Greenhouse Gas Technology News

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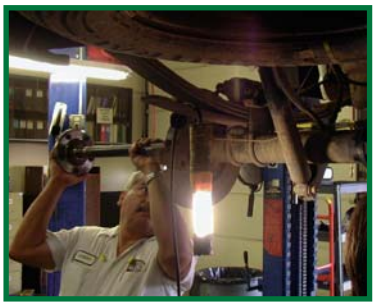
New Technologies Verified Across Several Economic Sectors

Since the last issue of Greenhouse Gas Technology News, four new performance verifications were completed on technologies applicable to the transportation, oil and gas, and electric power sectors.



Reassembling truck axle during the ConocoPhillips lubricant test

In the transportation sector, the GHG Center independently verified the performance of a new gear lubricant on a light-duty truck, one of the most widely used passenger vehicles in the United States. ConocoPhillips developed the lubricant in partnership with axle manufacturer Visteon Corporation. The product is marketed as a fuel-efficient, high-performance, multi-grade lubricant, and according to ConocoPhillips, consists of a lower viscosity, synthetic-base lubricant with optimized fluidity and friction modifiers when compared to standard axle lubricants. Independent performance verification of the lubricant was conducted by the GHG Center using a 2002 Ford F-150 pick-up truck at the light-duty vehicle testing facilities at the Southwest Research Institute. "Compared to using standard lubricants, we measured a 1% improvement in the fuel efficiency of our test truck," said Tim Hansen, manager of the verification test. "Although that sounds small, if the lubricant is used in all Ford vehicles that Visteon supplies axles to, we estimate the fuel savings would be equivalent to removing about 23,000 F-150 pick-ups from the road. That's a lot of air pollution reduced for little or no cost, and the fuel savings for consumers will add up over the life of a vehicle." In addition to fuel economy, emission rates of air pollutants and greenhouse gases from the test vehicle were also verified.

In the oil and gas sector, natural gas extracted from the ground often contains excess water vapor at the wellhead. This water must be removed to avoid pipeline corrosion and solid hydrate formation. Glycol dehydration is the most widely used natural gas dehumidification process. In the process, glycol is typically used to absorb water from natural gas in a contactor vessel, but it also absorbs natural gas (mostly methane), volatile organic compounds (VOCs), and hazardous air pollutants (HAPs). Gas dehydration is the third largest methane emission source in the natural gas production industry, and dehydrators also cause over 80 percent of the industry's annual HAP and VOC emissions. New technology for dehydrating natural gas with lower emissions has been developed by Engineered Concepts, LLC, of Farmington, NM. The new technology, referred to as the Quantum Leap Natural Gas Dehydration

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Stakeholders Confirm Center's Technology Focus

New Technology Areas and Collaborations Identified

The first meeting of the Advanced Energy Stakeholder Group was held on November 6, 2003, at the Hotel Monaco in Washington, D.C. A full agenda, meeting notes, and meeting roster are available on the Center's web site (www.sri-rtp.com). About 35 participants attended the one-day meeting - 28 Advanced Energy Stakeholder Group members, several observers, and four GHG Center staff. The day began with a panel of experts discussing technical, policy, and other issues relevant to users and vendors of advanced energy technologies. Speakers included: Bruce Poole, Office of Markets, Tariffs, and Rates-Federal Energy Regulatory

Stakeholder meeting session

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New Technologies

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Technology (QLT), was tested in the field by the GHG Center in April 2003. Testing consisted of a seven-day operational performance monitoring period followed by one day of environmental performance testing. According to Robert Richards, the verification test manager, "the QLT is effective, efficient, and has an environmental impact that's lower than most standard technology. While it dehydrates natural gas to pipeline quality standards, it fuels its own process with entrained vapors, requiring little or no external fuel gas supply. Also, it either burns recovered waste gases or condenses them into salable products, while conventional dehydrators often emit them to the atmosphere in large quantities as greenhouse gas and air toxic pollution." In the electrical power area, the focus was on distributed electrical generation (DG) technologies. The GHG Center, in collaboration with the New York State Energy Research and Development Authority (NYSERDA), evaluated the performance of a Capstone 60 kW-microturbine combined heat and power (CHP) system installed at a 57,000-ft² Waldbaum's supermarket in New York state. The heat recovered from the unit was used to provide supplemental space heat and dehumidification for the store's HVAC system. The classes of verification parameters evaluated included heat and power production performance (including energy efficiency), emissions performance (NO_x, CO, THC, CO_2, and CH_4), and power quality performance (e.g., harmonic distortions). Estimated NO_x and CO_2 emissions reductions for the CHP system were also estimated by comparing measured emission rates (lb/kWh) with corresponding emission rates for Waldbaum's baseline power and heat production systems (i.e., local utility grid and the facility's natural gas-fired boilers). "The NO_x emissions per unit electrical power output at full load were well below the average levels reported for the regional grid" said Bill Chatterton, the Center's verification test manager. "Interestingly, the average CO_2 emissions for the regional grid were nearly identical to the emission rate for the Capstone 60. After including the emission reductions attributed to the system's heat recovery, average annual emission reductions were estimated to be 17 percent for NO_x and 8 percent for CO_2."

Robert Richards of the GHG Center sampling QLT process streams

Quantum Leap Natural Gas Dehydration Technology (QLT) at a Colorado gas processing facility

A second DG technology was verified - the Plug Power proton-exchange membrane (PEM) fuel cell (model SU1). Verification of the SU1 was conducted at a private residence (2,060 ft²) in Lewiston, New York. The SU1 fuel cell is not a load-following system, but is configured to operate at nominal power outputs of 2.5, 4.0, or 5.0 kW. Testing commenced on April 10, 2003, and the same performance parameters evaluated for the Capstone microturbine were quantified here. "This is an early version of Plug's residential fuel cell and it does not have heat recovery" said Chatterton, the Center's verification test manager. "It is essentially a greenhouse gas-neutral technology. Although the estimated average CO_2 emission rate for combustion and other power generators used to feed the regional grid is slightly higher than the CO_2 emission rate for the SU1, methane emissions, although not extreme, are higher for the SU1."

Power Plug field test site in New York

Complete results for these and other technologies verified by the GHG Center can be downloaded at the Center's web site — www.sri-rtp.com.

Stakeholders

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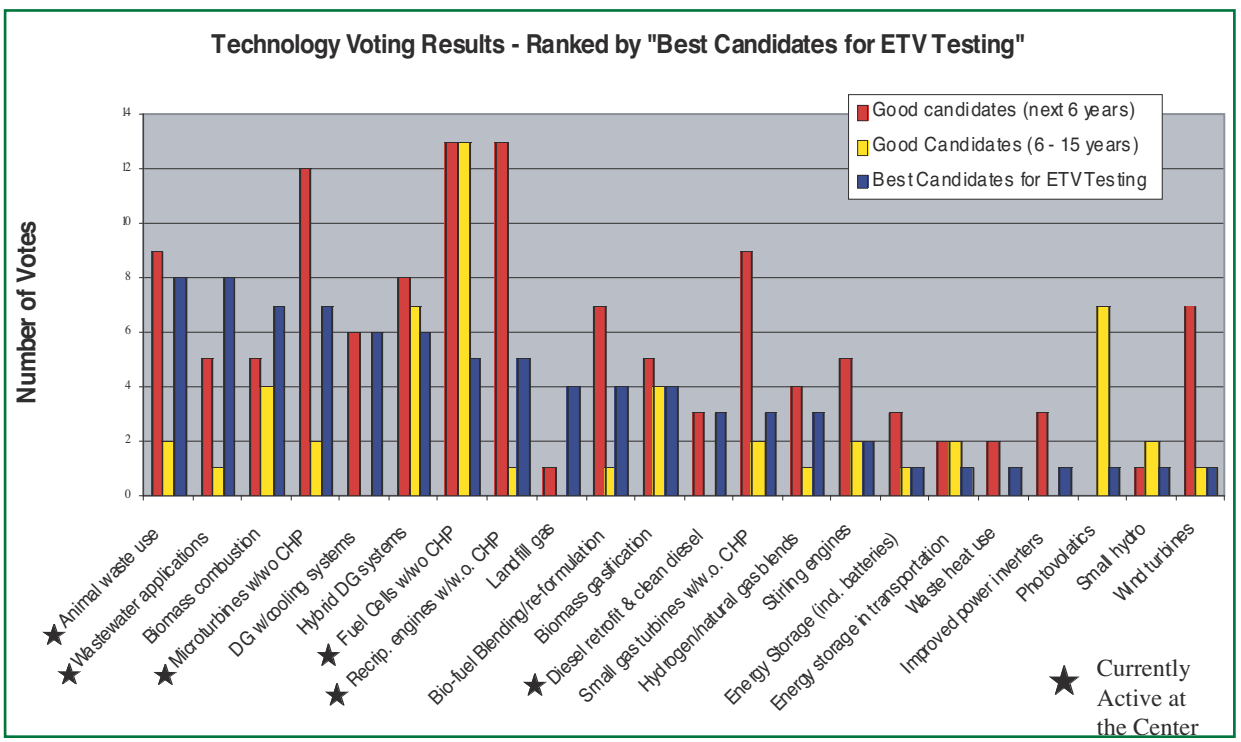
Commission (FERC); Tom Basso, NREL/IEEE SCC21 Standards Coordinating Committee; Roger Ballentine, President, Green Strategies, Inc; Bob Simon, Democratic Staff Director for the Senate Committee on Energy and Natural Resources; Steven Greenberg, RealEnergy; and Andy Skok, FuelCell Energy, Inc.

The GHG Center facilitated a series of sessions to focus the group on important Center business issues. A technology area prioritization exercise was held, the results of which were intended to help guide the Center's technology focus for several years to come. The results of that prioritization (see graph) confirmed the Center's focus on key advanced energy technology areas — six of the 12 top-rated technology areas are already active at the GHG Center. The prioritization also identified new technology areas the Center should consider. These included bio-fuels (e.g., diesel and bio-diesel blends), small gas turbines with and without CHP, and biomass gasification.A session was also held to prioritize technology performance measurement protocols and general testing strategies for advanced energy technologies.

Following these exercises, the remainder of the day was spent interacting with senior managers of advanced energy technology demonstration programs. The theme was to seek collaborative relationships, and a wide range of technologies and experiences were discussed by speakers, including Richard Drake — New York State Energy Research and Development Authority (NYSERDA); John Holt — National Rural Electric Cooperative Association (NRECA); Richard Handley — Northeast Regional Biomass Program (NRBP) of CONEG (Coalition of Northeastern Governors); Ed Lewis — Colorado Governor's Office of Energy Management and Conservation; and John Shea — New England Governor's Conference, Inc. (NEGC). A follow-up coordination with CONEG began soon after the meeting to seek biomass-related technologies as candidates for verification testing by the Center.

Roger Ballentine, President of Green Strategies and former Clinton Administration official addresses Stakeholders



Stakeholder Technology Voting Results

Three Major Scientific Studies Expand the GHG Mitigation Debate

Duke University Scientists Say Trees May Absorb Less Excess CO_2

Researchers from Duke University's Nicholas School of the Environment and Earth Sciences recently announced that their Free Air Carbon Dioxide Enrichment (FACE) experiment may not support the notion that trees can absorb much extra CO_2 by growing faster. FACE is being conducted in a forest ecosystem located in North Carolina where competition between organisms, resource limitations, and other real world factors exists and can influence how forests respond to increased CO_2 concentrations. For about seven years, several forest plots have been exposed to elevated levels of CO_2 to gauge how they may respond to future levels of CO_2 compared to adjacent plots exposed to current levels of CO_2 (see photo).

In May 1999, Duke researchers reported in Science journal that early results from FACE suggest about a 25% increase in net primary production occurred with elevated CO_2 — clearly a stimulated growth in the dominant species (loblolly pine). The researchers estimated that such an increase could fix about 50 percent of the anthropogenic CO_2 projected to be released into the atmosphere by 2050. However, as the FACE experiment progressed, more detailed trends and influences became apparent. Duke has found that, although the trees have boosted their annual growth rates by between 10 and 25 percent, the highest responses have been in the driest years and the effect of elevated CO_2 has been much less in normal and wet years.

According to Duke, these counterintuitive findings suggest that nitrogen deficiencies common to forest soils in the southeastern U.S. may limit the abilities of loblolly pine forests to use the extra CO_2 to produce more tissues as they take in more of the gas. "I'd be surprised if the forests of the world will take up more than one-third of the carbon dioxide from fossil fuel emissions in the year 2050, which is what our experiment simulates," said Duke professor and Nicholas School Dean William Schlesinger. When asked what this could mean for the mission of Southern's GHG Center, Dr. Schlesinger said, "This places an even greater burden on strategies that reduce greenhouse gas emissions at their source. Perhaps your Center should expand its efforts to identify and evaluate alternatives to current fossil fuel use technologies".

Contact: Duke University, website http://www.duke.edu.

NASA Studies Soot Impacts on Global Warming

NASA Goddard Space Flight Center (GSFC) recently reported to EIN Publishing's Global Warming Today that a team of NASA scientists conducted new modeling and other research that suggests emissions of black soot may alter the way sunlight reflects off snow and the retention of heat in the atmosphere, altering the climate system more than previously thought. "Black carbon reduces the amount of energy reflected by snow back into space, thus heating the snow surface more than if there were no black carbon," said NASA Goddard researcher Jim Hansen.

GSFC computer simulation indicates that black soot is potentially responsible for 25 percent of observed global warming over the past century. Soot can absorb more of the sun's energy and warmth than a snowy white background, so it is hypothesized that soot in areas with snow and ice may play an important role in climate change. Additionally, GSFC said that if snow- and ice-covered areas begin melting, the warming effect increases as the soot becomes more concentrated on the snow surface and the snow gets dirtier. Hansen also indicated soot's effect on snow "albedo," or solar energy reflected back to space,

(continued on page 5, see NASA)

Study Indicates Iron Fertilization Impractical as CO_2 Removal Strategy

Recent oceanographic studies have focused on the feasibility of iron fertilization of phytoplankton as a method of removing excess CO_2 from the atmosphere. One study in the Southern Ocean, for example, led by Kenneth Coale of Moss Landing Marine Laboratories (MLML) and Ken Johnson of Monterey Bay Aquarium Research Institute revealed that iron added to surface waters caused massive phytoplankton blooms that consumed more than 30,000 tons of CO_2. MLML feels these findings suggest iron fertilization causes billions of tons of carbon to be removed annually from the atmosphere. These results, according to MLML, show that iron supply to the Southern Ocean may have controlled the Earth's climate during past ice ages. MLML noted that similar observations were reported and presented separately in a recent issue of the Science journal by Ken Buessler of Woods Hole Oceanographic Institute and Jim Bishop of Lawrence Berkeley National Laboratory, concluding that much of the consumed CO_2 sank to the ocean bottom.

This iron fertilization concept was, however, recently refuted by Philip Boyd of the University of Otago (New Zealand) in a published article for Nature magazine. The concept seemed promising to Boyd in 1999 after his research team spread about 8000 kilograms of an iron solution in the Southern Ocean, creating a five-fold

(continued on page 5, see Iron Fertilization)

Center Focuses on Human and Animal Waste Utilization Technologies

While maintaining an emphasis on advanced energy production systems, most of the technologies currently being verified involve the expanding practice of producing and using biogas from the anaerobic digestion of hog, diary cow, and human waste. Electricity and process heat are usually the primary products.

The Center is currently evaluating six technologies involved with biogas - two biogas cleaning technologies and four combined heat and power (CHP) systems that use biogas to make electric power and heat. The two different biogas cleaning technologies, one offered by U.S. Filter and the other by The NATCO Group, remove hydrogen sulfide from biogas, sweetening the gas and reducing potentially large quantities of air pollution that would occur with its combustion. The advanced energy technologies being verified span a range of CHP systems: one 70 kW-engine CHP (Martin Machinery), two different 30 kW-microturbine CHPs (Capstone 30 with Unifin heat recovery and a Capstone 30 with Cain HRSG heat recovery), and one 250 kW-fuel cell CHP (United Technologies Corporation). A seventh technology, Bio-Regen, is an animal waste additive offered by Microganics LLC of Southlake, Texas. Microganics withdrew it's product from verification shortly before testing could begin.

Dairy farm test site in New York state

The technology verifications above are occurring at farms and wastewater treatment facilities located across the U.S. — Colorado, Iowa, and New York state. Performance characteristics evaluated for the two biogas cleaning technologies include contaminant removal efficiency, air emissions, and waste generation features. For the three different CHP systems, the Center will characterize a standard suite of performance parameters contained in the Center's published testing protocols for CHP systems (air emissions, energy efficiency, energy output, and power quality). Final Verification Reports should be completed during the spring and summer of 2004.

UTC fuel cells at wastewater treatment plant test site in Brooklyn

"Interest in animal and human waste technologies has grown significantly during 2003", said Stephen Piccot, GHG Center Director, "and it shows no sign of letting up. I anticipate signing on several new vendors this year, vendors that offer technologies ranging from waste additives that may accelerate biogas production to completely different strategies for handling these wastes."

NATCO test site at Cedar Rapids wastewater treatment facility

NASA

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may be contributing to early springs in the Northern Hemisphere, thinning of Arctic sea ice, melting of glaciers and permafrost, and other impacts.

Black carbon or soot is generated from industrial processes, outdoor fires, burning of coal and biomass fuels, use of diesel fuels, and other processes. "If this impact is as significant as the GSFC study suggests, the GHG Center may indeed start addressing technologies that mitigate soot air pollution" said Stephen Piccot, GHG Center Director. "We already work in some of these areas, such as diesel engines and electric power, but our focus has been on everything except soot emissions, and some strategies to control greenhouse gases and criteria pollutants can actually increase soot emissions. We plan to follow this closely."

IRON FERTILIZATION

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increase in phytoplankton blooms. Scientists hoped that these blooms could consume excess atmospheric CO_2 supplies.

However, a subsequent study by Boyd in the Gulf of Alaska could not produce results supporting these previous studies in the Southern Ocean. Boyd's research team concluded that the addition of iron is only part of the equation for increasing phytoplankton blooms and reducing CO_2 levels — large quantities of silicate must also be added for the phytoplankton levels to grow. Unfortunately, the silicate demand would be so great that five-thousand times as much silicate would need to be combined with the iron solution to see an effect on atmospheric CO_2 levels, demonstrating the impracticality of iron fertilization for CO_2 removal.

Transportation Verifications Start to Roll

The Center has started its second transportation-related technology verification. Testing will occur in the spring of 2004 using a heavy-duty diesel engine typical of those used in long-haul 18-wheel trucks. The vendor, Universal Cams of Stuart, Florida, indicates the technology is applicable to gasoline and other engines, and is capable of producing large fuel economy and emissions improvements.

Advertised as an after-market retrofit device, the Universal Cams technology involves replacing an engine's existing camshaft with a redesigned camshaft and cam sprocket. Special engine tuning and other modification may also be required. Phase 1 of the verification test will address how the technology changes the emissions and fuel economy of a heavy-duty diesel engine. If Phase 1 is successful, Phase 2 will address long-term performance and reliability issues.

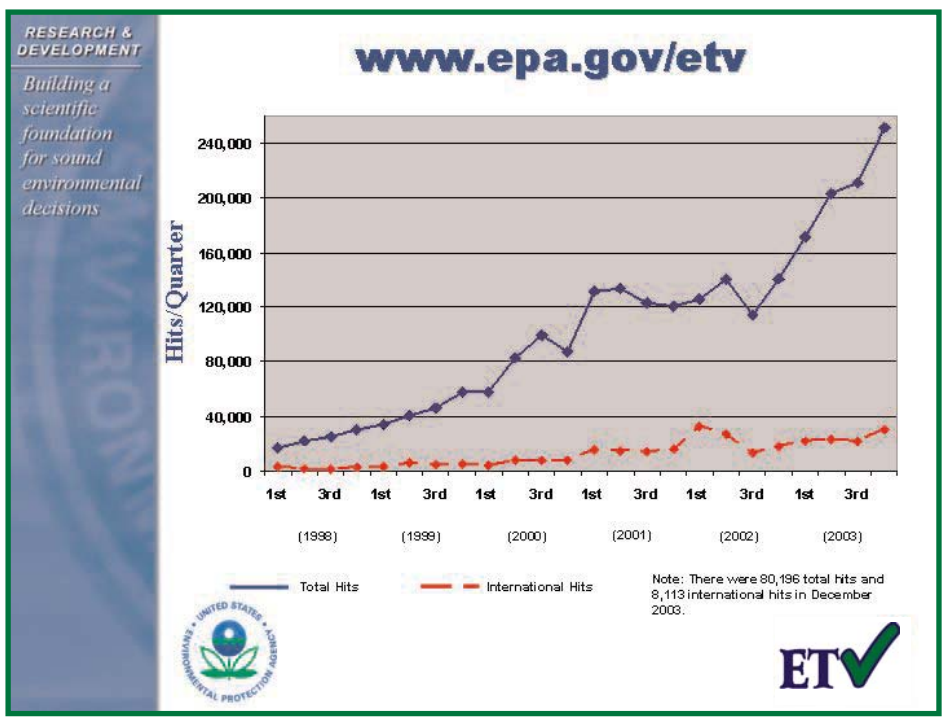
"Over the past few months we've talked with no fewer than 10 vendors that have technologies they claim will bring about fuel economy and other transportation technology improvements" said Piccot. "These guys all need independent performance data to prove their fuel economy and other claims, and they represent a surprisingly wide range of different approaches from fuel additives and pre-combustion fuel catalysis filters to engine retrofit devices and constant velocity transmission systems. We reported in our last newsletter that transportation technologies may be a new focus for the Center and this seems to be occurring, especially in the heavy-duty diesel market where industry is poised to make significant technology improvements over the next few years." In March, the Center entered into an agreement with EnviroFuels L.P., to evaluate the performance of a microfilm-based fuel additive on the fuel economy and emissions of a diesel locomotive. Testing should begin later in 2004.

ETV Web Site Activity Spikes

GHG Center Pages Among Highest Rated

The GHG Center operates under U.S. EPA's Environmental Technology Verification (ETV) Program. It is one of six Centers that verify technologies in the environmental and homeland security areas.

EPA maintains a web site for the ETV Program which, historically, has been among the most accessed areas in EPA's overall web site. The ETV site experienced over 240,000 hits in the third quarter of 2003, the highest level experienced to date (see graph). Pages devoted to GHG Center activities within the ETV site were among the top 10 pages accessed. "That's great", said David Kirchgessner, EPA's Project Officer for the GHG Center. "It says we're working in the right areas, areas of great interest to the public. This is exactly what the ETV Program is supposed to do".



Of the top 10 ETV Program web pages accessed, three belong to the GHG Center. All three were focused on advanced energy technologies, each providing results or testing protocol documents for distributed generation technologies including microturbines, fuel cells, engine generators and combined heat and power (CHP) technologies.

Contact the Greenhouse Gas Technology Center by calling Stephen Piccot at Southern Research Institute (919/806-3456), or David Kirchgessner at the U.S. EPA (919/541-4021). Additional information can be viewed on the GHG Center web site at www.sri-rtp.com or the U.S. EPA ETV web site at www.epa.gov/etv.

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