How to Reduce Future Climate Risk

In the rapidly growing economies of China and India, new pulverized coal plants are being built at an alarming rate.

Human society is performing a remarkable and uncontrolled experiment on the Earth. Because of the combustion of coal, oil and gas, carbon dioxide (CO2) levels are already higher than they have been for at least 430,000 years.

If such activities continue, CO2 will rise to levels not seen on the Earth for 30 million years or more.

CO2 is not the only cause of global climate change, but it is the primary cause. Reducing CO2 emissions is a necessary step to avert a potentially catastrophic future.

Many countries have adopted a global target of 550 parts per million (ppm), roughly a doubling of the pre-industrial value, as a safe and reasonable level that can be achieved over the next century.

The truth is that no scientist really knows what CO2 level is safe. What we do know is that even if CO2 levels stabilized today, the Earth would continue to warm as oceans and ice sheets gradually adjust over decades and centuries to their new atmospheric boundary conditions, bbc.co.uk reported.

Because the response times of the oceans and glaciers are so long, by the time we see a catastrophe on the horizon, such as the collapse of the Greenland ice sheet (equivalent to six meters of sea level rise), it will likely be impossible to stop it.

Coal Issue

Even a stabilization level of 550 ppm may be very difficult to achieve. Once released from a smokestack or tailpipe, CO2 remains in the atmosphere and surface ocean for centuries.

Moreover, the lifetime of a coal-burning power plant can be 50 years or more, so energy choices we make today will determine our path for the next many decades.

With the ratification of the Kyoto Protocol by Russia, the world sits at a crossroads.

Many developed countries are taking bold actions to reduce their own greenhouse gas emissions. However, it seems unlikely that substantial and effective actions will be sustained if the US is not engaged in the process.

Certainly it will be difficult to persuade developing countries to participate without US involvement.

Do the political and economic incentives or the relatively minor emissions reductions introduced by the Kyoto Protocol lead to the long-term investments in infrastructure that are required to stabilize carbon dioxide below 550 ppm? I suspect not.

Although it is good for countries to agree to work on the problem together, I fear that the Kyoto Protocol does little to face our major challenge: how to get energy from coal without releasing CO2 to the atmosphere.

Coal has the highest CO2 emissions per unit of energy, and coal will remain inexpensive long after the supplies of cheap oil and gas diminish over the next few decades.

Even with more widespread use of renewable energy technology and nuclear power, coal will remain a major source of energy, particularly in those countries with the highest energy demands.

Thus, it is not a question of whether China, India, and the US will use their vast coal reserves but rather how they will use them.

In the rapidly growing economies of China and India, new pulverized coal plants are being built at an alarming rate.

US Opportunity

There are some alternatives on the horizon, including coal gasification technology that produces a concentrated effluent of CO2 that is easier to capture and store underground.

But whatever technology is used, the developed world must work with the developing world to prevent the release of CO2 from coal combustion into the atmosphere if the goal of CO2 stabilization is to be achieved.

Animated Guide: Climate Change

This analysis identifies a new opportunity for the US to play a leadership role in reducing our exposure to future climate change.

One could envision bilateral agreements between the US and China, for example, in which the US provides financial assistance to US companies who produce energy in China without emitting CO2, while China provides access to its rapidly growing energy market.

High Oil Prices Here to Stay

The forecasts estimate world oil production will grow from about 80 million barrels a day to 120 million barrels a day in 2025.

Although the recent flurry of record oil prices might be temporary, government analysts said Thursday that $30-a-barrel oil should be expected for decades to come.

Crude is likely to cost about $35 a barrel in 2025, an increase nearly a third higher than predicted a few years ago, according to a long-term energy outlook report issued by the federal Energy Information Administration.

Guy Caruso, the agency's director, said long-term predictions for energy prices 20 years into the future are difficult and subject to change should there be unexpected global events that might affect oil supply or demand.

The agency's forecast is largely dependent on current assumptions about future oil production and expected economic growth, which will determine the intensity of demand for oil and other energy sources.

The forecasts estimate world oil production will grow from about 80 million barrels a day to 120 million barrels a day in 2025.

The report estimates that neither US production nor consumption will change dramatically in the next 20 years and that US refineries increasingly will have to depend on imported crude.

The higher prices, estimated at $31 a barrel in 2010 and $35 a barrel in 2025--not accounting for general inflation--are not expected to be high enough to force a significant decline in demand, the forecast said, myrtlebeachonline.com reported.

Increased conservation and improvements in efficiency are likely to be largely nullified by increased demand because of economic growth, the report said. It said US demand for petroleum products in 2025 is expected to be 2 percent less than it is today.

The agency estimated domestic oil production would increase about 6 percent by 2025 and that the country "is expected to become increasingly dependent on imports," which by then will account for two-thirds of the oil consumed, up from the current 56 percent.

Oil prices have been more than $40 a barrel for much of the past seven months and peaked in October at more than $55 a barrel. Prices rose again at the end of last week.

Many economists say the recent surges in oil prices this year do not reflect a long-term trend. Current global tensions, including the war in Iraq and the threat of terrorism in Saudi Arabia, could affect supplies. Some analysts have estimated this "fear factor" might be adding $10 to $15 on the cost of a barrel of oil.

Two years ago, when oil cost about $27 a barrel, the agency's long-term forecast predicted a barrel of crude would cost about the same in 2025, not counting general inflation. Last year, when crude was costing about $32 a barrel, the agency again estimated prices would be about $27 a barrel by 2025.

Russia Sees Hydropower Spinoff, Market Doubtful

Russian utility monopoly Unified Energy System, trying to inject life into stalled power sector reforms, said on Tuesday it planned to set up the nation's first federal wholesale hydroelectric power company by end-2006.

In a statement, the company said its board of directors would discuss the creation of the unit, which will have more than 22,000 megawatts capacity, at a Dec. 24 meeting.

Power sector restructuring is a major battlefield for market reforms in Russia but analysts say the wheels have come off in the politically fraught process.

While UES Chief Executive Anatoly Chubais has been putting pressure on his board to approve the creation of wholesale generation companies, the government has responded with further delays.

UES was hit by a flurry of downgrades after Energy Minister Viktor Khristenko said on Nov. 24 that the sale of wholesale generation companies, a cornerstone of power sector reform, was not on the agenda of a key government meeting on Dec. 16.

Khristenko has said the government will delay for at least 12 to 18 months the first sale of power generating assets--the second delay in a year.

"One step forward but how many backward?" Nikoil brokerage asked in a recent research note.

"The details of the most crucial reform issues--the terms and conditions for privatizing wholesale generating companies--have yet to be defined by the government, which we believe is poised to stall the reform process," it said, yahoo.com reported.

Under power sector reforms, Russia plans to break up UES by spinning off a wholesale hydropower company as well as six new wholesale generating companies and 14 regional generators, which will be auctioned to investors, Reuters reported.

Shareholders would then receive pro-rata shares in all divested companies. Over 40 of the regional utilities called energos are due to be broken into their constituent businesses, which will each be valued so that share swap terms can be set.

The reform process is being shaped up by an influential government committee that includes Khristenko, Chubais as well as aluminium tycoon Oleg Deripaska, whose business benefits from access to cheap electricity from UES.

The growing influence of Deripaska, whose RusAl is the world's third-largest aluminum producer, has worried some analysts.

"What's surprising is that a businessman with such obvious and compelling vested interest in stalling reform is invited to the top government table to elucidate government policy," United Financial Group brokerage analyst Derek Weaving said.

"According to Deripaska, the Russian power sector does not need reforming. Since the profitability of Deripaska's core business relies crucially on continued, privileged access to very cheap electricity supplies, this is not surprising."

Analysts expect little from the Dec. 16 government meeting.

"We wonder whether any voice will speak up in favor of just getting on with privatization," said Weaving.

"Rather, we expect further detailed deliberations on interim market rules, whose purpose seems to be to introduce competitive markets without having any competitors and to liberalize consumer prices, while ensuring that no one actually pays them."

Molecule Harvests Water's Hydrogen

The key to producing clean hydrogen energy is finding a non-polluting method to extract pure hydrogen from its most abundant source--water.

Researchers have been working for decades to develop catalysts that make it possible to use energy from sunlight to extract hydrogen from water. These materials absorb energy from photons in order to speed the rate at which electrons combine with hydrogen in water molecules to split water into hydrogen and oxygen.

Such catalysts are commonly made from the semiconductor materials used to make computer chips. Researchers are working to find catalysts that can extract energy from a greater portion of sunlight's spectrum and use the energy to move electrons more efficiently, technologyreview.com reported.

Virginia Polytechnic and State University researchers have developed a large molecule, or supramolecular complex, that combines sub-units that absorb light with sub-units that accept electrons.

The complex could be used to produce hydrogen for clean-burning combustion engines and fuel cells.

It has been known for years that molecules containing the metal ruthenium absorb solar light well and could produce enough energy to carry out hydrogen production. The stumbling block to producing such molecules is getting light to generate two or more electrons at a time, which is required to generate enough energy to split water.

The researchers' molecule has light-absorbing ruthenium subunits on each end, connector subunits near the middle and a reactive rhodium sub-unit in the center that collects electrons and delivers them to water.

Figuring out how to design, prepare and use a supramolecular complex capable of using light to collect electrons took more than a decade of work, according to the researchers.

The researchers presented the research at the 228th American Chemical Society National Meeting held in Philadelphia on August 22 through 26, 2004.

Deep Sea Hydrocarbon Factory

A team of University of Minnesota scientists has discovered how iron- and chromium-rich rocks can generate natural gas (methane) and related hydrocarbons when reacted with superheated fluids circulating deep beneath the floor of the Atlantic Ocean. Because the process is completely non-biological, the hydrocarbons could have been a source of "food" for some of the first organisms to inhabit the Earth. Also, methane is a potent greenhouse gas, and this process may have contributed to global warming early in geologic time, the researchers said. The researchers--Dionysios Foustoukos and Fu Qi and their graduate adviser, professor W.E. Seyfried, Jr.--will present a portion of this work Monday, Dec. 13, at the American Geophysical Union meeting in the Moscone Convention Center, San Francisco.

The most familiar sources of methane are bacteria that live in bogs, lakes and the stomachs of ruminants like cows. But before any life existed, there must have been an energy source that could be tapped by primitive life forms. The simplest sources are hydrogen-rich compounds like hydrogen gas, hydrogen sulfide gas and hydrocarbons, physorg.com reported.

In the laboratory, the researchers recreated the intense heat (more than 700 degrees F) and pressure (400 times air pressure at sea level) that exist on the ocean bottom in parts of the Mid-Atlantic Ridge (MAR). The MAR, which runs in a jagged north-south line beneath the Atlantic Ocean, is a site where upwelling magma is slowly pushing huge slabs of crust apart, exposing portions of the Earth's upper mantle. It contains structures called hydrothermal (hot water) vents, which spew superheated fluids into the seawater. The team found that under such conditions, hydrocarbons--methane, ethane and propane--could be produced on the surface of minerals rich in iron and chromium. These hydrocarbons may help account for the diverse communities of life that typically thrive around hydrothermal vents.

The process of hydrocarbon production occurs in two steps. In the first, an iron compound in rock strips water of its oxygen, liberating hydrogen gas. In the second step, hydrogen gas and carbon dioxide (from the degassing of magma) combine to produce methane and water. The Minnesota team discovered that rocks rich in chromium minerals accelerate the second step, while also producing more complex hydrocarbons--ethane and propane. Both likely serve as food for some bacteria.

"The second step is a reaction well known to chemists," said Seyfried, a professor of geology and geophysics. "But in several papers published in the last few years, researchers have noted great difficulty in forming hydrocarbons more complex than methane. Dionysios [Foustoukas] showed that in the presence of chromium-bearing minerals, it could happen.

"Chemists might want to tweak this process and see if they can produce hydrocarbons more efficiency. But we want to get clues about what goes on in hydrothermal vents and to understand how hydrocarbon gases are generated in the continental and oceanic crust."

In related work, Seyfried and his colleague Kang Ding have built chemical sensors that can be placed in hydrothermal vents to measure such items as acidity and the amounts of gases like hydrogen and hydrogen sulfide, which also serve as energy sources for microbial communities. Acidity also seems to play a role in hydrocarbon synthesis in submarine hydrothermal systems. To access the vents as deep as two miles beneath the sea surface, the researchers use the submersible ALVIN; they have now dived to a number of vent sites.