

This document is part of the Cambridge Insight Research Brief Series. Cambridge Insight Research Briefs present summaries of research that the company is performing on behalf of our clients. The outcomes are not final and are intended to stimulate discussion among the clients and friends receiving the Research Brief.

**Research Headquarters**  
1600 Massachusetts Ave.  
Suite 407  
Cambridge, MA 02138  
Phone: (617) 441-2915  
Fax: (617) 812-4659

**DC Office**  
3601 Connecticut Ave NW  
Suite 611  
Washington, DC 20008  
Phone: (202) 249-1838

Inquiries  
[info@cambridgeinsight.com](mailto:info@cambridgeinsight.com)

## Clean Energy: a revolution underway?

*Adolfo F. Chiri, Ph.D.\**

The nation that leads the world in creating new energy sources will be the nation that leads the global economy of twenty-first century, as stated by President Obama. This seems to be the new paradigm.

The nature of the future society is determined in large part by the way it resolves the tension that exists between the use of energy, the preservation of the environment, and economic growth. This tension is largely a result of the use of fossil fuel as a source of energy. If current trends continue, they will lead to greater environmental deterioration and place at risk the viability of modern society.

The supply of reliable, affordable, and clean energy, which will meet the needs of economic growth while at the same time reducing environmental damage and oil dependency, appears to be the great challenge for the future.

Wind, solar, geothermal, and other source of clean and renewable energy appear to point in the right direction.

The advanced economies of the world are investing substantial resources in research and development (R&D) in the area of clean energy, and designing policies that encourage the replacement of fossil fuels by clean and renewable resources. These dynamics suggest that in the coming years there could be a technological breakthrough that may redefine the global energy portfolio, and have considerable economic, political, and social implications.

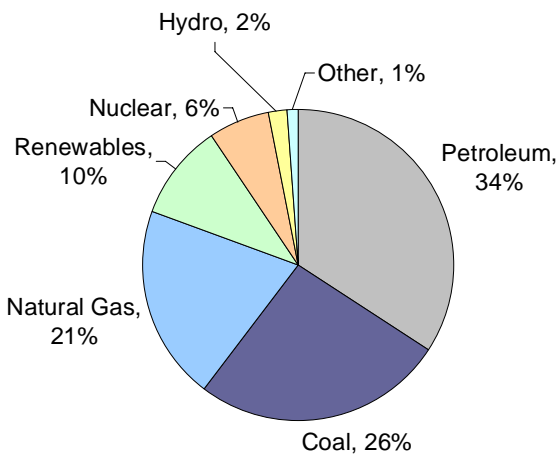
## The unsustainability of business as usual

There is consensus among the international scientific community that the current pace of climate change is a consequence of human activity. The Intergovernmental Panel on Climate Change, commissioned by the United Nations, released a report in 2007.

This report concludes that climate change is real and is a consequence of the production of greenhouse gas as a result of human activity. A growing body of scientific evidence suggests that climate change and environmental degradation threaten the economic and social stability of the international community.

The “greenhouse effect,” which is a result of the release of gasses such as carbon dioxide (CO2), is produced by fossil fuels, such as petroleum, coal, natural gas, among others. Currently, the global use of energy is mainly from fossil fuel sources. According to a report of the International Energy Agency, 80.9 percent of global energy usage is from fossil fuel sources, and only 10.1 percent is from renewable sources.<sup>1</sup> (Figure 1)

Figure 1: Global Energy Sources

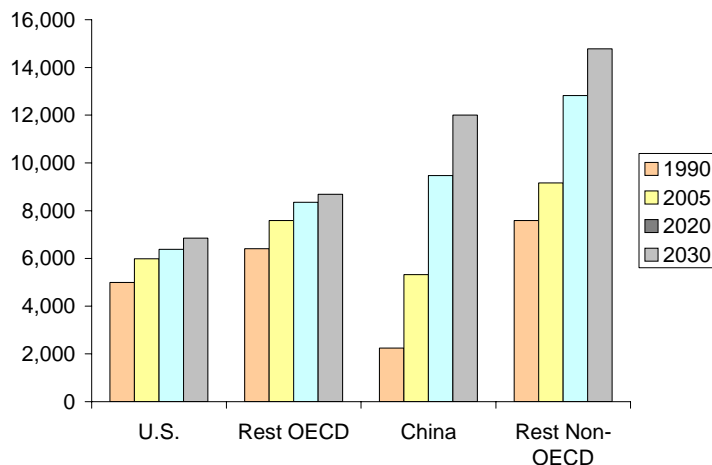


Source: International Energy Agency-2008.

The consumption of energy and emission of CO2 are in direct relation to the size of the economy. When economies grow, they tend to consume more energy and release more CO2. Therefore, the most advanced economies tend to have the greatest emissions of CO2.

Emerging economies, such as China and India have joined the countries that have significant emissions of CO2. This is illustrated by the fact that the Group of Twenty (G20) countries represent approximately three quarters of the world’s energy consumption and CO2 emission. As the emerging economies grow and they increase their usage of energy and emission of CO2, the pressures placed upon the environment become more immediate. (Figure 2)

Figure 2: CO2 Emissions by Region, 1990-2030 (millions of MT of CO2)



Source: IEA, International Energy Outlook, 2008.

The United Nations continues to promote a framework for reducing the production of greenhouse gasses. Since the Kyoto Protocol, through the planned Copenhagen meeting scheduled for the end of 2009, the international community has been trying to reach agreement on the mechanisms that will contribute to the reduction of CO2 emissions. These efforts were limited. However, taking into consideration the commitment of the Obama administration to regulate the CO2

emissions, these efforts are expected to make substantial progress.

In April 2009, the Obama Administration declared that CO<sub>2</sub> is dangerous for human health and well-being.<sup>2</sup> This determination, long anticipated by environmental groups, opens the doors for the U.S. Environmental Protection Agency to regulate CO<sub>2</sub> emissions, without the need for legislation by the U.S. Congress. This step taken by the United States constitutes a concrete initiative to regulate CO<sub>2</sub> emissions, as has been done in the European Union.

### **From mitigation to new energy sources**

Leaders of the scientific community have recommended that steps to mitigate climate change and its effects be taken in order to construct an economy based on clean energy. These recommendations include, in the short term, the efficient use of existing resources and increased usage of renewable resources. This implies a need for investment in the development of clean technologies, carbon sequestration technologies, and a comprehensive strategy for sustainable development. In sum, immediate and determined actions are needed to prevent potentially catastrophic effects of climate change and to secure the viability of the global economic system and society.

#### Improving energy efficiency

Although the move toward clean energy sources is a long-term process, in the short term, energy efficiency is an imperative today. Most of the advanced economies are developing policies and implementing programs to improve energy efficiency. An example of these policies is the case of the state of California. Over the last three decades, in the United States overall electricity

consumption grew by 50 percent. However, in California over the same period, electricity consumption remained flat, even though the state was growing at a pace just as fast as the rest of the country.

Institutions have also shown an increasing understanding of the need to conserve or improve energy efficiency. For example, Harvard University has identified “ten rules” that will contribute to the sustainability of the planet and energy efficiency:<sup>3</sup>

1. Drive less.
2. Turn off computers.
3. Unplug chargers.
4. Turn out the lights.
5. Take shorter showers.
6. Adjust your thermostat.
7. Eat less meat.
8. Wash clothes in cold water.
9. Ditch the plastic.
10. Reduce. Reuse. Recycle. Rethink.

Energy efficiency is a necessary step that not only helps to reduce CO<sub>2</sub> emissions but saves significant economic resources, principally in developing economies.

#### Increasing use of renewable energy

As discussed below, the transition to a clean-energy based economy offers considerable possibilities for economic growth, innovation, and prosperity. Clean energy is based essentially on the use and development of renewable energy, such as wind power, solar energy, geothermal energy, biocombustibles, among others. Although nuclear power does not pollute like fossil fuels, because nuclear waste may threaten the environment, there is hesitation to consider it within the portfolio of clean energy.

Wind power is the fastest-growing form of renewable energy in the world. According to the American Wind Energy Association, the use of wind power in the generation of electricity globally has grown by 40 percent. At the moment, it is believed that windfarms can generate sufficient electricity to supply entire cities, at prices that are competitive with those of coal and natural gas.

As the Renewable Energy Policy Project indicates, the growing use of wind power is generating new sources of employment. It is estimated that for each 1,000 MW of wind energy generation, there is a potential to create 3,000 manufacturing jobs and 1,300 jobs in facilities, operation, and maintenance.

The three largest windfarms in the United States are located in of Nolan County, Texas, an area that has a population of 18,000 people. It produces more wind power than the United Kingdom and France combined. The enthusiasm that has been generated in the United States for wind power is shown by the investments that have been made in this sector. For example, T. Boone Pickens, the pioneering oil industry investor, is today investing in a project to construct 2,700 turbines on 200,000 acres of land. It is anticipated that upon completion, the project will provide 4,000 MW of electricity, enough to provide energy for one million homes. Last year 40 percent of all new generation capacity in the United States came from wind energy.

The technology that converts energy from the sun into electricity and heats water are in increasing use in many parts of the world. Other solar technologies, like those used in the construction of buildings to take advantage of the sun for heating, cooling, and light, are becoming more frequently used. Materials are being selected on the basis of their thermal properties, and spaces are being designed to

favor the circulation of air. The increasing use of solar energy is illustrated, for example, by the state of California, which is developing a program to become the national leader in the use of solar energy. The state of California has set a goal to install one million roofs with solar panels in 200,000 houses and commercial buildings with heating systems based on solar energy.

The development of the solar energy industry has a great potential for economic growth. For example, the Clean Edge company estimates that the production of solar panels, including installation systems, will increase from \$20.3 billion in 2007 to \$74 billion by 2017.

Geothermal energy, generated by the heat of the Earth, is currently used in a variety of applications. It offers potential in certain geographic areas where geothermal reservoirs are located. The Geothermic Energy Association estimates that in the United States 2.8 million people use geothermal technology for their household energy.

Biocombustibles, and the bioenergy sector in general, have been the subject of international attention, mainly as a result of the oil crisis of 2008. The bioenergy sector employs the use of renewable materials of animal or plant origin to create liquid fuels like ethanol and biodiesel.

In spite of the potential conflict with food security and water usage, biocombustibles have met with large-scale acceptance in the market. However, these sources of energy are generally considered to be a transition whose usage will eventually give way to electric and hybrid fuel cars, once the industry becomes more developed. The ethanol industry employs approximately 238,000 people in the United States. There is a potential for increased growth because by 2022, the United States will use 36 billion gallons of renewable fuel.<sup>4</sup>

## The transition to clean energy

At the Group of the Twenty (G20) summit held in London on April 2, 2009, the leaders of the 20 largest economies of the world committed to recover confidence in the international financial system and to stimulate the economy. They also committed to respond to the challenges presented by climate change by constructing an inclusive, “green” and sustainable recovery.<sup>5</sup>

These economies are planning to expand their budgets by \$5 trillion in order to increase the global product by 4 percent and to accelerate the move to sustainable economic growth. This transition consists of orienting the global economy toward the efficient use of resources, improving infrastructure, and promoting the use of clean technology. The stimulus programs are also intended to direct financial resources toward the mitigation of climate change, and the development of renewable energy resources and new technologies. (Table 1)

Table 1: Stimulus Package Funds Directed Toward Climate Change

| Country        | Funds (US\$bn) | Period  | Green Funds (US\$bn) | Green Funds % |
|----------------|----------------|---------|----------------------|---------------|
| China          | 586.1          | 2009-10 | 221.3                | 37.8          |
| Japan          | 485.9          | 2009+   | 12.4                 | 2.6           |
| South Korea    | 38.1           | 2009-12 | 30.7                 | 80.5          |
| European Union | 38.8           | 2009-10 | 22.8                 | 58.7          |
| Germany        | 104.8          | 2009-10 | 13.8                 | 13.2          |
| France         | 33.7           | 2009-10 | 7.1                  | 21.2          |
| United Kingdom | 30.4           | 2009-12 | 2.1                  | 6.9           |
| Canada         | 30.8           | 2009-13 | 2.6                  | 8.3           |
| United States  | 972            | 10 años | 112.3                | 21.8          |

Source: HSBC Global Research, 2009.

The United States is the second country after China to invest in renewable energy development in order to position itself on the forefront of new energy technology. The United

States aims to position itself as a global leader in exporting renewable energy. The U.S. government is planning to make the largest investment in science and technology since the Apollo space program put a man on the moon in the 1960s.

The energy plan of the Obama administration, “New Energy for America,” has as a goal the elimination of oil imports from the Middle East and Venezuela within ten years. Other goals are to create millions of new green jobs, and 59 reduce greenhouse gas emissions by 80 percent by 2050. In order to achieve these goals, the government will invest \$150 billion over the next ten years to:

- help the private sector to create five million new jobs in the next ten years,
- put in circulation a million hybrid vehicles, which will be made in the United States, that will get up to 150 miles per gallon,
- assure that by 2012, 10 percent of the electricity generated will be from renewable energy sources, and by 2025, that it will be 25 percent,
- weatherize a million homes, and
- turn the United States into a global leader in the area of climate change.

In order to achieve the objectives, the Obama Administration’s 2010 budget included \$26.3 billion for the Department of Energy. The Administration’s view is that investments in the energy sector will have a multiplier effect on the rest of the economy. According to estimates conducted by U.S. government experts, for each \$1 invested by the government in research and development in energy, there is a return of \$40 in energy efficiency and new technology.

The companies that are working in the area of renewable energy have brought increased



dynamism to the energy sector. For example, companies like Orion Energy are developing technologies like the "Apollo Light Pipe," which collects and redirects solar light. Such technologies bring natural light to the interior of buildings without the need for electricity, thereby replacing traditional light sources for a large part of the day. Companies like Cisco and Coca Cola are using these technologies and have reported that they are saving sufficient energy to illuminate more than 500 houses a year. Also, companies like Sinmat are developing new ways to make microchips for intelligent energy systems that can make hybrid cars more efficient, and can improve the efficiency of household lighting.

Universities are also conducting fundamental research in the clean energy area. For example, MIT is developing new technologies that turn windows into high-efficiency solar panels; electric car batteries that can be charged in the amount of time that it takes to fill a tank of gasoline; light bulbs that are 500 percent more efficient than normal incandescent light bulbs; among others.

In its efforts to develop renewable energy, the European Union has set a goal for 2020 that 20 percent of final energy consumption will come from renewable energy sources. The proportion of renewable energy consumption in relation to total energy consumption has increased from 7.1 percent in 2006 to 7.5 percent in 2007. The proportion of renewable energy in relation to total electricity increased from 14.3 percent in 2006 to 14.9 percent in 2007. Given the present trends in Europe, with the decided support of the population, there is a favorable outlook for renewable energy in the European Union.

Emerging economies are also reorienting their efforts toward the use and development of renewable sources of energy. For example,

China, through its Quinquennial Plan, has established as a goal that 10 percent of energy consumption in 2010 must be from renewable sources, and 50 percent must be from renewable source in 2020. This approach is consistent with China's efforts to reduce its dependency of the use of coal, which is highly polluting. According to the Chinese Wind Energy Association, at the present there are 158 windfarms in China, and the government is developing efforts to generate an installed capacity of 10 GW by 2010.

## **Conclusion**

Global economic growth has been affected by the use of fossil-fuel resources, such as oil, coal, and gas. There are many issues raised by the continued use of these resources, including resource depletion, price volatility, and environmental degradation. The deterioration of the environment, as a result of human activity, places at risk the stability and future of the global system.

A potential alternative to the unsustainable use of fossil fuels as a continued source of energy is the use of renewable and non-polluting resources, such as wind, solar, and geothermal energy and bioenergy. Nevertheless, the development and intensive use of these resources are dependent upon technologies and infrastructure that will make them viable from a technical, economic, and political point of view. This is a long-term process, however, it has begun and is developing at a fast pace.

The largest and fastest-growing economies have begun to invest in the development of new technologies that may permit the construction of a new economy based on renewable and clean energy. Given the unsustainability of the current energy portfolio, and the advances in the area of renewable

energy demonstrated throughout the world, it is reasonable to believe that in the coming years there will be a revolution in the energy area that will have deep and long-lasting repercussions throughout modern society.

\* Dr. Chiri is President of Cambridge Insight, LLC, in Cambridge, Massachusetts, USA. He teaches the course on the Microeconomics of Competitiveness at CENTRUM-Católica in affiliation with the Harvard Business School.  
Email: [chiriad@cambridgeinsight.com](mailto:chiriad@cambridgeinsight.com)

## Endnotes

1. Key World Energy Statistics, 2008. International Energy Agency.
2. The Environmental Protection Agency. Washington, D.C., April 17, 2009.
3. Harvard University, Sustainable Development Program, 2009.
4. It establishes "renewable fuel standards," established in the "Energy Independence and Security Act of 2007."
5. "London Summit, Leaders' Statement," April 2, 2009.
6. The White House, Office of Management and Budget, March 2009.
7. President's Council of Advisors on Science and Technology-1997 PCAST, 1997.
8. Dr. Susan Hockfield, President of MIT, March 23, 2009.
9. EurObserv'ER, "The State of Renewable Energies in Europe", ed. 2008.