Greenhouse Gas Technology News

April 2003 NEWSLETTER Issue 8

Published by the Greenhouse Gas Technology Center

An Environmental Technology Verification (ETV) Organization Sponsored by
the U.S. Environmental Protection Agency and Partners from Industry, Government, and Academia.

Interest Grows in Technologies That Produce and Use Biogas

The U.S. EPA has estimated that methane emissions from livestock manure management were 17.0 million tons of carbon equivalents, accounting for about 10 percent of the total methane emissions in the U.S. The majority of these emissions were generated from large swine and dairy farms that manage manure as a liquid; EPA anticipates methane emissions from livestock manure in the U.S. will increase by more than 25 percent between 2000 and 2020.

Biogas production from livestock manure management facilities is of increasing interest to the energy and agricultural industries, as well as to regulatory and other communities. Technologies commonly referred to as anaerobic digesters rapidly decompose manure in a controlled environment using methagenic bacteria, allowing for the recovery and use of methane-rich biogas. This low-Btu biogas can be used to fuel combined heat and power (CHP) generators that produce electricity, process heat, domestic hot water, and other energy products. Digesters can also reduce odors along with other air pollutants, while reducing the risk of ground- and surface-water pollution.

Anaerobic digester at a 750-head dairy farm in New York.

The GHG Center has several active biogas technology verifications in process now: (1) a reciprocating

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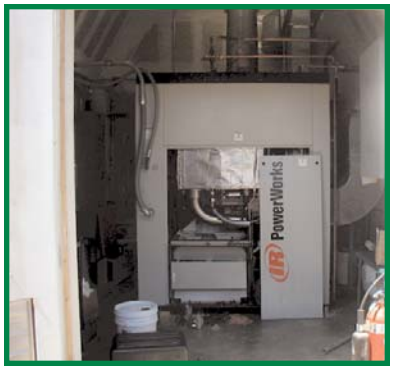
GHG Center Verifies Ingersoll-Rand PowerWorks™ Microturbine CHP

The GHG Center has completed independent performance verification of a new distributed power generation device, the Ingersoll Rand PowerWorks™ 70 kW Microturbine Combined Heat and Power (CHP) System. The gas-fired PowerWorks™ was designed for use on-site at commercial and industrial establishments, and is specified by Ingersoll-Rand to produce a nominal 70 kW of three phase electrical power and 51,100 Btu/hr.

Microturbine shed, located at the Crouse Community Center.

Verification occurred at the Crouse Community Center, a 60,000 square-foot assisted living facility in Morrisville, New York that cares for elderly residents. Similar to a hospital, the Center has private residential rooms, social and recreational areas, a commercial-scale laundry, and food service facilities. The PowerWorks™ was installed to provide electricity, domestic hot water, and hot water-based space heating.



Entrance of the shed housing the IR PowerWorks™.

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Biogas

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Biogas fueled engine-generator-CHP in use at a swine farm.

engine-CHP unit burning biogas from a swine waste digester, (2) a microturbine-CHP unit burning biogas from the same swine waste digester, (3) a microturbine-CHP burning biogas from a dairy farm digester, (4) a fuel cell-CHP using biogas from a human waste digester, and (5) a biogas purification technology. All of these applications convert biological waste into renewable energy, while reducing on-farm energy costs and in some instances, producing excess electricity for sale to the grid. Also, they can produce marketable by-products such as soil amendments while simultaneously mitigating air pollutants, GHG emissions, water pollution and nuisance odors.

Bill Chatterton, GHG Center Field-Testing Leader, reluctantly poses in cow manure storage bin.

"These waste-to-energy systems may offer win-win strategies for some farmers, and it seems like the GHG Center is getting more inquiries for verification of animal and human waste-related mitigation technologies," said Dr. David Kirchgessner, U.S. EPA Project officer for the GHG Technology Center. "It's not just energy production devices we're hearing about, it's alternative digester systems, non-digester solutions, waste additives, and others." The Center recently agreed to verify the performance of a new digester additive which is claimed to increase biogas production rates in anaerobic digesters and reduce biogas contaminants that produce air pollution when burned. If proven, it could enhance the economic viability of on-farm energy systems and further reduce the environmental impact from animal waste.

Anaerobic digester at a 5000-head swine farm in Colorado.

Microturbine CHP

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Existing boiler at Crouse Community Center that will be operated less due to the recovery of waste heat from the PowerWorks™.

Waste heat extracted from hot exhaust gases leaving the microturbine reduces the need for heat from the facility's two existing gas-fired boilers. Normally the facility uses all of the electricity produced by the PowerWorks™ however, on those occasions when the facility demand drops below the capacity of the PowerWorks™, power is exported to the local grid.

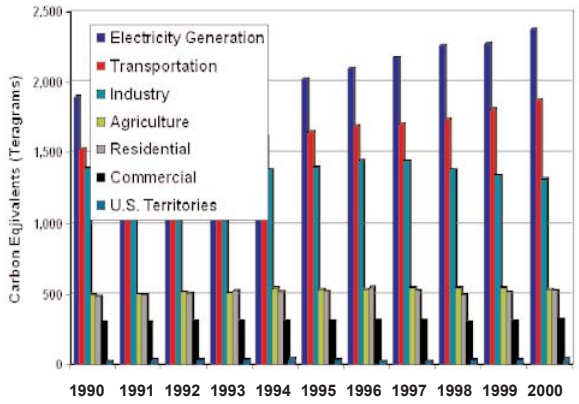
Performance parameters verified include electrical output and heat recovery rate, electrical and thermal efficiency, total system efficiency, power quality (frequency, power factor, voltage and current total harmonic distortion), emission rates of GHG's and conventional air pollutants, and estimated emission reductions for GHG's and nitrogen oxides (NO_x). The unit operates exclusively at 100 percent capacity, and during testing measurements of total system efficiency ranged from 46 to 51 percent. Use of the PowerWorks™ at Crouse was estimated to reduce carbon dioxide emissions by 34 percent as a result of electrical grid offsets combined with a reduced need for hot water from the existing gas-fired boilers. Emissions of nitrogen oxides were relatively low, about 1 part per million (ppmvd@ 15% O_2).

A synopsis and performance evaluation report can be obtained free of charge from the U.S. EPA website at http://www.epa.gov/etv/verifications/vcenter3-10.html or the GHG Center website at http://www.sri-rtp.com/Publications2.htm.

GHG Center Mulls Verification of Transportation Technologies

Are Heavy Duty Vehicles Poised for Technology Change?

Emission inventories indicate that electricity generation produces about one-third of the carbon equivalents released in the USA, while transportation activities produce about one-fourth (see chart). The GHG Center continues to evaluate innovative electricity generation technologies, but its involvement in the transportation sector is limited. "The Center is verifying fuel efficiency changes that accompany the use of a new lubricant for SUV's and light-duty trucks, but there are no other transportation technologies lined up for evaluation," said Steve Piccot, Center Director. "Given its GHG emissions significance we are currently examining several transportation sub-sectors, searching for innovative technology candidates."



GHG Emissions in the USA. (Source: US EPA)

Passenger cars and light-duty trucks account for about 60 percent of the total transportation-related GHG emissions in the USA. Changes have occurred to improve the performance of these vehicles, and efforts continue in the areas of fuel efficiency and emissions. In contrast, the heavy-duty vehicle sub-sector, which includes trucks and buses, and accounts for almost 20 percent of transportation-related GHG emissions in the USA, has seen fewer changes. The Center is investigating this sub-sector, and in a recent meeting of heavy-duty vehicle experts, the Center participated in a Delphi market survey of those experts. The survey was intended to identify new technology trends in the heavy-duty vehicle market. Excerpts from that survey are described below.

Fuel cell-powered city bus.

Delphi Survey Results (Sponsored by WestStart-CALSTART)

A modified Delphi market forecast exercise was conducted as part of the 3rd Annual Clean Heavy-Duty Vehicles Conference which was held in Tempe Arizona on February 19-21. While not a pre-selected group of experts, as is traditional in a Delphi exercise, attendees of the Clean Heavy-Duty Vehicles Conference did represent many different interest groups. Attendees comprised original equipment manufacturers (8%), suppliers and developers (34%), fleet and truck users (11%), military (11%), government agencies (12%), research groups (12%), fuel suppliers (8%), and others (4%).

Fuel cell-powered heavy duty truck.

The survey indicated that over the next decade, diesel fuel and engines will face a serious challenge defending their current dominance in the heavy-duty market. Key motivators of change will be tough new emission regulations, coupled with rising fuel costs. Prime challengers to diesel will include truck systems powered by natural gas and hybrid technology. Such are the overall findings of the industry market forecast conducted by WestStart-CALSTART (www.calstart.org).

A cross section of the participants believe the market share for diesel engine systems, now the dominant technology in heavy-duty trucks, will significantly decline by 2010. The results forecast diesel slipping to less

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Transportation

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New wide design X-ONE truck tire from Michelin is claimed to improve fuel economy by about 10% over conventional dual tire system.

than 80% of new heavy-duty vehicles sold by the year 2010, and to less than 66% of the new heavy-duty truck market by 2020. In contrast, by 2010 natural gas engine systems are projected to account for 10% of the market, hybrid systems for roughly another 10%, with fuel cell systems somewhere under 2%. By 2020, while natural gas is projected to remain essentially steady, increasing to just over 11% of new trucks hybrids are projected to increase to 17% and fuel cell systems will capture as much as 6% of the new truck market. These changes represent a significant potential shift in technologies and fuels.

Respondents provided forecasts in three other areas. In looking at alternative formulations of diesel fuel, they projected that gas-to-liquid or synthetic diesel formulations would make up 5-10% of the 2010 market for diesel fuels, and biodiesel somewhat less than 5%. By 2020, the market share for each of these forumulations is expected to rise to near 10%. Emission requirements and fuel costs are the two major factors motivating a shift to diesel alternatives by 2010 followed by energy security issues and global warming. By 2020, respondents believe that fuel costs will emerge as the primary issue motivating change, followed by emissions requirements, energy security and global warming.

Finally, respondents felt it highly likely that in ten years, natural gas and hybrid systems will be used in urban refuse trucks, urban delivery trucks, and transit buses. While most felt is highly unlikely that fuel cell drive systems would emerge in urban refuse or delivery trucks, 57% thought it likely that fuel cells would emerge in transit buses (see earlier photo). Most respondents felt long haul transport trucks were unlikely applications for natural gas, fuel cells (see earlier photo) and hybrids, although only 56% thought them unlikely candidates for hybrids.

Oberg Industries, a leading supplier to the automotive industry, recently announced the results of a survey of attendees at the Society of Automotive Engineers (SAE) 2003 World Congress. Oberg said participants were asked to project the number of new vehicles in 2010 that will feature the top 20 new automotive technologies. 73 percent of respondents believed that fuel cells will be in fewer than five percent of new vehicles in 2010, while 80 percent expected hybrid electric motors and diesel engines could reach up to one-fourth of new vehicles by the end of the decade.

Center Verifies COMM Engineering's Environmental Vapor Recovery Unit - Interest From Users Spikes

Recovers waste gases at oil and gas facilities

Installation of GHG Center flow monitoring equipment on the COMM EVRU system.

The GHG Technology Center has completed independent performance verification of a new device, the patented Environmental Vapor Recovery Unit (EVRU™) developed by Lafayette, LA.-based COMM Engineering, USA.

The EVRU™ technology uses energy from existing high-pressure natural gas pipelines to power its waste gas recovery functions (external power is not required). It captures valuable waste gases at different pressures using a closed-loop system, and then pressurizes those gases to allow their discharge into existing natural gas pipelines for sale and use - paying for itself in short order. Independent performance verification of the EVRU was conducted at the TotalFinaELf El Ebanito site near McAllen, Texas. A synopsis and final performance evaluation report can be accessed free of charge at the U.S. EPA website at http://www.epa.gov/etv/verifications/vcenter3-10.html or at the GHG Center website at http://www.sri-rtp.com/Publications2.htm

"COMM Engineering worked with the GHG Center for approximately one year in our quest for technology verification," said Mark Goodyear, president of COMM Engineering. "We can attest that this program helps cost-effective

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COMM

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technologies obtain credibility with the end user, and provides an unbiased assessment of a technology. This experience has been a brilliant example of how a government agency can facilitate free enterprise and enhance the environment. We have been bombarded with requests for quotations since the verification was completed and are hearing from many potential customers that we never worked with before," Goodyear affirmed.

COMM Engineering EVRU™ at the Total FinaELf Test Site in Texas.

Technology performance parameters verified for the EVRU™ include waste gas recovery rate, annual gas recovery rate, value of gas saved, total installed cost, and reduction in GHG and hazardous air pollutant emissions. The Center estimated that annual methane emission reductions would be 678 tons per year if the test site previously vented the waste gas to the atmosphere, or 68 tons per year if the test site previously used conventional vapor recovery units. For facilities that currently vent waste gas, a simple pay-back for the EVRU was estimated to be 0.3 years, but for facilities that currently use conventional vapor recovery units, the pay back would be longer.

New Advanced Energy Stakeholder Group Forming

Subcommittee of energy experts meets in Florida to help chart a path forward

The GHG Technology Center hosted a meeting of about 30 Electricity Generation Stakeholders in Arlington, Virginia in 1999. Distributed electricity generation (DG) technologies were at the top of their list of technology priorities. Since that 1999 meeting, the GHG Center prepared performance verification protocols for microturbines, spark-ignition engines, CHP systems, and fuel cells. The GHG Center also established partnerships with organizations interested in measuring DG technology performance; and completed performance verification of three DG devices. The GHG Center is currently verifying seven other DG systems installed at farms, a private residence, a supermarket, a chemical plant, a wastewater treatment plant, and an assisted-living facility.

Spurred on by these activities and a mission to cost-effectively reduce GHG emissions from electricity generation, the GHG Center has announced its intention to broaden its focus in the clean electricity generation area. "We announced our intention in 2002 to broaden our technology focus in electricity generation, then formed a small but diverse subcommittee of energy sector experts to help plan and form a new Advanced Energy Stakeholder Group," said Stephen Piccot, GHG Center Director. On December 10, 2002, the new Subcommittee met at the Rozen Plaza Hotel in Orlando, Florida.

The Subcommittee recommended the Advanced Energy Stakeholder Group include no more than 50 individuals and strive for diversity, including state and federal energy offices, trade associations (e.g., building and hospitality industries), carbon trading groups, offshore oil and natural gas companies, electric utilities (especially those in green power programs), university industrial & agricultural extension programs, the DOE Advanced Coal Research Program, and others. Subcommittee members felt that the performance parameters included in the GHG Centers current testing protocols (emissions, energy conversion, and power quality performance parameters) were appropriate, but that other parameters of major interest (reliability, availability, maintainability, and durability) should also be considered.

The Subcommittee listed technologies that are promising and worthy of further research or demonstration (see table of high-priority technologies). It was proposed that this list be presented to the full Advanced Energy Stakeholder group for prioritization and expansion at the first meeting, which has been tentatively scheduled for the summer of 2003.

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Stakeholders

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Organization Participating on the Subcommittee
ACEEE
Bowman Power Systems, Inc.
California Air Resources Board
California Energy Commission
Canadian Climate Change Secretariat
CANMET Energy Technology Center
City of Portland - Energy Division
Colorado Office of Energy Management and Conservation
Commonwealth of Massachusetts (pending)
Delta-Montrose Electric Association
Duke Energy - Science/Technology Planning
E Source
Emerging Energy Technologies
New England Governor's Conference
New Jersey Department of Environmental Protection
New York State Energy Research and Development Authority
Pinnacle West Capital Corporation
Portland General Electric
Portland General Electric
Safe Harbor Water Power Corporation
STM Power, Inc.
Tampa Electric Company
Tennessee Valley Authority
The Natural Gas Supply Association
United Nations Environment Programme
University of California Irvine
USDOE - National Energy Technology Laboratory
USDOE - Oak Ridge National Laboratory
USDOE - Office of Coal and Environmental Systems
USDOE - Sandia National Laboratory
USEPA - Office of Air and Radiation
USEPA - Office of Atmospheric Programs
Vermont Public Power Supply Authority
Yankee Gas Services Co., Northeast Utilities

High Priority Technologies Listed by the Subcommittee
Fuel cells
Microturbines
Reciprocating Engines (industrial and commercial co-gen)
Small gas turbines (industrial and commercial co-gen)
Stirling Engines
Hybrid Systems
Ground-source heat pumps
Bio-diesel fuel use at stationary energy production operations
Biomass gasification
Bio-fuel blending/re-formulation
Animal waste utilization (e.g., new Danish anaerobic digester)
Landfill gas recovery and utilization
Electrical transmission systems (high temperature superconductors substation-based power conditioning systems)
Power plant efficiency improvements (low pressure turbine blades, condenser re-tubing, motor controllers)
Energy storage
Carbon sequestration
Hydrogen storage and use
Power inverters (more efficient, flexible, and multi-source types)
Efficient energy use at mass railway transit operations
Energy efficiency and energy conservation measures
GHG monitoring
Photovoltaics
Wind
Small Hydro

GHG Center to Collaborate with ASERTTI

The Association of State Energy Research and Technology Transfer Institutions (ASERTTI), established in 1990, is a non-profit corporation composed of state and regional organizations that have energy research and technology transfer responsibilities. ASERTTI is developing and validating field and laboratory performance testing protocols for several distributed generation technologies under a $1 million contract from the U.S. Department of Energy. Three state energy office members of ASERTTI are providing co-funding.

"We are preparing contracts for the Gas Technology Institute (GTI) and Southern Research Institute to develop and validate national field and laboratory performance testing protocols for microturbines, reciprocating engines, small turbines, and combined heat and power systems," said Dr. Arthur Soinski, a California Energy Commission distributed power expert and technical leader of ASERTTI's effort. "Southern Research will develop field-testing protocols, GTI will develop laboratory protocols, and both groups will coordinate their stakeholder and other activities closely throughout the process."

“The plan is to use a Stakeholder-based process to guide protocol development and consensus building for national protocols," said Stephen Piccot, GHG Center Director. “It’s commendable that ASERTTI is committed to providing nationally accepted protocols to the public, and we’re looking forward to helping them accomplish that” said Dr. David Kirchgessner, U.S. EPA Project Officer for the GHG Center. “ASERTTI plans to use a stakeholder-based process, similar to the one we have used since 1998, and this has prompted EPA, through the Environmental Technology Verification (ETV) Program to collaborate with ASERTTI in several areas of mutual interest.”

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.