Electric utility executives face difficult choices. As the demand for power grows, the options for new generators look increasingly expensive. Those expensive choices portend very bad news for American industry, which for years has relied on cheap electricity. Expensive power will hurt U.S. competitiveness and jobs.

Coal, once considered the low-cost source for electricity generation, now looks downright costly. Construction expenses have soared, and U.S. utilities in 2007 scrapped plans for some 59 coal-fired power plants and postponed dozens more. Consider the cost escalations associated with Duke Energy Carolinas’ Cliffside Project. In 2002, Duke projected the two-unit coal-fired facility would cost approximately $2 billion. Four years later, estimates rose by $1 billion (almost a 50-percent increase). After the North Carolina Utilities Commission rejected a permit for two units, Duke announced that a single facility would reach $1.8 billion, excluding financing costs. Thus, in the course of five years, the cost of a single Cliffside unit rose almost to the level originally anticipated for two units.

Part of the cost-escalation problem results from China and India building more and more power plants, increasing the worldwide expenses for engineering expertise and steel and other construction materials. China, in fact, added 90,000 megawatts of coal-fired capacity in 2006 while India built an additional 930 megawatts, compared to 600 megawatts developed in the United States.

Another part of the problem is that U.S. coal-fired power plants finally are paying a larger share of the costs associated with their pollution. The Clean Air Interstate Rule (CAIR) and mercury regulations are forcing even existing generators to spend billions on pollution controls, often costing more than the plant’s initial construction. Rather than pay those expenses, some utility executives are closing their outmoded and dirty generating units. The addition of scrubbers and bag houses also increases a power plant’s demand for electricity (a parasitic load) and decreases its efficiency.

Delivered power from new coal plants, in fact, now demands at least 10 cents per kilowatt-hour, almost double today’s industrial average. Sequestering carbon, if it works, adds another 7 cents per kilowatt-hour. Natural gas generators, including combined-cycle gas turbines, also require over 10 cents per kilowatt-hour, and as gas generation increases, fuel costs, already high, will rise.

Renewable and nuclear power avoid greenhouse-gas emissions, but new wind generation exceeds 11 cents/kWh and solar photovoltaics require at least 24 cents/kWh (Europe and Ontario offer 42 cent/kWh contracts for solar power). Although the costs of new nuclear generation are unknown, reactors seem unlikely to be built without substantial government subsidies, and long-term waste storage remains unresolved.

How, then, does the United States obtain both affordable and clean power? The answer lies in looking at electricity options from new perspectives. The conventional energy debate assumes that power plants will be built the way they have for decades – as large, centralized facilities that require long-distance transmission lines to bring power to consumers. Yet this approach is amazingly wasteful, throwing away two-thirds of the fuel’s energy potential. Put another way, centralized power plants suffer from a dismal 33 percent efficiency, which has not increased since Eisenhower was in the White House. European countries,
A decade ago movi egoers flocked to see two films, Deep Impact and Armageddon, about killer asteroids on a collision course with Earth. In the films humanity grooped to use its technology to avoid a fate similar to the demise of the dinosaurs. Recent news reports are eerily reminiscent of the Hollywood thrillers, though the time scenarios may be in decades or centuries rather than days. The IPCC has made clear that large-scale global reductions in greenhouse gas emissions are needed if we are to avoid irreversible and quite disruptive climate change. Yet global carbon dioxide emissions from the energy sector have been rising at an annual rate of about 3%, an increase from the trend a decade ago. There already are signs that we may be experiencing the beginning of a kind of metastatic climate change where the warming feeds on itself, with methane emissions from a thawing Arctic tundra and melting sea ice and glaciers changing albedo and enhancing warming above that due to emissions from human agricultural and industrial activity. In addition, reports of a rapid acceleration in the rate of ocean acidification – a likely byproduct of the same factors threatening climatic disruption - suggest that the marine food chain may be at risk of a rapid unraveling.

In these circumstances some climate scientists are resembling the actors in asteroid films and are looking at improvised geo-engineering solutions to avert metastatic climate change. Already seeing evidence of reinforcing climate feedbacks and despairing of rapid changes in global energy systems, some highly regarded scientists are advocating a serious look at a variety of measures - sulfate clouds over polar regions to arrest glacial melt, satellite discs to deflect radiation back to space, or fertilization of the oceans with iron filings that might stimulate algal growth and possibly carbon dioxide absorption. Each of these may have unforeseen and unintended side effects, they concede, but we may soon be past a tipping point of glacial melt in polar regions that could in two or three centuries swamp all Earth’s coastal cities. We may ultimately be forced to such drastic measures as a last resort, and research into geo-engineering remains essential.

Still, the primary focus should be on two priorities. First is the identification of a workable approach to resolve the Alphonse - Gaston quandary, where industrial and developing countries each hesitate to act for fear that their actions alone won’t make much difference. Michael MacCracken, the Climate Institute’s Chief Scientist, has put forward a remarkably insightful proposal for reciprocal North-South action on emissions. (See page 3 of this newsletter). The developments of the past few weeks in Mexico and the Philippines provide some hope that banking on such action is no longer utopian. A second imperative is the identification of and stimulation of large-scale near term emission reductions to reverse the upward spiral that could soon move us past crucial tipping points. All of these must be viewed through a lens of a global economy in distress with few countries or regions immune from economic hardships that threaten livelihoods. Dependence on several hundred billion dollar annual carbon transfers may amount to a white flag of surrender, ensuring that we will pass irreversible tipping points.

Fortunately there are several measures that might produce large-scale reductions in global emissions, and some even with immediate benefits to the global economy. In my view the most obvious of these involves the removal of barriers to energy recycling - the subject of much of this newsletter. Credible estimates indicate that US carbon dioxide emissions might drop as much as 20% with savings annually of tens of billions of dollars for consumers and industry by removing anti-competitive restrictions on the resale of electricity and by adopting transmission pricing that no longer discriminates against local generation. Four countries in Northern Europe - Denmark, The Netherlands, Latvia and Finland - have each benefited from extensive energy recycling. The Calderon Government in Mexico seems to see increased use of natural gas cogeneration as an integral part of its ambitious green energy agenda. A particularly appealing aspect of this is the potential to make a huge dent in emissions both in the US and in such developing countries as China and India by harnessing waste heat that would otherwise be vented into the atmosphere.

There are two other approaches that I believe merit extensive research. The first is changing agricultural soils management to greatly increase sequestration of carbon dioxide in soils. We know that soils store even more carbon than trees and also that farmers are extraordinarily quick in adjusting to changed circumstances. If we can grasp how new soil management practices will increase carbon sequestration and develop economic incentives for farmers with minimal transaction costs, this might greatly offset energy sector emissions. The second option is the development of biofuels from carbon dioxide and bacteria or algae. While this may seem far fetched, the involvement of Craig Venter who brilliantly mapped the human genome suggests that this may be achievable quickly enough to make a difference. If successful this has two huge advantages: the fuels could be used in existing engines with no need for retrofitting, and it is possible that these biofuels might be produced onsite at major fossil power plants and prove much more economical than carbon capture and storage. Unlike energy recycling where there is a wealth of experience, these options will require significant research and analysis. However, the potential benefits are so great that serious exploration of both makes sense.

Commentary by John C. Topping
With developed and developing nations seemingly at loggerheads over transitioning from a path of increasing CO$_2$ emissions and accelerating climate change to a path of decreasing emissions and climate protection, Climate Institute chief scientist Dr. Michael MacCracken, working with Fran Moore, has suggested a path forward that, while requiring all nations to act aggressively, recognizes important issues of equity and fairness. Speaking June 25, 2008 before an audience of over 800 in Portland, Oregon at the annual meeting of the Air and Waste Management Association (AWMA), Dr. MacCracken reviewed the underlying science of climate change, described the need for strong early action, and offered a nuanced strategy for equitably parceling out responsibilities for emissions cutbacks. If implemented, this strategy would be likely to ensure the Earth avoids the level of warming that the European Union has recognized as very likely to exceed climatic tipping points that would cause “dangerous anthropogenic interference with the climate system.”

Dr. MacCracken’s summary paper, which focuses on the proposed emissions control strategy, was published in the June 2008 issue of em: The Magazine for Environmental Professionals. A lengthier paper, reviewing the science of climate change based on his four decades of studying and researching the issue of climate change, is published in the June 2008 issue of the Journal of the Air and Waste Management Association. This second article offers an easily understandable summary of the science and impacts of climate change, indicating both what is well understood and what is troubling the scientists—especially those aspects that might indicate that, as has been the case in the past, the scientific community is underestimating the seriousness of the issue. In addition to reviewing the scientific evidence of accelerating rates of climate change and sea level rise and the implications for humanity and other life on Earth, Dr. MacCracken argues that avoiding the most catastrophic potential aspects of climate change will require reducing emissions sharply by 2050 and to near zero by 2100.

To accomplish this difficult challenge, he proposes a reciprocal arrangement under which “(1) developed nations move rapidly to demonstrate that a modern society can function without reliance on technologies that release carbon dioxide (CO$_2$) and other non-CO$_2$ greenhouse gases to the atmosphere; and (2) … developing nations act in the near-term to sharply limit their non-CO$_2$ emissions while minimizing growth in CO$_2$ emissions, and then in the long-term join with the developed nations to reduce all emissions as cost effective technologies are developed.” Under this approach developing nations at the outset would focus on low hanging fruit — emissions reductions with significant ability to limit radiative forcing that are achievable at low relative cost. These include greatly reducing emissions of methane, air pollutants that contribute to tropospheric ozone, and black soot, which blackens glaciers, in turn causing greater absorption of solar radiation and melting of glaciers that are crucial to the water supply of a large portion of humanity. Initially, the primary efforts to limit CO$_2$ emissions in developing nations would focus on ending deforestation and on implementing energy efficiency measures — e.g. reducing power consumption for lighting, reducing conversion loss and transmission loss, and encouraging energy recycling including combined heat and power.

Dr. MacCracken, Chief Scientist for Climate Change Programs of the Climate Institute since 2002, has played a crucial role in the development of both scientific and public understanding of implications of climate change. Before joining the Climate Institute, he served as executive director of the National Assessment Coordination Office, which facilitated preparation of the US National Assessment of Climate Change published in 2000. He also played an important role in both the Arctic Climate Impact Assessment published in 2004 (Synthesis Report) and the Special Experts Group report prepared in 2007 under the auspices of Sigma Xi and the UN Foundation for the UN Commission on Sustainable Development, and titled: Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable. From 2003 to 2007 Dr. MacCracken served as President of the International Association of Meterology and Atmospheric Sciences. In addition, Dr. MacCracken’s Affidavit on behalf of the plaintiffs was cited by Justice Stevens in the Majority Opinion of the United States Supreme Court in Massachusetts v. EPA. At the Washington Summit on Climate Stabilization honoring the 20th Anniversary of the founding of the Climate Institute, Dr. MacCracken organized the September 19, 2006 scientific symposium and was the lead editor of the resulting book, Sudden and Disruptive Climate Change: Exploring the Real Risks and How We Can Avoid Them.
MEXICO COMMITS TO 50% GREENHOUSE GAS REDUCTION BY 2050 AND DEVELOPS FIRST NATIONAL INTERACTIVE CLIMATE RESPONSE SYSTEM

During the last quarter of 2008 Mexico advanced a remarkable movement on climate protection, achieving some objectives much past its more affluent neighbors to the north. Through a remarkable collaboration involving NGOs, museums, state governments, private foundations, and national government agencies (Mexico’s meteorological service and national institute for astrophysics, electronics and optics and the US’s NOAA and NASA), Mexico has begun to construct the world’s first national interactive climate awareness and response system. The brainchild of Luis Roberto (Ro) Acosta, the Director of the Climate Institute’s Mexico and Latin America Program, this effort has leveraged the national pride and excitement in soon having the world’s highest altitude greenhouse monitoring station to create a network linking the nearly operational climate observatory, museums in Cancun and Mexico City, an observatory education and outreach centre in Flor del Bosque State Park in Puebla, a similar one to be built in Cuernavaca, capital of the State of Morelos, and the Climate Institute environmental demonstration center in the northern part of Mexico City. This network will at the outset have at least four climate theaters with NOAA Science On a Sphere or similar programs, as well as computer terminals connecting visitors to images and data from the Sir Crispin Tickell High Altitude Climate Observatory and other greenhouse monitoring stations, allowing them to access climate scenario data.

The first portion of the interactive climate awareness and response system started to solidify on October 1, 2008 when Governor Mario Marin Torres, Sir Crispin Tickell, Ro Acosta and Environment and Natural Resources Secretary Francisco Castillo Montemayor unveiled plans to the public and media; later that day a dedication was held in Flor del Bosque State Park at the largely completed outreach center designed by national prize winning architect, Enrique Murillo. NOAA’s Science On a Sphere has been installed and the outreach centre is expected to be fully operational in February 2009. In early December 2008 a second portion of this system became visible: a climate theater and outreach centre in a room of the Pelopidas Museum in Cancun. Made possible by the generosity of the museum’s benefactor, Spanish entrepreneur Juan Poch, the climate theater is expected to be fully operational by February 2009 and also to serve as the hub for Climate Institute programs in the State of Quintana Roo. On October 1, 2008 representatives of four state governments (Puebla, Morelos, Tlaxcala and Hidalgo), leaders of state industry associations in Puebla and Mexico, and the director of Mexico City’s Museum of Natural History and Federal Senator Ludwina Menchaca of Quintana Roo all gathered for an open air luncheon at Flor del Bosque to hear about plans for the Interactive system. This has moved with remarkable rapidity with both the Mexico City Museum of Natural History and the State of Morelos signing contracts in December 2008 with the Climate Institute to create climate theaters and outreach centers. Construction is anticipated in spring 2009. Somewhat before that, construction is slated to be carried out on the Tickell High Altitude Observatory. Made possible by the generosity of Fondacion Pedro y Elena Hernandez with instruments provided by NOAA and NASA, this project in Pico de Orizaba National Park has required extensive environmental impact approvals.

The Interactive Climate Awareness and Outreach System rapidly taking shape has spurred much broader action in Mexico with Governments in six Mexican states in Central and Southern Mexico and Mexico City as well as industry associations in two states with about a quarter of Mexico’s industry working to develop climate response plans that may link to this evolving interactive network.

Just as the Interactive Climate Network has developed traction at the state and federal district level from elected officials of each of Mexico’s major parties (PRI, PAN and PRD) as well as the Green Party, Mexico’s national government made a dramatic announcement December 11, 2008 at the Poznan Conference vaulting Mexico into the lead in climate protection among developing countries. Environment Minister Juan Rafael Elvira and Vice Minister Fernando Tudela announced that Mexico will commit to reduce its greenhouse emissions 50% below 2002 levels by 2050 if it receives technological and financial support from developed countries. In February 2009 President Felipe Calderon is expected to announce details of this plan. The plan will likely include large-scale expansion of natural gas cogeneration, installation of 2500 megawatts of wind generation, and a sizable expansion of solar water heaters in the residential and hotel sectors.

Politics in Mexico can be very contentious but remarkably a broad political consensus for action has made it possible for the Calderon Administration to act decisively despite concerns expressed by its PAN party business constituency. This center right government has in some ways gone past even the aggressive climate protection positions of the incoming US Obama Administration. The incoming US Administration is committed to 80% reductions below current levels by 2050 - a sweeping change from the position of the Bush Administration. Yet as the US’s per capita emissions are about 3 ½ times those of Mexico, the Mexican commitments can be viewed as even more ambitious than those of the incoming US Administration. With a National Interactive Climate Awareness and Response System likely to be in place by mid-2009, Mexico may be even better positioned than the US to build the broad public support needed to translate Presidential vision to real change.
CLEAN ENERGY PROGRESS IN THE PHILIPPINES UNDER PRESIDENT ARROYO

The Philippines has long been a leader in climate protection. The 1995 film Global Warning, inspired by then Senator Heherson Alvarez, sounded the alarms in the Philippines much like the film that earned an Academy Award for Al Gore a decade later. The Manila Conference convened in 1995 by then Philippine President Fidel Ramos and the organization of green parliamentarians led by Senator Alvarez produced a Manila Declaration that helped lay the groundwork for negotiating the Kyoto Protocol 2½ years later. Earthsavers Dream Ensemble, a remarkable singing and dance group of Filipino youth led by Senator Alvarez’s wife Cecile, provided emotional highlights at both the Manila and Kyoto Conferences.

In recent months under the leadership of President Gloria Macapagal Arroyo the Philippines has moved to reassert its leadership of the climate protection effort in Asia. On November 20, 2008 President Arroyo convened a Carbon Cutting Congress at Malacanang Palace (the President’s residence) that drew together 350 leaders including governors, mayors and university presidents to shape the Philippines’ position at the Poznan Conference. The President departed from Malacanang Palace just before the Congress convened in the hope of participating in a peace conference to end the insurrection in Mindanao. Just before her departure she met with Climate Institute President John Topping who presented President Arroyo a copy of Sudden and Disruptive Climate Change as well as Michael MacCracken’s article on outlines for a North-South accord in the next round of the climate negotiations. The President was ably represented at the Congress by Vice President Manuel Noli De Castro, Jr. and Secretary Heherson Alvarez, Cabinet Level Adviser to the President on Global Warming and Climate Change and organizer of the Congress. Secretary Alvarez was chair of the Philippine delegation to Poznan. Although the Philippines’ per capita greenhouse emissions are only about 7% of those in the US, there seemed a willingness for the Philippines to act aggressively to limit its emissions. One governor, after describing the strong steps his state is taking to address climate change, suggested the Philippines should take advantage of the retreat in oil prices to impose a carbon tax whose proceeds might be rebated to the public. The Congress voted to have the Philippines seek to adopt an Interactive Climate Awareness and Response System akin to that being implemented in Mexico. John Topping had described this system in some detail in his speech.

A few weeks later it was clear the Philippines is quite serious about acting to limit its emissions. On December 16, 2008 President Arroyo signed into law the Renewable Energy Act of 2008 moving her nation to the forefront in alternative energy development in Asia. The law provides a seven year income tax holiday and tax exemptions for the carbon credits generated from renewable energy sources. It seeks to increase the Philippines energy self-sufficiency from its 56% level in 2005 to 60% in 2010 by harnessing resources such as solar, wind, hydropower, ocean and biomass energy, as well as geothermal energy where the nation is already a world leader.

President of Stirling Strategic Services, a Boulder, Colorado and Washington based consulting and public affairs firm, Deborah J. Stirling recently joined the Climate Institute’s Board of Advisors. Before founding Stirling, she was Legal Counsel and Director of Government Affairs for the University Corporation for Atmospheric Research (UCAR) in Boulder, Colorado, a consortium of over 60 North American universities and the parent organization for the world-renowned National Center for Atmospheric Research. Earlier in her career, Stirling spent 10 years as Subcommittee Counsel and Staff Director for Oceans and Atmosphere for the United States Senate Committee on Commerce, Science, and Transportation and was Staff Director of the Senate-wide National Ocean Policy Study. In addition, she functioned as Energy Counsel and Environmental Counsel to Senator Ernest F. Hollings (D-SC) during the same period. Ms. Stirling received her BA in International Studies and her JD from the University of South Carolina. While in law school, she studied coastal ecology and ran field programs in marine biology, fresh water pollution in blackwater swamps, and aquaculture, and specialized in environmental and science law. Stirling is a volunteer fire fighter and a first responder in her local fire protection district in Colorado, as well as a Director of the fire protection district. She is also a Director of the Colorado Musical Festival.
SUSTAINABLE SOLUTIONS FOR ENERGY AND WATER SECURITY IN THE UNITED ARAB EMIRATES

Corinne Kisner

The United Arab Emirates is one of many countries in the Middle East and North Africa that is rich in oil reserves but faces a severe freshwater scarcity. With stresses due to climate change, population growth, surging industry, urbanization, and volatile international oil markets, the UAE has begun adopting alternatives to avoid exploiting hydrocarbon fuel and groundwater supplies. These technologies are forward thinking: combined heat and power generation provides energy efficiency, desalination produces potable water from the abundant supply of seawater, and concentrated solar power brings sustainability to the next level by eliminating the dependence on fossil fuel, emitting no greenhouse gases, and reducing the cost of an energy-intensive lifestyle. By adopting these technologies, the UAE has already and will continue to be a leader in energy sustainability in the Middle East and the world.

The UAE has the 5th largest proven oil reserve in the Middle East, amounting to nearly 10% of the world’s crude oil reserves. Oil exports are essential to the country’s economy, accounting for 30% of the total gross domestic product. Abu Dhabi, the major hydrocarbon and industrial power, holds more than 90% of the UAE’s oil resources, or about 92.2 billion barrels. Dubai, the trading, financial and tourist center, contains an estimated 4 billion barrels. Together, Abu Dhabi and Dubai account for 80% of the UAE’s income. Despite the huge wealth of oil, aggressive government policies have diversified the economy, and new policies aim to reduce the country’s greenhouse gas emissions by pursuing renewable energy and energy efficient technologies. In 2005, the UAE became one of the first major oil-producing countries to ratify the Kyoto Protocol to the UN Convention on Climate Change, demonstrating a commitment to emissions reductions. Since then, its renewable energy initiatives are unmatched in the region. Of particular note is Masdar City, slated to be the clean energy capital of the world. This revolutionary city in Abu Dhabi has received billions of dollars of investment in sustainable technologies. The city is designed as a 50,000-inhabitant zero-carbon and zero-waste community. Essentially, Masdar City will be an ecosystem running on solar power and providing information and expertise for the rest of the world.

Even with these efforts toward environmental sustainability, the UAE still faces significant challenges. With a population of 4.4 million and an electricity consumption of 56.6 terawatt-hours in 2006, the UAE ranks as the highest per capita energy consumer in the world. Strong economic and industrial growth, an increasing population, and urbanization trends have driven huge spikes in the demand for electricity. Energy consumption in the UAE has quadrupled in the last two decades, and current estimates predict that the domestic demand for power will double again by the year 2020. At the end of 2004, the total installed electricity generating capacity of the UAE was 12,800 megawatts, but the 7% annual growth in electricity demand will necessitate an increase in generating capacity, bringing the country’s electricity capacity to 19,400 megawatts by 2010. A report by the Dubai Chamber of Commerce and Industry called for $8 billion in investments to the electricity sector in Dubai over the next six to eight years to meet the growing demand. The emirate of Dubai alone must increase its power generation capacity to 9.5 gigawatts by 2010. Although energy consumption in the UAE is already high, it will continue to rise due to economic necessity. In the post-hydrocarbon age, the UAE will have to pursue renewable energy resources in order to reduce the costs of development, curb the harmful greenhouse gas emissions that contribute to climate change, and achieve energy security while remaining competitive in the global economy.

The UAE is the highest per capita energy consumer and the third highest per capita water consumer in the world

In addition to their high demand for energy, residents of the UAE consume an average of 550 liters of water each day, placing the country as the third highest per capita water user in the world after the United States and Canada. Annual water consumption in Abu Dhabi Emirate alone is estimated to be 2.49 billion cubic meters, and this figure is expected to more than double by 2020, reaching 5.86 billion cubic meters. The demand for water is more difficult to meet than the demand for energy, since the country is rich in oil but woefully lacking in freshwater resources. Historically, all the UAE’s water requirements have been satisfied with groundwater obtained from shallow, hand-dug wells and the traditional falaj system of aquifers, as well as by the deliberate collection of seasonal rainfall. However, groundwater supplies have been nearly depleted, and the UAE has no rivers or lakes and limited rainfall. Ambitious agricultural and forestation projects, as well as a growing population with escalating demands, have strained the increasingly scarce natural water resources in the past two decades. With rising demand and falling supply, the UAE has turned to seawater desalination, boasting 19 facilities on the 2005 list of the 100 largest desalination plants.

Desalination involves evaporating saltwater under reduced pressure, condensing and capturing the steam, and then enriching the distilled water with minerals to create high quality potable water. This method requires large amounts of energy, but in an oil-rich country seeking freshwater resources like the UAE, this is a price worth paying. As the second-largest producer of desalinated water in the Middle East and North Africa, the UAE burned 9 million tons of oil equivalent in 2003 for desalination. By 2030, fuel requirements for desalination will reach 16 million tons of oil equivalent, or 20% of the country’s total primary en-
ergy demand. Although the UAE has the necessary oil resources available, energy markets are increasingly insecure due to the shift to the post-hydrocarbon age, and all countries would do well to move away from fossil fuels. Based on the country’s dual challenges of achieving water security and energy security in the face of climate change, cogeneration for power and desalination offers a tidy solution that is efficient, cost-effective, and environmentally friendly.

Combined heat and power (CHP) technology, also referred to as cogeneration, employs a single fuel source to produce both electricity and thermal energy. The integrated energy system works by combusting fuel (natural gas, oil, biomass, biogas or coal) to run an engine or turbine, which generates electricity to be used onsite or to be sold into the electrical grid. The hot exhaust gases produced through this combustion system are captured and converted into useful thermal energy in the form of steam or hot water; this thermal energy is used for the facility’s heating or cooling needs. In this way, CHP technology meets a facility’s thermal and electrical demands and provides economic and environmental benefits.

By integrating heat and power generation, CHP plants increase efficiency when compared with single-purpose plants. For four decades, the average fossil-fueled power plant in the United States has run at a 33% efficiency rate, wasting two-thirds of the fuel’s energy through heat vents. Capturing the exhaust heat for use as thermal energy results in a total system efficiency rate of 60-80%, meaning less fuel is required at CHP plants than at separate heat and power plants to produce the same energy output. The benefits of this increased efficiency include lower operating costs, fewer greenhouse gas emissions and air pollutants, and greater reliability and power quality. In addition to the direct financial benefits from reduced fuel consumption, CHP provides onsite-generated power in the case of grid blackouts and protects against unpredictable energy prices by allowing the facility to switch fuel inputs based on current prices. Using renewable inputs like biomass (especially agricultural waste) or biogas (the methane and carbon dioxide produced at landfills or sewage treatment plants) can further reduce fuel costs and the environmental impacts of generating the energy to meet demands.

Cogeneration can also be used to power desalination. The Shuweihat facility, located 250 miles west of Abu Dhabi City, burns natural gas (extracted in Abu Dhabi) to generate electricity, then uses the waste-heat steam to turn two turbines that also produce electricity, and then uses the turbine exhaust steam as the energy needed for desalination. The facility generates 1,500 MW of electricity and produces 450,000 cubic meters of potable water each day. Although the water is used primarily for irrigation, it is enough drinking water for 900,000 people. The two planned expansion phases will bring the facility’s capacity to 5,000 MW with a daily water production of 1.4 million cubic meters. By capturing and using the heat that would otherwise be vented into the atmosphere, the CHP facility increases its energy efficiency; by using the thermal energy to convert seawater to freshwater, the Shuweihat facility provides an integrated solution that tackles challenges on multiple fronts.

The UAE could take its sustainability initiatives one step further by capitalizing on an abundant natural resource: solar radiation. Each square kilometer of land in the Middle East and North Africa annually receives solar energy equivalent to combusting 1.5 million barrels of crude oil, an amount sufficient to desalinate 165,000 cubic meters of water per day. Combining concentrated solar power (CSP) plants with seawater desalination would have the same effect as CHP plants with desalination, with the added benefit of using solar power in the place of oil or natural gas. The harvested solar energy is used to generate electricity, and the waste heat from this process powers desalination. Some of the harvested solar energy can be stored for the night, and biomass can be used as a supplement to ensure constant electricity generation. Eliminating the need for hydrocarbon fuels eliminates greenhouse gas emissions and the vulnerability associated with insecure fossil fuel markets. At the present state of the art, CSP has a cost equivalent of $50/barrel of oil, with projected cost reductions due to economies of scale, mass production, and technological progress. Within ten years, costs will be equivalent to $25/barrel; by 2050, the cost of solar power could reach $15/barrel, making it a far more financially realistic input than fossil fuels.

**Sustainable solutions: convert abundant resources (sunlight and seawater) to highly desired resources (potable water and cheap electricity)**

In 2007, there was no installed CSP capacity in the UAE or in the entire Middle East and North Africa region. With the right government policies for rapid market introduction and development of CSP for electricity generation and desalination, this technology could replace the unsustainable extraction of freshwater within 10 or 15 years. CSP is neither limited by solar energy resources nor by its cost, but only by the efforts devoted to CSP capacity expansion. With strong initiatives, the UAE could be a leader in this highly sustainable technology as a source of electricity and freshwater. Already, Masdar has made progress with solar technology and has plans to build the UAE’s first of many CSP plants, with a capacity of 100 MW, for operation in 2010. Similar projects on a larger scale will provide an excellent example for other countries in the region, demonstrating the ability to capitalize on abundant resources, sunlight and seawater, to produce the electricity and freshwater necessary to meet high demands. Concentrated solar power, along with combined heat and power generation, are truly sustainable sources of energy that will allow the UAE and other countries to pursue economic development and prosperity without sacrificing the environment or climate.
THE EUROPEAN EXPERIENCE

Denmark

Although historically Denmark generated most of its energy from coal, coke, wood, and pelt, during the 1960s it gradually switched to cheap imported oil. By 1972 Denmark derived 90% of its energy from oil imports. During the energy crisis in 1973 when oil prices rose to previously unseen heights, Denmark’s policy makers acknowledged the nation’s vital interest in energy independence. Cogeneration was identified as a cornerstone of the Danish energy conservation strategy in 1975. Three decades of responsible and dedicated policymaking have paid off: between 1980 and 2005, the share of CHP in the total electricity produced in Denmark doubled from less than 20% in 1980 to 42.6% in 2006, and the share of CHP in heat provision increased to 75%; this has resulted in a 15% decrease in CO₂ emissions a year.

Denmark’s extensive heating demands through a large part of the year qualified the country as a prime candidate for cogeneration. By 1973 Denmark had built over 200 district heating (DH) networks, which generate heat at a central location and distribute it to households and commercial heating systems. This is oftentimes more efficient and less polluting than individual heating, especially in densely populated areas. The earliest phase of CHP development capitalized on the well-developed DH network in Denmark. The Energy Plan adopted in 1976 set a clear trend of switching from oil consuming power plants to coal-fired CHP and the 1979 Heat Law provided the needed market to make CHP profitable. Cities in Denmark were divided into areas suitable for DH and those more suitable for the traditional individual provision heating through natural gas. Households in identified areas were mandated to connect to the DH grid, which was made a local monopoly exempted from all competition when natural gas use was restricted and electric heating banned. This promoted the building of large centralized CHP plants near cities in Denmark to supply the district heating needs.

The Netherlands

CHP expansion in the Netherlands was driven almost exclusively by the electricity demands of Dutch industries. Since the early 1980s, CHP share in the Dutch electricity production increased from 7% to over 30%. However the share of CHP in heat production remained almost constant at slightly over 20% during the same time period. The initial impetus for CHP generation came from companies like Shell, Dow Chemicals, DSM, and others in energy intensive industries. When the energy crises hit in the 1970s, these Dutch giants already appreciated CHP technology and as energy prices doubled, they increasingly recognized the need to achieve energy independence from power producers. High electricity prices, combined with an already large internal market for heat and power, made cogeneration economically attractive to the industry. Initially, CHP was designed to serve only the companies’ internal energy demand and thus minimize interactions with the power producers.

At the same time, the Dutch government sought ways to reduce energy consumption and prices. In 1979 it created a Commission on Cogeneration in the Industry and used its findings to reduce barriers to energy cogeneration. In an effort to prioritize energy conservation, the government expanded cogeneration beyond the industrial sector by supporting and facilitating CHP feasibility studies for smaller companies, as recommended by the Commission on Cogeneration. The National Investment bank, created in 1982, provided loans at favorable terms, and an investment subsidy for CHP projects increased simultaneously. Gasunie – the Dutch natural gas and infrastructure company – also helped start many cogeneration projects by conducting feasibility studies, as it had a stake in the increased sales of natural gas to the CHP sector.

Furthermore, climate change became a factor when, in the late 1980s, the government recognized CO₂ emissions reductions as an added benefit of cogeneration. This understanding catalyzed voluntary agreements with the industry about reduced energy use and an environmental action plan with the electricity sector on CO₂ emis-

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Finland and Latvia

Both Finland and Latvia derive a significant proportion of their power from CHP. They have cold climates and thus a strong demand for both heat and power throughout the year. The liberalization of the European energy market, the associated decrease in electricity prices, and the stability of the market did not hurt cogeneration in the two countries due to well developed DH systems and a strong demand for both CHP outputs.

Finland has historically had an open energy market – industries and distributors were allowed to both produce and sell electricity. Separating generation from transmission and distribution was a big step towards increasing the share of CHP in Finland. This ensured that no individual energy producer had privileged access to the Finnish transmission network. At the same time, transmission and distribution were given the status of natural monopolies.

A large part of CHP success in Finland can be attributed to a well-functioning DH system. Customers in Finland, unlike Denmark, are able to choose how they want to heat their homes. Thus DH has to be a cost-effective alternative to be successful. In Finland, DH constitutes around 50% of space heating, 75% of which is supplied by CHP. In addition, over 70% of the electricity generated from polluting sources comes from CHP plants. Overall, Finland derived 34.9% of its electricity from CHP in 2006. In Helsinki, Finland’s capital, these numbers are even higher: 97% of Helsinki’s energy and 92% of its district heat come from CHP plants. Recently, district cooling has been added to CHP’s useful outputs in Helsinki. Finland shows that CHP can flourish even in a liberalized market: although there are some tax advantages for CHP in Finland, subsidies are low and cogeneration development has flourished primarily as a result of the actions of limited municipality companies.

Latvia is well suited for the development of cogeneration: it is a net importer of electricity and produces a lot of its heat in separate facilities. The government sets yearly quotas on renewable energy sources, including CHP generation, and has established feed-in tariffs for cogeneration. Their amount depends on the type of fuel used in the CHP plants: renewable fuels are favored over non-renewable ones. In order for CHP plants to be eligible for benefits they have to be at least 80% efficient and distribute at least 75% of their thermal output to a district heating network.

The government has also established a uniform procedure for the sale of electricity surplus to the grid. In 2006, Latvia derived 42.6% of its power from CHP. However, the Latvian cogeneration sector still faces obstacles, including hard-to-obtain licenses and competition with heating produced from cheap fuels like wood chips.

An impressive 42.6% of Latvia’s power came from CHP plants in 2006.

Each of the four examined countries followed its unique path towards energy efficiency. Denmark’s cogeneration sector was and is dominated by large centralized CHP plants supplying heat to an extensive network of district heating systems. The Danish government has created a strong positive regulatory and economical environment for the support of CHP. Although Finland and Latvia also capitalize on their DH networks, their energy markets are much more liberalized, leaving the industry to essentially fight for itself. In the Netherlands, industrial projects and joint ventures account for most of cogeneration growth in the past 30 years.

These cogeneration movements began due to:

- An energy crisis
- Extensive heating needs
- A desire to become energy independent
- The need for cheap electricity
- A concern for the environment
- The goal of meeting Kyoto targets for emissions reductions

Common strategies for boosting CHP include:

- Investment subsidies
- Official government support for CHP
- Feed-in tariffs
- Mandated access to the grid
- A separation of production from distribution of electricity
- CO₂/green taxes
- Targets for CHP and CO₂ emissions

Government involvement was warranted to jump-start the cogeneration industry. In most countries traditional separate generation of heat and power is so entrenched in the system that an outside impetus must be given to catalyze innovation. Government plays a crucial role in providing legitimacy, knowledge dissemination, a sound regulatory environment, and financial support. It is vital that all cogeneration plants, regardless of size, be given access to the grid and the ability to sell their excess energy to local consumers. Governments also must ensure that savings to the grid, saved transmission and redundancy costs, and environmental benefits are factored into the feed-in tariffs for CHP. So long as the free market does not include these externalities in the price of electricity, government involvement is not only reasonable, but essential.

97% of Helsinki’s energy and 92% of its district heat come from CHP plants.
systems with their excess heat. Denmark’s ten major cities with city-wide DH now have 95-98% of their heat produced in such large CHP plants. The increased investment and operational costs were paid for by the consumers who have in turn saved on heating fuel costs.

Furthermore, CHP plants benefited from various economic and regulatory incentives. The government regulated power stations, introduced a CO₂ tax, a green tax, low interest rates and guarantees for CHP investments, and subsidies and grants for cogeneration plants. While electricity prices in Denmark are now some of the highest in the industrialized world, without taxes, they would be among the lowest. The tax proceeds are used to subsidize investments promoting efficiency such as cogeneration and generation from renewable energy sources.

Increased environmental awareness led the government to encourage CHP generation based on renewable and local fuels such as natural gas, waste, and biomass. In 1986, the government mandated 450 MWe of small scale CHP based on these fuels. However, the development of additional CHP capacity stalled due to resistance from electricity companies. In response, the government increased the CHP target to 1,400MWe and allowed municipalities, industry, and local customers to participate in CHP generation along with the energy sector and developed the natural gas network along with the program. Deregulation combined with continued economic incentives led to the fulfillment of the ambitious goal.

THE EUROPEAN EXPERIENCE

Denmark, continued

As Denmark’s industries are not energy-intensive, industrial CHP developed more slowly. The government tried to promote it through a combination of green taxation, electricity tariffs, and subsidies; however, a prospective opening of the energy market to competition and an anticipated decrease in energy prices thwarted the effort. Since then, voluntary agreements in industry regarding green taxation have revived the program and industrial CHP potential has been evaluated at 670 MWe.

Cogeneration will likely remain an important instrument in Denmark’s efforts to meet its CO₂ emissions reduction targets. The CHP sector continues to develop – the Danish Avedøre 2 plant built in 2002 remains the most efficient power plant today with 95% efficiency. It uses natural gas and biogas for its electricity and heat production and is an important step towards achieving Denmark’s goal of phasing out coal-based generation by 2030. Since the 1980s, the Danish GDP has increased by 50% while its energy needs have remained constant, thanks to increases in efficiency. Cogeneration has not only boosted Denmark’s energy security; it has also resulted in significant reductions of CO₂ emissions, provided valuable experience to Danish energy companies, and work to Danish citizens – Denmark exported US$7.45 billion in energy technology and equipment in 2005. Although cogeneration is necessarily limited by the availability and proximity of heat requirements, there is still unused potential. For example, the possibility of CHP balancing out temporary outages in renewable sources (wind, solar) is also worth considering and exploring.

The Netherlands, continued

As emissions reductions. In 1987, chemical company Azko Nobel and regional utility EGD started the first joint venture project in the Netherlands. When the industry and the electricity sector collaborated in CHP joint ventures, both profited from the increased investment certainty and the energy savings achieved. Both parties now had a stake in the success of the project, and the distribution companies enjoyed a stable market for heat produced in their CHP plants while the industry gained access to cheaper capital from the distribution companies.

The Electricity Act of 1989 mandated the separation of electricity production and distribution. Distribution companies suddenly had to accept all locally produced electricity and pay a very favorable feed-in tariff – an important provision ensuring that utilities buy cogenerated electricity from producers at above market prices based on their avoided costs of central production. The subsequent proliferation of CHP resulted in a decreased demand for centrally generated electricity, caused higher electricity prices, and ultimately reinforced the incentives for cogeneration. Furthermore, electricity prices became tied to the prices of natural gas, which served as the main fuel both for traditional energy generation and cogeneration. This, combined with a special gas price for CHP producers, provided steady revenues for cogeneration plants and stabilized the industry. In fact, CHP became so attractive that it resulted in significant overcapacity and a temporary moratorium on large-scale cogeneration in 1994. The moratorium, however, boosted small-scale CHP projects.

Cogeneration growth stopped after the 1998 Electricity Act liberalized the electricity market and removed the favorable feed-in tariffs and subsidies. With low and uncertain electricity prices, new investment in CHP became unprofitable. However, as the total CO₂ reduction achieved through co-generation should reach 5 to 10 Mt CO₂ by 2010 (5 to 10% of the total reduction necessary to reach the emission level agreed to in the Kyoto protocol), the Dutch government decided to give cogeneration another boost. Subsidies for grid-delivered cogeneration electricity were redeployed in 2001 and cogeneration certificates based on the CO₂ emissions of a plant were implemented in 2003.
**DAN WILDCAT AND JOHN ENGLANDER JOIN CLIMATE INSTITUTE BOARD OF DIRECTORS**

In December 2008 both Dr. Daniel Wildcat, convener of the American Indian Alaska Native Climate Change Working Group and Director of the Environmental Research Studies Center at Haskell Indian Nations University, and John Englander, CEO of International Seakeepers Society, were elected to the Climate Institute Board of Directors. Both had served on the Institute’s Board of Advisors.

Dan Wildcat has been a driving force behind the formation and growth of the Working Group, an informal network of Native American climate experts and activists and other partners seeking to advance climate protection in American Indian and Alaska Native communities. A Yuchi member of the Muskogee Nation of Oklahoma, Professor Wildcat has been a member of the faculty at Haskell Indian Nations University in Lawrence, Kansas the past two decades. Co-Author with Vine Deloria, Jr. of Power and Place: Indian Education in America (Fulcrum, 2001) and co-editor, with Steve Pavlik, of Destroying Dogma: Vine Deloria and His Influence on American Society (Fulcrum, 2006) Dan Wildcat is also the author of Red Alert! Saving the Planet with Indigenous Knowledge (Fulcrum, 2008). Besides teaching at Haskell, Dan Wildcat has spoken widely on climate change implications at many places, among them Northwest Indian College, University of Northern Arizona, Dartmouth College and the National Museum of the American Indian.

Since 2004, John Englander has been the CEO of the International Seakeepers Society, “an organization set up in 1998 by a small number of yacht owners to address deteriorating conditions of the seas. Their initial mission has been to develop a compact, automated and cost-effective ocean and atmospheric monitoring system to install aboard their yachts, providing data to scientists on the health of the world’s oceans.” In 1974, he took over the struggling Underwater Explorers Society (“UNEXSO”) based in Freeport, Grand Bahamas, and turned it into one of the world’s largest dive operations, operating a fleet of boats, a diversified instructional program, and one of the biggest retail dive stores in the world. Englander also created the Dolphin Experience, an innovative close-encounter program that allowed for the first time divers and non-divers to interact with dolphins in the open ocean. He headed the diving industry’s non-profit environmental organization, Ocean Futures, and was shortly hired by Jacques-Yves Cousteau to become CEO of the Cousteau Society, where he served briefly until Cousteau’s death. In addition to extensive experience throughout the Caribbean, he has led scuba expeditions to the High Arctic and Lake Baikal in Siberia. In 1992, he organized a voyage to dive many of Columbus’ alleged landfalls.

“Affordable Energy for U.S. Businesses and Jobs” from p. 1

in contrast, are taking a different approach by capturing the waste heat from power plants in order to heat nearby buildings, run industrial processes, and operate air conditioners and chillers.

The conventional energy debate also focuses on specific technologies, with most utility executives advancing larger subsidies for coal-fired power plants and nuclear reactors, while environmentalists favor substantial tax breaks for wind turbines and solar collectors. Yet rather than have politicians and lobbyists pick technological winners, why not set a goal, perhaps based on increased efficiency or decreased greenhouse-gas emissions, and allow market competition to determine the most efficient or clean approaches?

Here’s a modest proposal that could have profound implications for the U.S. economy and environment. Why not have each state calculate the true costs of generating and delivering electricity from a new centralized power plant and then offer long-term contracts to anyone who can supply clean power at just 80 percent of that cost? Utility executives should appreciate obtaining new electricity at a discount. Assuming a strict efficiency standard for “clean power,” environmentalists should welcome the reduced emissions of pollutants and greenhouse gases. Energy entrepreneurs, meanwhile, would jump at the opportunity to invest billions in new power projects.

The Tennessee Valley Authority, Bonneville Power Authority, and Ontario Power Authority are developing such Clean Energy Standard Offer Programs (CESOPs). The utilities welcome both the lower costs and the ability to integrate new power into their systems. They also like keeping the CESOP facility as a customer, as well as placing all interconnection costs into their rate base.

The CESOP approach offers flexibility. Some states may want to initially limit the offering to, say, 1,500 megawatts of capacity and then extend and modify the terms based on that experience. Strict penalties could be imposed on CESOP plants that fail to meet the efficiency test or to provide all the contracted power.

No doubt pending electricity price hikes will hurt the U.S. economy. Rather than continuing to build centralized power plants that throw away their heat or debating the political merits of alternative energy technologies, why not set a clean energy goal and allow entrepreneurs to offer power at a discount? U.S. competitiveness and employment are at stake.
Founded in 1986, the Climate Institute was the first non-profit organization established primarily to address climate change issues. Working with an extensive network of experts, the Institute has served as a bridge between the scientific community and policy-makers and has become a respected facilitator of dialogue to move the world toward more effective cooperation on climate change responses.

The Climate Institute’s mission is to ....

CATALYZE innovative and practical policy solutions toward climate stabilization and educate the general public of the gravity of climate change impacts.

ENHANCE the resilience of humanity and natural systems to respond to global climate change impacts especially among vulnerable groups (e.g. Native American tribes and Small Islands).

WORK internationally as a bridge between policy-makers, scientists and environmental institutions.

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