricity generation technologies, such as

fuel cells and energy from algae, can require many years of investment and multiple demonstration plants before they are able to secure significant sales. And although it can be profitable to develop large power plants, it rarely produces the rate of return usually sought by VC firms, no matter whether the facility uses a conventional technology like natural gas, a relatively mature clean technology like wind turbines, or an emerging technology like solar thermal. Of course, there have been and will continue to be some cases where far-sighted entrepreneurs and savvy investors identify lucrative opportunities.

3. *Assuming technologies are clean and commercially viable.* New technologies and industrial processes are sometimes rolled out before all their limitations are known. Once they receive careful scrutiny, it may turn out that they do not deliver the anticipated environmental benefits or face logistical problems that prevent them from being used on a large scale. For example, enthusiasm for using palm oil for energy dissipated when it became clear that new palm oil plantations in Indonesia and other countries were destroying rainforests and harming local populations. There was a similar backlash against building wood-to-electricity power plants in Massachusetts after it was learned that they may not reduce greenhouse gas emissions in the near term. And early fuel cell installations turned out to be markedly less reliable than advertised. A technology will not prosper after it has received well-documented technical criticism, unless it is protected by unusually strong political interests, like the corn ethanol lobby in the United States.

4. *Overblown claims about green jobs.* Although the number of jobs associated with clean energy will expand steadily, the concept of "green jobs" is sometimes inaccurately portrayed as an economic silver bullet. Rapid job growth in this area cannot single-handedly wipe out unemployment, because clean energy starts from such a modest starting point (fewer than 1% of total jobs in most locations). Moreover, predictions of the number of future green jobs sometimes ignore the jobs that will be lost when fossil fuel use declines and do not consider slower job growth in other sectors of the economy when spending by consumers and governments shifts from those sectors to clean energy.

Despite these caveats, clean energy can have a positive economic and jobs impact. For example, there is solid evidence that money spent on cost-effective energy efficiency, which tends to be labor intensive, creates many more jobs than equal spending on fossil fuels, especially when those fuels are imported. Then, once the energy-efficiency measures are in place, lower energy bills free up money for other needs. More generally, the extent to which clean energy slows disruptive climate change represents a significant economic benefit that frequently remains uncalculated.



12. Al Gore, Testimony before the US Senate Foreign Relations Committee, January 28, 2009.

How Bright Is the Clean Energy Future?

After discounting the hype and acknowledging that not all clean energy enterprises will thrive in all locations, we should still recognize that clean energy business growth has been impressive and will most likely continue to be so. As long as unrealistic expectations are not used as the measuring stick (e.g., clean energy will imminently replace fossil fuels; clean energy start-up companies will be the next Google-like IPOs), clean energy will be perceived to be a highly significant and successful business trend.

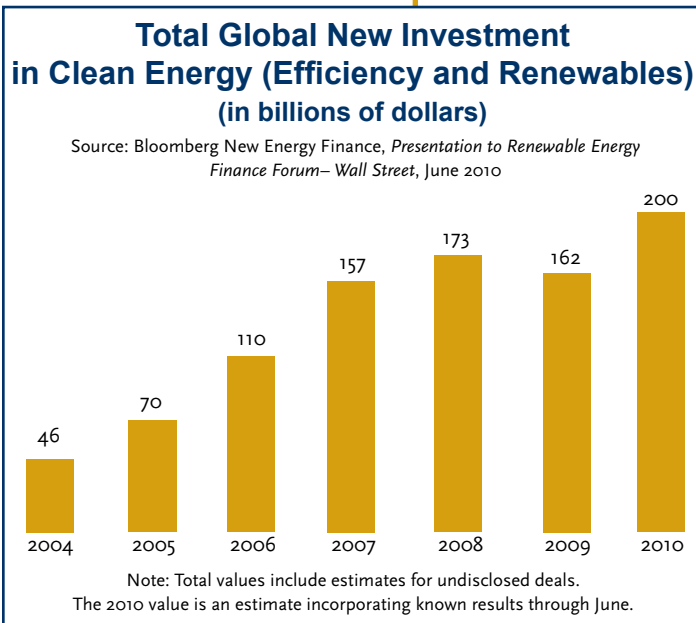
To take the solar photovoltaic industry as an example, annual global production increased from about 200 megawatts in 2001 to more than 10,000 megawatts in 2009.¹³ Similarly, global wind energy capacity grew by nearly 32% in 2009 and is on track to double over three years.¹⁴ Although it is highly unlikely that these *rates* of growth can be maintained as the base becomes larger, production will continue to increase in absolute terms, absent a global economic meltdown. Other technologies, such as white LED space lighting and battery-electric vehicles, are in earlier stages of ramp up, so they should experience impressive rates of growth, even though it will take many years for them to capture more than modest shares of their total markets.

Looking beyond these individual cases, there is considerable momentum behind all four areas of the clean energy realm, and there is no reason to believe that there will be a contraction in any of the areas. The significant research and development activity underway will inevitably lead to better, less expensive products. Moreover, the significant environmental and national security disadvantages of relying on fossil fuels will not disappear. Yet it is hard to project how steep the clean energy growth curve will be, in great part because government policy support is so essential but also unpredictable.

It is especially hard to know how concern about climate change will play out in the political arena, or how businesses and investors will be affected. As noted investment manager Jeremy Grantham points out, “Global warming will be the most important investment issue for the foreseeable future. But how to make money around this issue in the next few years is not yet clear to me. In a fast-moving field rife with treacherous politics, there will be many failures.”¹⁵

Anyone who wants to see clean energy succeed or seeks to make a career in the field should be prepared to monitor developments in the policy arena and take action to promote policies that favor clean energy.

Even though not every clean energy business or technology deserves government support in every location—and certainly not at any price—clean energy deserves and needs meaningful government help, even if it entails short-term economic costs.



13. Arnulf Jäger-Waldau, “Snapshot on European Photovoltaics in World-Wide Comparison,” in Hans Bloom et al., *Renewable Energy Snapshots 2010* (Luxembourg, European Union, 2010), p. 25

14. World Wind Energy Association, *World Wind Energy Report 2009* (Bonn: World Wind Energy Association, 2010), p. 5.

15. Jeremy Grantham, “Everything You Need to Know about Global Warming in 5 Minutes,” *GMO Quarterly Letter* (July 2010), p. 8.

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