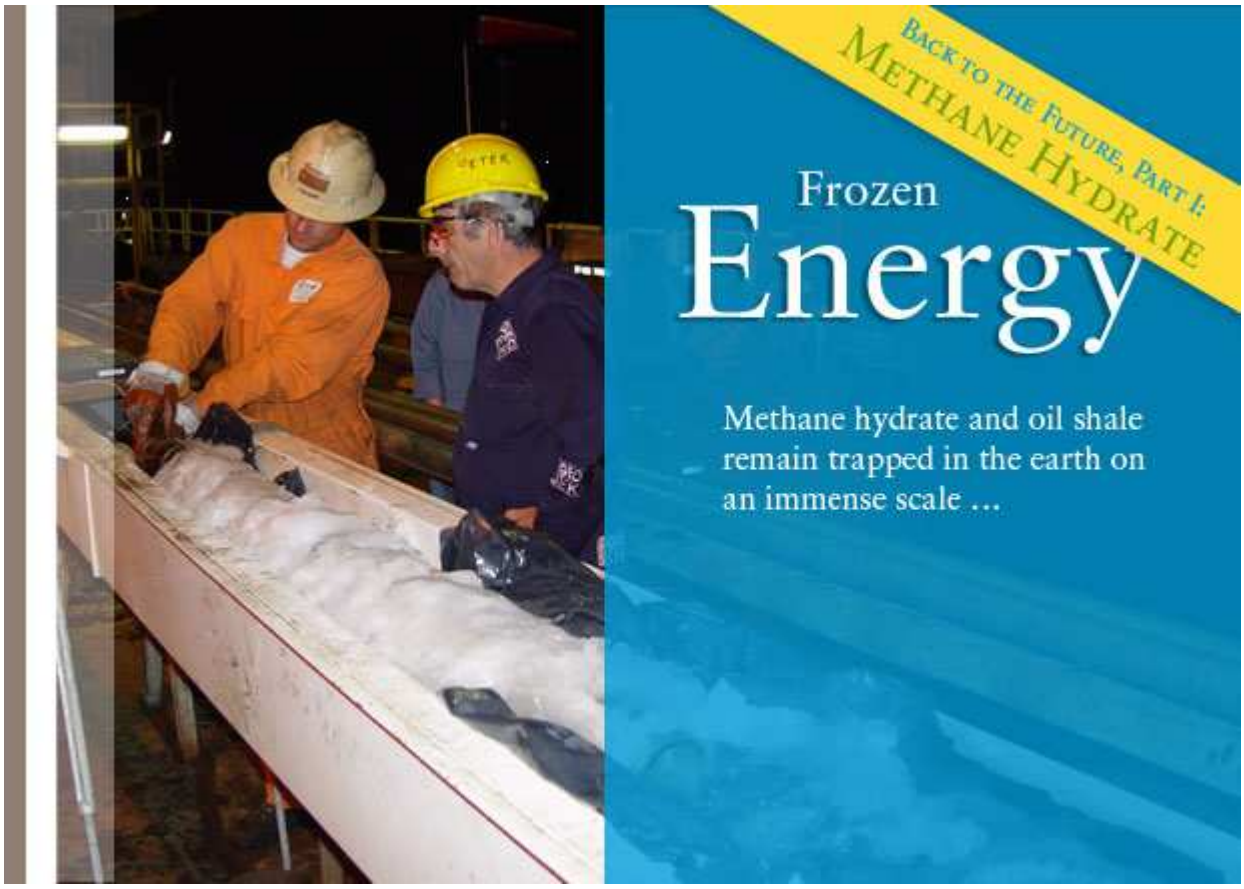
Line Rider
Global Employee eMagazine



June 2007 Issue

Also in This Issue

Back to the Future, Part 1: Methane Hydrate

Frozen Energy

Chevron is leading a government-industry research partnership to evaluate the potential of methane hydrate, a frozen form of natural gas.

It looks like ice but burns with a clean gas flame. An obscure laboratory curiosity of the 1800s, methane hydrate is a study in paradoxes.

It was viewed as an oil worker's nightmare because it could plug pipelines in hours and take days of hazardous effort to clear. Yet methane liberated from the earth's vast geologic hydrate deposits may become an important new energy source.

Natural gas hydrates carry the long–term potential to move the energy industry in a new direction.

What Is It, Exactly?

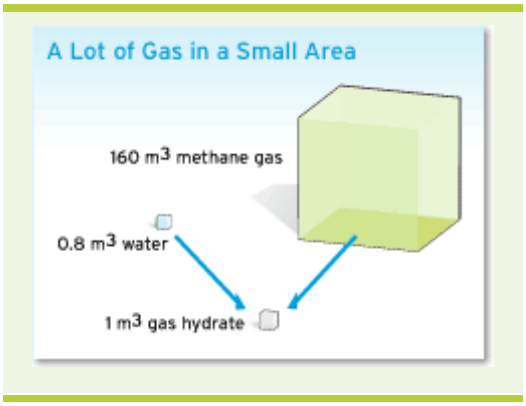
Hydrates are crystalline structures that look like ice but are actually comprised of molecules of certain gasses such as methane, propane, CO_2 or nitrogen tightly packed within cages of water molecules. Natural – or geologic – gas hydrates are mixtures of water and hydrocarbons, primarily methane, that have formed and accumulated in the pore spaces of deep–sea and arctic sediments over geologic time.

Another paradox: hydrate is bigger than it looks. Thirty-five cubic feet (1 cu m) of hydrate when melted – by increasing heat, decreasing pressure or adding a melting agent such as salt or methanol – will release roughly 5,650 cubic feet (160 cu m) of methane gas.

"Think of it as permafrost with an attitude," jokes John Balczewski, manager of Chevron's hydrate resource project.

The "ice that burns," was first encountered operationally in the 1930s when hydrate plugs began blocking the then new high-pressure natural gas pipelines.

New headaches arose during the 1960s and 1970s as oil drilling reached arctic and deepwater frontiers and extensive beds of geologic gas hydrates were discovered intermixed in sediments 1,000 feet (305 m) below the surface. As hot drill bits bore into these hydrate layers, they melted the hydrate and released large amounts of gas up the wellbore, in some cases leading to blowouts and fatalities.



The oil industry quickly changed strategy, avoiding hydrate deposits whenever possible and using special drilling techniques.

Where Is It?

According to the U.S. Department of Energy's (DOE) National Energy Technology Laboratory, methane hydrate is by far the most commonly found gas hydrate, and extensive deposits are believed to exist in deep ocean seabeds around the world and below arctic and antarctic permafrost.

Although estimates are highly speculative, the potential worldwide natural resource pool from methane hydrate could be a staggering 700,000 trillion cubic feet (20,000 trillion cu m), compared with 5,000 trillion cubic feet (142 trillion cu m) of known natural gas reserves. If successfully produced, methane hydrate could conceivably meet the world's fuel demand for hundreds of years – a "virtually inexhaustible supply of energy," according to the DOE.

However, that potential might not be known – let alone tapped – for decades. To help shorten the waiting period, Chevron is leading an international effort aimed at improving the industry's understanding of deep marine sediments containing hydrates.

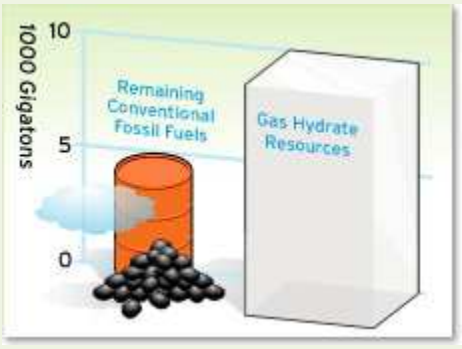
A Voyage of Discovery

The Chevron–led Gulf of Mexico Hydrate Joint Industry Project (JIP) was established in 2001 and is funded by seven petroleum and service companies, the DOE and the U.S. Minerals Management Service.

The successful first phase of the project was a $21.2 million, five–year program to collect scientific data and improve models on sediments containing hydrates.

"The project helped us more fully understand safety issues related to conventional oil and gas operations in areas prone to hydrate occurrence," says Emrys Jones, a Chevron senior consulting engineer serving as the JIP project manager.

"Of primary importance is the ability to safely drill the surface hole, set surface casing and maintain the integrity of the surface pipe as the entire well is drilled."



Remaining energy resources: There could be 700,000 trillion cubic feet of hydrate gas, compared with the remaining 5,000 trillion cubic feet of known natural gas reserves.

The current phase of the project builds on knowledge gained through the initial project work with an eye now toward hydrate resource characterization. The project will spend $20 million over three years to collect data on the hydrate-bearing sediments thought to be the most promising commercial resource targets.

In 2005, the project staff completed a 35–day cruise to analyze and sample hydrate–bearing sediments at two sites in the deepwater Gulf of Mexico. The expedition employed the semisubmersible vessel *Uncle John*, marking the first use of newly created tools for measuring the acoustics and other properties of sediments at subsea pressure conditions.

The voyage centered on two Gulf of Mexico sites: Keathley Canyon and Atwater Valley, both located on the outer continental shelf off the coasts of Texas and Louisiana in waters about 4,300 feet (1,310 m) deep.

Carrying a team of scientists and engineers from universities, national labs, industry and government, the *Uncle John* team found that Keathley Canyon contains hydrates in saturations of up to 10 percent. Findings show that with advanced data–processing techniques, industry–standard seismic data may also lead to detection of reservoir–quality hydrate deposits.

Into the Future

The project is currently analyzing data from the cruise and evaluating options for further field activities. According to Jones, the project will be extended through 2009 to allow for continuous progress, noting a great deal of research and development still lies ahead.

"We're just scratching the surface in terms of researching the feasibility of what it will take to tap the true potential of hydrate," he says. "A good outcome for this project would be the ability to use seismic signals to prospect for hydrate and develop successful modeling capabilities that tell us where a prospective site is, whether hydrate can be produced economically, and whether we can operate safely in the hydrate zone."

Nader C. Dutta, chief geoscientist with Schlumberger – one of the project partners – estimates it could be 20 years before any commercially successful development of methane hydrate takes place. "Economics will help determine when and if a way is found to mine these deposits for their commercial value," he says.

"Experts agree that methane hydrate could be the most important energy resource of the future, so this is a significant industry effort" says Emrys. "Being the prime contractor in this project demonstrates Chevron's leadership position and shows we are a partner of choice."

"Chevron believes that meeting the world's future energy demands will require the addition of new, large-scale resources and the technology to economically bring them to market," says Don Paul, vice president and chief technology officer. "Methane hydrate could represent one of these significant new resources.

"Certainly this potential resource is of immense scale, but many technical and business challenges remain. By taking a leadership role in the R&D phase, Chevron will be well positioned to capture this opportunity in the decades to come."

Emrys also points out that the development of methane hydrate – and Chevron's leadership position – provides a benefit for colleagues who become involved. "In its various phases and stages, this is a very long–term project that promises to be both challenging and fulfilling," he says. "Chevron has the expertise, resources and commitment to play a leading role for years to come."

Back to the Future, Part 2: Oil Shale

Heavy Rock Revival

Talented professionals from across the enterprise join forces to unleash the energy of oil shale.

Oil shale shares characteristics of meteors and dust from outer space, yet this is no science fiction.

Oil shale: the rock with untapped energy. These samples are from Colorado's Piceance Creek basin, the area in which Chevron plans to produce.

It's a huge resource with enormous potential for this planet. Hydrocarbons trapped in oil shale could supply trillions of barrels of oil to an energy-hungry world, according to recent studies.

That's a quantity equal to all the conventional oil the world is ultimately expected to produce — and this bounty is widely shared. Significant amounts of oil shale can be found on every continent except Antarctica and in at least 33 countries. Currently, there are no commercial operations, although countries such as Estonia, in Europe's Baltic region, have used oil shale in the past as a low-grade fuel to burn in power plants.

But first, just what is oil shale? The term itself is a misnomer since it is neither oil nor shale. Instead, it is a high molecular weight combination of organic-rich kerogen and fine-grained carbonate rock deposited close to the earth's surface more than 50 million years ago.

Most of that rock is relatively worthless inorganic material. However, the kerogen it contains is a fossil fuel created from insects and low plant forms such as pollen and algae. Kerogen-like components have been discovered in meteors, and astronomers have detected kerogen in interstellar clouds and the dust that forms around stars. But here on earth, what makes kerogen important is that it can be converted into gasoline and diesel fuel.

Tapping kerogen's potential will not be easy. Its heavy molecular weight makes it insoluble in normal organic solvents. Previous attempts in the 1980s got around this problem by mining oil shale and cooking it to extract energy. However, this approach ultimately proved too expensive and energy intensive to compete with conventional oil resources.

Now, a second act for oil shale is unfolding in Colorado's Piceance Creek Basin in the

western United States, where Chevron recently earned lease rights for an early–stage oil shale research and development project.

Going Underground

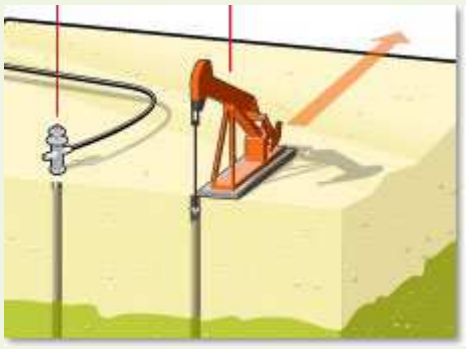
To develop this resource, Chevron is pioneering an innovative, new *in situ* (underground) recovery process. *In situ* recovery has important similarities to the methods used to refine heavy oil but with at least one major difference. Instead of occurring inside a refinery, the process will take place below the earth's surface.

"Our approach starts at the molecular level and focuses on a comprehensive understanding of kerogen's chemical structure," explains Robert Lestz, Chevron's oil shale technology manager. "From there, we'll develop an engineered solution to unlock the kerogen from the inorganic rock and flow it or its product, oil, to the surface."

"Unconventional resources take unconventional solutions," adds Brian Llewellyn, the project's production engineering manager. "The work being pioneered in Colorado could lead to a whole new definition of what's 'conventional' in oil industry terms. This might not only have long–term implications for the development of oil shale in other parts of the world or for other minerals like coal, it also could affect the development of technologies for effectively unlocking ultratight reservoirs for the production of oil and gas. We've already spun off some of what we've learned to help improve productivity and modeling of Chevron's deepwater U.S. Gulf of Mexico assets."

A Team Effort

To achieve its goals, the oil shale project draws on an impressive array of talents and technologies within Chevron, encompassing virtually the entire enterprise. The effort will involve new fracturing methods designed to enhance productivity in low permeability formations. (Fracturing involves cracking rocks to increase the ability of fluids to flow through them.)



Chevron is pioneering an innovative *in situ* recovery process, which has similarities to methods used to refine heavy oil but the process will take place underground, not in a refinery.

The project will make use of state–of–the–art seismic and subsurface imaging techniques, and it will capitalize on specialized knowledge gained from company successes with oil sands and heavy oil refining, among other "challenged crudes."

Outside resources are also being tapped. To help establish the fundamental science and engineering for commercial oil shale development, Chevron formed a research alliance with the U.S. Los Alamos National Laboratory in September 2006.

The lab, located in Los Alamos, New Mexico, is one of the largest multidisciplinary scientific institutions in the world, with world–class talent and technology and substantial facilities for research and development. As part of its role, Los Alamos will be involved in reservoir simulation and modeling, as well as experimental validation of new *in situ* recovery technology.

The social and environmental aspects of the current project are extremely important. The 1980s' mining approach required large amounts of groundwater in an area that is already among the driest on earth. Because the current approach focuses on *in situ* technology, it

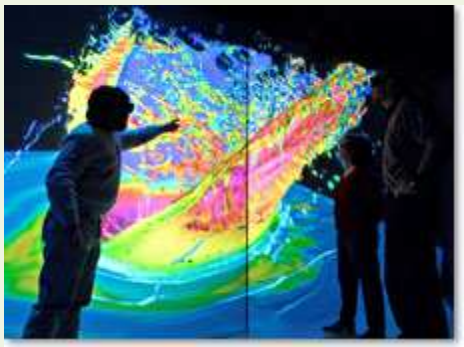
will have very minimal water needs and will develop specialized techniques to ensure that groundwater can be properly monitored and is not contaminated.

Communicating this environmental message to local towns, civic groups and other interested parties is important to build trust and confidence within communities in the area.

"We don't operate in a bubble," says Carley Hansen, the community engagement adviser assisting the oil shale project. "The region has a long history, encompassing multiple generations, and the people living there are interested in our plans."

She adds that people are sometimes surprised at how willing Chevron is to listen and how available stakeholders are to provide input into the project as it develops.

Delivering the Future



Scientists work in the RAVE – Reconfigurable Advanced Visualization Environment – facility at Los Alamos National Laboratory. The technology is used to view complex, 3–D, computational scientific data.

The project has four goals. The first and most obvious is to solve the resource challenge by finding an environmentally responsible and commercially viable way to liberate the potential energy locked in the rock. But the others are also significant and speak to the project's visionary scope.

A second key goal is to use the work being done with oil shale as a launch pad for developing spin-off technologies and discoveries with commercial potential. Robert Lestz compares it to the mission to place a man on the moon in the 1960s.

"In addition to achieving its important milestone, that project created a scientific bonanza, leading to the development of new products and technologies ranging from Velcro® fasteners to cold lasers," he says. "The oil shale project is expected to have similar value for Chevron, yielding an influx of new technology developments that will benefit the entire company for years to come."

A third goal is to build technology transfer capabilities within Chevron by giving people not directly involved in the project an opportunity to act as observers. When they return to their organizations, they will have new contacts and knowledge to innovatively apply.

And finally, the project can help build organizational capabilities by using Chevron's significant relationship with the Los Alamos National Laboratory as a recruiting tool. Interns and new hires brought into projects such as this one will have the opportunity to work with and be mentored by world–class scientists associated with this premiere research facility.

The goals are ambitious, and it could take up to a decade for the oil shale project to become commercial. "When we process unconventional oil in refineries, we're dealing with Mother Nature on our turf," says Phil Rosen, a member of the oil shale team. "When we process oil shale *in situ*, we're on her turf. The challenge in developing the world's vast oil shale resources will be to overcome that disadvantage in an environmentally and economically viable manner."

A Master of His Craft

Newest Master Driver credits his success on focus and rest.

Ask Jacinto "Junior" Conol what he attributes his perfect driving and fuel delivery record to and, without any hesitation, Chevron's newest Master Driver will tell you it's his ability to remain focused.

But talk to this soft-spoken native Hawaiian for more than five minutes and something else becomes readily apparent: Junior Conol lives and breathes Chevron's safety mantra. He is as deliberate about choosing his words as he has been about taking the time to do everything right — checking and double-checking at every stop along his delivery routes for more than 20 years.

"Because of the product we're responsible for, you've got to stay focused. You've got to apply what you've learned. You've got to double-check your work and make no assumptions. And you can't be in a hurry," he emphasizes.

"Having enough rest is key. That way, you're alert all the time," he explains. Junior credits his wife of 37 years, Carolyn, for enabling him to get this rest. "My wife was so good about taking care of the kids and reminding them: 'Daddy needs to rest.' She knows how critical my job is. She made sure everything was comfortable in the home so I could do what I needed to.

"One of the other things that helped me is that when I was growing up I saw what gasoline could do. Just the fear of what the 9,200 gallons (34,826 liters) of petroleum we haul could do to me or the public if there was an explosion or fire, from Day One I've carried that fear. It keeps me in line. It's kept me out of trouble."

Junior has driven out of the Hilo Terminal on the "big island" of Hawaii for his entire Chevron career. He is one of five company drivers navigating 80,000-pound (36,288-kg) tanker trucks over the curving roads and two-lane highways that crisscross this mountainous island.

While Chevron hasn't counted every mile over the past 20 years, Junior is likely to have driven close to a million (1.6 million km) and delivered between 19,000 and 20,000 loads of fuel without making a single mistake, a feat that's all the more remarkable given that Hilo, Hawaii, experiences more rainfall than any other city in the United States.

As one of only six active Master Drivers among Chevron's 1,000 company drivers worldwide, Junior is clearly one of the elite. A devoted adherent of Smith System Defensive Driving (see sidebar), the father of three sons has passed along his lessons learned — adjusting his speed according to road conditions, assessing risks, giving himself an out — to his entire family.

“I’ve always reminded my sons and my wife about the Smith System: to get the big picture, to leave themselves an out, to keep a cushion between themselves and other cars,” he recalls.

In July, Junior is scheduled to be flown to corporate headquarters in San Ramon, California, for his official induction as a Master Driver, a tradition Global Marketing President Shariq Yosufzai began for new Master Drivers in 2004. At that time Junior will meet with Chairman Dave O’Reilly, Global Downstream Executive Vice President Mike Wirth and Shariq. He’ll receive a load of gifts that mark his elevated status: a gold keychain engraved with “Master Driver” and an exclusive jacket worn only by drivers who achieve this status and a commemorative plaque, to name two. Colleagues will line the hallways to shake his hand as he passes. It is an occasion he’ll always remember. At the same time, achieving Master Driver status has been what Junior describes as a “bittersweet honor.”

In September 2005, Carolyn Conol was returning home with friends from a morning of community service in Hilo when her vehicle was struck from behind by a speeding motorist attempting to pass her illegally as she was turning from the main highway onto a residential street. The accident left her bedridden, with neurological damage that has rendered her unable to travel to San Ramon to share in the joy of her husband’s accomplishment.

“I’m really honored by all the attention I’m getting. But there’s a void because of my wife. To get the full impact, to really be happy, I would need to have her share my happiness. I don’t have that anymore.”

In addition to driving, Junior also spends some of his time as a driver instructor, helping train Chevron tanker drivers on the Hawaiian Islands. “I love what I’m doing,” he emphasizes. “I want to reach the hearts of the guys I’m training, to share what I’ve learned and help them feel the same way.”

Methane Hydrates: The Science Facts

Methane trapped in marine sediments as a hydrate represents a potentially vast energy resource. It even has important implications for climate change.

While it isn't a familiar term to most, "methane hydrate" is rapidly gaining popularity in the energy sector.

Why? Because in research and development circles, it's being evaluated as a potential fuel for the future. In fact, some believe there is enough methane in the form of hydrate – methane locked in ice – to supply energy for hundreds of, maybe even a thousand, years.

Methane hydrate contains methane, the principal component of natural gas, in a highly concentrated form. A methane hydrate is a cagelike lattice of ice, inside of which are trapped molecules of methane. Hydrate forms when water and gas (in this case, methane) come together at the right temperature and pressure.

It may look like ice, but this stuff burns.

Originally thought to occur only in the outer regions of the solar system, where temperatures are low and ice is common (Saturn's moon Titan, for example, has a methane hydrate crust more than 60 miles [100 km] thick), extremely large deposits of methane hydrate have been found under sediments on the ocean floors of the earth and, less frequently, below arctic permafrost.

Hydrate occurs both in deep sedimentary structures, at water depths greater than about 1,600 feet (500 m), where high pressures dominate, and as outcrops on the ocean floor. The hydrate deposits themselves may be several hundred feet thick.

Methane hydrate is believed to form from bacterial methane gas that migrates up from deep below the seabed along geologic faults. Crystallization (see animation above) occurs when the gas comes into contact with cold aquifers below the ocean floor.

This hydrate may have important implications for climate change. If released into the air by natural dissociation, methane is a greenhouse gas that traps 20 times more heat than carbon dioxide, the better known greenhouse gas. Conversely, if produced as an energy source, methane releases up to 25 percent less carbon dioxide than the combustion of the same mass of coal and does not emit the nitrogen and sulfur oxides known to damage the environment.

Energy to Spare for the Next Generation

In this issue of Line Rider, *we focus on two community youth projects boosted by Chevron employee volunteers.*

Setting the Stage for Science

Chevron scientists are stars of a multimedia road show that brings technology career options to life.

As in many other countries, Australia is in the grip of a skills shortage, suffering from a lack of graduates in science, technology and related industries.

To help counter the 20–year decline, Chevron Australia has been supporting the development of Beyond the Beaker: Discovering Careers in Science, a science outreach program that aims to inspire interest in these subjects among eighth through tenth grade students.

Beyond the Beaker presentations at high schools in Perth and throughout Western Australia are coordinated and delivered by Scitech, Perth's interactive science museum. Since the program's launch in August last year, more than 8,500 students have seen the presentation.

According to Australia business unit managing director Jay Johnson, the partnership with Scitech "helps address concerns that the supply of skilled graduates in the areas of science, technology, mathematics and engineering may not meet current or future demand."

"Many students still do not realize there is such a broad range of science careers to suit every interest," explains Scitech science careers coordinator Skye Kelliher. But their outlook changes radically after the guided audiovisual presentation by the program's young, enthusiastic science presenters.

Seated in an audience and using audience response systems that look like TV remote controls, students are asked to vote for the career areas they would like to learn more about, including working outdoors, with animals or in sport, art or travel. The video clips that are shown represent the highest vote getters.

Upbeat and inspiring video clips (see sidebar) feature Chevron Australia employees: petroleum engineer Nina Rudduck and geologists Bree Goff and Luke Johnson. Among the other professionals profiled are a forensic entomologist, agricultural scientist, zoologist and food technologist.

Beyond the Beaker presenters also engage the students in interactive experiments that answer questions on everyday scientific phenomena.

Teachers nominate high-potential students to participate in a special hands-on workshop using a hypothetical forensics scenario. Entitled "A Wedding and Two Funerals," the scenario revolves around a food–poisoning case that results in the deaths of two guests at a wedding reception.

Students work as microbiologists to identify the bacteria found in the victims' blood, as immunologists to analyze and identify blood serum samples to determine what antibodies are present, and as food technologists to analyze food and drink samples confiscated from the wedding banquet. The workshop is designed to encourage scientific thinking and critical analysis of real science scenarios.

"By showcasing a wide range of exciting career choices in the areas of science, engineering and technology, we hope to encourage more students to develop skills in these areas," Jay adds.

Giving Everyone a Chance

A Hong Kong community partnership helps level the playing field for young, low-income students

In Hong Kong, where more than a quarter of a million children live in poverty, Chevron has joined forces with the city's Boys' and Girls' Clubs Association to help break the cycle of poverty.

PROJECT PHOTO GALLERY

Learning is Sweet

Students watch and listen to instruction from a professional during a cake baking class organized at a local cooking school. Accompanied by a mentor or parent, the students each baked mango cream cakes to bring home to their families.

Caltex Project Chance involves 50 employee volunteers who provide hands–on

opportunities that broaden the horizons of 100 6– to 9–year–olds every year. The program offers academic assistance, emotional support, and cultural and educational opportunities not otherwise available to these children.

Whether it's from the one–to–one attention they receive, the trips to historic sites and shows, or the daily homework support that's theirs for the asking, the children involved in Project Chance blossom under the tutelage of the volunteers, who are part of Chevron's Hong Kong team.

Eight–year–old Yee Ping isn't shy about expressing her feelings about her mentor, Caltex retail card marketing consultant Kathy Wong: "I am impressed by Ms. Kathy, who is my mentor in Caltex Project Chance. She cares about me just like she is my elder sister. She listens to my feelings, both happy and unhappy. She teaches me social etiquette – to be thoughtful and care for other needy people. I want to be a lawyer when I grow up so I can help the poor fight for justice in the community. I also want to be a volunteer like Ms. Kathy and help the children from poor families."

From serving as mentors to the children to organizing extracurricular activities, sporting events and English classes, the volunteers are forging relationships that are proving valuable for all involved.

"It is particularly rewarding when I take the mentor role for the kids," says Kelven Lee, a senior engineer with Chevron Hong Kong Ltd. "During the mentorship, you find the kids make significant improvements in their academic work, self–confidence and social skills. Nothing is comparable to offering these children sincere encouragement and actual support for learning and emotional development."

For the benefits it provides to children through the dedication of Chevron volunteers, Project Chance was recognized as the top community project in Hong Kong and awarded the city's prestigious Outstanding Partnership Project Award in February.

"I hope there will be more companies like Chevron Hong Kong to join hands with nongovernmental organizations to provide support to children of disadvantaged families," said the Hon. Henry Tang, financial secretary of the Hong Kong special administrative region and chairman of the city's Commission on Poverty, upon presenting the award.

Letters to the Editor

Your letters continue to flow into the *Line Rider* in-box with comments, interesting suggestions, and kind words of praise and constructive criticism. Keep them coming!

Don't Drink (Coffee) and Drive

I really enjoy reading *Line Rider* and would like to commend all the folks who contribute to putting it together. I did have one comment on your contest ["Test Your Knowledge"]. While the contest is a great idea to engage your readers, the offer of a commuter mug strikes me as somewhat inconsistent with Chevron's focus on safe operations. Some folks might get the impression that a commuter mug would make it easier to drink their morning beverage while driving. Doing anything, including drinking coffee while driving, could be a distraction and might make a person's commute less safe. Please consider if the offer of a commuter mug is consistent with our company values. I'm sure there are other prizes you could offer that wouldn't send mixed messages about our focus on safety. Thanks, and keep up the good work.

Steve Sanford, Bakersfield, California, United States

Editor's comment: *Thank you for your excellent observation and kind words about the magazine. We agree that a commuter mug sends the wrong message, and we certainly don't want to encourage distracted driving. Your suggestion comes at the same time we've decided to change our prize to a wind-up flashlight, which is unveiled in this issue's quiz. We hope this higher-value prize, which brings both environmental and safety benefits as a handy device to stow in the glove compartment in the event of a vehicle breakdown, helps to redress the balance.*

And, talking of safe driving practices, see our article on Master Drivers in this issue!

Office Buildings: the Giant Energy Consumers

Hello from Down Under! As a new employee to Chevron, I am pleasantly surprised with the amount of effort that goes into to educating the employee about energy conservation matters [" Putting Waste To Work," March 2007]. In [our Perth building], we currently occupy some 11 floors of a skyscraper, and the amount of electrical load we consume would be considerable. I have a personal interest in saving electricity and water and built my last house using energy-saving technology [including a microprocessor-based control system that allows electric units to be individually programmed]. I recommend that we use [similar] technology in all Chevron locations to intelligently manage our electricity consumption.

John Kelly, Perth, Australia

Take a Break – Read Line Rider!

Line Rider makes for great reading. I guess it's the way the articles are written and presented and the technical content that makes it so very interesting. For me, reading *Line Rider* is like taking a break from serious business. My best wishes to the *Line Rider* team for superlative success.

Stephen Mariadas, Escravos, Nigeria