

Transition to a Low-Carbon Economy



Opportunities and Challenges of the Emerging Clean Energy Industry

Transitioning to a low-carbon economy presents both a significant opportunity and an enormous challenge. An opportunity in that the commercialization of low-carbon solutions, including clean energy technologies, can further catalyze an important emerging market and support the transformation of the global energy sector. Simultaneously, this transition presents an enormous challenge given the significant capital required to transform economies that have been reliant on an energy system that has been largely fossil-fuel based. This challenge is even greater when you consider the requirement to make investments today for benefits that will materialize well into the future. A successful transition will require close coordination between policy, technology and capital, at the core of which is partnership between the public and private sector as well as opportunities to partner with countries around the world.

In an in-depth discussion with *Private Wealth Forum*, Tracy Wolstencroft, Global Head of Environmental Markets at Goldman Sachs, shares views on the opportunities and challenges of a growing industry that has the potential to strengthen economic growth and secure greater energy independence, while reducing the impacts of climate change.



Tracy Wolstencroft is Global Head of Environmental Markets in the Executive Office. He oversees Goldman Sachs' efforts to further market-based solutions to environmental challenges.

A partner at Goldman Sachs since 1994, Tracy has served on both the Firmwide Partnership Committee and the Investment Banking Operating Committee. During his 25 year career, he has managed a wide range of businesses in the United States and abroad, including Investment Banking Services, Latin America, Public Sector and Infrastructure Banking, and US Debt Capital Markets Origination. While living in Asia, Tracy was head of Investment Banking in Japan, President of GS Singapore, and a leader of the firm's strategy in China.

He has managed many of the firm's global corporate and government relationships. He led Goldman Sachs' efforts focused on the initial restructuring and recapitalization of the banking sector in China. He also represented the firm testifying before the US Senate Committee on Banking, Housing and Urban Affairs on the "Condition of our Nation's Infrastructure and Proposals for Needed Improvements."

Tracy serves on the boards of the Brookings Institution, the National Geographic Society, the Asia Society, and the International Rescue Committee. He is a member of the Council on Foreign Relations. He earned his AB from Bowdoin College.

Private Wealth Forum: In terms of clean energy development, how would you describe where we are today?

Tracy Wolstencroft: We are still in the very early days of a transition from a high-carbon economy to a low-carbon economy. In looking for low-carbon alternatives to fossil fuels, it's important to recognize that the system that delivers our energy today has been around for over a century and does a remarkable job of providing power that is reliable, ubiquitous and relatively affordable. The challenge is transitioning to a system that is also cleaner, smarter, more efficient, and reflective of the environmental costs of greenhouse gas emissions.

Transforming our energy system will take time and a significant amount of capital. Given the magnitude of the challenge, it will also require close coordination among three key elements: policy, technology and capital. If you will, these elements represent three legs of a stool supporting the goal of a decarbonized world.

To give you an order of magnitude of the capital required, the International Energy Agency (IEA) estimates we need \$10.5 trillion in incremental investment globally in low-carbon energy technologies and energy efficiency by 2030. This estimate is across all sectors, including power, transport, residential and commercial building equipment, and industrial sectors, in order to limit global temperature increases to 2 degrees Celsius, the threshold that the United Nations Intergovernmental Panel on Climate Change has identified as necessary for "avoiding catastrophic climate change."

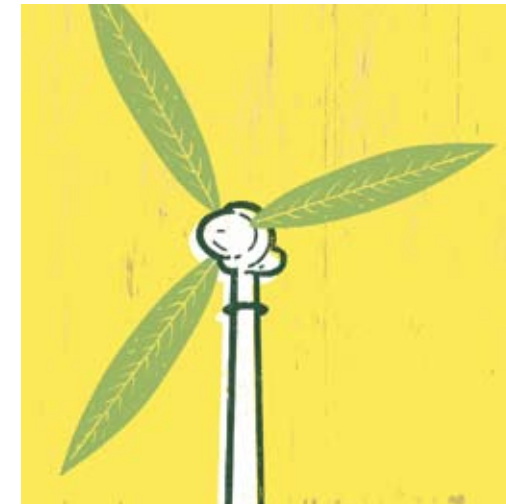
To deploy this amount of capital we need clear and consistent policies over a long period of time so that strategic and financial players have the confidence to invest in clean energy technologies. This is important not only because of the scale of capital that is necessary, but also given the long-term nature of energy assets.

The opportunities before us in clean energy technology offer enormous potential for creating new ways to generate the energy we need, and at the same time create jobs and drive economic growth. It also creates partnership opportunities with countries around the world.

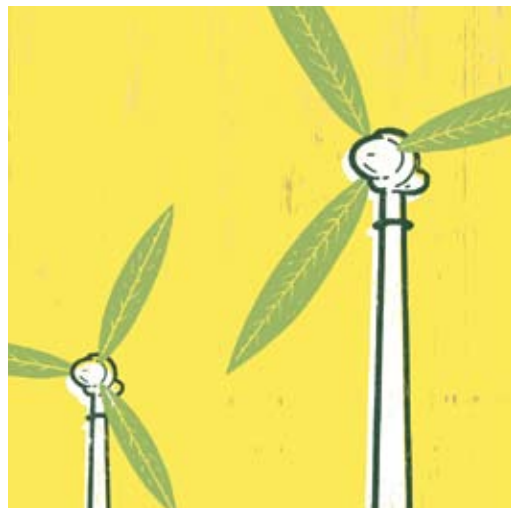
PWF: You mentioned the "three-legged stool" that is necessary to effectively transition to a low-carbon world. Are there particular examples where we can see this concept working effectively?

TW: We've seen select examples of how strong and balanced coordination between policy, technology and capital can support the build-up of clean energy technology. It is important to remember that energy is a commodity and commodities compete on price. A key role of policy is to help level the cost disadvantage that most clean energy technologies face relative to fossil fuels and, by doing so, further demand and capital deployment.

In the US, tax credits have been available to clean energy developers. Though there have been expirations to the tax credits, the most recent extension of these credits and the cash grants for clean energy development have provided a greater signal of certainty to the market. If you take the wind sector as an example, the cash grant policy was particularly helpful during a time of economic stress because, despite proven technology, a lack of tax appetite from traditional tax equity investors had significantly decreased capital flows to wind development. By enabling wind



One of the most important aspects of finance is connecting people, capital and ideas to drive solutions. At Goldman Sachs, this is exactly the role we are playing in the build-up of our clean energy future.



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developers to receive a cash grant in lieu of a traditional tax credit, more than 10 gigawatts of new wind generating capacity were built in the US during 2009. To put this into context, this was the largest year for wind development in US history and accounts for almost 40% of all new generating capacity in 2009.

Another example we've seen is in China with respect to investment in nuclear energy technology. In 2005, China released its 11th Five Year Plan, outlining its economic development initiatives for 2006 to 2010. This plan made clear the government's intention to significantly increase its nuclear energy capacity. Within a year, Toshiba Corporation enhanced its nuclear power generation expertise and global footprint by leading a consortium that acquired Westinghouse Electric Company for \$5.4 billion. There was a clear policy signal from the Chinese government and Toshiba followed it with capital investment in proven nuclear energy technology.

PWF: There seems to be a lot of good reasons to move clean energy development forward as quickly as possible. How important is a price on carbon to create incentives so that industry moves forward at a faster pace?

TW: Putting a price on carbon can impact clean energy development by establishing a market signal that will prompt companies to factor the costs of greenhouse gas emissions into their operating and investment decisions. In doing so, it helps level the costs for many of the low-carbon technologies and provides greater incentive for capital to flow towards innovation and scale-up.

The policy debates we've seen recently on this topic underscore the challenge of pricing an externality, such as carbon, through policies that cost something today, for an avoided consequence in the future.

The bottom line is that establishing a price on carbon can be an important policy tool. It is not a silver bullet. We have already mentioned the role of tax credits and cash grants. Complementary policies, such as renewable electricity standards that help stimulate demand and stronger coordination across states on transmission infrastructure and siting, also contribute towards the goal of decarbonization.

In addition, government policies play a meaningful role in spurring innovation for break-through technologies. Given the higher risks and spillover effects in the early stages of the technology life cycle, the private sector benefits from the partnership that government lends when it funds and coordinates research and development. An example is the Department of Energy's ARPA-E (Advanced Research Projects Agency-

Energy), which is modeled after the Defense Department's DARPA (Defense Advanced Research Projects Agency). DARPA, in working with academic institutions, created ARPANET, the primary catalyst behind the creation of the Internet and the subsequent basis for tremendous IT innovation.

PWF: How soon can clean energy become cost competitive with fossil fuels like coal, crude oil and natural gas?

TW: The commercialization of clean energy technologies is a very large emerging market. Like any emerging market, it is going to have volatility as it develops and becomes cost competitive.

The scale and magnitude of this emerging market means that its evolution will take place in a time period that is more analogous to a marathon than to a 100-yard dash. In the US, we have an enormous installed base of energy infrastructure that many would say works and works well. Modifying that installed base towards clean energy will be a significant undertaking. Additionally, the rapid growth of emerging economies and the expanding world middle class places increasingly high demands on our energy resources worldwide. Our Global Economics Research team recently published a report on the BRICs economies that indicates that China's economy could become as big as the US in less than 18 years. Overlay that with statistics on greenhouse gas emissions, with China below 5 metric tons per capita relative to approximately 19 metric tons per capita for the US, and you can quickly begin to appreciate the environmental impact should China's population of

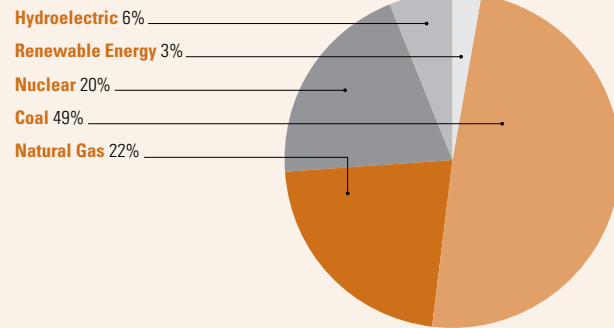
1.3 billion consume energy and emit greenhouse gases at a rate comparable to the US. We must find sustainable ways to meet the energy needs and support the continued growth of emerging economies around the world.

As for the cost competitiveness, recall that energy is a commodity that competes on price. This competition is constantly evolving. For instance, new estimates of significant unconventional gas reserves and new methods of extracting shale gas, puts downward pressure on natural gas prices, and further steepens the hill renewable energy sources must climb in order to be cost competitive. On the other hand, until energy storage technology further evolves, natural gas addresses the intermittency issue with renewable energy.

There are examples today in select markets where renewable technologies are at grid parity; however, those examples represent a very small percentage and are by no means comprehensive. This is where government can play an important role in developing policy initiatives that help stimulate the innovation and capital required to create low-carbon alternatives that are cost-competitive with fossil fuels.

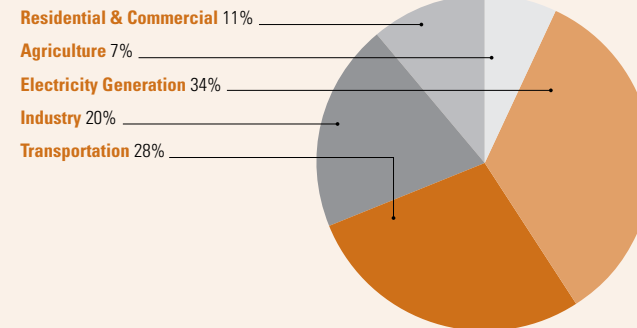
Energy Generation and Greenhouse Gas Emissions

US Electricity Generation by Fuel Type



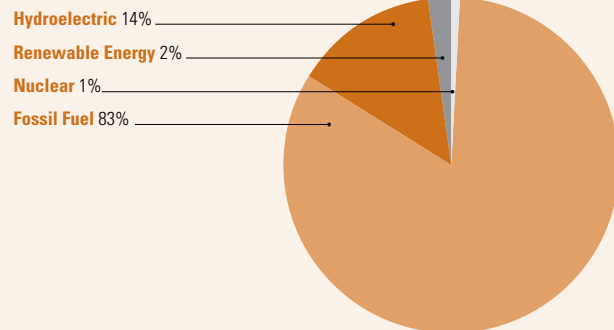
Source: US State Department, US Climate Action Report 2010; data represents 2008 electricity generation.

US GHG Emissions by Sector



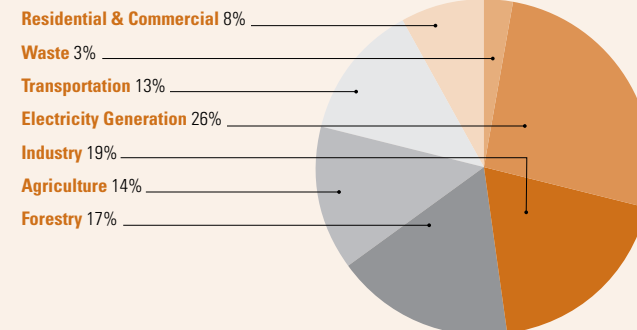
Source: US State Department, US Climate Action Report 2010; data represents 2007 emissions.

China Electricity Generation by Fuel Type



Source: US Energy Information Administration; data represents 2007 electricity generation.

Global GHG Emissions by Sector



Source: UN IPCC, Fourth Assessment Report, 2007; data represents 2004 emissions.

PWF: China has a very strong commitment to clean energy. How important will China's role be in developing and exporting clean energy technologies?

TW: China and the US are the world's two biggest emitters of greenhouse gases. Together, we account for close to half of the planet's emissions and, therefore, we have much at stake in pursuing the goal of a clean energy future. We both must lead the way, and in doing so, there are significant opportunities for partnership and collaboration between our two countries.

We've seen examples of collaboration between Chinese and American entities that facilitate innovation, access to markets and capital deployment.

One example is the creation of Lio Energy Systems, a joint venture between CODA Automotive, a Santa Monica, California-based electric car and battery company, and Lishen Power Battery, China's leading producer of rechargeable lithium-ion cells. Lio Energy Systems currently operates a one-million square foot lithium-ion battery system manufacturing facility in Tianjin, China. CODA has announced plans to build a similar facility in Ohio. This commercial collaboration between companies in the US and China will help address the environmental challenges of both countries and bring together complementary capabilities and skills.



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PWF: What role can government play to make sure the development of clean energy technologies is as successful as possible?

TW: There are many roles for government to play in scaling up clean energy technologies, and they have to be tailored for each country.

Europe has been a leader in helping to stimulate demand for clean technologies through policy initiatives, such as the European Union Emissions Trading System (EU ETS) and the solar feed-in-tariff (FIT). EU ETS is a policy mechanism that puts a price on carbon through a cap and trade mechanism. It is currently the largest emissions trading scheme in the world with over \$118 billion in total transacted volume in 2009. Despite this volume, the EU ETS is still a maturing market that will continue to develop post-2012 as it moves into its third phase of development. The solar FIT requires utilities to allow renewable energy access to the grid and pay the generator of the renewable energy a fixed price over a long-term contract that is generally higher than conventional power prices. FIT has been instrumental in creating the scale that has brought down the average selling price per watt (ASP) in the solar industry from approximately \$4.00/watt two years ago to \$1.50-\$2.00/watt today.

Similarly, the Chinese government has played a significant role in promoting the deployment of solar panels and wind turbines. In 2007, China announced a national plan to increase its renewable energy resources to 15 percent of its total energy consumption by 2020. Through policies that provide favorable

financing to develop and install new wind technologies and drive down production costs by stimulating domestic demand, China has doubled its wind capacity in each of the last five years.

In the US, the government has committed approximately \$150 billion of funding in various forms, including through the Department of Energy Loan Guarantee Program, to support our energy infrastructure, transmission, innovative low-carbon technologies and efficiency investments. These types of policies can provide much needed support when innovative clean energy technologies move from demonstrating technical viability to achieving commercialization, a stage where venture capitalists often find the scale of capital required too significant and commercial lenders find the risks still too great. Additionally, state and local government incentives, such as the California Solar Initiative and state-level renewable portfolio standards, have played an important role in the build-out of renewable generation in select regions.

There are other examples where government support can play an important role in scaling-up low-carbon solutions, such as energy efficiency. Energy efficiency measures are often referred to as the low-hanging fruit for achieving carbon emission reductions, but for a variety of reasons, including the dispersed nature of energy efficiency projects, behavioral challenges and uncertainty in quantifying cash flows from a stream of savings, they are not being widely implemented. As a result, we've seen several policy measures at the state level that have successfully promoted energy efficiency, such as energy efficiency resource standards, demand decoupling, or more efficient building codes, but we continue to lack large-scale adoption.

PWF: Is there an energy technology (ET) revolution likely to take place that is comparable to the information technology (IT) revolution?

TW: There are similarities, but there are also meaningful differences. What is similar is that both revolutions offer the opportunity to transform the way we live.

In the IT revolution, we went from records to CDs to mp3s... from pay-phones to cell phones to smart phones... it has evolved to the point where we are willing to pay more for our cable or cell phone bill – resources we think we need to survive – than we pay for water – a resource we actually need to survive.

An ET revolution could transform the way we live as well. Instead of an electric meter in our backyards, we would hold a smart meter in our palms. Instead of receiving an electric bill for the power we use, we would receive a credit for the power we generate in our home. Instead of pulling into a gas station, we would plug into our garages... the list goes on.

Another similarity is that both revolutions require a build-out of infrastructure. In the case of the IT revolution, infrastructure meant broadband networks and semiconductor technology.

An ET revolution will require similar investment in infrastructure, but the capital required and the political cross currents are often much more challenging. Consider the following as it relates to the transmission of renewable energy. Wind blows in the Dakotas, but the primary demand for that energy is in Chicago. Who pays for the wind project and infrastructure and how do you site and approve the transmission required to bring the energy across South Dakota, through Iowa, across Illinois and into Chicago? Government policy must play an important role in addressing this question.

The other big difference is the demand. Consider Moore's Law, named after Gordon Moore, co-founder of Intel, who predicted the doubling of processing power every 18 months. Moore's Law has validity because of human demand. Moore's Law is driven by our desire for more data and having all of that data at our fingertips 24/7. Without that demand, Moore's Law does not happen. Without that demand, the price of IT does not decrease every year.

We do not yet have the same demand driving a Moore's Law equivalent for the world's clean energy technologies. The challenge is creating the demand to achieve the scale necessary for energy from clean technologies to be cost-competitive with traditional energy sources.

PWF: Even though renewable energy capacity has been doubling every two years, it still produces only a small fraction of the total electric supply. In this context, can renewable energy ultimately produce enough electricity to make it a worthwhile area in which to invest on a large scale?

TW: To put it into context, if you add up all the renewable technologies in the US, apart from hydroelectric power, they supply just three to four percent of our energy needs. In Europe, this number is around seven percent. In China, it's two percent. Even if the US triples renewable energy generation – a significant accomplishment – it still would only represent roughly 10 percent of our generation mix.

While there is certainly a need for the expansion of renewable energy, it is just one part of the overall portfolio that we need to decarbonize our energy system. We will need to improve the efficiency of our energy systems, decarbonize our baseload energy sources by expanding our nuclear generation fleet and capturing carbon emissions from coal-fired power plants. Another element of the solution will be reducing emissions from the transport sector, which is currently dependent on oil.

As previously mentioned, natural gas is another relevant part of the portfolio, given the recent expansion of supply through new extraction techniques and its ability to address intermittency issues for renewable technologies like wind. Because natural gas is less carbon intensive than coal, it could serve as a near-term bridge as we scale-up other clean energy sources and transition to a low-carbon future; however, if the objective is to meet the emission reduction targets, natural gas is not a likely long-term solution.

Remember that the goal of decarbonizing our economy is an enormous task. There is no single solution, rather, it requires a broad portfolio approach.

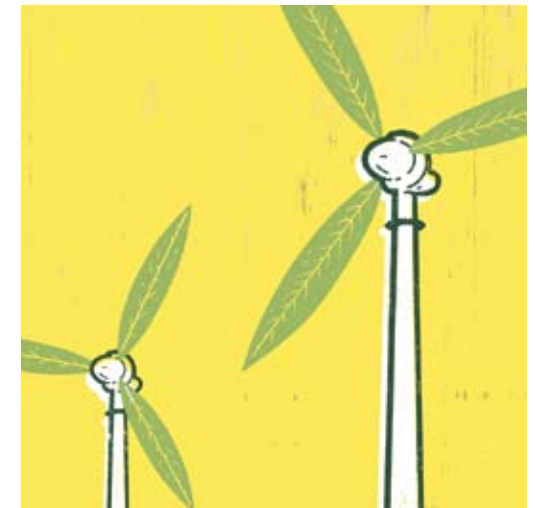
PWF: You mentioned nuclear energy. How important should nuclear energy be to the US?

TW: Nuclear power is roughly 20 percent of our energy footprint today, and roughly half of the operating licenses for the reactors currently in service expire before 2030.

In the US, plans for new nuclear power plants basically stopped in 1979 after the Three Mile Island accident. But nuclear technology has changed vastly since then and in some nations, like France, nuclear power counts for as much as 80 percent of electrical needs. Nuclear has succeeded in these select countries with government sponsorship. Given the length of time and amount of capital required to construct new nuclear plants, this sponsorship is vital. Many executives point out that a single nuclear project can approach certain utilities' entire equity market capitalization.

In order to accomplish the goal of decarbonizing our economy, at a minimum, we need to maintain the 20 percent of our power needs that nuclear currently provides. When you consider the nuclear build cycle, as well as how quickly the current fleet will expire, you realize that if we don't act quickly, we're going to miss the opportunity to maintain that 20 percent, let alone grow it.

In the US, the \$18.5 billion in loan guarantee authority that is currently available is essential for new nuclear development, but will not be enough on its own. The Department of Energy recently announced \$8 billion in loan guarantees to the Vogtle Electric Generating Plant in Georgia. Not only will the Vogtle plant benefit from the loan guarantees, but the Georgia Public Service Commission will allow for CWIP, or Construction Work In Progress. The ability to recover the cost of financing the plant during construction doesn't receive a lot of attention, but it is important.



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Water Risk Index Offers a Roadmap

Recently, Goldman Sachs partnered with General Electric and the World Resources Institute, a leading Washington-based environmental think tank, to develop a Water Index to measure water-related risks facing companies and their investors.

This project is born out of recognition that although water covers two-thirds of the Earth's surface, the amount of available fresh water amounts to less than one percent of all water. Global water consumption is doubling every 20 years. Water scarcity is especially acute in fast-growing economies and populations such as China and India, which together have one-third of the world's population, but less than 10 percent of its water resources.

The globally scalable Water Index will be a crucial tool to evaluate water risk and opportunity. The initiative aggregates nearly twenty weighted factors to assess cost, access, and potential disruption, offering a standardized approach to identifying water-related risk.

The pilot project, which is expected to be completed by the end of 2010, will create an in-depth analysis of a particularly water intensive industry in a region that has experienced water stress as the result of rapid economic growth: the thermal power industry in China's Yellow River basin.

PWF: Electric cars have been around for the better part of a century, and there have been several high-profile attempts to promote their widespread use, all to no avail. But with a number of soon-to-be-launched electric vehicles, will this moment likely be different from earlier attempts that fell short?

TW: The transportation sector alone accounts for over 30 percent of emissions in the US, and approximately 15 percent globally. It is clear that if we are going to address carbon emissions we must address the transportation sector, and electric vehicles are central to that strategy.

The advanced lithium-ion technology in electric cars today didn't exist ten years ago. It is this technology that allows electric vehicles to be broadly available to consumers. We will undoubtedly see continued improvement in battery technology during the next several years.

Traditional auto manufacturers, such as Ford, General Motors, Nissan and Toyota, are embracing electric vehicle alternatives in addition to start-up companies, such as CODA Automotive, Fisker Automotive and Tesla Motors, which are developing new electric vehicle models. As a result, model names, such as CODA, Karma, Leaf, Model S or Volt, will likely become familiar market brands in the near future.

A tremendous amount of time is being invested in understanding the infrastructure needs and demands on the electricity grid that comes with this technology. Members of Congress recently introduced two bills that would invest up to \$10 billion in electric vehicle deployment in select regions over the next six years.

PWF: What is the role for the financial sector, and specifically for Goldman Sachs, in this transition to a low-carbon economy?

TW: One of the most important aspects of finance is connecting people, capital and ideas to drive solutions. At Goldman Sachs, this is exactly the role we are playing in the build-up of our clean energy future.

We are pursuing what we believe is a very large emerging market through each of our core business functions: advising companies; financing investments; enhancing liquidity through market-making; and managing investor assets.

Since 2006, we have invested approximately \$3 billion of our own capital in clean energy technologies. During the same time, we have raised more than \$10 billion in financing for our clean energy clients around the world, providing the critical funding that these emerging industries need to ramp-up and become cost-competitive.

We have been an active participant in the European Union Emissions Trading Scheme as well as in the voluntary and pre-compliance markets in North America. By making markets through which these commodities can be easily traded, we enable more liquid, in-depth markets.

One topic that we haven't mentioned in the context of global greenhouse gas emissions is terrestrial carbon, which by some estimates account for nearly 20 percent of emissions. We have been deeply involved in seeking market-based solutions that value forests and other carbon sinks. In this effort, we have partnered with leading NGOs such as the Nicholas Institute for Environmental Policy Solutions, Resources for the Future and Woods Hole Research Center. Another example is Goldman Sachs and the Wildlife Conservation Society's partnership announced in 2004, which protects in perpetuity a vast tract of wilderness at the southernmost edge of

South America, on the island of Tierra del Fuego, Chile.

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We see the transition towards a low-carbon economy as an extraordinary opportunity for our clients to define and participate in a global energy market in transformation. This market is poised to become one of the largest global emerging markets and is critical to securing a more sustainable future. ■

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