The Future of Oil:

ENERGY SECURITY, CLIMATE RISKS, AND MARKET OPPORTUNITIES

June, 2007

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CIVIL SOCIETY INSTITUTE
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Ceres

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Summary of the October 4, 2006 Briefing at:
JPMorganChase

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PREFACE

Energy security concerns, climate change, and oil supply fluctuations are a growing concern for Wall Street leaders and policy makers.

Regional insecurities in the Middle East—the oil-richest part of the globe—are worse than ever before, threatening international security and global economic stability. Climate change and policies to address it are already affecting the global economy, with unpredictable changes in extreme weather and new regulations to try to solve the global warming problem. And as oil reserves have peaked in many parts of the world, and will soon peak in many others, the supply and demand curve is likely to drive prices higher throughout the 21st century.

In light of these trends, there are an abundance of new business opportunities in clean, safe alternatives available today. Academics have defined aggressive, yet achievable, solutions using existing technologies. And new cleantech solutions are developing every day. Venture capital into the cleantech sector is booming, and institutional investors capable of moving massive amounts of capital are also investing.

In October 2006, over 100 Wall Street analysts gathered at JPMorgan Chase to hear from eight oil market experts. The findings of this briefing lead in one direction: toward clean energy solutions. Money managers can diversify energy investments by moving capital into cleantech firms. Oil companies have the girth, R&D budget, and intellectual capital to speed the development of market-scale oil & gas alternatives. And governments can develop policy solutions that protect citizens from the effects of worsening climate change by supporting promising technologies and by being early adopters of such technologies. Governments can provide a ready and massive market to bring clean technologies to scale, driving down prices and driving up consumer acceptance.

Consumers all over the globe are looking for easy, seamless energy sources to light their homes, travel, build higher standards of living for themselves and their children, and to do all of these things in a way that is clean and sustainable for generations to come. Companies, governments, and investors who are looking to the future as business-as-usual will be left behind by this wave of market opportunities. It is up to the markets and policy makers to make this a reality. And it must start today.

Mindy Lubber
President
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Pam Solo
President
Civil Society Institute

EXECUTIVE SUMMARY

"Within every problem, lies a seed of opportunity. Climate change is no exception."

~ Lloyd J. Dumas, University of Texas

On October 4, 2006, over 100 Wall Street analysts and money managers gathered at JPMorgan's New York offices for a briefing from eight experts[1] on how the future of oil will be impacted by regional insecurities in the Middle East, the impact of climate change, and supply limitations. The panelists emphasized that the price of oil is expected to remain not only volatile, but also higher than historic norms; climate change regulations will have lasting impacts on the price of oil and drive demand for lower-carbon energy sources; and simultaneously, opportunities abound for investments in clean technology alternatives to oil.

- **Iraq is more unstable than ever before.** An Iraqi government of national unity has not developed, and Iraqi security forces have not matured to the point needed. U.S. options in Iraq include: expanding or maintaining existing levels of troops, withdrawing U.S. forces, or partitioning the country. Each of these options will put pressure on oil prices.
- **Geopolitical events in the Middle East impact the world economy.** Civil war in Iraq is only the beginning of a regional conflict that would wreak havoc on the world's most important oil-rich region. The Iranian government has been bolstered by the war in Iraq, and is not likely to slow its nuclear program. Saudi Arabia's "hands off" approach may change if the U.S. begins withdrawing troops, and drastic increases or decreases in oil production has been discussed as a weapon against Iran. Continued Islamic and Israeli-Arab conflicts complicate matters in this important oil-producing region.
- **The era of cheap oil is over.** A lack of crude "cushion" in the system, and limited underground reserves, leaves many analysts expecting the price of oil to remain around $50 to $75 per barrel in the near term, with a steady increase and possible price spikes toward the end of the decade. Some analysts even predict prices well over $200 in the next quarter century.
- **Climate change is already triggering economic impacts.** The costs of climate change are being borne out—in extreme hurricane events in North America, heat waves in Europe, floods and typhoons in Asia, and droughts in Africa. Governments at every level and in every region are considering or implementing new regulations to reduce greenhouse gas (GHG) emissions. Oil companies, and their investors, are feeling the effects of climate change, both through weather-induced damage to infrastructure and through regulations that will impact the market for their product. The costs of climate change will be passed to consumers through higher oil prices, which will lead consumers to increasingly seek out substitutes for fossil fuels.

- **Opportunities abound.** Renewable energy and energy efficiency solutions already exist and are being implemented to deal with the problem of unstable oil prices and the need for climate neutral fuels. Insatiable energy demand, energy security concerns, climate change pressures, and oil supply fluctuations all indicate that demand for clean technologies is not a bubble, but rather a trend that is here to stay.

- **Governments, investors, venture capitalists, and oil companies each have an important role to play.** While governments play a crucial rule in establishing the public policy framework to stimulate the growth of clean energy alternatives, they can also provide seed markets for new technologies to grow into robust, mature products. Venture capitalists and institutional investors have an important role in directing capital toward new businesses that develop sustainable energy solutions. And oil companies have the girth, financial wherewithal, and R&D expertise to drive new solutions to market.

Given this perfect storm of geopolitical instability, climate change, and limited supplies, leaders in Wall Street and Washington are now reconsidering the energy future of America. Smart investors, analysts, and companies are seeing bottom-line benefits to being early adopters and producers of low-carbon technologies that they see as the cash cows of the future.

THE FUTURE OF OIL: SECURITY, CLIMATE RISK, AND MARKET OPPORTUNITIES

Oil prices are no longer defined by a simple supply and demand curve, but are impacted by geopolitics, diminishing oil reserves, and a global push toward regulating carbon dioxide (CO_2), the primary human-induced greenhouse gas causing global warming. To better understand this changing investment and valuation environment, on October 4, 2006, over 100 Wall Street analysts and money managers gathered at the New York offices of JPMorgan for a briefing on the future of oil.

The briefing included presentations from eight seasoned practitioners in the fields of national security, oil valuation, oil exploration/refining/distribution, venture capital, and institutional investment. The presenters were: Trudy Rubin, Columnist, The Philadelphia Inquirer; Charles Maxwell, Analyst, Weeden & Company; Katherine Spector, Global Head of Energy Strategy, JPMorgan Chase Bank NA; Lloyd Jeff Dumas, Professor of Economics, University of Texas at Dallas; Bill Green, Managing Director, VantagePoint Venture Partners; Kevin Ball, Director of Low Carbon Business Policy, BP; Donald A. Kirshbaum, Investment Officer - Policy, Connecticut State Treasurer's Office; and Russell Read, Chief Investment Officer, California Public Employees' Retirement System (CalPERS).

The briefing resulted in several key findings. For Wall Street, the future of energy investments and stock ratings looks quite different than the past for several reasons. First, because of regional instability in the oil-rich Middle East and as a result of peaking oil supplies, the era of cheap oil is over. Second, climate change regulations are coming and will have profound implications for the oil industry. And finally, investments in a clean energy future are both profitable and necessary.

The Era of Cheap Oil is Over

Oil is expected to be a significant component of the global energy mix for the foreseeable future; however, the price of oil will remain both volatile and higher than the historic norm. Security concerns at the national and international levels, as well as geologic and infrastructure constraints on production, combined with rising climate change risks and new regulations on high-emitting sectors, are expected to maintain pressure on the oil markets.

High prices in the oil markets and futures, as well as falling prices for renewable technologies, will set the stage for an increasingly strong market for investments in alternatives to oil.

Political Instability in the Middle East

Iraq is the tenth largest crude oil exporter[2] and has the world's fourth largest proven oil reserves.[3] Iraq may have the second largest undiscovered reserves.[4] Its geographic position between Saudi Arabia and Iran, the largest and fourth largest crude exporters respectively, makes political conflict in Iraq even more destabilizing to global oil prices.

According to Trudy Rubin, a foreign affairs columnist for the Philadelphia Inquirer who has covered the Middle East for 30 years, "in any scenario the situation [in Iraq] stays unstable for a long time into the future." Rubin has been to Iraq seven times since 2003 and reports the

country to be more unstable than ever before. Two key elements for Iraqi stability that were assumed in the Bush Administration's post-war plans have not come to fruition: 1) An Iraqi government of national unity has not developed, and 2) Iraqi security forces have not matured/developed to the point needed.

Rubin described three potential options for U.S. engagement in Iraq, emphasizing that all three would lead to pressure on oil prices. The U.S. could pull out of Iraq, which nearly all experts agree would lead to civil war, and spiking oil prices. The U.S. could "stay the course" – maintaining and/or expanding troop levels – a scenario in which oil prices would remain volatile. Finally, the U.S. could partition Iraq, which would also likely result in civil war. In fact early in 2007, the Pentagon said that "some elements of the situation in Iraq are properly descriptive of a 'civil war'."[5]

The conflicts in Iraq do not occur in a vacuum. The Iranian government is more confident than ever before. In 2003, Iranian leaders were frightened by the U.S. threatening their regime; but in 2006, they feel they are the strongest country in the region. The U.S. has destroyed Iran's major enemies, Saddam Hussein and the Taliban. It seems unlikely that Iran will freeze its nuclear program, and the government has been openly helping the Iraqi Shiite militias. If the Bush Administration were to decide to bomb Iran's nuclear program in 2007, the impacts may include: solidified domestic support for the Iranian government because of a surge in nationalism; a delayed, but not destroyed, nuclear regime; an interrupted oil supply in the Gulf; unrest in all Shiite areas of the Gulf; and retaliation against U.S. troops in the region. All of these potential impacts would send oil prices sharply higher.

Rubin reports that much of the Middle East is entering an era of Islamist supremacy, inspired by U.S. policy in the region and Islamist success at the ballot box. Continued Islamic and Israeli-Arab conflicts complicate matters, and other regional conflicts will keep pressure on the price of oil. A Shiite-Sunni war would be devastating to oil prices in the Gulf.

Limited Oil Supplies

> ***"It will take an enormous surge in oil prices for behavior to change."***
> —Charles Maxwell, Weeden & Co.

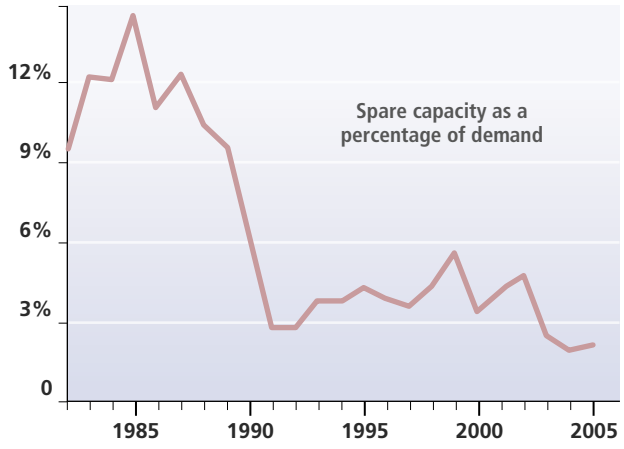
Oil and gas prices in 2006 were between three and four times higher than in 2002, and these price spikes are not likely to be followed by the deep valleys that characterized the price spikes after the 1973 oil embargo. First, worldwide demand for oil is growing faster than ever, at 4 percent in 2004 and 1.3 percent in 2005 (with most of that increase coming from developing countries).[6] The investment needed to meet this growing demand is roughly $4.3 trillion over the period 2005-2030 ($164 billion per year), and such investment is far from certain to occur.

Each year, the International Energy Agency (IEA)[7] has steadily increased its predictions for oil prices, with the 2006 World Energy Outlook (WEO) predicting prices of over $60/barrel through 2007, followed by a slight decline in prices through 2012, then a steady increase once again. Many analysts believe these numbers to be low.

Charles Maxwell, an analyst at Weeden & Company and one of the world's top analysts in the field, believes prices are likely to remain in the $50 to $75 per barrel range for the next few

Figure 1: Percent of Crude "Cushion" in Oil Supply System

Source: Wall Street Journal and PFC Energy



years. Unlike the IEA, which predicts a price slump around 2008, Maxwell predicts a renewed surge in prices that could lead to $85/barrel by 2010 and $285/barrel by 2015. Maxwell believes that during this vulnerable time period, conservation and efficiency will be essential to safeguarding against massive price spikes.

Unlike past price spikes, today's prices are exacerbated by the lack of crude "cushion" in the system. In 1987, the world had a surplus of oil supply over demand of nearly 20 percent. In 2000, 96 percent of oil capacity was being utilized, and the amount of utilized capacity has risen even further in the last six years. Today, people are using nearly all of the oil being produced, with an excess of only about 1 million barrels per day out of the 85 million barrels that are used (roughly a 1 percent "cushion" in the system). Maxwell described four factors that prevent re-establishment of an oil cushion:

1) **Lack of vision on part of the oil companies.** The oil companies did not see the surge in demand coming.

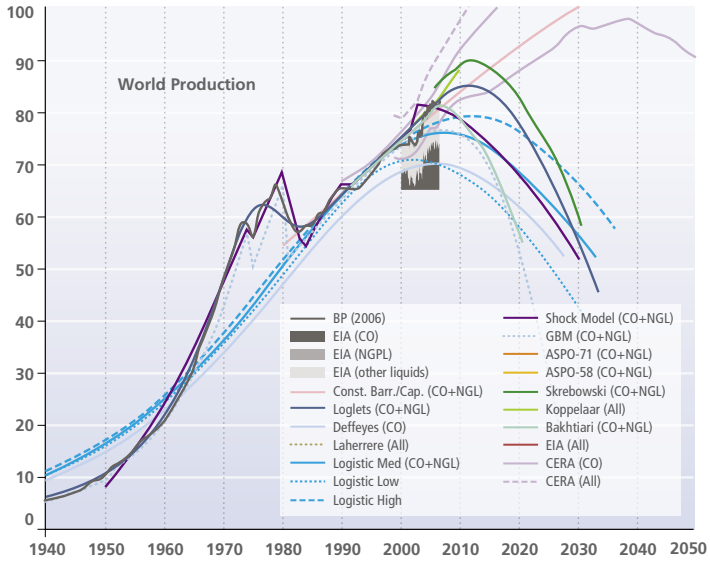
2) **Lack of focus, commitment, and talent from national oil companies globally.** Seventy-seven percent of world production comes from national oil companies, many of which are run more as political entities than commercial operations.

3) **Political Instability.** The geopolitics in the Middle East at present are more unstable than ever before, as described above.

4) **Hubbert's Peak Theory.** First presented in 1956, Hubbert's Peak Oil Theory states that oil production occurs in a bell-shaped curve. The theory assumes that the amount of oil is finite, and people will take the easiest oil first (close to shore, shallower wells, biggest structures, etc.), but that we will eventually need to get oil from more remote, deeper and smaller fields. Globally, "Hubbert's Peak" is expected to occur around 2015 if societies do not make any changes in demand. Eighteen countries say their oil production has peaked (America peaked in 1970, Russia in 1987), and China is close to peaking. Mexico probably peaked in 2004. As Figure 2 shows, nearly every model of peak oil shows global oil production declining after 2010/2015, with only a few models predicting continued growth of oil production.

Figure 2: Various Models of the Timing of Global Peak Oil

Source: TheOilDrum.com



Non-OPEC supply is expected to peak around 2010, perhaps earlier (see Figure 3).

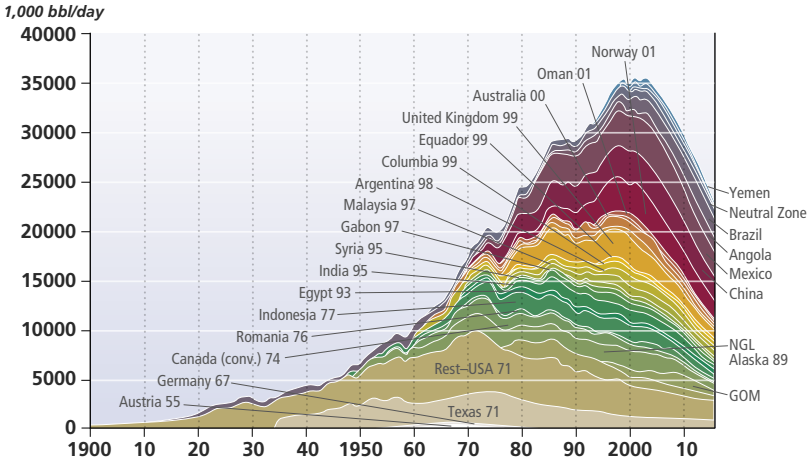
Once this happens, the price of oil will be set by OPEC, many of whose members are politically volatile nations.

According to Katherine Spector, Global Head of Energy Strategy at JPMorgan Chase Bank North America, neither OPEC, nor governments, nor oil companies, feel it is their responsibility to cover the cost of maintaining an oil cushion. Increasing certainty that oil prices will remain high in the long-term will lead to increased investment in alternatives. As a result, the cost of alternatives is bound to come down as production of renewables ramps up to help meet demand. There is also a need for efficiency, both in the production and use of oil and petroleum products.

According to the IEA, biofuels could capture between 4 and 7 percent of the transportation fuel market by 2030.[8]

Figure 3: Hubbert's Curve for Non-OPEC Countries

Source: IHS 2003, BP State Rev 2004; 2004: LBST estimate on Jan–Aug data Analyses and Forecast LBST



According to Spector, a "full cost accounting" of a barrel of oil, which would quantify in economic terms the many externalities associated with petroleum production and use, has never been done. If such an analysis were performed, the cost differential between renewable fuels and petroleum would likely decrease or disappear. Likewise, a full-cost accounting of alternatives to oil that are not renewable, such as tar sands in Canada, have not been completed to evaluate the wisdom of investing in such a carbon-intensive alternative that will only exacerbate the climate change problem.

An alternative energy horizon is likely to look vastly different across the globe. Already, in countries with poor electrical infrastructures, there has been a boom in off-grid solar electrification of rural villages. Similarly, depending on a country's natural resources, renewable alternatives to petroleum are likely to vary by region, with sugarcane-based ethanol dominating Brazil, and perhaps biodiesel growing in Europe where the market for diesel cars is dominant. The future for biofuels looks good in the U.S., where the federal policy environment seems to favor it, and the predominantly gasoline powered cars can be easily modified to use it.

Likewise, different oil companies are likely to seek a niche in different areas of renewable energy, with many even branching out of the transportation fuel business altogether. Companies such as BP have built a large stake in solar, wind and biofuels, while Shell has focused on both solar and wind.

Climate Change and Its Impacts

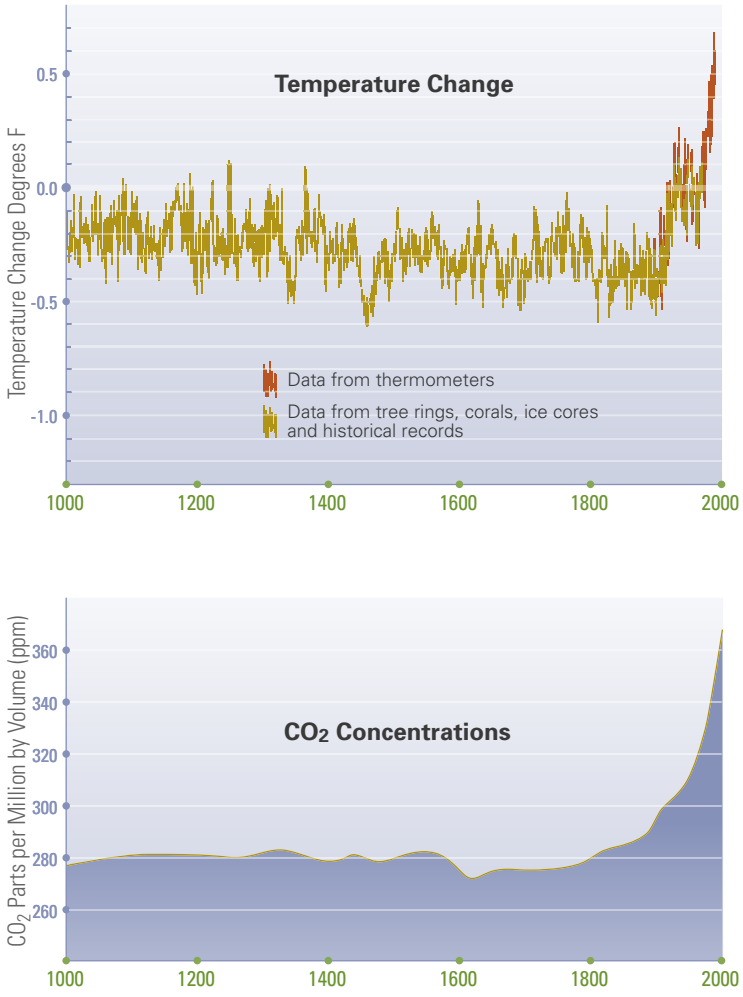
It is beyond the scope of this report to go into great detail on the science and impacts of climate change; however, there is scientific consensus that human-induced greenhouse gases from the burning of fossil fuels have contributed to a change in the Earth's climate leading to a rapid warming of the globe.

According to Lloyd Jeff Dumas, Professor at the University of Texas, the climatic system is both inertial and capable of abrupt change. Greenhouse gases are long-lived; thus even if GHG emissions stabilized today, temperatures would continue to rise for some time into the future. At the same time, a tipping point in the level of GHG's can cause major and rapid changes. Approximately 11,500 years ago, for example, the Earth's climate shifted dramatically over only a few years.

As warming occurs, scientists are observing unexpected feedback loops that may exacerbate global warming. For instance, Arctic permafrost stores massive amounts of methane, a powerful greenhouse gas. As the region warms, permafrost thaws, releasing billions of tons of methane that warms the region more, releasing additional methane and creating a dangerous feedback loop that, by itself, could increase global warming by 10-20 percent.

While scientists are still uncertain about precisely how climate change will play out, there is no question that it will impose significant economic costs. The EPA estimates that by 2050, worldwide annual costs due to climate change will be $500 billion per year,[9] and a 1 degree Celsius increase in average temperature could cause up to $2 trillion in damages by that time.[10] However, a recent report by Sir Nicholas Stern, Head of the U.K. Government Economics Service and Adviser to the U.K. Government suggests that these estimates are too low and that a 5-6 degree warming, which is "a real possibility for the next century, could lead to a 5-20 percent loss in global GDP.[11]

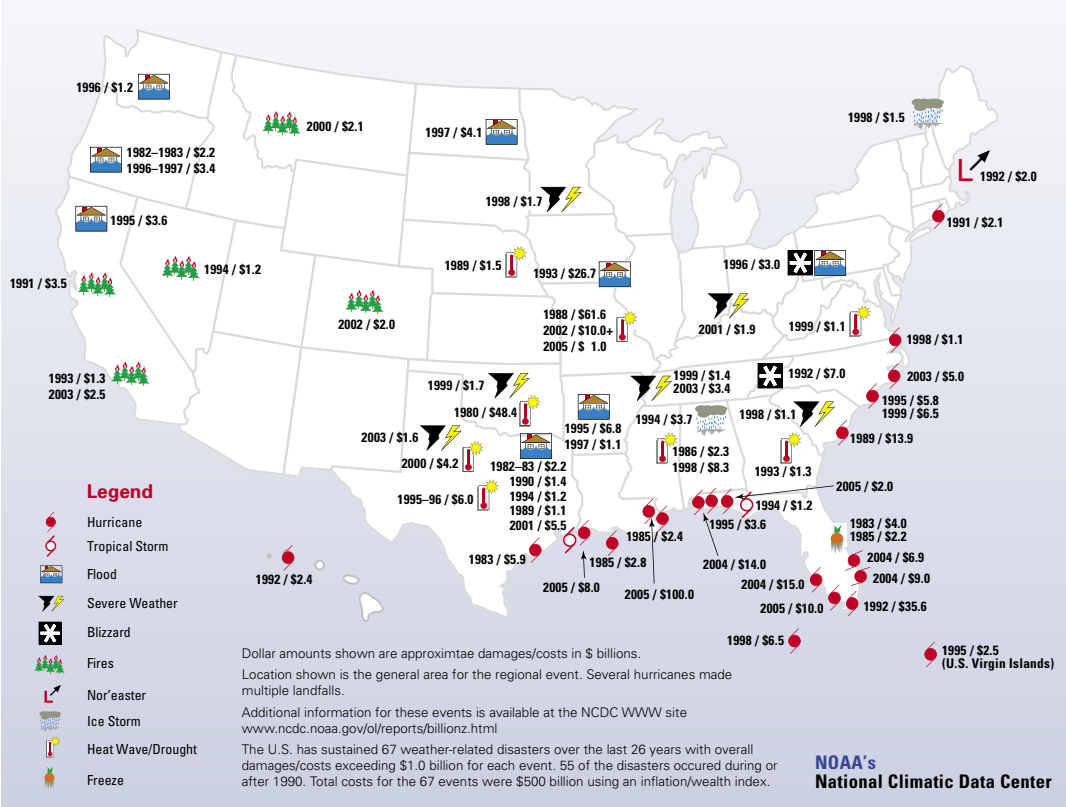
Figure 4: 1,000 Years of CO_2 and Global Temperature



By virtue of its carbon-intensive products and long capital investment horizons, the oil and gas industry is uniquely exposed to economic, competitive, and physical risks resulting from climate change. Petroleum fuels and natural gas are the largest sources of carbon dioxide (CO_2) emissions in America, accounting for 58 percent of the nation's total CO_2 emissions. As a result, the oil and gas industry faces climate risks and opportunities related to regulatory changes and to changes in weather resulting from climate change.

Climate Change Regulations. Both globally and domestically, regulations that limit CO_2 emissions will impact oil & gas companies both directly (through capping the industry's direct carbon emissions) and indirectly by driving the market toward low-carbon alternatives to oil and gas. In the past two years, the industry has seen the enactment of the Kyoto Protocol in dozens of industrialized countries, the first-ever carbon emissions trading program in Europe, and

Figure 5: Billion Dollar Weather Disasters 1980–2005



domestic legislation at the federal and state levels to reduce carbon emissions (see Appendix A). The world has also seen unprecedented global growth in the markets for solar, wind and other renewable energy technologies. In the electricity market, these regulatory forces will help propel solar and wind power—already the two fastest growing energy technologies in the world—to be cost competitive to coal and natural gas, posing a threat to the oil industry's bottom line.

Companies face risks in their oil businesses as well. In his 2006 State of the Union address, President Bush called for an end to the United States' "addiction" to oil, and in his 2007 State of the Union address, he called for 35 billion gallons of alternative fuels by 2017 to wean the country off of imports. In 2004, global production of biofuels exceeded 33 billion liters, about 3 percent of the 1,200 billion liters of gasoline consumed. Domestically, the 2005 US Energy Bill will increase production even further by requiring 7.5 billion gallons of biofuels to be sold by 2012, and Shell predicts "the global market for biofuels such as cellulosic ethanol will grow to exceed $10 billion by 2012." U.S. produced ethanol could top 50 billion gallons a year, displacing 2.6 million barrels per day of oil (about 13% of total current consumption).

Physical Effects of Climate Change. In addition to a new regulatory landscape, oil companies also face impacts to their business as a result of more severe weather events and changes in weather patterns due to climate change. While an entire report could be written on this topic, there are two broad areas where changes in weather may impact the oil industry.

First, the industry's infrastructure is at risk from both catastrophic weather events and

permanent changes to the environmental foundation on which pipelines and other infrastructure depend. For example, when Hurricanes Katrina and Rita barreled through the Gulf Coast in 2005, fueled by warmer water temperatures in the Gulf, they decimated critical oil production infrastructure, destroying 113 offshore platforms and seriously damaging pipelines and coastal oil and gas processing facilities.[12] These hurricanes caused nationwide petroleum shortages and caused surging gasoline prices at the pump. The U.S. consumer trend toward hybrid and fuel efficient vehicles soared.

Likewise, long-term capital investments may not properly account for climatic alterations. For example, the oil & gas industry has billions of dollars invested in infrastructure in Canada, Alaska, and other Arctic areas that depend on permafrost—or frozen ground—for support. When permafrost thaws, a process that has already begun faster than scientists anticipated, land that was once solid enough to support pipelines, roads, drilling platforms and other oil and gas infrastructure, transforms into a marsh-like ecosystem. Long-term capital investments are at risk of literally sinking away. The United States Global Change Research Program estimated that replacing existing pipeline damaged by permafrost could cost up to $2 million per mile.[13]

Second, less dramatic changes in weather can have significant impact on consumer demand for oil companies' products. With globalization pushing heavy industrial users of natural gas to leave the U.S. for Asia, the natural gas market in North America is increasingly weather-dependent, and the unusually warm weather experienced in the last several winters has thrown the natural gas markets into turmoil. The CEO of Chesapeake, a leading natural gas producer, recently declared that global warming is the "single largest threat to the natural gas industry" because of its potential to decimate winter heating demand.[14]

Opportunities Abound

Solutions already exist—and many are being implemented today—to deal with the problem of high and volatile oil prices and the need for climate neutral fuels. Venture capitalists, institutional investors, and major corporations are already jumping on the clean energy bandwagon.

New and Existing Technologies as Solutions

According to Professor Dumas, the United Nations Environment Programme projects that sales of renewable energy products and services will reach up to $625 billion by 2010 and up to $1.9 trillion by 2020. Similarly, $1.7 to $4 trillion in capital investment is needed by 2020 for renewables in the developing world. This is a tremendous opportunity for U.S. companies to capture new markets, a feat increasingly difficult in the "first world," yet many U.S. executives are not paying attention to this business opportunity.

The Renewable Energy Policy Network estimates that renewable energy already supplies roughly 4 percent of world power, and grid-connected solar power grew by 60 percent per year from 2000 to 2004.[15]

In his paper *Seeds of Opportunity: Climate Change Challenges and Solutions*, Professor Dumas identifies four opportunities related to climate change that have the potential to build profit: 1) technologies to reduce greenhouse gas emissions, 2) energy conservation devices and techniques, 3) greenhouse gas sequestration (storage) systems, and 4) increases in the

efficiency of alternative energy technologies. Many of these solutions have other benefits as well, such as reducing the U.S. dependence on foreign oil. Professor Dumas argues that it is important to "hedge our bets in this high stakes game by going for robustness and flexibility."

- **GHG reduction programs** such as cap and trade systems allow businesses to use their ingenuity to devise solutions that reduce GHG emissions. A permitting system would let companies trade GHG credits with one another to allow the market as a whole to reduce emissions in the most cost-effective way possible. Already, several U.S. states and regions have implemented CO_2 cap and trade systems (see Appendix A). Government can also serve as an early adopter of renewable technologies, providing a seed market for the technologies to come to maturity and scale.

- **Renewable energy sources**, such as waves, sunlight, wind, or tides, are relatively ecologically benign; however, their current cost means that they may require short run government subsidies to be competitive. There are three reasons that this is an acceptable solution: 1) it could help level the playing field by overcoming the enormous market distortion that resulted from earlier subsidies on oil and coal; 2) markets are not currently responding to the public costs of GHG emissions and if these costs were accounted for, renewables would be much more cost effective; and 3) subsidies for R&D are an investment not an expense.

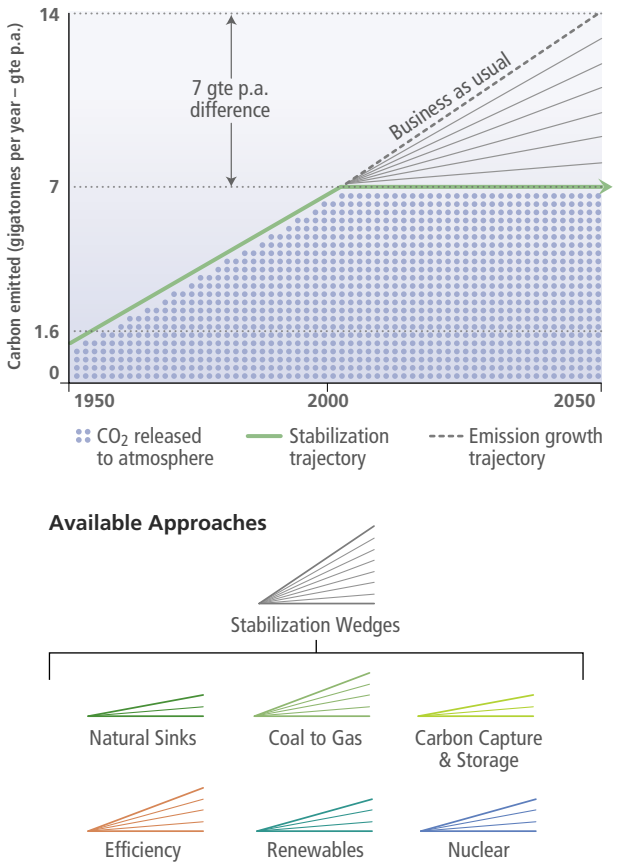
- **Efficiency** is another key part of the solution. In many cases, overall energy use can be dropped by 30 to 50 percent without changing living standards. By implementing simple solutions, such as windows that can be opened manually or light sensors, considerable energy can be saved. Likewise, over-design of buildings nearly always results in systems that waste energy. Recycling can also lead to significant efficiency gains.

- **Carbon dioxide sequestration** is also an area the offers significant business and profit opportunities. Sequestration of CO_2 underground is a largely untapped business, and if a 1000 megawatt coal burning power plant were built near an oil field, the injection of the CO_2 output from the power plant into the underground oil field could not only prevent the CO_2 from entering the atmosphere, but could also help increase oil recovery from the field.[16]

Kevin Ball, BP's Director of Low Carbon Business Policy, described the Pacala and Socolow Wedge Theory, which was developed by researchers at Princeton University. The Wedge Theory identifies a range of strategies that could achieve the goal of meeting a doubled energy demand over the next five decades (as is now projected) without increasing carbon dioxide emission rates above current levels. For each of these strategies, businesses have an opportunity to capitalize on technological innovation. Seven of fifteen

Figure 6: Socolow's Wedge Theory

Source: BP PowerPoint Presentation, October 2006



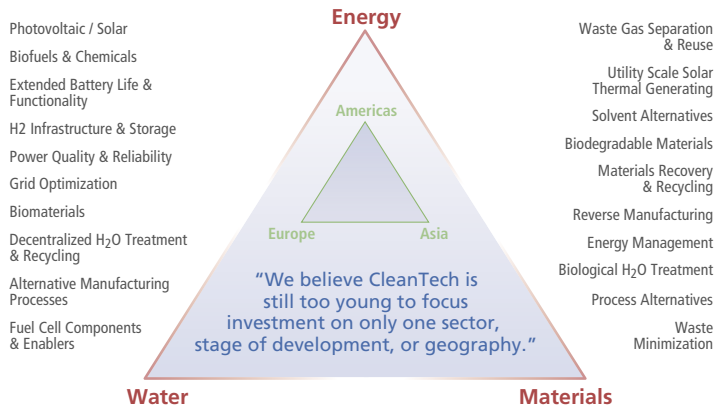
suggested strategies must be met in order to stabilize atmospheric GHG concentrations, and such strategies may include:

1. Using existing energy efficiency methods to cut carbon emissions from buildings by 25 percent.
2. Increasing fuel economy in cars so that 2 billion vehicles run at an average of 60 miles per gallon.
3. Using natural gas in place of coal at 1,400 one gigawatt generating plants.
4. Storing the carbon dioxide generated at 1,600 gas-fired generating plants.
5. Achieving a 50-fold increase in wind power.
6. Achieving a 700-fold increase in the use of solar photovoltaics.
7. Producing 34 million barrels of biofuels a day, using roughly 250 million hectares of arable land (approximately 16.5 percent of the world's available resources).

Venture Capitalists' Role

According to Bill Green, Managing Partner of VantagePoint Venture Partners, "CleanTech" venture capital has seen eight quarters of investment growth, and by 2009 there is likely to be $17 billion invested globally in CleanTech.[17] Activity in the various CleanTech sub sectors reflects their growing acceptance as reliable, cost competitive options: global wind and solar markets reached $11.8 billion and $11.2 billion in 2005 – up 47 percent and 55 percent, respectively, from a year earlier. The market for biofuels hit $15.7 billion globally in 2005, up more than 15 percent from the previous year. According to Clean Edge research, biofuels (global manufacturing and wholesale pricing of ethanol and biodiesel) will grow to $52.5 billion by 2015; wind power (new installation capital costs) will expand to $48.5 billion in 2015; and solar photovoltaics (including modules, system components, and installation) will grow to $51.1 billion by 2015.[18]

Figure 7: VantagePoint CleanTech Partners View of the CleanTech Landscape



Green believes that this rapid growth is not a bubble or investment fad, stating that the confluence of insatiable demands for energy, national and global security issues, climate change, and fluctuations in oil and gas supply make for a robust market for clean, renewable energy products and services, which is not to say that certain specific companies and sub-sectors will be free of artificial peaks and valleys. However, he believes that interest in CleanTech is likely to remain broadly robust, saying that if any two of these market forces remain in effect, the CleanTech market will be sustainable.

"CleanTech" has become a buzzword for the global emergence of technologies that deal with energy, water, and materials in a clean,

sustainable way. And venture capital in this space is the same as venture capital in any field: serving the investor, whose focus is on returns on investment. Examples of CleanTech from VantagePoint's perspective are shown in the image below. For venture capitalists, uncertainty about which company or technology will prosper requires a "market basket" approach.

Venture capitalists are not investing in CleanTech because they are environmental purists, but because they see the potential to create significant long-term financial value. Thus, companies do not necessarily need to promote "triple bottom line" credentials in order to attract CleanTech venture funds, but instead must show long-term financial viability. Green also emphasized that biofuels will develop at different paces and with differing mixes around the world. Sweden, which has already cut oil use in home heating by 70 percent in the last 20 years and has kept consumption flat in industry since 1994, despite a 70 percent increase in production, is now seeking to be free of imported oil by 2020 according to the Swedish government's panel on oil dependency. In Brazil, ethanol now accounts for as much as 20 percent of Brazil's transport fuel market.[19] However, in the U.S., consumers can't typically buy high ethanol blends at the gas station because the cost of biofuels is not yet in parity with fossil fuels. Government subsidies and tax credits for fossil fuels distort the current competitive environment. Different timelines in different countries presents a range of venture capital opportunities.

Green believes that in order to make CleanTech solutions viable, consumers have to want to buy them, and this requires that manufacturers think in new ways. Design is a measure of human intention, and people will buy more sustainable products only if they are, at the same time, cost effective and attractive. Thus, one of the tasks of CleanTech companies that face the consumer market is to deliver CleanTech products that not only demonstrate a positive environmental profile but that capture the consumers' imagination, as well. By doing so, they will speed adoption (a case in point is Tesla Motors, an all-electric sports-car that proves that

*Examples of Cleantech Companies That Have Received Venture Capital **

Angstrom: produces high density fuel cells for mobile devices.

BrightSource Energy: designs and builds large scale solar power plants for its industrial and utility customers worldwide.

Evergreen Solar: produces silicon cells that use a fraction of the silicon required to produce conventional solar cells; the process yields more than twice as many solar cells per pound of silicon as conventional processes.

Heliovolt, Miasolé, and Nanosolar: pursuing "thin-film" solar technologies, which use copper, gallium, selenium, and other elements to replace silicon entirely in the production of solar cells.

iWatt: power management for consumer and communication devices, reducing power consumption, size and cost of micro-devices.

New Energy Capital: provides project finance for distributed generation and renewable power.

SkyBuilt Power: produces the Mobile Power Station, a standard shipping container delivered to a disaster zone or an off-grid site; inside are solar panels, wind turbines, or other energy-producing components.

SolarCentury: designs and installs solar heat and power in the U.K.

Tesla Motors: developed a high performance 2 seat sports car that accelerates to 60 mph in under 4 seconds with extreme energy efficiency.

VeraSun Energy: makes technology to convert corn into fuel-grade ethanol.

**Information provided for illustrative purposes only and does not denote an investment recommendation.*

both style and peak performance are possible in an energy efficient car). Also important is to make the transition to clean technologies seamless to consumers. In the U.K., a recent test by a volume homebuilder indicated that homes built with solar integrated into the roof sold 11 percent faster than the same homes without solar, showing that consumers have an appetite for renewable energy if it is simple, integrated, and reliable.

Institutional Investors' Role

Institutional investors are big movers of capital and hold significant power in the market and with specific companies. Because energy costs can affect an entire portfolio for "universal owners" like pension funds and because institutional investors generally take the long-term perspective on investing, looking toward a new energy future is natural.

According to Donald Kirshbaum, an investment officer with the $23 billion Connecticut state retirement plan, the world ahead looks very different than the world behind. Many institutional investors are concerned about economic instability (for example, in Venezuela, the Middle East, and Sudan), the economy-wide impacts of energy price volatility (as consumers pay more for gas, they spend less elsewhere), and climate change's overall effect on the economy. Kirshbaum views a clean energy future not as a social responsibility issue, but as an economic imperative.

Climate change is predicted to have negative impacts on water availability, food production, and human health, and all of these factors are important to the value of overall portfolios. Additionally, climate change poses physical risks to the oil/gas industry and regulatory risks (in the form of carbon caps and the subsequent cost that these caps will impose on carbon emissions).

Yet institutional investors are not only looking to minimize risk. Like venture capitalists, many institutional investors are actively investing in clean energy alternatives. Investments in energy and materials stocks are expected to be an increasingly important investment opportunity.

According to Russell Read, Chief Investment Officer for the $218 billion pension fund of the California Public Employees' Retirement System (CalPERS), in 1980 energy and materials stocks comprised fully one-third of S&P500 market capitalization. However, by year-end 2000, these sectors accounted for less than 8 percent of the value of the S&P500. Today, these sectors account for 12.5 percent, and within a decade, CalPERS expects this percentage to exceed 20 percent.

By developing a clean technology program, investors can build superior long-term, risk-adjusted investment returns, while also catalyzing adoption of clean technologies in the broader marketplace, a cleaner environment for generations to come, and job creation in a new emerging industry. Examples of the types of investments that CalPERS is making can be emulated by other institutional investors:

- Private Equity
  - *Cleantech*
- Public Equity
  - *Developers of renewable energy technologies*

- Real Estate
  - *Green REIT's*
- Fixed Income
  - *Debt financing of projects and companies dedicated to renewable energy technologies*
  - *Provide credit enhancement for qualified municipal utility projects*

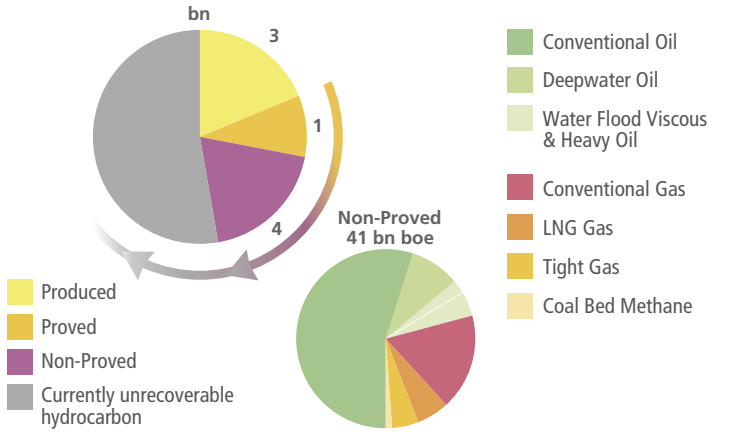
CalPERS believes that alternative and renewable energy opportunities are both increasingly attractive and sustainable over the coming business cycle; capital market opportunities are shifting towards the natural resources sector (including renewable technologies) across virtually all equity, fixed-income, and real estate markets; and the character of CalPERS natural and renewable resource investments increasingly involves multiple asset classes.

Oil Companies' Role

As one of the world's largest industries, oil companies have the capital and R&D talent to lead the development of renewable energies. According to Kevin Ball, BP's Director of Low Carbon Business Policy, smart oil companies are recognizing that geopolitics and global terrorism will affect oil supply in the future. Countries are already competing for resources, more and more regulation is coming into effect to manage climate change and energy security, and it is "not clear that the market alone will be able to mitigate against future risks."

These factors can be viewed as a risk to the old business model, or can be seen as an opportunity for new markets, new products, and new customers. To most oil companies, oil is still viewed as an important part of their portfolios for at least several decades. Most believe that there is still an enormous amount of oil in the ground, and that the core expertise of oil companies is figuring out how to find and extract it. The chart below shows an estimate by BP of global oil reserves, excluding exploration potential. Finding ways to bring these hydrocarbons to market without contributing to climate change (for example, by pumping and storing CO_2 underground) is a critical task.

Figure 8: BP's Estimates of Global Oil Availability

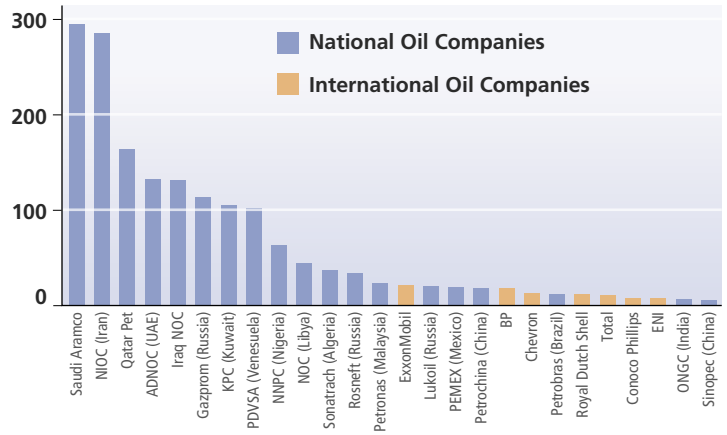


Nevertheless, according to BP, two decades from now the portfolio of most oil companies is likely to look very different. Alternatives to oil are being explored, produced, and marketed by oil companies as well as their cleantech competitors.

Importantly, as can be seen in the table below, the balance of power in the oil industry lies with the national oil companies rather than with the private companies. Thus, a commitment to a clean energy future must be driven not only by investors and corporations, but also by governments who control much more than the regulatory environment.

Figure 9: National Oil Companies Control Most of the World's Oil and Gas Proven Reserves

Source: Credit Suisse



As fossil fuels become increasingly fungible, oil companies—along with electric utilities—are beginning to transform into energy companies. Companies convert primary energy into various kinds of useful products (such as gasoline or electricity), and precisely how that is done is becoming more diverse. Oil companies and electric utilities are increasingly coming into competition with one another, and new entrants – such as GE and Siemens, along with cleantech start-ups – are entering the energy space as well to compete with big oil.

For oil companies, energy efficiency can be extraordinarily profitable. For BP, efficiency has been the most profitable project it has had in 10 years. With a $100 million investment, the company had $400 million in savings, an enviable R.O.I.

Parting Thoughts

On October 4, 2006, Wall Street analysts came together to discuss the future of oil in a world where geopolitics, climate change, peak oil and energy security concerns have altered traditional oil valuation methods for the foreseeable future.

National security experts described how regional insecurities in oil-rich parts of the world, including the Middle East, Russia, and West Africa, will leave global energy prices volatile and higher than historic norms. More and more governments are supporting and promoting alternatives to oil to lessen dependence on rogue states.

The world's remaining oil reserves are diminishing, and supplies are located in oil fields that are smaller, more remote, and more difficult to cultivate. Thus, while oil is likely to be a significant component of the world's near-term energy future, bringing that oil to market is expected to be more expensive.

Climate change is impacting oil and gas companies both directly and indirectly. Refineries, rigs, and distribution systems are at risk from changing weather patterns. New regulations to cap carbon dioxide emissions hit oil companies by requiring CO_2 reductions in refining and operations, and regulations are also expected to drive consumer demand for non-petroleum based products.

All of these challenges point to a different future for oil, one that is more expensive and more volatile. And the eight experts at the JPMorgan Chase briefing believe that opportunities are abundant for new investments in nascent technologies that can make energy safer for countries, less reliant on politically unstable nations, and free of global warming pollution.

Endnotes

1. Trudy Rubin, Columnist, *The Philadelphia Inquirer*; Charles Maxwell, Analyst, Weeden & Company; Katherine Spector, Global Head of Energy Strategy, JPMorgan Chase Bank NA; Lloyd Jeff Dumas, Professor, University of Texas; Bill Green, Managing Director, VantagePoint Venture Partners; Kevin Ball, Director of Low Carbon Business Policy, BP; Donald A. Kirshbaum, Investment Officer–Policy, Connecticut State Treasurer's Office; Russell Read, Chief Investment Officer, California Public Employees' Retirement System (CalPERS)
2. *Key World Energy Statistics*, International Energy Agency. October, 2006.
3. *World Energy Outlook 2006 (WEO2006),* International Energy Agency. October, 2006.
4. *How Much Oil Does Iraq Have?,* Brookings Institution. Iraq Memo #16, May 12, 2003.
5. *Measuring Stability and Security in Iraq,* March 2007 Report to Congress In accordance with the Department of Defense Appropriations Act 2007 (Section 9010, Public Law 109– 289), page 14.
6. *WEO2006*, op cit.
7. An intergovernmental body committed to advancing security of energy supply, economic growth and environmental sustainability through energy policy co-operation, the IEA acts as energy policy advisor for its 26 member countries in their effort to ensure reliable, affordable and clean energy for their citizens. The IEA was founded during the oil crisis of 1973–74.
8. *WEO2006*, op cit.
9. Dumas, Lloyd J. *Seeds of Opportunity: Climate Change Challenges and Solutions*. Civil Society Institute. April, 2006.
10. Kemfert, C. *The Economic Costs of Climate Change*. DIW Berlin's Graduate Center for Economic and Social Research. 2005.
11. Stern, Nicholas. *STERN REVIEW: The Economics of Climate Change*. U.K. Government. November, 2006.
12. United States Energy Information Agency. *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves 2005 Annual Report*
13. *US National Assessment of the Potential Consequences of Climate Variability and Change Educational Resources Regional Paper: Alaska,* October 2003
14. "Chesapeake CEO says low gas prices will eventually rise" CBSMarketwatch.com, October 3, 2006
15. REN21 Renewable Energy Policy Network. 2005. "Renewables 2005 Global Status Report." Page 4. Washington, DC: Worldwatch Institute.
16. Dumas, Lloyd. op cit.
17. INCR, CleanTech Venture Network Press Release, "*Largest Institutional Investors Eclipse $1 Billion Clean Technology Investment Goal*", September 21, 2006
18. Makower, Joel et. al. *Clean Energy Trends 2007*. March 2007
19. *The Wall Street Journal*, 16 January 2006

APPENDIX A: EXAMPLES OF PRESENT AND POTENTIAL CLIMATE CHANGE REGULATIONS

Level	Regulation	Details
International	**Kyoto Protocol**	• Covers 160+ countries globally (not U.S. or Australia) • From 2008–2012, developed countries must reduce GHG emissions an average of 5% below 1990 levels (specific national targets vary) • Companies can either reduce own emissions or purchase emission reductions from elsewhere
	China's regulation of auto emissions	• New 2008 fuel economy standards as high as 43 mpg for smallest cars and 21 mpg for largest • When fully implemented in 2008 and 2010, Chinese standards will be on par with those of the EU and more stringent than U.S. standards
	China's regulations on renewable energy	• National renewable energy requirement expected to boost energy consumption from renewable sources to 10% by 2020
	Japan's regulations	• GHG-reduction targets for major economic sectors • 23% reduction in vehicle CO_2 emissions by 2010 (from 1995 levels) and 12% improvement in fuel economy of large trucks and buses by 2015 (from 2002 levels) • 25–50% reduction in automobile tax and 200,000-300,000 yen purchase price deduction for low-emission and high-fuel economy vehicles • Target of 12.2 billion kWh of electricity produced by renewable sources in 2010 (4 times more than in 2002)
	Switzerland's CO_2 regulations	• 10% reduction in CO_2 from 1990 levels by 2010 • Different targets for different sources: emissions from heating fuels such as light fuel oil and natural gas must be reduced 15% from 1990 levels by 2010, while emissions from vehicle fuels such as gasoline and diesel must be reduced 8% over the same period • If it appears that the targets are not being achieved, the law authorizes the Swiss government to introduce a CO_2 emissions tax after 2004
	Taiwan's CO_2 regulations (proposed)	• Proposed law to cut GHG emissions & force Taiwanese heavy industry, utility companies, transport companies, and oil refineries to reduce or otherwise offset their dependence on fossil fuels

Continues...

Appendix A: Examples of Present and Potential Climate Change Regulations (continued)

Level	Regulation	Details
National	**McCain – Lieberman bill *(proposed)***	• Cap and trade system for all GHGs • Economy-wide coverage • Goal: reduce CO_2 emissions to 2004 levels by 2012, 1990 levels by 2020, 20% below 1990 levels by 2030, and 60% below 1990 levels in 2050
	Feinstein – Carper bill *(proposed)*	• Cap and trade system for all GHGs • Covers the electricity sector • Goal: cap GHG emissions at 2006 levels by 2011 and 2001 levels by 2015, with 1% per year reductions from 2016–2019 and 1.5% per year reductions from 2020–2050
	Sanders – Boxer bill *(proposed)*	• Cap and trade permitted but not required • Economy-wide coverage • Goal: 2% per year reduction from 2010–2020, reaching 1990 levels by 2020. Reduce to 27% below 1990 levels by 2030, 53% below 1990 levels by 2040, and 80% below by 2050
	Obama – Lugar bill *(proposed)*	• Goal: increase cellulosic ethanol production to 250 million gallons by 2012 • Goal: require 2 billion gallons of alternative diesels be mixed into the national diesel pool by 2016 • Goal: increase consumer demand for alternative fuels by providing short-term, 35¢/gallon tax credit for E85 fuel and by providing automakers with tax incentives to produce additional E85-capable Flexible Fuel Vehicles (FFV)
Regional	**Regional Greenhouse Gas Initiative (RGGI)**	• Cap-and-trade program for electric power sector in Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont (with Maryland to join in the summer of 2007) • Goal: stabilize emissions from the power sector at current levels from 2009 through 2015, with 10% reduction by 2019 • Some reductions will be achieved outside the electricity sector through emissions offset projects
	Western Regional Climate Action Initiative	• Arizona, California, New Mexico, Oregon, and Washington • Specific regional emissions targets by August 2007 • Establishment of market-based system by August 2008 • Will cover several sectors of the regional economy • May link up with RGGI

Continues...

Appendix A: Examples of Present and Potential Climate Change Regulations (continued)

Level	Regulation	Details
State	**California economy-wide cap on greenhouse gas emissions**	• Signed in September 2006 • Goal: reduce emissions to 1990 levels (25%) by 2020 • Details still to be worked out, requires California Air Resources Board to develop regulations and market mechanisms • Mandatory caps begin in 2012 for major GHG sources such as utilities, industries, and large businesses • Governor of CA and of NY agreed to explore ways to link California's future GHG emission credit market and RGGI market
	California utilities regulation	• Signed in September 2006 • Goal: prohibit CA utilities from buying electricity from out-of-state coal-fired power plants
	Illinois greenhouse gas reduction goals	• Announced in February 2007 • Goal: reduce state greenhouse gas emissions to 1990 levels by 2020 and 60% below 1990 levels by 2050
	Minnesota renewable portfolio standard	• Enacted in February 2007 • Goal: obtain 25% of the state's electricity from renewable power sources by 2025 – and for Xcel Energy, 30% by 2020
	States moving to limit CO_2 emissions from automobiles	• California: 30% reduction in CO_2 emissions from new vehicles sold between 2009 and 2016 • At least ten other states are adopting California's standards, would affect one-third of the North American market
	States regulating CO_2 from electric utilities	• Massachusetts (2001): aims for 10% combined reduction from 6 fossil fuel power plants • Oregon (1997): all new power developers must build and offset their energy facilities to meet a CO_2 emissions target 17% better than the most efficient base-load gas plant currently operating in the U.S. • New Hampshire & Washington also have laws

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