

Project Concept #1: A NEW CLASS OF ARICES MINIMIZING ENGINE EMISSIONS & sfc

Pao Chi Pien

Description

The combustion process of an existing four-stroke engine cannot be designed independent of the rest engine processes. As a result, low-temperature combustion can only be achieved by introducing a large amount of EGR or by delaying/prolonging the combustion process. The former reduces the engine geometrical efficiency and thus the mechanical efficiency, while the latter reduces engine thermal efficiency. Therefore a four-stroke engine cannot meet the twin goals of an engine that is both (i) clean burning and (ii) more fuel-efficient. A new class of ARICES has been created in order to overcome the limitations inherent in existing four-stroke engines and to achieve clean burning and more fuel efficient engines.

Benefits

The new class of advanced reciprocating engines can be immediately developed without seeking new technology and engine parts. With more than 40% reduction in specific fuel consumption, greenhouse gas CO₂ reduction would be reduced by the same amount and energy prices of California State could be greatly mitigated.

Objectives

The present proposal creates a group of new cycles for developing a new class of reciprocating engines. The overexpanded two-stroke diesel and Otto cycles can be obtained by modifying the intake and exhaust valve timings of the respective four-stroke cycles without altering their fuel systems. The significant reduction in the calculated sfc for both cases demonstrates the potential of these two new cycles to achieve significant increase in fuel efficiency. The discussion of the overexpanded two-stroke HCCI cycle and overexpanded low-temperature combustion diesel cycle shows the potential for minimizing engine emissions while simultaneously achieving a significant sfc reduction.

Budget

2005:

2006:

Other:

Comments

I am not ask for funding, but want you to know that my proposal gives you another approach to reach your goals with much less expenditure and more certainty of success. A technical Note describes how to develop this new class of advanced reciprocating engines will be sent to you upon request.

Project Concept #2: Natural gas replacement/synthesis using waste

Leland T. Taylor, Thermogenics Inc.
Thermogenics Inc.

Description

Gasification of wastes produces a gas comprised of hydrogen, carbon monoxide, methane, and other trace gases. Carbon monoxide and hydrogen are "synthesis gas" and can be used for production of methane by catalysis. It is feasible to either produce methane, pipeline quality natural gas from gasification of various wastes including municipal solid waste separated to a fuel grade refuse derived fuel, or use the gasified cleaned and cooled gas to replace natural gas for IC engine operation, boiler, kiln, or other large energy natural gas using facility. Thermogenics operates a fully integrated gasification system which can be used in an expanded mode for larger operations and tied to catalytic systems for natural gas production. EPA considers syngas as MACT and a direct comparable emission replacement for nat

Benefits

Continuous supply of energy from what are currently negatively valued feedstock which is being buried or transported for land application and are adequate heating value and carbon content for gasification, which would transform the present waste paradigm. Emission reduction from landfill generation of greenhouse gases, reduced transportation pollution and less transportation fuel using distributed conversion facilities will result. Typical waste to energy conversion facilities have minimal emission profiles, certainly less than current landfilling opera

Objectives

To replace natural gas with renewable gas produced from the hundreds of thousands of tons of municipal waste and other wastes per day. Several hundred thousand MCF of natural gas could be produced/replaced using this technology. To create a demonstration facility using existing equipment, and additional catalytic systems for production of pipeline quality natural g

Budget

2005: \$200,000
2006: \$1,000,000
Other: \$200,000

Comments

EPA openly promotes gasification as a manner of waste to energy conversion as opposed to incineration or mass burning. Thermogenics operates a demonstration facility which can be expanded to produce natural gas replacement and through catalytic conversion, Fisher-Tropsch transportation fuels of diesel, gasoline and othe

Project Concept #3: Sitegen

RCSystems

Description

electrical generation: optimizing consumer utility beyond offline. when and where can consumer tradeoff be cost effective? Summer peaks

Benefits

Objectives

To demonstrate the cost effective utility of consumer gas/electric generation.

Budget

2005: \$500,000

2006: \$200,000

Other: -

Comments

Project Concept #4: Bay Island Biodiesel Pilot Project

Martin Kurtovich, P.E.

Description

Petroleum refining is a large consumer of natural gas in California. Development of alternative fuel sources can offset future growth in natural gas consumption due to increased demand for petroleum resources in the State. A new means of producing biodiesel from local sources has been developed in the State of Washington and is being piloted in the Seattle area. This project would examine the feasibility of a similar pilot at appropriate locations in California and develop an initial pilot processing plant in Northern California. This technology is less costly than previous biodiesel technologies tested in California.

Benefits

Mitigate future demand for natural gas. Reduce greenhouse gas emissions. Mitigate future demand for petroleum resources.

Objectives

Development of a prototype plant that utilizes local agricultural resources to produce biodiesel. Determine the feasibility of this technology as an alternative fuel supply for large petroleum consumers. Identify an appropriate business model that can utilize this technology and provide a sustainable alternative fuel supply that competes with mainstream petroleum products.

Budget

2005: \$750,000

2006: \$2,500,000

Other: \$2,500,000

Comments

Project Concept #5: Renewable Biogas Solid Oxide Fuel Cell Development

David Tsay
RCSystems

Description

The proposed project is to develop and demonstrate a novel solid oxide fuel cell system prototype for clean and efficient conversion of landfill and digester gases into electrical energy. Current turbomechanical methods of conversion emit significant criteria air pollutants and are marginally efficient. Traditional fuel cells cannot effectively process the highly contaminated, low heating value waste biogas streams effectively. Ampion will incorporate patent pending materials and design including dry reforming to address these technical and market deficiencies and leverage the renewable benefits of waste biogas energy conversion.

Benefits

Foremost, the proposed system

Objectives

To demonstrate the ability to convert raw landfill and digester gases with minimal or no gas pretreatment requirements and excess of 50% energy conversion efficiency while emitting low levels of pollutants during operation. The prototype will be used as the foundation to design and construct larger demonstration units with the goal of product commercialization within a 3 year horizon.

Budget

2005:

2006:

Other:

Comments

Ampion Systems proposes to co-fund 50% of the project cost for 2006 and intends to aggregate partners in California for the purpose of prototype demonstration that will include site owners, independent power producer, certified engineering firms and other local or state agencies.

Project Concept #6: High Performance Compact Integrated Appliance

Richard F. Topping P.E.

Description

Zero Energy Homes have successfully demonstrated the potential for greatly reducing the need for energy through high efficiency while meeting remaining requirements with renewable technologies. However, unique and costly designs must be replaced with affordable solutions for ZEH to be embraced by the home building market. One particular need is for compact gas space heating and cooling equipment sized to meet the significantly lower loads of ZEH and at least 30 to 50 percent more efficient than current technology. An integrated appliance incorporating space heating, water heating, cooling and advanced features such as energy recovery ventilation and economizers is needed.

Benefits

The benefit in natural gas (and electric) savings to California from ZEH technology is substantial. ZEH technology could greatly improve the prospects for a more secure energy future for California residents. However, building equipment specifically designed for the reduced energy loads of the high efficiency home is needed to increase ZEH market penetration. CEC has the opportunity to spearhead the development of an integrated appliance specifically designed to most efficiently meet the space heating and cooling, water heating and related needs of California's Zero Energy Homes.

Objectives

The project would develop specifications for a ZEH compact integrated appliance tailored to the California climate; design and develop prototypes; and field test preproduction units to confirm energy savings, performance and commercial viability. It's envisioned that a manufacturer with the capability and interest in commercializing the product in California would be partnered with a technology and product development firm. The key objective would be to demonstrate the viability for California's ZEH market of an affordable, compact, high performance, multi-function appliance designed to minimize energy consumption and maximize performance and human comfort.

Budget

2005: \$500,000

2006: \$800,000

Other: 700,000

Comments

This proposed product development also meets a critical need for the U.S. Department of Energy and its Zero Energy Homes initiative.

Project Concept #7: Heating Only Gas-Fired Heat Pump

Richard F. Topping P.E.

Description

The proposed project is to optimize and validate the design of heating-only absorption heat pumps for residential and light commercial applications. GAX-type absorption heat pumps have been under development for many years but cost, complexity and reliability have been problems blocking successful commercialization. The cooling function has been the primary cause of the difficulties. Heating-only heat pump systems have applicability for a large portion of California's climate where central air-conditioning is not required and could be developed and sold at lower cost while providing the most significant potential energy savings over furnaces of any advanced natural gas technology currently envisioned.

Benefits

The benefit in natural gas savings to California from a technology that is 30% more efficient than the best current space heating products for residential and light commercial buildings is substantial. We know of no other new technology on the horizon that can offer anything approaching this magnitude of energy savings. At the same time, to reach acceptable levels of cost and reliability, the design of the heating-only, natural gas-fired heat pump must be optimized and performance verified through a rigorous hardware development program including field testing. CEC is well suited to spearhead this activity.

Objectives

The project would develop specifications for a residential/ light commercial natural gas-fired, heating-only absorption heat pump tailored to the California climate; design and develop prototypes; and field test preproduction units to confirm energy savings and commercial viability. It's envisioned that a manufacturer with the capability and interest in commercializing the product in California would be partnered with a technology and product development firm. The key objective would be to demonstrate the viability for California of a gas space heating technology with efficiency well over 100% (COP approximately = 1.3), significantly better than condensing furnaces (92%), the most efficient state-of-the-art technology.

Budget

2005: \$750,000

2006: \$750,000

Other: \$900,000

Comments

Project Concept #8: Pendulating Gravity Sail Prototype Development

Jonathon E. Mooring

Description

The Pendulating Gravity Sail project is a new type of wind driven electric power generation device or machine that requires minimal windspeeds to function on a dependable basis. While the PGS falls into the same category of a windmill, it works in an entirely different manner. The PGS utilizes the drag force of the wind much like a square rigged sail boat does, but instead of pushing a boat through water, the PGS sails and mast pendulate or rock back and forth turning a primary drive axle in a clockwise manner as its primary motive force. This primary drive axle binds six power generation stations that each contain twelve heavy duty spring motors. A timing mechanism keeps track of each stations bind rate and triggers each station in sequence once it becomes fully bound. So in essence the machine functions very much like a six cylinder automotive engine, but is powered by the wind and puts out only clean electric power on a steady dependable basis with as little as a 3-5mph wind. Instead of traditional sails, the PGS utilizes 3 sets of vertical vane assemblies stacked on a steel mast with a counter weight pivotally attached to the bottom. As the wind blows the sail assemblies over and the counter weight pivots on its mast attachment, this mechanical advantage is used to turn the vane assemblies to cut rather than catch the wind, allowing the force of gravity to stand the unit back up where again the counter weight bucket pivots on the mast attachment closing the vane assemblies at which point the unit is blown over again as the process repeats itself as it binds the motors in each power generation station. Each station drives a generator whose current is ran into an inverter before being fed onto a power grid.

Benefits

New form of clean renewable power generation, with the lowest environmental impact. Effective in almost any locale. Cheap to manufacture and set up. Very high cost to benefit ratio. It could eliminate our use of fossil fuels in California to generate power, resulting in much cleaner air and lower medical costs.

Objectives

To prove that this machine is capable of putting out clean renewable electric power on a steady dependable basis in a low wind environment where windmills would not even function. To prove that this machine uses torque and leverage rather than wind deflection to achieve its massive power output. To prove that this machine has a much lower environmental impact as a result of having its high speed components covered and safely secured. No aviary fatalities. To prove that this machine can be manufactured cheaply, and can be effective in a variety of locations where other types of power generation would be unacceptable.

Budget

2005: \$250,000

2006: \$250,000

Other:

Comments

A computer animation of the PGS in action is available on request.

Project Concept #9: Natural Gas Powered Steam/Gas-Electric Locomotive

Thomas W. Blasingame

Description

A Steam/Gas-Electric Locomotive fueled by Liquefied Natural Gas and powered by an axial-vane rotary steam expander engine can operate at greater efficiency because of the individual modular boiler units. Six of these modular steam generation units each produce 750 horsepower, for a total of 4500 HP. Since the fire burns under water in direct contact, there is no heat loss in the combustion process, and the usual emissions problems are completely eliminated. When natural gas is not available, other gaseous or liquid fuels can be used, again without emission problems. The steam generation system is approximately 97% efficient. The steam is condensed for reuse.

Benefits

Improvement in air quality due to almost complete elimination of pollutants with all types of fuels, reduction in sound levels compared to Diesel-electric locomotives of comparable horsepower, elimination of pollution or environmental damage caused by spills of liquid fuels used in Diesel engines.

Objectives

A reduction in emissions compared to internal combustion engines, including NOx and particulates, and the ability to also use other types of gaseous or liquid fuels with the inherent cleansing action of the submerged flame combustion system.

Budget

2005: \$4,000,000

2006: \$1,000,000

Other: none

Comments

This locomotive design is intended for main line freight and passenger service in medium range operations. The project will include testing by California railroads in both types of service.

Project Concept #10: Natural Gas Powered Steam/Gas-Electric Truck/Tractor

Thomas W. Blasingame

Description

A Steam/Gas-Electric Truck/Tractor fueled by Liquefied Natural Gas and powered by an axial-vane rotary steam expander engine can operate at greater efficiency because of the single modular boiler unit. This single modular boiler unit produces approximately 750 horsepower. Since the fire burns under water in direct contact, there is no heat loss in the combustion process, and the usual emission problems are completely eliminated. When natural gas is not available, other gaseous or liquid fuels can be used, again without emission problems. The steam generation system is approximately 97% efficient. The steam is condensed for reuse.

Benefits

Improvement in air quality due to almost complete elimination of pollutants with all types of fuels, reduction in sound levels compared to conventionally powered Diesel truck/tractors, and elimination of pollution or environmental damage caused by spills of liquid fuels used in Diesel engines.

Objectives

A reduction in emissions compared to internal combustion engines, including NOx and particulates, and the ability to use other types of gaseous or liquid fuels with the inherent cleansing action of the submerged flame combustion system.

Budget

2005: \$2,000,000

2006: \$500,000

Other: none

Comments

This truck/tractor design is intended for long and short haul on/off highway transportation services. The project will include testing by California motor transport companies in both types of service.

Project Concept #11: Natural Gas Powered Dual Fuel Diesel-Electric

Thomas W. Blasingame

Description

A Dual Fuel Diesel-Electric locomotive fueled by 99% Liquefied Natural Gas and 1% Diesel fuel can operate cleaner, quieter and with zero particulates and near zero NOx emissions in locations where Liquefied Natural Gas is available; and it can operate as a conventional Diesel oil fueled locomotive when the LNG is not available. The fuel changeover is automatic and does not require any operator or maintenance changes in procedures. The power output is not derated when operating with natural gas; the full 4500 HP is developed. The locomotive can operate with or without a long distance Tractive Effort Booster Unit LNG tender for added range.

Benefits

Improvement in air quality due to almost complete elimination of pollutants when operating under natural gas fueling, excellent proven performance under LNG and Diesel fuel operation.

Objectives

Use of a proven reciprocating prime mover with a track record of low emissions and the ability to operate as a true Dual Fuel Diesel engine will reduce the funding requirements. The elimination of the usual particulate emissions when operating with LNG will be a positive factor, as will the reduction in sound levels when operating with the LNG fuel compared to the Diesel oil fuel operation.

Budget

2005: \$3,000,000

2006: \$750,000

Other: none

Comments

The Budgetary Estimate covers the design, prototype construction and testing of the locomotive unit only. The construction of the long distance Tractive Effort Booster Unit LNG Tender would require an additional \$1,000,000 in 2006 and an additional \$250,000 in 2007. This locomotive design is intended for main line freight and passenger service in long range operations. The project will include testing by California railroads in both types of service.

Project Concept #12: Natural Gas Powered Steam/Gas-Electric Tug Boat Propulsion System

Thomas W. Blasingame

Description

A Steam/Gas-Electric Tug Boat Propulsion System fueled by Liquefied Natural Gas and powered by a modular piston-type steam-expander engine developing 3000 HP can operate at greater efficiency because of the individual modular boiler units. Four of these modular steam generation units each produce 750 horsepower, for a total of 3000 HP. Since the fire burns under water in direct contact, there is no heat loss in the combustion process, and the usual emissions problems are completely eliminated. When natural gas is not available, other gaseous or liquid fuels can be used, again without emissions problems. The steam generation system is approximately 97% efficient. The steam is condensed for reuse.

Benefits

Improvement in air quality due to almost complete elimination of pollutants with all types of gaseous or liquid fuels, reduction in sound levels compared to Diesel-powered tug boats of comparable horsepower, elimination of pollution or environmental damage caused by spills of liquid fuels used in Diesel engines.

Objectives

A reduction in emissions compared to internal combustion engines, including NO_x and particulates, and the ability to also use other types of gaseous or liquid fuels with inherent cleansing action of the submerged flame combustion system.

Budget

2005: \$3,000,000

2006: \$750,000

Other: none

Comments

The Budgetary Estimate includes costs for the propulsion system only, and does not include any costs for the hull or other systems. The proposed propulsion system is intended for ocean-going tug operations. The project will include testing by California-based maritime services companies.

Project Concept #13: Stationary Photovoltaic Modules with Parabolic-Prismatic Concentrators

Dr. Sergey N. Kivalov

Description

The goals of this project are: designing, developing and optimizing new parabolic-prismatic stationary concentrators of solar energy; developing and improving new non-expensive stationary photovoltaic modules on their base.
 By particularly substituting expensive solar cells in solar arrays, the stationary concentrators constructed from inexpensive materials could significantly reduce the cost of the photovoltaic systems. <p> The initial start up goal of this project is to optimize the geometrical configuration. At present the size of preliminary systems is still increasing much faster than the concentration degree; the concentration ratio and the uniformity of focal spot are hardly matched to each other; and the fraction of the time the concentrators show high performance drops rapidly with the achieved concentration ratios. Similarly, the photovoltaic modules are still far from optimal. It is necessary to develop the requirements on photovoltaic modules with stationary concentrators for their full scale testing and to compare them with the standard photovoltaic panels. Based on those requirements we will develop an appropriate design of concentrators. It is also necessary to develop the requirements on the special solar cells that will work most efficiently with these concentrators with low levels of concentrations up to 10X because the working conditions influence significantly the efficiency of the solar cells. There are two types of solar cells: the standard solar cells that are designed to work efficiently without concentration of solar energy, so their efficiency will drop with increasing concentration; the solar cells that are able to work with the high concentrations up to 1000X, which have special design, are very expensive and practically can not be used for low concentrations conditions. There are also the solar cells cooling and temperature stabilization problems because for the silicon solar cells the temperature increasing above 60C (140F) leads to a rapidly deteriorating solar cell productivity.

Benefits

The proposed stationary PV modules with the proposed parabolic-prismatic concentrators could be 25 - 30% cheaper than the regular PV modules because of using less expensive materials for the concentrators instead of the expensive solar cells. We should be able to reduce the installation cost of PV modules from about \$5 per kWp to about \$3 per kWp. This will help to reduce cost of the produced energy up to \$0.24 per kWh and make the PV modules with the stationary concentrators feasible for the customers and for the California electrical market. By using proposed PV module, the total electricity cost saving for California (californian customers) can be estimated at \$1,450,000 per year. <p> Electricity produced by the installed PV modules will be also able to cover peak electricity consumption on the air conditioning and cooling in the summer time that could be up to 30% of the total consumption in that period. This will help to reduce power load of the existing electrical plants and significantly reduce the amount of burned coal or oil for electrical needs. The heat removed from the solar cells by the cooling system could be used for the direct water heating for domestic needs.

Objectives

This proposal is going to solve the issues addressed in the description by developing and constructing the prototypes of the stationary concentrators and photovoltaic modules on their base with the improved characteristics. The goals of this project are: <p> • Develop the mathematical models of the parabolic-prismatic stationary concentrators for optimization of their concentration-efficiency-uniformity parameters;
 • Develop, produce and improve the stationary concentrators with improved characteristics;
 • Specify characteristics of solar cells that will be able to work with these concentrating systems and develop these solar cells;
 • Specify characteristics of cooling system for the solar cells that will be able to work with these concentrating systems and develop the cooling system; Design active cooling system that will be able to be used for the domestic water heating needs.
 • Produce and improve samples of photovoltaic modules with stationary concentrators with peak power up to 1000W that will demonstrate these accomplishments in the full scale testing. <p> The project has four stages to be completed:
 • STAGE 1. Developing the schemes of the parabolic-prismatic stationary concentrators for the photovoltaic modules and developing the PV modules with the stationary concentrators of solar energy on their base.
 • STAGE 2 Construction of prototypes of the developed Photovoltaic modules, choice of the places for the testing and installation of the produced prototypes.
 • STAGE 3. Studying of the real characteristics of testing photovoltaic

modules with the stationary concentrators and comparing with the existing photovoltaic panels without concentrators in the full time outdoor testing.
 • STAGE 4. Economical estimations for different type of modules on the base of the created prototypes.
 <p> Total project duration is 3 years. The estimated funding necessary for this project is about \$1,300,000.

Budget

2005: \$400,000

2006: \$500,000

Other: \$400,000

Comments

Project Concept #14: Printed Photovoltaic Roofing Material

Dr. Russell Gaudiana

Description

This 4-yr project will include research, development and demonstration of printed photovoltaic roofing material. Building on our successful CEC EISG project, Konarka will 1) develop photoactive cyan, magenta, and yellow dyes, 2) develop a non-iodine solid state hole carrier, and 3) develop a production process for a transparent conducting mesh electrode to boost efficiency. We will work with a printing equipment company in California to print cells for testing and optimization in years 1 and 2. Using the proven printing processes, Konarka will work with a large California manufacturing firm in year 3 to produce larger format prototypes for integration into roofing material. Konarka will then partner with an established California PV roofing company to develop a full roof demonstration of imaged roofing material in year 4.

Benefits

An affordable, aesthetically pleasing roofing material that produces electricity could be a major capacity contributor to the California RPS goal of 20% renewable generation by 2017. A recent study by the Energy Foundation showed that by 2010, at prices of \$2 to \$2.50 per installed watt (within Konarka's installed cost range), the market potential for rooftop residential and commercial building PV is 2,900 MW per year, and that California alone represents 40 percent of this market potential. Rooftop PV systems offer reliable power supply, reduce daytime peak loads on the utility system, and improve air quality by reducing demand for conventional fossil fueled power.

Objectives

The key objective of this project is to develop affordable printed photovoltaic roofing materials that mimic conventional roofing materials to address key adoption barriers of cost and aesthetics. A large working demonstration will follow successful achievement of three technical objectives described above, including formulating new printable dyes, developing a solid state hole carrier, and developing a production process for high volume manufacture of the mesh electrode material.

Budget

2005: \$400,000

2006: \$400,000

Other: 2008-2009 \$600k each

Comments

Project Concept #15: Absorption Power and Refrigeration Cycle

Hank Leibowitz

Description

Using absorption refrigeration principles the APRC has been designed to convert heat contained in a gas turbine

Benefits

Currently gas turbines in the 5-20MW range are typically used for cogen or peaking. Baseload all electric duty is limited because of expensive generation cost in all electric operation. The APRC changes this: 1. On a year round basis the capacity is increased by ~35% and heat rate decreases by ~30% in moderate to warm climates. 2. During summer operation capacity is increased by 40-45% while heat rates is reduced by 30%. 3. Emissions on a per kWh basis are reduced linearly with heat rate decrease. The cost of additional APRC generation is less than 3 cents per kWh. 4. The APRC is directly applicable to gas fired industrial waste heat sources. 5. Where refrigeration is not needed the cycle may be used in an all-electric version as an APC. 6. The APRC eliminates separate heat recovery and GT inlet cooling systems, the latter typically electric driven centrifugal chillers. 7. Only commercial equipment is used. Long expensive development is avoided.

Objectives

An APRC installation/demonstration using a simple cycle GT is necessary to demonstrate the thermodynamic and economic advantages of the APRC. It will also confirm its robust design and low O&M requirement due to its closed loop design. Absorption refrigeration systems are more than a century old but none have ever combined refrigeration and power in the same system. A demonstration is required to confirm this approach and to eliminate financing hurdles now confronting the commercial roll-out of the APRC.

Budget

2005: \$400,000

2006: \$600,000

Other:

Comments

Project Concept #16: California-Mexico Natural Gas Issues

Rick Van Schoik, SCERP
SCERP

Description

Project Summary: The history of flow of natural gas across the California-Mexico border is short, dynamic, and poised to change dramatically yet again, much without planning, control, or assessment. Two natural gas terminals are planned for Baja California and one in Sonora, all poised to introduce significant amounts of non-traditional (different quality, Wobbe number, methane content) fuel into the California system. Neither the current Energy Action Plan draft nor the Joint Workshop report considers these new sources, feasibility of exchange, or consequences.

Benefits

Project Benefit: The study will identify policy framework and areas where significant binational and bi-state traction can be made. A precedent-setting transboundary environmental impact assessment will examine regional and localized air quality consequences, global climate change inducements, and viable alternatives.

Objectives

Projects Objectives: • Southern California Natural Gas Needs Assessment Meta-Study (review of all existing supply, demand, and cost research) • Secure and Safe Supply and Storage Infrastructure Study (for both routine and emergency connections) • Examination of Carbon Nanotubule, NO_x, Ozone, and Greenhouse Gas Consequences (both positive and negative and health connection of each) • CPUC Issue Inquiry (legal, financial, federal interface, etc.)

Budget

2005: \$50,000
2006: \$150,000
Other:

Comments

SCERP, the Southwest Consortium for Environmental Research and Policy is a collaboration of US and Mexican universities. We have done binational energy work for 10 of our 15 years.

Project Concept #17: Ultra-Low NOx Duct Burner for Natural Gas-Fired CHP Turbines

Kenneth O. Smith

Description

A second generation of industrial gas turbines is being developed with lower NOx emissions, in some instances as low as 2.5 ppm (@ 15% O2). At the same time, high fuel prices are motivating an increased use of CHP. Many CHP operators require the flexibility afforded by a duct burner downstream of the turbine. However, without improvements in the duct burner NOx emissions, the public health benefits associated with turbine NOx emissions will not be realized. There is a technology gap in duct burner emissions that will limit the growth of CHP systems in California.

Benefits

Current duct burners can limit NOx emissions to approximately 0.08 lb/MMBtu. Work is underway to reduce NOx to 0.04 lb/MMBtu. This project will work to cut emissions by another factor of 2 with its target of 0.02 lb/MMBtu. This will allow easier siting of CHP systems in California without the need for SCR exhaust cleanup systems. Thus CHP economics will be improved. In addition, through the growth of CHP in the State, overall fuel use efficiency will increase, the reliability of the State

Objectives

Working with a duct burner manufacturer, Solar proposes to develop an ultra-low NOx duct burner for industrial turbine CHP applications. The target will be to maintain CHP system NOx emissions to no greater than 0.02 lb/MM Btu. The technology will be evolved from subscale rig tests to a full scale system field test. Program outcomes will include: a more economical ultra-low NOx CHP system as SCR exhaust gas cleanup will not be required; improved CHP system flexibility to meet variable heat demand; and reduced environmental impact through reduced NOx emissions and/or avoidance of ammonia release to the environment from SCR systems.

Budget

2005:

2006: \$750,000

Other: \$500,000

Comments

Technology advancements in the duct burner industry have been slow due to extreme price competition within the industry. A key challenge of this program is to apply advanced combustion technologies in a cost-effective manner. For this program, the initial target for commercial application will be the Solar 4 Mw Mercury 50 gas turbine. This new machine has a simple cycle efficiency near 37% and is guaranteed to limit NOx emissions to below 5 ppm. As the Mercury 50 achieves these NOx levels without SCR (and its associated ammonia slip), the SCAQMD has provisionally recognized the Mercury 50 turbine as comparable (environmentally) to a turbine/SCR system at 2.5 ppm NOx.

Project Concept #18: Ultra-Low NOx Gas Turbine Combustion System for Landfill Applications

Kenneth O. Smith
P.E.

Description

The first generation of low NOx industrial gas turbines (NOx < 25 ppm) was introduced in the early-to-mid 1990s. A second generation of clean turbines is now evolving. For example, the Solar Mercury 50 turbine is guaranteed to meet regulations requiring no more than 5 ppm NOx (@ 15% O2). Discussions with SCAQMD suggest that, for permitting, SCAQMD may equate 5 ppm NOx (achieved through clean combustion) as equal to 2.5 ppm NOx from a turbine that uses SCR. The proposed project will extend the 5 ppm NOx Mercury 50 technology from natural gas-only to the low and medium-Btu gaseous fuels typical of landfills. This increased fuel flexibility will promote the use of alternative fuels for power generation in California with a much reduced environmental impact.

Benefits

The major benefits of the proposed project will be to: 1. Enable the exploitation of low and medium-Btu fuel sources in California for power generation thus reducing the State

Objectives

This project will focus on the Mercury 50 as the initial target for technology deployment. The ultra-low NOx combustion system of the Mercury 50 will be used to define and develop technologies needed to burn a range of fuels rather than only pipeline quality natural gas. Work will progress from single injector development to full scale engine tests. The technical goal will be to maintain the current Mercury 50 performance (~4 Mw and ~37%) while keeping NOx emissions below 5 ppm. Unique engine durability issues raised by the use of landfill gases will be addressed. The project will conclude with a field test of a Mercury 50 at a landfill site. Essentially this milestone will represent the commercial introduction of the combustion technology and lead to further implementation on other gas turbines.

Budget

2005:
2006: \$750,000
Other: \$500,000

Comments

Project Concept #19: A Desiccant-Assisted Evaporative Cooler for Commercial Buildings

Andrew Lowenstein

Description

A liquid desiccant air conditioner (LDAC) is similar to an indirect evaporative cooler (IEC). Both systems reject heat by evaporating films of water from their heat transfer surfaces. However, the LDAC has several important advantages: (1)The LDAC will continue to cool at ambient wet-bulb temperatures that make an IEC ineffective. (2)The LDAC can provide latent cooling (i.e., dehumidification) (3)The volume of air the LDAC must process to meet a given cooling load is less (i.e., it has a lower "cfm per ton") However, a price must be paid for these advantages: thermal energy is needed to regenerate the desiccant. In the proposed project, an LDAC will be demonstrated that captures most of the advantages of an IEC. The LDAC will have an operating mode in which the flow of desiccant is turned off and the LDAC operates as an IEC. During hours when either latent cooling is needed or ambient wet-bulb temperatures are high, the liquid desiccant will be turned on. During these hours a gas-fired boiler will provide thermal energy to regenerate the desiccant.

Benefits

The proposed project will demonstrate a technology that can displace a significant fraction of California

Objectives

The proposed project will demonstrate both the practicality and effectiveness of the LDAC in California. The performance data that will be collected during the test will be used to (1) determine comfort levels within the building, (2) project the state-wide impact of the technology on energy use and peak electrical demand, and (3) determine the economics of owning the LDAC. All new HVAC technologies have difficulty in gaining acceptance, and a successful demonstration of the LDAC will be an important first step to commercial acceptance in California.

Budget

2005:

2006: \$50,000

Other:

Comments

The National Renewable Energy Laboratory (NREL) has supported the development of the LDAC. NREL may be interested in co-sponsoring a demonstration in California. More information is available at www.ailr.com.

Project Concept #20: Coal Gasification

William A. Lansville

Description

Gasify coal without producing greenhouse gasses (NO_x, CO, CO₂ etc). Products produced include coke, coal gas, thermal energy, electrical energy, steam and raw chemicals contained in coal. Coal or other carbon based fuels (peat, Tire Derived Fuels (TDF) or Biomass materials as animal feces) can be used as the process feed.

Benefits

Benefits include elimination of greenhouse gasses because the process does not oxidize the coal or other feed materials. The process occurs in a vacuum therefore, the process temperatures are significantly reduced. The use of microwave, solar, or laser energy eliminates the need to heat massive ovens or other holding containers. This directly translates to significant energy saving on the order of 90% over other methods to produce coke and syngasses. All chemicals removed from the coal are captured by a vacuuming process using liquid Nitrogen and the cold trapping media.

Objectives

The process will yield: 1. Coke (Carbon) used extensively in the steel industry. 2. Coal gas to be sold to other syngas users or used as an on site fuel for electrical generation. 3. Thermal energy generated by heating the coal using direct sunlight, microwave energy, or laser energy. This energy will be captured via heat exchange from the carbon to water/steam. 4. Electrical energy developed via steam generators. 5. All other raw chemicals contained in the coal or feed materials captured via a cold trapping process in a vacuum.

Budget

2005: \$1,000,000

2006: \$2,000,000

Other:

Comments

Once the process begins all gasses and solids will be under positive control. All byproducts will be contained without the need for further intervention from outside sources. There will not be any air, water or ground pollution from the process.

Project Concept #21: Cost Effective Landfill Gas To LNG Processing

CryoEnergy International, Inc.
CryoEnergy International, Inc.

Description

CryoEnergy International, Inc. (CEII) has developed an economical landfill gas to LNG process utilizing a single stage process to separate the CO₂ and CH₄ into high purity product streams without the need for further processing. The methane product stream can be liquefied to form a high value product in the same stage in which the separation of carbon dioxide and methane takes place resulting in a system that offers lower capital costs, lower operating costs, and reduced complexity. If funded, the proposed Project Suggestion will enable the first full scale demonstration of the technology and will validate economic viability.

Benefits

The proposed technology will allow the exploitation of a large number of landfills and anaerobic digestors that have been previously uneconomical and will offer superior gas processing capabilities at larger landfills. The technology diverts bio-gas that would otherwise be burned in an engine or flared to produce pipeline quality gas to be substituted for natural gas and utilized in low emission applications. The proposed technology will: • Displace natural gas consumption with a renewable alternative • Reduce greenhouse gas emissions and recover CO₂ for industrial use • Reduces NO_x and CO emissions produced from engines at bio-gas sites enabling use in cleaner burning natural gas end use technologies.

Objectives

- Demonstrate the throughput, energy intensity and economics of the technology in a full-scale configuration.
- Develop a repeatable business model suitable for other California landfills and bio-gas sites
- Assess California market prospects and develop a Technology Transfer Plan.
- Verify performance in the field

Budget

2005: \$1,250,000
2006: \$250,000
Other:

Comments

Budget estimate is \$13.5 million of which \$1.5 million is sought from the California Energy Commission. Project duration is estimated at 20 months – 3 months for design, permits and field test business agreements; 9 months for procurement and fabrication, 2 months for installation ; and 6 months for commissioning and performance verification.

Project Concept #22: Gas fired Heat Pump for Commercial and Light Industrial Applications

Robert Panora, Tecogen, Inc.
Tecogen

Description

TECOGEN, Inc. manufactures small CHP systems for California and other CHP economic zones in the United States. Tecogen's product portfolio includes CHP electric packages and CHP mechanical drive packages including engine-driven chiller and refrigeration systems. The project concept is to modify the chiller products (starting with the 50 ton air-cooled chiller) to operate as a heat pump to displace gas use in boilers. The nominal capacity of this unit is estimated to be 1 MMBTU/hr and can serve low to medium temperature applications. The unit can be configured to switch to cooling mode for facilities without a year-round heating load

Benefits

The proposed project, if successfully developed, will enable heating COPs of 1.5 or more for low to medium temperature applications in California's climate. The heat pump, with integral heat recovery, approximately doubles the efficiency of conventional boilers. The proposed product (1 MMBTU/hr) will fit a high portion of commercial, institutional, multi-family and industrial applications. The heat pump can:

- Provide significant energy and cost savings to end users
- Substantially increase the efficiency of gas for heating
- Conserve natural gas, particularly during periods of high gas demand
- Significantly reduce greenhouse gas emissions
- Cut peak period electric demand when heat pump is used as a chiller

Objectives

- Optimize design of 50 ton chiller for heat pump operation
- Develop COP/capacity performance map for a range of ambient and delivered heat conditions
- Identify candidate applications and select field test sites
- Verify performance in the field

Budget

2005: \$550,000

2006: \$150,000

Other:

Comments

Budget estimate is \$1.2 million of which \$700,000 is sought from the CEC. Project duration is estimated at 18 months – 3 months for design and analysis; 6 months for product development and factory testing; 3 months for field test site design, procurement and installation; and 6 months for performance verification.

Project Concept #23: Radiation Fog, Lower Temperatures, and Natural Gas Use in Central CA

Dr. Jeffrey Underwood

Description

The population of the Central Valley is growing rapidly and with this rapid growth comes greater consumption of natural gas for winter season heating. One of the primary contributors to lower winter temperatures in the Valley is radiation fog. Very little is known about the climatology of these valley fogs and their effect on solar radiation and temperature. This project contends that radiation fog plays a pivotal role in sustaining cool temperatures across the Valley, and with these sustained cool temperatures increases in Natural Gas consumption. There are three primary goals for this project. First the project will use the historical climate record to construct the first climatology of radiation fog and fog-affected temperature in the Central Valley of California. Secondly, the project will use historical natural gas use data to link Gas consumption to temperature thresholds across the Central Valley. The third goal of the project is to use existing regional climate change research as a basis for modeling the fog/temperature climatology over the next 25-to-50 years for the Central Valley.

Benefits

The project will provide a baseline for future research in the context of fog cover and energy consumption in central California. The project will develop a model for analyzing future climate scenarios in the Central Valley. The model may project the frequency of fog days per season, the frequency of continuous fog days per season, the expected depth of fog per event, and the reduction in surface temperature expected from various fog development scenarios. The project will provide climate analysis tools to energy planners and the community so that energy decisions can be made with greater knowledge of the regions present and future climate.

Objectives

This project will produce the first climatology of radiation fog and will link fog parameters to temperature reduction and Natural Gas use in the rapidly populating Central Valley. This project will produce a model that will allow energy planners to forecast seasonal fog parameters and thus more accurately forecast winter season temperatures and natural gas needs.

Budget

2005: \$70,000

2006: \$70,000

Other:

Comments

This project focuses on a large region of California that is experiencing rapid population growth. Planning for the future energy needs of the Central Valley must take into consideration the climate of the region. Winter season in the Valley often consists of frequent radiation fogs which can persist for days and even weeks. Knowledge about Central Valley radiation fog is limited and there have been no previous studies to project future winter season scenarios for the Valley. This project will be the first to address what may be the primary energy planning variable (other than population growth) for the region.

Project Concept #24: Infrared Biogas Sensor

Carthago International Solutions, Inc.

Carthago International Solutions, Inc.

Description

Due to the variable consistency and quality of biogas, a biogas based power system must be operated at a lower capacity than a continuous feed natural gas system. While the methane content from a single anaerobic digester can vary by as much as +/- 15%, natural gas based fuel cells and microturbines have been designed to accommodate only a +/-3% variance. As a result, biogas based fuel cells and microturbines are typically operated at less than full output in order to avoid shut-downs associated with decreases in biogas methane content. This project introduces a new gas sensor for the detection and measurement of Methane and Carbon Dioxide to measure the performance and control the operation of anaerobic digesters and low-to-zero-emissions power generators, i.e. microturbines and fuel cells. The microminiature, low power sensor is a highly engineered instrument based on a proprietary infrared/MEMS technology. The implementation of this technology in farms (biogas from livestock manure), waste water treatment plants (WWTPs), landfills and food manufacturing and processing plants will improve the value, cost competitiveness and reliability of biogas-to-electricity systems.

Benefits

The safe and reliable production and processing of biogas is crucial. With an average of 50% Methane, biogas is not only a potent greenhouse gas, but also explosive. By collecting most of the biogas for power generation, the risk of gas migration and all associated environmental control and compliance costs will be considerably reduced. The accelerated use of "Green Power" will contribute in creating new jobs associated with the design, construction, and operation of energy recovery systems, as well as rural community development. In addition, the sensor will provide the scientific community with a state-of-the-art instrument for research and education and contribute in advancing fundamental knowledge in the areas of low power sensor design, miniaturization, self-diagnostics, and integration of sensors into engineered host systems.

Objectives

The objective of this project is to build advanced sensor prototypes for full scale qualification tests and field demonstrations to assess the sensor performance. The commercialization of the new sensor will provide farmers, operators of landfills, WWTPs and food processing plants as well as Original Equipment Manufacturers (OEMs) the relevant and adjustable parameters affecting the output of biogas-to-electricity systems. The sensor will enable to:

- Determine the correlation between biogas methane content (BTU value) and power output
- Optimize the biogas-to-electricity conversion efficiency, increase by an estimated 10 to 15%
- Maximize systems run time for electricity production
- Reduce the costs of biogas monitoring and control by as much as 90%

Budget

2005: \$350,000

2006: \$300,000

Other:

Comments

Project Concept #25: Intrinsically Safe Gas Sensor

Carthago International Solutions, Inc.

Description

While demand for natural gas is expected to double within the next 20 years, the aging infrastructure will require extensive upgrading and maintenance to improve energy efficiency and reduce the potential for adverse environmental impacts. The objective of gas utilities has been to take advantage of emerging technologies to replace inefficient, energy-intensive and environmentally inadequate inspection practices to automate operations, extend the useful life of the infrastructure and optimize the productivity of human and capital assets. This project introduces a new gas sensor for the remote detection and monitoring of gas leaks along the gas distribution system, providing a new control technique between the field and utilities control centers. The microminiature, low power sensor is a highly engineered instrument based on a proprietary infrared/MEMS technology, it can be deployed for unattended operation in remote gas distribution nodes, providing round-the-clock, high-speed measurement and notification in real-time.

Benefits

The remote inspection and prompt notification will enable the systematic and timely repair of gas leaks to reduce/mitigate methane emissions, a potent greenhouse gas (GHG), a direct contribution to the Federal Government's Global Climate Change Initiative (GCCCI). The new sensor will significantly reduce the explosion risk, enhance the safety of employees and public, and minimize the liability exposure of gas transmission and distribution companies. In addition, the sensor will provide the scientific community with a state-of-the-art instrument for research and education and contribute in advancing fundamental knowledge in the areas of low power sensor design, miniaturization, self-diagnostics, and integration of sensors into engineered host systems.

Objectives

The objective of this project is to build advanced sensor prototypes for full scale qualification tests and field demonstrations to assess the sensor performance. The commercialization of the new sensor will provide gas utilities a technology that enables to:

- Run operations more efficiently and save up to 70% of current leak inspection costs
- Conserve up to 80% of lost gas inventory by keeping leaked gas in the system for sales
- Achieve an Internal Rate of Return above 40% and payback in less than two years

Potential Applications:

- Pressure Regulator Stations
- Compressor Stations
- City Gate Stations
- Service Regulators
- Gas-fired Power Plants
- LNG/CNG/LPG Processing, Storage and Refueling Facilities
- Gas Drilling and Production Platforms

Budget

2005: \$350,000

2006: \$300,000

Other:

Comments

Project Concept #26: Bio-Hydrogen from wood waste with mixed culture of microorganisms

Richard W. Prosser - GC Environmental Inc.
GC Environmental Inc.

Description

The project goal is to develop a cost-effective continuous process for the production of bio-hydrogen through the use of the mixed culture thermophilic fermentation to decompose wood waste. In landfills, there are two stages of anaerobic decomposition of complex organic waste to generate methane with Clostridium and Methanogenic bacteria. The similar two-stage concept can be applied to the production of bio-hydrogen with Clostridium and Thermotogale bacteria at temperature between 60 – 80 oC. The most challenging task is the identification of the metabolism pathways to optimize the decomposition yield and rate. The integrated information derived from this process can be applied to the Landfill sites which is a best culture base with the injection well of hot air/steam to prepare the environment for the thermophilic fermentation.

Benefits

1)Providing distributed hydrogen production using a waste material. 2)Reduced NOx and CO emissions based on using hydrogen fuel. 3)Reduced natural gas usage by H2 production. 4)Use of an otherwise waste material (wood waste).

Objectives

1)Identify the integrated metabolism pathways of wood/cellulose degradation. 2)Quantitatively assess the effect of controlling parameters. 3)Demonstrate the capability of 80% cellulose degradation. 4)Demonstrate the capability of 45-50% hydrogen production. 5)Confirm the saving of natural gas to be 1.3 million therms. 6)Confirm the feasibility of distributed hydrogen production by this technology. 7)Confirm that a 500 SCFM project can produce products (bio-hydrogen) with a potential value larger than \$1,370,000/year. 8)Confirm that this process to be financially viable for a smaller project.

Budget

2005: \$100,000

2006: \$100,000

Other:

Comments

The proposed bio-hydrogen project is introduced in the hope that there can be a renewed utilization of wood waste in California. The successful implementation of this project will offer a reasonable probability of providing benefits to the general public by providing inexpensive distributed hydrogen production.

Project Concept #27: Hydrogen from Coal and Sunshine

Dr. Sergey N. Kivalov

Description

We propose to produce hydrogen from the carbonaceous fuels and water with the necessary energy delivered as solar heat. First of all we support the steam reforming process, and then we generate lime from limestone in a solar furnace. The lime is used in the production of hydrogen from coal and water. By capturing carbon dioxide the lime drives the water gas shift reactions to completion producing new limestone and hydrogen. By combining chemical energy in fossil fuels with solar energy, we obtain an optimal combination that maximizes the usefulness of fossil fuels as well as the efficiency of solar energy. <p> Our goal is to sketch out a viable process, identify the processing steps, and design a prototype for hydrogen production.

Benefits

Customers will receive the clean hydrogen and non carbone fuel based potentially recyclable heat supply for their needs (including possible water heating).<p> • The proposed technology is environmentally friendly. Using solar energy, the demand for fossil fuels and therefore CO₂- emissions can be reduced up to 40 % compared with conventional steam reforming processes for producing hydrogen. The produced CO₂ can be easily caught during the separation process and send to the sequestration facility.
 • The heat of carbonation of lime goes nearly completely into the production of hydrogen. Once the cycle is closed there is virtually no wasted energy. Virtually all the collected solar heat will be transferred to chemical energy in hydrogen.
 • The part of the system that is limited in its operation to sunshine hours is reduced to the absolute minimum. The water gas shift reactor and hydrogen polishing system can work 24 hours a day. Power generation could operate day and night as well.

Objectives

We start with existing schemes of mirror-based solar furnaces. We plan to investigate new appropriate schemes of concentrator systems for steam reforming process and for calcining limestone and calcium hydroxide. For hydrogen production we take the carbon dioxide acceptor process, similar to the recently developed ZECA process and use it to produce hydrogen from coal, lignite or tar. We may consider steam reforming processes and hydro-gasification for the coal. <p> The following specific steps in a three-year project are proposed:
 1. Survey of existing technologies and their relevance for solar driven water gas shift reactions.
 2. Investigate and develop the prototypes of the reactor for the coal based steam reforming process.
 3. Investigate and develop solar concentrator systems for providing steam reforming process and generating lime from limestone and calcium hydroxide. Decide on working fluid, heat transfer mechanisms, and temperature and pressure regime. Learn from the experience of other solar applications. Minimize losses from sensible heat in heating reactants and cooling reaction products. Consider options for start-up and shutdown on a daily basis.
 4. Consider storage cost, and storage silo design for lime storage.
 5. Design options for the carbon dioxide acceptor process matched to solar processes. Minimize water consumption, provide heat balance, energy balance, and manage calcium oxide recycling. Consider heat transfer through calcium hydroxide formation. Allow for hot and cold lime injection into the process.
 6. Develop prototype design on the Megawatt scale.
 7. Provide a summary report for the first year and a final report for the second year.
 8. Outline a timeline and a proposal for the design and construction of a pilot plant. <p> Total project duration is 3 years. The estimated funding necessary for this project is about \$4,000,000.

Budget

2005: \$1,000,000
2006: \$1,500,000
Other: \$1,500,000

Comments

Project Concept #28: Demonstartion of High Efficiency Natural Gas CHP Systems in California

Prashant S. Chintawar
Carthago International Solutions, Inc.

Description

Small scale (<10 kW) natural gas based fuel cell systems are on the verge of commerciliazation for combined heat and power (CHP) and distributed generation markets. Japan seems to be the primary entry market followed closely by US and Europe. In US, due to high electricity prices, California is likely to lead the market adoption and penetration. Nuvera has developed highly efficient and reliable 5 kW class system "Avanti" for CHP market. Avanti systems have been / are being demonstrated in Japan, Europe, and in northeast US. Field demonstration of such systems will pave the pathway for commercial launch in 2007-2008 timeframe.

Benefits

Reduction of several tons of SOx, NOx, CO2 emissions.

Objectives

Ensure alignment of Avanti cost and performance with market requirements. Find areas where improvements are needed. Assess the market readiness for fuel cell launch. Showcase technology to public via field demonstrations.

Budget

2005: \$100,000

2006: \$25,000

Other:

Comments

Project Concept #29: Gas Engine-Driven Chiller in Innovative Heating

James D. Corlett

Description

A gas engine-driven chiller can be creatively applied to produce hot water with 2 to 3 times less fuel consumption than a gas boiler. Payback periods of less than 3 years are achievable. Potential applications include heating greenhouses, swimming pools, and preheating boiler feedwater. This proposed demonstration project will move inherent heat from an existing pond (an air cooled arrangement can be substituted with slightly diminished performance) into a greenhouse. Metering devices will be installed to determine efficiency of the engine-driven system versus the conventional gas boiler approach.

Benefits

The project will highlight the significant energy (natural gas) savings by using a standard natural gas engine-driven, water cooled chiller to heat greenhouse plant beds in lieu of a gas-fired boiler. Benefits from this project can be easily transferrable to the many greenhouses throughout California. Additional benefit could be derived through other water heating applications beyond greenhouses.

Objectives

1. Demonstrate an innovative application of existing gas engine-driven chiller technology in a highly efficient water heating service. 2. Calculate Coefficient-of-Performance (COP) of the chiller versus a gas-fired boiler. 3. Publish gas consumption reduction and operating cost savings of the new approach.

Budget

2005: \$250,000

2006: \$100,000

Other:

Comments

Project Concept #30: Effects of Fuel Gas Composition for Natural Gas

Dr. Daniel Olsen

Description

Natural gas composition variability is emerging as an important issue due to recent changes in the natural gas market. Combustion in reciprocating natural gas engines is significantly impacted by composition. Because of the transient nature of combustion it is not dictated by the traditional metric, Wobbe Index. To address this issue we will design and build the necessary research infrastructure to quantify the performance and emissions effects for a wide-range of fuel gas compositions. Additionally, we will develop and verify new methods to measure, predict and proactively control engine operation to maintain performance and emissions within established limits.

Benefits

The research results will be critical to the development of natural gas engines that can adapt to varying composition without sacrificing emissions compliance or performance, guide new specifications for limits of natural gas composition, and provide credible, unbiased data to be referenced by engine manufacturers and regulatory agencies.

Objectives

1) Establishment of a natural gas composition test facility, 2) Unbiased quantification of effects of natural gas composition on reciprocating engines, 3) Identification of key metrics for characterization of natural gas composition, 4) Development of sensing and control strategies to adapt to varying natural gas composition.

Budget

2005: \$700,000

2006: \$300,000

Other: \$600,000

Comments

Project Concept #31: Ignition System Development for High BMEP Natural Gas Engines

Dr. Daniel Olsen

Description

In a high BMEP reciprocating natural gas engine the ignition system is typically the limiting factor in further reductions in emissions due to emissions formation in the precombustion chamber. Recently, much effort has gone into the development of new ignition systems such as micropilot and laser. Very little effort has been invested into the further development of precombustion chambers, used on most lean burn engines. We will explore a number of innovative ideas for dramatically improving precombustion chambers that have not been pursued. Significant performance improvements will be realized by building on proven technology.

Benefits

The research results will be critical to further advancements in high BMEP reciprocating natural gas engines. Further reductions in emissions and increases in efficiency will be enabled. The cost will be relatively low because it is an adaptation of exiting technology.

Objectives

1) Development of an optically accessible cylinder head for imaging of precombustion chamber operation on a high BMEP industrial natural gas engine, 2) Generation of new concepts and designs for new precombustion chamber systems, 3) Modeling of new precombustion chamber concepts, 4) Fabricate new precombustion chamber designs, 5) Experimental evaluation of new precombustion chamber designs.

Budget

2005: \$300,000
2006: \$300,000
Other: \$600,000

Comments

Project Concept #32: A New Concept in High Efficiency Natural Gas Fired Space Heating

Charles Hannon

Description

Most homes in the U.S. are heated by furnace systems employing ducting systems for thermal energy distribution. However, duct systems can lose as much as 20%-25% of the thermal energy leaving the furnace. Distributed heating systems such as electric baseboard eliminate those thermal losses, and the zoning inherent in electric baseboard heating can reduce residential energy consumption by an additional 20%. However, the cost of electric heating is several times that of gas heating, so the consumer realizes no economic benefit from the improved energy efficiency. A distributed gas-fired heating appliance is needed to improve efficiency, reduce operating costs and improved occupant comfort.

Benefits

The principal benefit of the proposed project concept to the public at large is the reduced consumption of natural resources accompanied by the reduction in emission of pollutants and greenhouse gases associated with the combustion of natural gas for space heating. These benefits accrue regardless of whether an individual lives in a home using the technology. For those individuals who do make direct use of the technology in their homes, an additional benefit is the reduced cost for residential space heating. In addition, technologies developed under the proposed project concept have the potential to offer greater personal comfort by tailoring the interior climate to suit individual needs and preferences.

Objectives

A research effort is required to fully assess the feasibility of commercializing the proposed distributed heating appliance. The three principle objectives of the initial phase of research to develop a new highly efficient concept in natural gas fired space heating are: 1) Estimate the potential efficiency improvement of the new concept relative to the performance of current natural gas fired forced hot air systems in new residential construction. Estimate the potential for reduction in the emission of pollutants and greenhouse gases. 2) Assess the feasibility of the concept in terms of compatibility with existing residential construction methods, code compliance, safety, ease of use, and acceptability to end users. 3) Estimate capital and installation costs for both new and retrofit construction. Use these estimates along with the efficiency improvement estimate to develop an economic cost-benefit model that can be used to assess the suitability of the concept for different regions of the country.

Budget

2005: \$200,000
2006: \$500,000
Other: \$500,000

Comments

The basic building block for a small, low-cost, modulating gas fired heater has been developed at Pacific Northwest National Laboratory (PNNL). The MicroHeater is a compact, modular, high-capacity combustion system capable of 80-85% combustion efficiency (HHV) with emissions levels that meet or exceed the California Emissions Control standards for stationary heaters. The significance of the MicroHeater development was acknowledged in 1999 with the award of an R&D 100 award from R&D Magazine . The MicroHeater uses state-of-the art microchannel technology to significantly reduce the scale of combustion and heat transfer equipment. A palm-sized module (5 cm x 5 cm x 1 cm) has a output of about 500 W. By assembling an array of 8-10 modules, a small heater can be built with sufficient input to heat a typical room, and fit within the wall cavity of typical residential construction. Locating this heater in an exterior wall would enable the combustor to be sealed from the conditioned space, drawing combustion air from, and venting directly to the outdoors. The room interface for such a heater would be no more intrusive than a typical hot air register. Such a heater can be made step-wise modulating by firing each module in the array individually to tailor the heat output to the room demand. MicroHeater modules are water

cooled so they can be easily integrated with standard baseboard hydronic heaters, or a forced hot air heater could be built by adding a small fan-coil to transfer cooling water heat to room air. A heater built in this manner has the potential to be an order of magnitude smaller than comparable through-the-wall heaters. The significance of the MicroHeater development at PNNL is more than just the reduction in scale. It is also in the innovative low-cost manufacturing method developed to fabricate the microchannel combustor and heat exchanger. This method uses a built-up laminated construction process which is well suited for automated mass production. It is estimated that a cost of \$20 to \$40/kW is attainable in production runs of more than 100,000 units per year. This is comparable to, or better than, the unit cost for gas fired residential furnaces and hydronic heating boilers.

Project Concept #33: Aggregated Methane Production at Concentrated Animal Feeding Operation

John M Brown

Description

The research will investigate opportunities for aggregating methane production around beef and dairy Concentrated Animal Feeding Operations (CAFOs) in the California Central Valley. The research will identify market opportunities, technical and regulatory barriers and economic thresholds for CAFO-produced-methane beyond electricity production. Though programs exist to assist farmers to capture methane for eliminating pollution and producing on-site electricity and heat, published literature provides little guidance to farmers or state and local government policy makers regarding markets beyond electricity production. As natural gas prices continue to rise with decreasing availability and increasing demand, new methane to market opportunities open for CAFO-produced-methane including direct-tie to the gas distribution system and processing to LNG.

Benefits

The Central Valley faces numerous challenges with respect to energy supply, air quality and employment. With over 1.2 million head of cattle at dairy operations alone in the Central Valley, methane and ammonia emissions produced by beef and dairy CAFOs play a significant and important role in air quality. Rising energy costs place a substantial burden on economically challenged Central Valley residents. These challenges coupled with ready access to gas transmission and local markets create many benefits including:

- 1) Air and water quality improvement through capturing and eliminating waste,
- 2) Enhanced energy security and improved energy reliability,
- 3) Stable long-term energy prices,
- 4) Retention of money in the local community,
- 5) Creation of new job opportunities.

Objectives

- 1) Summarize and quantify total potential CAFO-methane available in the Central Valley, taking into account energy necessary to capture and process methane and provide electric grid stability (Year I)
- 2) Identify near and medium term market opportunities for CAFO-methane including integration with distribution systems and conversion to LNG (Year I)
- 3) Identify technical and regulatory barriers surrounding capture, production, processing and integration of CAFO-methane into local and regional markets (Year I)
- 4) Assess key economic thresholds including identification of the most efficient and cost-effective forms for the gas product to take and tools available to state and local policy makers (Year I)
- 5) Identify one or more pilot project opportunity(ies) and conduct preliminary engineering, design and economic modeling. (Year II)

Budget

2005: \$135,000

2006: \$95,000

Other:

Comments

The Renewable Energy Cooperative Corporation (RECC) develops, finances, and operates renewable energy systems and provides complete energy solutions to farming and ranching operations throughout the United States. RECC is backed by a group of experienced and dedicated professionals who understand rural renewable energy resources such as biomass and wind, combined with energy efficient technologies, can be leveraged into economically sound investments and new revenue streams for small, medium and large-scale farming and ranching operations. Working with farmers on a local, regional and national basis, RECC uses the power of collaboration and aggregation to ensure that members and partners realize maximum benefit, including savings, revenue, energy and job security, from products produced by farm-based renewable energy systems.

RECC has initiated discussions with local farmers and ranchers in the Central Valley regarding capture and production of CAFO-methane. RECC has also contacted local, state and environmental air quality personnel (CARB, USDA, EPA etc...) and received strong verbal support for the research. RECC will work closely with local gas transmission companies, local utilities and city and county government officials to determine the best use of CAFO-methane for the region,

taking into account long term policy and development goals, as well as technical, regulatory and economic barriers and opportunities.</p>

Project Concept #34: Natural Gas Pump Using Water Agency Efficiency Improvements

Water and Energy Consulting - Lon W. House, Ph.D.

Description

Water agencies in California are significant natural gas users, consuming approximately 6,000 MMCFD. The use is primarily for natural gas engines to pump water. Approximately 15 percent of the water pumped by water agencies is pumped with natural gas. We, via Efficiency Analysts Int., are the CEC certified firm to provide technical audits for energy efficiency and peak reduction for water agencies. Unfortunately, existing funding limited us to the electric side, we have not been able to offer these services to water agencies that use natural gas. This funding limitation, combined with the relative dearth of information about applicable measures on the natural gas side, have left the natural gas using water agencies virtually untouched by efficiency improvement efforts.

Benefits

The natural gas using water agencies have historically been overlooked when it came to energy efficiency and peak reductions. This project will provide these water agencies with recommendations to improve the operating efficiency of their systems, reducing natural gas and electricity use with resultant environmental benefits, and will allow these water agencies to reduce their peak period pumping, relieving natural gas distribution system peak period constraints and potentially reduce their on peak electrical demand via a comprehensive system analysis. Deliverables include an agency specific report describing analysis and methodology used and detailing specific recommendations for efficiency improvements and peak demand period reductions, along with quantification of the magnitude of savings possible via each recommended measure and the cost effectiveness of each recommended measure.

Objectives

This project will provide the following: 1)technical audits for natural gas using water agencies to determine how they are using energy, and integrating natural gas engines with electric pumps, 2)identify areas of potential efficiency improvements and peak reduction opportunities in natural gas use, 3)develop strategies for better integration of natural gas pumps with the rest of the water agencies electric pumps, 4)provide a list of applicable energy efficiency improvements, the relative magnitude of potential savings, and the estimated cost of the applicable measures.

Budget

2005: \$200,000

2006: \$150,000

Other: \$500,000

Comments

In virtually all cases, water agencies use natural gas engines as a part of their system, the rest of the pumping and treatment being supplied by electricity. Some agencies use natural gas as their relatively constant, high volume pumps, while other agencies use their natural gas engines only during the peak periods, using their electric pumps during the remainder of the time. It requires a comprehensive water agency system assessment to determine the applicability and impact of changes in natural gas efficiency on the rest of their system. That is what this project proposes to do.

Project Concept #35: Gas Supply Strategic Plan and Collaborative

Paul Brooks

Description

To meet anticipated increases in natural gas demand in the State of California, alternative sources of natural gas are expected to supplement traditional North American supplies to maintain a reasonable supply/demand balance and keep gas commodity prices in an acceptable range. This will necessitate new gas production from unconventional domestic resources and from increased imports of liquefied natural gas (LNG). Improved societal and technical understanding is necessary concerning the degree to which gas from unconventional sources and LNG can supplement traditional North American natural gas without hindering the safe, efficient, and environmentally acceptable delivery and use, while addressing public concerns and local impacts. Efforts are necessary to investigate issues associated with siting and operating LNG receiving terminals and processing facilities, while minimizing impacts on the gas delivery infrastructure that will deliver the gas to the end user. It will also be important to ensure that natural gas from whatever source can be mixed or interchanged for interconnection at utility delivery points to assure acceptable quality that will minimize any adverse impacts on end user equipment and air quality.

Benefits

The availability of better information through collaborative efforts, California and the gas industry will be able to make sound decisions for providing adequate gas supplies, based on the merits and limitations of various options. The primary benefit to gas ratepayers accrues through the cost savings from the existence of a larger and more economically viable gas supply resources, and enable a more diverse and reliable gas supply. Gas supply research should be designed to extend and increase the availability of economically available alternative supplies of natural gas to ensure that the natural gas delivered to customers continues to be of high quality and gas from whatever source can be mixed or interchanged without adverse impact on equipment operation, efficiency and durability.

Objectives

A strategic plan should be developed and maintained to investigate, identify and address issues related to unconventional gas supplies such as LNG. The process for developing the plan should include outreach to a wide range of stakeholders, experts and interested parties to provide direction and oversight. This multiple-year strategic plan, with annual updates, is critical for keeping current on related R&D programs and activities; for seeking collaborative efforts where warranted; and ensuring that the R&D activities are consistent with California's public purpose needs. Collaboration with national efforts is necessary to minimize duplication of efforts, understand overall issues associated with alternative natural gas supplies, understand regional issues specific to California, definition of gaps that are specific to California, and investigation of alternatives to address those issues.

Budget

2005: \$250,000

2006: \$100,000

Other: \$250,000

Comments

PG&E encourages the different segments of the natural gas industry to work together in a collaborative manner to investigate and recommend guidelines and specifications to accommodate alternative gas supplies, while minimizing the costs and maximizing safety of gas appliances. These guidelines are necessary to develop an effective long term plan. Additional research is needed to expand or modify the specifications to optimize gas supply flexibility while continuing to assure customer safety and end use equipment reliability.

Project Concept #36: Gas Interchangeability-Impacts of Alt. Gas Supplies on Gas Appliances

Paul Brooks

Description

Currently, California's existing natural gas quality specifications are designed to fit the historical gas sources, end use applications, and system supply constraints. As new gas supplies are introduced, in particular liquefied natural gas (LNG), fuel interchangeability must assured compatibility with historical natural gas supplies. End use equipment is generally set up to operate on the gas that is available during installation. New and different supplies of natural gas could require existing appliances to be re-adjusted to assure safety, performance, efficiency, and emissions of end-use equipment are not significantly affected. California specifications should be sufficiently flexible so that interstate (FERC) and LNG supplies are not unnecessarily blocked and they should allow local production to be maximized as long as safety and reliability are not impaired.

Benefits

Changes in gas quality specifications can have a major impact on the cost of gas (added processing costs, etc). Any changes must be backed by solid research. Developing specifications that are compatible with LNG and interstate supplies will increase California's natural gas supply options to assure a reliable supply of reasonably priced natural gas.

Objectives

Gas quality specifications should be tested and defined to assure that gas supplies at utility delivery points is of acceptable quality to address interchangeability issues that could affect end-use equipment safety, performance, efficiency, and emissions. LNG suppliers have stated they can meet current specifications but more information is needed on air quality and equipment performance impacts before being finalized. On a national level, the National Gas Council (NGC+) has done a good job in developing interim gas interchangeability specifications which are generally more restrictive than current specifications. Additional research is needed to validate the need to finalize more restrictive NGC+ specifications and potential LNG supplies.

Budget

2005: \$2,000,000

2006: \$1,000,000

Other: \$1,000,000

Comments

Project Concept #37: Environmental/Economic Impacts from CHP and Digesters at Hog Farms

Steffen Mueller, PhD

Description

The University of Illinois at Chicago, Energy Resources Center (UIC/ERC) proposes to assess: 1)The natural gas reduction potential provided by the installation of Combined Heat and Power Systems Integrated with Anaerobic Digesters at Hog Farms (CHP/AD). 2)The environmental benefits (nutrient management, emissions reductions, and odor control) from CHP/AD at hog farms. 3)The economic benefits (net job growth) from CHP/AD at hog farms.

Benefits

This project will provide CEC with information on: 1)The cost to produce biogas (\$/MMBtu) relative to the cost of natural gas. 2)The benefits of CHP/AD systems to consumers (i.e. the farmers) from substituting natural gas with biogas. 3)The emissions reductions (SO₂, NO_x, CO₂, Hg) associated with CHP/AD generated electricity in California (tons per year) compared to the emissions from current electric generating facilities. 4)The severity from odor associated with hog operations relative to population growth. 5)The electric generating potential (in MW) from hog manure in California. 6)The cost of CHP/AD generated electricity (\$/kWh) relative to the cost of existing generating facilities. 7)The potential job growth from promoting CHP/AD looking at the shifts in employment for various industrial sectors (for example, growth in equipment manufacturing vs. reductions in fuel imports) from increased CHP/AD deployment.

Objectives

A recent USDA statistic indicates that the shift from small animal operations to large ones in the US is “more dramatic for swine than for any other major livestock type.” This is becoming a problem for California (one of the largest swine producers in the US) since highly concentrated hog farming operations generate manure quantities too large to be applied to the surrounding land at agronomic rates. Furthermore, the nitrogen-rich odor from hog manure is more offensive than cow manure. CHP/AD systems constitute a solution to these problems turning concentrated manure into an asset. However, low familiarity has impeded CHP/AD adoption. This project will provide CEC project managers with immediate information on the reductions in natural gas usage that can be achieved from substituting natural gas with biogas. Furthermore, this report will quantify the environmental benefits (emissions and odor reductions) as well as the job growth benefits associated with increased deployment of CHP/AD technologies. Such information will allow CEC to correctly evaluate investments in this area.

Budget

2005: \$100,000

2006: \$30,000

Other:

Comments

With the California Public Interest Gas R&D Program spanning a wide range of alternative energy technologies, such as renewable resources, advanced generation, energy efficiency, environmental, strategic analysis, etc., it is essential that the contractor takes the time to seek input from CEC staff and other stakeholders. The PI will commit up to 1 week per month of time in Sacramento to facilitate the close interaction with the project managers.

Project Concept #38: Compressed Air Energy Storage and Enhanced Gas Recovery

Curtis M. Oldenburg (LBNL), and Pat Ross (Princeton Natl Gas LLC)
LBNL/ (Princeton Natl Gas LLC)

Description

This research addresses whether depleted natural gas reservoirs can be used for Compressed Air Energy Storage (CAES) while simultaneously using the injected air for Enhanced Gas Recovery (EGR). CAES uses off-peak electricity to compress air and inject it into the reservoir. When energy demand is high, the compressed air is produced and mixed with additional CH₄ to generate electricity in a gas turbine. Compressed air can replace up to two thirds of the CH₄ in the gas turbine. The air injection also sweeps remaining CH₄ from the reservoir (EGR). Because the energy for CAES/EGR will come from wind power, this work addresses renewable energy.

Benefits

This project will determine whether CAES can be coupled with EGR to add value to the many depleted gas reservoirs available in California. If this coupled process can be made to work, the extra CH₄ that is produced is “green” energy because it was produced using renewable wind energy. The critical issues of the feasibility study are the extent to which (1) mixing between injected air and CH₄ occurs, (2) the reservoir can be repressurized without fracturing it, (3) oxygen is consumed in the reservoir, and (4) energy from compressed air can be recovered from a porous reservoir.

Objectives

We propose to carry out a feasibility study of the injection of compressed air for the purpose of EGR and CAES in a depleted gas reservoir in California. The study will involve reservoir analysis and simulation (including geochemical modeling) leading to a design for air injection and natural gas (CH₄) production, as well as air production for energy recovery. The collaboration involves the owner of the Princeton Gas Field (PGF), a largely depleted gas reservoir in Colusa County, and scientists at Berkeley Lab, where EGR and other gas reservoir engineering processes are studied. The PGF is estimated to contain an additional 7 Bcf CH₄ in sands at an average depth of 2300 ft (700 m).

Budget

2005: \$400,000

2006: \$1,000,00

Other: carryover from FY07

Comments

Collaborator: Pat Ross Princeton Natural Gas LLC Dana Point, CA 92629 Drillforgas@sbcglobal.net (858) 775-9897 or (970) 577-9316 CAES is being developed in Iowa: (<http://www.planetark.org/dailynewsstory.cfm/newsid/21004/story.htm>) We have already investigated enhanced gas recovery (EGR) by CO₂ injection (Oldenburg et al., Energy&Fuels 15, 293–298, 2001). In this process, injected CO₂ increases reservoir pressure and displaces CH₄ toward production wells to enhance and accelerate CH₄ production. The repressurization and displacement processes will be similar if the injected gas is air instead of CO₂.

Project Concept #39: Optimizing or eliminating reheat in high tech buildings

William Tschudi

Description

Most energy intensive high-tech buildings (Laboratories, cleanrooms, data centers, hospitals) have complex HVAC systems to maintain safe and tightly controlled environmental conditions. Often these systems are designed to cool air to a low temperature (e.g. 58 degrees) and then reheat the air to the desired temperature because it is felt that this improves control. This process wastes energy in both the initial cooling and the subsequent use of gas for reheating. This project would investigate strategies to optimize or eliminate use of reheat.

Benefits

Reducing reheat in high tech buildings can provide large electrical demand savings by reducing the amount of cooling required and equally large gas savings. Since these facilities typically operate continuously they represent an attractive target for improvement. In most of the climates in California, there are a large number of hours where this simultaneous cooling and heating is occurring. The targeted market is large and crosscutting through many industries and institutions. Benchmarking has shown that the HVAC systems can be responsible for 50% or more of energy use in high tech buildings.

Objectives

Study the current use of reheat and estimate potential savings through optimization. Provide case studies which demonstrate energy efficiency potential. Develop recommendations to optimize or eliminate use of reheat in high tech buildings. Transfer reheat optimization technology through industry associations.

Budget

2005: \$250,000

2006: \$250,000

Other:

Comments

Through LBNLs prior involvement with the Labs 21 program (sponsored by DOE and EPA) and other prior High Tech Buildings projects (PIER, Utility, NYSERDA, Northwest Efficiency Alliance projects) a broad network of industry contacts has been developed that will facilitate the proposed gas efficiency investigations and subsequent technology transfer.

Project Concept #40: Feasibility of CO₂ as Cushion Gas for Natural Gas

Curtis M. Oldenburg

Description

This research addresses the question of whether CO₂ can be used as an effective cushion gas for natural gas storage. The questions to be addressed include (1) evaluation of the advantages of using CO₂, (2) the conditions under which CO₂ will be most effective as a cushion gas, and (3) the extent to which CO₂ cushion gas will mix with the working gas (CH₄). This work addresses energy efficiency and climate change (environmental) because CO₂ is sequestered in the process and gas storage is more efficient when CO₂ is used as the cushion gas.

Benefits

Using anthropogenic CO₂ as a cushion gas has two main benefits: (1) the injected CO₂ is sequestered carbon, and (2) CO₂ is a super-cushion (i.e., it is more compressible than ideal gas) when the reservoir is operated around the critical pressure and therefore more CH₄ can be stored in the reservoir than if native CH₄ is used as the cushion. This work evaluates a process that could add significant value to depleted gas reservoirs.

Objectives

This project has feasibility and pilot study phases. In the feasibility phase, we will build on prior studies (Oldenburg, 2003) and simulate CO₂ injection into a depleted gas reservoir to enhance gas recovery while simultaneously filling the reservoir with cushion (CO₂) gas. Then we will simulate seasonal natural gas storage and evaluate the advantages of CO₂ and the extent of mixing of cushion and working gas. In the pilot study phase, we will find a small compartment of a reservoir in California to test the use of CO₂ as a cushion gas. If feasible, this process could make depleted gas reservoirs valuable as CO₂ and CH₄ storage sites.

Budget

2005: \$300,000

2006: \$2,000,000

Other: carryover on pilot

Comments

We have already studied the fundamental processes and advantages of CO₂: Oldenburg, C.M., Carbon dioxide as cushion gas for natural gas storage, Energy & Fuels, 17, 240-246, 2003. Further research is needed for more realistic reservoirs and gas storage operation scenarios to test feasibility.

Project Concept #41: California

Coughlin, Katie; Fridley, David; Masanet, Eric; Rosenquist, Greg

Description

In June 2005, ExxonMobil declared that North American natural gas production had peaked and would continue to decline, even with the construction of two Arctic natural gas pipelines. This turning point poses a critical challenge to California, where gas supplies 30% of the state's energy. Although California plans to turn to imported LNG, it will be competing with China and India, where imports are expected to soar to 53 million tonnes by 2015. As peaks in both global petroleum and natural gas production are expected by 2020, California may face physical shortages. This study will identify California's vulnerabilities and propose a modeling framework for public policy analysis and response.

Benefits

This project will develop a number of new tools that can be used to understand the physical role of energy resources in the California economy, and provide a solid basis for evaluating risk management alternatives. These include: 1) a measure of the primary and secondary energy content of different resource inputs, which incorporates the notion of energy return on energy invested; (2) development of baseline and future constrained supply scenarios; (3) a model representing the production capacity for different economic sectors given fixed energy supply inputs and (4) a determination of the sensitivities of different sectors, calculated as the ratio of change in production with unit change in supply.

Objectives

The primary objective is to quantify the impacts of possible natural gas supply constraints on the productive economy. Economics assumes that supply of any commodity is always available at a high enough price. This directly contradicts the physical fact of finite resources, and begs the question of how medium-term supply disruptions may force a reconfiguration of the economy itself. The approach is to develop an accounting model for the physical resources used in production, similar to an input-output model, but replacing the economic cost function with an energy cost function. The model will be used to quantify the vulnerability of different sectors of the California economy.

Budget

2005: \$150,000

2006: \$100,000

Other: -

Comments

Project Concept #42: High Efficiency Engine Systems through Waste Heat Utilization

Daniel Olsen, PhD

Description

A system for utilizing waste-heat from Diesel truck engines will be developed. This system will capture the waste heat in the coolant and exhaust streams to power a closed Rankine cycle, and inputs the recovered power back into the drivetrain. Rankine cycles are currently used for waste heat recovery of large engines, but have not been applied to on-highway engines. This program will focus on development of suitable components suitable and system integration, rather than on fundamental research. Since the technology exists for producing all required components commercially, this technology could be implemented in a relatively short timeframe.

Benefits

A fuel efficiency benefit of 10% is expected over the operating cycle of an on-highway truck. Application of this technology could save 14.3 million gallons of Diesel annually by 2012, approximately \$1.35 Billion per year. A simultaneous reduction of 6.2 million tons annually of CO2 emissions may be achieved.

Objectives

1) Develop a waste heat recovery system that improves the efficiency of a heavy duty Diesel engine by 10%, 2) Facilitate close collaboration with industrial partners who will manufacture end-product, 3) The recovery time of the incremental cost of the waste heat utilization system must be approximately 1 year.

Budget

2005: \$250,000

2006: \$500,000

Other: \$500,000

Comments

Project Concept #43: Aftertreatment Technologies for Lean Burn Natural Gas Engines

Daniel Olsen, PhD

Description

This program focuses on exhaust aftertreatment for reduction of oxides of nitrogen (NOX) from lean burn natural gas engines. Currently, the predominate aftertreatment technology for these applications is selective catalytic reduction (SCR). Other technologies that require development for removal of NOX from lean exhaust, include lean NOX catalysts (no reducing agent), non-thermal plasma, and lean NOX absorbers. Also, there are many SCR issues that need to be addressed, such as ammonia slip, production of additional pollutants like HCN, and control system design. An SCR research facility will be installed at the Colorado State University Engines and Energy Conversion Laboratory.

Benefits

The research results will be critical to the development of natural gas engines that will emit ultra-low levels of emissions without producing emissions by-products or sacrificing performance, and provide credible, unbiased data to be referenced by engine manufacturers and regulatory agencies.

Objectives

1) Establishment of an aftertreatment test facility, 2) Unbiased quantification of effects of SCR and other aftertreatment methods on reciprocating engines, 3) Identification of key metrics for characterization of aftertreatment methods, 4) Development of sensing and control strategies to adapt to varying engine parameters

Budget

2005: \$250,000
2006: \$500,000
Other: \$250,000

Comments

Project Concept #44: LNG Terminal Safety & Security Study

Ray Smith

Description

Build a simulation tool that accurately describes the overpressure, thermal radiation and burn plume that will result from LNG tankers and terminals as the result of large-scale accidents or terrorist actions. Inputs should include site topography, tanker and terminal specifications and local weather conditions. The output of this simulation will include a probabilistic risk assessment of damage to surroundings.

Benefits

The CPUC and CEC need safety and security criteria for siting LNG terminals that are based on the maximum credible accidents or terrorist actions. Although siting authority may ultimately reside with FERC, the CPUC and the CEC need independent analysis to support their siting preferences before FERC.

Objectives

1) Establish the composition limits to LNG that will determine if detonation or deflagration is likely in an accident; 2) Establish overpressure versus distance for estimating structural damage; 3) Validate the simulation model using LNG spill experimental data from the Nevada Test Site; 4) Determine the influence of local weather on damage footprint; 5) Seek terminal designs that mitigate risk;

Budget

2005: \$1,200,000

2006: \$700,000

Other: \$100,000

Comments

Large expansion of NG usage in California will depend on public acceptance of the risks that are involved with LNG tankers and terminals. Siting and operational criteria should be based on the best scientific knowledge that we can generate on accidents or attacks.

Project Concept #45: Renewables in Commercial, Institutional and Industrial Markets

Paul Bautista

Description

California's Energy Action Plan presents strategic priorities to meet the state's energy demand and supply needs – conservation/energy efficiency, renewable energy/distributed generation, and clean fossil fuel generation. This project proposes to facilitate the development of renewable resources for mid-sized, end-use customers (e.g., commercial, institutional and small industrial), an under-exploited market segment by developing needed reference guidance. Increased renewable resources minimize dependency on natural gas. The following will be provided: characterizing existing and emerging renewable energy technology options, defining existing incentive programs and customer eligibility, describing the environmental footprint of renewable resources, and proposing approaches for single-project development and multiple-site aggregation of renewable and renewable natural gas hybrid systems.

Benefits

This project would result in increased renewable resources in market segments with relatively low penetration. Project developers, original equipment manufacturers, and utilities have not made these segments priorities. Businesses, industry, and institutions that employ renewable resources as a replacement or supplement to natural gas can reduce dependency on natural gas and reduce negative environmental impacts. The public benefits from increased use of renewable resources include reductions in air emissions, energy diversity, improved system reliability and less price volatility through reduced dependency on natural gas in the projected tight natural gas market.

Objectives

A guidebook (hard copy and electronic formats) will be produced that would serve as a reference for project developers and interested end-users to design and install renewable and renewable/natural gas hybrid systems at mid-sized, end-user facilities. It will address perceived and real barriers to growth in renewable projects, thus dispelling confusion and providing clear and accurate information to simplify and accelerate the project feasibility assessment and development process. A step-by-step, user-focused guidebook will provide information on technologies, technology selection, integration with legacy equipment, state and utility incentives, potential value from emissions reductions credits and renewable energy credits, air permitting, codes/standards, and case studies.

Budget

2005: \$150,000

2006: \$50,000

Other:

Comments

Activities will include an industry advisory group, literature review, interview surveys and case studies. Project advisors and survey participants would include project developers, state agencies, technology vendors, and commercial, institutional and industrial costumers.

Project Concept #46: Synergistic Efficiency & Emissions Enhancements for Industrial Heating

Robert K. Cheng

Description

California's very stringent environmental rules for industrial stationary sources can be a costly compromise to system efficiency. But with a new generation of ultra-clean and highly cost-effective combustion concepts, there is a great opportunity to exploit synergistic approaches that can reverse this trend from efficiency losses to efficiency gains. Our plan is to develop and demonstrate synergistic efficiency and emission enhancement methods for low (up to 1250F) and medium (1250F to 1800F) heat processes. They are most prevalent in California's chemical production industries and manufacturing industries that require heat treating, drying and baking and represent a large portion of the industrial natural gas utilization (970 Mth total in 2002). Our enabling technology is a patented ultra-clean combustion process that has recently been commercialized for small industrial direct fired heating systems (up to 6 MMBtu/hr).

Benefits

The main targeted application areas are direct fluid heaters, drying, and heat treating. Currently, these processes have very low system efficiencies of 15 to 85% and the potential to increase efficiency and save energy is significant. These combustion goals alone will improve system efficiency by 2 to 4%. In addition, the operational flexibility offered by this concept (compared to much more restrictive operational envelope of other low emission combustion concepts) can be an additional 5 - 25% efficiency gain depending on the process. Depending on the heating system, natural gas saving can be up to 50 Mth per year. NO_x will be lowered from current average levels of 50 ppm to less than 9 ppm to remove 1000 tons of NO_x. California industries can stay competitive by having cost-effective low emission systems that are more energy efficient than their current counterparts.

Objectives

The research will apply the scientific underpinning of our ultra-clean combustion technology to enhance the performance of combustion system of up to 30 MMBtu/hr through improvements in heat transfer, load following, turndown, and decreasing excess air and fan requirements. The deliverables are a set of proven design guidelines and engineering rules that can be readily applied to build new ultra-clean industrial heating systems or upgrade existing industrial systems to increase their system efficiencies as well as meeting California's air quality rules. The metrics are $5 < \text{NO}_x < 9$ ppm throughout the system load range, no more than 3% excess O₂ for combustion, at least a 5:1 turndown ratio and cost effectiveness comparable to current high NO_x systems.

Budget

2005: \$250,000

2006: \$250,000

Other: \$150,000

Comments

Due to the diversity of industrial systems, the R&D work will involve laboratory experiments and computational studies to develop and evaluate the synergistic approaches. These concepts will be demonstrated at full and reduced scale low temperature and medium temperature systems in partnership with combustion equipment manufactures and end users.

Project Concept #47: Near-zero Excess air Ultra-clean Industrial & Commercial Burners

Robert K. Cheng

Description

California's industry and commercial enterprises utilize natural gas to generate heat for hot water, steam, and operating key processes. These stationary sources are subjected to stringent emission regulations. Current low NO_x burners in these systems rely on high excess air burning with flue gas recirculation (FGR). This approach compromises efficiency by requiring parasitic energy to pump additional combustion air and FGR, and reduces turndown capability and options to enhance heat transfer. The goal of our research is to develop next generation ultra-clean burners that require < 3 % excess O₂ and no FGR. The technology will base on advance fuel staging for our patented low-swirl combustion (LSC) method. These new LSC systems will be very cost effective to afford significant energy and financial savings.

Benefits

The projects will benefit end-users of water heaters, boilers and indirect fluid heaters. Currently, the efficiencies of typical non-condensing systems are about 85%. The potential to increase efficiency and save energy can be achieved through lowering the parasitic energy and improving heat transfer. This will improve overall efficiency by 2 to 4%. In addition, the operational flexibility (compared to much more restrictive operational envelope of other low NO_x combustion concepts) can be an additional 1% efficiency gain depending on the process. Operational energy saving of parasitic energy alone can be up to 30 MW of electricity per year. NO_x will be lowered from current average levels of 50 ppm to less than 9 ppm. California industries can stay competitive by having cost-effective low emission systems that are more energy efficient than their current counterparts.

Objectives

Our goal is to develop, test, and demonstrate advance burners of 0.3 to 50 MMBtu/hr burners for water heaters, boilers and indirect fluid heaters. The basic approach is to exploit the low-swirl combustion methods to produce a stable ultra-fuel-lean primary combustion zone complimented by a secondary rich zone that consumes the excess O₂. Laboratory studies have demonstrated that this lean/rich concept is simpler and much more effective in reducing NO_x and amenable to flame shaping (to optimize heat transfer thus efficiency) than current rich/lean approach. The designs will be guided by our fundamental understanding of the LSC concept and combustion chemistry to scale and adapt to different combustion chambers. The metrics are $5 < \text{NO}_x < 9$ ppm throughout the load range, no more than 3% excess O₂, at least a 5:1 turndown ratio, and first and operating costs comparable to current high NO_x systems.

Budget

2005: \$300,000

2006: \$300,000

Other: \$200,000

Comments

Due to the diversity of industrial systems, the R&D work will begin with laboratory experiments and computational studies to develop and evaluate the staged LSC concepts and optimize the design of burner prototypes for different applications. The size and configuration for demonstration of the new burner prototypes will be selected in collaboration with OEMS. The burners will then be built to meet the specific system requirements followed by full demonstration in partnership with combustion equipment manufactures and end users.

Project Concept #48: Dimethyl Ether Alternative Fuel

Ray Smith

Description

Converting natural gas to dimethyl ether (DME) for transport through existing pipelines can increase the energy throughput by twenty fold! Although the current energy conversion penalty for making DME from natural gas is nearly 50% new nano-catalysts offer the potential of 90% conversion efficiency. Questions of complete compatibility with all natural gas appliances must be addressed. Atmospheric chemistry models will be used to determine DME lifetime (reputed to be on the order of days) from infrastructure leaks.

Benefits

Higher throughput of gas energy without building new pipelines. Increase NG pipeline lifetime due to much lower pressure operation. Significant reduction in GHG effects which could be used to offset CO2 emissions.

Objectives

1) Determine the potential energy conversion efficiency from NG to DME on small scale experiments; 2) Determine the compatibility and emissions on a variety of NG appliances; 3) In conjunction with a pipeline operator estimate the increase in lifetime of NG pipelines converted to DME; 4) Determine reduction in greenhouse gas effects by converting from NG to DME

Budget

2005: \$750,000

2006: \$750,000

Other:

Comments

LLNL would partner with PG&E for the pipeline costs and operational details. We would partner with UC Berkeley for the gas appliance compatibility and emissions measurements.

Project Concept #49: Gas-Electric Industry Coordination and Reliability Enhancement

Jeremy Platt

Description

The power sector

Benefits

The power sector in the state is changing, with new gas generation, renewables (mostly wind), retirements, possible municipalizations, and transmission enhancements. Gas use in the power sector is vital to reliable service, yet the sector competes for gas supplies with all other users. Joint contingency planning relying on the industry

Objectives

Budget

2005: \$400,000

2006: \$400,000

Other: \$200,000

Comments

The research approach will provide independent simulation of power sector gas requirements, and will rely on the gas industry to conduct state of the art gas supply simulations (incorporating but not disclosing proprietary information). The project will involve a learning period among representatives of the gas and power industries, both influencing contingency definition and determining the implications of results for operations and communications. There is no effort to "reinvent" the wheel in terms of commercial simulation tools, as this is viewed as unnecessary and inferior. Several years are required to build the analytical base and working relationships, using the New England Gas-Electric Discussion Group as a very successful precursor to this effort.

Project Concept #50: Off-Peak Electricity Storage for Peak-Demand D.G. Applications

John Halloran, P.E.

Description

The project will demonstrate the feasibility of using the recently patented "Potential Energy Storage System" approach to store off-peak power each night for use during peak-demand daylight hours. PESS technology downsizes the proven hydro pumped-storage concept for use in the "distributed generation" mode. This is accomplished by installing a hydraulic support system under new commercial structures, thus using their weight to push hydraulic fluid through a turbine/generator during peak power demand periods. Application of the PESS concept will address most of the actions adopted in the Ca. Energy Action Plan.

Benefits

1) Allows sustained growth by reducing peak demand via stored, off-peak power; 2) Controls electricity and gas costs to off-peak rates, even during peak demand; 3) Reduces total emissions by using a higher relative amount of off-peak power containing a higher percentage of gas and "green power" generation sources; 4) Reduces required capital for upgrade and expansion of T&D infrastructure; 5) The new DG sites will be "zero discharge" sources of uninterrupted power; 6) Enhances the integrity of new structures relative to seismic activity due to the unique "hydraulic cushion" incorporated into PESS structural supports.

Objectives

2006 Prepare and test a demonstration-scale model of the PESS: -design/size the model and select a model laboratory to host the testing; -size/select all hydraulic equipment/systems to match the model size; -fabricate and install the model structure on its prepared foundation; -install test equipment and conduct initial commissioning of the system; -run pump/generate cycle and model stability tests; prepare test report. 2007 Prepare equipment/system design for first commercial site (250-500kw size). Install PESS in conjunction with a new real estate development project.

Budget

2005: \$220,000

2006: \$1,250,000

Other:

Comments

1) "Pumped Storage" of electricity is the largest (19GW) and most successful form of storage and has been in operation for many years at various U.S. sites. Since these sites require large water reservoirs and elevation changes (hydro form) or large underground cavern formations (compressed air form), they are not applicable to small distributed generation sites close to load centers. 2) Using the weight of various types of commercial structures to provide the hydraulic "pressure head" for small turbine-generators (the PESS approach) allows the "pumped storage" approach to be downsized for the DG market.

Project Concept #51: Natural Gas as a Bridge to Hydrogen Sourced Energy Solutions

Dan McCormick

Description

H-Solutions would employ engineers, chemists, environmental specialists, and technology managers in the research and design of a system that would use natural gas in an efficient, low emissions process to generate and store hydrogen in support of a no emissions electrical power generation process. Such a system could use natural gas in the following methods: · Reforming natural gas to hydrogen and waste compounds · Powering of an electrolysis process Continuous generation of hydrogen ensures availability during high electrical power demand times for industrial applications. For residential environments with net metering, excess power produced during could be sold to utilities.

Benefits

Although the technology for efficient, small scale, production of no emission electrical power from hydrogen exists today, the infrastructure is not in place to deliver hydrogen gas to all potential power generation locations. The pervasive infrastructure for delivery of natural gas can be exploited to liberate hydrogen for use in the production of electrical power at various industrial, residential, and vehicle fleet locations. This project is intended to accelerate the movement to a hydrogen based economy, and reach critical mass with the technology while avoiding significant investment in hydrogen distribution infrastructure. This power generation system will increase the robustness of the power distribution grid and ultimately lower the cost of electrical power to consumers.

Objectives

The primary objective of this proposed project is the development of a cost effective system, suitable for industrial and residential use to provide continuous generation of hydrogen from natural gas. Hydrogen storage and distribution technologies supporting multiple use environments would be researched and documented. Current Commercial Off The Shelf (COTS) products and technologies would be studied to provide a gap analysis between state of the art and where we need to be to support large-scale deployment of natural gas to hydrogen systems. Additionally, a thorough search for like and complementary technologies would be performed in an effort to find further synergies and efficiencies.

Budget

2005: \$700,000

2006: \$1,000,000

Other:

Comments

Research, theoretical development, and documentation of such systems would require one year at a cost of \$700,000. Following the research and development efforts, the commercial feasibility of such systems would be determined. If the proposed systems were found to be economically viable, the next phase would be to build and test prototype systems. The estimate for the prototype phase is another year, with an additional \$1,000,000 cost. Successful prototypes would likely lead to licensed manufacturing agreements with private corporations.

Project Concept #52: Comprehensive Roadmap for transformation to Clean City with NGVs

Rusi Patel and Henry DeLima

Description

We propose to develop a comprehensive plan to demonstrate the viability of commercial Natural Gas Vehicles (NGV) in a California city to be selected by us and CEC. The design will be based on lessons learned from the recent successful introduction of CNG for all commercial vehicles including over 10,000 buses within metropolitan New Delhi, India in 2002. From being the fourth-most polluted city in the world, New Delhi is now one of the cleanest due to the conversion of the entire fleet of taxis, buses and commercial vehicles to CNG. The emission characteristics of CNG versus gasoline or diesel makes this evident.

Benefits

- o Operating Cost of CNG vehicles is 60% to 70% that for conventional vehicles
- o NGVs reduce emissions of CO by 70%, non-methane organic gas by 87% and CO₂ by 20% below those of gasoline vehicles.
- o CNG vehicles exceed the requirements of the SCAQMD Rule 1191 and US emissions requirements for 2010.
- o American Lung Association of California – “evaporated hydrocarbon emissions, the most significant pollution problem in gasoline vehicles, is completely eliminated in NGVs”.
- o Reduced maintenance costs
- o Increased engine life
- o Natural gas is a domestic fuel with 87% from US, 12% from Canada, and 1% from foreign countries.
- o Economic activity for vehicle conversions, fueling stations, contributes to the tax base and jobs.

Objectives

Develop in-depth understanding of the transformation of New Delhi from the fourth most polluted city to a clean city, through the use of CNG in commercial vehicles. Develop a comprehensive plan to transform a California city (to be selected) through widespread introduction of CNG as transportation fuel within the city. Issues include:

- Technical
 - o Gas availability, distribution
 - o Refueling site availability, ownership, training
 - o Vehicle fleet characteristics
 - o Conversion Potential, equipment availability
 - o Emissions, safety testing
- Institutional
 - o Select demonstration city
 - o Government funding, champions, codes, inspections, fleet conversion
 - o Private sector
 - o Industry groups
- Economic
 - o Payback or ROI
 - o Incentives
 - o Economic impacts

Budget

2005: \$400,000

2006: \$400,000

Other: \$0

Comments

The demand for natural gas vehicles has shot up all over the world, from New Delhi to Argentina and from Karachi to the United Arab Emirates. The reason is simply economics. The current and projected price of gasoline and diesel on the one hand and natural gas on the other, makes the operation of NGVs substantially cheaper than that of gasoline and diesel vehicles. A TIAX study, completed recently found that at crude above \$31 a barrel, NGVs are less expensive to operate. With crude above \$60 a barrel, NGVs are way ahead of conventional vehicles. The auto makers and large vehicle manufacturers are having difficulty keeping up with the Worldwide demand. It is time to switch.

Project Concept #53: Outlook For LNG: A Global Assessment

Energy Ventures Analysis, Inc.

Energy Ventures Analysis, Inc.

Description

The proposed research would provide a global assessment of the rapidly evolving LNG industry, with the primary focus being an assessment from several different perspectives of the relevant range of future U.S. LNG imports. Included in this global assessment would be an analysis of: (1) the project milestones to date of the 90 proposed North American regasification terminals, along with an assessment of those most likely to be completed; (2) the likelihood of completion and timing for the 75 new liquefaction projects proposed throughout the world; (3) the competing 93 regasification terminals proposed outside of North America; (4) the supply commitments to date from new liquefaction projects by region of the world; and (5) the evolving spot market for LNG, for which the U.S., to date, has been so heavily dependent. Included in this global assessment would be a separate section on California-specific projects and their potential impact on the California gas market.

Benefits

This research would provide a complete and thorough appraisal of the likely range of future U.S. LNG imports, and the role of the U.S. within the rapidly expanding global LNG market, which currently are two of the most debatable topics in both the natural gas and power industries. It would provide significant insights into both overall supply reliability and the risk associated with being involved with an international market. The bedrock information contained in this research would allow other researchers to more accurately assess the outlook for future U.S., as well as regional, gas supplies and, as a result, to be better able to judge the potential price effects of a changing supply outlook for the nation. In addition, the project-specific information contained in the research could be used for a variety of policy analyses concerning LNG projects and the industry as a whole.

Objectives

Within both the power and natural gas industries, the critical variable in assessing the comparative economics of either conservation or technology alternatives has become the current elevated levels of natural gas prices. With respect to the outlook for gas prices, the most debatable aspect is the level of future U.S. LNG imports, their reliability, and their impact, if any, on U.S. natural gas prices. In order to obtain a firm grasp on the relevant range of the former, it is necessary to examine the LNG industry on a global basis, and from several different perspectives, in order to triangulate on likely outcomes for this very dynamic issue. The proposed research will accomplish this and, as a result, provide a sound basis for assessing this critical component of any natural gas outlook, as well as assessing policy issues associated with LNG facilities and imports.

Budget

2005: \$65,000

2006: \$35,000

Other:

Comments

Features of the proposed research include a series of appendices, maps, summary tables, historical data on the industry and analysis of critical issues. The appendices would provide relevant information (e.g., location, capacities, etc.) and project milestones to date for (1) North American regasification projects, (2) liquefaction projects throughout the world and (3) competing regasification projects outside of North America. An assessment of each project's likelihood would be included. The maps generated by this research would identify the location of new regasification projects in North American and elsewhere in the world, as well as the sites for new greenfield and expanding brownfield liquefaction projects. One of the most critical analytical tasks of this research will be the detailed assessment of supply commitments from the new liquefaction projects by country and region of the world. Other analytical tasks include analyzing each of the segments of the LNG chain, as well as key issues within the industry, such as the use of open-rack vaporization, gas interchangeability, competition from new pipeline gas in key foreign countries and others. In light of the dynamic nature of this subject, the initial report, which should be

delivered in 2006, would be updated in 2007.

Project Concept #54: Development and Application of a New Wind Energy Forecast System

Steve Chin

Description

Wind power has shown its value to reduce the emissions of pollution and greenhouse gases from natural gas-fired power plants. Our recent research for a CEC supported wind energy project clearly exhibits systematic improvement of wind forecast errors with increasing grid resolution (from 36 km, 12 km to 4 km) during the high wind power season; averaged wind forecast absolute errors is about 15 ~ 20% for the windmill farm at the Altamont Pass. Due to the nonlinear relation between wind speed and wind power, the error in the forecast wind energy would be ever larger. The implication of this research strongly supports the value of high-performance computing to further improve wind forecast errors with higher grid resolutions for the real-time, accurate wind energy forecast. Our research also suggests a better model terrain representation to improve the wind forecast accuracy for the airflow over the complex terrain.

Benefits

Wind energy has demonstrated its readiness to become a more significant contributor to the electricity supply in the western U.S. and help ease the power shortage. The practical exercise of this alternative energy supply also showed its function in stabilizing electricity prices and reducing the emissions of pollution and greenhouse gases from natural gas-fired power plants. Therefore, the anticipated benefits from this proposed research would cover a wide range of aspects including power industry, local economy, alleviation on air pollution and climate impact, and help meet the newly enacted Renewable Portfolio Standards calling for 20% of renewables in California's power generation mix by 2010. This proposed forecasting tool can also be applied to any other geographic locations to promote the wind power usage.

Objectives

A state of the art, real-time wind energy forecasting model is proposed to provide an improved wind power forecast for an effective power management in California and better handling of cut-in and cut-out speed of wind turbines to reduce the operational cost of the wind farms. Unlike the current funded approach of using the wind tunnel facility and the weather forecast model, the proposed forecasting system will be developed by coupling the turbine power curve with a new code architecture (distributed memory) of LLNL's weather forecast model (COAMPS) for high-performance computing, better terrain database, and the large-eddy simulation capability for high-resolution (horizontal grid size less than 100 meters) prediction. The advantages of this new approach are (1) to eliminate the data transmission time in providing COAMPS forecast to drive the parameterized power curve from the wind tunnel facility, and (2) to reduce the sources of errors by supplying a more consistent data input to drive the wind turbine.

Budget

2005: \$190,000
2006: \$200,000
Other: \$110,000

Comments

The budgets for 06 and 07 are for both research development and operational forecast products, which are useful for California independent system operator in the power management. The reduced request in 08 is for providing operational forecast products using the final state of the art wind energy forecasting system.

Project Concept #55: Chemical recuperation of natural gas feed for gas

Barney Rush

Description

Over the coming decade, California will be receiving increasing and ultimately substantial quantities of LNG. The ability of local gas distribution companies and end use customers to use a wide variety of LNG gas, with varying contents and characteristics, is an important goal for the State to avail itself of the lowest price gas possible. To achieve this goal, it will be necessary to ensure that gas turbines, including those with advanced Dry Low NOx combustors, are capable of burning gases with substantial variability. This is an issue of substantial concern to both the turbine OEM's and the LDC's alike. We believe that the use of a Partially Chemically Recuperated Gas Turbine Cycle (PCRGTC) may offer an attractive solution to the challenges presented by variable gas quality, thus facilitating the use of lower-priced LNG without compromising environmental quality. This can be achieved by chemically-converting the heavy hydrocarbons and a small part of the methane in the natural gas using H2Gen's advanced steam reforming catalyst technology. Such systems have been proposed in the past, but have not been realized in practice. In part, this has been due to the shortcomings of previous-generation catalysts, especially in the start-stop service and low temperatures called for in gas turbine applications. H2Gen's reforming technology was designed for frequent, rapid starts using impure gas. H2Gen is also expert in low thermal mass reformer design, a critical element needed to achieve cost-effective, compact, and responsive systems needed for turbines.

Benefits

The most general benefit will be demonstrating a low-cost technology that meets increasingly strict environmental requirements, without being limited by natural gas variability and which can also be retrofitted on older turbines. Specific benefits include: 1. wide tolerance to fuel quality variations without degraded NOx performance 2. flame stability equal or better than currently achieved 3. lower exhaust gas temperature from the turbine plant, which may reduce the need for supplementary air blowers for SCR's 4. Extended SCR catalyst life due to elimination of sulfur oxides in exhaust gases 5. An improvement in plant heat rate from simple cycle plants 6. An Increase in power output from simple cycle plants where installed generator and transformer capacity permit

Objectives

The key objective is to design, develop and test an optimal PCRGTC system which will undertaken on a gas turbine typically used in the State of California. Our partners in this research will be Siemens Westinghouse, which have a large fleet of turbines in the State.

Budget

2005: \$750,000

2006: \$1,500,000

Other:

Comments

H2Gen is pleased to be working with Siemens-Westinghouse on this project. Combining H2Gen

Project Concept #56: Benefits from a Statewide Natural Gas Energy Efficiency Program

Athanasios (Tony) Bournakis, Ph.D., Principal Research Economist

Description

The University of Illinois at Chicago - Energy Resources Center (UIC/ERC) proposes to evaluate the potential impacts of a statewide Natural Gas Energy Efficiency Program for the California Public Interest Gas R&D Program designed to reduce natural gas use by a significant amount (such as 15%) by 2020. A wide range of energy efficiency measures could be used to meet these targets. The study will identify specific energy efficiency measures for each customer sector (residential, commercial, and industrial) and calculate the installation costs, the energy savings, and the cost effectiveness of each energy efficiency measure. These calculations could be used to determine the optimal energy efficiency approach for each sector. The study would also calculate the impacts to the California economy (in terms of output, income, and job creation) and measure the positive environmental benefits (reductions of NOx, CO2, SO2, etc.).

Benefits

This project will provide CEC program/project managers with detail information on the benefits and impacts that an aggressive statewide natural gas energy efficiency plan could have on consumers, the economy and the environment. The information will also allow project managers to optimize allocation of resources to projects that offer the greatest benefits to consumers, and most pronounced impacts on the economy and the environment. In addition, the study will create benchmark/targets for energy savings potential created from a gas energy efficiency portfolio standard.

Objectives

This project will provide CEC and the Gas R&D Program Managers with information on the impacts that the implementation of a statewide gas energy efficiency plan will have on consumers, the economy and the environment. The study will investigate the following: 1) Estimate natural gas use by 2020 for California; 2) Estimate annual natural gas savings from energy efficiency measures to achieve a 15% (or other agreed figure) reduction in gas use by 2020; 3) Identify and evaluate the cost/benefit ratio for the energy efficiency measures available for the residential, commercial and industrial sectors; 4) Prioritize the energy conservation measures based on cost-based criteria and energy saved; 5) Optimize a mix of energy efficiency measures for each sector; 6) Evaluate annual investments in energy efficiency measures (by sector) through 2020; 7) Identify benefits to gas customers, the economy (output, income, and job creation), and the environment benefits associated with the energy efficiency measures.

Budget

2005: \$150,000

2006:

Other:

Comments

The principal investigator (PI) will work closely with the gas program managers in the development and evaluation of a statewide energy efficiency scenario for the California Gas R&D program. The PI will commit 1 to 2 weeks per month of time in Sacramento to facilitate the close interaction with the project managers. Engaging the appropriate staff (program/ & project managers responsible for the major R&D areas) and stakeholders early in the process and utilizing their input while developing the targets for the gas energy efficiency plan will help ensure CEC's "ownership" of the project and the support of the CEC staff in its implementation.

Project Concept #57: Catastrophic Earthquake Risk Analysis and Remediation

Stuart Nishenko and Yousef Bozorgnia

Description

Insuring a robust and reliable natural gas infrastructure in California following the occurrence of a catastrophic earthquake requires a risk management approach that addresses the threats to the utility's natural gas transmission and distribution system, the customer, and the mitigations to reduce those threats to an acceptable level of risk. The principal earthquake related threats to utility gas systems include fault rupture and ground failure (either from landsliding or liquefaction). Basic scientific and engineering research to characterize and remediate these seismic hazards provides the technical foundation for informed policy decisions and the development of credible industry guidelines and practices.

Benefits

There are no identified competitive benefits of this research; on the contrary, there is on-going interest in co-funding cooperative efforts among the utility, building, and transportation agencies in California to improve earthquake performance. The implementation of research results by both the utilities and the customers contributes to the goals of public safety as well as local and state economic resilience by minimizing the costs and impacts to business and the residential sector associated with utility disruptions after major earthquakes and other natural disasters.

Objectives

Research objectives are divided into three separate but interrelated areas – Seismic Threat Characterization, Seismic Threat Remediation, and Pre- and Post-Event Evaluation. Seismic Threat Characterization: • Surface Fault Rupture Models – develop consistent procedures to evaluate fault displacements. • Areal Prediction of Landsliding and Liquefaction– develop methodology to probabilistically evaluate ground deformations before (planning) and after (response) significant earthquakes. Seismic Threat Remediation: • Cost-Effective Strategies for Mitigating Ground Deformation due to earthquakes. Pre and Post-Event Evaluation • performance and reliability of gas shut off valves, identify gas related incidents, and the overall performance of the gas system during earthquakes.

Budget

2005: \$750,000

2006: \$750,000

Other:

Comments

Caltrans, through the Pacific Earthquake Engineering Research Center (PEER), has committed \$1.2 million over the next 5 years to conduct common interest research on earthquake ground motion and ground deformation. Opportunities for additional coordination with the Pipeline Research Council International, Inc. (PRCI) and the DOT Office of Pipeline Safety have also been identified.

Project Concept #58: The new compact external combustion engine

Dr. Sergey N. Kivalov

Description

<p>We are going to research and develop a prototype of a new compact and nonexpensive external combustion engine with a looped phase transfer liquid - vapor working cycle. The thermodynamic process we are going to use is based on the Rankine cycle. The final efficiency of the two stage process we propose will be higher than the real Stirling engine efficiency with the same working conditions.</p> <p> The developed external combustion engine will be compact and will be able to be used with low potential heat sources or solar concentrative dishes to provide customers with mechanical work and/or electricity. </p>

Benefits

<p> Customers will receive the high efficient engine combined with an electricity generator. </p> <p> •For external combustion, the developed engine will be able to produce both mechanical work and electricity for customer by using variety of heat sources (from coal to biofuel).
 •With using of solar energy concentrators, the proposed technology becomes environmentally friendly and non-expensive source of both mechanical and electrical energy from sun.
 •The estimated cost of the developed engine is not more than \$1.0 per Wp. This allows to produce electricity from solar energy and low potential fuel sources with the cost cheaper than \$0.1 per kWh that is comparable to the regular electrical cost. </p>

Objectives

<p>We start with existing schemes of Rankine cycle and Stirling engine. We plan to investigate a new cycle and schemes of compact engines, which allow us to remove the high pressure boiler equipment and incapsulate its features into the engines. </p> <p> The following specific steps in a three-year project are proposed:
 1.Researching and investigating properties of the proposed thermodynamical cycle and selecting key parameters to increase its efficiency.
 2.Designing the shemes of the non-boiler external combustion engine working with the new cycle. Chosing an appropriate heat carrier.
 3.Developing the mathematical model of the cycle - engine pair to simulate and improve working characteristics.
 4.Developing the constructive documentation for the small scale prototype of the engine.
 5.Developing the prototypes for working with the solar concentrator and with the low potential fuel.
 6.Testing the prototypes of the engines with different types of fuels and with the solar dish.
 7.Providing a summary report for the first two years and a final report for the third year.
 8.Outlining a timeline and a proposal for the design and construction of a pilot plant. </p> <p> Total project duration is 3 years. The estimated funding necessary for this project is about \$3,000,000. </p>

Budget

2005: \$1,000,000

2006: \$1,000,000

Other: \$1,000,000

Comments

Project Concept #59: Conic Threaded Fasteners

Dale E. Van Cor

Description

Build and test tooling prototypes that can produce different size threaded fasteners that can work on lathes or milling machines common to machine shops. The thread cutting tool needs to rotate on its axis relative its position on the cone shape. The tooling has to make hybrid fasteners as well. These are a combination of standard and conic threaded components. A conic threaded seat at the top of bolt can provide the sealing capabilities to the entire bolt.

Benefits

The conic thread is inherently self sealing. This keeps high pressure in and corrosives or contaminants out. This is due to the high surface mating of the conic thread. A 95% plus surface mating should be easily achieved while 50% would work. The conic thread is inherently easier to install: the cone shape allows deep insertion and the final 3-5% of rotation locks it in. The conic thread is a strong fastener: With the high degree of matching surfaces, the coefficient of friction is applied over the largest amount of surface. It will be more difficult to remove than convention nuts and bolts. This technology has a wide number of applications outside of natural gas. It can be used in machinery or infrastructure of buildings and bridges.

Objectives

To develop a new technology that has a wide range of applications that includes natural gas. The self sealing aspects of the conic threads means a longer lasting fastener system can be resist environmental corrosion. This lengthens the life of the structure or machinery it is used in. That in turn reduces the waste stream of product or structure replacement. Because the mating surfaces of the conic thread is 95% plus and the standard thread is around 35%, the fastener can be made smaller or shorter than a corresponding standard fastener, which in turn also reduces the amount of waste stream.

Budget

2005: \$100,000

2006: \$80,000

Other:

Comments

The conic thread is a mathematical construct develop from the conic gear (see www.vancortransmission.com). The conic thread looks like a tapered thread. It is not. The conic thread maintains its perpendicular distance to the thread. The thread angle changes with the change in diameter. A tapered thread is based on the axis of rotation. The conic thread can morph into other shapes across the length of the thread. This is achieved local to the cross section of the thread. That means that it has to have room for a smaller, but different shape to pass through. In other words, if it can fit, it can be done. A likely example is a diminishing thread. These technicalities expand its uses.

Project Concept #60: Low-Cost Sensors for Efficiency Optimization of Large Gas Burners

David Littlejohn and Donald Lucas

Description

Much of the natural gas consumed in the State supplies large burners with control systems. The burners used in these systems often do not operate at optimum efficiency because of concerns related to pollutant emissions. In some cases, these systems may generate significant amounts of air pollutants in spite of burner controls. This issue is particularly important in multi-burner systems. Low-cost sensors can be developed that will be incorporated into burner assemblies and interfaced to the burner controls. The sensors will monitor the relevant flame properties and allow the burner to operate at high efficiency while maintaining emissions within regulatory limits.

Benefits

Demand for natural gas has been increasing in recent years because it is generally a cleaner fuel than liquid hydrocarbons. Improving the efficiency of heating systems will ease the pressure on constricted natural gas supplies within California. It is possible that a several percent efficiency improvement in heating systems can be achieved by optimizing burner operation. This will moderate natural gas prices for California consumers. The optimization of process heaters will also reduce industrial emissions of NO_x and CO by as much as several hundred tons per year, and will benefit consumers by reducing air pollution levels in California.

Objectives

One of the key objectives of this proposed project is to develop sensors that will allow higher operating efficiencies in natural gas-fired burner systems used in industrial, residential, and commercial systems in California. The improved operating efficiencies will reduce demand for natural gas and help avoid increases in natural gas prices for California consumers. Another key objective is to reduce pollutant emissions from these facilities. Reduced emissions will improve air quality in California and provide a more healthful environment.

Budget

2005: \$200,000

2006: \$200,000

Other: \$100,000

Comments

Project Concept #61: Conic Pipe Threads

Dale E. Van Cor

Description

Build and test conic threaded tap and die systems for making conic threads in pipes and various connecting components in the field. The cutting system has to be portable and make left and right handed threads. The initial tool would be an AC motorized unit. More portable DC would be developed after proof of concept.

Benefits

The conic thread is inherently self sealing so high pressure applications can be achieved without sealants. Ease of installation: locking force on the last 3-5% of rotation. The cone shape allows deep insertion before contacting mating threads. There a few rotations and they are easy because of the diminishing cavity between the threads. Inherently precise, can not be "fudged". Pipe cutting and fitting has to be more precise. Because of the high surface contact, the materials coefficient of friction is applied over the largest area possible. This makes the connection strong and harder to remove then conventional threads. This technology can be applied across other industries.

Objectives

The most important objectives are a pipe connecting system that is inherently safe and easy to install. The tools developed have to be easy to calibrate and easy to use. Mathematically the conic thread has the greatest amount of matching surface contact possible thus making it the tightest seal possible without any sealants. This can be achieved with low tolerances because a mating 50% over the length of the thread would handle thousands of pounds of pressure, so a 90% plus tolerance would be acceptable.

Budget

2005: \$300,000

2006: \$100,000

Other:

Comments

The conic thread is a mathematical construct develop from the conic gear (see www.vancortransmission.com). The conic thread looks like a tapered thread. It is not. The conic thread maintains its perpendicular distance to the tangent of the thread. The thread angle changes with the change in diameter. A tapered thread is based on the axis of rotation.

Project Concept #62: Conic Threaded Valve

Dale E. Van Cor

Description

Develop a valve system based on conic threads. A conic thread has a cavity between its mating surfaces when apart. As the threads are screwed in, the cavity is reduced to zero with the final turn. This process creates a tight seal. The project is to first build and test a series of these valves; Second, make the specialize machinery that can mill the molds of the valve components; and third to make the machining process for the finishing of the valve components.

Benefits

Simple in design: Two threaded components that are both the controls and the valve seats. Quite: The gas or fluid is spinning in an organized vortex when exiting the valve which is less turbulent then regular valves. Long life: The design of the valve can be designed so wear can be compensated for by literally screwing the threads in deeper. Versatility in design parameters: The threads can morph into different shapes from one end of the valve to the other. This allows an expansion of the cavity cross section for high to low pressure applications or for cryogenic conversion from liquid to a gas. This technology can be applied to other industries.

Objectives

The project will establish the requirements and make prototypes of two types of machinery: Equipment that can mill out the molds for the valve components; and machinery the can finish these molded components.

Budget

2005: \$400,000

2006: \$100,000

Other:

Comments

Conic threads are a mathematical construct based on the development of the conic gear (see www.vancortransmission.com). They are difficult to machine requiring at least a 5-axis milling machine for a square thread. Specially designed milling tools can be made for making molds of valve components. These would be simpler and cheaper then a 5-axis machine. Finishing the molded valve components would require another specially designed milling machine that would shave off the last 50 thousands of an inch of the mating surfaces. There would be two types, internal thread and external thread. They would have a cutting tool that rotates as it shaves the threads.

Project Concept #63: Efficient and Ultra Low Emissions Supplemental Firing Burner for CHP

Dr. John T. Kelly

Description

Combined Heat and Power (CHP) systems can reduce gas use, air pollution and overall costs, per unit of delivered energy. However, in many applications, the electric power and heat needs are not compatible. Through the use of supplementary firing, the electric and heating needs of a site can be more easily balanced, broadening the applicability of CHP systems, and giving them greater overall impact on fuel use reductions. However, ultralow emissions duct burners are required to achieve this flexibility, without negatively impacting the environment. The project goal is to further develop and test an ultralow NOx duct burner, which has shown the potential to achieve 2 ppm NOx at 15% O₂, in small-scale laboratory feasibility tests.

Benefits

As is well known, CHP yields significant savings, in the range of 40%, in fuel use, air pollution and overall costs, per useful energy delivered. Current ultralow NOx gas turbines can produce these benefits, while controlling emissions to low levels. However, without supplemental firing, CHP applications are unnecessarily limited. Using conventional duct burners to gain flexibility, drives up emissions. By utilizing the proposed ultralow NOx duct burners, the benefits of CHP can be broadened to more markets, without negatively impacting the environment. Assuming 40% of the 8600MW of new CHP generating capacity would be impacted, the total cost saved, by not having to apply a post combustion NOx control system, would be \$126 million/year. Annual fuel savings would be approximately 58 billion CF of gas, valued at \$381 million.

Objectives

The key objective will be to develop and test, under actual gas turbine based CHP conditions, a prototype version of the ultralow NOx duct burner, which can achieve 2 ppm NOx at 15% O₂, while meeting all other required emissions, flame stability and heat transfer requirements.

Budget

2005: \$400,000

2006: \$300,000

Other:

Comments

This work would leverage earlier feasibility test work supported by CEC. Also, the development and test work would utilize gas turbine equipment available at the proposer's test site.

Project Concept #64: High Efficiency Gas Fired Radiant Burner

John T. Kelly

Description

In many applications, radiant heating is beneficial, particularly when the atmosphere on the object being heated must be controlled. Radiant heating is usually accomplished by electrical heating elements. Given the efficiency of electricity production and distribution, this ultimately wastes gas, and is costly. An efficient gas-fired closed radiant burner, which recovers waste heat, is proposed. Implementation of this burner will reduce ultimate gas use and costs, as well as control emissions to needed levels.

Benefits

Present electric radiant heaters waste gas at the electric power plant, and are costly. Also, gas-fired radiant burners waste gas, by not recovering heat. By implementing the proposed highly efficient radiant burner, gas use and fuel costs will be reduced by 53%, while simultaneously controlling emissions to the needed level.

Objectives

The objective of the effort, is to develop and test, in an environment consistent with an important application of interest, a prototype radiant burner, which will save gas use and costs, while controlling emissions to the needed level.

Budget

2005: \$400,000

2006: \$200,000

Other:

Comments

The proposed work will leverage prior work on radiant burners, for commercial cooking applications.

Project Concept #65: High Efficiency Gas Engine Driven Heat Pump

Dr. John T. Kelly

Description

Electric-based air conditioning puts excessive loads on the grid, during peak summertime operation. Heat activated cooling systems would reduce electric power needs, but are expensive, and still require electric power to operate fans and controls. A small, highly efficient and quiet engine is proposed, to directly drive an efficient heat pump refrigerant compressor, and provide electric power for heat pump, ancillary equipment, as well as export power needs. By implementing this direct drive approach, efficiency is high, current inrush problems are avoided, summertime grid loads are reduced and gas is saved, relative to that which would be consumed at the power plant. The goal of the project would be to demonstrate a prototype of the engine driven heat pump system.

Benefits

To avoid expensive electric grid failures, peak summertime loads must be reduced. By implementing gas engine direct driven heat pumps, electricity demand will be reduced during peak electric load periods. Also, in contrast to heat activated cooling systems, this approach will cover all electric power needs, as well as provide the opportunity for export power. Also, because low emissions technology is incorporated into the design, emissions are controlled to the needed levels.

Objectives

The objective of the effort, is to develop and test a prototype gas fueled direct driven heat pump, which will save gas, decrease grid loads during summer peaks, reduce costs, and control emissions to needed levels. This unit could be applied to both residential and commercial needs.

Budget

2005: \$400,000

2006: \$400,000

Other: \$400,000

Comments

This effort leverages innovative engine and heat exchanger developments, supported under earlier Altex efforts.

Project Concept #66: High Air Preheat Low Emissions Heat Recovery Burner

Dr. John T. Kelly

Description

Many industrial processes produce high temperature exhaust streams, which result in high heat loss, and excessive gas use. Recovering the waste heat, by air preheating, reduces gas use, but increases costs and emissions. A low emissions burner that compactly recovers heat is proposed, which will reduce gas use and costs, while meeting all emissions requirements. The goal of the project will be to develop and test a prototype of this burner, and quantify the gas, cost and emissions benefits.

Benefits

By implementing this burner in processes with exit temperatures from 800C to 1300C, gas fuel savings, from 30% to 50%, could be realized. This directly translates to cost savings. Furthermore, these gas use and cost benefits are achieved, while maintaining emissions, within the regulated limits, and at low cost.

Objectives

The key objective of the effort, is to develop and test, at modest scale, a prototype of the integrated heat recovery, low emissions burner, in an industrial process furnace. This burner will use a compact and low cost heat exchanger innovation, as well as a novel emissions control technology.

Budget

2005: \$400,000

2006: \$200,000

Other:

Comments

The proposed burner technology leverages high air preheat, low NOx burner and compact heat exchanger technologies, developed under prior efforts.

Project Concept #67: Low NOx Waterheater Burner

Dr. John T. Kelly

Description

Water heaters are unpowered and very low in cost. Typical reduced NOx burner technologies require power, and are expensive, relative to water heater burners. An innovative burner technology is proposed, which requires no power, has an incremental cost of less than \$2.00, and can be easily incorporated into existing water heater designs.

Benefits

By introducing this innovative and low cost burner, conventional water heater NOx emissions would be reduced, by up to 75%, at an incremental unit cost of less than \$2.00. Given the 9 million water heaters in use in California, this could reduce NOx emissions by 1071 tons/year, at a cost of \$840/ton NOx removed.

Objectives

The objective of the proposed effort, is to develop and test, in a typical water heater, the innovative low NOx water heater burner, to show that it can reduce NOx to 10 g/J, at acceptable flame, and other emission conditions.

Budget

2005: \$200,000

2006: \$100,000

Other:

Comments

This innovative burner technology leverages prior water heater burner technology work, which produced a 20Ng/J burner, at an incremental cost of less than \$1.00. This prior work experience will be usefully applied, under the proposed project.

Project Concept #68: Modeling Natural Gas Systems in Various Power Generation Scenarios

Paul Bautista

Description

The reliability of older gas-fired power plants, the pending retirement of a significant number of aging power plants, and the requirements of new gas-fired power plants present operational and infrastructure concerns for natural gas delivery systems. The reliability and supply contribution of new plants depends upon a gas delivery system that is responsive to the unique deliverability needs of new gas turbine based power systems. A critical, under-analyzed design aspect of adding this capacity is ensuring that the gas system is fully able to provide the fuel supply requirements under all anticipated transient conditions. This project will use transient pipeline modeling methods and scenario analyses to analyze system capabilities to handle variations in load from new gas-fired capacity additions/replacement and identify the needs for additional operational procedures or facilities.

Benefits

This project will improve the flexibility and reliability of the natural gas delivery system in meeting the anticipated growth and changes in California's gas-fired power generation systems. The approach allows for a common framework to enable collaboration among the various gas industry interests and the public (through the CEC) to address the current and projected operational issues of California. Public interest benefits come from maintaining and improving the reliability and robustness of the integrated natural gas delivery and power systems in California through the future period of added demand for gas-fired power generation.

Objectives

The project will be developed and executed in consultation with industry advisors and will provide insights, guidance and techniques to better understand the unique factors that affect California's gas systems and power generation mix. The primary objective is to determine the system's ability to satisfy such variable load requirements. Secondly, results of the project will also identify needs for specific operational practices or new facilities. A third objective is to provide analysts and asset management personnel at the California gas companies with guidance and techniques to model and address the unique site specific factors that affect their systems and customers.

Budget

2005: \$150,000

2006: \$100,000

Other:

Comments

The approach utilizes hypothetical models that are representative of the loads, supplies, physical constraints, pressures, sizes, and storage capabilities of the California gas systems. A set of different pipeline/power generation operational scenarios will be analyzed. Although the simulations will be hypothetical, they will be based upon realistic models developed in consultation with industry advisors. The real models of the actual systems are proprietary and confidential to the gas companies.

Project Concept #69: Unitary LiBr Absorption Heating and Cooling System

Neil Leslie

Description

This project will develop a unitary Lithium Bromide absorption heating and cooling system with 60,000 to 120,000 Btuh heating capacity and 5 to 10 tons cooling capacity specifically designed for the California market. The appliance leverages LiBr chiller technology commercially available in Asian markets to provide a highly reliable heating and cooling product with seasonal energy efficiency greater than 1.2 heating COP and 1.0 cooling COP.

Benefits

Conventional heating systems today are at or near their theoretical limits for efficiency. New breakthrough technology is required to achieve significant efficiency increases and quantum reduction in greenhouse gases. The proposed absorption heating and cooling system is 25% more efficient than a current state-of-the-art condensing gas furnace, and 50 % more efficient than a typical gas furnace. By providing efficient air conditioning operation, this system will reduce California's peak electric demand during the cooling season. Estimated incremental annual energy benefits are 0.3 BCF heating gas savings, \$60 Million consumer savings, and 200 MW deferred peak electric load. Projected incremental annual environmental benefits are 35 Million lbs CO₂ reduction and 59,000 lbs NO_x reduction. Mature sales projections range between 15,000 and 25,000 units per year.

Objectives

To leverage advances in current LiBr chiller/heater designs to develop a 1.2 heating COP and 1.0 cooling COP product for light commercial and residential applications in conjunction with a major manufacturer of LiBr cooling systems. The initial phase will focus on preliminary design, construction, and bench testing of one laboratory prototype system. Based on successful laboratory results, the next phases, co-funded by the gas industry, will finalize system design, prototype development, laboratory and field-testing, certification, and commercialization.

Budget

2005: \$1,000,000

2006: \$1,400,000

Other:

Comments

Budget includes partners and cofunding

Project Concept #70: Gas Fired Agricultural/Industrial Dryer Heat Pump

Donald C. Erickson

Description

A highly efficient drying concept is proposed using an innovative gas fired absorption heat pump. It heat pumps reject heat from process stream; ambient air; or from process refrigeration to achieve 60% higher efficiency than existing technology. The heat pump uses a novel ammonia-water single effect cycle, common materials of construction and commercially available components. Delivery of 180oF temperature (typical in drying applications) has been developed in previous research, but this concept has never been applied to drying. Research needs to be performed to optimize the exchange between the drying air and the heat delivery components of the heat pump, and also between the exhaust air and the cold section of the heat pump.

Benefits

California has annual agricultural revenues over \$27 billion. Post harvest drying represents substantial natural gas use and associated environmental emissions. The proposed gas fired dryer is 60% more efficient than existing technology. It will reduce operating cost, improve product quality (controlled atmosphere drying); reduce moisture, particulate, and VOC emissions; and minimize odor.

Objectives

The main objectives are 1) design a robust system; 2) demonstrate the technology in key applications; and 3) quantify benefits and market. The technology will be appropriately designed and demonstrated at several replicable target applications. Quantifiable benefits will be determined in terms of gas savings, consumer benefit, industry benefit, potential state-wide gas savings, and environmental quality improvement.

Budget

2005: \$500,000

2006: \$1,000,000

Other: \$500,000

Comments

Key applications are California's extensive food processing industry, including dairy (cheese making, powdered and condensed milk manufacture); dried fruit (raisins, prunes, apricots); and vegetables. Other key industrial applications include lumber drying and textiles drying. Across the state, it is estimated that 4 to 5% of all natural gas is used for industrial drying applications. Implementation of this technology will result in a net statewide gross reduction in natural gas consumption of 2.4 to 3% below current levels. Reduced operating costs for food processors, lumber dryers, and textile plants will strengthen the viability of these industries as they compete with lower international labor rates, and cheaper energy rates in neighboring states. The University of California – Davis operates the California Institute of Food and Agriculture Research, and is a leader in food drying and processing. The project would draw on the expertise of CIFAR for this development.

Project Concept #71: Solar Thermal Energy Alternative to Natural Gas

Charles L. Bennett

Description

Using several tons of inexpensive material (porous gravel) for high temperature (700 Celsius) thermal energy storage, solar heat collected during the summer may be used to provide thermal energy throughout the year, thereby enabling the abundant solar heat of summer to be used for the peak heating demand in winter. The stored heat is hot enough that it may be used directly to heat air for cooking, to heat water, to provide industrial process heat, or to efficiently generate electricity, as demand requires. Long term thermal storage furthermore assures the availability of solar thermal power during periods of extended solar obscuration.

Benefits

New technology for the solar receiver, the heat transport, and the heat engine promise to make the solar thermal energy alternative to natural gas less expensive than natural gas, and thus to enable substantial reduction in the consumption of natural gas. Along with the economic benefit of less expensive solar thermal power, displacement of natural gas combustion with solar thermal power reduces the emissions of natural gas combustion products. With the creation of an economically profitable solar thermal power industry, without the need for government subsidies to be profitable, market forces would tend to feed on themselves, and greatly expand the market penetration of solar thermal energy.

Objectives

The primary objective is to demonstrate, in the near term, that high temperature solar thermal energy offers an economical, safe and practical alternative for essentially all of the heating applications of natural gas. A follow up objective is to lay the foundation for commercialization of solar thermal power for both heating and electric power generation. A third objective is to quantify possible unanticipated environmental impacts, or potential hazards associated with high temperature solar thermal energy storage and power generation.

Budget

2005: \$500,000

2006: \$500,000

Other: \$250,000

Comments

Recent inventions at LLNL promise to substantially increase the efficiency and lower the cost of solar thermal energy, and are the foundation for this project suggestion.

Project Concept #72: Climate change impacts on energy generation and

Philip B. Duffy

Description

Climate change will affect energy demand, primarily but not exclusively through more frequent and more extreme hot-weather events. These affect both mean and peak energy demand. Energy production will be affected through changes in river flows (affecting hydropower), changes in wind patterns (affecting wind-power generation) and changes in cloudiness (affecting solar power generation). Climate change will also affect our ability to grow biomass energy sources. Taken together, these changes in energy generation and demand could significantly affect the State's ability to meet its future energy needs. This is especially important in light of mandates to increase use of renewable energy sources, as these will be most strongly affected by climate change. Improved understanding of these impacts is therefore needed to plan the State's energy future.

Benefits

Better understanding of future demands for energy, and of our ability to meet those demands by generating energy from wind, sunlight, biomass, and flowing water (i.e. hydropower). This will help the State to understand and to meet its future energy needs. This is needed particularly for renewable energy sources, whose increased use is mandated and in any case is needed to minimize climate change and other environmental problems.

Objectives

We will produce a set of projections describing how climate change will affect energy generation and demand in the State. These will be made using LLNL's unique high-resolution global- and regional- domain climate models. These models have been shown to be better than other models at simulating spatial and temporal extremes of climate, which strongly affect energy demand and production. Project results will be made available publicly via the Internet.

Budget

2005: \$350,000

2006: \$350,000

Other: \$350,000

Comments

Project Concept #73: Natural draft Low NOx Burners for Water Heaters and Furnaces

David Littlejohn and Robert Cheng

Description

California air districts are proposing stringent emission limits on residential and commercial water heaters ($\text{NO}_x < 10$ ng per joule). Most low NO_x burners for industrial systems are not adaptable to small systems because fans to supply combustion air would entail high add-on costs. Our goal is to develop and demonstrate natural draft low- NO_x burners that do not need electric fans. The operating principle of these burners will be based on our patented combustion concepts. Burner prototypes suitable for residential and commercial systems will be developed and demonstrated. These burners will be optimized for the next generation water heaters and furnaces with significant reduction in standby energy losses.

Benefits

Residential and commercial water heaters and furnaces are commodity products that cannot afford advanced technologies. For example, water heaters with forced draft low- NO_x burners may cost twice as much as current products. Due to the fact that these appliances contribute significant emissions and waste a large amount of natural gas due to standby losses, simple and cost effective natural draft low NO_x burners will have a large impact on both air quality and efficiency. These new burners can be adapted to appliances without substantial modification, resulting in negligible cost increases. Adaptation of these burners to next generation systems will reduce standby losses and further contribute to energy savings and pollutant loading.

Objectives

We intend to incorporate natural draft operation into low NO_x burners by utilizing natural gas pressure to entrain combustion air. Both the low-swirl burner and ring-stabilizer burner designs have low pressure drops. Forced draft versions have been demonstrated in residential and commercial systems. For natural draft operation, burners with gas injectors optimized for air entrainment will be developed and demonstrated. Development for next generation water heaters with reduced standby energy losses is also planned. The outcome will be burner design guidelines for scalability, reliability, durability, and cost-effectiveness to enable OEMs to adapt appliances capable of meeting emission criteria in ozone non-attainment areas.

Budget

2005: \$200,000

2006: \$200,000

Other:

Comments

Project Concept #74: Nanotechnology Based Sensors

Donald Lucas

Description

New materials based on novel properties of nanoscale materials (<100 nm) can be used to detect a variety of species associated with the combustion of gas phase fuels. These sensors can be used to measure and control the combustion process, as well as measuring fuel properties and emissions. Different properties can be employed, including a variety of spectroscopic characteristics, properties that exploit the extremely high surface to volume ratio and adsorption/binding characteristics, as well as electronic measurements of physical changes such as size, shape, and composition.

Benefits

Since there is often a trade-off between efficiency and pollutant emissions, combustion systems often operate at less than optimal conditions, especially when the fuel stream varies. Better control of the combustion process depends on the sensing of relevant parameters. Improvements in sensing would allow devices to be tuned to maximize their performance while minimizing pollutant emissions.

Objectives

This project could produce new methods to detect important parameters in the combustion process, allowing low-cost devices to be incorporated into consumer appliances as well as commercial and industrial equipment.

Budget

2005: \$250,000

2006: \$250,000

Other:

Comments

Project Concept #75: Ultra-Clean Residential and Commercial Space Heaters

David Littlejohn and Robert Cheng

Description

Current high-end space heaters have high NO_x emissions (about 150 ppm) compared to large industrial systems (15–30 ppm). Combustion technologies developed for large systems are not cost effective for small heaters. Ultra-clean burners developed at LBNL can cost effectively reduce emissions from small heaters. Both designs are adaptable to mass production. They emit less than 9 ppm NO_x and 20 ppm CO, and can improve overall heater efficiencies. The focus of the project will be to adapt these burners to forced air furnaces up to 1 MMBtu/hr and duct heaters up to 3 MMBtu/hr. Due to size variations the heat exchangers, our strategy is to develop engineering guidelines to help equipment manufacturers adapt these burners to fulfill their requirements.

Benefits

Depending on the heating system, implementation of these burners to residential and commercial space heaters is expected to reduce NO_x emissions from 150 ppm to 15 ppm and increase system efficiency by 1 to 3%. This will help to reduce 3000 tons of NO_x emissions per year. (Estimate based on 430 Mth per year usage in California for the targeted space heaters). This project directly addresses issues on reducing emissions without negatively affecting energy efficiency.

Objectives

The deliverables are proven burner design guidelines and engineering rules for manufacturing low-swirl burners and ring-stabilizer burners for heating applications. The metrics are $9 < \text{NO}_x < 15$ ppm, manufacturing cost not to exceed 20% more than current products, operating cost same as current products, utilize existing controls, and improve efficiency by 1 to 3% from current system baselines. We plan to partner with several OEMs of space heating equipment to demonstrate these burners in representative systems. Knowledge gained from these developments will be encapsulated in the guidelines and rules for adaptation to other systems and mass production methods.

Budget

2005: \$200,000

2006: \$200,000

Other:

Comments

Project Concept #76: Low Emission Burners for Secondary Heating

David Littlejohn and Robert Cheng

Description

There are many applications where it is advantageous to recover waste heat from exhaust gas or other hot gas stream. The heat recovery boosts system efficiency and avoids the need for a separate heating system. In some applications, it is beneficial to incorporate secondary heaters (duct burners) upstream of the heat recovery system to recover additional heat and boost overall system efficiency. However, current line burner and duct burner designs have poor emissions and are unsuitable for areas with regulated emissions. There are low emission burner designs that can be adapted to a reduced oxygen environment to provide clean secondary heating.

Benefits

Low emission burners for secondary heating applications will allow a wide variety of industrial and commercial systems to operate at higher efficiency while maintaining emissions within accepted regulatory limits. The improvement in system efficiency will translate into reduced demand for natural gas.

Objectives

We will adapt the low emission burner designs developed at LBNL for secondary heating applications. The burners will be optimized to efficiently operate in hot vitiated air with minimal emissions. Engineering rules for the designs will be developed so the burners can be adapted for a variety of environments where secondary heating can be used, such as combined heat and power and distributed generation systems.

Budget

2005: \$200,000

2006: \$200,000

Other:

Comments

Project Concept #77: Design of an Energy-efficiency Incentive Program

Rupert Kruger and Paul Taylor

Description

The Energy Efficiency program is demonstrated as being the UK's most cost effective way of reducing energy consumption for organisations, with cost less than \$10 per tonne of CO2 saved. The UK, like the US, does not believe in high-tax energy efficiency solutions. Instead it has built, over twenty years, the world's richest "menu" of government-supported energy efficiency incentives. Atkins' experience running the UK energy-efficiency "menu", coupled with our local presence and knowledge, will allow us to select those items best tailored to Californian needs and energy saving potential. The program will include a broad range of part and fully-subsidised support, including Published Advice, Direct Advice through Helpline and Website, Local Consultancy Support, Financial tools, and an 'Energy Technology Register'

Benefits

- Create the structure for effective on-going support for Energy Efficiency
- Draw on Atkins' UK experience of running a cost effective energy-efficiency program, calibrated for California
- Develop innovative tools to allow encouragement through market forces
- Energy Technology Register built through testing new energy-efficient technologies

Objectives

- To identify the Californian business needs from an energy-efficiency program, by sector;
- Production of cost effective energy-efficiency program;
- Design of program impact analysis tools;
- Develop program for testing, listing and promoting new energy efficient technologies;
- Program to ensure utilization of local experts and development of local knowledge;

Budget

2005: \$250,000

2006: \$180,000

Other:

Comments

Project Concept #78: Low-emission Fuel-flexible Burner for Natural Gas and Renewable Fuels

David Littlejohn and Robert Cheng

Description

Renewable resources have the potential to make significant contributions to California

Benefits

Development of fuel-flexible low-emission burners will benefit commercial and industrial customers by increasing their ability to use alternate fuels. These burners will give them a choice to utilize biogas for commercial and industrial heating while maintaining low emissions. The LSB is a low pressure drop design that requires low parasitic energy. Therefore this development also addresses efficiency improvement by reducing emissions without producing an associated efficiency penalty. Biogas has the potential to contribute up to 5% of the natural gas supply for California. Being a renewable resource, it does not contribute to the atmosphere

Objectives

Unlike most burner designs that cannot easily switch between fuels, the design of our low-swirl burner (LSB) can be conveniently adjusted to accommodate a wide range of fuels while maintaining high combustion efficiency, good flame stability and low emissions. The objective of this work is to apply our knowledge of the operating principles of the LSB and the flame properties of biogas and biogas-natural gas blends to design fuel-flexible burners. Prototype burners for commercial and industrial applications will be built and demonstrated to show their ability to maintain flame stability and low emissions despite variation in the fuel compositions and heat contents.

Budget

2005: \$200,000

2006: \$200,000

Other:

Comments

Project Concept #79: An Integrated, Low-CO2 Emission Power Plant for

Daniel Chinn

Description

Proposed technology is a 400MW combined-cycle, gas-fired power plant with 85% lower CO2 emissions. An advanced amine-treating plant removes CO2 from exhaust. Program combines engineering studies, pilot testing of components, and eventual pilot-scale demonstration (1-5 MW). The integrated process has the following elements: 1. Partial flue-gas recycle to the power plant combustor concentrates the CO2 entering the amine plant. 2. Heat integration with the power plant reduces the steam consumption of the amine regenerators. 3. Design using advanced solvents and engineering practices. Work is needed to establish proof-of-concept. Preliminary analysis shows substantially lower CO2-mitigation costs versus conventional technology.

Benefits

If successfully deployed, California will be positioned to be a technology leader in low-CO2 emission power generation using natural gas. In fact, the CCP1 has funded some of the initial (and likely future work) engineering work with companies in California (Bechtel, Nexant, Fluor). A typical 400-MW, gas-fired power plant will emit about 1.3 MM tonne/year CO2. With a \$20/tonne CO2 liability, this amounts to \$26 MM/yr. Reducing the emissions by 85% would result in reducing the CO2 liability by \$22 MM/yr.

Objectives

The funds will be allocated to engineering companies, turbine manufacturers, and solvent providers to do the following: 1. Burner tests to establish the feasibility of flue-gas recycle 2. Engineering design and economic analysis 3. Pilot testing to verify solvent performance in integrated scheme. Success for the above objectives would bring the technology closer to commercialization. If commercialized, the integrated process works directly with California's goal of efficient power generation using natural gas while reducing CO2 emissions. Besides California, other government entities have expressed interest in seeing a pilot-scale demonstration: European Union, U.S. DOE, and Norway.

Budget

2005: \$1,000,000

2006: \$1,000,000

Other:

Comments

The CO2 Capture Project, Phase 2 (CCP2) is a 3-year (2005-2007), partnership of eight integrated energy companies: BP (operator), Chevron, ConocoPhillips, Hydro, ENI, Shell, Petrobras, and Suncor, and three governments: US DOE, EU, and Norway that develops emerging technologies to reduce the cost of CO2 capture from large point sources and to mitigate the risks of geologic storage of CO2. CCP2 has some prior and ongoing work for the "integrated power plant," and will welcome the opportunity to work with the California Energy Commission's R&D program in furthering its development.

Project Concept #80: California Residential IAQ Study Update

A.L. Wilson

Description

During the winter of 1991-2, SoCalGas, PG&E, and SDG&E together with GRI conducted the "California Residential Indoor Air Quality Study". It was primarily concerned with CO and air exchange rates. The 1991-2 study built upon data from an earlier study in 1984 for nitrogen dioxide and air exchange rates in southern California. New homes have been built tighter since those studies; perhaps 4 to 6 times tighter than older homes. Also, there has been a large effort to weather strip older homes. The goal is to update the 1984 and 1991 studies for indoor pollutants, air exchange rates and proper gas appliance operation.

Benefits

The primary energy related benefit is the quantification of the air exchange rates as a function of the age of the home and other housing characteristics including furnace type, cooking type, square footage, construction type and number of stories. The primary environmental related benefit is the quantification of the indoor and outdoor concentrations of combustion products including carbon monoxide, nitrogen dioxide and other pollutants. This basic research effort will provide data beneficial to regulatory agencies and gas utilities in their efforts to reduce indoor pollution, increase energy efficiency of residencies and assess the impact of new gas supplies on appliance operation.

Objectives

This project will establish the current impacts of gas appliance usage and energy efficiency measures on the indoor pollutants statewide. It will also provide a statistically valid sample of actual air exchange rates in California residencies (at least 1000 homes) . All gas appliances will be thoroughly inspected after the indoor measurements are taken. These inspections will provide a comprehensive database of the appliances that were installed and operating properly plus a statistically valid estimate of the percentage of specific malfunctions and installation issues. Data will also be gathered on occupant behaviors, such as heating the home with the gas stove, which can affect indoor concentration.

Budget

2005: \$1,000,000

2006: \$1,000,000

Other: \$500,000

Comments

It is anticipated that SoCalGas, PG&E, and SDG&E will provide trained utility service technicians to inspect the appliances following similar protocols they used in the 1991-2 study. By using full-time utility staff we were able to gather accurate data on the status of the gas appliances and was thus able to correlate that data with indoor pollution.

Project Concept #81: Repowering of California Utility Boiler Plants

Ashok Rao

Description

A study is proposed to evaluate various repowering options by the addition of gas turbines in existing boiler plants to assess the improvement in efficiency and reduction in the cost of generating power and environmental signature. Two types of repowering can be incorporated in an existing plant: (1) installing a gas turbine and utilizing its exhaust as combustion air to the boiler while the boiler continues to operate on natural gas (WINDBOX REPOWERING) and (2) retiring the existing boiler and converting the facility to an unfired combined cycle by the installation of gas turbine(s) and utilizing the existing steam turbine and BOP equipment (COMBINED CYCLE REPOWERING). Within the first concept, a number of options are available: either to cool the gas turbine exhaust to the temperature acceptable by the existing boiler windbox by generating additional steam or preheating boiler feed water, or to upgrade the windbox and duct the hot gas turbine exhaust directly to it. The size and type of gas turbine (pressure ratio) dictate the configuration for this type of repowering. This type of repowering has the advantage of minimizing the initial investment cost, minimizing the downtime for the existing power plant while the capacity addition realized is limited as compared to the other option consisting of converting the existing facility to an unfired combined cycle. Significant portion of the NOx present in the gas turbine exhaust is expected to be destroyed in the boiler. On the other hand, the thermal efficiency of the unfired combined cycle plant will be significantly higher.

Benefits

Many of California

Objectives

For a selected number of boiler plant sizes / scenarios, the study will evaluate the various repowering options in order to quantify the improvement in thermal performance and environmental signature that can be achieved, rough order of magnitude capital expenditure requirements, and recommend the most suitable repowering option for a given boiler plant size / scenario. An assessment of the re-use of existing equipment will be made as well as the existing power plant downtime required for implementing the repowering options. The quantitative impact of utilizing dry cooling towers in order to conserve water or minimize thermal pollution will also be made. For the Windbox repowering option, the applicability of the recently introduced GE aero derivative intercooled gas turbine (LMS100) will be made where the intercooler heat may be utilized for boiler feed water preheating. Its very high pressure ratio results in lowering its exhaust temperature as compared to heavy frame gas turbines, such that its exhaust may be supplied directly to the boiler windbox while minimizing the modifications to the windbox.

Budget

2005: \$190,000

2006: \$190,000

Other:

Comments

Project Concept #82: LNG Terminal Hydrogen Production/Liquefaction

Charles Powars

Description

Hydrogen use as a fuel is a key California and Federal strategy for reducing imported petroleum dependence, improving air quality, and addressing global warming. Advanced distributed hydrogen production technologies are being researched, but there are substantial barriers to success. Centralized hydrogen production and distribution by steam methane reforming (SMR) and liquefaction are proven technologies, but the energy required for liquefaction (30-40% of hydrogens heating value) is usually cited as a serious issue. At the same time, a number of LNG import terminal projects are planned for California and the northwest coast of Mexico. Integration of a hydrogen-production SMR and liquefaction plant with an LNG import terminal would provide the technical, economic, and societal benefits summarized in the Benefits section.

Benefits

The energy security and environmental benefits of using hydrogen as a transportation and stationary facility fuel are well established. But the technical barriers to economical realization of these benefits are substantial. Integration of proven large-scale SMR production and liquefaction technology with an LNG import terminal would provide approximately 60% of the needed liquefaction energy at no cost. This would also eliminate NG transportation costs and provide other benefits involving siting, permitting, and operating costs. Integration with relatively popular hydrogen economy plans may also mitigate public objections to LNG import terminal projects.

Objectives

The overall objective of this research is to assess the technical feasibility and potential benefits of integrating hydrogen production and liquefaction with an LNG import terminal. LNG terminal designs with land-based and offshore revaporization will be considered. Technical issues will be identified, and the relative economics (compared with other LNG vaporizer integration strategies and other hydrogen production options) will be quantified.

Budget

2005: \$75,000

2006: \$25,000

Other:

Comments

Project Concept #83: LNG Retrofit system for Diesel to LNG Lean Burn System

Karl Jacobi

Description

Research and development in the area of retrofit systems utilizing the technology of our existing CARB certified, (CARB Executive Order B-51), Cummins L10G Lean burn system and apply to the most popular Class 8 truck engines that are in use on our roads today, and through the past decade. Retrofit system will be designed to take existing diesel engines which have NOx emission level range of 4, 5, or 6 g/bhp-hr, Particulate Matter emission level range of .60 to .10 g/bhp-hr and convert to run on LNG (natural gas) and have tailpipe emissions equal to or better than 2007 levels.

Benefits

The LNG retrofit will provide a means to convert existing diesel engines to 2007 emission levels or beyond without replacing vehicles, and while being highly cost effective in lowering NOx and PM. This will be accomplished by development of LNG retrofit kit for each of the popular class 8 truck engines.

Objectives

Reduce NOx and PM emissions to 2007 levels or beyond, reduce dependence on foreign oil, maintain diesel engine power levels and performance, highly cost effective way to reduce NOx and PM, longer engine life and lower operating costs, lower cost of fuel, cost effective method of upgrading fleets to 2007 emission levels without replacing vehicles.

Budget

2005: \$490,000

2006: \$490,000

Other:

Comments

Currently our retrofit is used on the Cummins L10 engine and in use by Harrison Industries in Ventura, CA. and by GI Rubbish in Simi Valley, CA, funded by Ventura County APCD (Jerry Mason) which has funded 15 units to date. ECO Power Systems has proven technology which can be applied to more diesel engine models. Using our lean burn retrofit on heavy duty class 8 truck engines emissions would be reduced by 1.5 tons/year of NOx and 300 pounds/year of particulate matter! There are 7 engine models we have selected for retrofit development which will cover 90% of trucks on the road today, and through the past decade. The objectives will be complete once the CARB/EPA certifications have been received for each of the seven retrofit systems.

Project Concept #84: National Gas Efficiency Program Conference Co-Sponsorship

James Fay

Description

This project would secure CEC co-sponsorship of a national conference on the topic of natural gas efficiency programs to be held in 2006. The unique aspects of natural gas applications, the natural gas industry and its customers make a conference dedicated solely to the issues surrounding natural gas efficiency programs necessary. Since the higher gas prices of 2000-2001, there has been renewed interest in funding gas efficiency programs. This critical conference will review lessons learned and best practices in the design, evaluation, and implementation of natural gas efficiency programs.

Benefits

California gas efficiency program stakeholders would benefit through a more focused and informed consideration of the many issues in gas efficiency programs. Further, the specific intended result of the conference is to improve the effectiveness of gas efficiency programs, resulting in more cost-effective gas energy savings. Co-sponsorship of this conference will significantly leverage the CEC funds.

Objectives

The objectives of the conference are to present and discuss issues associated with improving the impact and effectiveness of natural gas efficiency programs. It is expected that this conference and its documented results will provide all stakeholders in gas efficiency programs (gas program planners, designers, reviewers and implementers, the gas industry and its regulators) with useful guidance on dealing with unique gas issues.

Budget

2005: \$4,750

2006:

Other:

Comments

Project Concept #85: Advanced Usage of Syn Gas Reactions for Direct Electricity Generation

Dr. Savas Vasileiadis (lead), Dr. Zoe Ziaka

Description

Synthesis Gas coming out of combined Reforming, Gasification with other secondary operations and reactions is a valuable source of electric generation in direct advanced gas fired cycles, including higher efficiency gas turbines. This work will include the design, analysis, modeling, and operation of combined gasification, reforming cycles and side operations, which use liquid slurries of heavier hydrocarbons and solids-carbonaceous rich hydrocarbons. Innovative differentiated designs will be applied with respect to the feedstock-hydrocarbons/fuels used in various degrees, and the reaction/separation equipment and the inner conditions involved. The directive consecutive use of the exit quality syn gas mixture by means of proposed advanced power cycles and flow charts, increases significantly (in Btu measures) the fuel consumption capacity and improves the characteristics of combustion progress within the turbine.

Benefits

Benefits - The use of lower quality liquid and solid hydrocarbon fuels for upgrading and use in direct electric power generation. - The utilization of renewable multiphase type hydrocarbon feedstocks in such direct electricity generation operation. - The effective use of combined gasification-reforming operations for fuel conversion and electric generation; with total final process efficiency improvements. - Cost reduction in total electric generation and fuel usage.

Objectives

Summary of Objectives: - Higher quality synthesis gas generation from lower quality multiphase hydrocarbons/fuels; - Higher efficiency in applied combined electric power generation cycles; - Effective inner process designs for hydrocarbon conversion; - Cost improvements in overall process for electricity generation from liquid and solid hydrocarbons.

Budget

2005: \$115,000

2006: \$100,000

Other: \$80,000

Comments

Responsiveness to CEC Goals: The described work is within the goals of the 2006 PUC and CEC as are described within this program. It agrees with several program objectives (i.e., renewables, advanced generation) as they have been described in the announcement.

Project Concept #86: Dual-output gas turbine engine

Dale E. Van Cor

Description

A feasibility study on a dual output turbine engine: This is two mechanical output shafts, one is the turbine shaft and the other is a drum containing the fixed stator and compressor blades. This drum is designed to rotate in the opposite direction of the rotation of the turbine and have an output shaft as well. Basically it is taking the current fixed outside of the engine turbine and putting it in an opposed orbit around the turbine. This engine would maintain is operational speeds between the fixed blades and the turbine blades. What would be different is the turbine can have different net output speeds. An example would be an operational 7,800 RPMs would be split between 6,000 RPMs Clock Wise (CW) on the turbine shaft and 1,800 RPMs Counter Clock Wise (CCW) on the drum. The different speeds relationships are controlled by a transmission.

Benefits

This increases the range of applications of gas powered turbines and their efficiency. Multiple outputs allows for better optimization. The can be applied to other turbine engines

Objectives

Have an engine that can operate at its peak efficiency with variable output. Turbines are designed to work best at specific parameters. Variable outputs are usually with transmissions outside of the engine. This incorporates the engine components into the power train to achieve better efficiency, and thus less fuel.

Budget

2005: \$200,000

2006:

Other:

Comments

My web site: www.vancortransmission.com has a paper on the Kinetic Storage System. This is about the Torque Amplifier that takes a constant mechanical input and converts it to a constant acceleration of two flywheels in opposite directions. There are two mechanical inputs from an orbiting field coil electric motor/generator. The configuration has two outputs, the armature in one direction and the field coil in the other. This allows a unique "float" where the relationship between the field coil and armature can stay at 1,800 RPMs but the armature could be at 600 CW and the field coil 1,200 CCW, or 800 CW and 1,000 CCW, or any combination that adds up to 1,800. This relationship is controlled by two Van Cor Transmissions (VCTs). I would like to do a feasibility study on a gas turbine engine that would have a turbine spinning in one direction, and the fixed stator and compressor blades inside a drum turning in the opposite direction. The rotational relationship would be controlled by a VCT. The core concept is using two opposed engine outputs to achieve a net variable speed output. The variability would be forwards, dead stop and backwards. The scope of the study would have to include the merits of the VCT(1), VCT2 and VCT5 (see web site). I have been invited to present a paper on the Torque Amplifier at the Electrical Energy Storage Applications and Technologies conference, October 17-19, 2005 in San Francisco.

Project Concept #87: Catalyzed Combustion to improve natural gas

Dr. Brian Ahern & Curtis Firestone (Catalyzed Combustion Associates)
Catalyzed Combustion Associates

Description

Methane is a compact molecule that provides the greatest amount of energy per unit CO₂ of all hydrocarbon fuels. However, nearly 1% of methane is exhausted without reacting and constitutes a significant source of environmental pollution. Catalyzing the combustion with a high concentration of electrons has been shown to enhance the combustion rate. The equipment for conducting catalyzed combustion has been developed and optimized over the past 40 years, but to date it has not been applied to natural gas combustion. Commercial adoption is expected to be easy and low cost.

Benefits

The catalyzed combustion reduces the concentration of unburned hydrocarbons in the exhaust. It also reduces the concentration of NO_x, because the spray equipment employs a fine mist of water droplets that are atomized into droplets with a mean diameter of 40 microns. The water can be generated from exhaust condensation. The same equipment has already demonstrated a 15% increase in combustion efficiency in a commercial diesel engine with a 60% reduction in NO_x and a 90% reduction in particulate matter.

Objectives

Existing electrostatic spray equipment has already been shown to enhance the combustion rate in diesel engines. The same equipment will enable natural gas flames to more completely burn all of the methane in a given flame. Adapting electrostatic spray equipment to the air intake of a burner system is a routine matter and measurement of the exhaust stream will result in a reduction of unburned hydrocarbons. The electrical input is in the ten milliwatt range for flames releasing tens of kilowatts.

Budget

2005: \$100,000

2006: \$150,000

Other:

Comments

Combustion systems routinely employ catalytic systems for reducing harmful emissions. Catalyzing combustion with negatively charged water droplets is a direct method for increasing efficiency while at the same time reducing the emission profile. The benefits of this approach are only realized once the electron concentration exceeds the ion concentration in the flame. The electron concentration must exceed 10^{12} electrons/cm³ in order to \

Project Concept #88: Cool Flame Methane Reformation

Professor Howard Pearlman

Description

Efficient, less expensive methods for hydrogen gas production are needed before hydrogen replaces, or supplements petroleum, on a large-scale in the transportation sector and in fuel cells. Cool flame methane partial oxidation is a new, non-catalytic technique that is less costly and potentially more efficient than existing hydrogen generation methods including catalytic partial oxidation or steam reformation. Cool flame partial oxidation exploits the low-temperature chemistry of methane in its cool flame regime (750-850K). Hydrogen conversion efficiencies in excess of 75% can be achieved and depend on the equivalence ratio, the pressure, the inlet gas temperature, and the reactor heat loss.

Benefits

Cool flame methane reformation is a less expensive and a potentially equally efficient hydrogen generation method, compared with existing techniques such as catalytic partial oxidation and steam reformation. Without the need for expensive catalysts, costs decrease and problems including catalyst poisoning (owed to CO and S compounds) are no longer relevant. The end-result will be clean burning hydrogen power vehicles and the hydrogen used will be generated from methane in a cost-effective, efficient way.

Objectives

Converting methane to hydrogen in its cool flame regime is virtually unexplored. The objectives are to: 1. Compute the hydrogen concentrations that can be achieved using detailed chemical kinetic models, 2. Measure the hydrogen concentration in a stirred tank reactor, 3. Determine the optimal reactor parameters for maximum hydrogen production.

Budget

2005: \$134,215

2006: \$92,641

Other:

Comments

Project Budget (Draft): The proposed research will be conducted in the Frederic Hess Engineering Research laboratory at Drexel University, which contains 33,000 square feet of assignable space. Some instrumentation, imaging equipment, data acquisition, gas mass flow controllers and a gas chromatograph are available. A furnace, quartz reactor, gas sampling probe(s), gas plumbing and computer analyses are needed. Funding for this equipment, an annual software license for CHEMKIN software, personnel support and graduate student tuition for two academic years is requested. Contact Information: Howard Pearlman Associate Professor Drexel University, MEM Dept, 3141 Chestnut Street, Philadelphia, PA 19104 215-895-1373, 215-895-1478 (FAX)

Project Concept #89: Low-Cost Condensing Commercial Water Heater

Joseph Gerstmann

Description

More than 70% of all commercial buildings use gas for water heating, and about 17% use heating boilers. Although condensing water heaters are available with thermal efficiencies of 95% or more, they are expensive, and most buildings owners and operators purchase less expensive non-condensing water heaters that are only about 80% efficient. Copper-tube commercial water heaters are widely used on account of their excellent heat transfer performance, but cannot operate in a condensing mode on account of corrosion by flue-gas condensate. Protective coatings either lack the necessary durability or would be damaged by heat from the burner. The proposed project would develop an inexpensive condensing water heater that would be as durable as less-efficient non-condensing water heaters

Benefits

An inexpensive high-efficiency water-heater with a payback period of not more than one year would be widely accepted by the commercial sector. The gas consumption of the proposed water heater would be about 15% less than that of non-condensing copper-tube water heaters, and 15% to 40% less than that of storage-type gas water heaters. The lower operating expense would reduce the cost of providing goods and services to the public, and the lower gas consumption would correspondingly lower the discharge of harmful emissions.

Objectives

The key objective of the proposed program is the development of a low-cost, high-efficiency, condensing commercial water heater that is cost-competitive with non-condensing heaters. The enabling technology for this objective will be the design of a condensing heat exchanger that is protected from the corrosive effects of flue-gas condensate and from damaging heat by the burner gases.

Budget

2005: \$400,000

2006: \$600,000

Other:

Comments

The proposed primary budget would be leveraged by a similar level of private co-funding.

Project Concept #90: Small-Scale Solar Combined Heat and Power

Dennis A. Dudzik, P.E.

Description

An exploratory study and bench scale technology testing project is proposed to compile information on a natural gas-fired domestic and commercial-size hot water and steam small-scale Solar Combined Heat and Power (SCHP) unit. The project will incorporate the Rankine-cycle with new steam production and waste heat recovery technology along with a 10 kW generator. The following innovative features characterize the project. - High pressure direct steam generation absorber pipes - Innovative parabolic trough concentrator with low heat emissions losses - High speed reciprocating oil-free steam engine for high efficiency (25 % electricity) and high specific power (kW/kg, kW/\$) - Intermediate buffer/storage (Steam Buffer & Condenser Buffer) accommodates heavy fluctuation of thermal and electrical demands

Benefits

1. High renewable resource utilization 2. Significant natural gas reduction 3. Improved air quality 4. Short term Energy storage of intermittent renewable and low cost electricity. 5. High system efficiency at relatively low solar collector temperature compared to Stirling Engines (Cheaper Solar Collectors) 6. Prompt response to thermal and electrical demand 7. High specific peak power (kW/kg, kW/\$) 8. High part load efficiency 9. UPS (Increased quality services (UPS= Uninterruptible Power Supply). 10. Flexible provisions of electricity and heat

Objectives

1. Demonstration and quantification of the natural gas consumption reduction capabilities of modern Rankine cycle small-scale solar combined heat and power 2. Quantification of the economic aspects of ownership of this technology, in both new and retrofit applications 3. Identification of other small-scale solar combined heat and power technology, both existing and under development, which reduce the consumption of natural gas 4. Comparative technical and economic analyses of other small-scale solar combined heat and power systems with the modern Rankine cycle technology 5. Identification of technical and institutional barriers to the deployment of these technologies

Budget

2005: \$570,000

2006: \$240,000

Other: \$230,000

Comments

Matching funds will be provided as follows: 2006, \$700,000; 2007, \$600,000; and 2008, \$400,000. In addition to the matching funds listed above, development of this technology is being supported by a European Commission (EC) grant in the amount of \$1,000,000 (for the steam portion of the system), as part of a small scale combined cycle system with heat recovery from an internal combustion engine. The total EC contribution for the entire small-scale combined cycle system is \$5,000,000. A large private European research and development firm is also providing funding support for this project.

Project Concept #91: Industrial Plant Air-Makeup and Space Heating

Stephen J. Sikirica, R&D Manager – Process Heating

Description

Industrial air-makeup and space conditioning systems are large consumers of energy in California. Air-make up often is the largest energy consuming operation in an industrial facility. Improvements in heat recovery and indirect heating systems combined with plant reductions in makeup air demand can improve industrial and commercial facility energy efficiency. Additional improvements can be focused on fan design and power supply

Benefits

Lower energy costs (10%) for California ratepayers, increased overall energy efficiency (25%), and reduction in air emissions (10%).

Objectives

Develop a higher efficiency industrial air makeup and conditioning system that meets California environmental standards, with acceptable first cost, and a 25-50% improvement in overall energy efficiency.

Budget

2005: \$350,000

2006: \$350,000

Other:

Comments

Likely co-funding level for project estimated at 40%

Project Concept #92: Best Practices to Assist Utilities in Reducing Emissions of Natural Gas

Glyn Hazelden

Description

All gas industry sectors, including gas production; processing, transmission, and distribution emit methane to the atmosphere to varying degrees. Methane emissions are generally process-related, with normal operations, routine maintenance, and system incidents being the primary contributors. In 2003, in the US, 5,998 Gg (Gigagrams) of methane was emitted from natural gas systems (1). Many available cost effective technologies and practices can reduce various emissions from all sectors of the gas industry. (1) US EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2003

Benefits

Benefits to the California Gas Industry include reduced methane emissions; reduction in gas lost by utilities, reduction in gas utility O&M expenses, and improved operations.

Objectives

The proposed project will identify natural gas emission control methods, and document and quantify the emissions reduction by using different technologies. These technologies may be already available, or have recently been developed. Solutions developed may either be an actual piece of equipment to assist in eliminating emission of natural gas, or a procedure that can be performed differently to minimize gas lost to atmosphere. Visits will be made to gas industry sites to observe current operations, identify procedural changes that can be made that will result in reduced methane emissions, and quantify the potential emission savings and cost issues of such mitigation measures. Recommendations will be made as to the most effective ways to reduce methane emissions for each sector of the California natural gas industry.

Budget

2005: \$220,000

2006: \$165,000

Other:

Comments

The project will be approximately 20 months in length

Project Concept #93: CARB CHP Building Efficiency Assessment.

Marek Czachorski

Description

Application of Cooling, Heating, and Power (CHP) in buildings can greatly improve operating economics and produce significant energy saving. However, this potential depends strongly on effective recovery and utilization of the waste heat produced during generation of electricity. A realistic assessment of CHP for California buildings is complicated by the local climatic condition making it difficult to economically utilize available heat. GTI will use its set of proprietary engineering tools and its commercial quality Building Energy Analyzer program, to assess the practical potential of applying CHP in California.

Benefits

Most of California's peak energy is supplied by simple cycle natural gas fired power plants. Advanced high efficiency technology placed in commercial buildings reduces peak demand and natural gas use. The project will establish clear guidelines for the practical application of CHP technologies in California buildings based on expected/achievable improvements in the buildings energy efficiency, reduction in emissions, and improvements in the utilization factor of the energy distribution infrastructure.

Objectives

Identify practical limits of energy conservation and air quality improvements expected through optimized application of CHP technologies in the commercial sector in California.

Budget

2005: \$150,000

2006:

Other:

Comments

CARB requested this assessment.

Project Concept #94: Co-Production of Hydrogen and Electricity from Natural

Kevin Krist

Description

There are two main methods for H₂ production: water electrolysis and natural gas reforming. Electrolysis makes the purest hydrogen, while reforming is the most efficient and lowest cost hydrogen production method. GTI is proposing an approach for small-scale, on-site, H₂ production that combines the best attributes of both by integrating a natural gas depolarized steam electrolysis module with a solid oxide fuel cell (SOFC). The judicious combination of a high temperature electrolysis module with an SOFC can lead to more efficient co-production of both electricity and pure H₂ from water and natural gas. The improved H₂-generation efficiency results from the minimal amount of electric current required for the depolarized steam electrolysis process, the efficient SOFC source of the electric current, and the ability to use high quality waste heat generated by the SOFC. Pure H₂ is obtained by condensing steam downstream of the cathode and drying – bypassing expensive pressure-swing adsorption processes needed to purify H₂ in conventional reforming.

Benefits

This exciting new system will synergistically co-produce electricity and hydrogen. This can be used for onsite industrial applications and hydrogen vehicle fueling stations. Cost-effective onsite hydrogen production can reduce energy consumption and improve industrial competitiveness in key California-based industries such as semiconductor fabrication, food processing, high-performance chemicals, and advanced metal alloys. The cost of merchant H₂ for chemical, power generation, transportation, semiconductor electronics, food and beverage processing, high-performance metals processing and treating are important to California. In addition, increased hydrogen consumption may decrease the use of tractor trailers to haul hydrogen gas or liquid to users. It can lower costs to users and avoid traffic congestion and emissions by relying on the natural gas infrastructure for onsite energy delivery. This technology can also fit into the future need for high-purity hydrogen for vehicles.

Objectives

GTI and Versa Power Systems, Inc. (VPS), working with a Lawrence Livermore National Lab (LLNL) consultant, will develop improved electrolysis cells and show the viability of this concept in real-world conditions. VPS is a leading SOFC system fabricator. GTI will map the performance of full-area natural gas depolarized steam electrolysis cells as well as short stacks (up to 5 cells). Cell feed gas compositions, utilizations, and current densities will be systematically varied to determine stable operating conditions. Post-test analysis will use standard surface analytical methods. Prototype H₂ generation stacks systems will be designed with electrolytic cells closely coupled with VPS SOFC short stacks, thereby taking advantage of the high quality heat generated by the SOFC to raise steam for the electrolysis cell. Combined cycle efficiencies (electricity plus hydrogen) will be determined under realistic operating conditions. Heat and material balances and capital and operating costs for the prototype systems will be determined. The results will also provide quantitative measures of the potential for meeting stationary durability targets. The system will be compared with other approaches for small-scale H₂ production. GTI will lead the project with VPS as a partner and LLNL as a consultant. Southern California Gas (SCG) will cost share and advise on potential applications. After proof-of-concept milestone targets are met, GTI will work to secure US DOE funding to provide additional leveraging of CEC funding.

Budget

2005: \$300,000
2006: \$400,000
Other: \$500,000

Comments

Southern California Gas has indicated potential for cost sharing up to \$75,000 per year. GTI projects a Go/No Go decision point after 18 months. With promising results at this point in time, GTI would seek to secure US DOE funds to accelerate development and demonstration and to offset the proposed program costs

Project Concept #95: Solar Chiller - Renewable Energy Project

Chevron Energy Solutions - Gregory Coxson
Chevron Energy Solutions

Description

Chevron ES proposes the use of solar chiller systems to provide peak load cooling requirements for Los Angeles Community College District and other higher education facilities. The solar chiller system utilizes roof mounted solar hot water heat pipe panels that deliver hot water for storage at a central plant location. Hot water from storage is used to supply and feed a 350-500 ton hot water absorption chiller, in lieu of being supplied via natural gas. The solar chiller system would provide the campus peak / base load and will save annual utility cost as well as comply with the District's goal to use renewable and sustainable energy. Research project will be a joint effort between Chevron ES and Cal State Northridge Engineering Dept.

Benefits

If shown to be viable this type system could be proposed for any application that has large on peak chilled water demand requirements. This system has the potential to significantly reduce peak demand requirements, especially in Community colleges, higher education facilities and large K-12 school facilities, which have passed bonds and are in the process of replacing older infrastructure and cooling and heating systems. This application would replace or supplement the use of natural gas for both heating and cooling

Objectives

Key Objectives include a demonstration that a large scale solar chiller system is viable and will supply adequate hot water to meet peak demand requirements. The major concerns with this type system is the real time output under overcast conditions as normally experienced in the California coastal regions. Project will also demonstrate reliability of the system to reduce peak electrical demand, by replacing the use of electrical chillers during peak periods. The solar system will be operated in conjunction with ice thermal storage in order to ensure that peak demand reductions are maintained during lower hot water availability periods. The study would also evaluate the use of the solar hot water system for space heating during heating season..

Budget

2005: \$1,200,000

2006: \$300,000

Other:

Comments

The requested funding would be used to provide the marginal cost increase for solar chiller system compared to installing the traditional gas/electric central plant, research and reporting

Project Concept #96: Distributed Production of Hydrogen

John M. Pratapas

Description

In this proposed 36-month project, GTI and its partners will build and test a 10kg/day pilot-scale system and confirm the technical and economic feasibility of a novel, self-powered, low cost, distributed hydrogen production technology that could serve hydrogen fueling stations and supply hydrogen-enriched compressed natural gas. In Phase I, the Project Team will model and test a 48 kW partial oxidation reciprocating engine for hydrogen rich syngas and power production, develop process options for integrating downstream shift reaction and separation, and perform economic analyses. Phase I results will be reviewed by Air Products and Chemicals and the BOC Group in support of a Phase II Go/No Go decision by CEC and commercial partners. The Phase II deliverables will be performance data from operating an integrated pilot-scale system to produce 10 kg/day of hydrogen along with an engineering design package for scale-up by at least a factor of ten in hydrogen production capacity.

Benefits

The commercial technology resulting from this proposed project could provide a near-term, low cost means for small-scale distributed hydrogen production in support of the California Hydrogen Highway Initiative. The proposed technology can be configured to provide heat, cooling and power for homes and businesses while co-producing hydrogen for use in vehicles. Hydrogen fuel can be used in stationary engines as well as vehicles powered by either internal combustion engines or fuel cells, resulting in near-zero or zero tailpipe emissions. The public benefits include improved air quality through significantly lower emissions of NO_x, unburned hydrocarbons, CO and CO₂ from fuel cell powered and hydrogen enriched compressed natural gas vehicles compared to conventional gasoline and diesel engine powered ones. The distributed hydrogen production system proposed is CO₂ capture ready, non-catalytic, easy to operate and ready for pilot-system demonstration with minimal development.

Objectives

The proposed concept provides integrated hydrogen-rich syngas and power production capability in a compact, rugged, low cost package. By utilizing commercially available reciprocating internal combustion engine technology as the “chemical reactor” to produce syngas by partial oxidation, the research is targeted to achieve approximately a 70% reduction in capital cost compared to state-of-the-art steam methane reforming technology for nominal 690 kg/day of hydrogen capacity.

Budget

2005: \$1,097,000

2006: \$1,386,000

Other: \$894,000

Comments

Proposed Partners would include the Institute of Transportation Studies, UC Davis, Russian Academy of Sciences-Institute of High Temperatures, BOC Group, Air Products and Chemicals and the industrial marketing group of PG&E. Proposed budget includes costsharing

Project Concept #97: Advanced Gas Water Heater

D. Kalensky, R. Knight

Description

Gas storage water heaters are known for their ability to handle large coincidental hot water loads, but standby heat loss can account for 25 percent of their annual operating cost. Instantaneous gas water heaters have little standby loss, but large coincidental loads challenge their ability to meet domestic hot water needs under peak conditions. In addition, neither system designs adequately incorporate solar for optimal performance. This project will exploit GTI's advanced water heater concepts to deliver a product that can handle large coincidental hot water demands at low standby loss and adequately incorporate solar-assist options.

Benefits

Natural gas water heaters have a 79% market share in the California residential population, or 9 million homes. Assuming a 10% market share, 1 million homes will realize an energy savings of 57 percent, or 108 therms per home. This results in an annual savings in natural gas of 12 Bcf per year or \$60 million savings to California consumers. This energy savings equates to reduction in NOx emissions of 200 tons per year.

Objectives

GTI will work with a major water heater manufacturer. Objectives include: 1) validate design, performance, and market criteria; 2) bench assembly and testing; 3) modeling and analysis; and 4) develop, test, and refine system prototypes. The project includes an evaluation of solar-assist for power and thermal reduction, which has not been previously implemented. At the end of this project, the product will have lab validation and will have had limited accelerated life testing. It is anticipated that the manufacturer will conduct a limited field test and some additional testing and cost reduction prior to product rollout.

Budget

2005: \$600,000

2006: \$300,000

Other:

Comments

Natural gas utilities, the boiler manufacturer, and end users will supply additional cofunding both in actual and in-kind dollars, estimated at \$400K in 2006 and \$700K in 2007.

Project Concept #98: Gas Engine-Driven Combination Heat Pump and Standby Generator

Neil Leslie

Description

Description: This project will develop a unitary natural gas engine-driven combination heat pump and standby generator for the small commercial and residential market. The appliance comprises a low-emission natural gas engine-driven generator set that supplies electricity to a standard hermetic compressor or pre-selected standby electrical loads. The system will use currently available and market-tested technology with high efficiency, low emissions, and significantly lower cost, smaller size, and longer life. Product features include: *f*{ A highly reliable, low-cost, rugged, compact natural gas engine designed by Yanmar (the participating engine manufacturer). *f*{ Standard hermetic compressors. *f*{ Brushless generator. *f*{ Low-cost, rugged microprocessor controls. *f*{ Catalytic technology developed for NGV_i's and applied to the Yanmar engine.

Benefits

The combination heat pump/standby generator appliance will increase the efficiency and reliability of residential and light commercial air conditioning and heating while providing electric power for standby use during emergencies, brown-outs, and grid outages. The product will benefit energy consumers, utilities and government. During the summer cooling months, each appliance will reduce peak electric power generation requirements as well as alleviate transmission and distribution peak loads by approximately 1 kW for each ton of installed equipment. Estimated incremental annual energy benefits are \$50 Million consumer savings and 400 MW deferred peak electric load. Projected incremental annual environmental benefits due to reduced distribution losses are 11 Million lbs CO₂ reduction and 14,000 lbs NO_x reduction. Mature sales projections range between 20,000 and 50,000 units per year.

Objectives

: To leverage advances in established, proven technologies currently used in high-volume applications to cost-effectively develop and commercialize a viable new high-efficiency product line (cooling and heating COP_i's >1.1) for light commercial and residential applications. The initial phase will focus on preliminary design, construction, and bench testing of one laboratory prototype system. Based on successful laboratory results, the next phases, co-funded by the gas industry, will finalize system design, prototype development, laboratory and field-testing, certification, and commercialization

Budget

2005: \$800,000

2006: \$1,000,000

Other: \$1,100,000

Comments

Project Concept #99: Dual Natural Gas – Electric Hybrid Heaters

Stephen J. Sikirica, R&D Manager – Process Heating

Description

Combinations of gas and electric heating systems can optimize heat transfer and heating quality in industrial thermal processes while providing the end user with flexibility in fuel selection. Historically, inadequate development was done due to low energy prices, although the feasibility of combining electric resistance heating and natural gas indirect heating, gas pre- or post- heating with electric induction, and gas and electric infrared and convective heating, has been demonstrated.

Benefits

Lower energy costs (20%) for California ratepayers, increased overall energy efficiency (25%), and reduction in air emissions (10%).

Objectives

Develop and field-test cost-effective dual natural gas – electric hybrid heating systems.

Budget

2005: \$350,000

2006: \$450,000

Other:

Comments

Project Concept #100: High Efficiency Gas-Fired Drum Dryer for Food

Yaroslav Chudnovsky, Ph.D.

Description

Drum drying is used in the food and dairy industries. The use of steam heating requires the drums to meet ASME codes for pressure vessels which limits the dryer operating steam pressure and the shell temperature causing a limitation to their drying capacity. Drum drying has been replaced by more costly spray drying, in part because of this drying limitation. Significant improvement in energy efficiency and productivity can be made through development of cost effective high-efficiency, high-drying-rate drum drying technology.

Benefits

The new approach will allow a significant increase in the surface temperature of the dryer (up to 600°F), thereby increasing the drying rates. Successful development of the gas-fired drum dryer will provide large energy savings to the industry based on an energy efficiency increase from 65% (steam operated) to 75-80% (gas operated). Additionally, the ability to tailor heat transfer along the drum could also lead to product quality enhancements or new product opportunities for California process heat users.

Objectives

The overall objective is to successfully design, laboratory test, and field test a full-scale high efficiency drum dryer prototype. The prototype would benefit from prior GTI work in drum internal surface enhancements and drum heating development for paper drying applications. Proof-of-concept will be accomplished for temperature sensitive food processing applications.

Budget

2005: \$450,000

2006: \$550,000

Other:

Comments

In California, dried and dehydrated fruits and vegetables processing consumes an estimated 6.2 TBtu, while evaporated and condensed milk processing consumes an estimated 8.3 TBtu total energy per year (Report No. GRI-03/0075). Additionally, drum drying or drum heating is used in a variety of other food processes and other industries such as pharmaceuticals.

Project Concept #101: Hydrogen Fueling Station Development and

William Liss

Description

GTI has been working actively with the US DOE on the development of an integrated natural gas to hydrogen fueling station. This system has a compact and efficient steam methane reformer that, when coupled with a gas purification system, can produce high-purity hydrogen. GTI has also developed a state-of-the-art hydrogen fueling dispenser. In this proposal to the CEC, GTI, GreenField Compression, Southern California Gas, and other partners will develop collaborative hydrogen fueling station and hydrogen-powered vehicle development and demonstration project. The project will research the potential for further improvements in hydrogen conversion efficiencies, explore hydrogen purification technologies such as palladium membranes, and design novel onsite hydrogen storage approaches – including in-canopy designs and underground storage. In addition, equipment would be put into the field for reliability and durability testing. GTI will work with St. Croix Research (Palo Alto, CA) on hydrogen codes and standards specific to the use of hydrogen fueling stations and onsite hydrogen production technology in California. This will include outreach work to fire marshals and other stakeholders. The findings from this research will help advance the knowledge base for designing and operating onsite hydrogen fueling stations in California.

Benefits

California is a leader in using natural gas and hydrogen (largely made from natural gas) as a means of diversifying energy use in the transportation sector while also significantly reducing air emissions. This program will help advance the knowledge base and familiarity with using natural gas to produce and dispense high-pressure hydrogen on a distributed basis.

Objectives

1. Develop and validate a high-efficiency natural gas to hydrogen fueling station in Southern California. 2. Design and develop technology advancements and application methods that improve the performance, efficiency, reliability, durability, and safety of integrated onsite hydrogen fueling stations. 3. Increase awareness and acceptance of hydrogen fueling stations with various stakeholders.

Budget

2005: \$450,000

2006: \$500,000

Other: \$400,000

Comments

Other cash and in-kind funding will substantially leverage CEC funds. GTI is currently working with SoCal Gas on this effort and will be in discussions with SCAQMD and other partners for participation, including fuel cell vehicle manufacturers

Project Concept #102: High-Temperature Proton Exchange Membrane (PEM) Technology Development

Dr. Chinbay Fan

Description

GTI is proposing to work with the CEC, US DOE, and other partners on the development and validation of high-temperature, low humidity fuel cell membrane technology for use in efficient stationary cogeneration systems, hybrid solar/fuel cell systems, and the transportation market. A stationary high-temperature PEMFC system operating between 100 to 160°C produces higher quality heat that can be recovered as low-pressure steam or in an absorption cooling system. Such a system could also be integrated into a hybrid solar-assisted hot water system to improve overall efficiency and allow flexible hot water production. GTI is working with partners, which include Southern California Gas, Arkema, and Nissan, on the development of a high-temperature PEM fuel cell membrane. GTI has worked extensively on PEM fuel cell membranes and has developed an exciting new PEM membrane that is much lower cost than conventional fluoropolymer-based products. Building on this experience, GTI has several advanced membrane technology solutions in development that show promise for meeting the challenging requirements for operation in a PEM fuel cell at temperatures above 100°C.

Benefits

The development of a high-temperature proton exchange membrane (PEM) fuel cell membrane has two primary benefits: 1) high-quality thermal heat allows a stationary PEMFC system to be used in various cogeneration applications and 2) allows dramatically lower costs for fuel cell vehicle systems. There is also a technical benefit of making the fuel cell more tolerant to carbon monoxide (CO). There are significant efficiency and environmental benefits that result from the use of fuel cell technology for cogeneration systems and fuel cell-powered vehicles. In the stationary market, the current low quality heat from a PEM fuel cell makes the cost for thermal energy recovery marginal. By raising the temperature of thermal energy produced in this system, it can enable various types of cogeneration systems – including low pressure steam, hot water, and absorption cooling. For residential and commercial customers, such a system could also be integrated with a solar thermal hot water system to achieve synergistic operational and efficiency benefits.

Objectives

1. To quantitatively validate the performance and durability of a large scale (over 300 cm² active area) high-temperature PEMFC membrane. 2. To achieve a membrane cost target that is 1/10th the cost of currently available low-temperature products. 3. Undertake design and engineering studies to quantify the system and energy efficiency benefits for high-temperature PEM fuel cell stationary cogeneration and hybrid solar/natural gas cogeneration systems.

Budget

2005: \$150,000

2006: \$200,000

Other: \$200,000

Comments

GTI is submitting a proposal to US DOE to accelerate this work and is requesting support from CEC. The CEC funding will be highly leveraged, including an estimated \$1.6 million in US DOE funding as well as other industrial cost share.

Project Concept #103: Low-Cost Real-Time Hydrocarbon Dew Point Measurement Tool

Dr. Ram Sivaraman

Description

Local Distribution Companies and end users in California are affected by potential liquid hydrocarbon dropout problems in natural gas infrastructure. This causes major impacts on compressors, operational safety, reliability and system integrity for gas companies. There are also impacts on end use equipment such as turbines and emissions issues due to lower gas quality. The proposed project will develop and demonstrate a fast, cost-effective, safe, and field-deployable hydrocarbon dew point measurement device for California natural gas pipeline operators. This device will assist in LNG blending control and quality assurance. It will have the ability to communicate the data via the SCADA system for control monitoring.

Benefits

Impacts on operational safety, reliability, system integrity and the environmental due to the liquid condensates drop out will be minimized. The proposed unit will be useful to establish gas quality assurance with O&M cost savings for Local Distribution Companies, and End Users.

Objectives

- Develop a viable, safe, low cost, highly accurate, state-of-the-art acoustic resonance Hydrocarbon Dew Point (HDP) device that can monitor/measure HDP in-situ and real time reporting to SCADA system.
- Develop instrumentation for accurate (better than 0.5%#61616;C) in-situ HDP measurements for the natural gas mixtures delivered by pipelines
- Demonstrate the prototype for its capability under simulated natural gas transmission pipeline conditions at GTI in Phase I. In Phase II, the device will be demonstrated at four field sites to be selected in coordination with Sempra Energy and PG&E, leading to beta testing and commercialization.

Budget

2005: \$150,000

2006: \$300,000

Other:

Comments

GTI will coordinate with Sempra Energy and PG&E to coordinate field testing.

Project Concept #104: Ultra-Efficient Hydronic Heating Systems

R. Knight, D. Kalensky

Description

Modern high efficiency boilers can have premature heat exchanger failure if the corrosive condensate, a product of combustion is not properly dealt with. Typically, sophisticated vent systems are employed that add cost. If not properly installed, condensate settles on the heat exchanger causing premature failure. This project will apply transport membrane condenser (TMC) technology developed and proven for industrial steam boilers to commercial and small industrial hydronic heating systems. TMC technology raises energy efficiency to >97% (High Heating Value) without discharge of corrosive condensate, removes a majority of the latent heat from flue gas, and maintains the vent gas in a non-condensing state thereby completely preventing any corrosion.

Benefits

Approximately 66,000 boilers in California fall within 400KBtu to 2 MBTU size range. Replacement of conventional hydronic heating units with high-efficiency units can increase thermal efficiency from 60% to 97%. A 2 percent capture of the commercial gas heating market will result in annual energy savings of 9 million therms per year. The proposed development increases reliability of high-efficiency boiler systems through innovative condensate management.

Objectives

GTI will work directly with a major California boiler supplier to incorporate TMC technology into their products. This will include design, testing, and a field demonstration of TMC modules in several commercially available hydronic systems at minimal capital cost and minimal impact on installation requirements.

Budget

2005: \$400,000

2006: \$200,000

Other:

Comments

[Cofunding sources]Natural gas utilities, the boiler manufacturer, and endusers will supply additional cofunding both in actual and in-kind dollars. \$200K in 2006; \$400K in 2007.

Project Concept #105: High Efficiency Low NOx Immersion Fluid Heater

Yaroslav Chudnovsky, Ph.D.

Description

Fluid heating represents the largest category of process heating energy use. One large area of fluid heating in California includes the immersion heating of tanks for a variety of industrial processes; for example, chemical cleaning, washing, plating, coating, food processing, and metals quenching. Immersion heaters on average have low fuel efficiencies of between 30% and 60%, and relatively high NOx air emissions. An opportunity exists for an advanced immersion heater with 70 to 80% efficiency and relatively low NOx emissions.

Benefits

Successful review, analysis and advanced concept development for fire-tube immersion heaters will lead to 15-20% thermal and energy efficiency increase as well as air emission reduction of the discussed equipment employed in a variety of California industrial applications. There is a potential for 1 TBtu energy savings in California.

Objectives

The primary objective of this project is to perform a state-of-the art analysis of industrial fire-tube immersion heating applications and apply an advanced concept for cost-effective immersion heaters efficiency improvement. Applications would be suitable for both retrofit and new installations. Efficiency improvements will be achieved by applying improved combustion techniques to the immersion tube design and modifying tube design to increase the local heat flux and reduce overall pressure drop. After initial analysis and testing, GTI together with project sponsors and industrial partners, will identify a host site for the field trial of the project, which will be an extensive evaluation of the developed concept in an operating environment. GTI together with the project partners will convert the field trial information into commercial design recommendations for the retrofit or new development of advanced high efficiency fire-tube immersion heaters. Deployment of the developed technology will follow.

Budget

2005: \$300,000

2006: \$450,000

Other:

Comments

Project Concept #106: High Efficiency Industrial Ovens

Stephen J. Sikirica, R&D Manager – Process Heating

Description

Industrial ovens provide good temperature uniformity (product quality) and process flexibility. They operate above ambient air temperature to about 1400 oF often in temperature sensitive processes. However industrial ovens move large volumes of air to transfer heat to the product resulting in low overall energy efficiency. Curing, drying, forming, or annealing in painting, coating, metal finishing, food processing, agriculture, metals heat treating, and other processes can be made more energy efficient through development of a new generation of ovens by reducing air volume demands or using low grade supplemental heat from other processes. This project will support development of the next generation of energy efficient industrial ovens.

Benefits

Lower energy costs (10%) for California ratepayers, increased overall energy efficiency (25%), and reduction in air emissions (10%) for industrial ovens.

Objectives

Develop a high efficiency industrial oven that meets California environmental standards, with acceptable first cost, and overall 25-50% improvement in overall energy efficiency.

Budget

2005: \$400,000

2006: \$400,000

Other: \$800,000

Comments

Project Concept #107: In-Situ NOx and O2 Sensors

D. Chojnacki, J. Rabovitser

Description

Reliable and low-cost in-situ sensors are needed for optimizing low-emission combustion systems. Mixed-potential NOx sensors currently under development for engine applications can measure low NOx and O2 in flue gases. GTI proposes to apply these sensors to boilers and other industrial and commercial applications. GTI will work with sensor developers and combustion equipment manufacturers to determine response and reliability of the sensors and additional developments such as sensor heaters, sensor signal processing, calibration methodology, and control systems. The program will include parameter testing in GTI

Benefits

An inexpensive in-situ sensor for low NOx and O2 measurements will greatly improve low-emission performance in industrial/commercial boilers and other combustion systems. Process efficiency will also be improved while maintaining low emissions.

Objectives

The project will (1) evaluate the in-situ mixed-potential NOx sensors for industrial applications; (2) identify and develop the additional requirements for applying in-situ NOx/O2 sensors to specific industrial applications; and (3) collect test data to evaluate the longevity of the sensor in industrial applications.

Budget

2005: \$250,000

2006: \$300,000

Other:

Comments

Cofunding sources include DOE, Utilization Technology Development Company (UTD), sensor manufacturers, and combustion equipment manufacturers.

Project Concept #108: Field Demonstration of Low NOx/CO Burners for Crude Oil Heaters

D. Cygan

Description

Stringent environmental regulations are forcing the owners of crude oil heaters to install low-emission burners. In Bakersfield, California there are 137 burners ranging from 2 to 8 million Btu/h installed on 80 heaters. Conventional burners operate with about 70 vppm (at 3% O₂) NO_x emissions. Upcoming regulations require each burner to achieve NO_x emissions below 15 vppm by June 2006. The advanced burner is based on GTI's successful Forced Internal Recirculation (FIR) burner technology that incorporates proven NO_x reduction techniques and low excess air operation. Burner performance has been confirmed in laboratory tests and the technology is ready for field demonstration.

Benefits

The FIR burner technology will fundamentally change the crude oil heater market for new and retrofit applications – delivering a 75% reduction in NO_x emissions while maintaining low CO and THC emissions compared to present state-of-the-art burner technology. The FIR burner technology will achieve the required emission reductions at an estimated 28 percent savings compared to alternative approaches that require flue gas recirculation.

Objectives

Conduct a successful field demonstration of the FIR burner technology on a crude oil heater. Burner performance will achieve NO_x emissions below 15 vppm (at 3% O₂) and CO and THC emissions below 50 vppm, over a 2:1 turndown. Coen will offer the burner technology as an industrial burner package.

Budget

2005: \$250,000

2006:

Other:

Comments

GTI has been actively developing the FIR burner technology for firetube and watertube boiler applications since 1993. Approximately \$4.2 million was spent on development and demonstrations with GTI's Sustaining Membership Program, GRI, DOE, and Southern California Gas Company support. The burner technology was licensed to Johnston Boiler Company in 2001 and Coen Company Incorporated in 2002 for firetube and watertube boiler applications respectively. The GTI/Coen Team is well positioned to apply the FIR burner to crude oil heaters. GTI has previously installed a 2.5 million Btu/h burner at Vandenberg Air Force Base and has tested burners in the 2 to 8 million Btu/h range successfully in the laboratory.

Project Concept #109: Low NOx Residential Gas Water Heater Operational Durability Program

Rich VanCamp

Description

The program will evaluate and improve the durability of low NOx gas water heaters and associated technologies within these appliances. This effort will enhance current product offerings, integrate near horizon technologies and develop new technologies that demonstrate reliability, meet 2006 California emissions requirements for NOx and provide expected safety. Recent research has tested and proven a low NOx burner and CO limit shutoff system in two Flammable Vapor Ignition Resistant (FVIR) designs. The proposed research will rigorously test a representative population of these systems to prove the durability of the low NOx burners in conjunction with related safety components.

Benefits

The benefits to California will be the availability of several, durability tested, low NOx emission residential water heater products that can be counted upon to meet the January 2006 (10 ng/J NOx) emissions requirement for California, while maintaining the Flammable Vapor Ignition Resistant (FVIR) design with its CO emissions limit requirement as per ANSI Z21.1.10a-2002. The integration of emergent technologies and the rigorous testing of a representative population of these water heaters with alternate technologies will provide the market with reliable, cost-effective appliances

Objectives

The primary objective of this program is to evaluate the durability of current and emergent technologies applied to low NOx residential water heater designs. A second objective is to develop and advance near horizon technologies that improve the reliability of systems for safety and improved emissions. Current ANSI standard compliant water heaters have not been exhaustively tested for durability and repeatability with respect to CO limit shut-off devices and long-term operational characteristics within reduced NOx combustion systems. Further, advances in emissions sensing (both CO and NOx) and in low NOx burners merit testing and comparison within these appliances.

Budget

2005: \$450,000

2006: \$750,000

Other:

Comments

Includes cofunding

Project Concept #110: Energy and Water Recovery from Flue Gas Using Nanoporous Membrane Tech

D. Chojnacki, D. Wang

Description

GTI proposes to expand the application of its patented Transport Membrane Condenser/ Humidifying Air Heater (TMC/HAH) heat recovery system (HRS) to recover energy and water from flue gases in various low temperature commercial and industrial systems. The TMC selectively transports water vapor with its latent heat, and the HAH transfers part of the TMC-recovered water and heat back to the combustion air to save energy. GTI and its manufacturing partners will design and test systems for various applications and conduct a field test program to demonstrate the operation of the HRS and evaluate the application economics.

Benefits

The nanoporous membrane heat recovery system enables increased energy efficiency and water recovery across a broad slate of common commercial and industrial applications. Based on past results, projected energy savings of up to 20% of natural gas usage in commercial, light industrial, and agricultural applications and water savings of up to 5% of fresh water can be achieved. The environmental impact of increased efficiency includes reduced NO_x, CO, and CO₂ emissions per unit of industrial output.

Objectives

(1) Deploy 2 to 3 field test units of the HRS in various high volume commercial/industrial retrofit applications including installed steam boilers, hot water systems, process heaters, and dryers; (2) Confirm ability of the HRS to achieve up to 94% (HHV) energy efficiency and 50% water recovery from flue gases; (3) Optimize the HRS design for specific applications with a goal of 1- to 2-year payback; and (4) Develop a commercialization and technology transfer plan with manufacturers and end user groups.

Budget

2005: \$250,000
2006: \$350,000
Other: \$200,000

Comments

Cofunding sources include DOE, Utilization Technology Development Company (UTD), boiler manufacturers, combustion equipment manufacturers, end users

Project Concept #111: Natural Gas Heating-Value Sensor

Serguei Zelepouga, PhD

Description

The expected introduction of LNG and gas from different sources in California is increasing pressure to more accurately and more regularly measure the natural gas heating value. Monitoring the heating value (Btu) of natural gas directly at industrial end-use devices is also becoming more important for process optimization and more critical for process control purposes to maintain and improve energy efficiency and to support sensitive operations in low air emissions combustion processes. Current Btu measurement technology; gas chromatographs (GCs), require frequent maintenance and skilled operators, and have long response times (often greater than 5 minutes). GCs are also large and expensive. GTI is developing a heating value sensor capable of significantly improving listed performance parameters of GCs. Proof of concept testing has been completed for a new optical heating value sensor. The sensor utilizes optical properties of natural gas to determine the Btu content and composition. Accuracy of real time heating value measurements will closely match those of a GC at much lower cost.

Benefits

Benefits of this meter include: 1) Improved energy efficiency and reduced air emissions – use of a fast-response heating value meter in industrial process control will increase production efficiency and environmental performance. 2) Reduced cost - the natural gas heating value meter proposed would significantly reduce costs of monitoring natural gas while maintaining a comparable degree of accuracy of current gas chromatograph technology. This economical technology would lead to more frequent and increased deployment for monitoring. 2) Use of alternate fuels – Natural gas blending applications would benefit from the rapid metering response of this technology resulting in more accurate gas mixtures. In addition, improved gas metering would facilitate use of blended fuels in sensitive operations.

Objectives

1) Development of a heating value meter prototype capable of heating value and component measurements sufficient for industrial applications 2) Side-by-side field-test of the prototype heating value meter and gas chromatograph. Tests will be conducted at host sites identified with high potential for beneficial application. Manufacturing partners for the upgraded heating value meter will participate in the project.

Budget

2005: \$345,000

2006: \$345,000

Other:

Comments

GTI analysis indicates that the technology can be lower cost than GCs. The testing conducted by GTI over the past two years has proven at bench-scale that the technology can accurately determine gas heating values in real-time. Potential for up to 40% co-funding.

Project Concept #112: Net Zero Peak Electric Building Energy System

John Kelly, Greg Rouse, and Marek Czachorski

Description

The project entails engineering research, design and demonstration of a “Plug and Play” integrated energy system package with advanced SCR emissions control. GTI and Enercon Engineering will develop a nominally 300kW building energy system with a 90 ton absorption chiller which supplies electricity, heating and cooling. GTI will test the package and conduct a field demonstration in California.

Benefits

This building energy system will significantly reduce peak electric load thereby displacing natural gas fired generation, conserving natural gas. The product will capture and utilize most of the energy typically wasted in the power generation process. The modular building system will reduce installed costs, improve reliability and improve efficiency thereby furthering the penetration of distributed energy systems in California. Further market penetration of these systems will offset natural gas use for boilers and natural gas powered generation plants.

Objectives

Develop a high efficiency building energy system with high reliability and low life cycle costs particularly suited for California markets. The project will include a demonstration of the system in a typical application and a technology transfer plan for further implementation and commercialization in California..

Budget

2005: \$400,000

2006: \$400,000

Other:

Comments

Partners include U.S. DOE, Enercon Engineering, Equity Office Partners, Cummins West, Hitachi.

Project Concept #113: On-Line Inspection of Pressure Vessels and Pipes

Serguei Zelepouga, PhD

Description

Petroleum refineries are the largest users of natural gas in California with a production capacity of about 2.2 million barrels per day. Process heaters are used to heat a fluid stream contained in pressurized tubes within an enclosure before further processing in both petroleum and chemical industries. A typical process heater is fired at over 50 MM Btu/hr and there may be up to 100 units at a large petroleum refining facility. Process heaters are used for distillation, cracking, hydroprocessing, preheating, reboiling, pyrolysis, and reforming. On-line inspection would increase run time of process equipment and reduce energy associated with start-up and shut-down. (see Energy Efficient Roadmap for Petroleum Refineries in California published by CEC in 2004).

Benefits

Efficiency will be improved 15% through reduction in downtime and maintenance and reduction in hot spots, unstable or inefficient combustion, flame nonuniformity, or other flame abnormality.

Objectives

The major objective of the proposed effort is to develop a cost-effective sensor combining thermal imaging to monitor process heater pipe surface temperature and flame sensor to monitor its position relative to the heater's burners and walls. A bench-scale prototype will be developed followed by field trials.

Budget

2005: \$375,000

2006: \$450,000

Other: \$500,000

Comments

GTI has prior experience in applying thermal imaging technology in glass operations and is currently developing flame monitoring technology through U.S. DOE sponsorship.

Project Concept #114: Power Generation from Waste Energy – Advanced

John Kelly and Greg Rouse

Description

The project entails engineering research, design and demonstration of an advanced waste energy recovery cycle. The project will utilize a dual stage heat recovery process with a proprietary fluid medium to increase the heat recovery capacity of organic Rankine cycle by up to 50%. Equipment employing the advanced cycle will be demonstrated on a California-based facility

Benefits

The project will demonstrate the capability of producing electrical power from a waste fuel source that is normally vented to the environment. The catalytic combustor emissions will meet CARB 2007 requirements. The project will extend the availability and efficient use of fossil fuel supplies while advancing the use of renewable resources, thereby reducing both global and local air emissions.

Objectives

Develop and demonstrate a high efficiency waste energy recovery power generation product that will significantly improve the economics of waste energy recovery.

Budget

2005: \$400,000

2006: \$400,000

Other:

Comments

Partners include WOW, GE, DOE, and Basin Electric.

Project Concept #115: Non-Destructive Evaluation and Monitoring of Composite Pressure Vessel

Mark Richards

Description

Composite materials provide a strong, durable and lightweight material for construction of gas storage containers used in natural gas vehicles (NGV) and hydrogen vehicles. These lightweight containers help improve efficiency. However, in certain applications, composite pressure vessel technology adoption is inhibited by concerns over tank integrity—particularly where external impacts may occur that are not readily visible or easily detected. In this effort, electronic non-destructive evaluation (NDE) methods will be evaluated for characterizing impact-induced damage in compressed gas containers. From this, the research will develop a reliable and repeatable damage detection method. The proposed technique is based upon an ultrasonic inspection method in which a signal is transmitted through the container walls from one transducer to another, using built-in inexpensive piezoelectric transducers. Significant changes in the signals indicate damage may be present. This method can be used for periodic or continuous monitoring of high-pressure composite pressure vessels. GTI has assembled a cross-functional team comprised of experienced independent research organizations, container manufacturers; industrial gas companies/tube trailer operators, and vehicle manufacturers. These project partners will support development of information, technologies, and products for the following applications: • Bulk gas transport with compressed gas tube trailers using composite pressure vessels • Stationary bulk gas storage using composite pressure vessels • On-board gas vehicle fuel containers using composite pressure vessels

Benefits

California is a leader in using natural gas and hydrogen as a means of diversifying energy use in the transportation sector while also significantly reducing air emissions. This program will help address long-term safety considerations for these vehicles

Objectives

1. Develop a next-generation working prototype using state-of-the-art digital signal processing electronics and low-cost piezoelectric transducers. 2. Validate the NDE system functionality of two different cylinder types and cylinders of different dimensions. 3. Conduct real-world field tests with several California-based fleet operators.

Budget

2005: \$150,000
2006: \$150,000
Other: \$250,000

Comments

This effort has been proposed to the U.S. Department of Energy at a level of \$1.6 million. Other cash and in-kind funding will further leverage CEC funds. GTI is currently working with SoCal Gas on this effort and will seek to include PG&E as a partner.

Project Concept #116: Renewable Methane Recovery and Utilization

William Liss

Description

There are significant renewable bio-methane resources generated within California at wastewater treatment plants, landfills, as well as dairy and swine farms. In many cases these potential energy resources are either an environmental issue (i.e., is vented or flared) or use a value-added process to generate electricity or heat. GTI is proposing to expand this into a new value-added use in the form of liquefied natural gas (LNG). GTI and its partners are proposing to work with the CEC and others to demonstrate the viability of onsite liquefaction technology for the recovery and conversion of bio-methane to LNG. There are several prospective sites that are under consideration, including major landfills, municipal wastewater plants, and/or large agricultural operators with digesters. The LNG produced is projected to be used for LNG vehicles or in an industrial operation. GTI and BOC, a major industrial gas firm, have developed and demonstrated a pre-commercial onsite natural gas liquefaction system. To date, this system has been validated on pipeline quality natural gas at levels of 1500 gallons per day as part of a major US DOE program. In this effort, the team proposes to develop system enhancements that enable operation on different bio-methane resources and to demonstrate this technology in the field at a scale of at least 2500 gallons per day.

Benefits

California is a leader in advancing the application of landfill gas to energy. Even with this, less than 20% of landfill facilities are effectively converting this resource into useful energy. This program will build upon California's leadership in waste to energy and natural gas vehicles by helping to demonstrate a new value-added use for landfill gas in the form of LNG. There are wide-ranging environmental and societal benefits from using bio-methane for LNG vehicles. These include improving renewable energy recovery, reducing greenhouse gases, lowering NOx and particulate emissions (in place of diesel fuel), and reduced state reliance on imported oil products.

Objectives

1. To design and develop methane gas clean-up and onsite liquefaction system designs specific to bio-methane resource recovery. 2. To quantitatively assess the efficiency and reliability of an onsite liquefaction system at an operating bio-methane production facility.

Budget

2005: \$700,000

2006: \$900,000

Other:

Comments

Additional cash and in-kind industry cost sharing is anticipated to fully fund this technology development and demonstration program.

Project Concept #117: Model Community District Energy System – Research & Design

John Kelly and Marek Czachorski

Description

The project entails engineering research and design of a hybrid CHP, renewable, EE and energy storage - scaleable distributed energy system for Chula Vista, California. The system design will serve as a follow-on project to the comprehensive model community energy master plan for the City approved for CEC support in August, 2005. The model master plan seeks to advance the efficient use of all fossil fuel resources and promotes the expanded use of renewable resources to reduce peak load demand/natural gas fired power, global greenhouse gas emissions, and increase energy security, particularly for critical urban infrastructure and services.

Benefits

Reduce peak energy costs and relieve an already constrained electric distribution system. The project will reduce energy consumption per acre while advancing the use of renewable resources, thereby reducing natural gas use and carbon emissions. Additionally, as a pilot project, the design will create a model for communities to consider across the State of California to replicate these project benefits for all citizens

Objectives

Reduce or eliminate electric peak load growth for a planned community development while significantly reducing fossil fuel energy consumption, increasing renewable supply to 20%, and reducing the environmental impacts of energy use.

Budget

2005: \$400,000

2006: \$400,000

Other:

Comments

Partners include the City of Chula Vista, SEMPRA, local developers, Department of Energy

Project Concept #118: Natural Gas Quality Requirements and Tradeoffs

Charles Powars

Description

Natural gas quality (i.e., composition and/or properties) specifications have profound effects on California's gas availability, gas costs, and air quality. Natural gas vehicle fuel requirements are problematic. Heavy-duty engines are the main issue, and there are three categories: older open-loop lean-burn (the "legacy" fleet), newer closed-loop lean-burn, and future stoichiometric three-way catalyst engines (to meet 2007-2010 emission regulations). Specifications with a low percentage of heavier hydrocarbons (e.g., to ensure high knock resistance) mean that California's associated gas and anticipated LNG imports cannot be used without expensive processing. The PUC, ARB, CEC, and DOGGR are addressing this challenge, but there is considerable uncertainty regarding requirements for 2007-2010 engines and the best compromise strategy for California.

Benefits

The benefit of this research will be a sound technical basis for developing natural gas composition specifications and quality tariffs that provide the optimum balance of gas availability, energy costs, air quality, application functionality, safety, reliability, and energy security for all Californians. The goal is a specification that will enable utilization of the State's associated gas assets and anticipated LNG imports without compromising the expanding use of natural gas as a transportation fuel, which is a key component of California's air quality improvement and petroleum import reduction strategies.

Objectives

The objectives of this research are to: 1) determine natural gas fuel composition requirements for heavy-duty engines meeting 2007-2010 emission regulations, 2) characterize fuel composition tradeoffs affecting the three generations of heavy-duty natural gas engines, and 3) recommend a natural gas quality specification that provides the optimum benefit balance for California. A representative developmental heavy-duty natural gas engine with stoichiometric combustion and a three-way catalyst and EGR will be tested, with the manufacturer's cooperation, to define the effects of fuel composition on emissions, performance, and fuel consumption. These tests are not now part of any manufacturer's development program. The results will be combined with available fuel property requirement information for existing natural gas engines, and also for stationary applications (e.g., appliances, gas turbines), to quantify tradeoffs and recommend an optimum natural gas quality specification.

Budget

2005: \$200,000

2006: \$150,000

Other:

Comments

Project Concept #119: Benefits Assessment & Verification Contractor for the Gas R&D Program

Athanasios (Tony) Bournakis, Ph.D., Principal Research Economist

Description

The University of Illinois at Chicago, Energy Resources Center (UIC/ERC) proposes to be designated as the Benefits Assessment and Verification (BA&V) contractor for the California Public Interest Gas R&D Program. UIC-ERC will support CEC in the following tasks: 1) Design a comprehensive Benefits Assessment and Verification methodology/strategy; 2) Implement the BA&V strategy by collecting, documenting and providing data, analysis, and information to CEC to support the goals of the Gas R&D Program; 3) Create Annual Assessments of the Economic, Employment and Environmental Impacts of the Gas R&D Program to the California Consumers and Economy.

Benefits

This project will provide CEC program/project managers with immediate access to information on the impact that the gas R&D programs/projects have on consumers, the economy and the environment. The information will allow project managers to optimize allocation of scarce resources to projects that offer greatest benefits to consumers, and most pronounced impacts on the economy and the environment. Also, it will provide the project managers and CEC with an annual report for use in reporting to the legislature, and other clients/constituents, the progress and the impacts of the California Public Interest Gas R&D Program.

Objectives

This project will provide CEC program/project managers with updated information on the impacts that the Gas R&D program has on consumers, the economy and the environment. UIC-ERC will provide the following: 1) Create a Benefits Assessment and Verification Action Plan Design. This will allow for a consistent approach in identifying the impacts of R&D projects across a wide range of alternative energy technologies, such as renewable resources, advanced generation, energy efficiency, environmental, strategic analysis, etc. 2) Implementation of the BA&V Strategy. This will include: development of a BA&V database; review existing market evaluation reports; verification of already estimated benefits (audit of existing assessments); and assessment of benefits for (not previously evaluated) gas R&D projects. 3) Create an Overall Program Evaluation Report (annually). This will provide CEC with annual quantitative evaluations of the Gas R&D Program.

Budget

2005: \$200,000
2006: \$250,000
Other: \$250,000

Comments

This project is envisioned as a long-term process, providing CEC with continuing information on the impacts of the Gas R&D Program. With the Gas R&D Program spanning a wide range of alternative energy technologies, such as renewable resources, advanced generation, energy efficiency, environmental, strategic analysis, etc., it is essential that the contractor take the time and expend the effort up front to seek and secure input from CEC staff and other stakeholders on the actual program areas that resources are invested. The principal investigator (PI) will work closely with the CEC program/project managers in the identification and evaluation of the benefits from the Gas R&D projects. The PI will commit up to 2 weeks per month in Sacramento to facilitate a close interaction with the program/project managers. Engaging the appropriate staff and stakeholders early in the process and utilizing their input while developing the BA&V strategy and the benefits assessments, will help to ensure that CEC project managers take "ownership" of the BA&V strategy and support its implementation. Also, UIC-ERC will work closely with Gerald D. Pine, CEC consultant, currently working on benefits assessment for the PIER program, to create a benefits assessment program that would be applied consistently to both gas and electric R&D programs.

Project Concept #120: Public health benefits of natural gas emissions

Lobscheid, Agnes and Thomas McKone

Description

This project quantifies public health impacts of natural gas energy generation in a form that allows decision makers to assess the relative costs and health benefits of end-use efficiency relative to plant modifications. Specifically, this project explores how residential end-use and supply-side technologies translate to decreased disease burdens. Over 30% of California's energy needs are supplied by natural gas technologies. In addition, natural gas is California's single largest fuel source (approximately 33% or 100,000 GWh in 2002) for electricity generation. Our preliminary estimates indicate that for each MWe online generated from natural gas power plants, over 30kg each of PM2.5 and SO2, and over 1000kg of NOx are emitted to the atmosphere. Many of these power plants are ideal candidates for cogeneration technologies, leading to plant efficiencies greater than 80%. However, only 30% of the online MWe capacity (CEC, 2004) from natural gas involves plants with cogeneration technologies.

Benefits

This project's case studies will demonstrate the public health benefits of energy efficient technologies applied to natural gas generation and end-use, ultimately resulting in savings for diseases averted and energy infrastructure. This project will allocate impacts both spatially (urban vs rural regions and by air basin) and temporally (season). All supporting databases developed will be made available to the public for further exploration of how various end-use and supply-side technologies can minimize emissions while maximizing the amount of energy extracted from the supply of natural gas. This project promotes the goals of the California Energy Action Plan in terms of supporting the most cost effective and environmentally sound strategies, especially in light of supply concerns regarding the quality of natural gas and the distance it is transported.

Objectives

In order to quantify reductions in disease burden this project characterizes source-to-dose relationships for California population from atmospheric emissions of toxic pollutants produced from natural gas combustion, including NOx, SO2, PM2.5, and toxic polycyclic aromatic hydrocarbons (including benzo(a)pyrene and toluene). This project includes data and model evaluation (sensitivity and uncertainty) of several case studies that analyze how residential end-use efforts, such as installation of higher R-value insulation, higher seasonal energy efficiency ratios of air conditioners, and energy efficient tinted windows (increased U-values) translate into reducing disease burdens from natural gas base-load and peak power plants. This project compares the reduced disease burden resulting from these residential end-use modifications with modifications made at the plant level, specifically increasing the overall efficiency of power generation by introducing combined heat and power (cogeneration) technologies.

Budget

2005: \$100,000

2006: \$100,000

Other:

Comments

This project relies on the following, non-inclusive, list of information sources: the Database for Energy Efficient Resources 2001 Update, USEPA AP42 emission factors, the RETScreen International, Title 24 of the California Code of Regulations, and the CEC's database on power plants in California that generate greater than 0.1 MWe online. The collaborators on this project are currently involved in the final phases of a related study to address the public health benefits of end-use electrical energy efficiency in California, taking into account the entire mix of electricity generating fuels, under the CEC's PIEREA Exploratory Grant Program. The PIER EA research involves development of a framework and evaluation of a single case study (residential fiberglass attic insulation installation). The project suggestion we are submitting to the Natural Gas Research Program will build on the framework we developed for the PEIR EA exploratory grant and includes additional pollutants as well as considers various energy technologies related to natural gas energy generation. The primary collaborators on this project

are: 1) Thomas McKone, Senior Scientist and Deputy Department Head at the Indoor Environment Department, and Adjunct Professor of Public Health, Environmental Health Sciences, University of California, Berkeley. He is a leading authority on human exposure assessment and his large body of pioneering work encompasses environmental fate and transport, uncertainty analysis, life-cycle impact assessment, development of multimedia models to characterize human exposures to environmental contaminants and development of public health policy. 2) Agnes Lobscheid, a recent PhD graduate (2004) of the Environmental Health Sciences at the University of California, Berkeley under the mentorship of Thomas McKone. Her research focuses on assessing human exposure to pollutants released to the atmosphere from combustion-related processes. Her work includes analyzing data from various energy related sources and multimedia modeling of atmospheric emissions to characterize source-to-dose (human receptor) relationships.

Project Concept #121: Low-Cost, Low NOx, 100% Premixed Natural Draft Water Heater Burner

Brady Krass

Description

AMTI proposes a residential water heater using a 100% premixed burner with a sealed combustion chamber to meet the goals of SCAQMD 15 ppm NOx emissions and CPSC explosion proof requirements. Applying both NOx reduction and explosion proof components to conventional natural draft water heaters would increase the initial cost and result in consumers purchasing more inefficient electric water heaters. Electric water heaters use more energy than direct-fired gas water heaters due to electric generation and transmission losses. A low cost, low NOx gas fired water heater would be competitive with electric water heaters and overall use less energy and create less pollution.

Benefits

Many residential hot water heaters in the California are electric, and typically operate during peak demand periods. Electricity supplied to the water heater is about 30% to 50% efficiency due to generation and transmission losses. Storage losses reduce the net water heating efficiency by another 10% to 15%. In contrast, a gas-fired water heater typically converts 55% to 75% of the gas heating value into useful hot water. Thus, electric water heaters consume two to three times the source energy and emit correspondingly more CO2 per unit of hot water compared to gas-fired water heaters.

Objectives

AMTI invented a burner as part of a DOE funded project to develop a high efficiency gas-fired hot water heater. The project resulted in a working prototype natural draft burner that produced very low levels of NOx and CO. A development project to optimize the design and reduce the cost of this burner to be cost competitive in an explosion-proof water heater would make this technology available to a wide range of gas combustion applications. The goal of the proposed project is to achieve a simple, compact, inexpensive-to-produce burner, while maintaining its low NOx emission quality.

Budget

2005: \$100,000

2006: \$150,000

Other: \$100,000

Comments

Commercialization of the resultant burner and water heater from this project will result in efficiency gains at the point of use by decreasing stand-by losses because of the compact combustion chamber design, offset peak electrical demand by replacing inefficient electric water heaters. It will also reduce the CO2 generation by operating at an overall higher efficiency, and simultaneously meet the explosion proof and NOx emission requirements by use of a 100% premixed burner system.

Project Concept #122: Minimum Effort Tight Duct System

Skip Mandracchia, Proctor Engineering Group

Description

In most HVAC systems, ducts deliver all of the heating and cooling to conditioned spaces. Any duct leakage translates directly into extra air that must be supplied increasing the effective heating and cooling loads as well as the required fan energy due to increased flow and/or run time. Proctor Engineering Group is developing a duct joining system that, in a single design provides an air-tight seal and a snap together locking mechanism. Traditional duct interconnections are accomplished using three sheet metal screws and sealed using duct tape. Unfortunately, the sealing effectiveness of duct tape degrades over time. Sealing with mastic or aerosol instead of tape improves sealing effectiveness; however, these methods of sealing are costly and time consuming. By design, the Snap-Duct(TM) system has none of these problems.

Benefits

Performance tests conducted at Proctor Engineering Labs, and confirmed by Lawrence Berkeley National Laboratory, show the Snap-Duct(TM) standard joint leakage to be approximately 0.05CFM. Identical tests performed on a standard duct joint using the three screw assembly method yielded leakage levels of 1.4CFM. Based on these test results Snap-Duct(TM) technology reduces joint leakage by more than 95 %. There are approximately 1.4 million homes manufactured in the U.S. per year. Approximately 93% of those, or 1.3 million, will have ducted mechanical systems. Assuming 1.4 Quads of energy loss due to duct leakage per year. Snap-Duct(TM) technology has a potential primary energy savings of at least 1.33 quads per year.

Objectives

Proctor Engineering Group's commercialization strategy is to develop the technology to maturity and license the technology to manufactures that currently have a strong presence in the HVAC industry. Execution of the strategy involves several critical steps. First, the technology must be developed. Next, a strong intellectual property protection strategy must be executed by obtaining patents, trademarks, copyrights, trade secrets, etc. Finally, the technology must be packaged and transferred to potential Licensees. Currently, Proctor Engineering is finalizing the Snap-Duct system design and evaluating manufacturing licensees. Remaining work includes further development for duct fixtures and transitioning the standard Snap-Duct(TM) joint from laboratory prototype to a reproducible design in a manufacturing environment. Accordingly, the 2005 budget will primarily be used to fund technology development and testing, intellectual property protection, finding a licensee, and field testing Snap-Duct(TM) systems. The 2006 budget will focus on bring the technology to market.

Budget

2005: \$150,000

2006: \$175,000

Other:

Comments

The Snap-Duct(TM) system's level of technical quality has been assured since its development under a Department of Energy CRADA with Lawrence Berkeley National Laboratory. To date, Proctor Engineering Group has been issued two patents (6,279,967, 6,193,285), one pending S/N: (09/753,122), and is in the process of obtaining Snap-Duct(TM) as a trademark, solidifying PEG's intellectual property position.

Project Concept #123: Enhancing Power Generation Efficiency with Concomitant CO2 Capture

Paul K.T.Liu

Description

Rising atmospheric CO₂ concentrations have encouraged research into capturing/storing CO₂ from power-plants. H₂ and electricity co-production with simultaneous CO₂ capture is thought as a promising way to accomplish this goal. In the typical co-production configuration natural gas (NG) is steam reformed to synthesis gas (SG) at ~ 100 bar ; CO in SG is converted to H₂ in a water-gas-shift reactor (WGSR). H₂ is purified by PSA. The purge gas from PSA, after recompression, is fed to a gas turbine (GT) for power generation. To capture the CO₂, absorption is used to treat the WGSR output, prior to entering the PSA unit, for CO₂ removal. The advantage of this technology is its ability to produce pure H₂ to be utilized in PEM fuel cells. The disadvantage, results from the energy required for recompressing the PSA purge for use in the GT, and for liquefaction (70 -80 bar and 25-30°C) of the CO₂ that is separated from the absorber for sequestration. Our solution is to implement the PEMFC/GT process using our innovative H₂ selective membranes. Combining PEMFC with GT doubles the power generation efficiency; the challenge for PEMFC, however, is the availability of high purity H₂. Our unique membranes can produce pure H₂ from the steam reformed NG. The remaining stream, after H₂ separation, is primarily CO₂ at ~100 bar, which is ready for sequestration after chilling. Thus, the cost for separation and compression of CO₂ for sequestration is avoided.

Benefits

The proposed process offers several unique advantages and benefits, as outlined below:

- The power generation efficiency can be enhanced to as high as 75% with the hybrid PEMFC/GT process. Doubling the power generation efficiency, means a 50% reduction in NG demand.
- Minimal cost increase for the CO₂ sequestration step, primarily for delivery and disposal. CO₂ capture, the main cost item, is built-in in the proposed process. CO₂ capture through power generation is an effective sequestration avenue, as opposed to the capture through dispersed sources.
- The proposed process promises great capital cost reduction as a result of the use of process intensification; this results from replacing the scrubber, the compression, and PSA units, with a simple membrane unit together with a cooler.

Objectives

The key objective of the project is to demonstrate the proposed PEMFC/GT power generation process with built-in CO₂ capture ability. Our team is composed of Media and Process Technology Inc. (M&PT), a membrane developer and supplier, the University of Southern California (USC) and the Southern Company. M&PT and USC will responsible for membrane process development, and for testing the individual aspects of the technology at the bench-scale. The Southern Company will perform system integration, and will offer its expertise to assess the proposed technology in terms of power generation efficiency, heat recovery, and operating economics. In addition, the Southern Company will make the Wilsonville facility available for pilot-testing of our proposed technology.

Budget

2005: \$350,000

2006: \$350,000

Other:

Comments

- The major technology blocks involved in this innovative process, including methane steam reforming (SMR), PEM, GT, are commercially available. Our proposed hydrogen selective membrane technology, currently under field tests in major refiners, will play a pivotal role in bringing this highly efficient power generation process with concomitant CO₂ capture into commercial reality.
- We address a California-unique issue. U.S. DOE has placed its main focus on CO₂ sequestration for coal-based power generation, due to the projected cost advantage in coal. Their focus is using SOFC instead of PEMFC. Unfortunately, SOFC remains to be developed. Our proposed hydrogen selective membrane allows us to implement the PEMFC/GT process for NG power generation
- When producing

H₂, removing CO₂ from the syngas is worthwhile even if CO₂ is eventually vented because: (i) it substantially increases the heating value of the PSA purge gas so as to make feasible its use in a GT following compression; (ii) it reduces the size (and thus the cost) of the PSA system.

Project Concept #124: Low Cost - No Cost Therm Reduction

Jon Lee

Description

Target industrial, commercial, agricultural and residential core customers with a desire for reducing energy consumption and that may not have the financial resources for new or updated equipment. By testing their equipment and analyzing the normal daily operation, A Low Cost – No Cost alternative is provided that minimizes operational impact.

Benefits

This is a Low Cost, No Cost program. With minimal time and small operational variance the probability of the end user implementing suggested changes are very high. Complies with the California Energy Action Plan, supports the State Energy Policy. Reduces Natural gas consumption and the environmental impact associated(emissions). An average therm reduction of 11.1% has been seen in test cases. The average use per case was 213,448 therms.

Objectives

1. Reducing the End – Users consumption of natural gas. 2. Comply with stated State and CPUC policies. 3. High participation from end – user because of low or no capital investment. 4. A reduction in natural gas consumption by large users will benefit small users by keeping rates low and supply available. 5. Fill a gap not serviced by any other energy efficiency program. 6. Reduction of environmental impact.

Budget

2005: \$112,500

2006: \$169,500

Other: \$177,975

Comments

Project Concept #125: BioMethane to Gasoline and Chemicals

Jeffrey H. Sherman

Description

The goal of this project is to demonstrate the capability of the patented GRT Cataloreactant Process to convert biomethane to gasoline and chemicals in a 10 to 20 BBl/day pilot plant. The State of California estimates that over 30,000,000 metric tons of methane are released to the environment each year. Converting this biomethane to gasoline would result in the production of over 6 billion gallons of gasoline could be produced (equivalent to over 1/3 of the demand for gasoline in the State of California). GRT, along with the University of California Santa Barbara, have successfully demonstrated the technology in a reactor designed to produce 1 gallon per day of high octane gasoline from methane. Eight US patents have been allowed on the technology to date. The data collected so far on the process has shown that for each 10,000 cubic feet of methane, 42 gallons of gasoline can be produced.

Benefits

The quantity of methane released within the State of California (30,000,000 metric tons annually) represents a virtually untapped resource and a substantial contributor to global warming (methane is 25 times more potent than carbon dioxide as a greenhouse gas). Converting methane to gasoline will correct both of these problems while greatly reducing the dependence of the State of California on imported oil and gasoline. Additionally, the gasoline produced by the process will be considered a renewable fuel and help the State achieve the Renewable Fuels Content requirement of the new US Energy Policy Act.

Objectives

Successfully demonstrating the technology at the 20 BBl/day scale will serve as strong evidence that the GRT technology can be efficiently scaled to convert biomethane to gasoline. Important outcomes include 1) confirming that the high levels of carbon dioxide as well as other biomethane contaminants can be successfully managed by the process; 2) heat generated by the exothermic process reactions can be successfully managed and used for cogeneration of electricity; 3) that the gasoline product is acceptable for gasoline blending.

Budget

2005: \$4,000,00

2006: \$6,000,00

Other: None

Comments

GRT will use the funding provided by the State of California to design and construct the 20 BBl/day pilot plant. The technology, jointly developed by GRT and the University of California Santa Barbara, has already resulted in several partnerships for the commercialization of the technology using non-renewable sources of hydrocarbons (natural gas and crude oil). Funds are sought from the State of California to extend the utilization of the technology to include biomethane, a renewable resources. In 2006, we will complete the design and begin construction of the pilot plant facility. In 2007, we will complete the construction of the pilot plant and operate the facility. Funding for a demonstration facility capable of producing up to 1000 BBl/day of gasoline will come from GRT or from private sector companies interested in using the technology.

Project Concept #126: Nanotechnology gas flow sensor based flowmeters

Mr. Prasanna Chitturi

Description

A new CNT(carbon nano tubes) and/or silicon-based sensor technology is now available. The results of this research were published in the Physical Review Letters of The American Physical Society by Sood et al in August 2004 (Vol 93, No. 8). TRIDENT Metrology based in Hillsboro, Oregon has licensed this technology (patents pending in all major markets worldwide) to commercialize it for use in Natural Gas and Industrial Gas applications. The passive nature of these sensors (requires no energy input, either electric or thermal) and their miniature size coupled with mechanical strength and chemical resistance lend them to be used in harsh environments.

Benefits

(1) Higher accuracy - accurately profiling flow at multiple points in a pipe cross-section. We anticipate <0.5% of flow; (2) Lower operating costs - practically zero pressure drop, most likely do away with flow conditioners, no requirement to stop flow for any cleaning maintenance or parts replacement (will use extraction tool); (3) Greater reliability and uptime - no moving parts, oil creep in pipeline not an issue; (4) Extendability: Can be applied to 48-inch through <1-inch pipe diameters; (5) High turndown ration - 150:1 already demonstrated.

Objectives

To design and build robust working prototypes, characterize them in lab, simulate flow design using computational fluid dynamics, design and build the electronics, communications, and overall flowmeter design. All flowmeter layout, design, test, and calibration to be done in partnership with SwRI (Southwest Research Institute) in San Antonio, Texas. To include 12-month beta testing in NG Transmission and Distribution lines and at select sites for industrial gases.

Budget

2005: \$1,200,000

2006: \$1,600,000

Other: \$800,000

Comments

Project Concept #127: Increasing Underground Gas Storage Capacity Using Hydrate Technology

Dr. Ram Sivaraman

Description

Gas storage allows the efficient use of the supply and transportation assets while meeting widely varying seasonal gas demands. California needs to increase storage capacity at reduced costs to meet its peak natural gas demand needs. Gas Technology Institute and West Virginia University have developed a promoter-enhanced gas storage concept to convert natural gas to hydrates and allowing low pressure hydrate storage at temperatures up to 80° F. This enables the gas industry to utilize aquifer storage and depleted gas/oil fields for gas hydrate storage with 3 to 4 times the energy content in the same space, thereby providing a cost-effective, near-market solution for California seasonal energy demands.

Benefits

The application of Promoters to convert natural gas to gas hydrates at elevated temperatures will enable the ability to utilize aquifer storage, and depleted gas/oil fields for natural gas hydrate storage with 3 to 4 times the energy in the same space. Therefore, underground hydrate storage systems could be developed in additional sites close to major gas markets where traditional underground gas storage has not been possible. The proposed gas hydrate storage technology would be an effective, near-market, solution for California peak natural gas demand needs.

Objectives

The objective of this proposal is to determine the technical and economic feasibility of a promoter-enhanced underground natural gas storage system using hydrates as the storage medium. The research team will define and determine the engineering parameters (temperature, pressure, and depth ranges; system capacity, and storage rates) associated with the storage of the promoter-enhanced hydrates followed by field tests to evaluate system performance and economics.

Budget

2005: \$350,000

2006: \$350,000

Other: None

Comments

The project would require approximately 24 months to complete. 2006: Phase I: Feasibility study of hydrates as alternate natural gas storage technology
2007: Phase II: Field Testing and Gas storage capacity evaluation
California Storage Operators (PG&E and Sempra Energy) will be test site coordinators.

Project Concept #128: Natural Gas Energy Efficiency for Seniors in Older

Rusi F. Patel and James Fay

Description

Seniors' need for space heating and water heating are generally higher than the rest of the population. However, at the same time, they occupy older houses compared to the rest of the population. We propose to develop, market and implement a comprehensive natural gas conservation program for seniors living in older residences. The package would comprise of envelope improvements, space and water heating equipment efficiency improvements, and general maintenance and re-commissioning type improvements. The program would include marketing / outreach, education, financing and implementation. In addition, we would leverage the existing programs to serve this hard-to-reach population.

Benefits

This program strengthens the weakest link and reaches a hard-to-reach population. In senior households the need for space and water heating is high and there is higher likelihood of the residence being older and not as efficient as in the general population. According to EIA's 2001 Residential Energy Consumption Survey (RECS), 2.4 million homes in California were built before 1950 and 6.7 million before 1970. Also, there are 4 million homes headed by someone 55 or older and over 1 million headed by 75 or older. Targeting these older residences headed by senior citizens, will result in substantial energy savings (10% to 15%) and corresponding environmental benefits. In addition, jobs will be created in California for the retrofit program.

Objectives

The key objective is to market gas conservation program, design packages of gas conservation measures and implement retrofits in at least 500 older residences with at least one senior resident each year. Total of 1500 residences will be retrofitted over a three year period. - Develop packages of gas conservation measures for older dwellings - Prepare marketing materials aimed at the senior population - Market to seniors living in older residences through education. - Implement packages of natural gas conservation measures in older residences with seniors - Track and feedback results on an ongoing basis - Coordinate with and leverage other CPUC - CEC programs

Budget

2005: \$1,200,000

2006: \$1,000,000

Other: \$1,000,000

Comments

The fact that a disproportionate share of seniors live in older residences and that these residences are generally less energy efficient, especially space and water heating, demands our attention. The program described not only sets up the required program, but also delivers 1500 retrofitted residences over a three year period. The program can be accelerated or slowed down, depending on the availability of funds.

Project Concept #129: Environmental/Economic Impacts from CHP at Landfills

Steffen Mueller, PhD

Description

The University of Illinois at Chicago, Energy Resources Center (UIC/ERC) proposes to assess: 1)The natural gas reduction potential provided by the installation of Combined Heat and Power Systems fueled by Landfill Gas at municipal solid waste landfill operations (CHP/LF). 2)The environmental benefits (emissions reductions and odor control) from CHP/LF. 3)The economic benefits (net job growth) from CHP/LF.

Benefits

This project will provide CEC with information on: 1)The cost of landfill gas (\$/MMBtu) relative to the cost of natural gas. 2)The benefits of CHP/LF systems to consumers (i.e. the landfill operators) from substituting natural gas with landfill gas. 3)The emissions reductions (SO₂, NO_x, CO₂, Hg) associated with CHP/LF generated electricity in California (tons per year) compared to the emissions from current electric generating facilities. 4)The electric generating potential (in MW) from optimized CHP/LF technology in California. 5)The cost of CHP/LF generated electricity (\$/kWh) relative to the cost of existing generating facilities. 6)The potential job growth from promoting CHP/LF looking at the shifts in employment for various industrial sectors (for example, growth in equipment manufacturing vs. reductions in fuel imports) from increased CHP/LF deployment. 7)The odor reduction potential from CHP/LF systems relative to population growth.

Objectives

A recent USEPA statistic indicates that California has the highest number of operational landfills in the US that are good candidates for electricity generation (119). Several of these landfills operate some form of electric generating or boiler systems. However, very few landfills operate an integrated/optimized landfill gas collection, electric generation, and heat recovery process, thereby foregoing substantial environmental and economic benefits. This project will provide CEC project managers with immediate information on the reductions in natural gas usage that can be achieved from substituting natural gas with optimized landfill gas recovery for CHP application purposes. Furthermore, this report will quantify the environmental benefits (emissions and odor reductions) as well as the job growth benefits associated with increased deployment of CHP/LF technologies. Such information will allow CEC to correctly evaluate investments in this area.

Budget

2005: \$110,000

2006: \$30,000

Other:

Comments

With the California Public Interest Gas R&D Program spanning a wide range of alternative energy technologies, such as renewable resources, advanced generation, energy efficiency, environmental, strategic analysis, etc., it is essential that the contractor takes the time to seek input from CEC staff and other stakeholders. The PI will commit up to 1 week per month of time in Sacramento to facilitate the close interaction with the project managers.

Project Concept #130: Real-Time XRF Nanotool for Underground Gas Storage Well Bores Integrity

Dr. Ram Sivaraman

Description

Scales, corrosion and precipitates plugging in gas storage well bores cause gas deliverability decline of 5 to 20%. The mineral scale formation assessment in well bores is complicated due to the range of storage conditions. GTI, Bay Energy - California and Rice University, propose to develop and demonstrate a real-time Nano XRF tool for in-situ identification and quantification of scale in gas industry storage lines and well bores with California gas storage operators (Southern California Gas and PG&E). Appropriate cost-effective precipitate removal and prevention procedures will be established. The project goals include improved well bore integrity, gas deliverability and reduced O&M costs.

Benefits

- Improved gas deliverability by up to 20% from underground gas storage facilities
- Improved reliability in identifying scale characteristics such as composition, quantity, growth rate, and location within well bore
- Accurate, real-time, analysis provides environment for effective and timely decisions regarding mechanical, biological, or chemical treatments
- Potential for XRF Nano-tool to be run along with other wire line tools, significantly reducing operating costs
- Knowledge of growth rates, location, and composition provides ability to create proactive remedial programs designed to maintain well bore and gas storage asset deliverability while reducing O&M costs

Objectives

The project objective is to enhance supply deliverability and reliability of underground gas storage facilities by real-time identification of locations where scaling or precipitate formation require treatment. The GTI team proposes to modify and demonstrate an in-situ x-ray fluorescence tool to identify the presence and type of scaling in gas storage well bore and piping so appropriate treatment can be applied to prevent them. This tool can be used with wire line equipment in all common sizes of casing and tubing strings used in gas storage operations, and is integral to developing a cost-effective gas storage well bore maintenance program.

Budget

2005: \$450,000

2006: \$400,000

Other: None

Comments

The project would require approximately 24 months to complete. 2006: Phase I: Nano XRF tool modification for in-situ and real-time identification and location of scales and precipitates in gas storage well bore 2007: Phase II: Field demonstration, testing of the device and ready for commercialization Equipment commercialization and development partner Bay Energy Company is based in San Francisco, CA. California Storage Operators (PG&E and SOCAL) will be field test site coordinators.

Project Concept #131: High Efficiency Commercially Viable Solid Oxide Fuel

Craig R Horne

Description

The project will develop unique high performance SOFC stacks containing advanced cells, interconnects, and seals using a novel, low-cost fabrication process. Novel cells with electrocatalyst gradients in electrodes along fuel and oxidant flow paths and protective coatings on metal interconnects will be fabricated. Cells with higher electrocatalyst composition at gas outlets will have lower thermal gradients (reducing stresses within the cells and strains on seals) and increased fuel utilization, thereby increasing durability and efficiency, respectively. High durability interconnects will comprise cathode- and anode-side protective coatings on ferritic stainless steel. Stacks designed to leverage these attributes will be developed and tested

Benefits

These novel SOFC stacks will increase net electrical power generated per BTU of natural gas. High efficiency, high durability, and low cost combine to lower generation costs. High durability and low manufacturing cost enable mass commercialization. SOFCs virtually eliminate emissions. Furthermore, proposed process substantially reduces SOFC manufacturing environmental impact.

Objectives

Achieve <1% degradation per 5000 hours and exceed 90% fuel utilization. Gradient electrode and metal coating fabrication plus stack design completed in 2006. Stack fabrication and testing in 2007. Commercialization targeted for 2009

Budget

2005: \$300,000

2006: \$600,000

Other: \$1,800,000

Comments

Project Concept #132: Development of TCR with Process System-Waste Heat Recovery

Harry Kurek

Description

One approach for utilizing the energy contained in waste heat is called TCR (Thermochemical Recuperation). TCR is a technique that recovers sensible heat in the exhaust gas from an industrial process, furnace, or engine and uses that heat to transform the fuel source into a "reformed" fuel with a higher total calorific heat content. Calorific heat in the exhaust can be recovered as well if the exhaust gas can be burned out in the TCR. This project will encompass development of a laboratory scale unit and testing the TCR technology for selected processes specific to California high temperature industrial furnaces.

Benefits

1) Decrease in the fuel rate for large industrial furnaces in glass, metals heating processes between 20 – 40% Reduction of NO_x, CO and CO₂ emissions. If 10% of the population of industrial furnaces in the State of California were retrofitted with the TCR technology, the resultant annual emission reductions are estimated to be: (1.5 trillion BTUs), (460,000 NO_x-lbs, 60,000 CO-lbs), and (20,551 CO₂-metric tons)

Objectives

The "reforming" process uses the waste heat plus steam (water vapor) and/or (CO₂) to convert the fuel into a combustible mixture of hydrogen and (CO), increasing its calorific heat content by up to 28% (with the TCR process) if the original source fuel is natural gas. The fuel becomes preheated during the TCR process, adding sensible heat content to the fuel. In the TCR process, steam, CO₂, or both can be reacted with natural gas (hydrocarbons). Because both steam and CO₂ can be utilized in the TCR process it is advantageous for an air-fuel fired system since both of these gases are major products of combustion and are therefore readily available in a preheated state. Further, they can be used in the same 2:1 ratio as they exist in the combustion products. GTI will utilize extensive prior analysis done in-house and with its partners to build and test a prototype system under conditions simulating industrial furnace conditions to prove the concept prior to full-scale prototyping.

Budget

2005: \$500,000
2006: \$500,000
Other: \$500,000

Comments

Project Concept #133: Deployment of the Reverse Annulus Single Ended Radiant Tube (RASERT)

Harry S. Kurek

Description

GTI proposes to finalize development and demonstrate the Reverse Annulus Single Ended Radiant Tube (RASERT), a novel concept which will provide substantial energy, environmental and economic benefits to the State of California. The RASERT has broad applicability in heat treatment processes that are found in captive and commercial heat treating operations that use either gas-fired radiant U-tubes, straight-through tubes, gas-fired SERTs or resistive elements. When fired at or near maximum temperatures, conventional tubes can fail in less than 10 months due mainly to creep, thermal shock, carburization, melt through, and oxidation. Recent experience with RASERT technology indicates expected life at least twice as long, with 20% increase in available heat.

Benefits

The table below is a sampling of a series of initial tests conducted comparing the current prototype RASERT with a conventional SERT.

PERFORMANCE METRIC	RASERT	Commercially Available SERT	Tube Temperature
Uniformity – HSOA	10° F	20° F	Average Outer Tube Temp
(Available Heat)	68%	62%	NOx Emissions (@ 3% O2)
Outer Tubes	50° F	130° F	Estimated benefits for the State of California, are:
0.23 NOX-LBS	330,000	CO- LBS	10,000
198,000 MWH/YEAR		CO2-METRIC TONS	3,700
		Electric-to-Gas Conversions	

Objectives

The project objective is to optimize and validate the RASERT design with respect to burner efficiency, lower emissions, radiant tube temperature uniformity and lower internal tube temperatures. The result for the end-user will be quantifiable: energy benefits, without emissions penalty and service life benefits. A Reverse Annulus SERT (RASERT) is being developed by GTI and North American Manufacturing Company (NAMCO) as follows. Earlier concept tests at NAMCO's facility have shown that the temperature differential between the outer tube and the inner tube of the RASERT is less than 100° F (50% less than the SERT), and that NOx at air preheat greater than 1000° F is nominally between 50 - 75 ppmv NOx (40% lower than the SERT). The RASERT was tested at GTI to develop additional information not obtainable at NAMCO. GTI carried out base line tests on a commercially available SERT and the results are being used as the reference line to compare metrics.

Budget

2005: \$200,000

2006:

Other:

Comments

Project Concept #134: Sequestration of CO2 Emissions through Biocatalytic Mineralization

Diane Saber

Description

On June 1, 2005 Governor Arnold Schwarzenegger signed an Executive Order committing California to an ambitious program to reduce CO2 emissions. To be in compliance with this policy, gas and electric utility industries may reduce their CO2 emissions by: (1) displacing higher emitting fossil fuels with lower emitting fuels or non-emitting energy sources, (2) improving the efficiency of generation, transmission, and distribution, and (3) implementing a CO2 sequestration program. Of the three options for reducing CO2 emissions, the third option is the subject of this proposal. Specifically, GTI proposes to ultimately construct a working pilot-scale bioreactor that can efficiently and effectively sequester CO2 emissions using an enzyme based system. This research may provide an option for elimination and control of CO2 emissions, regardless of power demand using existing carbon based fuel supplies. As a first step towards this end, a feasibility study is proposed.

Benefits

The scope of this work is to demonstrate a biocatalytic process for sequestering CO2 emissions. The first step of the program will be a feasibility project to analyze and verify an economic scaleable enzyme system capable of transforming carbon dioxide gas to carbonate salts. The proposed enzyme system has proven success in other applications, but a detailed cost to achieve success in CO2 sequestration can be estimated through an initial feasibility study. Other parameters may be included in this study, to more accurately estimate schedule and limitations for a full-scale process. The initial feasibility study will include Analysis of genetic engineering and biochemistry of systems useful in CO2 bio-sequestration. Engineering analysis, including cost modeling of a full scale reactor system. Economic, and performance modeling and analysis.

Objectives

1. The outcome of this proposal provides three distinct benefits: 2. A detailed analysis and risk reward statement of a self-contained reactor/recovery chamber that studies the viability of CO2 bio-sequestration. 3. Detailed description and economic modeling of a system that creates non-hazardous, solid material managed with minimal cost. 4. A plan for a biocatalytic system capable of generating CO2 sequestration data for use on large scale

Budget

2005: \$93,000

2006:

Other:

Comments

The total anticipated project timeline: 9-12 months

Project Concept #135: Chemical CO₂ Mitigation of Natural-Gas-Fired Power

Greg H. Rau

Description

The project will investigate power plant CO₂ mitigation options that exploit the chemical reactivity of CO₂ to extract and concentrate this gas from waste streams and/or to form storable or usable carbon compounds. Examples include CO₂ capture and neutralization with wet limestone (Rau and Caldeira, 1999 and 2005), use of waste CO₂ as an oxidant in H₂-producing fuel cells (Rau, 2004), and novel CO₂ capture/separation schemes (e.g., Trachtenberg et al., 2005). With the recognized need to reduce the State's CO₂ emissions (Schwarzenegger, 2005; CEC/CPUC, 2005), the project will critically evaluate processes that would allow natural gas to continue to be California's primary energy source while reducing the urgency to transition to more costly/risky, carbon-neutral options (biomass, solar, nuclear).

Benefits

The release of CO₂ from fossil fuel combustion (e.g. natural gas) is dramatically increasing atmospheric CO₂. This is anticipated to negatively impact California climate and water supplies (UCS/ESA, 1999). Secondly, the air-sea invasion of much of the released CO₂ will acidify the ocean (TRS, 2005) impacting the State

Objectives

1) Select chemical processes that exhibit promise in inexpensively reacting CO₂ out of conventional power plant flue gas waste streams, forming concentrated CO₂ or other compounds that are useful or storable. 2) Partner with industry (Duke Energy, Babcock and Wilcox, Nexant, Carbozyme, Inc), government (LLNL), and academic (U. Calif.) researchers to rigorously evaluate the practicality and economics of applying the preceding processes to mitigating CO₂ from current and future power plants. Evaluation will include experimental tests in both laboratory and field settings, as well as computer modeling to determine performance, cost, impacts, and safety at large scales. 3) Compare these results to other CO₂ mitigation options to determine appropriate regional to statewide marketing and mix of CO₂ mitigation technologies.

Budget

2005: \$700,000

2006: \$700,000

Other: \$400,000

Comments

References: CEC/CPUC. 2005. Draft Energy Action Plan II. State of California, Sacramento. Rau, G.H. 2004. Possible use of Fe/CO₂ fuel cells for CO₂ mitigation plus H₂ and electricity production. Energy Conversion and Management 45: 2143-2152. Rau G.H., Caldeira K. 1999. Enhanced carbonate dissolution: A means of sequestering waste CO₂ as ocean bicarbonate. Energy Conversion and Management 40:1803-1813. Rau G.H., Caldeira K. 2005. Method for extracting and sequestering carbon dioxide. United States Patent 6,890,497. Schwarzenegger, A. 2005. Executive Order S-3-05. State Of California, Sacramento. Trachtenberg M.C., Bao L., Smith D.A, Goldman S.L., Wu X. 2005 Enzymatically driven, cost-efficient, capture of flue gas CO₂. DOE/NETL 4th Ann. Carbon Capture and Sequestration Meeting. Alexandria, VA. TRS. 2005. Ocean acidification due to increasing carbon dioxide. The Royal Society, London. UCS/ESA. 1999. Confronting Climate Change in California. Union of Concerned Scientists/The Ecological Society of America, Cambridge, MA.

Project Concept #136: GIS-based Field Notification of Protected Wetlands/Endangered Habitats

Diane Saber

Description

Gas and electric utilities, especially within the state of California, often own and manage thousands of acres of diverse land regions, from mountainous areas to ocean coastlines, and deserts to wetlands. Various construction, maintenance, and repair projects by the utilities may involve access through, onto or across these areas. The strategy for this procedure is of particular importance when the target regions are environmentally-sensitive areas, such as protected wetlands or habitats for endangered/threatened species. There is a need for a small, easy to use and verifiable device that can accurately notify both engineers and oversight agencies of these sensitive zones, so that construction and/or encroachment within these areas is avoided. The device should interface with databases containing up-to-date information, regulations and prioritized decisions points for accurate decision-making.

Benefits

The gas and electric utilities will have an up-to-date and comprehensive wetland/endangered habitat GIS database and a portable and user-friendly device that can accurately notify construction engineers of protective wetlands zones when they are performing field construction and/or rehabilitation activities. Additionally, this device will incorporate current information regarding wetlands and endangered environments. It will be designed for real time input of new information and possess built-in backup justifications.

Objectives

A GIS-based technique is an ideal solution for notifying field engineers of protected wetlands/environmentally sensitive areas at or in the vicinity of their target construction and/or rehabilitation area. In an effort to make this tool portable, accurate and easy to use, GTI proposes to create a program which integrates input and requirements from key agencies and stakeholders, in order to compile a comprehensive wetlands/endangered habitat GIS database. The database would then be uploaded onto a handheld GPS device for field crews and oversight agencies to use while in the field.

Budget

2005: \$140,000

2006: \$60,000

Other:

Comments

The proposed work will be completed in 24 months. Task 1 will take 6 months; Task 2 will take 10 months; and Task 3 will take 8 months. The scope for this proposed work can be divided into three main tasks. The descriptions for these tasks are as follows. Task 1: Search and Compile Available Wetlands GIS Data A detailed search for available wetland/endangered habitat GIS data will be performed. Representatives from key California agencies and other influential parties will be consulted as to appropriate input to the initial database. Some wetlands GIS data are available for download from the internet. Prominent sources for data input will be consulted. The results from this search will be compiled into type (e.g., type of wetlands, area, etc.), region of wetland coverage (e.g., city, county or environmental region), scale of the data (e.g., 1:250,000, 1:24,000, etc.), and the date that the data were collected. A similar process will input data regarding other environmentally sensitive regions. Task 2: Load and Maintain the Wetland GIS Data on ArcView A selected set of suitable and compatible data compiled in Task 1 will be retrieved and loaded onto ArcView, a GIS-based software. Periodic searches will be performed to keep the dataset up to date. Task 3: Upload Region-Specific Wetland GIS Data onto Handheld GPS and Test its Performance in the Field Region-specific datasets will be chosen and uploaded onto a handheld GPS to test the system. The selected handheld GPS will have the capability of a mobile GIS that provides access to the wetland data, yet is also portable and easy to use. ArcPad® by ESRI or a similar system is a probable candidate for this task.

Project Concept #137: Identifying the Sources of Methane Emissions through Environmental For

Diane Saber

Description

Methane emissions can be attributed to a wide range of sources. Methane produced from biological activities is one of the biggest contributors to total methane emissions within California (e.g., microbial decomposition of organic matter that occurs within landfills). Although point sources from the natural gas industry, such as combustion and compression stations and storage tanks, are continuously monitored for methane emissions, there is still a need to identify emissions from pipelines and discern these emissions from other sources (e.g., landfills, wetlands, wastewater treatment plants, cattle ranches, etc). Because of the continuous migration and co-mingling of methane emissions within the atmosphere, determining which sources contribute most substantially to the greenhouse gas production is very important in order to achieve recent goals set forth by Governor Schwarzeneger. The Gas Technology Institute (GTI) proposes using environmental forensics to identify the sources of methane emissions in the environment. In this way, accurate source identification is achieved and source reduction, if claimed, can be verified. The proposed research will use environmental forensic analysis, specifically compound specific isotope ratio analysis (CSIR) to identify the ranges of stable carbon isotope ratios of methane from natural gases and other sources. This database can then be conveniently used to identify unknown methane sources found in the atmosphere.

Benefits

There are several benefits that can be realized for California, including: (1) obtaining a method to accurately identify low-level sources of methane in the environment, (2) achieving more accurate emissions data to help verify overall state emissions reduction, in order to meet new proposed standards, and, (3) providing a knowledge base for the future use of stable carbon isotope analysis as an effective method to verify emission reductions as the industry moves towards "Green Trading."

Objectives

Compound specific isotope ratio (CSIR) analysis has successfully been used in the natural gas industry to accurately discriminate between MGP-related polycyclic aromatic hydrocarbons (PAHs) and urban background PAHs in soil and sediment. CSIR analysis is a technique that GTI has extensively developed, thereby providing a strong foundation for transferring this established and effective environmental technique from the matrices of soil and sediment to air. In a similar manner, GTI intends to use the powerful capabilities of environmental forensics to discriminate between methane from natural gas and methane from other biogenic sources.

Budget

2005: \$185,000

2006: \$90,000

Other:

Comments

The overall duration of the proposed project is 18 months, the task-by-task breakdown for both schedule and budget are as follows: Task 1 – Months 1-8 – \$175,000 Task 2 – Months 3-18 – \$100,000 The scope of work for the identification of thermogenic and biogenic methane emissions using stable carbon isotopes will involve three tasks: Task I Method Development for Forensic Analysis and Collection of Samples Task II Forensic Analysis and Building CSIR Methane Database Task III Project Management and Final Report Task 1 – Method Development of Forensic Analysis and Collection of Samples Activities associated with method development will include the selection of suitable analytical materials for analyzing methane using the forensic technique of GC/IRMS, sample introduction of an air matrix, and creating a gas chromatographic method. An efficient and effective method will be created to optimize methane detection and source differentiation. In addition, air samples will be obtained from different methane sources. These sources will include major contributors to state of CA methane emissions, including but not limited to landfills, wetlands, petroleum systems, wastewater treatments plants, and areas around leaking and non-leaking underground pipelines. Approximately 20 air samples will be obtained using evacuated gas

canisters and analyzed in the laboratory for carbon isotopic composition. Task 2 – Forensic Analysis and Building CSIR Methane Database Laboratory analysis will be conducted on each sample to determine the carbon isotopic compositions from the different methane sources collected and method developed in Task 1. These data will be compiled and a database will be created. Statistical analyses will

Project Concept #138: Effects of Microbial Activities on the Integrity of Plastic Pipes: LNG

Diane Saber

Description

Polyethylene (PE) pipes have been widely used in gas industry for decades, but there has been limited research regarding the reliability and performance of PE pipe under the long-term influence of microbial activities, along with varied soil conditions, temperatures, and mechanical stress. The general conception is that microorganisms are unable to degrade PE due to the material's high molecular weight. However, it is known that many environmental factors, such as heat, mechanical stress and chemical constituents, can trigger oxidative degradation, which breaks down polyethylene into smaller molecules which can be used by microbes as a source of food. Additionally, there exists no information on the effects of LNG-based gas on the microbial deterioration of PE pipes. Degradation of PE may be enhanced by the introduction of LNG, especially under conditions which are particular to the state of California (soils containing naturally-occurring hydrocarbon concentrations or crude oils). Pipe failure not only brings release of greenhouse gas into the environment, but also poses significant health and safety concerns. GTI has developed a genetic technique which is far more accurate than traditional microbial growth tests. It is proposed that this methodology be used to compare the effects of natural gas and LNG on PE pipes under ambient California conditions. This information will help in predicting potential problems associated with LNG interchangeability using existing pipelines and infrastructure systems.

Benefits

- Knowledge/database of the long-term effects of microbial activities in different soils and temperatures on the integrity of PE pipe under different levels of mechanical stress for natural gas transmission and distribution
- Knowledge/database of the long-term effects of microbial activities in different soils and temperatures on the integrity of PE pipe under different levels of mechanical stress for LNG transmission
- Projected effects of LNG interchangeability for PE pipe transmission and insights into the pipeline's subsequent lifespan
- A reliable prediction/estimate for the risk of microbial activities on the long-term PE pipe performance and reliability under conditions particular to California
- Recommendations for mitigation of PE pipeline deterioration

Objectives

Task 1 – Literature Review A thorough literature review will be performed to fully understand the current status regarding the microbial activities and the degradation and erosion of polyethylene, including investigation of California market LNG constituents which may influence PE degradation. Task 2 –Effect of Microbial Activities in Laboratory Conditions The long-term effects of microbial activities on the integrity of PE pipe exposed to ambient and elevated temperatures, and different levels of mechanical stress under the presence of natural gas and LNG will be tested. Task 3 – Effect of Microbial Activities in Soils PE pipes will be buried in soils typical to the state of California, and exposed to ambient and elevated temperatures and different levels of mechanical stress. The long-term effect of microbial activities on the integrity of PE pipe will be investigated. Task 4 – Effect of Microbial Activities in Soils Spiked with Concentrated Bacteria Cultures The experiments similar to Task 3 will be carried out, however, in Task 4, all treatments will be spiked with concentrated bacteria culture to increase the microbial activities and accelerate the microbial process in the potential deterioration of PE pipe. Correlations and adjustments will be made in consideration of LNG constituents.

Budget

2005: \$200,000
2006: \$200,000
Other: \$200,000

Comments

Project Concept #139: Production of Nanoparticles by the Natural Gas Industry: Current Status

Diane Saber

Description

Human activity produces nanoparticles, primarily through combustion of fossil fuels. Nanoparticles have been investigated for their health effects on biological tissues through research at major universities in the US, including substantial toxicology investigations on manufactured carbonaceous nanomaterials. Evidence suggests that nanoparticles may vary in their effects on human tissues, based upon type and configuration. While the exact mechanisms by which nanoparticles affect human health are still under research, it is clear that they result in increased mortality and morbidity, cardiovascular disease, asthma and lung diseases. These human health issues are of concern to California residents and increases in these diseases are mounting. As the correlation between nanoparticles and impacts to human health and the environment is better understood, there is a need to define the sources of nanoparticles and their introduction to the environment. There is evidence to suggest that nanoparticles (carbon nanoparticles and nanotubes) are produced and may be introduced to the atmosphere through the combustion of natural gas through industrial and commercial burners, boiler systems, stationary and vehicle engines and other end-use systems. It is unclear whether or not these particles have been effectively removed through scrubbing and other emission control processes. Furthermore, no data exists regarding the interchangeability of LNG and the additional production of nanoparticles. Through this research, GTI will investigate the sources of nanoparticle production through natural gas combustion, type of nanoparticles produced and removal efficiencies.

Benefits

California ratepayers will benefit from the combined resources of GTI in the areas of environmental research, combustion technologies and particle analysis. The CEC will benefit from a parallel study regarding potential sources and types of nanoparticles produced by non-LNG and LNG combustion and removal current efficiencies using both sources. This information is important in support of regulation and mandated upgrades to existing systems as well as those destined for receiving LNG, as these particles are highly air borne and suspected to pose deleterious and wide spread health effects, especially in areas of concern for CA residents.

Objectives

This project will fulfill the following four objectives: Task 1: Establish a clear understanding of nanoparticles produced by combustion of natural gas (non-LNG and LNG sources), Task 2: Using combustion systems at GTI and modeling, establish the rates of nanoparticle production using the tested systems, Task 3: Examine the characteristics of the nanoparticles produced (size, shape, chemistry, etc.) through SEM/STEM examination and analytical testing, Task 4: Establish whether or not traditional scrubber systems remove particles by testing in GTI on-site facilities.

Budget

2005: \$200,000

2006: \$150,000

Other:

Comments

Project Concept #140: On Line Chemical Reactive Control of HCCI Engines

Theodore T. Tsotsis

Description

In HCCI engines a homogeneous natural gas (NG) mixture is introduced into the cylinder, and is compressed until ignited. The advantage of HCCI is reduced soot and NO_x emissions, and high efficiency. The key challenge is controlling the auto-ignition timing over a range of loads and speeds. A potential strategy to overcome this problem is to actively control the ignition timing on a per cycle basis. To accomplish this, we propose to equip the HCCI engine with on line Chemical Reactive Control (OLCRL). OLCRL couples advanced electronic control with reactor technology for the in-situ production of C₂-hydrocarbons (C₂H₄/C₂H₆) from NG through the use of the oxidative methane coupling (OCM) reaction. C₂H₄/C₂H₆ exhibit greatly improved ignition characteristics and, therefore, provide flexible and efficient “knobs” to fine-tune NG ignition.

Benefits

The success of this research will have a broad impact on the development of a new generation of NG HCCI engines with potentially much better efficiency and pollutant characteristics than the existing spark ignition NG engines. Making their operation feasible will have significant benefits to the people of California. In the future HCCI engines may be used to combust renewable methane sources (i.e. landfill gas, biogas), thus turning current waste-products into usable energy. Successful implementation of the HCCI operation due to OLCRL has the potential of revolutionizing distributed power generation through ultra-low NO_x emissions, as well as high fuel efficiency.

Objectives

In phase I of this joint study between USC and GTI, we will investigate the feasibility of using in situ generated C₂ hydrocarbon additives as effective “knobs” for OLCRL of NG HCCI stationary engines. The ignition chemistry will be studied through ignition delay time calculations and experiments with well-equipped laboratory engines. The pollutant formation characteristics of such engines (particularly NO_x) will be studied to quantify the technology’s potential for attaining low NO_x emissions. Thermal and thermochemical recuperation issues will be also investigated, and a conceptual design for the overall system will be carried out. In subsequent project phases, the OLCRL concept will be validated in large-scale engine studies at GTI, and with a field-study at an end-user facility.

Budget

2005: \$300,000

2006: \$250,000

Other:

Comments

The advantage of OLCRL over other competing technologies is that it does not require the use of externally provided additives (e.g., diesel, DME), thus avoiding the significant costs associated with the purchase, transportation, and safe storage of these materials. The advantage over other methods for in situ production of such additives (e.g., steam reforming for H₂ production), is that it does not require the use of water (very important for the unattended operation of such engines in remote locations), and that it provides an additional level of flexibility in control of chemical reactivity due to the presence of the C₂ hydrocarbon additives. Compared with control methods such as temperature and pressure (compression) manipulation currently being advanced in other laboratories, the OLCRL concept is advantageous in that it offers a more direct combustion control strategy by manipulating independent process variables rather than dependent variables.

Project Concept #141: Impact of California Market Structure on Natural Gas

LCG Consulting
LCG Consulting

Description

California has undertaken to introduce market-based energy transactions using recently announced market redesign technology upgrade (MRTU), which envisions a LMP-based day-ahead market for procuring and producing electricity. Recently, there has been increased reliance on gas-fired generating plants and to some extent renewables to meet the energy demand. This has increased the need for gas procurement and improvement in the delivery system. To augment the availability of gas, several pipelines and LNG terminals have been proposed in California as well as nationally. There is considerable uncertainty of long-term gas prices, availability and delivery. There could be curtailment in gas supply to the generators just as in the past creating high gas prices for a long period of time. We suggest a state-wide or region-wise focused study for modeling the electricity grid and the gas system simultaneously using the data and tools already developed such as UPLAN-LMP plus UPLAN-Gas to provide a complete view of both gas and electricity markets and their interaction, volatility and risks.

Benefits

A creditable analysis of the interaction between electricity and gas will provide a realistic estimate of how much gas is available for electricity production and an estimate of how much price we will pay to secure the gas supply. It can be used as a basis for evaluating alternative technologies as well as their benefits and risks.

Objectives

Develop long-term forecasts of (1) electricity demand, (2) natural gas requirements for different technologies, (3) natural gas demand and prices, (4) capital investment necessary for generation, natural gas and electric transmission infrastructure. We will identify the fundamental drivers of volatility, quantify them and use them for simulating future market prices, quantities, and generating efficiency. A volatility analysis will provide financial values of all the uncertainties on the part of consumers, producers and the society as a whole.

Budget

2005: \$300,000

2006: \$300,000

Other:

Comments

To complete the project successfully, it requires an integrated electric and gas model that can faithfully simulate the electricity market using MRTU protocol and the gas supply and delivery system under various uncertain future volatilities.

Project Concept #142: Changing Gas Compositions in Western Gas Grid

Harry Vidas

Description

The project will use EEA's Regional Infrastructure Assessment Modeling System (RIAMS) to develop detailed forecasts of flowing natural gas quantities and chemical compositions in the Western U.S. and Mexico over the next ten to twenty years. RIAMS will be used to examine the impact of incremental LNG import volumes and changing domestic gas wellhead compositions and processing on the chemical compositions of natural gas in California and other states. The version of RIAMS to be used will be a 2,500-node implementation that includes the Rocky Mountain producing states, California, Arizona, Nevada, Washington, Oregon and Mexico. The project will take advantage of existing RIAMS applications and extensive databases EEA has compiled on U.S. and Canadian gas compositions and processing practices. Alternative scenarios will be developed looking at different volumes and points of import of LNG in the U.S. and Mexico and different interchangeability standards with which LNG terminals must comply.

Benefits

The primary benefit will be a detailed 20-year outlook for gas infrastructure, flows and chemical compositions in and around California. This information can be used to evaluate public policies on gas interchangeability and infrastructure development. The information will also be used for gas industry planning purposes. Once developed, the model and scenarios can be used in many other applications.

Objectives

The objective is to provide rigorous analysis and quantitative data regarding future changes in flowing natural gas volumes and gas compositions at different points on the Western U.S. and Mexican gas grid. This provides policy makers with the basis for economic analysis of alternative interchangeability rules. The study will also provide a means of assessing how alternative outcomes will affect seasonal natural gas compositions in each citygate area.

Budget

2005: \$150,000

2006: \$150,000

Other:

Comments

Project Concept #143: Semiconducting Metal-Oxide Microsensors for Emission Monitoring

Hai Wang

Description

The need for highly sensitive, stable, selective, and affordable gas sensors continues to grow at a rapid rate. Major driving forces for this expanding interest include the intensifying environmental regulations for the power and energy generation industry, which require inexpensive but accurate continuous emissions monitoring. One of the promising concepts for creating mass-produced, inexpensive sensing devices involves measuring the changes in the electrical conductance of thin films of nanophase, semiconducting metal oxide (SMO) materials, including oxides of tin (SnO₂), titanium (TiO₂), tungsten (WO₃), and zinc (ZnO). The key challenge is the nanophase design of these SMO materials to achieve superior sensor stability, sensitivity and selectivity. At USC we have recently developed a unique SMO synthesis technique that has a great potential to meet this challenge. The SMO materials prepared with this technique are of single crystals of ultra small sizes (a few nanometer), controllable to within +/- 1 nm. They are thermally stable against sintering up to 500 degrees C. They have unique, discrete optical absorption band gaps. Preliminary ultra-vacuum absorption studies show that the nanophase SMO films are capable of differential absorption/desorption of carbon monoxide and benzene. All of these properties appear to indicate that the synthesized SMO materials are ideally suited for sensor applications. The research project proposed herein seeks to further optimize our synthesis technique for gas-sensor applications.

Benefits

The success of this research will broadly impact our ability to monitor combustion emissions, and potentially revolutionize sensor technology. Specifically, the SMO sensor device will drastically reduce the cost of emission monitoring (as compared to available techniques), and make such monitoring economically feasible. The SMO sensor technology can also potentially be used for applications such as the detection of chemical and biological warfare agents.

Objectives

Initially we will fabricate suitable SMO sensor arrays and characterize these sensors with respect to their stability, selectivity, and sensitivity for detection and quantification of trace species in combustion products. The characterization study will be focused on establishing correlations among synthesis conditions, individual particle properties, and sensor performance. These correlations will then be used to optimize the SMO synthesis conditions and sensor array design. Subsequently, prototype sensors and their associated electronics for online and wireless data transmission will be designed and tested in laboratory and in a field study at an end user facility.

Budget

2005: \$180,000

2006: \$200,000

Other:

Comments

The use of SMO for sensor application is not a new idea. Previous studies have shown that a material gap exists, which has largely limited the SMO sensor technology to be developed into a practical technology. This material gap may be attributed to our inability to produce SMO nanoparticles that are ultra small, of uniform size distribution and stable, and have desirable electric and surface absorption/desorption properties. With the particle synthesis technique advanced at USC, we will demonstrate that this material gap is removed.

Project Concept #144: Impact of Efficiency and Renewables on Natural Gas

Kevin Petak

Description

This project will quantify the impact of energy efficiency and renewable energy on natural gas prices and volatility. Specifically, EEA will use its Gas Market Data and Forecasting System (GMDFS) to assess the seasonal price effects of expanded efficiency programs and renewable technologies goals of the CEC and other State agencies. Programs will include 1) energy efficiency and conservation programs targeted at natural gas, and 2) energy efficiency and conservation programs targeted at electricity. The expected volume changes of conservation programs will be based on CEC analysis and goals. EEA will evaluate the volume changes at the sectoral level for residential, commercial and industrial consumption. In addition, this project will evaluate gas market impacts of potential renewable resources in the State based on existing research results and program goals. The conservation and renewable program volume estimates or goals will be formatted to serve as an input matrix to the EEA model. The GMDFS evaluates natural supply and demand at the national level, producing monthly price projections at 106 points across North America. The model includes an electricity generation module, and reductions in electricity demand will be explored. The model will be used to produce a baseline assessment. In addition, several scenarios will be evaluated for alternative program estimates or goals. The project will take advantage of data and methodologies EEA has employed in similar projects for ACEEE, NYSERDA and others.

Benefits

This project will give policy makers a solid analytic basis to evaluate the economic impacts of such programs and to quantify the impacts of alternative program goals and portfolios.

Objectives

Quantify impacts on natural gas consumers of programs to reduce natural gas and electricity consumption and to expand use of renewable energy.

Budget

2005: \$100,000

2006:

Other:

Comments

*2006 budget is \$25,000 to \$100,000 depending on scope and number of cases.

Project Concept #145: Impact Natural Gas Supply Disruptions on Electric and Gas Consumers

Kevin Petak

Description

The project will use EEA's Regional Infrastructure Assessment Modeling System (RIAMS) to develop detailed forecasts of natural gas demand in the Western Electric Coordinating Council area and the impact of various infrastructure disruption scenarios on natural gas availability to individual gas-fired power plants and gas consuming citygate areas. The version of RIAMS used in this analysis will have approximately 2,500-nodes covering all States in the WECC region. Alternative scenarios will be developed looking at gas pipeline ruptures, compressor station outages, gas processing plant disruptions, storage field damage or delayed LNG deliveries. The project will look at selected months in the next few years. This project will build upon work EEA is now doing on infrastructure security for DOE and other Federal and State agencies.

Benefits

This project will help policy makers and emergency planners better understand the operation of the natural gas infrastructure and interdependencies with electric systems. The study can also be used to evaluate the reliability impacts of alternative future infrastructure developments including LNG terminal and onsite storage, new underground gas storage and new pipeline capacity.

Objectives

To identify critical natural gas infrastructure and to locate and quantify the impact in terms of lost service to gas consumers of specific disruption scenarios, including the impacted megawatts of power generation. Also, the model could be linked to CEC's Supply Adequacy Model to look at power plant redispatch opportunities and reserve margins after the natural gas disruption.

Budget

2005: \$150,000

2006: \$150,000

Other:

Comments

Access to study data and results must be limited for security reasons.

Project Concept #146: Valuation of Natural Gas Storage for Public Policy

Bruce Henning

Description

The purpose of this project is to describe the role of natural gas storage in the California and broader North American gas markets and to juxtapose how gas storage is valued by individual market participants versus how it might be valued from the perspective of public benefits and public policies. The analysis will include background on how gas storage is now used in California and surrounding markets and the likely evolution of storage markets in the future. The results will include a description of how storage is bought and sold and how holders of storage capacity evaluate its value. Specific evaluation models will be discussed along with social benefits of storage and under what circumstances externalities (including supply reliability and reduced price volatility) might result in a market solution that produces suboptimal levels of storage capacity or use.

Benefits

The project will educate policy makers on how natural gas storage is used, how it is evaluated by market participants and what its value is to society. The project will specifically identify the kind of circumstances in which public interest funding for gas storage technologies and projects might be appropriate.

Objectives

The objective of the project is to provide a conceptual framework for looking at the value of gas storage from both the perspective of market participants and society as a whole.

Budget

2005: \$50,000

2006:

Other:

Comments

Project Concept #147: High Compression Spark Ignition System

Karl Jacobi

Description

Develop an Ignition system capable for use in a high compression engine which will increase the efficiency, power, and performance of LNG (natural gas) fueled engines for on-highway vehicles. We will explore some new ways to increase the power of the secondary ignition system while maintaining a practical size. Upon successful completion of project the out come will allow an LNG (natural gas) fueled engine to be competitive with the diesel engine in power and performance, but will be more economical and will operate at much lower tailpipe emissions.

Benefits

Improve LNG fueled engine performance, Improved fuel economy, Improved operater acceptance, Reduced emissions by use of natural gas (LNG) for vehicle fuel, Reduced dependence of foreign oil.

Objectives

1. Develop new technology to enhance/improve secondary coil performance to include the following components: spark plug, ignition control, ignition coils. 2. Design an Ignition system to work in a high compression engine, such as 16.5:1 to 18.0:1 compression ratios. 3. To increase the efficiency of a spark Ignited, LNG (natural gas) fueled engine. 4. Reduced emissions by the improvement to the alternative of the diesel engine, and provide the operator with greater fuel efficiency and power & performance equal to the diesel engine. 5. To make the spark ignited LNG fueled engine more acceptable in today's environment.

Budget

2005: \$250,000

2006: \$250,000

Other:

Comments

A key to the continued success of the spark ignited LNG fueled engine will be the much needed development of the secondary ignition system. With greater public acceptance more operators would choose/purchase LNG fueled engines if the power, performance, and efficecny levels existed. Most important of all will the reduced tailpipe emissions due to expanded markets on LNG fueled heavy duty vehicles.

Project Concept #148: Future Foreign Pollution: Impact on Nat. Gas & Air-Quality in Calif.

Philip Cameron-Smith

Description

The impact of natural gas combustion on air-quality depends on the concentrations of chemicals already in the air when the exhaust gases (nitrogen oxides and incomplete combustion products) are released. This is because the chemical reactions that form ozone are a highly non-linear function of the concentration of its pre-cursor chemicals: nitrogen oxides (NO_x), hydrocarbons (HC), and pre-existing ozone (O₃). The background concentrations of these pre-cursor chemicals come from both local sources (ie, California) and long-range transport (eg, Asia and the stratosphere.) In order to predict the impact of future natural gas combustion on air-quality (with all the associated health, economic, and political consequences), we will first predict future ozone pre-cursor concentrations (in 10, 20, 50 years time) due to the rapidly rising emissions from Asia and elsewhere, plus the effect of climate-change on stratospheric intrusions. We will then use these concentrations to evaluate how the air-quality impact of natural gas combustion in California will change in the future.

Benefits

Forewarning of the likely air-quality pre-cursors in the future, and the implications for natural gas emissions, will allow better decision making now in order to: (1) Improve the overall air-quality impact on health due to natural gas combustion in California. (2) Minimize economic and political consequences of exceeding air-quality standards in the future.

Objectives

The key steps in this project will be: (1) Insert predicted future emissions in Asia and elsewhere, plus output from a climate model 10, 20, and 50 years into the future, into our global 3D atmospheric chemistry transport model (the LLNL-IMPACT model) to determine future air-quality pre-cursor concentrations over California. (2) Insert the predicted pre-cursor concentrations for the future from the IMPACT model into a California regional air-quality model (such as the WRF-chem model). (3) Run the regional air-quality model with various natural gas emission scenarios for California using both present-day and future pre-cursor concentrations. The difference between the runs will indicate how future externalities will affect the air-quality impact of natural gas.

Budget

2005: \$300,000

2006: \$300,000

Other: \$300,000

Comments

(1) The LLNL-IMPACT global chemistry transport model is the best model in the world for handling this task. It is a state-of-the-art global 3D chemistry transport model with: high global resolution (~100 km grid) that will resolve California better than comparable models. It also models the stratosphere and troposphere simultaneously, thereby predicting stratospheric intrusions. It is well tested and validated, and has been published in the peer-reviewed literature. (2) Lawrence Livermore Nat. Lab (LLNL) has the state-of-the-art super-computers needed for this task. (3) We will collaborate with colleagues at the University of California, plus other atmospheric chemists and energy experts at LLNL. (4) This effort will leverage institutional funding & grants from other agencies.

Project Concept #149: LNG Interchangeability for Power Generation Boilers

Rick Tidball

Description

There are over 80 electric generation boilers in California that produce base load power using natural gas as the primary fuel. These boilers, which range in size from 20 to 750 MWe, use various NOx control technologies to comply with emissions standards. As LNG imports increase, the natural gas fuel composition will change, and this change may cause NOx emissions to increase. Fuel composition fluctuations will impact stoichiometry (fuel/air ratio) and combustion temperatures, and these variables influence NOx formation. LNG imports may cause fuel compositions in the California gas grid to change on a seasonal, daily, or even hourly basis depending on the location of LNG import terminals, domestic pipeline flows, and gas storage withdrawals. As gas composition changes – not only seasonally, but perhaps hourly – it is unclear how NOx control technologies used on power generation boilers will respond, and whether these boilers will continue to comply with NOx emissions standards.

Benefits

Benefits are expected to be a greater understanding of the impact that LNG has on emissions, efficiency, and safety performance of power generation boilers. This information will help researchers understand what performance data is available and what data gaps remain to be filled.

Objectives

The primary objective is to gain a better understanding of the emissions performance of power generation boilers that receive fluctuating gas compositions due to LNG imports. A secondary objective is to understand the impact of LNG concentrations on efficiency and safety. The approach will be to contact power generation boiler manufacturers (e.g., Babcock & Wilcox, Combustion Engineering/ABB, Foster-Wheeler, and Riley Stoker) and determine what technical data exists that can be used to understand the emissions performance of power generation boilers subjected to various LNG blends. Data will also be collected and evaluated to understand safety and efficiency considerations. Contacts with boiler manufacturers and operators in Europe and Japan – regions that have significant LNG imports – will also be conducted.

Budget

2005: \$80,000

2006:

Other:

Comments

Project Concept #150: Collaborate Strategic Plan to Foster Renewable & Efficiency Investment

Richard Mrlik

Description

The positive attributes of renewable energy and energy efficiency have monetary value yet less than 1% are realized today. In California alone, the monetization of these attributes could provide \$400 million of extra revenue to energy consumers and potentially incentivize \$2 billion annually in renewable or efficiency investments. The monetization of renewable and energy efficiency attributes requires an integrated process that combines measurement, validation, electronic transmittal, price discovery and payment. The technology and systems for each functional step have been developed -- the integrated process has not. A catalyst is also needed to bring interest groups together including equipment, metering, telemetry online procurement vendors, utilities, government and regulatory agencies.

Benefits

1) Will promote broad based market penetration of energy efficiency and renewable investment without public funding. 2) Has a high probability of providing financial and intangible (improved environmental) benefits to California citizens. 3) Project offers a very high benefit to cost ratio because it leverages existing technology and its collaborative approach should spur co-funding opportunities with other entities.

Objectives

To provides strategic direction to enable existing science or technology to be combined in a functional process that enables the monetization of the positive attributes of renewable energy and energy efficiency investments. The Project shall first establish a preliminary certification standard for measurement and validation of a renewable or efficiency attribute via a collaborative working group which includes equipment & metering vendors, sponsors of existing certification programs, utilities and government agencies. The next objective is to establish preliminary specifications for the management of metered and validated attributes via a separate, collaborative working group. To monetize the attributes, the Project shall develop preliminary platform specifications for the trading of renewable attributes via collaborative a working group that also includes existing buyers/sellers of Renewable Energy Credits.

Budget

2005: \$100,000

2006: \$100,000

Other:

Comments

The Project is not adequately addressed by competitive or regulated entities as the implementation requires the integration of several functions that combine to serve a developing market. The developing market is being driven by Renewable Portfolio Standards (RPS), environmental compliance and demand by corporate and private citizens. A practical, cost-effective and ubiquitous platform is needed to serve the market and monetize the positive attributes of renewable energy and energy efficiency.

Project Concept #151: Life-Cycle Cost and Energy Modeling of Home Water Heating Systems

Eric Masanet, Lynn Price

Description

Water heating systems consume ~25% of residential energy in California. The vast majority of homes utilize natural gas based storage tank systems with significant energy losses. Alternative technologies exist that might reduce natural gas consumption, including high efficiency tanks, tankless heaters (both natural gas and electricity based), point-of-use temperature/flow management systems, and solar heaters. Little work has been done to analyze the full range of tradeoffs associated with alternative technologies, which includes tradeoffs in equipment purchase and installation costs, operational costs, operational energy and water consumption, equipment manufacturing energy, equipment disposal/recycling implications, purge water generation, and the supply chain benefits of any applicable energy and water savings. We propose to develop a model for comparing the full economic and environmental tradeoffs of major alternative technologies to traditional natural gas based home water heating systems in California, using a full cost accounting and life-cycle environmental assessment approach.

Benefits

The proposed work will quantify the full range of economic and environmental tradeoffs associated with different home water heating system technologies; it will therefore help in identifying cost- and environmentally-effective strategies for reducing home natural gas consumption in California. For California consumers, the model could be used as the basis of a green purchasing tool to identify best solution(s) under different residential scenarios (available energy sources, hot water end uses, water usage patterns, etc.). For California energy analysts, the model could be used to quantify the statewide natural gas savings potential associated with different technology saturation levels, and to assess the total direct and indirect cost and energy implications of switching between various technologies. For California policy makers, the model could be used to identify specific scenarios for which certain technologies should be promoted and to assess where product economic incentives (such as rebates or tax deductions) might lead to the greatest natural gas savings potential.

Objectives

This work will produce a model that quantifies the “true” lifetime costs and energy consumption associated with major home water heating system technologies. Economic modeling will employ full cost accounting, which captures not only direct life-cycle consumer costs (e.g., equipment purchase and installation, maintenance, energy use, and disposal) for each technology, but also indirect costs, such as the costs of energy-related air pollution, waste management, and purge water treatment. Environmental modeling will employ life-cycle assessment, which captures the energy required for equipment manufacture, maintenance, and disposal, the energy consumed during use (including applicable systems losses, such as pipe heat and purge water losses), and the energy required to produce fuels and water (i.e., the embodied energy) consumed over the lifetime of the system. Such a modeling approach will allow alternative technologies to be compared on a common, systems-level basis in both economic and environmental dimensions.

Budget

2005: \$200,000

2006: \$100,000

Other:

Comments

Project Concept #152: Natural-Gas-Assisted Cyclic Catalytic Autothermal Reforming of Biomass

Wyman Clark

Description

EERGC Corporation, teamed with General Electric Energy and Environmental Research has completed a DOE-funded Phase II STTR project demonstrating the use of the cyclic catalytic autothermal reforming process, "Unmixed Reforming," to produce PEM-fuel-cell-quality hydrogen from biomass. The proposed project will further develop this technology by: improving consistency and controllability by using natural gas as a trimming agent to make up for unavoidable variations in composition and feedrate of the heterogeneous biomass; addressing engineering challenges such as the mechanisms for feeding the biomass and exchanging the catalyst between beds; and building and operating a next-generation demonstration unit.

Benefits

Displacing fossil fuels with biomass will reduce the generation of greenhouse gases and will reduce U.S. dependence on foreign fuels. Coupled with hydrogen transport/storage technology, the proposed technology will allow replacement of automobile engines with hydrogen fuel cells, reducing emissions of NO_x and other pollutants that cause ozone and smog.

Objectives

1) Demonstrate the production of fuel-cell-quality hydrogen 2) Develop a monitoring/control strategy for natural gas trimming and demonstrate the consistency and controllability of the process. 3) Design, build and operate a demonstration unit 4) Develop a detailed cost estimate for a production unit.

Budget

2005: \$300,000

2006: \$700,000

Other: \$700,000

Comments

Schedule: In 2006, the demonstration unit will be designed, key components (feed and solids transport mechanisms) will be tested, and permits will be obtained. In 2007, an atmospheric pressure demonstration unit will be built and operated. In 2008, a pressurized unit will be built and operated. Potential Cofunders include Department of Energy, Department of Agriculture, gasification technology developers (e.g., General Electric), power-generating utilities, and research consortiums such as GTI and EPRI. Background: In the Unmixed Reforming process two fluidized bed reactors (a reformer and a regenerator), are used and solids are transferred between the reactors. Steam, biomass, and natural gas as a trimming agent, are injected to the reformer and the fuels are converted to hydrogen in the presence of a redox catalyst. The product is hydrogen, water vapor (which is easily removed) and CO₂, CO, and some hydrocarbons as contaminants. In addition to the redox catalyst, the bed material in the reformer also contains calcium oxide, which absorbs CO₂ from the product gas and captures it as calcium carbonate. This CO₂-sink causes CO to shift to CO₂ (and then to CaCO₃) while producing more hydrogen through the water gas shift reaction: $H_2O + CO = H_2 + CO_2$; thus increasing the yield and purity of the hydrogen. The regenerator is operated at a higher temperature than the reformer and is fluidized by air. In the regenerator the redox catalyst is oxidized and the calcium carbonate is decomposed to release CO₂. Thus the regenerator exhausts CO₂-laden oxygen-depleted air. The advantage of unmixed reforming is that it produces nearly-pure hydrogen (undiluted with nitrogen) in a self-powered process that does not require expensive oxygen; and it is capable of doing this with an inexpensive fuel, such as biomass.

Project Concept #153: Integrated OxGen/Reforming Process for Producing H2 from Natural Gas

Wyman Clark

Description

EERGC Corporation is conducting a DOE-funded Phase I STTR project developing an innovative breakthrough technology for producing low-cost oxygen using push/pull absorption. A substantial reduction in the cost of oxygen will make the use of oxygen attractive in a number of applications that were not previously economically viable. In the proposed project EERGC's oxygen production technology will be coupled with oxygen-blown autothermal reforming of natural gas, and EERGC's reactive heat exchanger technology for drying and purifying (removing CO, CO₂, and Sulfur Species) the reformer product gas to produce hydrogen of purity suitable for use in PEM fuel cells.

Benefits

The proposed technology will provide an energy-efficient, cost-effective, low-pollution solution for distributed power applications. Coupled with hydrogen transport/storage technology, the proposed technology will allow replacement of automobile engines with hydrogen fuel cells, reducing emissions of NO_x and other pollutants that cause ozone and smog.

Objectives

1) Demonstrate the production of fuel-cell-quality hydrogen 2) Build and operate a demonstration unit 3) Develop a detailed cost estimate for a production unit.

Budget

2005: \$500,000

2006: \$1,000,000

Other:

Comments

Cofunding: It is anticipated that \$500,000 in cofunding will be available from DOE for the Phase II STTR project: "Separation of Oxygen from Air via Push/Pull Adsorption." Other potential cofunders include: gasification technology developers, power-generating utilities, and research consortiums such as GTI and EPRI. Background. In EERGC's Push/Pull Absorption technology for production of oxygen, air and steam are alternately passed over a bed containing a high-surface-area reversible redox agent and a reversible drying agent. In the air cycle, the redox agent removes oxygen from the air in an exothermic reaction that is balanced by the endothermic release of water vapor from the drying agent. In the steam cycle, the high temperature causes the redox agent to release oxygen in an endothermic reaction that is balanced by the exothermic capture of the steam by the drying agent. The product is pure, wet oxygen. EERGC is currently conducting a DOE-funded Phase I STTR proof-of-concept project for this technology, which will be followed by development and demonstration with further DOE funding in Phase II. In oxygen-blown autothermal reforming, natural gas is reformed with steam in a nickel-catalyzed reaction to produce wet hydrogen (with some CO and CO₂). A small amount of oxygen is added, which partially oxidizes the natural gas providing enough energy to power the endothermic reforming process. This is a well-established process. In EERGC's reactive heat exchanger technology, hot reformed gas products (and contaminants) are passed through a bed of initially cold CaO. The CaO absorbs CO₂ as CaCO₃, CO shifts toward CO₂ in the water gas shift reaction $CO + H_2O \rightleftharpoons CO_2 + H_2$ and is similarly captured; and sulfur is captured as CaSO₄. The result is a stream of cool, pure wet H₂. The hot, spent bed is regenerated by passing cold air through it (countercurrent to the reformer gas). The CaCO₃ releases its CO₂ and the CaSO₄ releases SO₂ to regenerate and cool the CaO. Schedule: In 2006, lab-scale testing will be conducted to validate the reactive heat exchanger concept and show that it can produce fuel-cell quality hydrogen, an integrated oxygen production/autothermal reformer/ reactive heat exchanger demonstration unit will be designed and permits will be obtained. In 2007, the demonstration unit will be built and tested.

Project Concept #154: Combined Electrical, Heat & Cooling Generation Onsite

H. Adam Bosschieter & Earl Schmid

Description

The Residential Community Electric, Heating and Cooling (EHC) Project

Benefits

With centralized large scale power generation, large thermal and electrical losses are realized both in a plant and through transmission losses. Average net energy use efficiencies of 30-45% are typical. Small scale on site combined power, heating cooling generation can net energy use efficiency of 75% doubling the useful output of the natural gas and cutting in half the negative environmental issues such as volume of unwanted gases generated. Public benefits potential in the energy expense savings alone would exceed \$60 Billion a year. While it is perhaps unrealistic to expect all buildings to be converted a 20% level would yield a \$12 billion savings..

Objectives

This project would provide a model for developers and communities to follow in new construction and retrofit. It is also expected to raise public awareness of the large cost benefit to the consumer of community energy systems. Other countries in the world such as Denmark use central community heating and cooling and realize the huge financial and environmental benefit. Over 60% of the buildings in Denmark are served by a central system. This project would track the costs and consumptions to clearly define the savings and distribute this information to citizens and developers..

Budget

2005: \$2,000,000

2006:

Other:

Comments

Project Concept #155: Pulsed Reburning for NOx Control

Wyman Clark

Description

EERGC Corporation, teamed with General Electric Energy and Environmental Research has completed an Air-Force-funded Phase II STTR project demonstrating on a boiler simulator furnace that the control of NOx emissions by reburning with natural gas can be enhanced by pulsed fuel injection to optimize mixing of the reburning jet with the primary combustion products. The proposed project will further develop this technology by: developing and testing a monitoring/active-control/pulse-actuation system to find and maintain operating conditions for optimum NOx control; developing and validating a model to scale the process; estimating retrofit costs; and providing a full-scale demonstration of the technology.

Benefits

This technology will enhance mixing and extend the application of reburning, an inexpensive NOx control technology well-established for large-scale boilers, to smaller (industrial-size) gas-fired boilers and furnaces which have inadequate residence times for conventional reburning. This will reduce emissions of NOx and other pollutants that cause ozone and smog.

Objectives

1) Develop monitoring/control/actuation system; 2) Develop model to scale the process; 3) Test control system and model on pilot scale unit; 4) Develop detailed cost estimate to retrofit the technology; 5) Find host site for demonstration and develop a test plan; and 6) Provide full-scale demonstration of the technology.

Budget

2005: \$150,000

2006: \$350,000

Other: \$1,500,000

Comments

Schedule: In 2006, Objectives 1 and 2 will be addressed. In 2007, Objectives 3, 4 and 5 will be addressed. In 2008, Objective 6 will be addressed. Potential Cofunders include Department of Energy, reburning technology developers (e.g., General Electric), manufacturers/owners/operators of industrial boilers, power-generating utilities, and research consortiums such as GTI and EPRI. Background: Reburning is a NOx control technology in which a portion (typically 10-20%) of the fuel is injected into a secondary combustion "reburning" zone, driving the local stoichiometry fuel-rich and introducing combustion radicals that enhance the reduction of NO to N2. It is followed by a fuel-lean tertiary zone where additional air is injected to complete the combustion process. Effective reburning requires sufficient residence time (in the appropriate temperature window) to allow the reburning jet to mix with the primary combustion products. Small (industrial-size) boilers do not typically have enough time in the appropriate temperature window for effective reburning. Enhanced mixing (and thus, improved NOx control) can be achieved by pulsing the reburning fuel, reducing the residence time needed for effective reburning.

Project Concept #156: Reduction in Infrastructure Requirements for Large House Developments

Ken Darrow

Description

An emerging trend toward mega-developments brings together residential housing units, commercial and institutional clusters, and recreational facilities in such a scale that small cities essentially develop from empty land in a relatively short period of time, creating tremendous strain on existing energy and water resources and infrastructure. In several locations, mega-developments are planned for areas of land far enough away from current urban centers that significant new energy and water infrastructure development will be required, including: „X Gas transmission and distribution lines „X Water and waste water treatment systems and lines „X Electric transmission and distribution lines and possibly distributed power generation

Benefits

The benefits of this project will include higher energy efficiency in new housing developments, reduced capital investment requirements, and increased energy security and reliability for both the residents of new communities and for the state as a whole.

Objectives

The objectives of the proposed assessment are to 1) quantify the magnitude of the growth in mega-developments; 2) assess the build-out schedule in comparison to current utility expansion plans; 3) model the energy consumption and emissions profiles of a conventional energy services approach compared to one using gas-fired integrated energy systems, distributed generation, and thermally activated technologies to meet energy services with less infrastructure expansion required, particularly peak electric generation and T&D.

Budget

2005: \$150,000

2006:

Other:

Comments

Project Concept #157: Low-Cost Reduction of Biofouling at Gas-Fired Power Plants

Greg H. Rau

Description

Biofouling of cooling water intakes and condenser surfaces poses a >\$250M/yr maintenance problem for California's natural-gas-fired power plants. Current treatments or preventatives for this problem are expensive, time consuming, environmentally impactful, and ultimately ineffective unless frequently applied. However, preliminary research funded by EISG/CEC (Rau, 2004) has demonstrated that small quantities of power plant flue gas (specifically, CO₂) when equilibrated with cooling water can act as an effective anti- and de-foulant. It is proposed that an industry/university team further evaluate this low-cost solution to a long-standing problem for California's power generators.

Benefits

With California power plants consuming 1.5 trillion gallons of water/yr for cooling, the biofouling of the associated water intakes and heat exchange surfaces poses a major problem for plant efficiency (e.g., EPRI, 1998; PIER/CEC, 2001). Current treatments for biofouling include the application of chemicals such as bleach, heating of the water, and physical scraping/removal. These processes are costly, can require lengthy power plant downtime, and pose significant downstream threats to California's marine environment. This proposal seeks to test the use of an abundant power plant waste stream to significantly reduce the cost and impact of current anti-and de-fouling methods.

Objectives

Controlled experimentation will be performed on actual or simulated seawater intakes to determine the effectiveness, impacts, safety, costs, and optimum rate of flue gas application. This will be conducted at one or more coastal, gas-fired power plants with close involvement of power plant companies (e.g. Duke Energy), appropriate regulatory agencies, and university researchers. The three-year project will definitively evaluate whether or not a small portion of a waste stream copiously produced by California's power plants can be used as a low-cost, safe biocide for cooling water treatment.

Budget

2005: \$300,000
2006: \$300,000
Other: \$200,000

Comments

References: EPRI. 1998. Nontoxic Biofouling Control Technologies. Electric Power Research Institute, Palo Alto, CA. PIER/CEC. 2001. Water Quality Parameters for Cooling Towers. Public Energy Interest Research/California Energy Commission. Rau G.H. 2004. Use of flue gas to reduce biofouling of power plant cooling water intakes. Final report to the Energy Innovations Small Grant Program of the California Energy Commission.

Project Concept #158: Grease Control in Kitchen Ventilation Systems

Cherif Youssef

Description

One of the biggest problems in commercial kitchen ventilation systems is the grease build up which can eventually cause a fire. The problem is exacerbated when there are char-broilers under the hood. Research is needed on how to combat this problem and help restaurateurs in controlling grease in the kitchen hood. Exhaust fans and duct work become saturated in grease, become hard to clean and also pose a fire hazard. In addition increase grease build up results in increase pressure drop in filters and ducts resulting in increased fan energy use. Clean, grease-less and well maintained kitchen ventilation system will be more efficient and safer. The research shall include development of prototype grease control systems and testing and demonstrating their application. The California restaurant existing floor stock is over 150 million square feet with average restaurant floor area of approximately 11,000 square feet. In addition kitchen ventilation systems exist in cafeterias in institutions, hotels, hospitals and retirement homes. Therefore the market potential of a grease-less kitchen ventilation system is enormous.

Benefits

Benefits from a kitchen ventilation grease control system include reduced maintenance costs, energy efficiency, and safety. Early detection of grease in kitchen hood will reduce overall maintenance and system down time. This will result in maintenance cost savings. Reduced grease build up will result in reduced pressure drop in ducts and filters which in turn will reduce fan energy use. Although not significant, energy reduction will result in operating cost savings. The safety feature due to increased frequency of maintenance resulting in reduced grease build up is a significant benefit.

Objectives

Budget

2005: \$150,000

2006: \$200,000

Other: \$100,000

Comments

Project Concept #159: Gas Treatment Options for Sensitive Customers

Ken Darrow

Description

The introduction of LNG into the California gas supply mix may create problems for selected customers with sensitive equipment such as large reciprocating engines (detonation) or chemical feedstock applications (product efficiency and yield). Other work is ongoing to address customer sensitivity and central options for mitigation at the LNG terminal. This study will focus on options and costs for heavy hydrocarbon removal from natural gas at sensitive customer sites using pressure swing adsorption and other processes. Costs for centralized removal at the LNG receiving terminal will also be estimated and compared to removal at sensitive customer sites.

Benefits

The benefits of this project will be a reduction in the infrastructure requirements associated with the introduction of LNG into the gas supply mix in California

Objectives

The objective of the proposed assessment is to provide comparative cost and performance data on site removal of heavy hydrocarbons from pipeline gas and the number of sensitive customers and to provide a comparison to the costs of central treatment options.

Budget

2005: \$80,000

2006:

Other:

Comments

Project Concept #160: Demand Control Ventilation in Kitchen Hoods

Cherif Youssef

Description

Kitchen ventilation systems waste a significant portion of facilities energy. Ventilation systems could run for several hours a day with no cooking and sometime even overnight. Research is needed to develop a demand control ventilation system to reduce energy use in the kitchen ventilation system by providing varying degrees of ventilation depending on the amount of kitchen effluent at a given time. With such a ventilation control, there is a potential to save as much a 40% of the ventilation energy use in a kitchen. Research will be directed to develop a ventilation system that will sense the use of the cook-top , griddle or grille and based on the percentage use, vary the air flow in the kitchen exhaust hood as well as the make-up air handler. The sensing device could be based on the kitchen effluent or specific designchange in the kitchen equipment that will send a signal to the ventilation controller to either slow down or speed up the fans. The California restaurant existing floor stock is over 150 million square feet with average restaurant floor area of approximately 11,000 square feet. In addition kitchen ventilation systems exist in cafeterias in institutions, hotels, hospitals and retirement homes. Therefore the market potential of a demand control ventilation system in kitchen ventilation is enormous.

Benefits

The primary benefit from the technology will be the reduced energy use in the kitchen exhaust fan and the make-up air fan. In addition the reduced kitchen ventilation will impact the building cooling system in summer months resulting in further savings. The result will be reduced operating cost and increased comfort. This technology is the wave of the future and hopefully in years to come every kitchen system will have a demand control unit. These systems make a huge impact by reducing the overall energy use of the building.

Objectives

Budget

2005: \$200,000

2006: \$200,000

Other: \$100,000

Comments

Project Concept #161: Combined Heat and Power Market Impacts on Gas and Electric Pricing

Ken Darrow

Description

EEA developed a CHP market model for the state of California that was part of a larger policy study for the 2005 Integrated Energy Policy Report. The model was used to evaluate the market penetration of CHP under a variety of proposed policies. It is proposed that this framework be used to determine the impact of CHP market penetration on gas prices, the impact on electric prices and development needs, and the impacts of CHP deployment in surrounding states for export to California.

Benefits

The benefits of this project will be a better understanding of the benefits of CHP deployment and the impacts on the energy infrastructure in California.

Objectives

The objectives of the proposed work will be to define the secondary price impacts of CHP deployment on retail gas and electricity prices; and to define the CHP export potential from nearby Northwest and Southwest states.

Budget

2005: \$150,000

2006:

Other:

Comments

Project Concept #162: Hydrogen Technology Park

Cherif Youssef

Description

This project would involve the procurement, installation, and operation of various hydrogen technologies at a central location that would provide access to the public. Technologies to be demonstrated could include (1) fuel cells, (2) hydrogen reformation systems (steam reformers, electrolysis), (3) hydrogen storage systems, (4) hydrogen powered IC engines, (5) microturbines and (6) fueling systems. The equipment would be operated and monitored continuously, with data on individual equipment performance as well as system integration being recorded. The information acquired would be made available to the public. In addition, public will be invited for training sessions and symposiums on equipment operation and performance. Possible participants are utilities, vendors, and various state and federal agencies (DOE, APCD's, AQMD's). The exhibition will be similar to the energy centers currently operated by the utilities in which state-of-the-art residential, commercial and industrial technologies are on display. These centers have been proven to be greatly beneficial to the public and are cost effective. They stimulate interest and early adoption of the technologies.

Benefits

The benefits will be to provide the public with first hand and real world experience with hydrogen technologies. Current equipment used to heat, cool, and power facilities (residential, commercial, and industrial), either use combustion process directly or get their power from the grid. Utilizing hydrogen equipment can result in efficiency gains. Fuel cells can be as much as 30% more efficient than turbines or conventional IC engines. Hydrogen equipment can reduce emissions of greenhouse gases to almost zero (depending on the source of the hydrogen).

Objectives

There are three key objectives for this work. First objective is to provide a platform for testing and evaluation of hydrogen technologies and equipments outside of the laboratory or manufacturers testing facilities. This will enable operators and the public to experience first hand how the equipment perform under simulated real world conditions. Second objective is to will allow the operators to observe and evaluate operation of the various components of the hydrogen technology as a system. The final objective is to share the information with the public, particularly builders, A&E's, planners, commercial facility managers and industrial plant operators. This will help to educate them about the capabilities and benefits of incorporating hydrogen technologies in their facilities.

Budget

2005: \$1,000,000

2006: \$1,000,000

Other: \$1,000,000

Comments

There is high interest in hydrogen technologies at both the federal and state level. Note the governor's hydrogen highway initiative. Successfully demonstrating these technologies can help to bring them to market earlier than they might otherwise appear, bringing the benefits of increased efficiency and reduced emissions to the State of California.

Project Concept #163: Gas Market and Infrastructure Implications of Gas Availability

LCG Consulting
LCG Consulting

Description

It is desirable to limit dependence on natural gas in order to limit physical and financial vulnerability to disruptions and price volatility, as well as to manage environmental emissions and infrastructure commitments. One approach is increased reliance on renewable and other non-gas-fired generation. However, such generation is often distant from loads, intermittent and/or has limited (or no) dispatchability. Therefore, dispatchable gas-fired generation close to loads, especially new and even distributed generation, would still play a key role in maintaining electric supply load following and reliability/deliverability, including “firming” of nondispatchable generation, perhaps competing with or complementing storage. This suggested state-wide or geographically focused study would use modeling (potentially both electric grid/market and gas system) and other analytic and data tools to examine long-term implications of major non-gas (e.g., wind and other renewables) generation scenarios on important aspects of California’s natural gas and electric systems and markets.

Benefits

Understanding how long-term temporal and locational requirements for gas supply, gas infrastructure, and gas-fired generation and its operation are impacted by dramatic but credible generation scenarios designed to limit reliance on natural gas. How difficult and credible is it to move further and further away from gas, and, especially, what are the infrastructure (and thus environmental) and market (electricity and gas) implications? For example, on state-wide and local bases: how much natural gas use can we realistically back out, how much gas infrastructure additions can we realistically avoid, how would remaining gas-fired generation have to operate (and locate), and (preliminarily only) what is the infrastructure (and implied environmental) tradeoff for displacing gas-fired generation with non-gas, especially renewables?

Objectives

Develop credible and informative long-term (at least 20 years) non-gas generation to meet key policy goals such as reduced dependence on fossil fuels and reduced CO₂. For reliably and securely meeting electricity demand across all locations, project and evaluate the impact on (1) natural gas generation requirements (amounts, operating patterns and capabilities, locations, perhaps technologies), (2) natural gas demand patterns (temporal and geographic), (3) natural gas and electric transmission infrastructure requirements including environmental implications and degree of utilization. This might be done for multiple “non-gas” electric supply scenarios, and for variations in key drivers such as load growth (perhaps including electrification), gas supply/prices, and hydro conditions. Long term expansion of natural gas infrastructure and of electric generation and transmission would likely be treated both as drivers (exogenously specified) and as “solutions” to electric reliability requirements - - implying an iterative approach.

Budget

2005: \$400,000
2006: \$400,000
Other:

Comments

Project requires realistic electricity market/grid modeling capability ideally down to bus level, and would also benefit from (perhaps not strictly require) natural gas system modeling as well.

Project Concept #164: Locating and Characterizing Outdoor Natural Gas Leaks

Michael D. Sohn

Description

LBL has developed a sensor data fusion algorithm called BASSET (Berkeley Algorithm for Sensor System Engineering and Testing) for locating and characterizing outdoor leaks of natural gas. BASSET can interpret real-time measurements (e.g., data from PSI's Remote Methane Leak Detector (RMLD) or a MIRAN detector) by statistically comparing them against airflow and gas dispersion predictions from a suitable outdoor model (e.g., NARAC, HPAC, QUIC). It probabilistically estimates, in real time, the likely locations of leaks and the amounts being lost, and determines where to gather more sensor data to improve the estimates. However, scientific research is still needed to test the robustness of the algorithm, and a proof-of-concept demonstration has not yet been shown.

Benefits

Natural gas leaks have both economic and environmental implications to California, as well as for global warming. Containing pipeline leaks alone, for example, will significantly reduce the costs to store and distribute gas to end users, and will reduce consumption of nonrenewable resources.

Objectives

Test the efficacy and reliability of BASSET for locating multiple leaks in a typical California urban setting. We will generate synthetic data of pipeline leaks (with measurement errors) and apply BASSET to statistically compare them to existing airflow and gas dispersion predictions of outdoor gas releases (predictions where generated by researchers at Los Alamos National Laboratory for a different project). We will determine the amount of data needed to locate leaks and determine under what conditions the algorithm succeeds and fails. We will also estimate the costs and resources needed to prepare BASSET for use by practitioners.

Budget

2005: \$100,000

2006: \$100,000

Other:

Comments

The BASSET algorithm was described and demonstrated in (1) Sohn, M.D., Reynolds, P., Singh, P.N., and Gadgil, A.J. Rapidly locating and characterizing pollutant releases in buildings: An application of Bayesian data analysis. *Journal of the Air and Waste Management Association*, 52: 1422-1432, 2002, and (2) Sreedharan, P., Sohn, M.D., Gadgil, A.J., and Nazaroff, W.W. Evaluating Sensor Characteristics for Real-Time Monitoring of High-Risk Indoor Contaminant Release. Submitted to *Atmospheric Environment* June 2005.

Project Concept #165: Over-fired Broiler Improvements

Frank Johnson

Description

Used in many food service operations, over-fired broilers provide easy access, less heat gain to the kitchen than open charbroilers, a seared product appearance and a "char broiled" taste that cannot be achieved through other cooking processes. However, broilers have a lower efficiency and higher emissions compared to other foodservice equipment. This project will address these issues while maintaining the broiler's favorable qualities. Changes to the existing design will be completed and tested to confirm the new unit has the same or improved efficiency and emissions in accordance with SCAQMD requirements. This project will be completed by The Food Service Technology Center (FSTC), which is administered by PG&E, and Gas Technology Institute (GTI).

Benefits

This development research benefits public interest in two ways: 1) the energy savings benefits accrue directly to California citizens in the form of improved system efficiency, and 2) the environmental benefits of the reduced emissions. Currently about 170,000 gas over-fired broilers are in use in the foodservice industry, with approximately 20% of these are in California. The redesign broiler will result in a 25% reduction of the 1100 therms/yr that typical broiler uses. If 20% of the existing units are replaced with the new broiler, 935,000 therms/yr would be saved in California alone.

Objectives

1) Redesign of the broiler 2) Conduct performance tests confirming the efficiency rating 3) Conduct emissions tests confirming improvements

Budget

2005: \$160,000

2006:

Other:

Comments

\$40,000 in additional cofunding has also been identified.

Project Concept #166: Smart system diagnostic, monitoring & controls of emission-ProcessHtrs

Cherif Youssef

Description

Fuel or air staged burners are used to reduce NO_x emissions for process heating. Staging requires maintaining accurate air to fuel ratios in both the rich flame zone and lean flame zone. Fuel composition and heating value variations can cause significant combustion inefficiencies and an increase in NO_x and CO emissions. To ensure complete combustion, overall air to fuel ratio is usually maintained at 15 %. The development of an advanced sensor technology to monitor combustion processes of varying stoichiometry occurring at different flame locations would allow a more precise control of combustion and reduction of overall air to fuel ratio. This reduction of air usage will increase overall combustion efficiency by 3-5%. Large commercial boilers and process heaters will be the primary candidate for the control technology. There are thousands of large commercial boilers operating in the State of California. Process industries such as metals, glass, ceramic, plating and other industries located in the urban areas of Los Angeles, San Diego, San Francisco and other cities will also benefit from this technology.

Benefits

Efficiency will be improved 3-5% through improvements combustion processes in process heaters. This will result in annual operating cost savings for plant owners as well as reduced environmental emissions due to reduced annual emissions of NO_x and CO₂.

Objectives

The major objective of the proposed effort is to develop a cost-effective flame sensor to monitor combustion processes in the real time. On-line real time flame sensors will allow improvement of process heater efficiency and reduce NO_x and CO emissions. A bench-scale prototype will be developed followed by field trials.

Budget

2005: \$375,000
2006: \$450,000
Other: \$500,000

Comments

Project Concept #167: System Diagnostic, Monitoring & Controls of Emissions from IC Engines

Cherif Youssef

Description

To meet the future stringent emission limits in CA, stationary gas engines must utilize advanced control systems for air/fuel, ignition and catalytic after treatment equipment. Emissions and engine performance requirements creates a growing interdependence between signals from these systems. The number of interfaces is growing exponentially. A novel approach -- called the Human Machine Interface (HMI) Control/Diagnostic System -- can effectively monitor all signals from critical engine operating parameters on natural gas engines to ensure that the engine and catalyst system are maintaining compliance with the permitted emissions regulations. In order to do this, the HMI will interface with the engine

Benefits

Measuring engine emissions using continuous emissions monitoring system (CEMS) or portable emissions analyzer only tells the regulator or engine operator if the equipment is in or out of compliance. The HMI provides the engine operator and maintenance technicians with real time information that attempts to provide continuous assurance that Emissions are below prescribed limits. A recent survey by the SQAQMD of reciprocating engines in the district found the majorities were out of compliance. They estimate that non-compliance could result in about 30 tons per year of excess NOx emissions in 2005. HMI technology will ensure engine compliance, reduce emissions and perhaps reduce energy consumption due to optimized combustion.

Objectives

Budget

2005: \$70,000

2006: \$150,000

Other: \$50,000

Comments

SoCalGas and Compliance Controls would provide Co-funding.

Project Concept #168: Gas Engine Air Compression

Cherif Youssef

Description

Air compression is widely used to operate pneumatic driven machinery in the metals, plastics, food, and chemicals industries. Air compression is also used for drying applications in the food and textile industries. Customers want their air compression systems to be highly reliable and operate at a low cost. Natural gas air compression systems can provide customers with greater reliability (because of diversity of fuel source) and lower operating costs than electric systems. Industrial air compression represent large power loads that normally run right through the peak daily power demand period. Alternatives to reduce that load include application of advanced motor and control technologies, variations in practice, better maintenance, and substitution with engine-driven systems. Research needs to be conducted to develop engine packages uniquely positioned to address the air compression market with emissions levels that meet or exceed current air quality regulations. The total installed capacity of air compressors above 100 HP in SoCalGas' service territory is estimated at 150,000 HP with an annual replacement and expansion market of about 15,000 HP. This is a huge opportunity to reduce electric demand in this end use in the industry.

Benefits

The greatest benefit gas air compression offers is the opportunity to reduce energy costs by 33%. It also offers customers the ability to expand operations without expensive electric upgrades. For customers who retain the incumbent electric equipment, gas air compression also provides increased reliability and flexibility on the energy source (gas or electric) to use. The rate payer benefits include shifting or elimination of electric demand.

Objectives

The main objective is to develop engine driven air compressor packages that meet today's air quality regulations and are reliable with low maintenance costs and easy to operate.

Budget

2005: \$300,000

2006: \$300,000

Other: \$0

Comments

This project is of real significance since the broad effort by the CPUC and the CEC to require the state utilities to promote demand response programs through the utilities Energy Efficiency programs. The industrial market segment is a large user of electricity and its energy demand coincides with the peak demand hours of the electric utilities. Reduction in electric energy use during these peak hours in this market segment will have great TRC benefits to the state of California.

Project Concept #169: Gas Engine Refrigeration

Cherif Youssef

Description

Mechanical refrigeration is used in cold storage application and agricultural product storage. Customers want their refrigerated warehouses to be highly reliable and operate at a low cost. Natural gas engine driven refrigeration compressors can provide customers with greater reliability (because of diversity of fuel source) and lower operating costs than electric systems. Refrigerated cold storage represents large power loads that normally run right through the peak daily power demand period. Alternatives to reduce this load include substitution with engine-driven systems. Research needs to be conducted to develop engine packages uniquely positioned to address the refrigeration compressor market with emissions levels that meet or exceed current air quality regulations. The total California stock area of refrigerated warehouses is approximately 1.2 billion square feet with average size warehouses totaling over 200,000 square feet. This is a huge opportunity to reduce electric demand in this end use in the industry.

Benefits

The greatest benefit gas refrigerant compression offers is the opportunity to reduce energy costs by 25%-30%. It also offers customers the ability to expand operations without expensive electric upgrades. For customers who retain the incumbent electric equipment, gas air compression also provides increased reliability and flexibility on the energy source (gas or electric) to use. The ratepayer benefits include shifting or elimination of electric demand.

Objectives

The main objective is to develop engine driven refrigerant compressor packages that meet today's air quality regulations and are reliable with low maintenance costs and easy to operate.

Budget

2005: \$300,000

2006: \$300,000

Other: \$0

Comments

This project is of real significance since the broad effort by the CPUC and the CEC to require the state utilities to promote demand response programs through the utilities Energy Efficiency programs. The industrial market segment is a large user of electricity and its energy demand coincides with the peak demand hours of the electric utilities. Reduction in electric energy use during these peak hours in this market segment will have great TRC benefits to the state of California.

Project Concept #170: Optimal Energy and Water Systems for Car Washes

James Fay

Description

There are over 30,000 car washes in California (Dun & Bradstreet, 1999). According to the California Car Wash Association, unique and immediate challenges for this customer group include water management, energy costs and wastewater disposal fees. The goals of this project would be to identify and demonstrate least-cost energy and water management systems that are optimally applicable to car washes. The project would segment this market (there are automatic, self-service, hand wash and bay type- all of varying sizes), monitor and analyze energy and water consumption profiles, design an economically optimal system considering both energy and water needs (and considering gas-fired and electric options, but emphasizing hybrid system designs with renewables), and demonstrate selected systems. Energy and water conservation performance would be the key parameters to demonstrate; however, adequate reliability and maintenance would also be proven.

Benefits

System configurations taking into account the unique energy and water needs of car washes are expected to generate significant and cost-effective energy and water savings. It is expected that cofunding partners would also be interested in participation. If these systems and their benefits can be successfully demonstrated, it is expected that rapid adoption will occur within this segment. Successful designs may find further application in other small commercial, high thermal load sites, such as health clubs.

Objectives

The primary results of this research will be new and demonstrated systems designed for the specific energy and water needs of car washes. Because of the unique combination of water usage (and wastewater production), lower temperature thermal requirements, and power needs, it is expected that new and innovative systems that 1) optimize designs considering all these factors, and 2) consider the latest technical capabilities of new energy technologies, including renewables, will be developed. In addition, the special scheduling and peak business demands of car washes may also offer a compelling opportunity to manage electric peak demand in a way that takes advantage of real-time pricing and/or demand response programs.

Budget

2005: \$300,000

2006: \$700,000

Other:

Comments

Project Concept #171: Advanced Usage of Syn Gas Reactions In Direct Fuel Cell Cycles

Dr. Savas Vasileiadis

Description

Synthesis and Fuel Gas coming out of combined Reforming, Gasification and other secondary reaction operations is a valuable key source of distributed electric generation in direct higher efficiency fuel cells. This work will include the design, analysis, modeling, and operation of combined gasification, reforming cycles which use liquid slurries of heavier hydrocarbons and solids-carbonaceous rich hydrocarbons. Advanced differentiated designs will be applied with respect to the feedstock-fuels used at various degrees, the reactions, separations, and the inner conditions involved. The direct consecutive use of the exit synthesis-fuel gas mixture by means of researched advanced fuel cell cycles and units and respective flow charts, increases significantly the fuel consumption and conversion capacity, and improves the characteristics and performance of the electrochemical process within the fuel cells used.

Benefits

- The use of lower quality liquid and solid fuels for upgrading and use in direct electric fuel cell power generation.
- The utilization of renewable multiphase type hydrocarbon feedstocks in such direct fuel cells generation operations.
- The effective use of combined gasification-reforming operations for fuel conversion and fuel cell electric generation; total final process efficiency and performance improvements.
- Cost reduction in electric generation and usage of corresponding fuel cells.

Objectives

- Higher quality synthesis and fuel gas generation from lower quality multiphase fuels;
- Higher efficiency in combined fuel cell generation cycles;
- Effective inner – output process designs for fuel conversion;
- Cost improvements in overall process for fuel cell distributed electricity generation from liquid and solid hydrocarbon fuels.

Budget

2005: \$125,000

2006: \$100,000

Other: \$80,000

Comments

Our described research work is within the goals of the 2006 PUC and CEC phase as described within this program. It agrees with several program objectives (i.e., renewables, advanced generation) as they have been described in this announcement. A number of related engineering articles, reports, and patents have been issued in current years in related work. This lead research team is accepting proposals for collaboration with other research labs with related background and research work;

Project Concept #172: Strategies for Energy-Efficient Natural Gas Technology RD&D Projects

Donald B. Kazama, P.E.

Description

The California Energy Commission (Commission) has established an extensive network with California industry, utilities, and universities. Much of the Commission

Benefits

By conducting the described RD&D activities and implementing energy-efficient natural gas technologies, California industry will not only save money by reducing their overall energy usage, but will improve the state

Objectives

Budget

2005: \$500,000

2006: \$750,000

Other: \$500,000

Comments

Project Concept #173: Sustainable Community Strategies, Santa Monica Demonstration Project

Cherif Youssef

Description

The Santa Monica Sustainable Communities Demonstration project ("Project") is a partnership of Southern California Gas Company, Southern California Edison, The Energy Coalition and the City of Santa Monica ("The City"). The Project is designed to promote sustainable development, showcase energy-efficient design and building practices, and encourage local developers to incorporate clean on-site energy generation systems in their multifamily and commercial new construction projects. The demonstration project will incorporate high performance energy efficiency and demand reduction technologies, along with clean on-site generation, water conservation, transportation efficiencies and waste reduction strategies. Although interest continues to grow, sustainable design is still in the infancy stage, and the cumulative effects of sustainable buildings to utility infrastructure are unknown. Further emphasis is needed to encourage energy efficiency within sustainable building projects through good design practices beyond the current building/community design standards. The Project will incorporate high performance energy efficiency and demand reduction technologies, along with clean on-site generation, water conservation, transportation efficiencies and waste reduction strategies. Case studies and fact sheets will be developed and distributed on completed projects to the target market to increase the sustainable building knowledge base locally. The project will showcase and provide community examples for developing and adopting sustainable building policies.

Benefits

Sustainable buildings contribute to greater overall energy and demand savings than captured in the California Energy Code. Moreover from a community perspective, monitoring these projects would provide the utility with valuable experience and information on the overall utility and customer benefits. The utility can acquire valuable real time information on the cumulative effects of sustainable building practices that may lead to advancements in infrastructure planning and customer adoption.

Objectives

To understand the cumulative effects of sustainable design (water conservation, building commissioning, waste reduction, etc) and technologies (solar, continuous building monitoring, fuel cells, etc.) implemented within new construction building projects to utility infrastructure. Acquire information for an extended period of time to demonstrate the overall energy efficiency, demand reduction benefits and supply-side design integration of sustainable community development.

Budget

2005: \$500,000

2006: \$1,000,000

Other: \$500,000

Comments

This request will augment funding proposed by SoCalGas and SCE in their June 1, 2005 Energy Efficiency proposals for program years 2006-2008.

Project Concept #174: Power Generation from Waste Energy – Catalytic Microturbine

John Kelly and Greg Rouse

Description

The project entails engineering research, design and demonstration of an advanced waste energy recovery cycle that is applicable to producing electric power from fuel sources with methane concentrations down to two percent. The project will include modifying a microturbine to add a catalytic reactor and specialized fuel system to allow for fuel oxidation down to such low concentration levels. The project will also include a demonstration at an oil refinery for operation on waste gases normally flared off after blending with natural gas.

Benefits

The project will demonstrate the capability of producing electrical power from a waste fuel source that is normally so lean that it requires flaring with the assistance of natural gas. This advanced cycle will convert a waste gas from that requires natural gas assistance for disposal to a useful fuel that can be used for power generation without natural gas assistance. The catalytic combustor lends itself to low emissions that are lower than typical flares. The project will extend the availability and efficient use of fossil fuel supplies while advancing the use of renewable resources, thereby reducing both global and local air emissions. The catalytic combustor emissions will meet CARB 2007 requirements.

Objectives

Develop a high efficiency waste energy recovery power generation product that will significantly improve the economics of waste energy recovery. Demonstrate the ultra low Btu microturbine at an oil refinery site with waste gases having energy contents below 75 Btu/scf.

Budget

2005: \$200,000

2006: \$200,000

Other:

Comments

Partners include Capstone, Chevron, Flex Energy

Project Concept #175: Hybrid HVAC with TES

Cherif Youssef

Description

Conduct research into development of a gas/electric hybrid chiller plant that utilizes thermal energy storage (TES) to operate a cooling plant with the lowest operating cost potential. By packaging gas and electric cooling equipment with TES and developing advanced controls, customers will be able to operate their systems in an efficient, reliable and cost effective manner. Natural gas fired engine driven chillers could be operated during mid-peak hours with electric chillers operating during off-peak hours to store cooling energy in a TES system to be used during peak cooling demand hours that coincide with peak electric demand hours. This will provide very valuable peak load/demand reductions at the worst and most critical periods of electric power grid distress. Research will focus on improved engine efficiencies, effective heat recovery, state-of-the-art emissions monitoring and control system that optimizes system performance by scheduling the chillers and TES system operation.

Benefits

Optimize efficiency of operation of a hybrid cooling plant with TES to offset peak period energy demand. Enable lower electrical peak demand during afternoon periods using TES output. Facilitate energy price arbitrage for lowest possible operating costs

Objectives

The objective of the research is to develop a controls package that can optimally operate a hybrid cooling plant with TES and field demonstrate its effectiveness from the standpoint of cost effectiveness, operational efficiency and maintenance benefits.

Budget

2005: \$300,000

2006: \$300,000

Other: \$0

Comments

This project is of real significance since the broad effort by the CPUC and the CEC to require the state utilities to promote demand response programs through the utilities Energy Efficiency programs. The commercial market segment is the largest user of electricity and its energy demand coincides with the peak demand hours of the electric utilities. Reduction in electric energy use during these peak hours in this market segment will have great TRC benefits to the state of California.

Project Concept #176: Hybrid HVAC Cooling Plant

Cherif Youssef

Description

With today's advances in electric and gas space conditioning technology, customers should be able to switch and choose between gas and electric options. By packaging gas and electric equipment and developing advanced controls, customers will be able to operate their systems in an efficient, reliable and cost effective manner. This will provide very valuable peak load/demand reductions at the worst and most critical periods of electric power grid distress. Economic value is increasing as energy costs more closely reflect "time dependent valuation." The potential for packaged hybrid HVAC equipment in the non-residential market is huge. There are approximately 7 billion square feet of existing commercial stock area. Thousands of central plant and packaged HVAC equipment are replaced annually. The new construction market is over several million square feet that are built annually. The potential demand reduction and annual energy cost savings potential is very significant. In addition, the added savings in environmental emissions and increase in building HVAC system reliability is undeniable.

Benefits

The customer would benefit from being able to switch between electric and gas heating and cooling operation depending on the time of day and rate structure. This could provide a substantial operating savings to customers. The state of California gains a better understanding of the opportunities to economically shift energy form for a significant small commercial load at critical periods of grid stress.

Objectives

The objective is to work with OEMs, fabricators and packagers to develop combined heating, cooling and power generation technology using gas and electric equipment in a cost effective manner. The scope will be to lab test the equipment and then field-test them to monitor their performance, reliability and cost effectiveness. In addition, research the development of integrated systems controls that can intelligently switch system operation from electric equipment to natural gas equipment and vice versa during times of grid distress and time-of-use rates and enable operator and/or utility initiated switching of equipment.

Budget

2005: \$300,000

2006: \$300,000

Other: \$300,000

Comments

This project is of real significance since the broad effort by the CPUC and the CEC to require the state utilities to promote demand response programs through the utilities Energy Efficiency programs. The commercial market segment is the largest user of electricity and its energy demand coincides with the peak demand hours of the electric utilities. Reduction in electric energy use during these peak hours in this market segment will have great TRC benefits to the state of California.

Project Concept #177: Reduction of Lost and Unaccounted for Gas Volumes

Michael Whelan

Description

Develop technologies and methods to reduce lost and unaccounted for (LAUF) gas volumes, to minimize pass-through costs to consumers from inaccurate measurement and gas leaks in the gas delivery system, and minimize the environmental impact of methane release by detecting areas of the system that experience disproportionate gas measurement imbalances. LAUF reduction is a multi-faceted issue, requiring a set of coordinated actions, but the potential financial benefits (see below) are quite significant.

Benefits

The technologies and methods developed by this project would be utilized by all pipelines operating in California, as well as by pipelines bringing gas supplies to the California border. 2004 California Gas Supply/Demand statistics indicate that losses amount to 267 MMcf/day, or 3.78% of total CA gas demand. At \$7/Mcf wholesale gas prices, this costs consumers \$1.869 MM per DAY. Tariffs generally allow these losses to flow down to be paid by consumers. If these losses can be cut by 1/3, then benefits of over \$600K/day - over \$200MM per year - would be directly realized by consumers.

Objectives

· Development of guidelines for system balance procedure. · Assessment of the ability of new, mobile metering technologies, such as clamp-on ultrasonic meters, to perform segment balances at locations where measurement infrastructure does not exist. · Definition of industry-acceptable check metering performance specifications, systems, and procedures to help identify potential metering problems at that could adversely affect system balance. Development of guidelines for meter calibration/proving frequency intervals to help optimize meter calibration intervals and minimize facility maintenance costs. · Development of guidelines for meter station inspection frequencies to minimize facility maintenance costs.

Budget

2005: \$500,000

2006: \$500,000

Other: \$0

Comments

Project Concept #178: Accommodating Liquefied Natural Gas (LNG)

Michael Whelan

Description

U.S. DOE estimates that imported LNG will make up 17% of the U.S. supply of natural gas within 20 years. Significant investment in ports and LNG re-gasification facilities is occurring at numerous locations around the U.S. Because LNG is typically produced in geographical areas without local markets for liquefied petroleum gases (ethane, propane, butane), these components of natural gas are not extracted from produced gas before liquefaction. As a result, re-gasified LNG can have a significantly higher calorific value and molecular weight than domestic natural gas. This can have significant effects on the accuracy of existing flow meters and gas chromatographs used for custody transfer measurement of natural gas. The proposed project will investigate the effect of LNG on the existing natural gas measurement infrastructure.

Benefits

In almost all instances, net gas receipt and delivery imbalances are placed into a “lost and unaccounted for gas” (LAUF) account. These volumes – valued at the current commodity cost of gas – are flowed through to customer bills, as an element of the cost of service. Any reductions in LAUF will directly reduce consumer charges. Flow rate bias errors as low as 0.1% to 0.2% can have a significant influence on LAUF gas. For example, eliminating a potential 0.2% flow rate bias error between the amount of LNG that is projected to be consumed in California (17% of the 2.5 TCF/yr of gas consumed statewide) and the amount of gas actually measured, could account for \$5.9MM in savings to consumers (based upon an annual average pipeline delivered California cost of \$7.00/Mcf).

Objectives

The objective of this project is to critically compare the measurement of medium- and high-Btu re-gasified LNG to a comparable measurement of natural gas blends acquired from domestic utility. This will characterize the accuracy of existing measurement infrastructure to handle varying gas blends due to LNG imports.

Budget

2005: \$300,000

2006: \$0

Other: \$0

Comments

Project Concept #179: Certified Low-Emission High-Efficiency CNG Industrial Truck Engine

Jo-Ann Yantzis and Greg Gilbert

Description

To research & develop a certified low-emission, high-efficiency CNG industrial truck engine. Low-emission certification objective is 50% or more below the 2007 LSI standard, to voluntarily offer significant environmental benefits through dramatic emissions reductions in excess of regulated requirements (thereby reducing the environmental effects associated with gas usage), and to benefit the health and welfare of citizens employed by or residing near industrial facilities that utilize this equipment. Optimization of engine combustion efficiency will be included in this R&D activity, to minimize fuel consumption, increase efficiency, and reduce emissions. Through this R&D activity, advanced technologies and operating techniques will be developed and deployed for MY2007 engines/equipment. As this equipment is predominantly used indoors, indoor air quality and operator health and welfare are also addressed. Background: Prior to 2004 regulations, CNG conversion kits were installed on propane- or gasoline-powered engines/equipment for large fleet operations that invested in CNG refueling infrastructure. These CNG-conversion activities ceased on post-2004 certified engines/equipment due to tampering issues, thereby resulting in the retention of older high-emitting equipment and negative growth to CNG fuel sales to this industrial sector. A certified CNG-powered industrial truck has not been available from any Original Equipment Manufacturer (OEM) since the implementation of the 2004 regulations. Our OEM Client has recently certified a MY2005 CNG-powered engine that meets the current standard. Further research and development is required to commercialize a low-emission, high-efficiency model. Our OEM Client will cost share for this project. This R&D activity could lead to future R&D activity on hydrogen-powered technology.

Benefits

The current applicable emissions standard is that of Large Spark Ignited (LSI) engines, at 3.0 g/bhp-hr NO_x + HC and 37.0 g/bhp-hr CO. The pending 2007 LSI emissions standard is 2.0 g/bhp-hr NO_x + HC and 15.5 g/bhp-hr CO. This project will result in the commercialization of MY 2007 engine/equipment that voluntarily reduces the above 2007 emissions by 50% or more, while optimizing fuel efficiency and providing an OEM product option for CNG. These lower emissions will directly benefit the employees of and the residents near industrial users of this equipment. Benefits to indoor air quality, greenhouse gases, and ambient ozone are achieved through this project. Based on the conservative sale of 100 new units in 2007, the resulting environmental impact is the reduction of 3.9 tons/year NO_x + HC and 29.3 tons/yr CO (at minimum), based on the CARB inventory profile for industrial trucks of: 1800 hrs/yr, 30% load factor, and 7 yr useful life.

Objectives

1) Low-emission, high-efficiency, certified CNG-powered industrial truck manufactured, distributed and warranted by a major US- and Japan-based Original Equipment Manufacturer (OEM). 2) Voluntary significant emissions reductions that exceed regulatory requirements, and offer substantial health & welfare and indoor air quality benefits. 3) Optimization of combustion efficiency for energy conservation, and emissions reductions. 4) Obsolescence of older, uncontrolled, high-emission CNG-powered industrial trucks resulting from purchases of this new OEM product.

Budget

2005: \$400,000

2006: N/A

Other: N/A

Comments

The availability of an OEM certified low-emission, high-efficiency CNG-powered industrial truck provides fleet users with an option that prevents the potential migration to higher-emitting energy sources that may result from its non-availability.

Project Concept #180: Condensing sidearm water heater

Jim Lutz

Description

Build and test early prototypes of a condensing sidearm gas-fired residential water heater. A condensing heat exchanger as a sidearm would use standard water heater tanks, thus reducing cost. Drawing water from the bottom of the tank means the heat exchanger will always be transferring heat to the coldest water which will improve heat transfer. The water will circulate through the sidearm by thermosyphonic action to help preserve stratification and eliminate a circulating pump. Both of these factors will increase the efficiency of the water heater. Combustion products will be cool enough to be vented through plastic. It may be possible to reduce burner size enough so the draft inducer can be powered with low voltage electricity making installation much simpler.

Benefits

Current gas-fired residential water heaters have an EF of about .60. Water heaters of this design could have an EF of .85. Under nominal field conditions this would be equivalent to more than 20% energy savings compared to current typical models. The theoretical potential gas savings to the state would be 37 billion BTU/year.

Objectives

To demonstrate the possibility of building a low-cost, easy-to-install, condensing gas-fired residential water heater that can run on low-voltage power with an EF above .85.

Budget

2005: \$500,000

2006: \$500,000

Other:

Comments

This project would complement and extend the potential of the Super Efficient Water Heating Appliance Initiative (SEGWHAI) the CEC is currently undertaking. By coordinating with existing programs this project could dramatically leverage CEC money. Taking advantage of the fan-assisted combustion required by a condensing water heater should allow the use of innovative burners which would reduce NOx emissions. The South Coast Air Quality Management District is very interested in controlling NOx emissions from gas water heaters and may wish to collaborate on this project.

Project Concept #181: Accommodating Varying Gas Chemistries from Non-Traditional Gas Supply

Michael Whelan

Description

Increased demand for natural gas has led to the potential of wide variations in the quality of the gas supply available to California. A proportion of the incremental demand will be met by LNG imports, by supplies from depleted reservoirs, and by renewable resources, such as biogas. Variations in gas composition can cause variability in equipment performance and in the amount of pollutants emitted by gas-fired equipment. Large end users and gas transportation systems may require real-time, accurate and reliable methods to detect and react to changes in gas quality, in order to provide feed-forward controls to their equipment so that it can maintain in proper operating mode.

Benefits

Gas transmission and distribution system operators and large industrial consumers will have the ability to determine real-time gas quality and gas properties, allowing them to react quickly to changes in gas properties, avoiding increased emissions, reducing operating issues and providing a generally safer and more reliable operation. It is not known what the costs of wide swings in gas quality might be, as California generally enjoys stable gas compositions. However, this is expected to change - possibly rapidly - in the future, and it will be important for large users to be able to adapt rapidly to these changes with proven equipment options.

Objectives

Field test newly emerging gas composition and gas calorific value determination devices to allow integration of feed-forward control capability that adjusts for changes in gas composition and gas chemistry.

Budget

2005: \$500,000

2006: \$500,000

Other: \$0

Comments

There is the potential to obtain co-funding from PRCI, the U.S. Department of Energy, the American Gas Association, and/or, the American Petroleum Institute.

Project Concept #182: Communication Systems for Coordination of DG and Gas Delivery

James Fay

Description

Gas-fired distributed generation projects have grown to be a substantial, diverse and highly variable subset of the power generation customer base. Gas demand from this group is expected to continue to increase in the future. Because of the special gas delivery needs of this group (volumetric and pressure requirements of a greater than MW-sized turbine-based distributed generation project can be significant). In California, the demand for power and the demand for natural gas are closely linked. Improved communication and coordination among smaller scale gas generators and gas utility planners and dispatchers will lower the cost of gas supplies and improve gas and electric system reliability, especially during periods of coincident high gas and power demand. This project will develop and demonstrate advanced communications protocols and systems for coordination of distributed generation and gas delivery systems in California.

Benefits

The further integration of wholesale power markets, distributed power and gas delivery systems will place an increasing premium on coordination. Gas utilities can improve engineering design of the delivery system, but also, with better information and more lead time about current and expected small power loads, gas utilities can both lower costs of service, but also better maintain deliverability during critical demand periods. The anticipated benefits to maintaining the reliability of the electric system should also be considered as an important result of this project.

Objectives

The primary results of this research will be new and improved communication systems that enable distributed generation operators and gas utility dispatchers to better anticipate distributed generation gas demand. This project will determine the optimal role for increasing the communication of information, its frequency, format and lead times. The project will optimally design the combination of data acquisition, communication protocols, and the best hardware and software for implementation given existing systems at distributed generators (and, most likely, information regarding the status expected conditions in the electric power markets) and gas utilities. The project will further coordinate a demonstration of the optimal design(s).

Budget

2005: \$250,000

2006: \$500,000

Other:

Comments

Project Concept #183: Laser Ignition System Demonstration for Natural Gas Pipeline Engines

Bryan Willson

Description

Natural gas must be compressed by engines (or turbines) to be transported through pipelines. The engines used for pipeline compression are large 2-stroke, direct-injection, slow-speed lean-burn engines, fueled by natural gas. Research has shown that the use of laser ignition can reduce emissions in 4-stroke, carbureted, high-speed natural gas engines. This project would extend current laser ignition efforts to pipeline engines. Prior work has shown that the combustion characteristics of pipeline engines are quite different, requiring a separate development effort which builds on current efforts.

Benefits

This work offers the potential for simultaneous reductions in NO_x emissions, fuel consumption, and operating costs. The project would eliminate a major maintenance shortfall of pipeline engines, thereby increasing the reliability of California's natural gas infrastructure, while improving California's environment.

Objectives

- Adaptation and demonstration of a single-cylinder laser ignition system from the work on distributed generation currently being supported by DOE and CEC.
- Adaptation and demonstration of laser ignition for an entire engine.
- Long-term life and performance testing.
- Commercialization.

Budget

2005: \$250,000

2006: \$300,000

Other: \$250,000

Comments

Project Concept #184: Gas Transmission Measurement Equipment Operating Range Expansion

Michael Whelan

Description

With an increase in natural gas delivery system capacity likely to be needed in the relatively near future in California, the existing infrastructure should be assessed to determine its ultimate throughput limit. It may be possible to substantially expand current meter station operating ranges through relatively minor system modifications, thus minimizing capital expenditures. For instance, it may be possible to increase the throughput limit for existing orifice flow meter stations by relaxing restrictions on orifice plate beta ratio size and/or differential pressure limits (assuming that supporting test data were available).

Benefits

Extended operating envelope and enhanced capacity for natural gas delivery system meter stations will defer capital expenditures that would otherwise be required to prepare the CA gas transmission system, as well as large volume gas customers, to accommodate significant swings in gas flows and overall increases in gas demand. If the installation of additional meters can be avoided through expanding the operating range of existing meter stations, those savings have direct benefit for all gas customers, as gas rates are based on the in-service capital base of the CA utilities.

Objectives

The proposed research project would assess current meter station performance for operating beyond current design limits, and would include the following: 1) Investigation of the gas velocity restrictions placed on existing meter systems and the potential for expanding these velocity limits. 2) Quantification of the influence of velocity-induced noise on meter performance. 3) Effect of higher velocities on control valves and other flow/pressure control equipment. 4) Meter station piping configuration changes that may be required by higher flow rates. The project would quantify the risk to measurement accuracy, precision, and bias associated with operating meter stations beyond typical manufacturer-recommended ranges, in order to obtain greater gas throughput without large capital expenditures.

Budget

2005: \$250,000

2006: \$0

Other:

Comments

There is the potential to obtain co-funding from PRCI, the U.S. Bureau of Land Management, the U.S. Minerals Management Service, the U.S. Department of Energy, the American Gas Association, and/or, the American Petroleum Institute.

Project Concept #185: Pipeline Right-of-Way (ROW) Environmental

Michael Whelan

Description

Permitting for new pipeline construction is often delayed by various agencies charged with protecting the right-of-way through which the pipeline passes. Concerns over the potential fragmentation of critical habitats and destruction of vegetation can lead to re-routing and/or higher design and construction costs. Future expanded use of the same right-of-way is often impeded by these same considerations. Validating the integrity of newly installed pipe requires hydrotesting prior to start-up, with water disposal a significant issue. To assure an acceptable environmental footprint for new construction and subsequent integrity assessments, better understanding is needed to minimize the impacts on natural habitats and vegetation, and for the safe disposal of hydrotest waters. The proposed program will investigate integrated vegetation management strategies, methods for handling habitat fragmentation, environmental effects of multiple pipelines in the same ROW (cumulative effects), and the disposal of hydrotest waters.

Benefits

While costs for the disposal of waters used in initial hydrotesting can be as low as \$1.50 per foot, if hydrotesting for future mandated integrity assessments is required, water disposal costs can range from \$30,000 to \$250,000, depending on the contaminants involved, for a typical 15 mile segment of pipeline. The proposed research will produce improved outcomes for communities, agencies and pipelines, will expedite project approvals, and will improve the ability of all parties to accommodate sensitive environments - thereby assuring safety of the environment and potentially reducing costs of construction and permitting delays. Both construction cost savings and improved system capacity and flexibility due to timely project completion directly serve the interests of California gas consumers.

Objectives

Develop practices for ROW maintenance and handling of hydrotest waters. Studies will focus on determining the environmental impact of pipeline construction to guide the development of recommended practices for integrated vegetation management and the handling of habit fragmentation. Environmental effects of the addition of multiple pipelines to a single ROW and the disposal of hydrotest waters will also be evaluated. Ultimately, research results will be used to standardize design methodologies, enable simplified information exchange, and to facilitate permitting by minimizing conflicts with local, State and Federal agencies - preventing significant delays.

Budget

2005: \$400,000

2006: \$300,000

Other: \$0

Comments

PRCI and the Interstate Natural Gas Association of America will consider cofunding this work.

Project Concept #186: Chemical Synthesis from Natural Gas

Dr. Zoe Ziaka, Dr. Savas Vasileiadis

Description

Chemical synthesis from natural gas and natural gas streams is an important and key chemical production process with related side chemical operations. Chemical products coming out of combined natural gas conversion, separation, and other secondary operations are highly valuable, and can be used either directly or in consecutive synthesis and energy cycles and flow charts. This work will include the design, analysis, modeling, and operation of combined natural gas conversion and separation cycles to produce a number of key utility chemicals in an efficient way. Advanced differentiated designs will be applied with respect to the natural gas used in various reaction/separation degrees; the reaction/separation equipment used with the inner conditions involved for the final delivered product. The consecutive utilization of the exit chemical product in direct and side synthesis increases significantly the yield and efficiency of the proposed process. Innovative methods for increased target product(s) are going to be analysed and tested.

Benefits

- The effective use of natural gas feeds for direct chemical production and utility cycles. - Continuous delivery and utilization of natural gas streams in direct specialty chemicals production operation. - The effective use of new combined conversion and separation operations with total process yield improvement in chemical production. - Cost reduction in total process of specialty chemicals production and usage from natural gas in comparison with related processes.

Objectives

- Chemicals production from natural gas hydrocarbon streams; - Higher efficiency in combined reaction-separation production cycles; - Effective inner process designs for yield improvements in chemical production; - Cost improvements in overall process for chemical production from natural gas feedstocks.

Budget

2005: \$125,000

2006: \$110,000

Other: \$75,000

Comments

Our described research work is within the goals of the 2006 PUC and CEC phase as described within this program. It agrees with several program objectives (i.e., energy efficiency, advanced generation) as they have been described in this announcement. A number of engineering articles and related patents have been issued in the last years in this abstract work. We accept applications from students for this project.

Project Concept #187: Increased PCB Mobilization in Transmission and Distribution Pipelines

Diane Saber

Description

In June 1998, the U.S. EPA made changes in the PCB regulations under the Toxic Substances Control Act (TSCA), also known by the industry as the PCB Disposal Amendments or the "Mega Rule." The 200-page rule, including preamble, encompasses more than 80 changes in the PCB regulations. Polychlorinated biphenyls -- or PCBs -- are synthetic, chlorinated organic compounds. These compounds were manufactured between 1926 and 1977 for use by gas utilities, electric utilities, and many other industries in applications where stable, fire-resistant, heat-transfer properties were mandatory. Congress halted the production and usage of PCBs in the 1970s due to their toxic effects on the environment as well as the human health. They are a recurring problem because they can still be found in thousands of miles of natural gas transmission and distribution piping and equipment (nearly 120,000 miles of such piping exists in California), with compressor lubricants and valve grease containing high concentrations in older lines. PCBs have been identified around gas pipelines and compressor stations since they may enter the environment through spills, leaks, drains and improperly abandoned pipe. Once they enter the environment, PCBs are not readily biodegradable and therefore can pose a continuing environmental risk. The American Gas Association and INGAA have formed task forces to investigate identification of PCBs in pipelines and compliance with the Mega Rule. However, the effects of LNG interchangeability on the mobilization and release of entrained PCBs has emerged as an important topic. LNG interchangeability may affect the parameters which make PCB compounds more mobile and subject to introduction into the environment. Investigation into this topic is warranted and important, as new interpretation of the Mega Rule and focus on "dioxin-like" PCBs are likely to influence PCB cleanups and disposal.

Benefits

There are three objectives to this study: 1: Perform a literature search into the parameters which affect the release of entrained PCBs from pipes under current natural gas transmission conditions. In tandem, a search will be performed to identify conditions which enhance release of PCBs. These results will serve as a basis for a comparative test. 2: In the laboratory and using retired pipe from a variety of conditions known to possess PCB concentrations, test the release of PCBs under a variety of conditions, using LNG sources. Parameters such as moisture content, organic compound loading and other identified variables will be tested. 3: Prepare a database of findings which compare the incident of PCB release under natural gas transmission as compared with LNG interchangeability

Objectives

1. Clear understanding of the parameters which influence potential increased mobilization and availability of PCBs in existing pipes by the introduction of LNG. 2. Better tools for identifying potential problem areas when LNG is introduced into existing pipe networks. 3. Better understanding of potential health & safety aspects to LNG interchangeability, including increased release of "dioxin-like" PCB compounds. 4. Increased security that introduction of LNG will not pose significant problems or hamper Mega Rule compliance.

Budget

2005: \$40,000

2006: \$100,000

Other: \$40,000

Comments

Project Concept #188: Natural Gas Impurities – Impact on Appliances and Equipment

Alex Lekov and Gabrielle Wong-Parodi

Description

Research has shown that variable natural gas quality impacts the performance and reliability of residential and commercial appliances (in particular the existing stock of natural draft equipment). Increased demand for natural gas in California will be satisfied by a diversity of sources, each of which possess distinct compositional characteristics (interchangeability) and quality (level of impurities). Past studies in California have only focused on a few select utility companies. The two main goals of this study is to assess the impact of natural gas composition and quality: (1) on the performance of appliances and equipment (statewide), and (2), by the introduction of LNG.

Benefits

Economically, consumers would benefit from increased savings over the lifetime and prolonged life of the appliance and/or equipment by increasing the efficiency by improved natural gas quality. An incremental improvement in appliance performance, multiplied by the number of users of natural gas in California, will impact the physical savings of natural gas. Environmentally, indoor air-quality will be improved by reduced pollutants such as particulates and CO that occur when natural gas combustion is incomplete. On a larger scale, outdoor pollutants would be reduced by improved natural gas quality (reducing amount of impurities) such as particulates, by use by industrial and electric generation consumers of natural gas.

Objectives

The most important objective is to develop recommendations for Gas Utilities on the “right” composition of natural gas to provide the best performance of appliances and equipment for consumers that are both technologically feasible and economically justified by performing an assessment of: (1) Different types of natural gas interchangeability indices and quality criteria will be performed in order to determine optimal regional specifications. (2) Economic and environmental benefits by testing different types of appliances with different natural gas compositions and/or analysis of existing data. (3) The magnitude of benefits to the Utility. (4) The possible barriers to implementation of any recommendations.

Budget

2005: \$125,000

2006: \$175,000

Other:

Comments

The proposal will have an analytical and experimental component. The experimental component will include a sample of approximately 30 models of furnaces and water heaters. The analysis component will provide sufficient and conclusive results that can be generalized to the state of California.

Project Concept #189: Infiltration and Ventilation Interactions with Gas Appliance Venting

Craig Wray

Description

Combustion products from gas-fired appliances can enter the indoor environment accidentally when venting is insufficient or deliberately in the case of unvented appliances. In either case, product concentrations must be minimized to avoid causing health or comfort problems for building occupants. Naturally-aspirated vented appliances typically rely on leaks in the building envelope to provide makeup air that supports proper venting to outdoors. Unvented appliances rely upon having a sufficient air change rate indoors to dilute combustion products. Both these venting processes involve air-exchange related energy penalties, which in turn affect the load imposed upon gas appliances used for space heating. When the building envelope is tightened to reduce air infiltration or when mechanical exhaust systems are operated, the airflow assumptions may no longer be valid and inadequate venting or space ventilation may occur. Although there has been substantial work over the past 20 years outside of California in the United States and in Canada to understand the impacts of exhaust system operation on the venting of naturally-aspirated combustion appliances, no such work has been carried out to address California housing and climate characteristics. Using field studies, this project would determine both the energy and environmental impacts of infiltration and ventilation interactions on vented and unvented gas appliance operation for a wide range of California houses throughout the state. It would also develop simplified diagnostic procedures for use in commissioning and retrofit programs to assess the airflow-appliance interactions, and would produce new guidelines for the safe and efficient operation of these appliances in California homes.

Benefits

Although there has been substantial commendable activity by the gas industry over the past 100 years to define safe operation guidelines for gas appliances, this industry has not addressed the impacts of infiltration and ventilation system interactions, which occur outside the boundaries of the appliance and its venting system. In part, this inactivity has been due to the multifaceted complexities of the problem and the fragmented nature of building industry itself. It also appears to be a result of no clear evidence that there are problems in California houses (in part due to a lack of diagnostics to identify problems), as well as a concern that addressing such issues is counter-productive to the gas industry: addressing problems beyond the immediate control of the gas industry might impact consumer inclinations to use gas appliances. The new knowledge embodied in the diagnostics and guidelines developed in this project would be a public good that is uniformly available to all institutions, including manufacturers, contractors, building inspectors, regulators, utilities, and consumers. It would also provide a basis for the further development of related standards by professional organizations such as ASHRAE and ASTM. The primary benefit of the project would be improved indoor air quality (IAQ). In particular, the direct benefit would be reduced concentrations of combustion products indoors and better occupant health (e.g., reduced exposure to combustion-generated nitrogen dioxide can lead to reduced chronic respiratory problems). Because the project would also address improved ventilation as an integrated strategy for controlling combustion products, indirect IAQ benefits may also result from the reduction of other indoor pollutant concentrations in addition to the direct benefits. Further benefits could include improved occupant comfort and better energy performance through the provision of data that allow improved choices of equipment.

Objectives

The most important outcomes will be diagnostic procedures for use in new and existing houses and guidelines on how to effectively use gas appliances in California houses to avoid airflow-related problems. Particular emphasis will be placed on developing diagnostics that can rapidly and reliably identify appropriate metrics such as the cold-vent establishment pressure (CVEP) for naturally-aspirated appliances. The CVEP represents the maximum indoor-outdoor pressure differential against which the hot combustion gases from the appliance can establish a proper flow through the vent. Emphasis will also be placed on defining air-tightness, air change rate, and unbalanced ventilation constraints that enable gas appliances to operate properly while minimizing associated energy penalties.

Budget

2005: \$500,000
2006: \$400,000
Other: \$400,000

Comments

Air tightening is limited by the need to provide sufficient ventilation and to avoid creating excessive house depressurization. Part of this project would examine existing ventilation standards to better define these limits and, when necessary, take mechanical ventilation into account.

Project Concept #190: Automated Building Diagnostics/Continuous Commissioning Software

Cherif Youssef

Description

Development of automated building system Fault Detection, Diagnostics and Optimization (FDDO) software. There are a number of existing software products that work with commercial building control systems to provide information on equipment performance and failures. However this existing FDDO software are not developed to the point where widespread market acceptance can be achieved. New software needs to be developed and existing software needs to be enhanced. This software needs to be “packaged” so that it can be easily installed and operated by existing building maintenance personnel. Areas of weakness in existing software include the complexity of data collection and software configuration, the level of human intervention required, anomaly costing. New software can be developed to address these deficiencies and also provide FDDO for gas-fired equipment such as absorption chillers, boilers, and engine generators. The new software can be designed to provide energy consumption indexing for building systems so that energy efficiency improvements can be quantified using a standard set of protocols. Retro commissioning of large commercial buildings has a huge potential to save energy and operating costs for these building operators. The State of California large commercial floor stock exceeds over 2 billion square feet. This includes office buildings, retail stores, institutions and government facilities. There is increasing interest in commissioning of new buildings and retro commissioning of existing buildings at the CEC and the CPUC. CEC is examining the energy savings potential of retro commissioning of existing buildings under its Senate Bill AB549 directive.

Benefits

There will be direct financial and environmental benefits from energy efficiency savings and load shifting and peak demand reduction with the use of advanced FDDO software that works in concert with building automation system. The FDDO software can assist building operators to shift load during periods of grid congestion to substantially reduce demand and energy consumption. This will result in financial savings due to reduced energy bills, repair costs, maintenance costs and capital costs.

Objectives

The key objective is to develop a software platform that can work across all building automation systems to provide real time information on the operation of all components of a building energy system including HVAC, lighting, fire protection and security systems by detecting, diagnosing and correcting anomalies in HVAC and lighting systems on an ongoing basis. The developed product can then be packaged and marketed to building operators to save energy, reduce operating costs and improve occupant comfort (i.e., operating buildings optimally).

Budget

2005: \$500,000

2006: \$500,000

Other:

Comments

Project Concept #191: Wind, Hydrogen, Natural Gas Hybrid System

Bryan Willson

Description

A drawback of current wind systems is their poor availability / dispatchability due to varying wind conditions. Load leveling can be accomplished by using electricity for electrolysis to generate hydrogen when demand is low. The hydrogen can be used for power generation when demand requires. Analysis shows that the overall economics and environmental benefits can be maximized by co-firing hydrogen and natural gas (i.e. "Hythane") in high efficiency internal combustion engines. Hydrogen mixtures as low as 10% (by energy content) can produce significant reductions in emissions and overall energy consumption, and can dramatically improve project economics.

Benefits

This project builds on current wind, hydrogen and natural gas R&D to demonstrate an advanced wind, hydrogen, natural gas hybrid system. The demonstration will gather in-use data which will then be utilized in economic models to document real-world benefits. Systems analysis has shown that a quantity of hydrogen can have a much greater impact as a Hythane blends than as pure. The blends improve wind / H2 economics to the point that many marginal projects will become cost-effective. Finally, the greater allowable run time has the ability to significantly improve grid reliability.

Objectives

1) Adapt a high-efficiency engine and control system to run on H2 / natural gas blends at a current wind / H2 hybrid facility, or one under development (candidate sites have been identified). 2) Demonstrate the ability to run on a wide variety of H2 / natural gas blends, from 100% H2 to 100% natural gas. 3) Define the allowable operational window of H2 / natural gas blends to meet California emissions regulations. 4) Document the Technical Performance: efficiency, emissions, availability, costs. 5) Using modeling tools, analyze potential economic benefits.

Budget

2005: \$300,000

2006: \$300,000

Other: \$250,000

Comments

Candidate project sites, technical partners, and wind / utility partners have been identified. One option is a new project currently being implemented. Early participation could result in significant leveraging of resources. Tremendous replication potential exists.

Project Concept #192: Smart Technology-Communication Interface

Cherif Youssef

Description

Development of smart communication interface that can become part of residential equipment and appliances and small commercial equipment to enable the new Advanced Metering Infrastructure (AMI) technology to communicate with these equipment to optimize their operation, shift load and shut down during peak hours. Common communication protocols need to be developed to link AMI devices, thermostats, air conditioning units, furnaces and lighting systems, entertainment systems, cell phones and home computers. There are over 7 million single-family residential and 3.6 million multi-family building stock in California. Commercial stock area exceeds 7 billion square feet of which close to 25% is small commercial space with area less than 50,000 square feet. These buildings typically have small HVAC equipment, boilers, appliances and equipment. Thus there is a tremendous potential to save energy in these buildings. The CPUC has required the IOUs to implement smart metering or interval metering on a pilot basis. Sempra Utilities is in the process of implementing AMI technologies in residential homes in a pilot project. Research is needed to determine if manufacturers can easily incorporate interface technologies into the appliances and equipment so that they can be integrated into the AMI system for utility operated optimization.

Benefits

AMI devices can become more cost-effective if they are able to provide more services by communicating with household appliances. If for example, AMI devices could communicate with thermostats, air conditioning units, furnaces and lighting systems, entertainment systems, cell phones and home computers, they might be able to facilitate load shifting, load balancing, fault diagnostics and repair, indoor air quality and safety services. There will be direct benefit to the occupant in reduced energy and demand charges, greater comfort through optimized equipment operation, increased reliability and security. Public benefits of utility system demand reduction, energy security and reduced infrastructure costs can be realized through AMI technology coupled with equipment interface.

Objectives

The primary objective is to conduct research to develop equipment and appliance interface that can work with AMI technology for optimal operation, load shifting and improve occupant comfort. Additionally, help customers save energy, reduce expenses and achieve greater comfort and safety through technologies that can communicate with, and through, utility AMI devices.

Budget

2005: \$500,000

2006: \$500,000

Other:

Comments

Project Concept #193: Natural gas price dynamics and forecasting models

Katie Coughlin, Alex Lekov and Gabrielle Wong-Parodi

Description

It is very likely that the true cost of natural gas price volatility is under-valued in current policy analysis methods. Natural gas price forecasts are a fundamental input to investment planning for natural gas production and delivery capacity, electric capacity and the development of fossil fuel vs renewable sources, and conservation and efficiency programs. Forecasts typically rely on general equilibrium models that balance economic and demographic growth, fuel availability, and technological change under various smooth growth hypotheses. These models cannot represent the dynamic phenomena frequently seen in real markets. Our proposal is to develop relatively simple models that deal explicitly with dynamics, and use these to examine the impact of potential forecast inaccuracy under different risk management strategies.

Benefits

To a certain extent, price volatility is captured in forward contract prices, but because forward and spot markets are linked, forward prices can also show significant volatility over the time scales that are typical of planning horizons. Therefore, use of forward curves does not in and of itself take care of the problem of modeling volatility. As planning decisions, once made, can be difficult to modify or reverse, considerable costs may be incurred by underestimating the likelihood of abnormal market events. For example, when electricity capacity investments occur in a boom-bust dynamic rather than through smooth increments, it can add \$1-\$3/Watt to the investment cost(1).

Objectives

The goal is to develop modeling tools that are mathematically adequate to represent the dynamic behavior of natural gas prices, and develop criteria that permit a measure of the robustness of planning goals under different scenarios. A relatively simple phenomenological model of the dynamics of natural gas markets will be formulated from a review of the data. The sensitivity of the net benefit of different supply options (including conservation and efficiency) to price forecast scenarios will be estimated. The short and medium-term costs associated with episodes of extreme price volatility will be modeled, and the overall impact on cost vs risk-minimizing planning approaches will be discussed.

Budget

2005: \$100,000

2006: \$100,000

Other:

Comments

Demand growth of 1/2 percent per year would require roughly 250 MW of capacity. Even a small adjustment to the cost of building capacity can lead to significant savings. Reference(1) Katie Coughlin and Robert Van Buskirk 2001, Boom-Bust Cycles in Electricity Infrastructure Investment, EPRI Forecasting Symposium, Nashville TN.

Project Concept #194: Fast, Moderate Temperature Waste Gasification

Peter E. Jonker

Description

The project

Benefits

Objectives

The project

Budget

2005: \$600,000

2006: \$1,200,000

Other: \$2,000,000

Comments

Dairy manure is an under-utilized source of energy and economic benefit, in addition to constituting an ever-increasing environmental challenge both from a water quality as well as an air quality standpoint. The South Coast Air Quality Management District (SCAQMD) last year adopted new rules to combat emissions from dairy operations, and Kelly Space & Technology engineers have held discussions with that agency about KST

Project Concept #195: Maximum Safe Loads On Buried Pipelines

Michael Whelan

Description

Buried pipelines can be subjected to a wide variety of mechanical loads due to their location in congested areas, used of heavy equipment for farming, transportation and construction, and proximity to other infrastructure. Traditional design and evaluation tools adequately address the majority of these situations. However, a number of unique or “non-typical” conditions do occur with some frequency that are not addressed by existing design and engineering tools. These conditions include shallow buried pipes that are subjected to very large surface loads, due to heavy construction equipment and blast loadings from nearby construction activities. These conditions are a particular concern where known weld defects and/or pipe wall loss due to corrosion is present. It is noteworthy that the California infrastructure contains older vintage pipeline dating back to as early as 1900.

Benefits

Primary benefits to be realized from the proposed study include improved safety of construction and blasting operations through proper and prioritized design and mitigation requirements, and the ability to prescribe maximum safe surface and blast loads on buried pipes that contains early vintage welds and minor corrosion defects. Specifically, California gas pipelines would save ~\$400,000 annually on avoided protective slabs, avoided in-service pipeline lowering and avoided pipeline relocation. These savings would arise from improved design and assessment criteria that enable the utilities to avoid overly-conservative actions. These savings would directly flow to gas consumers via the periodic rate-case proceedings, and the general public would be less inconvenienced at construction sites.

Objectives

Develop guidelines for the assessment of the mechanical integrity of pipelines subjected to non-typical loading conditions. Create physical test databases that define the pipe stress as a function of surface and blast loadings, and corresponding load and capacity models to predict the response and remaining capacity of new and vintage pipe and associated welds and/or corroded pipes. One approach to development of the physical test databases includes scale modeling, which if successful, will provide a validated method for replacement of costly full-scale geotechnical tests. Guidelines resulting from the study will be sufficient to address shallow burial conditions, large surface loadings and blast loadings on new and existing installations. These will be used by pipeline operators, pipeline engineering firms and Code Bodies that establish operating practices on and around pipelines.

Budget

2005: \$600,000

2006: \$600,000

Other: \$0

Comments

PRCI would consider cofunding this project.

Project Concept #196: Advanced Cycle-Resolved Engine Controls

Bryan Willson

Description

Natural gas engines suffer from cycle-to-cycle combustion instabilities which increase NO_x emissions and reduce efficiency. These combustion instabilities were assumed to be random until recent work in “Chaos Theory” and “Non-Linear Controls” has demonstrated the ability to identify patterns in the combustion process. This offers the opportunity to stabilize the combustion process, reducing emissions and improving efficiency. This project will combine the efforts of current researchers to develop a real-time cycle-based control system which will be demonstrated in California on a large natural gas engine used for pipeline compression, or a smaller natural gas engine used for distributed power generation.

Benefits

This project will produce an engine control system intended to reduce cycle-to-cycle combustion instabilities. The system will be monitored to determine its ability to: improve combustion stability, reduce NO_x emissions, reduce fuel consumption, and increase engine reliability. If successful, the control system could be applied to many pipeline engines for little additional cost, providing very favorable cost / benefit performance.

Objectives

The outcomes / objectives of this project are to: 1) Extend work being conducted in the partners’ research laboratories to the large natural gas engines used for pipeline compression and / or for distributed power generation. 2) Demonstrate the ability of the system to improve combustion stability on large natural gas engines. 3) Document performance benefits from the cycle-resolved engine controller. 4) Analyze the systems’ reliability and economics. 5) Work with potential users and industrial partners to gauge the systems’ commercial potential. 6) Identify a technology transfer strategy.

Budget

2005: \$300,000

2006: \$300,000

Other: \$300,000

Comments

Significant cost-sharing is available from project partners and a consortium of natural gas pipeline companies. The project will be conducted by a team consisting of a national laboratory, a university with significant experience in this field, commercial partners, and the natural gas industry.

Project Concept #197: Mitigating the effects of Landslides on Gas Transmission Lines

Michael Whelan

Description

California has an extensive amount of terrain that is susceptible to landslides due to both slope and rainfall intensity. For buried pipeline systems subject to large scale ground movement, there is a large degree of uncertainty in current practice to quantitatively evaluate geotechnical failure processes, pipeline/soil interaction events and load transfer mechanisms that contribute to pipeline strain demand behavior. There is a need to refine these predictive methods, reduce conservatism, expand capability (e.g., ASCE guidelines considers only undrained soil conditions for clay soils), and advance physical and numerical modelling techniques to generally reduce uncertainty.

Benefits

The benefits to be realized include the ability to address new regulations requiring the assessment of geohazards along pipeline routes, and the ability to accurately assess and prove the integrity of a pipeline system using a qualitative risk-based framework. Ultimately, the primary benefit will derive from reduced outages due to pipeline failure due to landslide and ground displacement events, which carries significant public safety and continuity of gas service value.

Objectives

Engineering practices to assess large scale ground movement geohazards, and guidance to define pipeline design and operational measures that mitigate large scale ground displacement effects on buried pipelines. The project work scope will address recommended practice on the following: 1) procedures to identify the potential geohazards, 2) techniques to define the aerial extent, magnitude and severity of the ground displacement along the pipeline route and map the geohazards, 3) amount and type of subsurface soils investigations that must be performed, 4) guidance to define the physical/environmental conditions (e.g., unusual rainfall, changes in land use, site development, flooding) that should be considered, 5) assessment of pipeline response and associated mitigation measures of expected ground movements, and, 6) guidance for implementing the identified design alternatives or mitigation strategies.

Budget

2005: \$400,000

2006: \$400,000

Other: \$140,000

Comments

PRCI, Southern California Gas, TransCanada Pipelines, Pacific Gas & Electric, and C-CORE will consider cofunding this project.

Project Concept #198: Advanced Production of LNG from Natural Gas

Dr. Savas Vasileiadis

Description

Liquefied Natural Gas (LNG) coming out of combined hydrocarbon conversion, separation, and other secondary operations and reactions is a valuable source of energy in consecutive energy cycles and flow charts. This work will include the design, analysis, modeling, and operation of combined hydrocarbon conversion, separation, and liquefaction cycles which use mixtures of natural gas as the feedstock. Advanced differentiated designs will be applied with respect to the natural gas used in various separation/purity degrees; and the reaction/separation and liquefaction equipment used with inner conditions involved for the final delivered product. The directive consecutive use of the exited liquefied natural gas mixture by means of the proposed advanced utility cycles and flow charts, increases significantly the LNG consumption capacity and yield within the consecutive utility cycle.

Benefits

- The use of lower quality natural gas feeds for upgrading and use in LNG production and utility cycles. - Renewed production and utilization of liquefied natural gas in direct power generation operation. - The effective use of combined conversion, separation, liquefaction operations with total process efficiency improvements in LNG production. - Cost reduction in total process for LNG production and usage.

Objectives

- Higher quality liquefied natural gas generation from lower quality natural gas fuels; - Higher efficiency in combined reaction-separation-liquefaction cycles; - Effective inner process designs for quality improvements in LNG production; - Cost improvements in overall process for LNG production from natural gas feedstocks.

Budget

2005: \$115,000

2006: \$100,000

Other: \$75,000

Comments

Our described research work is within the goals of the 2006 PUC and CEC phase as described within this program. It agrees with several program objectives (i.e., energy efficiency, advanced generation) as they have been described in this announcement. Cooperative applications from other research labs with related background and work are encouraged.

Project Concept #199: Quantifying the net benefits of distributed generation

Douglas Saucedo

Description

This project will demonstrate net benefits associated with distributed cogeneration infrastructure in conjunction with intermittent renewable electricity production. California's antiquated, natural gas fired, electrical generation infrastructure will need to be replaced within the near future. Distributed cogeneration technologies hold great promise for natural gas infrastructure that can efficiently produce electricity, heat, and hydrogen vehicle fuel while stabilizing electricity grids containing intermittent renewable electricity production (C1). The project will use propriety modeling software to optimally allocate distributed cogeneration infrastructure in space and time. The project will quantify pre- and post- distributed cogeneration metrics to demonstrate distributed cogeneration's net benefits over customary generation technologies.

Benefits

Distributed cogeneration coupled with renewable electrical generation offers a method to greatly decrease per capita natural gas and other fossil fuel energy demand. Distributed cogeneration also allows for decreased emissions from both power generation and transportation. Quantifying the net benefits associated with distributed cogeneration will help guide decision makers and planners when considering replacing or developing new natural gas energy generation infrastructure. Providing a proof of concept for the proprietary software will demonstrate the software's utility in quantifying economic, environmental, and engineering performance parameters. Providing methods for improving California's energy reliability and performance has broad economic, sociological, and environmental implications.

Objectives

This project will demonstrate the net benefits associated with high efficiency, distributed, natural gas fired cogeneration rollout. The project will quantify metrics for comparing optimally distributed, cogeneration infrastructure to pre-optimized benchmarks. Metrics include economics, natural gas demand, systems efficiency, emissions, and grid stability. The project will also demonstrate methods for quantifying local hydrogen vehicle fuel supply reliability. Sensitivity analysis and stochastic modeling will further quantify uncertainties associated with the model assumptions and net benefits. Stochastically modeling intermittent renewable electricity generation effects on grid stability is an exemplary sensitivity analysis. This project will be a proof of concept for this proprietary engineering software.

Budget

2005: \$200,000

2006: \$78,000

Other: \$0

Comments

C1. Combined Heat and Power Complements Renewable Energy Accessed 31 July 2005 11:27PDT
<http://www.renewableenergyaccess.com/rea/news/story?id=34532>

C2. The 2006 budget includes funding for purchasing high power computer systems, developing a parallel implementation of the propriety software, and purchasing auxiliary equipment.

Project Concept #200: Demonstration of Tri-Generation of Electricity, Heat and Hydrogen

David Carter

Description

In the interest of maximizing our beneficial use of existing natural gas resources, a Hydrogen Power Park concept has been created. The Power Park feedstock will be landfill gas that is currently flared. The landfill gas will be cleaned and injected into the existing gas grid. An equivalent volume of pipeline gas will be withdrawn at the Power Park site. A molten carbonate fuel cell will convert the pipeline gas into electricity and heat. Hydrogen vehicle fuel will be recovered from the anode exhaust. In this way, natural gas consumption and CO₂ emissions will be reduced thereby providing public benefits.

Benefits

When compared to California's electrical grid mix, approximately 40% less CO₂ will be emitted producing electricity at the Power Park. Using landfill gas as feedstock means that net CO₂ emissions would be zero. Additionally, busses and cars fueled by hydrogen emit no CO₂. This increases the magnitude of CO₂ reduction associated with the project and therefore, the public benefits. With approximately 1500 kW of energy in and 990 kW of energy out, a net system efficiency of 66% can be attained. This high efficiency example has public education value and presents a strategy for maximizing the reach of remaining natural gas reserves.

Objectives

Such a demonstration project would highlight the versatility of natural gas fuel and represent a model for its efficient use. The project would provide an opportunity to build public/private partnerships. Key manufacturers are poised to install a demonstration project of this type. Other stakeholders include: energy companies and government entities. The project would provide O&M data for additional projects that could be installed as part of a distributed tri-generation infrastructure designed to maximize efficient gas use while minimizing CO₂ emissions. The use of landfill gas as proposed, would present one strategy for supplementing natural gas reserves while reducing CO₂ emissions.

Budget

2005: \$500,000

2006: \$3,500,000

Other: \$1,500,000

Comments

The estimated \$500,000 required in 2006 is for a project development study and consortium building activities. The estimated \$3,500,000 required in 2007 is for initial construction and other project implementation costs. The estimated \$1,500,000 required in 2008 is for additional construction costs and a contingency. The project will be implemented by a public/private partnership combining "inkind" contributions and capital funding from various organizations. Participation in this partnership through some level of funding would meet the goals of the California Public Interest Gas R&D program.

Project Concept #201: Feasibility of Landfill Gas Utilization in the Natural Gas

J. Bohn

Description

The goal of the project is to develop standards and practices for injecting landfill gas (LFG) into the California gas grid. Many landfills are flaring their LFG and Utility companies are not currently accepting the LFG into the gas grid. The project will identify technical and regulatory issues associated with converting LFG to pipeline quality gas and, through collaboration with utility companies, will develop guidelines for the process. These guidelines can then be used by utility companies, landfill managers, and municipalities to streamline the implementation of LFG to PNG projects. Potential economic and grid impacts will also be addressed.

Benefits

This analysis will generate a tool which can be used to increase statewide access to renewable gas resources, and will assist in landfill gas utilization.

Objectives

Increased utilization of the LFG within the California natural gas grid system will help advance California's renewable energy portfolio. This project will provide landfill owners with insight into their options for managing the LFG, and will identify the advantages and costs of LFG to PNG injection. Furthermore the development of utility-accepted standards and practices would facilitate and simplify the implementation of LFG to PNG projects.

Budget

2005: \$49,500

2006:

Other:

Comments

Project Concept #202: Gas Research and Development Project Concept Abstract - Curbing Califo

Eric R. Coffman

Description

California has 81,000 restaurants, equaling \$51 billion in sales, 950,000 employees, and \$4 billion in state tax revenue. Thousands of new CA facilities are expected by the end of the decade. The proposed project will examine gas end-uses in the sector through site visits, collaboration, and a Web-based survey. Outcomes include: Y1 "Future Restaurant" prototype design, (Similar analysis was done by Aspen staff on behalf of EPA's ENERGY STAR program, see http://www.cee1.org/cee/mtg/6-05_ppt/lewis2.pdf for presentation of data by EPA staff), Y2 industry review of the prototype(s) negotiations with major franchises and chains to implement prototype, and Y3 groundbreaking for prototype(s).

Benefits

Increased understanding of natural-gas use in the sector, "future restaurant" packages yielding persistent gas savings for the CEC and utilities to develop programs at a maximum B/C ratio. Global benefits include reduced emissions, curtailed gas use (5 to 8% per facility is possible), market stability, and improved market penetration of ENERGY STAR and gas equipment.

Objectives

Developing a "future restaurant" prototype that can be replicated across major chains and franchises promoting gas saving technologies such as ENERGY STAR Qualified Food Service equipment and other technologies. Profiling the food service industry, identifying underutilized gas-saving technologies, promoting gas saving technology, incorporating ENERGY STAR and other equipment into franchise designs, reducing facility gas use, operating costs and emissions.

Budget

2005: \$250,000
2006: \$200,000
Other: \$150,000

Comments

Project Concept #203: Advanced Residential CHP Systems

William Steigelmann P.E.

Description

Distributed CHP systems are a natural and logical fit among the array of features homeowners want and builders and developers are providing. Research shows that back-up generators are desired to accommodate the 21st Century digital lifestyle. CHP systems can provide this feature together with a reliable source of electricity and domestic hot water with a combined efficiency of 80 to 85 percent. Two siting options will be investigated: individual-home and cluster. The cluster configuration is ideal for high-rise and low-rise condo and apartment complexes, and town-house and other high-density developments. The economics of the cluster configuration are more favorable because of load diversity and economies of scale. Off-setting this advantage is higher cost to distribute electricity and thermal output (hot water and perhaps also chilled water) to dwellings, and to meter these energy outputs. In either siting case, the CHP system would operate in parallel with the electric grid. The project will consider low-emission Stirling engine primer movers as well as fuel cells, and will investigate market acceptance as well as economics.

Benefits

Improved efficiency of natural gas use through high cycle efficiency, reduced emissions (e.g., CO₂, SO₂, NO_X), improved electricity supply generated within load centers (reduced transmission congestion) and markets for advanced energy technologies.

Objectives

Developing a plan for "Smart Residential Growth" that includes CHP technology that makes the best of California's energy resources and infrastructure while reducing emissions (particularly in identified air quality non-attainment regions).

Budget

2005: \$250,000

2006: \$200,000

Other: \$150,000

Comments

Project Concept #204: Modeling Air Quality Consequences of Natural Gas Energy Generation

Peter Connell

Description

California's recent experience has shown that electricity-generation is a complex interplay of energy use, distribution, resource availability, and air quality. An important consideration is balancing the air quality costs of operating smaller plants nearer to consumption regions (distributed generation) against intended benefits of more direct distribution and availability at peak demand. Air quality assessment is dominated by the species distribution tail at high values, so parametric modeling of high values and exceedances should be addressed with computational tools that can relate specific sources with specific regions of impact. LLNL has forefront models that can be applied (e.g. in the San Francisco Bay Area) to predicting the response of ozone maxima, for example, to positioning of natural gas power plant emissions.

Benefits

The costs of exceedances can be large in terms of mandated implementation plans to meet standards. The operation of peaker plants at times of high demand, high temperatures, and high stability may solve the immediate problem of electricity undersupply, but at the longer term costs of causing air-quality non-compliance. A photochemistry- and physics-based prediction, using LLNL's high-performance computing tools, could be of substantial benefit to optimizing supply without compromising air quality. Such a capability would also serve as a module of the overall systems model (including policy models such as LLNL's META Net model) required to plan strategically for future demand.

Objectives

The project will combine a comprehensive model of photochemistry in the urban/regional setting with the LLNL FEM3 finite element fluid dynamics code to capture the necessary dynamics for predicting ozone maxima in the downwind portion of the Bay Area (e.g. Livermore). This model will be supplied with boundary conditions from the LLNL IMPACT global photochemical model. The combined model will demonstrate magnitudes and sensitivities for these ozone maxima through comparison to the extensive air quality data base. Parametric studies of different generation strategies will be conducted and the model responses evaluated for their ability to quantify the air quality tradeoff.

Budget

2005: \$350,000

2006: \$350,000

Other: \$350,000

Comments

LLNL has a variety of high-performance computing application projects underway. The project will evaluate whether other approaches, for example Adaptive Mesh Refinement, could be incorporated to improve the proposed model's predictive performance. A connection to LLNL's energy policy modeling effort will be established and may be exploited in the generation of specific parametric tests, i.e. rejecting scenarios infeasible on policy and economic grounds.

Project Concept #205: Passive Energy Flue Dampers

Advanced Conservation Technology, Inc. (DBA: ACT, Inc Metlund Systems)
Process Heating R&D Manager

Description

The flue damper reduces the standby losses of tank-type water heaters. The device sits on top of the flue pipe underneath the diverter hood. It has a floating diaphragm that quickly lifts when the water heater is firing. Openings around the diaphragm allow the gases to escape up the chimney. After the burning cycle, the floating diaphragm settles down and closes, reducing the standby heat loss rate. This device also prevents down drafts coming through the chimney from blowing out the pilot light. The flue damper can be installed in both new and retrofit applications.

Benefits

First, average savings between 5 percent and 9 percent, depending on the gas water heater capacity. This equals to an average savings of \$25 a year, which is 2.4 therms on a single home. With the passive energy flue damper installed on 80,000 to 100,000 homes, the total average annual savings are from \$2 million to \$2.5 million, which is 92,000 to 240,000 therm savings in California. Second, reduce standby loss by 25 percent. Third, increase water heater efficiency. Fourth, the payback period is approximately one year. Fifth, the passive energy flue damper uses no energy to operate. Sixth, the life time expediency and maintenance free operation.

Objectives

The passive energy flue damper requires no energy to operate. In a typical water heater, 61 percent of the energy goes for actual consumption and 39 percent is used to replace standby losses. Using the proposed passive energy flue damper will decrease total energy use by eight percent and changes the percent that is consumption and standby to 66 and 34 percent. The objective is to install between 80,000 and 100,000 passive flue dampers on existing and new homes in California within the first two years.

Budget

2005: \$150,000

2006: \$100,000

Other:

Comments

There are no flue dampers currently in the market that are passive energy related. Current flue dampers are power vent operated for commercial application or are bi-metal flue dampers for residential applications. Power vent are related expensive and bi-metal flue dampers are not acceptable. Benefits to California citizen are reduce gas bills, more efficient water heaters, and rapid payback. Current homes using tank type gas water heaters do not have any type of flue damper in their systems. Since there are approximately 8 million to 10 million gas tank water heaters in California, the passive energy flue damper represents tremendous potential energy savings, reduce air population, and dollars saved to the State of California.

Project Concept #206: Use of natural gas in propane reforming for fuel cell application.

Dr. Zoe Ziaka

Description

Innovative methods using natural gas for propane reforming are going to be analyzed. Modeling and simulation of several important parameters such as yield, selectivity are going to be tested and optimized. The target product, H₂, is going to be utilized in fuel cell applications. Performance characteristics are going to be examined and presented. Wise utilization of the by-products are going to be completely analyzed for better energy usage e.g., propylene to polypropylene production (a very important industrial chemical, basis for production of other critical chemicals). Complete kinetic analysis first time to be reported.

Benefits

-Higher capacity fuel in comparison with CH₄ reforming. -H₂ assisted combustion. -Increased product yield, selectivity. -Combined cycles for reduced cost and better energy utilization.

Objectives

More H₂ production than the CH₄ reforming. Better energy utilization of the natural gas. New methods to investigate the reaction and performance parameters.

Budget

2005: \$110,000

2006: \$90,000

Other: \$80,000

Comments

Students are welcome to participate. The author has related papers, book-chapters/books and patents, many years experience in related projects, that are going to support this project.

Project Concept #207: Absorption Heat pump Powered Dryer

H. Adam Bosschieter & Earl Schmid

Description

Any dehydration of industrial or agricultural product in California consumes substantial natural gas and released volumes of process air into the atmosphere. This project is to marry a 'thermally driven' absorption heat pump (AHP) with a traditional dryer to demonstrate energy saving and closed loop drying. The AHP cycle produces 180F heat for the product drying air as well as refrigeration to condense evaporated moisture out of the drying air, thus allowing continuous closed loop air recycling. The AHP cycle will recover the latent heat of vaporization and recycles this heat in the process creating very high operating efficiency. Such a dryer modification will both offer both operating cost savings and environmental benefit.

Benefits

This drying process is calculated to operate at 30% the operating cost of a traditional 'pass through' drying system, and calculates to cut the energy cost even with the best available technology. The closed loop air recycling system will eliminate >90% of the traditionally evacuated VOC polluted air to atmosphere. Such technology will offer operations with driers a new cost effective solution to help meet clean air standards.

Objectives

The objective is to engineer the use of a newly established AHP in conjunction with a 'drying system' combining with a correctly sized equipment to demonstrate closed loop drying of product. The equipment developed will be tested & demonstrated in operation over a period of time, recording operating parameters to prove the calculated data. The equipment will be designed to allow for retrofit of any dryer to provide both energy saving and air cleaning benefits for dryer operators.

Budget

2005: \$600,000

2006: \$200,000

Other:

Comments

Project Concept #208: Enhanced web-based analysis tool to reduce residential natural gas use

Evan Mills, Rich Brown

Description

Consumers, consumer advisors, energy service providers, and policy analysts need improved tools to evaluate the technical and economic impacts from behavioral or technical actions taken to reduce natural gas consumption, shifting among tariffs, or switch fuels. Building on electricity-focused work previously funded by PIER, the proposed work enhances the existing web-based Home Energy Saver (HES) residential energy analysis tool (<http://HomeEnergySaver.lbl.gov>) to improve the modeling of natural gas end-uses and energy-saving technologies, allow easier modeling of fuel switching, and allow modeling of solar water-heating. HES is a whole-house tool using the well-validated DOE-2 engine to model HVAC energy (22 California weather locations available) and other methods developed at LBNL to model all other end uses in the home. The site currently sees approximately 500,000 visits per year, 90% of which are from residential consumers.

Benefits

The expected benefit of this project will be energy savings induced by the information provided by the Home Energy Saver tool. In an ongoing survey of nearly 1,900 HES users, more than 1/3 of respondents report taking action to reduce their energy use based on the information and recommendations provided by the HES web site. Assuming 10% of the HES visitors are from California, and those making upgrades to their house save 15% of their annual gas consumption, total annual savings in California due to HES could be nearly 1.4 million therms. In addition, the tariffs added in this project would be available on-line (<http://tariffs.lbl.gov>) for public use, and accessible for 3rd-party bill calculators.

Objectives

Consumers will be able to accurately identify the best strategies for saving natural gas in their homes. This will be accomplished by adding the following functionality to HES:

- A fuel switching module to easily estimate the energy bill and greenhouse-gas emissions impact of switching end-uses between natural gas and electricity.
- Allowing users to select actual utility-specific natural gas tariffs and adding California natural gas tariff data to an existing on-line database (<http://tariffs.lbl.gov>) used in HES.
- Providing information to users about recommended furnace sizing.
- Estimating the cost-effectiveness of additional efficiency measures, such as tankless water heaters.
- Improving the modeling of hot water distribution losses.
- Estimating the cost-effectiveness of solar water heating, and corresponding natural gas savings.
- Improving the modeling of miscellaneous gas use (pools and spas, mainly), and estimating cost-effectiveness of efficiency measures for these end-uses.

Budget

2005: \$300,000

2006: \$100,000

Other:

Comments

Project Concept #209: Closed Brayton Cycle Residential Energy Conservation System

Johan Wassenaar, Creative Energy Systems

Description

A natural gas-fired residential total energy system, comprising a two-staged closed Brayton cycle high speed permanent magnet power generator with heat capture, to provide all residential power, heating and cooling needs and render the home energy independent, except for natural gas or alternative liquid fossil fuel supply. Optionally, excess power generated could be sold to the utility grid through a synchronous coupling.

Benefits

The object is to save the household its entire monthly electricity bill with little or no increase in heating fuel consumption. The net result in a typical California utility service area would be a 60% drop in greenhouse gas emissions attributable to the household.

Objectives

The design criteria are a system comparable to existing household utility systems in cost, longevity, reliability, and servicing requirements, using less installed space, operating silently, and being capable of constant high thermal efficiency over the wide range of typical household electricity and heating demands.

Budget

2005: \$750,000

2006: \$1,250,000

Other: \$25,000,000

Comments