July 2006 Trendevents

Russia and Iran Lead the New Energy Game

By Pepe Escobar Asia Times 14 July 2006

Whatever the West may have thought about it, Russian President Vladimir Putin has already spectacularly preempted this weekend's Group of Eight (G8) summit in St Petersburg with his own bit of Pipelineistan news. Putin announced in Shanghai on June 15 that "Gazprom is ready to support the construction of a gas pipeline from Iran to Pakistan and India with financial resources and technology".
He was referring to a fabled US $7 billion, 2,775-kilometer, 10-year old project - an Iranian idea - which should now be finished by 2009, developed by Gazexport, a Gazprom subsidiary. As a result, by 2015 both India and Pakistan should be receiving at least 70 million cubic meters of natural gas a year.

Thus the two top global gas producers - Russia and Iran - reached a strategic partnership abiding not only by their own interests but the interests of India, Pakistan, China and part of Central Asia, something that spells nothing less than an auspicious economic future for a great deal of Asia - independent from any American interference. Washington was not amused.

Not surprisingly, everyone else in the region begged to differ. For Iran this represents the coveted Pipelineistan way to the east. India will save at least $300 million a year. Pakistan will receive as much as $600 million a year in transit fees. The pipeline will inevitably be extended to Yunnan province in China. No wonder the announcement was made at the annual meeting of the Chinese-inspired Shanghai Cooperation Organization (SCO).

The Russian masterstroke is to divert the bulk of upcoming Iranian gas exports to Asia - while Russia is still negotiating a very complex and very lucrative deal with Brussels to supply the European Union. Tehran and Moscow have reached a remarkable agreement. Putin and Iranian President Mahmud Ahmadinejad will be working in tandem. In Shanghai they all but decided to consult on all matters regarding gas prices and the new routes of Pipelineistan. Control of prices plus transportation routes obviously spell out a gas OPEC (Organization of Petroleum Exporting Countries) just around the corner

(Putin though was careful to dub it just "a joint venture", not a cartel).
Now, a decade and a half after the end of the Cold War, the US and Russia's lines of friction are startlingly similar: Eastern Europe, the Black Sea basin, Ukraine, Moldavia, Georgia and Iran. Sixty years ago, the Soviet Union offered Iran an energy partnership. Now Moscow is offering not only a nuclear partnership - building the nuclear reactor in Bushehr - but still an energy partnership, in the manner of selling its own gas wealth the most profitable way for both sides.

Putin is an accomplished chess player. Accusations of heavy-handedness - on civil liberties and on energy policy - aside, the Kremlin does not need a confrontation with the "colonialist" West (the qualification is Putin's). What it needs is to find the best use for the massive financial flows that are pouring over Russia. The Russian weekly Vlast identifies "a new Russophobia in the West, hypocrite and erroneous". The Russian response is to challenge the West to accommodate to its own terms. The Kremlin calls its own internal experiment "sovereign democracy". As the Kommersant daily put it, "the West must answer to a series of ultimatums posed by Russia, including its refusal of European rules on the energy market, it particular position regarding Iran and the assurance of non-intervention on Russian internal affairs".

Putin's message to the G8 is loud and clear: we're back. And this Gazprom nation, also reveling on oil at $75 a barrel, and rising, is doing things its own way - like exterminating, with perfect timing, public enemy number one, Chechen rebel leader Shamil Basayev, or banishing homeless people, street vendors, intellectuals and opposition voices from St Petersburg ahead of the G8 summit. There's virtually nothing the West can do about it. Russia is not struggling to be part of "the West" anymore; it has evolved its own system, and not unlike the Middle Kingdom, at the center of the system lies the Kremlin.

Preemption is the (Russian) name of the game. Russia's strategic partnership with China has been solidified via the SCO. On the ultra-sensitive Iranian nuclear dossier, Moscow's game is extremely flexible, and all about nuance, as are Russia's relations with the Islamic world. It is charging market prices to both Ukraine and Georgia for its gas. And sooner - rather than much later - the gas OPEC with Iran and Central Asia may be a done deal.

The Oil Frontier

By Bryant Urstadt http://tinyurl.com/q94p5

The easy oil is gone. To get to the new oil, you board a yellow Bell 407 helicopter outside New Orleans and fly south, touching down 140 miles offshore, on a ship that's drilling holes in the seabed nearly a mile below.

Along the way, you fly down a 50-year timeline of American offshore oil extraction. Through the glass panel at your feet, you watch the delta slide by with its flat islands of green and its fishing camps, occasionally passing the remains of a barge rig -- the first and simplest water-borne oil rigs, which simply settled in the mud and drilled. After the barrier islands come the brown waters of the continental shelf of the Gulf of Mexico. Here, the platforms increase in number but are only slightly more complicated; of the roughly 4,000 platforms in the gulf, most are simple scaffolds standing on the bottom in 30 to 200 feet of water.

Out here, 4,300 feet above the seafloor, floats Discoverer Deep Seas. Leased by Chevron, it's a ship that would have been too expensive to use 10 years ago, a ship that represents 20 years of advances in the art and science of oil extraction. It's not particularly beautiful. With its derrick amidships and its rusty waterline, Deep Seas looks like a ghost tanker trying to make off with the Eiffel Tower. But it is a breathtaking expression of ingenuity, and a glimpse of what we'll increasingly have to do to get energy.

The ship is so big that my incomplete tour will take a day. It's 835 feet long -- on end, it would be the height of an 80-story skyscraper -- and 125 feet wide. Because it is so tightly packed with machinery, a visitor winds through Deep Seas rather than walking its perimeter, as one might on a cruise ship, and never gains a full sense of its size.

My guide is Eddie Coleman, the lead drill-site manager on Deep Seas. A quiet Texan in a denim Chevron shirt and jeans, Coleman has spent the past 32 years offshore, working two weeks on and two weeks off, shuttling between his home of Brookhaven, MS, and platforms and drillships progressively farther offshore and more advanced. Like most of the people I meet in this business, he says he wouldn't want to do anything else.

Coleman is in a decent mood, but he could be happier. Last night, the drilling in a well that Chevron calls PS002 stalled at 20,351 feet. Deep Seas doesn't produce oil; it drills for it, capping the wells and leaving them to be put into "production" by equally expensive and complicated floating platforms. The oil field that Deep Seas is exploring is called Tahiti, and it's about 24,000 feet below a 5-by-1.5-mile section of seafloor leased from the Minerals Management Service of the U.S. government, in an area known as Green Canyon. PS002 is the second well of a scheduled six, and the whole field is slated to go into production in 2008. Chevron hopes to pump 125,000 barrels a day out of Tahiti.

Pumping is a long way off, though, and now the drilling has stopped, too. "We tagged something," explains Coleman, "but we're not sure what. So we're tripping right now." To "trip" means to bring the drill bit back up or send it back down. Coleman and a team back in Houston have decided that the casing, the tube that is dropped down in increasingly narrow segments as drilling progresses, in order to maintain the integrity of the well, has probably gotten out of round or developed a spur of some kind. So once they've tripped the bit back up, they'll send down a mill to bore out the casing. And when they've retracted the mill, the bit will have to be tripped down again.

The trip takes about 12 to 13 hours either way, and it's expensive. Deep Seas is leased from a company called Transocean, and the daily rent is about $250,000. With the cost of labor and equipment, drilling in Green Canyon costs Chevron around $500,000 a day. Casing, for instance, costs around $100 per foot. The drill bits run around $80,000 each, and there are 140 to 175 well-paid people onboard, from cooks to highly trained geologists. Developing the Tahiti field will cost about $3.5 billion.

Because of financial pressure, Deep Seas hasn't been back to shore since it was launched five years ago. Every six months or so, a supply ship pulls up alongside and pumps a million gallons of diesel onboard. The fill-up takes about 24 hours. The diesel runs six generators, which send five megawatts of power to each of six electric omnidirectional thrusters, which keep the ship in position. On a calm day like this, the thrusters, fed by GPS data and overseen by a team of dynamic-positioning operators on the bridge, keep the 100,000-metric-ton ship essentially stationary; it drifts only by inches over the well below.

A Race to the Bottom
The term "deepwater" generally refers to wells drilled in more than 1,000 feet of water, and Chevron, like all the big oil companies, has kept a weather eye on deepwater prospects for years. An exploration well in the leased Green Canyon region, for instance, was drilled in March 2002, and it went down 28,411 feet, through a two-mile-thick layer of salt and into a 400-foot-deep pay zone of sand and oil.

In November 2002, Chevron began developing the oil field, starting with a series of appraisal wells drilled at its estimated north and south ends to offer a clearer idea of what was there. The results were better than Chevron expected. The pay zone looked to be 1,000 feet thick and 7.5 square miles in size. If all goes well, Tahiti ought to be about a 500-million-barrel field, a huge find in today's market.

Lured by such prospects, oil companies have been pressing into ever deeper water, with Chevron, Kerr-McGee, and BP leading the field in the Gulf of Mexico. Abroad, major prospects include the waters off West Africa, the South China Sea, and possibly even the Mediterranean. From 1997 to 2003, the number of deepwater projects in the Gulf of Mexico grew from 17 to 86. The number of ultradeep-water projects in the gulf, those in more than 5,000 feet of water, has more than doubled in the last two years alone. In the past 10 years, as inshore wells have slowed down, deepwater oil production has risen more than 840 percent.

When Chevron began developing Tahiti, it ordered a platform. Like everything in the deepwater field, platforms are moving toward new heights of size, complexity, and cost. They can't simply rest on columns driven into the seabed, so they have to float; but otherwise, their design varies. Some platforms, like BP's Thunder Horse -- currently the largest, it is bigger than the largest aircraft carriers and took 15 million man-hours to build -- float on pontoons. Tahiti's platform will be designed as a spar, which is often likened to a Coke can. The spar is delivered horizontally to the site and then tipped into place as its bottom fills with saltwater ballast.

At a time when oil prices have been as high as $75 a barrel, such costly equipment more than pays. It follows that Chevron and Transocean have already worked out a long-term lease on a yet larger ship, Discoverer Clear Leader, which is to be delivered in 2009 and will cost Transocean some $650 million to build. Similar in many ways to Deep Seas, it will have a larger drive unit at the top of the derrick, allowing it to drill in up to 12,000 feet of water, boring as far as 40,000 feet below sea level. It's expected to cost Chevron roughly $750,000 a day to lease and operate.

Twelve thousand feet of water is bordering on the practical limit of exploration, at least in the Gulf of Mexico. It may not be as far as technology can take deepwater drilling, but it is probably as deep as Chevron will need to go to get oil. "Get any deeper, and you're leaving the sedimentary deposits of organic matter that make oil," says Paul Siegele, who oversees the company's offshore exploration and development in the gulf. "The bottom of the deep ocean is just solid basalt." Not that the oil companies haven't started to survey the deepest ocean floors anyway, just in case.

Roughnecks and Mud
Coleman takes us through the Deep Seas' 200-bunk living quarters, its offices, and the bridge, and then out onto a catwalk that hovers over the deck. Below is a rack holding "risers," 75-foot-long sections of pipe that house the drill string on its way to the seafloor. The drill string isn't actually a wobbly piece of cable but a series of 130-foot-long hollow pipes "strung" together, which push the bit down through the risers and into the earth. Enormous cranes lift each section of riser onto a conveyor belt. The belt then tips and guides each riser into position in the derrick.

The catwalk follows the riser belt onto the drill floor of the 226-foot-tall derrick. It's the derrick, a giant scaffold narrowing toward a peak, that you think of when you think of an oil well. From it hangs the hook holding the drive that spins the drill string and the bit below. There used to be a guy way up there, on what's called the monkey board, but automatic pipe-racking systems have recently replaced him. Dozens of sections of drill string are stacked inside the Deep Seas' derrick, and they swing with the slow motion of the ship. Beneath the drill floor -- which we'll visit later -- is the moon pool, the one spot of transcendent beauty on Deep Seas. There, the risers and the drill string within vanish into a pellucid square of water, fish shimmering around them.

We leave the derrick and head down a few stories to see the mud module, which looks a little like a cross between a brewery and a sewage treatment plant. "Mud" is one of the most important tools in the driller's kit, though it is rarely thought about or mentioned outside the industry. A synthetic or petroleum-based lubricant, mud is sometimes said to look like chocolate milk. Deepwater drilling requires the synthetic version, which was developed in the mid-1990s. It has two outstanding qualities: it maintains its lubricating properties under higher pressures than the traditional diesel-based mud, and is not classified as a pollutant by the U.S. Environmental Protection Agency. In the mud module, just past the derrick, are stored 15,000 barrels of the stuff, which -- at $165 a barrel -- is a king's ransom in mud.

Mud does more than lubricate, though. It is pumped down the well -- through the drill string and out the bit -- and it comes back up inside the riser, bringing with it "cuttings," chips and shards of sediment and rock. Mud can be made in different weights, at great depth it exerts immense pressure on the casing and on the walls of the "hole", the freshly drilled bottom of the well. That keeps equally huge geological pressures from collapsing the well or, worse, starting oil flow too early, which is the definition of a "blowout."

After leaving the mud module, we head back along the deck until we meet Hercules, a remote-controlled submarine, which is currently sitting under a crane and ready to swing out alongside the ship. At 4,000 feet below, everything is done by the unmanned Hercules; it is simply too deep for human divers. Hercules is a box of mechanical arms, propellers, cameras, and lights overseen by contract technicians. Of its two remote arms, one is controlled by joystick and the other by a glove of sensors attached to the hand and arm of the operator. The setup is accurate enough to turn a half-dollar-sized bolt with a wrench.

The $8 Million Question

In some ways, Deep Seas itself is a remote vehicle, directed by Chevron's Houston office. This becomes clear on our return to Houston, where, the next morning, we watch Curt Newhouse at work. It's just before 8:00, and Newhouse is sitting in a room with 20 other people, trying to make a decision. If his decision is wrong, it will be expensive; in his job, pretty much every type of error is. "No matter what, it always seems to take about $8 million to fix," he says.

The room he's sitting in is called the WellDecc, or Well Design and Execution Collaboration Center. Here, every morning, Newhouse and a group of geologists, petroleum engineers, and earth scientists -- the subsurface team -- gather to decide what to do next on Deep Seas.

In the WellDecc is a conference table that does not quite accommodate all the staffers. Crammed in, they all face a wide screen, which has a number of windows projected on it, controlled by a desktop computer and a wireless keyboard in front of Newhouse. One window is a video feed of the team on the Deep Seas, while another shows the group in the WellDecc. Another window is a graphic display of the progress of the bit, and the last is dense with numerical measurements from the well. Newhouse will move and manipulate these and add others throughout the conference.

Newhouse's staff has been watching everything that has happened on the drillship in the past 24 hours. Information about mud weight, bit depth and speed, the resistance of the material being bored through (to determine whether it contains oil or water), and the kind of stuff coming up with the mud is all uploaded to Houston, where it is pored over in each cubicle until the group gathers each morning... Because of what he has learned about yesterday's drilling, geologist David Rodrick is worried that the bit is moving too quickly through the layers of the Miocene era, which settled between 5 million and 23 million years ago.

There are many such layers -- containing a lot of sand -- and Chevron numbers them by their rough age in millions of years. In this well, the bit is at M12, the pay zone is at M21, and each level is at a different pressure. Drilling from one layer down to another is a delicate operation, and the integrity of the hole is maintained by the pressure of the mud pumped into it. Too little pressure and the hole or the casing above it could collapse. Too much and leaks could develop, or fractures in the rock, disturbing mud circulation.

Having already drilled two wells nearby, the subsurface team knows that at M17, the pressure ramps up quickly. The $8 million question is when to stop drilling and step down to the next size in casing, which can withstand more intense pressure. Reduce the casing size too early and you needlessly lose valuable oil flow. "We don't want a straw down there," says Newhouse. "We want to see a good 30,000 barrels a day." Stick with the bigger casing too long, and the deepest part of the well may collapse before it can be cased. Newhouse, though, isn't convinced the bit is close enough to the M17 sands to change the casing yet. He's thinking about the future of the well, 10 years down the road, and he wants to see a good flow, not an overly conservative casing decision.

Looking for More
Behind the drillships and platforms, and the superintendent in the WellDecc, are the computer geeks, whose efforts to guess where the oil is are often credited with enabling the deepwater rush. One of them is Barney Issen, the Jerry Garcia of Big Oil. A guy with a beard and long wavy black hair parted in the middle, he happily admits to driving for years with a "Question Authority" bumper sticker on his car. He has questioned how the earth came to be, too. "Most of us ended up here because we had that moment on the mountain, wondering how it all came to pass, and how we could learn more about it," he says. For Issen, that path led to a degree in geophysics -- he originally wanted to work on a moon shot -- and a job running the computers at Chevron.

To get an idea of where oil is, ships with special air cannons send out blasts of vibration, which travel down tens of thousands of feet and back. The velocity of the returning signals, and their round-trip times, are recorded by sensors on miles-long cables dragged behind the ship. Signals reflected by different strata have different speeds, which helps geologists picture what lies below the ocean floor. The big problem in deep water is the layers of subsurface salt, which refract vibrations in confusing ways. "It's like trying to see things through those cubes of glass, or through the edge of a fish tank," explains Issen... Every year, Issen gets better at making sense of erratic signals. Computers have been getting faster and algorithms more powerful, and oil companies are beginning to be able to see through the salt with some degree of certainty.

When Chevron gets ready to talk about drilling, it gathers with investors, often other oil companies. They meet in a room they call the Visualization Center, and they all look at Issen's models on an 8-by-25-foot screen. Investors bring their own models to the conversation, and a consensus about where the oil is begins to emerge. It's still a business that requires guesswork: three out of four deepwater drills are unsuccessful. But not long ago, companies drilling on land hit oil in only one of every ten wells... As the oil companies get better at finding the oil, though, the oil is getting harder to find.

But while it is true that a lot of good oil is left in the deep waters of the Gulf of Mexico -- the Minerals Management Service estimates that about 44.5 billion barrels of oil remain to be discovered -- deepwater drilling is only a small part of the solution to the oil shortage. Although Chevron considers the 500-million-barrel Tahiti field an "elephant" of a find, for example, elephants aren't what they used to be. Saudi Arabia's Ghawar field, which was tapped in 1951, has already yielded some 54 billion barrels and may have 70 billion more. The United States alone, meanwhile, consumes roughly 20 million barrels of oil every day... Bryant Urstadt has written for Harper's and Rolling Stone.

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Lucerne Fuel Cell Forum
2-6 July 2007, Lucerne / Switzerland

Fuel cells are energy converters, not energy sources. They will be part of a sustainable energy solution only if they can compete with other conversion technologies. Time has come for a critical assessment.

We need fuel cells for available fuels, not synthetic fuels for new fuel cells. Natural gas and oil-derived liquid hydrocarbons will be around for many years. However, their use will be restricted by costs, environmental concerns or even political reasons. Sustainable hydrocarbons like bio-methane, bio-ethanol and bio-methanol from organic waste, wood or farming are already replacing fuels of fossil origin. Hydrocarbon fuels will be important forever and so will fuel cells capable of directly converting these fuels into electricity.

The impressive performance of phosphoric acid, molten carbonate and solid oxide fuel cells clearly indicates that these fuel cell families can meet the challenges of a sustainable future. Some of these fuel cells have reached 65,000 hours of operation with the first stack and natural gas or bio-methane.

It is highly uncertain that synthetic hydrogen can ever be established as a universal energy carries. Electricity from renewable sources will be the source energy in a sustainably organized future. The direct distribution of electricity to the consumer is three to four times more efficient than its conversion to hydrogen by electrolysis of water, packaging and transport of synthetic energy carrier to the consumer and its conversion back to electricity with efficient fuel cells. By laws of physics, hydrogen economy can never compete with an "electron economy".

But the laws of physics cannot be changed with further research, investments or political decisions. A sustainable future energy harvested from renewable sources (nuclear energy is not sustainable!) must be distributed and used with the highest efficiency. A wasteful hydrogen economy does not meet the criteria of sustainability. As a result, a viable free-market hydrogen infrastructure will never be established and fuel cells for hydrogen may not be needed. For all applications electricity from hydrogen fuel cells have to compete with the source electricity used to make hydrogen.

The European Fuel Cell Forum is committed to the establishment of a safe energy future. Therefore, it will continue to promote fuel cells for sustainable fuels, but discontinue supporting the development of fuel cells for hypothetical fuel supplies. Time has come for decisions. Keeping all options open is not an adequate response to mounting energy problems.

I would like to thank all who have contributed to establish the European PEFC Forum. You and your colleagues have developed a magnificent technology, but the fuel needed to make it work is not offered by nature. We cannot solve the energy problem by wasting energy. The laws of physics speak against a hydrogen economy. Physics cannot be replaced by wishful thinking, or changed by presidential initiatives, research programs and venture capital. Solutions must be implemented soon as long as resources are available for this most challenging task. Ulf Bossel, Ph.D. (Hydrogen: A dead-end Technology<><><><><><><><><><><><><><><><>

Change http://www.dailyplanettv.net/2006/06/09/editorial-on-global-climate-change/ Story by Lucas van Grinsven, European Technology Correspondent Editorial on Global Climate 7/9/06

First, I should say that I have not seen the movie by Al Gore. I have not followed or read the popular opinion maker's take on this subject. I do not care what the politics of this subject are. This is an issue of scientific fact and theory. It is not an issue of politics and therefore any political aspect of this subject is irrelevant to me or my analysis. I am a scientist; and what I know about this particular subject is a result of the job I do. I am a strategic analyst for a group whose job is to gather, examine, analyze and synthesize huge sets of facts and data into a predictive pattern. And then I am asked to predict what will be occurring at some point in the future. I use monstrous computational power along with massive databases - and an almost carte-blanche access to just about anything that is wired to the net.

Here is what I know to be true.
Global climate change is occurring. This is a fact that is NOT in dispute. Overall temperatures are in a rising phase according to every record keeping data set we have. NASA storm data from satellites show that storms are increasing in number and intensity. Temperature is rising and storms are increasing. By definition, climate on the Earth is changing. There are ONLY two areas of disagreement. First, is this a climate fluctuation (meaning temporary) or a climate shift (meaning permanent - at least in human terms)? Second, is this a natural set of events or did we have something to do with it? And if we had something to do with it, did we just exacerbate an existing problem (are we just one of many contributing factors and we just added our little bit)? Or did we alone CAUSE it to happen? NONE of these specific issues are agreed upon.

The most likely situation is that the extreme positions (it is a natural phenomenon or that we alone caused it to happen) are incorrect. Climate change is happening; it probably is not a completely natural change; and it is more than likely that we had something to do with it. From a strategic analysis perspective, if we had something to do with it, then it is not relevant how much we may be contributing or whether we alone are responsible (I'll explain below). What the analysis shows is that any contribution made to global climate change by us - is critical. So the only real question (from a tactical view) is whether there is anything we can do to stop affecting it. I have heard the position that it is arrogant for us to believe that we could affect the global weather. The general premise of that argument is that the Earth is so large that we cannot really have an effect on the planet as a whole. This same argument was used in the issue of ozone depletion. Opponents of the plan to reduce ozone-depleting chemicals from use said that the damage to the ozone layer had to be due to some other source. Their position was that the amount of chemicals released into the atmosphere could not possibly be enough to affect the ozone layer. They also suggested that any restriction on the ozone depleting chemicals would have a negligible effect on the ozone layer.

But the reality has turned out much different in more ways than one. By strongly curtailing the release of ozone depleting emissions, the ozone layer has actually healed up in places much faster than was anticipated. This is good news for the ozone layer but it brings up a few very important questions that are requisite in our understanding of the issue of global climate change. First, if the problem was so big, how could it have been corrected so quickly in certain instances? Second, would the atmosphere have corrected itself whether we reduced the ozone depleting emissions or not? And finally, could this mean that the ozone depleting emissions were not as destructive to the ozone layer as were previously believed? These are all good questions that we did not have the answers to - until after we restricted ozone depleting emissions and measured the response of the ozone layer. And the answers have to do with the way very, very, very large systems behave during times of transition.

Let me explain. In the past twenty years or so, mathematicians have developed a new form of mathematical analysis and computation called fractal geometric complexity math (also referred to as chaos dynamics). This system of math was developed as we began to attempt to do calculations that involve enormous quantities of individual components or pieces (ultra large sets). Using massive computer power, scientists created models of real life phenomenon such as weather, chemical, astronomical and atomic systems, that had previously been beyond the capability of human calculation. And this is what they discovered. When a system is composed of many, many, many individual pieces (on a level and scale beyond comprehension in normal life) then the system begins to show unique and unpredicted behavior - called emergent properties. When that system undergoes expansion (increase in the numbers of individual components) then these emergent behaviors very slowly increase - until a critical point is reached.

At that critical point, the system will either squelch down and stabilize at a lower activity level, or the system will undergo rapid and radical system expansion and growth corresponding with a massive increase and intensity of activity. This new level of violent activity and growth will maintain as long as the energy and individual pieces are supplied to feed the growth. Once either element is limited, the system will stabilize. If the overall system is large enough, then this phenomenon can be represented in multiple areas of the system (like storms occurring in different places all over the Earth). If the overall energy and rate of the expansion in certain emergent behaviors is great enough, then either the new emergent activity will be sustained indefinitely (like the eye-storm on Jupiter) or the stabilize point (where it stops changing) will be significantly different from the starting point.

This is best explained by example. Anyone who has studied chemistry is familiar with the idea of a buffered solution. In simplistic terms, a buffered solution is a liquid that has a reacting chemical in it, as well as, another chemical which is the buffer. When a third chemical, that is reactive to the main chemical in the solution, is added to the solution then the buffer prevents the reaction between the two ingredients from occurring. Even as more of the chemicals are mixed, the buffer prevents the chemicals from reacting. As long as the buffer is working, there is very little if any change in the solution. In a typical buffered reaction, the reagent (second chemical) is continually added (and the buffer prevents a reaction) until a critical point is reached. At this point, the chemical reaction between the main chemical and the reagent occurs. The reaction occurs rapidly and completely (the reaction completely consumes all of one of the two ingredients and then stops). What does this mean for global climate change? It means that there is no way to tell a normal fluctuation from the beginning of a catastrophic shift until it is too late. The beginning trends in both a temporary fluctuation and a major shift are expanding, but only moderately. The difference in a fluctuation that stops and reverses, is that one of the elements (energy or individual pieces) stops increasing in time. If neither of these stops in time, then there will come a point where the next small increase, will be the "straw that broke the camel's back" and a catastrophic shift will begin. This critical transition point shifting is fact. It is supported by the most advanced math we know. And this math accurately models every known example of large system dynamics we have ever examined with it.
The math cannot tell us when a catastrophic shift will occur in any large system (such as global climate) but it tells us that it will definitely happen once that critical transition point is reached.

Which brings up the issue of strategy. Maybe man-made ozone depleting emissions were not to blame for the destruction of the ozone layer. But their elimination was just enough to start the reversal process and allow the Earth to begin healing the holes that had opened up in the ozone layer. It is one of the unique characteristics of large complexity systems that small changes in critical properties that occur at transition stages can have huge impacts on the overall system. So even if our contribution to global climate change is small, it is strategically imperative that we stop. The closer we are to the critical transition, the more important every small addition becomes. But the reality is that our contribution is not really all that small. Since the industrial revolution, by any calculation man has released trillions and trillions of tons of CO_2 into the atmosphere. This is CO_2 that was removed by the Earth millions of years ago (when the atmosphere on Earth was a lot denser in CO_2). A ton of CO_2 is 2,000 pounds of carbon dioxide (which is a gas). The number of molecules of CO_2 gas in one liter is multiple of Avogadro's number (which has 23 digits in it).

This means that the number of individual molecules of CO_2 that has been released by the burning of fossil fuels is mind-numbingly enormous. Each and every molecule of CO_2 is an individual piece in the complexity system we call the atmosphere. Everything we have learned from complexity math theory says that when you increase the individual components in any ultra large system, that system will undergo change. When you massively increase the numbers of elements in a system, then that system will undergo radical and permanent change before stabilizing. Radical long-term change in the atmosphere is called climate change. CO_2 levels are rising and the atmosphere and climate are changing. There is almost certainly a direct correlation between them.

But - even if our contribution of CO_2 is not the main reason for climate change, it is still important that we reduce and eventually eliminate the release of CO_2 from fossil fuels. If we are close to the tipping point, then any small amount of increase may be the amount that pushes us over the edge. By the same token, if we are close to the tipping point, then any small decrease will take us that much further from the edge of a catastrophic shift in climate. And according to the math, we cannot know for certain how close we are to the point of no return, until it is too late. So if you are looking for absolute proof, you will not get it unless you are willing to sacrifice everything. Because, you cannot have absolute confirmation that a catastrophic change is occurring - until it has begun and cannot be stopped. Most importantly, the question of whether the current climate change is temporary or permanent - is most likely a question of how big the current climate change that we are undergoing turns out to be. If efforts to reduce known climate altering emissions are successful in reducing the trend to global warming, then it is likely that the climate change will fluctuate rather than shift.

Global weather is a massive chemical reaction that obeys the rules of complexity math. By removing both energy and constituent elements from any chemical reaction or complex system, the activity level of the system will stabilize. Reducing human emissions of CO_2 will remove both energy and constituent elements in the overall atmosphere. This is not a hypothesis. Throughout the geologic history of this planet, when atmospheric levels of CO_2 were reduced, the Earth's weather cooled and calmed. Right now, the Earth's weather is warming and getting more active. This is a fact. The climate is changing. As for whether the climate change is temporary or long term, there is no way to tell unless we try to reverse any effect we may have had on the climate. So the critical issue of reversing climate change is really a question of us doing the only thing that we have any control over. And that is reducing the CO_2 emissions from fossil fuels. This ancient source of CO_2 is contributing to global climate change, and it is CO_2 that does not belong in our modern atmosphere. And it is an astronomical amount that we have released and continue to release.

Global warming does not pose a threat to the Earth. Nor does it pose a threat to life on this planet. Both the Earth and life on the planet will survive the effects of global warming and catastrophic climate change. What is in danger - is us... Lucian