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October 7, 2008

VIA HAND-DELIVERY

filed electronically in docket office on 10/07/08

Chairman Tre Hargett
c/o Ms. Sharla Dillon
Tennessee Regulatory Authority
460 James Robertson Parkway
Nashville, Tennessee 37243

Re: Gas Technology Institute Generic Contested Case Docket To Analyze And Evaluate The Cost Benefits And Funding Mechanisms For Energy Conservation Research
Docket No. 08-00064

Dear Chairman Hargett:

Enclosed please find an original and six (6) sets of copies of Gas Technology Institute's Natural Gas Research and Development Proposals.

Please return two copies, which I would appreciate your stamping as "filed," and return to me by way of our courier.

Should you have any questions concerning any of the enclosed, please do not hesitate to contact me.

With kindest regards, I remain

Very truly yours,

R. Dale Grimes

RDG/lfr
Enclosures

cc: J. W. Luna, Esq.

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BEFORE THE TENNESSEE REGULATORY AUTHORITY
NASHVILLE, TENNESSEE

IN RE:	)	
	)	
GENERIC CONTESTED CASE DOCKET TO	)	
ANALYZE AND EVALUATE THE COST	)	
BENEFITS AND FUNDING MECHANISMS	)	**Docket No. 08-00064**
FOR ENERGY CONSERVATION RESEARCH	)	

GAS TECHNOLOGY INSTITUTE'S NATURAL GAS RESEARCH AND DEVELOPMENT PROPOSALS

Pursuant to the Notice of Filing and Status Conference filed by the Hearing Officer in this docket on September 30, 2008, Gas Technology Institute ("GTI") respectfully submits these proposed examples of research and development projects that could be undertaken for the benefit of Tennessee ratepayers subject to funding by the natural gas local distribution companies in Tennessee under the jurisdiction of the Tennessee Regulatory Authority ("TRA"). These do not represent all the types of research and development projects that could be undertaken, but as discussed at the June 12, 2008 status conference in this docket they are only examples of such projects that are submitted so the parties can assess costs and benefits of such projects in the context of actual specific examples.

A. Examples of Proposed Research and Development Projects

Detailed descriptions of specific proposed example projects are set forth in Exhibit A. Detailed cost/benefit analysis information for specific projects is contained in Exhibit B. More general descriptions of the types of example projects and the need for the projects are set forth below.

1. Energy Efficiency Needs of Tennessee's Residential Gas Consumers

Residential customers in the United States used about 4.9 quadrillion Btu's (quads) of natural gas in 2007,[1] about 66 percent of which was for space heating and about 27 percent for water heating. Despite the relatively mild Tennessee winters, the biggest residential gas load in Tennessee is still space heating, at roughly 35-45 million Btu's per year (MMBtu/yr) per dwelling, depending on heating degree days, home or apartment size, insulation, infiltration, windows, and heating system efficiency and size. At the average Tennessee residential price (EIA 2007 prices) of $13.91/MMBtu, the energy costs for heating range from $486-$626 per year. Reasonably affordable fully condensing residential furnaces (offshoots of those pioneered by GRI in the 1980's) are available in efficiencies ranging from 90% to 96% (with a $1,000-$3,000 installed cost premium over (non-condensing) National Appliance Conservation Act – NAECA -- compliant 78% efficient models), and no R&D is required on those units. Nationally, gas (non-condensing) furnace sales[2] in the U.S. run about 2.4 million units per year. Condensing gas furnaces sales are at about 750,000 per year. While efficiency gains are possible with gas heat pumps (GHPs), with coefficients of performance of 1.00-1.20 possible (equivalent to output energy of 100% to 120% of input energy due to the ability of heat pumps to mechanically transfer energy from the colder outside air back into the warmer home), this can be accomplished only at (projected) substantially increased first costs (a $3,000-$10,000 projected cost premium). Residential GHP technology is not commercially available in this country. GHPs can also provide gas cooling, offering further reductions in gas use for peaking electrical power as described above. So GHP R&D is needed to validate long-term performance and reduce first

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[1] http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm
[2] Gas Appliance Manufacturers Association, Comments on Efficiency Standards for Residential Furnaces and Boilers, April 10, 2002, Docket No. EE-RM/STD-01-350.

costs. If a residential customer were to replace a NAECA-compliant 78% efficient furnace with a 100%-120% efficient GHP, energy savings of 9-14 MMBtu/yr are likely, resulting in energy bill savings of $125-$195 per year per residential customer.

The second largest residential gas load is the water heater, at 20-25 MMBtu/yr per dwelling. At the average Tennessee residential price (2007) of $13.91/MMBtu, the fuel cost is $278-$348 per year. The average annual fuel use efficiency of tank-based residential water heaters is 50-60%, primarily to substantial standby losses when the unit is not in use. Conventional tank-based water heater system shipments in the U.S. are about 4.7 million per year.[3] There are some so-called "high-efficiency" non-condensing tank-based units on the market, with installed first costs of $900-$1,300 and efficiencies of 62%-67%. These units are selling in very limited quantities at about 10,000 per year. Three types of alternative systems can be developed to increase the efficiency of home water heaters. The first is the tankless or instantaneous water heater, which has a very small or no storage tank (and so no standby losses) and can achieve efficiencies of about 70%-80%. Gas tankless water heaters account for about 255,000 shipments in the U.S. per year. The installed first-cost premium on these devices ranges from a low of $500 (not yet technically proven) to a high of $1,470-$2,500 (available on the market) over standard tank-based units. The second device is a fully condensing pressurized vent system with efficiencies in the 90% range, with projected installed costs of $1,300-$2,000. One residential fully condensing water heater (developed by the U.S. Department of Energy and GTI) is being offered for limited sale in the marketplace, sales are estimated at less than 10,000 units per year. The third device is a heat pump water heater, with coefficients of performance over 1.0 possible, costs not yet known, but certainly higher than the fully condensing unit. The

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[3] ENERGY STAR Residential Water Heaters: Final Criteria Analysis, April 1, 2008.

gas heat pump water heater technology is not yet available on the market. The electric heat pump water heater, a simpler device, is being sold in limited quantities in the U.S. of about 2,000 per year. If an instantaneous 80% efficient water heater replaced the standard 55% tank-based unit, an energy savings would be realized of about 8 MMBtu/yr, or about $111 per water heater per year.

GTI is performing R&D and deployment of a combination space/water heater system that uses an oversized fully condensing water heater to heat both the water and the furnace, with 90% efficiency. This device would be perfect for smaller homes and for apartments and condos in Tennessee.

The third largest residential gas load is clothes drying, and the fourth is the gas stove with or without the gas rangetop. Other gas uses include gas lights, fireplace inserts, and natural gas grills. No R&D is proposed in these areas.

2. Energy Efficiency Needs of Tennessee's Commercial Gas Consumers

Commercial consumers in the U.S. used about 3.1 quads of natural gas in 2007. There are 4.7 million commercial buildings in the U.S. and 581,000 (12 percent) are served by boilers. Commercial boilers at office buildings, health care facilities, and educational institutions account for over half of boiler energy units and capacity. Natural gas accounts for over 85 percent of commercial boiler units and over 87 percent of capacity. Commercial boilers consume 1,630 trillion Btu's per year (TBtu/yr), which is 28 percent of all (non-electricity) energy consumption at commercial facilities. Of this, natural gas dominates commercial boiler consumption at 1,350 TBtu/yr. The average capacity factor (CF -- percent of the 8,760 hours in a year the unit is operating) of commercial units is 16 percent, about 4 hours per day. The average size of these units is 9.6 million Btu's per hour (MMBtu/hr), ranging from 3.6 MMBtu/hr for educational facilities to 20.9 MMBtu/hr for health care facilities.[4] So an "average" commercial boiler in Tennessee at 9.6 MMBtu/yr and 16% CF uses 13,455 MMBtu/yr. The cost of running this unit is $169,000 per year (using EIA average 2007 Tennessee commercial gas prices of $12.58/MMBtu). (Contrast this with residential space and water heating at 55-70 MMBtu/yr and $765-$974 per year!)

Steam generation for institutions (e.g., hospitals, prisons, and schools), health clubs, hotels and motels, and other commercial dwellings is a major use for natural gas in Tennessee's commercial sector, up to 30% of commercial load. Much of the steam generation technology on the market is 75% efficient or less. The near condensing boilers now currently available can achieve efficiencies of 80-88%. Fully condensing boilers with efficiencies of 90% and higher are not yet available. GTI R&D in this area is focusing on the "superboiler" a 94% efficient fully condensing boiler. With a 10% increase in boiler efficiency (GTI superboiler compared to near condensing boiler), average savings of $16,900 *per year* are likely. Compared to the average 75% efficient commercial boiler now in use, savings of $32,161 per year are achievable.

Water heating accounts for 38 percent of commercial natural gas usage in mild climates.[5] U.S. commercial water heating natural gas use was 458 TBtu in 2000[6] (Boiler and water heating load can overlap, for instance in health facilities.) Similar to the residential sector, primary needs are for instantaneous or tankless water heaters at 80% efficiency and fully condensing water heaters at 90% plus efficiencies.

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[4] Characterization of the U.S. Commercial/Industrial Boiler Population, EEA for Oak Ridge National Laboratory, May, 2005

[5] California Energy Commission, California Statewide Commercial Sector Natural Gas Energy Efficiency Potential Study, rev. July 2003.

[6] GRI Baseline Projection Data Book: 2000 Edition, January 2000.

Space heating accounts for about 31 percent of commercial natural gas usage in mild climates (CEC study). Nationwide, 1,693 TBtu was used for commercial space heating, but this is not representative of the Tennessee market (from the GRI Baseline Projection). (Note that boiler and space heating loads overlap.) While fully condensing commercial heating units are 90-96% efficiency are available, commercial GHPs at efficiencies of 100%-120% are not generally available in this country.

The third largest load in mild climates is commercial cooking, at 22 percent of commercial natural gas use (CEC study). U.S. commercial cooking natural gas use was 343 TBtu in 2000 (GRI Baseline Projection). Conventional cooking equipment is relatively low efficiency and major reductions in energy use are possible with technological advances. R&D needs in this area include high-efficiency appliances, infrared appliances, power burner applications, convection ovens, steam ovens, and advanced electronic controls.

Commercial cooling using natural gas (absorption or engine-based systems) has a small market share in the U.S. Commercial cooling natural gas use was 119 TBtu/yr in 2000 (from the GRI Baseline Projection). Technological advances that can increase the efficiency and bring down the first cost of these units are needed. As was discussed above, depending on the type of peaking plants used in Tennessee, gas cooling can actually result in reductions in natural gas used.

Combined heat and Power (CHP) applications offer both electricity savings and natural gas savings, with the waste heat from energy conversion being used for space or water heating or absorption cooling. Commercial CHP represented about 162 TBtu of natural gas use in 2000 (from the GRI Baseline Projection). R&D is needed on both the energy conversion system (reciprocating engines or small gas turbines or fuel cells) and waste heat utilization (including absorption cooling).

3. *Energy Efficiency Needs of Tennessee's Industrial Gas Consumers*

Industrial consumers in the U.S used over 6.8 quads of natural gas in 2007. Over 226,000 manufacturing facilities and 21,000 other industrial facilities in the U.S. have boilers. Five major steam-intensive industries are host to most of the industrial boilers, food, paper, chemicals, refining, and primary metals. Natural gas is the most common fuel for industrial boilers and is the primary fuel for 78 percent of industrial boilers units and 56 percent of boiler capacity. Industrial boilers consume 6,467 TBtu or 37 percent of all (non-electricity) energy consumed at industrial facilities. Natural gas consumed in boilers is 2,141 TBtu/yr (the largest boiler fuel is industrial byproducts). The average industrial boiler is 36 MMBtu/hr, much larger than its commercial counterpart. The average industrial CF is 47 percent (that is, industrial boilers are operated a little less than 12 hours per day every day of the year). So an average Tennessee industrial boiler consumes 148,000 MMBtu/yr, at an average cost (at the EIA average Tennessee 2007 industrial price of $8.85/MMBtu) of almost $1.3 million! Industrial boiler efficiencies, like commercial boilers, of units in place are 75% or less. Near condensing boilers are also available in this market. Fully condensing boilers of 90% plus efficiencies are not available. Using the GTI superboiler (94% efficient) compared to near condensing boilers now available; energy cost savings of $131,000 per year are likely. Compared to average boilers now on the market, energy savings of $249,000 per year are achievable.

Industrial process heating is a major industrial load, 2,809 TBtu in 2000 (from the GRI Baseline Projection). R&D needs include infrared heating, direct impingement heating, advanced melters, and advanced combustion systems and burners such as the GTI forced internal recirculation (FIR) burner that offers both increased efficiency and lower NOx.

CHP applications offer both electricity savings and natural gas savings, with the waste heat from energy conversion being used for process heating or steam generation. Industrial CHP represented about 1,400 TBtu per year of 2000 natural gas use (from the GRI Baseline Projection). R&D is needed on both the energy conversion system (reciprocating engines or industrial gas turbines or fuel cells) and waste heat utilization (including process heating).

4. Energy Efficiency Needs in the Gas Operations Area

Gas operations R&D needs include (1) pipe and leak location, (2) pipe materials, repair, and rehabilitation, (3) excavation and site restoration, (4) pipeline integrity management and automation, (5) operations infrastructure and support, and (6) environmental science and forensic chemistry. This R&D is needed to assure efficient, reliable, and safe transport and distribution of the natural gas to the end use customer.

For pipe and leak location, the key need is for development of a plastic pipe locator and a look ahead tool for direction boring tools. Other needs include remote leak surveys using lasers and metallic joint locators.

For pipe materials, repair, and rehabilitation, R&D needs include development of: advanced plastic materials for higher pressure mains, flaw acceptance criteria, non-interrupted meter changeout kit, fifty-year metallic pipe coatings, live mains cleaning system, ultrasonic inspection techniques for plastic pipe joints, and an ultraviolet curing technique for cured-in-place liners.

For excavation and site restoration, R&D needs include development of: evaluation techniques for flowable fill around pipes, soil compaction measurement devices, techniques to reduce riser/meter set corrosion, and advanced techniques for keyhole repair.

For pipeline and integrity management and automation, R&D needs include development of: inspection platforms for unpiggable lines, advanced sensors to measure wall thickness, techniques to monitor internal corrosion, plastic pipe risk assessment model, and casing and pipe within casings integrity assessment models.

For operations infrastructure and support, R&D needs include development of: crew truck productivity techniques, adaption of GPS/GIS techniques to gas piping systems, and guidelines for using copper-clad steel tracer wire.

Environmental research needs include development of: in situ technique to detect PCB's in gas lines, mercury vapor techniques, mercury vapor contamination detection approaches, and manufactured gas plant (MGP) forensic tools, and volatile organic compound (VOC) forensic techniques.

B. Authorities Supporting TRA Approval of Research and Development Projects

TRA Rule 1220-4-1-.11(1) (c) for Classes A and B gas companies requires[7] utilities to follow the Uniform System of Accounts (USOA) as adopted and amended by the National Association of Railroad and Utility Commissioners (NARUC). This uniform record keeping ensures the integrity, reliability and comparability among companies of similar size of financial

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[7] http://www.state.tn.us/sos/rules/1220/1220-04/1220-04-01.pdf

data contained in financial reports submitted to the Authority. It provides the TRA one of its most useful regulatory tools for establishing just and reasonable rates.

Under Section 32 B of the USOA, the following is defined and listed as an appropriate accounting category:

> B. Research, Development, and Demonstration (RD&D), means expenditures incurred by natural gas companies either directly or through another person or organization (such as research institute, industry association, foundation, university, engineering company, or similar contractor) in pursuing research, development, and demonstration activities including experiment, design, installation, construction, or operation. This definition includes expenditures for the implementation or development of new and/or existing concepts until technically feasible and commercially feasible operations are verified. Such research, development, and demonstration costs should be reasonably related to the existing or future utility business, broadly defined, of the public utility or licensee or in the environment in which it operates or expects to operate. The term includes, but is not limited to: All such costs incidental to the design, development or implementation of an experimental facility, a plant process, a product, a formula, an invention, a system or similar items, and the improvement of already existing items of a like nature; amounts expended in connection with the proposed development and/or proposed delivery of substitute or synthetic gas supplies (alternate fuel sources for example, an experimental coal gasification plant or an experimental plant synthetically producing gas from liquid hydrocarbons); and the costs of obtaining its own patent, such as attorney's fees expended in making and perfecting a patent application. The term includes preliminary investigations and detailed planning of specific projects for securing for customers non-conventional pipeline gas supplies that rely on technology that has not been verified previously to be feasible. The term does not include expenditures for efficiency surveys; studies of management, management techniques and organization; consumer surveys, advertising, promotions, or items of a like nature.

Thus, RD&D is already included in the USOA, which is mandated and used by the TRA.

Also at the State of Tennessee level, the TRA and its predecessors have approved, directly or indirectly, R&D funding for Bellcore under their jurisdiction over local telephone companies, American Water Works Association Research Foundation (AwwaRF) under their jurisdiction over local investor-owned water companies, and GTI through automatic intervention in FERC program proceedings. The Electric Power Research Institute (EPRI) is also funded by Tennessee electric ratepayers by TVA membership in EPRI, although this is not regulated by the TRA. Further, Tennessee municipal customers of Middle Tennessee Gas, Greenville Gas, and Memphis Gas Light & Water contribute to GTI R&D through the American Public Gas Association Research Foundation (APGARF), although again not under TRA jurisdiction.

The GTI (and GRI) R&D program was approved by the Federal Energy Regulatory Authority (FERC) under FPC (later FERC) Order No. 566[8]. This order set forth that FERC could approve an R&D proposal that provided:

> 1. Evidence that the RD&D objectives of the company or research organization have been clearly established.
>
> 2. Evidence that the plan evolves from these RD&D objectives and adequately utilizes the viewpoints of scientific, engineering, industry, economic, consumers and environmental interests.
>
> 3. Evidence that an effective mechanism exists and is used for coordinating this research and development plan with other relevant efforts of national scope.
>
> 4. Evidence that the project or program is well conceived and has a reasonable chance of benefiting the ratepayer in a reasonable period of time, having due regard to the basic, exploratory or applied nature of each submitted RD&D project.
>
> 5. Evidence that whatever achievements may result, including the knowledge gained or technology developed from the RD&D effort, if any, will accrue to the benefit of the sponsoring jurisdictional company(s) and its/their customers.

This provided the basis for FERC's subsequent approval of R&D plans and proposals from GTI. In its first order approving GTI's R&D program,[9] FERC indicated that it was changing the

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[8] FERC Order No. 566, June 3, 1977

[9] FERC Opinion No. 11, March 22, 1978

Uniform System of Accounts "to provide additional procedures and guidelines whereby requests for advance assurance of rate treatment for R&D expenditures may be used by jurisdictional companies to insure the support of well-planned and comprehensive R&D programs."

Further, FERC indicated that "membership in GRI is open to any organization which provides fuel gas services in the United States under tariffs or rates regulated by federal, *state*, or local government agencies, and which is an interstate pipeline company, *investor-owned distribution company* or intrastate pipeline, or municipal or other publicly owned distribution system." (Emphasis added.) Public utility commissions were automatic intervenors in the FERC rate proceedings involving GTI, and were free to provide comments on the programs and projects.

C. Energy Conservation Includes Energy Efficiency

Energy efficiency, which reduces the amount of input energy used, is a major subset of energy conservation and should be included in any consideration of energy conservation research and development projects. "Improving energy efficiency" is defined as: action to maintain the same unit of output (of a good or service) without reducing the quality or performance of the output, while reducing the amount of energy required to produce that output.[10] Thus, all increased energy efficiency measures fall within the definition of conservation. Energy conservation focuses on how much energy is consumed. Energy efficiency focuses on how much energy is used relative to the services demanded.[11]

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[10] Bradbrook, Adrian J., Regulatory Framework for Promotion of Energy Conservation and Energy Efficiency In Australia, The Energy Charter Treaty, Article 19 (3)(c), www.unescap.org/energy/publications
[11] International Herald Tribune, October 30, 2007, Paris, www.iht.com/articles/2007/10/30/business/reneff.php

The term "conservation" frequently conjures up some of the measures undertaken in the 1970's, that is, getting by with less, or using less, both source energy and output energy. Implicit in this is not only using less energy, but also potentially *reducing* the quality of energy services, lowering thermostats in the winter, or raising thermostats in the summer, reducing the output (lumens) of light bulbs, or making refrigerators warmer. However, conservation is actually a broader category that encompasses input energy reduction for the same energy service in addition to the narrower notion of encouraging the consumer to reduce the quality of energy service as well.

In addition to turning down thermostats and considerations of increased-efficiency end-use equipment, conservation also includes consideration of insulation, tighter homes, and more energy efficient windows and doors. GTI suggests, since these non-device features are similar for gas consumers, electricity consumers, propane consumers, and wood consumers alike, that Tennessee gas consumers alone not be asked to pay for R&D into insulation, reducing air infiltration into homes and buildings, and more energy-efficient windows and doors, unless non-gas homes using these conservation options pay for the R&D as well.

By focusing Tennessee's conservation R&D efforts on increasing energy efficiency, GTI believes that Tennessee's consumers can enjoy the benefits of increased energy efficiency (lower energy use, lower gas and energy bills, lower gas demand, and reduced emissions and CO2) without having to sacrifice their comfort in the winter and summer, or reduce their quality of life.

D. Energy Conservation Research and Development Costs Will be Appropriate

The benefit/cost analysis attached as Exhibit B provides a key set of information here. Existing Tennessee gas customers can benefit from the R&D with a benefit/cost ratio of 14.8:1.

That is, for every dollar invested by the customers, they can save $14.80. There is an additional consideration. Will existing customer classes (residential, commercial, and industrial) benefit from the R&D? As long as the R&D reduces energy use, reduces first cost of equipment, or even lowers O&M costs (see next section), then existing customer classes will benefit. Since the R&D projects are typically 2-5 years in duration, with another year for commercialization of the product, they are 3-6 years from the marketplace, given R&D success. (Not all R&D projects, which by their very nature are technically challenging, will be successful.) Time to market can be reduced because some of the R&D projects funded by Tennessee will already be underway, and so will be able to reach the marketplace in less than 3-6 years. So there is a very good chance that not only existing customer classes but existing customers themselves will be able to purchase and/or benefit from the new technology developed through R&D. So the technology developed through the R&D will in fact be "used and useful" by existing customers.

What are some examples of this? In the end-use area, the first (90 percent plus efficient) fully condensing gas furnace was developed by GTI (at that time GRI) in the early 1980's. It took about two years for the R&D to be completed and another year for the technology to be commercialized. For the period 1995-2000, over 29,000 of these fully condensing furnaces were sold to Tennessee consumers, resulting in a net present value (NPV) of direct benefits of $22 million in energy savings alone, not including the additional indirect benefits of demand reduction to all consumers. In the operations area, GTI developed in the 1990's the first series of guided horizontal boring tools, reducing O&M costs for installation of gas mains and services. The Optical Methane Detector (OMD) resulted in the ability for gas companies to conduct leak surveys at 25 mph, 5 times faster than walking leak surveys, resulting in enhanced safety and lower O&M costs. Both the guided boring tools and the OMD R&D projects were conducted in less than five years, with about a year for commercialization of the technology.

E. Operations R&D Should be Included in a Conservation R&D Program

Since the R&D programs proposed for Tennessee will include an operations component as well as energy efficiency, a logical question to ask is, "Why include Operations R&D under a Conservation R&D umbrella?"

The rationale is threefold. First, natural gas is delivered to the end-use customer with an efficiency (energy out divided by energy in) of 90.5%.[12] While this is a comparatively high percentage (energy delivered from coal power plants to consumers has an efficiency of about 80% before conversion to electricity, and about a third of that afterwards), increasing the efficiency of the natural gas supply, transmission, and distribution system can lead to major consumer benefits. For instance, 1.4% of the natural gas "used" in the natural gas system in actuality is leakage from the system.[13] While this seems small, over the 22 trillion cubic feet (Tcf) used per year, this amounts to 308 billion cubic feet (Bcf). This leakage is paid for by gas consumers (as part of "lost and unaccounted for" gas). If even one half of this leakage can be eliminated by advanced technologies, the savings to gas consumers are enormous. At the 2007 average (U.S.) city gate price of $8.11/Mcf,[14] a 50% reduction in leakage can result in consumer savings of ***$1.23 billion dollars per year***. So both energy efficiency and dollar savings will

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[12] Source Energy and Emission Factors for Residential Energy Consumption, American Gas Association, August 2000

[13] Methane Emissions from the Natural Gas Industry, Gas Research Institute and Environmental Protection Agency, GRI-94/0257.1, EPA-600R-96=080b, June 1996

[14] EIA, http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_nus_a.htm

accrue to consumers as a result of leakage reduction, improved transmission and distribution system integrity, replacement of aging infrastructure, and reduced third-party damage.

The second reason is ensuring that the delivery of gas is provided to the consumer and used in the home and office in the safest fashion possible. So R&D on leak detection and surveys, reducing third party damage, metering and in-house piping and venting safety all would fit under this criterion.

The third reason is one of economics and reliability, providing the most affordable method of bringing the gas to the end user and in maintaining the aging infrastructure so that the consumer can continue to enjoy the benefits of lower delivery costs and reliability and integrity of the gas delivery system. ***It does little good to provide the most efficient end-use equipment if gas cannot be delivered safely, reliably, and economically to the end-use site.***

F. Proposed Costs for Tennessee and
Funding Levels Selected in Other States for Gas Consumer Benefits R&D

The R&D projects indicated are within the GTI-managed Utilization Technology Development ("UTD") and Operations Technology Development ("OTD") Programs. These costs are encompassed within the proposed cost in Tennessee of 90 cents per customer meter per year, as discussed elsewhere. Typical project costs range from $100,000 to $300,000 per project per year, but these costs are shared by all participating OTD and UTD members. Further, the R&D projects are not one-year efforts, but range from 2-4 years in length.

Historically, the FERC-approved charge (through 1998) was 1.74 cents per MMBtu on interstate natural gas. After that, as a result of a settlement, the charge was reduced, going to zero in 2004. Thereafter, funding came under the aegis of state regulatory bodies for companies under their jurisdiction. The current funding in various states is set forth below:

New York – Most of the ten companies are collecting at 1.74 cents per MMBtu. Given an average residential load[15] in New York of 80.1 MMBtu in 2006, this would come to $1.39 per residential customer per year.

Florida – TECO is collecting at a fixed cost of $500,000 per year. Given 321,000 customers, this comes to $1.56 per residential customer per year.

Utah – Questar is collecting at 1.18 cents per MMBtu. Given an average residential load of 82.1 MMBtu per year in 2006, this comes to 97 cents per residential customer per year.

California – PG&E is collecting at $1.4 million per year. Given 3.8 million customers, this comes to 37 cents per customer per year. (PG&E is funding only OTD, not UTD.)

Illinois – Atmos Energy is collecting at 1.74 cents per MMBtu. Given an average residential load of 101.2 MMBtu per year in Illinois, this comes to $1.76 per residential customer per year. Nicor is collecting $750,000 per year. Given 2.1 million customers, this comes to 36 cents per customer per year. (Atmos is funding both UTD and OTD; Nicor is funding only OTD.)

Virginia – Atmos Energy is collecting at 1.74 cents per MMBtu. Given an average residential load of 65.1 MMBtu, this comes to $1.13 per residential customer per year.

New Hampshire – NiSource is collecting at 1.74 cents per MMBtu. Given an average residential load of 73.3 MMBtu per year, this comes to $1.28 per residential customer per year.

Mississippi – Atmos Energy is collecting at 1.74 cents per MMBtu. Given an average residential load of 50.7 MMBtu in 2006, this comes to 88 cents per residential customer per year.

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[15] A.G.A. Gas Facts with 2006 Data, Table 6-14

Kentucky – Columbia Gas of Kentucky is collecting at 1.74 cents per MMBtu. Given an average residential load of 63.3 MMBtu, this comes to $1.10 per residential customer per year.

Delaware and New Jersey had "black box" settlements, so it is impossible to determine the exact funding formula.

Pennsylvania – National Fuel Gas Distribution Company is contributing at 1.74 cents per MMBtu. Given an average residential load of 80.7 MMBtu per year in 2006, this comes to $1.40 per residential customer per year.

Oklahoma – ONEOK is collecting at $250,000 per year. Given a customer level of 800,000, this comes to 31 cents per customer per year. (ONEOK is in UTD only.)

New Mexico and Minnesota – PSNM and CenterPoint Minnegasco are contributing only to GTI's Emerging Technology Sustaining Membership Program (SMP), neither OTD nor UTD. So funding is very nominal, but major R&D programs are not covered.

Washington, Oregon, Idaho, Wyoming and Alabama companies are contributing at 1.74 cents per MMBtu per year.

North Carolina – Piedmont is contributing at $250,000 per year (UTD only).

Arizona – SW Gas is contributing at 90 cents per customer per year (for OTD and UTD).

In summary, most companies and states are contributing at 1.74 cents per MMBtu. In Tennessee (with an annual residential load of 59.2 MMBtu per year), this would come to $1.03 per residential customer per year. **GTI suggests that Tennessee companies contribute enough to support OTD and UTD programs, or 90 cents per customer per year. This comes to 7.5 cents per customer per month.** This is consistent with GTI's most recent filings (in Louisiana, Pennsylvania, and Ohio), in which GTI has also suggested funding levels of 90 cents per customer meter per year.

Respectfully submitted this 7th day of October, 2008.

R. Dale Grimes
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CERTIFICATE OF SERVICE

I hereby certify that a true and exact copy of the foregoing has been forwarded via U.S. Mail, postage prepaid, to the following on this the 7th day of October, 2008:

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R. Dale Grimes

Proposed R&D Projects for Tennessee

Field Testing of Prototype SuperBoiler

This R&D project features a breakthrough 94% efficient fully condensing boiler with NOx and CO emissions of less than 5 ppm. (Average boilers are 75% efficient or less, best available near condensing units are 80-85% efficient, with NOx emissions of over 70 ppm.) To achieve high efficiency, a heat recovery system was developed which employs a novel transport membrane condenser, a humidifying air heater, and ultra-compact economizer. Previous R&D has led to design and testing of each subsystem and validation through laboratory testing of system efficiency and emissions goals. This project will field test the boilers in commercial and industrial applications, to validate efficiency and emissions under realistic field conditions. Boilers consume about 8,100 trillion Btu's (TBtu) per year, accounting for about 40 percent of all (non-electric) energy consumed in the U.S. commercial and industrial sectors . Major demand reductions are possible if the SuperBoiler testing and subsequent commercialization is successful. Benefits to gas consumers are reduced gas bills, lower energy usage, and lower emissions. There will be a small first cost premium, with payback occurring in less than a year.

Hybrid Optimized Tankless (HOT) Water Heater

This project features laboratory testing of a lower-cost gas "tankless" (actually the unit has a small pony tank for optimized usage) water heater, with installed-cost goals of no more than $500 more than a tank-based gas water heater, with efficiencies of 70%. This compares to (1) a typical tank-based water heater with efficiencies of 50-60% and installed costs of $800-$900; and (2) today's tankless water heaters, with efficiencies of 80-85% and installed costs of $1,470-$2,500. The project will involve product design and development and laboratory testing. Benefits to gas consumers include lower first costs, reduced gas bills, and lower energy usage.

Combination Space/Water Heater

This project features a 90% efficient fully condensing oversized tank-based water heater and no combustion unit in the furnace. Instead, a water-to-air heat exchanger provides the energy needed for the furnace. Laboratory and field testing has been completed. Further development of the water heater will involve testing some innovative approaches (including eliminating the need for stainless steel components) to reducing first costs (to no more than the cost of a replacement conventional water heater and furnace). First cost premiums are considerable for fully condensing water heaters. Efficiencies of typical tank-based water heaters are 50-60%, as mentioned above, and standard (NAECA-compliant) home furnaces are 78% efficient. There is at only one combination space/water heater on the market, available in limited quantities, but the fully condensing (86%) water heater being used in the unit (not available on its own) is very expensive, using stainless steel components to deal with corrosion issues sometimes present in fully condensing units due to the presence of precipitated-out combustion products. Benefits to gas consumers of the advanced combination unit include reduced gas bills and lower energy usage at comparable first costs.

Gas Heat Pump (GHP)

The 90-96% efficient fully condensing gas furnaces are the most efficient space heating units currently on the market for residential gas customers. However, there are possibilities to push the heating Coefficient of Performance (COP) to 1.60, equivalent to a 160% efficient heating system, by the use of GHP technology. There are three different technical approaches available, (1) engine-driven vapor compression system, (2) absorption-based, and (3) adsorption- based. GTI is investigating an engine-driven GHP system for the residential market that can achieve a heating COP of 1.60. The technology uses an existing Japanese low-NOx engine coupled to a vapor-compression heating and cooling system. Through heat exchange technology, the proposed system is able to achieve such high heat COP's by using the waste heat from the engine in the heating mode. In addition to providing consumers with energy savings and lower gas bills in the winter, the GHP provides natural-gas-based space cooling, lowering electric bills and reducing peak electric demand.

Advanced Commercial Fryer

Standard commercial gas fryers are about 35% efficient . They are large energy users, running at 100,000 Btu/hr, on for 12-16 hours per day, running full-out about 25% of the time. Annual energy usage can be 100-120 MMBtu/yr, almost double the use in an average Tennessee home (59 MMBtu/yr in 2006). GTI is developing an advanced commercial fryer with an efficiency of 62% and with goals of reduced oil volume and increasing the ease of cleaning. With the development and commercialization of this technology, gas bills will drop from $1,378 to $778 per year per fryer, and energy use will be reduced by 48 MMBtu/yr/ fryer.

Remote Leak Survey

Current leak surveys of natural gas distribution systems involve use of "flame packs" and the mobile (GTI-developed) Optical Methane Detector (OMD). Both of these leak location technologies require that the detector be brought in contact with the gas leakage plume, a very labor-intensive effort. The Laser Line-scan Camera (LLC) technology being developed with Laser Imaging Systems, Inc. (LIS) and AVISYS, Inc. allows "stand-off" inspection of both mains and service lines out to distances of 30 meters from a moving vehicle. The initial results of the on-going project are very encouraging. However, the detection limit, inspection speed, operator interface and packaging of the system will require further evaluations/improvements to make the LLC an attractive alternative to the current leak survey practices. The primary objective of the proposed project is to evaluate/improve the detection limit and inspection speed of the LLC, and to make the system more user-friendly. This will be accomplished by conducting additional testing in laboratory, in field, and upgrading various components of the current LLC design. Benefits of the project include increased safety, reduced methane leakage, lower operating and maintenance (O&M) costs, and enhanced crew productivity.

Commercial Grade Acoustic locator

Under the previously funded project by Operations Technology Development (OTD), a prototype acoustic pipe locator for metal and plastic gas distribution pipe was developed and tested successfully at three different utility sites and under several ground surfaces. This proposed project is a continuation of this prototype acoustic locator development to a commercial-grade level and conduct evaluation of the locator at several field sites. The objective of this work is to improve the acoustic locator prototype to a commercial-grade version, and test the commercial-grade device at several utility sites. In addition, a potential commercialization organization will be involved to assure that the developed system can be marketed directly to utilities at the successful completion of the project work. Benefits include increased system integrity, reduction in third-party damage, lower O&M costs, and enhanced safety.

Micro-Excavation

This objective of this project is to develop equipment, tools, sensors, materials, and procedures to access, examine and maintain buried pipe through two, 2" diameter excavations. The objectives of this project are to: (1) develop a prototype articulating device to hold sensors, tools and light sources, and to successfully deliver them through a 2" opening down to a buried pipe, (2) evaluate prototype sensors to examine a section of pipe through a micro-excavation opening to inspect for corrosion, coating conditions and wall thinning, (3) evaluate the effects of creating small voids around the pipe during micro-excavation, and to determine methods to sufficiently backfill and compact micro-excavation openings, (4) evaluate existing anaerobic sealing tools and procedures for use in micro-excavations, (5) develop methods to install anodes on pipes through micro-excavations, and (6) evaluate methods to abandon gas services through micro-excavations. Benefits of this project are reduced O&M costs, enhanced crew truck productivity, reduced call-backs, and enhanced safety.

Increase in Design Factor

Title 49, Part 192 of the Code of Federal Regulations governs the minimum requirements for the safe use of plastic piping systems. In particular, sections 192.121 and 192.123 prescribe procedures for determining the design pressure of thermoplastic pipe and its design limitations. Included in the equation for determining maximum allowable stress for plastic pipe is a design factor (factor of safety), currently set at 0.32. There are two primary implications associated with the change in design factor. First, for a given pipe size – diameter and wall thickness, there will be a corresponding increase in the calculated design pressure. Second, and more importantly, for a given design pressure, one can utilize a thinner wall piping material. The latter would have a tremendous impact from both an economic viewpoint and from capacity considerations. The objective of this project is to develop scientific data to support (or refute) an increase in design factor for plastic pipe, while ensuring that system safety and integrity are not compromised. The benefits of this project include reduced installation costs for plastic pipe (if thinner wall pipe is used) or increased deliverability (higher pressures allowed with current pipe wall thickness).

Broadband Electromagnetic Technology Sensor to Measure Wall Thickness

The gas industry is seeking ways to comply with the Pipeline Integrity Management rules, and to determine the condition of older deteriorating lines, in a cost-effective manner. Broadband Electromagnetic (BEM) technology has been used in the mineral exploration industry for many years. It is also used for the in-line inspection of pipelines. BEM technology works by inducing eddy currents to flow in close proximity to the transmitter on a steel or cast iron pipe. Defects on the pipe are found because they change the distribution of the eddy currents in the objects being examined. If the pipe wall is cracked, the currents are forced to go around or under the crack, causing the magnetic field produced by the eddy currents to change. This project will focus on adapting and field testing BEM technology for use with external direct assessment, and will be specifically modified for use with keyhole excavations. The intention will be to adapt the sensors to working on traditional and keyhole excavations, and to validate the performance in field tests. Benefits of the project include enhanced system safety and integrity and reduced costs for direct assessment.

Risk-Based Distribution Integrity Management Plan (DIMP) and Procedure and Software for Plastic Pipes

The Department of Transportation's (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) is currently developing rules for a risk-based distribution integrity management program that will address plastic pipe. The anticipated DOT PHMSA ruling is expected to require natural gas distribution systems to implement risk-based integrity management procedures. While significant research has been performed to gain a solid understanding of pipe failure risks and mitigation techniques for steel and cast-iron pipes, this same body of knowledge is currently not available on plastic pipes. In response, research is being conducted under the sponsorship of OTD and the DOT to address several plastic pipe issues. The objective of this project is to develop a customizable, effective, step-by-step and easy-to-implement plastic pipe risk model and software system for the management of plastic distribution pipes. Benefits of this project include enhanced distribution system integrity and safety and reduced O&M costs.

Repair Techniques for Damaged Low-Stress Pipelines

The Office of Pipeline Safety (OPS) of the Department of Transportation (DOT) has introduced a new Pipeline Integrity Management (PIM) rule - 49 CFR Part 192, Subpart O - that requires the inspection of natural gas transmission pipelines in high consequence areas. In the near future, low stress pipelines, those operating at less than 40% of specified minimum yield strength (SMYS), will be subject to the integrity assessment requirements of Subpart M of this new rule.

The flaw acceptance criteria used to assess high stress lines (at or above 40% SMYS) will almost certainly be used for low stress lines. The criteria and repair methods used for high stress lines will be too demanding and unnecessarily expensive when applied to low stress lines.
A significant percentage of the flaws discovered in low stress lines, such as dents, gouges, scratches and buckling, are expected to be minor and will not affect the lines' integrity. Unfortunately, there are few, if any, engineering test results, criteria or repair methods applicable to low stress lines. The DOT's new rule and the American Society of Mechanical Engineers' ASME B31.8 both provide specific rules and guidelines for repair practices on non-leaking high stress lines. However, neither of these codes provides guidance for assessment or repair of flaws in low stress lines.

Gas utilities are anxious to comply with the new rule to ensure that their lines are safe and reliable. At the same time, they need to operate and maintain these lines in a cost-effective manner. Gas companies want to work with the regulators to develop appropriate guidelines for low stress lines that ensure safety and reliability while keeping operations and maintenance costs as low as possible.

GTI will work with gas utilities, technical associations, and the OPS to identify and define the specific range of pipeline stresses and flaw types that will form the basis of flaw acceptance criteria for low stress lines.

Recoating and Other Surface Preparation for Underground Vaults

Many utilities experience considerable coating maintenance costs for facilities in vaults. The cool gas in the pipe, in combination with the humid air and/or surrounding irrigation and/or a high water table, causes considerable condensation on the pipe which can lead to atmospheric corrosion. There are two primary causes of corrosion: improper surface preparation and exposure to soil-based chemicals. Surface preparation of gas piping in vaults can continue to corrode after recoating. Below ground systems can be exposed to chlorides (from deicing, road salts, or from a coastal environment), nitrates from fertilizers, or other "surface attached reactive salts." The salts, along with partially attached corrosion products and excessive (and cyclic) condensation all lead to accelerated corrosion. This accelerated corrosion can also occur under freshly applied coating and/or occur from the improper adhesion of the coating to the steel substrate.

GTI will evaluate coating techniques used for underground surface preparation used in other industries, develop new techniques if necessary of adapt existing ones to gas industry environments, subject specimens from candidate approaches to accelerated laboratory testing under American Society for Testing and Materials (ASTM) rigorous standards, and field test the three leading approaches under actual gas industry conditions.

Benefits of this project are lower O&M costs, reduced corrosion, enhanced safety, and increased system integrity.

Keyhole Technology

Emerging smaller-hole repair techniques have proven to be viable alternatives to the much larger bellhole excavation used in standard gas industry repair and replace projects. Keyholes of 12-18 inches in diameter can replace 12 foot by 6 foot bellholes. However, a comprehensive testing, evaluation, standardization approach needs to be taken to ensure that keyhole technologies are safe, cost-effective, and can meet regulatory standards.

GTI''s Keyhole Technology Program will develop and test tools, protocols, subsystems, and power equipment needed to support this technology area. Applications include, but are not limited to, leak stoppage, polyethylene and steel pipe repair and replacement, air knives, and vacuum excavation.

Benefits of this project include reduced O&M costs, lower repair and replace times, and enhanced public and worker safety.

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Summary of Benefits to Tennessee Consumers of GTI R&D

Project Title	Projected Benefits per Year ($)
Operatons R&D	
Remote Leak Survey Using Lasers	$53,342
Commercial-Grade Acoustic Locator	$69,350
Micro-Excavation Development	$47,000
Non-Interrupted Meter Change-Out Kit	$114,750
Increase in Design Factor	$82,602
Broadband Electromagnetic (EM) Technology Sensor for Wall Thickness	$86,789
Repair Techniques for Damaged Low-Stress Natural Gas Lines	$110,000
Risk-Based Distribution Integrity Management Plan (DIMP) for Plastic Pipe	$381,250
Keyhole Technology	$125,600
Re-Coating with Minimal or No Surface Preparation for Vaults and Other High Moisture Environments	$115,000
Operatons R&D: Total consumer benefits per year benefits	**$1,185,683**
End Use R&D	
SuperBoiler	$1,863,360
Hybrid Optimized Tankless (H.O.T.) Water Heater	$168,486
Combination (Combo) Space-Water Heater	$1,008,347
End Use R&D: Total consumer benefits per year benefits	**$3,040,193**
Total Consumer Benefits per year of selected R&D projects	**$4,225,875**

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Total R&D costs per year	**$286,200**
Benefit/Cost Ratio	**14.8**

Tennessee Statistics

Gas customers, statewide

Sector	Customers	Load, Bcf	Load per customer, Mcf
Residential	1,049,032	66	62.9
Commercial	124,755	54	432.8
Industrial	2,497	95	38,046
Total	1,176,284	215	

Ref: http://www.aga.org/Research/state+profiles/tennessee.htm

Gas customers, jurisdictional companies

Company	Customers	Load, Bcf	
Piedmont Nashville Gas	134,000	24	
AGL Chattanooga Gas	62,000	20	
Atmos Energy - TN	122,000	21.2	
Totals	318,000	65.2	
Jurisdictional as a percent of state total	27.0%		(1)

Ref: Ref: GTI gathered data

Breakdown of gas customers by class for jurisdictional companies, using above (1) percentages

Residential	283,598
Commercial	33,727
Industrial	675
Total	318,000

Form 7100 Statistics:

Parameter	Atmos Energy - TN	AGL Chattanooga Gas	Piedmont Natural Gas	TN Jurisdictional Companies Totals
Miles of Main, Steel/Unprotected/Bare	87	49	0	136
Miles of Main, Steel/Unprotected/Coated	0	0	0	0
Miles of Main, Steel/Cathodically Protected/Bare	0	0	0	0
Miles of Main, Steel/Cathodically Protected/Coated	837	601	2,107	3,545
Miles of Main, Plastic Pipe	2,137	861	923	3,921
Miles of Main, Cast Iron, Wrought Iron	0	31	0	31
Miles of Main, Ductile Iron	0	0	0	0
Miles of Main, Copper	0	0	0	0
Miles of Main, Other(1)	0	0	0	0
Miles of Main, Other(2)	0	0	0	0

Total Miles of Main	**3,061**	**1,542**	**3,030**	**7,633**
Numbers of Services, Steel/Unprotected/Bare	1,890	848	0	2,738
Numbers of Services, Steel/Unprotected/Coated	153	0	0	153
Numbers of Services, Steel/Cathodically Protected/Bare	0	0	915	915
Numbers of Services, Steel/Cathodically Protected/Coated	15,346	15,817	106,724	137,887
Numbers of Services, Plastic Pipe	115,828	52,496	60,674	228,998
Numbers of Services, Cast Iron, Wrought Iron	0	0	0	0
Numbers of Services, Ductile Iron	0	0	0	0
Numbers of Services, Copper	0	0	0	0
Numbers of Services, Other(1)	0	0	0	0
Numbers of Services, Other(2)	0	0	0	0
Total Numbers of Services	**133,217**	**69,161**	**168,313**	**370,691**
Total Leaks, Corrosion/Mains	180	36	2	218
Total Leaks, Corrosion/Services	46	20	21	87
Total Leaks, Natural Forces/Mains	0	1	1	2
Total Leaks, Natural Forces/Services	0	2	1	3
Total Leaks, Excavation/Mains	115	51	59	225
Total Leaks, Excavation/Services	232	210	142	584
Total Leaks, Other Outside Force Damage/Mains	1	5	0	6
Total Leaks, Other Outside Force Damage/Services	2	1	0	3
Total Leaks, Material Or Welds/Mains	4	7	1	12
Total Leaks, Material Or Welds/Services	110	9	4	123
Total Leaks, Equipment/Mains	0	79	8	87
Total Leaks, Equipment/Services	0	159	0	159
Total Leaks, Operations/Mains	3	0	0	3
Total Leaks, Operations/Services	19	1	0	20

Total Leaks, Other/Mains	30	2	101	133
Total Leaks, Other/Services	39	3	182	224
Total Leaks, Total	**781**	**586**	**522**	**1,889**
Total Leaks, Mains	**352**	**182**	**172**	**706**
Total Leaks, Services	**429**	**404**	**350**	**1,183**
Total Leaks, Number of Known System Leaks at End of Year Scheduled for Repair	262	3	5	270
Total Number of Leaks on Federal Land Repaired or Scheduled	0	0	0	0
Leaks per mile of mains	**0.11500**	**0.11803**	**0.05676**	**0.09249**
Leaks per number of services	**0.00322**	**0.00584**	**0.00208**	**0.00319**
Estimated Leaks per miles in Plastic mains (a)	**0.08049**	**0.16957**	**0.18413**	**0.12445**
Estimated Leaks per number of services in Plastic services (a)	**0.00288**	**0.00555**	**0.00195**	**0.00296**
Miles of 2" PE pipe	404	706	774	1,884
Miles of 4" PE pipe	106	131	121	358

(a) using miles or number of services of plastic pipe and not including corrosion based leaks

Tennessee Natural Gas Prices

ref: http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_STN_a.htm

2007 Residential Price ($/Mcf)	$13.91
2007 Commercial price ($/Mcf)	$12.58
2007 Industrial price ($/Mcf)	$8.85

Remote Leak Survey Using Lasers (LLC System)

Assumptions and Analysis

Parameter	**Value**	**Ref.**
Percent of services inspected per year	23%	(1)
Services inspected per day by surveyor	123	(1)
Working days per year	250	
Services inspected per year by surveyor	30,750	
Number of surveys performed per per year	85,259	
Percent that can be performed by LLC	80%	
LLC surveys per year	68,207	
Surveyors replaced per year	2.2	
Employee cost per year	$52,000	(2)
Savings from reducing person-years	$115,342	
LLC surveys per day	492	(3)
Number of LLC vehicles needed	0.6	(4)
Annual Capital Cost of LLC (amortized over 10 years)	$10,000	(5)
Employees cost to operate LLC	$52,000	
Net Savings per year	**$53,342**	

(1) Gas industry data
(2) Assumes loaded labor rate is $25 per hour
(3) LLC vehicle can travel 4 times faster than a walking survey crew
(4) Assume 1 LLC vehicle is bought for TN and serves all three companies under contract
(5) LLC vehicle cost is $100,000

Acoustic Pipe Locator

Assumptions

Parameter	**Value**	**Ref.**
Plastic Pipe (miles)	3,921	(1)
Percent with no or inoperable tracer wire	50%	
Plastic Pipe Locates per mile per year	0.124	(1)
Plastic pipe Locates per year with no tracer wire signal (unlocateable)	244	
Hours saved to locate plastic pipe without signal	2	
Cost per hour	$25	
Estimated hits per year due to mismarks of unlocateable PE	11.5	(3)
Avg. cost to repair hit	$3,500	
Cost per year	$40,250	
Cost to excavate unlocateable PE	$200	
50% of unlocateables that have to be excavated for location verification	122	
Cost per year for excavation of unlocateables	$24,400	
Extra cost of acoustic pipe locator per year over 10 years (3 devices)	$7,500	(2)
Net cost savings per year	**$69,350**	

(1) Form 7100 data
(2) capital cost of $25,000 per acoustic locator
(3) Assume 10% of excavation leaks from Form 7100 caused by mis-location of plastic pipe

Micro-Excavation

Assumptions	Costs	Ref.
Bellholes per year	270	(3)
Cost to excavate and (5'X5") backfill bellhole	$475	(1)
(2'X2') bellhole	$415	(1)
Assume half the holes are of larger size, half are keyhole (smaller)		
Cost of bellholes	$120,150	
Cost to excavate and backfill 2 micro-excavation openings	$250	(5)
Cost to micro excavate	$67,500	
Permit costs to open bellhole	$0	(4)
Permit costs to open micro-excavation	$0	(4)
Capital costs for Micro-excavation	$56,500	(2)
Amortized cost over 10 years	$5,650	
Compressor & Vacuum Equipment	$40,000	
Micro-Excavation Tool	$1,000	
Bar Hole Tool	$500	
Misc Tools & Equipment	$5,000	
2 days of Training	$10,000	
Savings per year using micro-excavation	**$47,000**	

(1) Industry data
(2) Projected cost of micro-excavator
(3) Using Form 7100 data
(4) assumes no permit costs in TN
(5) assumes two holes per excavation for long-handled tool manipulation

Non-Interrupted Meter Changeout (NIMCO) Kit

Time savings for not having to enter customer premises (minutes)	15
Personpower costs per hour	$25
Percent of meters exchanged per year	2%
Meter exchanges per year	6,360 (1)
Savings to not enter cust premises per year	$39,750
Assume 50% of exchanges are tagged for return to relight	3,180 (2)
Time to return to customer's home relight and back to previous location (minutes)	60
Savings to not have to return to customer's home	$79,500
Number of units needed	15
Estimated cost per unit	$1,500
Amortized tool cost	$4,500 (3)
Savings per year	**$114,750**

(1) Assumes 5% of meters exchanged per year
(2) No need to cut off gas with NIMCO kit, gas bypasses around meter
(3) assumes 5 year NIMCO equipment life

Changes in Design Factor
Increase in Design Factor

Assumptions
Allows the use of PE pipe with 0.40 design factor

Parameter	**Value**
Feet of 2" PE purchased per year	497,376 (1)
Cost of 2" PE per year	$289,970
Feet of 4" Coiled PE purchased per year	94,512 (1)
Cost of 4" Coiled PE purchased per year	$195,923
Total cost of PE pipe per year	$485,894
17% Material savings for thinner walled pipe	$82,602
Savings	**$82,602**

(1) Form 7100 data, assumes 5% increase in plastic pipe per year
(2) Project goals based on revised design factor

Broadband Electromagnetics for Determining Wall Thickness

General Assumptions:

Parameter	**Value**	**Units**	**Ref.**
Costs of making lines piggable	$3,480	$/mile	
Permanent pig traps	$8,572	$/mile	(1)
Extensive Modification of pipeline to accommodate pigs and add permanent pig traps	$23,449	$/mile	(1)
Direct Assessment (	$7,000	$/mile	(7)
Hydrostatic testing	$5,274	$/mile	(1)
Smart pigging	$3,210	$/mile	(1)
Pigging statistics			(2)
Easily piggable	50%		
easily made piggable	5%		
Piggable with extensive retrofits	20%		
Not piggable	25%		
	100%		
TN LDC Assumptions:			
Miles of mains	7,633		(3)
Percent under high pressure	3.65%		(8)
Percent under high pressure in high consequence areas	30%		(8)
Total miles under Pipeline integrity rules	84		
Direct assessment costs	$146,272		
Piggable miles	63		
Pigging costs (4)	$643,586		
Unpiggable miles	21		
Hydrostatic testing costs	$110,205		
Total Cost savings (5)	$607,520		
Cost savings per year (6)	**$86,789**		

(1) OPS Report, 2001$

(2) AGA estimates to OPS
(3) Form 7100 Data
(4) + (1 - nonpiggable %) * miles * smart pigging cost/mi +easily made piggable % * miles *
(permanent pig traps cost/mi + cost/mi to make piggable)
+ extensive retrofit % * miles * mod to accommodate pigs plus pig traps cost/mi
(5) Direct assessment - pigging - hydrostatic testing
(6) Assuming 7 year testing interval
(7) Modified due to industry input
(8) industry data

Repair Techniques for Low-Stress Gas Lines

Assumptions and Analysis	**Number per year**	**Low**	**High**
Cost to make repairs due to dents, gouges, scratches, and buckling		$10,000	$100,000
Number of minor flaw repairs avoided per year	2		
Savings per year		$20,000	$200,000
Average savings per year		**$110,000**	

Distribution Integrity Management for Plastic Pipe

Assumptions and Analysis

Parameter	**Value**	**Ref**
Plastic pipe failures per year (nationally)	160,000	(3)
Cost of Plastic Pipe Repair (nationally)	$ 250,000,000	(3)
Repair Cost per failure	$ 1,563	
Miles of PE, nationally	619,000	(1)
Plastic pipe leaks per mile (TN)	0.12	(3)
TN miles of plastic pipe	3,921	(1)
Failures and PE leaks avoided per year	488	
Percent reduction due to DIMP	50%	
Savings per year	**$ 381,250**	

(1) Form 7100 data
(2) AGA Gas Facts: 2004 Data
(3) DOT statistics show 0.26 failures of PE per mile
(4) assumption

Recoating of Vaults

Assumptions	Value	Reference Notes
Number of vaults	250	(1)
Percent of vaults inspected each year	100.0%	(2)
Percent of inspected vaults needing extensive repair	20%	(3)
Cost to repair vaults with conventional approaches	$2,700	(1)
Hours to repair using new technique	16	(4)
Personhour cost	$25	(1)

Analysis	
Number of vaults needing repair per year	50.0
Labor cost for old techniques	$135,000
Labor cost for new technique	$20,000
Added materials costs	$0
Net savings per year	**$115,000**

(1) Assumption
(2) Typical industry annual compliance work
(3) Estimate
(4) GTI estimate

Keyhole Technology

Main Repair

Assumes 3 dedicated trucks, capital cost per year	$9,000 (3)
No. of Main Repairs per year	100
Cost of large opening	$475 (1)
Cost of temporary patch	$100
Final restoration	$1,000
Large opening total cost	$1,575
Cost of keyhole opening	$229 (1)
Savings per hole	$1,346
Total annual savings	**$125,600**

(1) Industry data
(2) Assumes equipment capital cost ranges from $20,000 (drill plus tools) to $40,000, including truck
(3) Assumes equipment life, including truck, is 10 years.

SuperBoiler

This is the development of a 94% efficient boiler for the industrial and commercial market. Today's best boilers are about 84% efficient. Older boiler put in in the 1950-1973 era are about 60% efficient at best, 1973-1980 boilers are in the 75% range.

Assumptions and Analysis

Parameter	**Value**	**Ref**	**Value**	**Ref if different than for commercial**
	Commercial Boilers		**Industrial Boilers**	
C/I Meters in jurisdictional cos. Territories	33,727	(1)	675	
C/I meters in U.S. (utility delivery)	4,984,700	(2)	197,900	
C/I meters in TN	124,755	(4)	2,497	
C/I Boilers in US	119,790	(3)	43,015	
Percent of C/I sites with boilers, based on national data	2.40%		21.74%	
Calculated number of TN C/I sites with boilers, based on national percentages	2,998		543	
Calcuated number of boilers at C/I sites within jurisdictional co. territories.	**811**		**147**	
Average boiler sales per year under 10 MMBtu/hr (C) and over 10 MMBtu/hr (I), national	4,500	(3)	437	
Calculated replacement (and new) rate per year	3.76%		1.02%	
Assumed penetration of replacement and new boilers by superboiler	5%		5%	
Calculated average superboiler sales per year nationally, commercial sites.	225		22	
Calculated sales per year of superboiler in TN	6		0	
Average Boiler size in C/I establishments (MMBtu/hr)	9.6	(3)	36.0	
Average capacity factor for C/I boilers	16%	(3)	47%	
Average price of natural gas, C/I market, in TN ($/Mcf) for 2006	$12.58	(5)	$8.85	

Assumed efficiency of conventional boiler at the plant	75% (6)	75%
Assumed Superboiler Efficiency	94% (7)	94%
Calculated: Gas used per year by conventional boiler (MMBtu)	13,455	148,219
Calculated: Gas used per year by superboiler (MMBtu)	10,736	118,260
Annual cost of operating the conventional boiler	$164,338	$1,273,534 (9)
Cost of operating the superboiler	$131,121	$1,016,117
Savings per year per boiler	$33,217	$257,416
Capital cost differential	$50,000	$150,000
Capital cost diff of one year of sales	$281,560	$35,619
Net energy opeating cost savings per year in all superboilers (one year of sales) in jurisdicational co. territory	$187,054	$61,127
NPV of energy savings one year of sales, 10 years of use, and real discount rate is 3%	$1,643,473 (8)	$537,067
NPV of energy savings net capital costs	$1,361,912	$501,448
Total NPV of benefits	**$1,863,360**	

(1) Derived on TN Statistics worksheet
(2) A.G.A. Gas Facts, 2005 Data, Table 8-6 (C), Table 8-7 (I)
(3) "Characterization of the U.S. Industrial/Commercial BoilerPopulation" EEA for ORNL, May 2005
(4) http://www.aga.org/Research/state+profiles/tennessee.htm
(5) EIA: http://tonto.eia.doe.gov/dnav/ng/ng_pri_sum_dcu_STN_a.htm, this is conservative, as no escalators are used on fuel prices
(6) This is conservative. Older boilers may be as low as 60-75% efficient
(7) Project goals
(8) http://eag.dfpni.gov.uk/steps/step8.htm
(9) 1030 Btu per cubic feet

Hybrid Optimized Tankless (H.O.T.) Water Heater

Assumptions and Analysis

Parameter	**Value**
	Residential Market
Residential (R) Meters in jurisdictional cos. Territories	283,598 (1)
R meters in U.S. (utility delivery)	66,900,000 (2)
R meters in TN	1,049,032 (3)
R water heaters in the U.S.	58,200,000 (4)
Percent of R sites with water heaters, based on national data	87% (5)
Calculated number of TN R sites with water heaters, based on national percentages	912,611
Calcuated number of water heaters at R sites within jurisdictional co. territories.	**246,718**
Average R water heater sales per year, nationally	4,654,436 (6)
Calculated replacement (and new) rate per year	8%
Assumed penetration of replacement and new water heaters by HOT units	5%
Calculated average HOT sales per year nationally, commercial sites.	232,722
Calculated sales per year of HOT in TN	987
Average price of natural gas, R market, in TN ($/Mcf) for 2006	$13.91
Assumed efficiency of conventional R water heater	53%
Assumed HOT Efficiency	70% (7)
Gas used per year by East South Central water heater (Mcf)	22.6 (8)
Annual cost of operating the conventional unit	$314
Implied output load (Mcf)	12.0
Input load needed for HOT unit to supply output load (Mcf)	17.1

Cost of operating the HOT	$238
Energy Savings per year per unit	$76
Capital cost differential per unit	$500 (9)
Net energy savings per year for all HOT in jurisdicational co. territory for one year of sales	$75,318
Capital cost for all units sold in one year	$493,270
NPV of energy savings one year of sales, 10 years of operations, at a 3% real discount rate	$661,756
NPV of energy savings minus capital costs	**$168,486**

(1) Derived on TN Statistics worksheet
(2) http://www.eia.doe.gov/emeu/recs/byfuels/2001/byfuel_ng.pdf
(3) http://www.aga.org/Research/state+profiles/tennessee.htm
(4) http://www.eia.doe.gov/emeu/recs/byfuels/2001/byfuel_ng.pdf
(5) Since water heater population is based on later data (2006) than gas meter data (2005), just assumed 100% penetration instead of 101%
(6) http://www.appliancemagazine.com/stats/editorial.php?article=1692&zone=109&first=1
(7) Slightly higher than conventional tankless model (80%) due to addition of a "pony" tank for small loads
(8) AGA Gas Facts (2005 Data), Table 10-1
(9) HOT installed first cost goal of no more than $500 above the cost of a conventional tank-based water heater

Residential Combination Space-Water Heater

Assumptions and Analysis

Parameter	**Value**	
	Residential Market	
Residential (R) Meters in jurisdictional cos. Territories	283,598	(1)
R meters in U.S. (utility delivery)	66,900,000	(2a)
R meters in TN	1,049,032	(3)
R water heaters in the U.S.	58,200,000	(4)
R furnaces in US	60,500,000	(4)
Percent of R gas sites with water heaters, based on national data	87%	(5)
Percent of total Tennessee households with "utility gas"	36%	(5a)
Total Tennessee households	2,439,443	(5a)
Ttennessee households with gas heating	878,199	Calculation
Percent of Tennessee gas metered households with gas heating	84%	Calculation
Calculated number of TN R sites with water heaters, based on national percentages	912,611	
Calcuated number of water heaters and furnaces at R sites within jurisdictional co. territories.	**237,415**	Calculation
Average R water heater sales per year, nationally	4,654,436	(6)
Average R gas furnace sales per year	3,512,464	(6)

Calculated water heater replacement (and new) rate per year	8.0%			
Total R Gas meters in U.S.	58,623,800	(6a)		
Percent of gas households with furnaces (U.S.)	52%	(6b)		
Number of gas furnaces (US)	30,484,376	Calculated		
Calculated furnace replacement (and new) rate per year	5.8%	Calculated		
Assumed penetration of replacement furnaces/water heaters by Combo units	5%			
Calculated sales per year of Combo in TN jurisdictional companies service territories	689	conservatively used furnace replacement rate		
Average price of natural gas, R market, in TN ($/Mcf) for 2006	$13.91		$13.91	
	Water Heater		**Furnace**	
Assumed efficiency of conventional R unit	53%	Average of 50%-55%	78%	Average NAECA-compliant furnace efficiency
Combo Efficiency	90%	(7)	86%	Assumes 95% water-to-air heat exchanger efficiency
Gas used per year by East South Central water heater and furnace (Mcf)	22.6	(8)	43.6	(8)
Annual cost per year of operating the conventional unit	$314		$606	
Implied output load (Mcf)	12.0		34.0	

Input load needed for Combo unit to supply output load (Mcf)	13.3	39.8
Cost of operating the Combo Unit	$185	$553
Savings per year per unit	$129	$53
Installed first cost differential	$0 (9)	$0
Net savings per year	$129	$53
Net savings per year for all Combo units sold in one year in jurisdicational co. territory	$89,070	$36,664
NPV of ten years of fuel savings and real discount rate is 3%	$714,311	$294,036
Total Benefits, NPV	**$1,008,347**	

(1) Derived on TN Statistics worksheet
(2) A.G.A. Gas Facts, 2005 Data, Table 8-5
(2a) http://www.eia.doe.gov/emeu/recs/byfuels/2001/byfuel_ng.pdf
(3) http://www.aga.org/Research/state+profiles/tennessee.htm
(4) http://www.eia.doe.gov/emeu/recs/byfuels/2001/byfuel_ng.pdf
(5) Since water heater population is based on later data (2006) than gas meter data (2005), just assumed 100% penetration instead of 101%
(5a) http://factfinder.census.gov/servlet/QTTable?_bm=n&_lang=en&qr_name=DEC_2000_SF3_U_DP4&ds_name=DEC_2000_SF3_U&geo_id=04000US47
(6) http://www.appliancemagazine.com/stats/editorial.php?article=1692&zone=109&first=1
(6a) AGA Gas Facts: 2006 data, Table 8-5
(6b) Ibid, Table 10-2
(7) Based on project goals
(8) AGA Gas Facts (2005 Data), Table 10-1
(9) Combo unit goal, no more than the cost of the conventional unit

VERIFICATION

CITY OF WASHINGTON)
)
DISTRICT OF COLUMBIA)

I, Ronald B. Edelstein, hereby declare that I am the Director of Regulatory and Government Relations for Gas Technology Institute, that I am authorized to make this verification on behalf of Gas Technology Institute, that I have read the foregoing document and that the facts stated therein are true and correct to the best of my knowledge, information and belief.

Ronald B. Edelstein
Director of Regulatory
and Government Relations

Sworn to and subscribed
before me this 7th day of October, 2008.

Notary Public
My Commission Expires:

PATRICIA A. NEIL
Notary Public, District of Columbia
My Commission Expires September 30, 2013