1. Regarding TGS Low-Income Residential Programs, please provide me with the invoices for work that took place in 2017. I would also like to know the square footage of the homes the work took place in if this information exists in a reasonably retrievable form.

If there is a privacy issue, then I accept redaction of addresses.

I realize that this information might be voluminous. Since I do not know the format of this information, I worded the request broadly. I will consider amending this request in order to obtain essential information if contacted by a TGS representative.

RESPONSE:

Vendor invoices contain confidential and commercial sensitive information and cannot be provided. TGS does not collect or have access to the square footage of participants' homes. However, TGS is providing the standard pricing sheet used by all participating contractors. Please refer to Robbins 1-1 Attachment for this information.

- 2. Regarding the TGS Low-Income Residential Program to replace furnaces:
 - A. If the program replaces central furnaces, does it also pay for replacement of central air conditioners as part of the work? If the program does pay for central air conditioners, how many of these installations are expected in the 2018 budget.

RESPONSE: TGS does not pay for the replacement of central air conditioners.

B. What other types of heating equipment is given away in this program?

RESPONSE: TGS provides for the replacement of natural gas central furnaces and natural gas wall furnaces.

3. Regarding the TGS Low-Income Residential Programs, what are the maximum amounts paid for various types of equipment?

RESPONSE: Please refer to the pricing sheet provided as Robbins 1-1 Attachment.

4. Regarding the TGS Residential Programs that are not directed to low-income customers, participation is assumed to rise for most of them compared to 2017. This includes rebates for high-efficiency water heaters and central furnaces in both retrofits and new construction, as well as Home Improvement Program rebates.

I am requesting the rationale for this increase in participation.

RESPONSE:

TGS considers prior year trends in participation as well as current year actual participation when determining forecasted participation. In 2017, participation in both residential retrofit and residential new construction programs was at a higher level than in prior years. Due to budget constraints, new construction program applications were not accepted beginning in June 2017 and residential retrofit program applications were put on hold beginning in November 2017.

With lower rebate amounts for high-efficiency water heaters and home improvement programs in 2018, the budget dollars will be able to accommodate higher participation numbers even if demand were to remain flat year-over-year.

5. Regarding the TGS Residential Programs for new construction, please provide a list of builders and addresses of the homes that received these rebates in 2017.

RESPONSE:

Customer data, such as addresses of homes, is protected information that cannot be shared with the public by TGS. Please refer to Robbins 1-5 Attachment for a list of all 2017 new construction program participating homebuilders.

6. Regarding the TGS Residential Program for high efficiency furnaces, the same savings is assumed in both existing and new construction, even though new building codes mandate more efficient homes.

Why was the same savings estimate assumed in both cases?

RESPONSE:

The Company determined that this approach is reasonable. Tests for cost-effectiveness as outlined by the California Standard Practice Manual are dependent on a multitude of evaluation assumptions. The Company also took into account that it would be administratively burdensome and cost prohibitive to collect, track, and perform analysis on an individualized basis.

7. Regarding the TGS Residential Program for high efficiency water heaters, increased maintenance of these units does not appear to be accounted for in the Benefit/Cost analysis.

Why was this not included?

RESPONSE:

Maintenance costs are accounted for within the Participant Test. Each test measures costeffectiveness from a different standpoint and is calculated utilizing a unique formula composed of varying inputs and considerations. Each of the five benefit/cost tests are explained in detail within the direct testimony of Paul H. Raab. Please refer to Robbins 1-7 Attachment for this information.

8. Regarding the TGS Residential Program for Mail-out kits, what surveys or other evidence do you rely on to assume that the equipment will actually be installed?

RESPONSE:

The cost-effectiveness for this program relies on a savings discount rate of 26% for showerheads and 23% for aerators to account for measures that are delivered but not installed. These discount rates were provided by the vendor based on a study of participants in Mississippi.

How will potential participants in this program be selected and contacted for enrollment in this program?

RESPONSE:

Eligible customers will be contacted via email or bill insert. Interested customers can then request a kit via email.

9. Regarding the TGS Residential Program for hydronic water heaters, this was phased out in 2018 because it was assumed not to be cost effective.

I was told by a TGS representative that the cost effectiveness evaluation did not consider the savings in construction costs. (Since this is a combined space heater and water heater, it eliminates the need for a second gas supply line and flue. It may also reduce the need for appliance-closet space).

Why was this not considered in the Benefit/Cost analysis?

RESPONSE:

Construction costs are not considered within the five tests applied as defined by the California Standard Practice Manual.





<u>Free Natural Gas Equipment & Weatherization Program</u> Austin Area

I. GAS SPACE HEATING APPLIANCES

A. Vented Wall Furnaces with Wall Thermostat

Replacement of furnace unit includes labor, permits, a new natural gas shutoff valve, a new AGA-approved flexible natural gas appliance connector, and CO testing upon initial startup.

<u>New installation</u> of furnace unit includes the above as well as installation of a flue pipe (up to ten feet), roof penetration, a vent cap atop the flue pipe, and a digital wall thermostat. (Does not include combustion air provision.)

	Equipment Specification		eplacement	New installation	
1. Powe	r-Vented Furnaces (Category III)				
a.	15,000 to 49,999 BTU/hr input	\$	2,700	\$	3,500
b.	50,000 to 84,999 BTU/hr input	\$	2,900	\$	3,700
c.	85,000 to 110,000 BTU/hr input	\$	3,100	\$	3,900
2. Induc	ced-Draft Furnaces (Category I)				
a.	15,000 to 49,999 BTU/hr input	\$	2,500	\$	3,300
b.	50,000 to 84,999 BTU/hr input	\$	2,600	\$	3,400
c.	85,000 to 110,000 BTU/hr input	\$	2,700	\$	3,500
3. Doub	le-Wall Induced-Draft Furnaces (Category I)				
a.	50,000 BTU/hr input	\$	2,500	\$	3,000
4. Furna	ace-Related Equipment (including installation cost)				
a.	Side outlet register kit	\$	135	\$	160
b.	Rear outlet register kit	\$	135	\$	160
с.	Free standing kit	\$	255	\$	275
d.	Blower kit	\$	250	\$	225
e.	One way/two way diffuser grille	\$	40	\$	50
f.	750 millivolt pilot generator	\$	65	\$	65
g.	Evaportator Coil 2-5 Tons	\$	1,550	\$	N/A

Reimbursement Price Sheet

Attachment 7 Page 5 of 51

1.

B. Central Heating System

Replacement includes labor, permits (electrical, plumbing, and mechanical), a new natural gas shutoff valve, a new flexible appliance connector, sediment trap, reclaim freon, remove and reinstall existing coil, recharge coil, and CO test furnace upon initial startup.

<u>New installation</u> includes the applicable items above as well as a drain pan, installation of a flue pipe (up to ten feet), roof penetration, a vent cap atop the flue pipe, and a digital wall thermostat.

Equipment Specification	Replacement	New installation		
Vertical Unit (closet)				
a. less than 50,000 BTU/hr input	\$ 2,500	\$	2,500	
b. 50,000 - 69,999 BTU/hr input	\$ 2,600	\$	2,600	
c. 70,000 - 99,999 BTU/hr input	\$ 2,700	\$	2,700	
d. 100,000 or more BTU/hr input	\$ 2,800	\$	2,800	

2. Horizontal Unit (attic)

New attic installations should include a duplex receptacle and a power switch at the attic opening.

a. less than 50,000 E	STU/hr input	\$ 2,100	\$ 2,700
b. 50,000 - 74,999 B	TU/hr input	\$ 2,200	\$ 2,800
c. 75,000 - 99,999 B	TU/hr input	\$ 2,300	\$ 2,900
d. 100,000 or more I	3TU/hr input	\$ 2,500	\$ 3,100

C. Incidental Work and Materials (separate from installation of new HVAC equipment)

3. Miscellaneous HVAC Work

a.	Reclaim freon	\$ 150
b.	Recharge coil	\$ 350
c.	Mastic	\$ 25
d.	Duplex receptacle (electric outlet)	\$ 200
e.	Light switch at attic opening	\$ 150
f.	Drain pan	\$ 120
g.	Digital wall thermostat	\$ 100
h.	Carbon monoxide test	\$ 75
i.	float switch	\$ 145
j.	Service/Repair	\$ 75HR
k.	Materials allotment	\$ 50

4. Duct System

Installation and material cost (flexible ducts, buckets, registers and mastic)

a.	Six inch diameter	\$ 15	per linear foot
b.	Seven inch diameter	\$ 16	per linear foot
c.	Eight inch diameter	\$ 18	per linear foot
d.	Twelve inch diameter	\$ 20	per linear foot

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D. Gas Lines

E.

Installation or replacement including material cost All materials must be AGA-approved.

1. Black Steel Gas Pipe

a.	Half inch $(\frac{1}{2})$ diameter, > 5 foot section	\$ 24	per linear foot
b.	Three-quarter inch $(\frac{3}{4})$ diameter, > 5 foot section	\$ 30	per linear foot
с.	One inch (1") diameter, > 5 foot section	\$ 35	per linear foot
d.	One and one quarter inch (1 $\frac{1}{4}$ ") diameter, > 5ft section	\$ 43	per linear foot
2. CSST	Flexible Gas Pipe		
a.	¹ / ₂ " diameter	\$ 30	per linear foot
b.	³ / ₄ " diameter	\$ 40	per linear foot
с.	1" diameter	\$ 50	per linear foot
d.	1 ¹ / ₄ " diameter	\$ 60	per linear foot
3. Flexib	ole Gas Appliance Connector		
a.	12 - 15 inch section	\$ 60	
b.	16 - 23 inch section	\$ 65	
с.	24 - 35 inch section	\$ 70	
d.	36 - 48 inch section	\$ 75	
Safety	v Devices		
Install	ation and material cost per unit		
a.	Smoke Detector	\$ 40	
b.	Carbon Monoxide Detector	\$ 75	

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В.

II. OTHER GAS APPLIANCES

A. <u>Gas Water Heater (Storage Tank Type</u> > .62 Energy Factor)

Replacement includes water heater, permit and inspection, a new gas shutoff valve, water flex connectors, T&P valve with connection to existing T&P line (up to 5 feet), new natural gas shutoff valve, flexible appliance connector, sediment trap, and CO test equipment upon initial startup.

<u>New installation</u> includes the above as well as extension of the existing water lines to the water heater (up to five feet of pipe), a drain pan, roof penetration, and installation of a flue pipe (up to ten feet) with vent cap.

	Equipment Specification		F	Replacement			ew installation
1. 1	st fl	oor installation					
	a.	30 gallon capacity (these are rarely called for)	\$	1,300		\$	1,300
	b.	40 gallon capacity	\$	1,300	-	\$	1,500
	c.	50 gallon capacity	\$	1,300	-	\$	1,500
2. A	ttic	installation			_		
	a.	30 gallon capacity (these are rarely called for)	\$	1,300		\$	1,500
	b.	40 gallon capacity	\$	1,300		\$	1,500
	c.	50 gallon capacity	\$	1,300		\$	1,500
Т	ank	less Natural Gas Water Heater					
D	oes 1	not include piping new gas lines or water lines.					
	a.	Indoor/Outdoor Installation 7.5-9.8 gpm	\$	1,500		\$	1,500
	b.	Indoor/Outdoor Installation 5.3-7.4gpm	\$	1,200		\$	1,400
1. Ir	ncid	ental Materials and Work					
In	stall	ation and material cost per unit					
	a.	Extension of T&P line to outside of home	\$	12	per fo	ot	
	b.	Extension of drain pan line to meet city code	\$	12	per for	ot	
	c.	Water Alarm	\$	30		\$	30
	d.	Flood Stop Valve	\$	250		\$	250
	e.	Drain Pan	\$	80			
	f.	18" stand (required in open garage)	\$	100		\$	100
	g.	Vacuum breaker hose bibb	\$	15			
	h.	Natural gas shutoff valve	\$	50	_		
	i.	Expansion tank (when required by code)	\$	150		\$	150
	j.	Drip leg (6" black pipe + cap + tee)	\$	21			
	k.	Pipe insulation	\$	4			
	1.	Watts 210-5 emergency shutoff valve + materials	\$	590		\$	590
	j.	Materials allotment	\$	50			
	k.	24" water heater enclosure & 36x36" concrete pad	\$	275	_	\$	275

C. Gas Range (Electronic Ignition)

Replacement includes range, flexible appliance connector, sediment trap, and a new gas shut-off valve.

<u>New Installation</u> includes the above plus gas piping, which would be billed according to section above.

a.	Install gas range	\$ 850	\$ 850
b.	Install vent hood above range	\$ 300	\$ 500

Att Pa	achment 7 ge 8 of 51	Reimbursement Pri	ce She	et		
	c. Pipe d. 1/2	venting from vent hood to the outdoors inch appliance regulator	\$ \$	100 150	\$	175
C. 1	Gas Rep	Cook Top 30-36 inch only (Sealed burners with <i>lacement</i> includes new gas shut-off valve.	th electron	nic ignition)		
	Insta Insta	Ill 30" gas cook top all 36" gas cook top	\$ \$	825 825		N/A N/A
D. <u>Gas Dryer Replacement (Factory equipped moisture sensor or equal to)</u> <u>Installation</u> includes new gas stop, flex connector up to 48", and vent kit						
	a. Gas	Dryer (Moisture Sensor)	\$	1,100	-	N/A

Attachment 7	
Page 9 of 51	
I. REPAIRS	
Directly associated with the installation of appliances.	
A. Electrical Work	
hr block of labor (includes incidental materials)	\$ 85
8. Plumbing Work	
hr block of labor (includes incidental materials)	\$ 85
C. Carpentry Work	
hr block of labor	\$ 85
a. Materials allotment	\$ 50
) Pressure Test on Natural Cas Lines	
	••••
Includes capping-off any unused gas valves	\$ 200
E. Roof Penetrations	
Including installation of vent pipe and flashing through a roof	\$ 200
Repair to existing flashing only	\$ 100
F. Water Lines	

Installation of sections longer than five feet, including up to two fittings (elbows/T's). * Sections shorter than five feet are included in water heater new installation price.

1. Copper

a. $\frac{1}{2}$ " diameter, > 5ft section	\$ 10	per foot
b. $\frac{3}{4}$ " diameter, > 5ft section	\$ 10	per foot
c. 1" diameter, > 5 ft section	\$ 11	per foot
2. PVC - for drain lines		

a.	¹ / ₂ " diameter,	> 5	5ft section	\$ 10	per foot
b.	¾" diameter,	> 5	5ft section	\$ 10	per foot
c.	1" diameter,	> 5	5ft section	\$ 10	per foot
d.	1 ¼" diameter	; > :	5ft section	\$ 15	per foot

G. Venting

Installation and material cost per unit (double-wall vent pipe).

a.	3 ft. section, 3" diameter	\$ 60
b.	3 ft. section, 4" diameter	\$ 65
c.	5 ft. section, 3" diameter	\$ 75
d.	5 ft. section, 4" diameter	\$ 85
e.	45 degree elbow, 3" diameter	\$ 50
f.	45 degree elbow, 4" diameter	\$ 55
g.	90 degree elbow, 3" diameter	\$ 45
h.	90 degree elbow, 4" diameter	\$ 55
i.	Vent cap, 3" diameter	\$ 40
j.	Vent cap, 4" diameter	\$ 45
k.	Vent section above, 4" diameter	\$ 35
1.	Joint connection above, 4" diameter	\$ 40

H. Sheetrock Patching with Tape and Float

Installation and material cost

a.	No texture or painting	\$	20	per square foot
b.	Including texture or painting	\$_	25	per square foot

I. Addition of Combustion Air

Installation of louvers and vent grills, including labor and materials

\$ 110	
\$ 115	
\$ 120	
\$ 25	per foot
\$ 25	per foot
\$ 30	per foot
\$ \$ \$ \$ \$	\$ 110 \$ 115 \$ 120 \$ 25 \$ 25 \$ 30

updated 10/27/16

FEP is derived of several sources consisting of RS Means Contractor's Pricing Guide and local Austin market contractor's guotes.

If you have questions, please email Conservation@TexasGasService.com or call (512) 370-8243.

Texas Gas Service Conservation Program 1301 S. Mopac, Ste. 400 Austin, TX 78746 (512) 370-8243 Conservation@texasgasservice.com Attachment 7 Page 11 of 51

TGS Residential New Construction Program 2017 Homebuilder Participants

Assured Builders Bridgewater Custom Homes Brohn Homes **Buffington Homes** Calatlantic Homes Carty Custom Builders Cater Joseph's Homes Cedar & Rock Builders **CPPOD Holdings** D R Horton Truehome Desgin.Build David Weekly Homes East Village Properties **Empirico Development Gossett Jones** Housing Authority of Central Austin Legacy DCS Mackey Adams Properties Mezger Homes Morgan Group, Pearl Lantana Moazami Homes The Muskin Company MX3 Homes New Castle Homes **Patriot Builders** Pro Widyah LLC **Rand Gins Risher Martin Fine Homes River Rock Custom Homes Russell Epright Homes** Saldana Homes Scott Felder Homes LLC South Austin Development Group VII Custom Homes Waters Custom Homes Wes Peoples Homes

GAS UTILITIES DOCKET NO. _____

STATEMENT OF INTENT OF TEXAS§GAS SERVICE COMPANY, A DIVISION§OF ONE GAS, INC. TO CHANGE GAS§UTILITY RATES WITHIN THE§UNINCORPORATED AREAS OF THE§CENTRAL TEXAS SERVICE AREA§AND SOUTH TEXAS SERVICE AREA§

BEFORE THE

RAILROAD COMMISSION

OF TEXAS

DIRECT TESTIMONY

OF

PAUL H. RAAB

ON BEHALF OF

TEXAS GAS SERVICE COMPANY

June 20, 2016

DIRECT TESTIMONY OF PAUL H. RAAB

1	Q.	PLEASE STATE YOUR NAME, OCCUPATION, AND BUSINESS ADDRESS.
2	A.	My name is Paul H. Raab, and my business address is 5313 Portsmouth Road, Bethesda,
3		Maryland 20816. I am an independent economic consultant.
4		I. QUALIFICATIONS
5	Q.	WHAT IS YOUR EDUCATIONAL BACKGROUND?
6	A.	I have a B.A. in Economics from Rutgers University and an M.A. from the State
7		University of New York at Binghamton with a concentration in Econometrics. While
8		attending Rutgers, I studied as a Henry Rutgers Scholar.
9	Q.	PLEASE DESCRIBE YOUR BUSINESS EXPERIENCE.
10	A.	I have been moviding conculting convices to the utility inductory for even 25 years beying
1 1		I have been providing consulting services to the durity industry for over 55 years, having
11		assisted electric, gas, telephone, and water utilities; Commissions; and intervenor clients
11		assisted electric, gas, telephone, and water utilities; Commissions; and intervenor clients in a variety of areas. I am trained as a quantitative economist so that most of this
11 12 13		assisted electric, gas, telephone, and water utilities; Commissions; and intervenor clients in a variety of areas. I am trained as a quantitative economist so that most of this assistance has been in the form of mathematical and economic analysis and information
11 12 13 14		assisted electric, gas, telephone, and water utilities; Commissions; and intervenor clients in a variety of areas. I am trained as a quantitative economist so that most of this assistance has been in the form of mathematical and economic analysis and information systems development. My particular areas of focus are planning issues, costing and rate
11 12 13 14 15		assisted electric, gas, telephone, and water utilities; Commissions; and intervenor clients in a variety of areas. I am trained as a quantitative economist so that most of this assistance has been in the form of mathematical and economic analysis and information systems development. My particular areas of focus are planning issues, costing and rate design analysis, and depreciation and life analysis. I began my career with the
11 12 13 14 15 16		assisted electric, gas, telephone, and water utilities; Commissions; and intervenor clients in a variety of areas. I am trained as a quantitative economist so that most of this assistance has been in the form of mathematical and economic analysis and information systems development. My particular areas of focus are planning issues, costing and rate design analysis, and depreciation and life analysis. I began my career with the professional services firm that is now known as Ernst & Young, where I was employed

18 Q. HAVE YOU TESTIFIED PREVIOUSLY BEFORE COMMISSIONS IN 19 REGULATORY PROCEEDINGS?

A. Yes. I have provided expert testimony before the state regulatory authorities of Alaska,
Colorado, the District of Columbia, Georgia, Indiana, Iowa, Kansas, Kentucky,
Louisiana, Maryland, Michigan, Missouri, Montana, Nebraska, Nevada, New Jersey,

New Mexico, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, West
 Virginia and Wisconsin. I have also provided expert testimony before the Federal Energy
 Regulatory Commission, the Michigan House Economic Development and Energy
 Committee, the Pennsylvania House Consumer Affairs Committee, the Province of
 Saskatchewan and the United States Tax Court. Details on the subject matter of the
 testimony presented are provided in Exhibit PHR-1.

7

II. PURPOSE OF TESTIMONY

8 Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

9 A. Currently, the Company rewards customers of Texas Gas Service Company ("TGS" or
10 the "Company") for making smart energy choices by choosing natural gas appliances and
11 completing energy-efficient home improvements in its Central Texas Service Area
12 ("CTSA") for customers served by the municipal electric and water utility in Austin,
13 Texas. The TGS Conservation Program provides more than \$2 million in rebates each
14 year to qualified customers and offers more than 15 different rebates that help customers
15 choose the most efficient systems for their home or business energy needs.

16 The Company would like to expand this program in order to continue to provide 17 CTSA and to start providing South Texas Service Area ("STSA") customers with the 18 benefits of conservation and energy efficiency and is requesting authority to do so in this 19 rate filing. The purpose of my testimony in this proceeding is to present the Commission 20 with benefit/cost evaluations that support the Company's proposed programs for the new 21 Central Texas Consolidated Service Area ("CTCSA")¹.

¹ In this proceeding, the Company seeks to consolidate the CTSA and STSA into the new Central Texas Consolidated Service Area.

1

III. IDENTIFICATION OF EXHIBITS

2 Q. DO YOU SPONSOR ANY EXHIBITS IN SUPPORT OF YOUR TESTIMONY?

A. Yes. I sponsor three exhibits. Exhibit PHR-1 is a summary of my qualifications and
experience. Exhibit PHR-2 summarizes the assumptions upon which the benefit/cost
evaluations of Exhibit PHR-3 are based. Exhibit PHR-3 provides the benefit/cost results
for all of the measures proposed by the Company, using the benefit/cost tests commonly
employed to evaluate conservation and energy efficiency programs throughout the
country. These tests include the Participant Test, the Rate Impact Measure Test, the
Total Resource Cost Test, the Program Administrator Test and the Societal Cost Test.

10The above-designated exhibits were prepared by me or under my direction and11supervision.

12

IV. ORGANIZATION OF TESTIMONY

13 Q. HOW IS YOUR DIRECT TESTIMONY ORGANIZED?

A. My direct testimony is organized into five additional sections, labeled V through IX.
Section V discusses the measures included in the Company's proposed program offerings
and includes a description of the resulting programs. Section VI presents the five costeffectiveness tests introduced above. Section VII summarizes the assumptions that I have
made in order to implement these cost-effectiveness tests, by measure. Evaluation results
are presented in Section VIII. Finally, Section IX provides an overall summary of my
testimony and associated recommendations.

21V. PROPOSED CONSERVATION AND22ENERGY EFFICIENCY MEASURES

Q. PLEASE PROVIDE A BRIEF DESCRIPTION OF THE CONSERVATION AND ENERGY EFFICIENCY PROGRAMS THAT THE COMPANY IS PROPOSING.

1 A. The Company proposes to offer conservation and energy efficiency programs to both 2 Commercial and Residential customers in the proposed new CTCSA. Multiple measures 3 will be offered within six Commercial programs: a Commercial Water Heating 4 Equipment Program, a Commercial Dryer Program, a Commercial Food Service 5 Program, a Commercial Direct Install Program, a Natural Gas Vehicle Program and a 6 Commercial Education Program. The Company's proposal also includes eight programs 7 for Residential customers: a Residential Water Heating Program, a Residential Space 8 Heating Program, a Natural Gas Vehicle Program, a Residential Dyer Program, a 9 Residential Home Improvement Program, a Low Income Program, a Residential Whole 10 Home Program and a Residential Education Program.

11Q.PLEASE DESCRIBE THE COMMERCIAL WATER HEATING EQUIPMENT12PROGRAM.

A. The Commercial Water Heating Equipment Program continues the Company's successful program of providing incentives for water heating equipment used by its Commercial customers in its CTSA served by Austin Energy and the Austin Water Utility. Consistent with its current Austin program, the Company proposes to offer the following rebates to Commercial customers in the CTCSA who install high-efficiency water heating equipment:

14 percent of the equipment cost for a new natural gas commercial water heating system with an energy factor of 0.82 through 0.86 or a thermal efficiency of 82 to 86 percent;

- 20 percent of the equipment cost for a new natural gas commercial water heating
 system with an energy factor of 0.87 or higher or a thermal efficiency of 87 percent or
 higher; or
- \$600 for the purchase and installation of a new tankless water heater with an energy
 factor of 0.82 or higher or a thermal efficiency of 82 percent or higher.

1		Additionally, the Company will provide an incentive of up to 20 percent of the installed
2		cost for the purchase and installation of a new solar water heater with natural gas backup.
3	Q.	HOW DOES THE COMMERCIAL DRYER PROGRAM OPERATE?
4	A.	The Commercial Natural Gas Dryer Program offers Commercial customers a \$225 rebate
5		for the purchase and installation of a new natural gas dryer with a moisture sensor.
6 7	Q.	WHAT EQUIPMENT DOES THE COMMERCIAL FOOD SERVICE PROGRAM PROMOTE?
8	A.	The Commercial Food Service Program provides rebates equal to 10 percent of the new
9		equipment cost to encourage the installation of high-efficiency (ENERGY STAR® rated)
10		natural gas convection ovens, fryers, griddles and steam cookers. ENERGY STAR®-
11		certified commercial food service equipment helps café, restaurant, and institutional
12		kitchen operators save energy by cutting kitchen utility and maintenance costs without
13		sacrificing features, quality or style. Saving energy also helps save money on utility bills
14		and protects the environment by reducing greenhouse gas emissions.

15Q.WHAT MEASURES ARE INCLUDED IN THE COMMERCIAL DIRECT16INSTALL PROGRAM?

A. Under this program, TGS will engage a conservation service provider, CLEAResult, to
install a number of low-cost, high impact conservation measures in the businesses of
Commercial customers throughout the Company's Central Texas Service Area. These
measures include 0.5 and 1.0 gallon per minute (gpm) faucet aerators, high-efficiency
pre-rinse spray valves and wall-mounted and handheld showerheads. CLEAResult is
responsible for marketing these measures to customers and installing the measures on
customer premises. The measures will be provided at no direct cost to TGS Commercial

1 customers, and they save energy by reducing the need to heat water, so eligible 2 businesses must use a natural gas water heater to be eligible for the spray valves and 3 aerators.

4 5

Q. WHAT ACTIONS ARE THE COMPANY'S PROPOSED NATURAL GAS VEHICLE PROGRAM INTENDED TO ENCOURAGE?

- 6 A. This program provides a \$2,000 rebate for the purchase of a new natural gas vehicle or a
- 7 \$3,000 rebate for vehicles recently converted to natural gas by a certified technician. In
- 8 addition, the program also provides the following incentives for pre-owned vehicles that
- 9 were converted by the previous owner:
- Light duty vehicles (pick-up trucks, vans and automobiles) \$2,000;
- Medium duty vehicles (step vans, transportation, medium duty trucks, and airport shuttles) \$2,000;
- Heavy duty vehicles (garbage trucks and top kick trucks) \$2,000
- 15 Forklifts \$1,000;
- 16 And finally, the Natural Gas Vehicle Program offers \$2,000 for the purchase and 17 installation of a new natural gas vehicle home refueling unit.

18

13

Q. PLEASE DESCRIBE THE COMMERCIAL EDUCATION PROGRAM.

A. Under this program, TGS will provide its Commercial customers with information about
the benefits of conservation and energy efficiency in general and about the Company's
specific conservation and energy efficiency programs so that Commercial customers can
actively participate in these offerings. As will be discussed more fully below, the
Company assigns no energy savings benefits to this program, so the program is expected
to be paid for by the energy savings benefits generated by the other program offerings
discussed above.

1Q.HOW DOES THE PROPOSED RESIDENTIAL WATER HEATING PROGRAM2OPERATE?

A. Under this program, residential customers can receive a rebate for installing either a high efficiency storage water heater or a high-efficiency tankless or super high-efficiency
 natural gas water heater.

6 (

7

Q. WHAT WATER HEATING EQUIPMENT QUALIFIES AND WHAT LEVEL OF REBATE IS THIS EQUIPMENT ELIGIBLE FOR?

8 A. Residential customers can qualify for a \$100 rebate for the purchase and installation of a

- 9 new high-efficiency natural gas storage water heater with an energy factor greater than
- 10 0.67. The program also offers \$750 for the purchase and installation of a new natural gas
- 11 tankless or super high-efficiency water heater with an energy factor of 0.82 or higher or a
- 12 thermal efficiency of 82 percent or higher.

Q. WHAT NATURAL GAS SPACE HEATING EQUIPMENT QUALIFIES UNDER THE COMPANY'S PROPOSED RESIDENTIAL SPACE HEATING PROGRAM?

15 A. Under this program, the Company is proposing to offer equipment rebates of \$675 for the

- 16 purchase and installation of a new natural gas central furnace with a minimum AFUE of
- 17 92 percent or \$125 for the purchase and installation of a new natural gas hydronic heating
- 18 system with energy factor eligibility requirements that vary according to tank size and
- 19 input Btu rating as follows:

Tank Size	BTU Rating	Energy Factor
40 gallon	40,000	>.58
50 gallon	40,000 - 52,500	>.57
50 gallon	53,000 - 65,000	>.55
75 gallon	75,000	>.54

20 The Company also proposes to offer \$40 to offset the cost of a natural gas furnace check 21 and tune-up, thereby providing its customers who are not in need of a major capital investment the opportunity to participate and reap the benefits of the Company's
 conservation and energy efficiency programs.

3Q.WHAT ACTIONS ARE THE COMPANY'S PROPOSED RESIDENTIAL4NATURAL GAS VEHICLE PROGRAM INTENDED TO ENCOURAGE?

A. As with the Commercial Natural Gas Vehicle Program introduced above, this Residential
program also provides a \$2,000 rebate for the purchase of a new natural gas vehicle; a
\$3,000 rebate for vehicles recently converted to natural gas by a certified technician; and
a \$2,000 rebate for the purchase and installation of a new natural gas vehicle home
refueling unit.

10

Q. PLEASE DESCRIBE THE COMPANY'S RESIDENTIAL DRYER PROGRAM.

11 A. Like the equivalent Commercial program described above, the Company's Residential 12 Natural Gas Dryer Program offers \$225 for the purchase and installation of a new natural gas dryer with a moisture sensor. In addition, the program also offers \$300 for the 13 14 installation of a new natural gas dryer stub connection in the laundry area of the home 15 (where a natural gas dryer stub did not previously exist). As discussed more fully below in the evaluation section of my testimony, I assign no energy savings benefit to dryer stub 16 17 incentives and all of the budgeted expenditures for dryer stubs to actual dryer 18 installations. In this way, energy savings benefits generated by the installation of high-19 efficiency natural gas dryers are expected to support the payment of dryer stub incentives.

20Q.WHAT ENERGY EFFICIENCY AND CONSERVATION MEASURES ARE21ENCOURAGED BY THE RESIDENTIAL HOME IMPROVEMENT PROGRAM?

A. The Company's Residential Home Improvement Program provides rebates to residential
 customers who engage in HVAC system duct sealing, replacement or insulation, those
 who upgrade their attic insulation or those who install a Wi-Fi thermostat.

4 Even with an energy-efficient furnace, leaking ductwork can reduce a heating 5 system's effectiveness and cost money. The duct component of this program offers a 6 rebate equal to \$0.08 per square foot for sealing the ductwork on an existing natural gas 7 furnace. With respect to attic insulation, much of the heat in a home can escape through 8 the roof. TGS customers who heat with natural gas can get cash back through the 9 Residential Home Improvement Program for upgrading the insulation in their attic. 10 Finally, a Wi-Fi enabled thermostat saves energy by scheduling heating service only 11 when it is needed in the home.

12Q.PLEASE DESCRIBE THE COMPANY'S PROPOSED LOW INCOME13PROGRAM.

A. TGS provides a number of free services for customers who are on fixed or moderate
incomes, as well as to the elderly and those with disabilities. Services include free
installation of new and replacement wall or central furnaces, natural gas water heaters,
dryers and ranges. Free weatherization services and installation of carbon monoxide and
smoke detectors are also available.

19Q.PLEASE DESCRIBE THE COMPANY'S RESIDENTIAL WHOLE HOME20PROGRAM.

A. The Residential Whole Home Program is designed to promote whole home energy
 efficiency by encouraging the installation of multiple high-efficiency natural gas using
 appliances. Specifically, to be eligible for rebates under this program, homeowners must
 purchase and install both a new high-efficiency natural gas storage water heater with an

1 energy factor greater than 0.67 and a new high-efficiency natural gas furnace with an 2 AFUE greater than .92.

PLEASE DESCRIBE THE RESIDENTIAL EDUCATION PROGRAM. 3 0.

4 Like the Commercial Education Program introduced above, under this program, TGS will A. 5 provide its residential customers with information about the benefits of conservation and 6 energy efficiency in general and about the Company's specific conservation and energy 7 efficiency programs so that customers can actively participate in these offerings. As is 8 the case with the Commercial Education Program, the Company likewise assigns no 9 energy savings benefits to this program, so the program is expected to be paid for by the 10 energy savings benefits generated by the other residential program offerings discussed 11 above.

12 VI. BENEFIT/COST EVALUATION OF THE COMPANY'S 13 **CONSERVATION AND ENERGY EFFICIENCY PROPOSALS**

14 Q. HOW DOES ONE DETERMINE WHETHER THESE CONSERVATION AND 15 **ENERGY EFFICIENCY PROGRAMS ARE COST-EFFECTIVE?**

- 16 A. Cost-effectiveness of conservation and energy efficiency programs such as those 17 described above is generally determined by applying five tests: the Participant Test; the 18 Rate Impact Measure Test; the Total Resource Cost Test; the Societal Test; and the 19 Program Administrator Test.
- 20 **O**.

PLEASE DESCRIBE THESE TESTS.

21 A. These tests were first developed for the evaluation of conservation and energy efficiency 22 measures in California in the early 1980s. Most recently published in 2001, the

1		California Standard Practice Manual: Economic Analysis of Demand-Side Management
2		Programs and Projects ² describes these tests:
3 4 5		• The Participant Test – This test determines whether the conservation and energy efficiency measure is cost-effective for the party who receives the conservation and energy efficiency treatment.
6 7 8 9 10		• The Ratepayer Impact Measure ("RIM") Test – This test determines the impact that the conservation and energy efficiency measure will have on non-participants. Because of this, the test is often referred to as the Non-Participants Test and measures the rate impacts of the utility offering the program.
11 12 13 14 15		• The Total Resource Cost ("TRC") Test – This test is designed to measure whether the conservation and energy efficiency measure is cost-effective from society's standpoint. Because this test can be derived as the sum of the Participant Test and the Ratepayer Impact Measure Test, it is often referred to as the All Ratepayers Test.
16 17 18 19 20 21		• The Societal Test – A variant of the Total Resource Cost Test is the Societal Test, which modifies the TRC in the following ways: uses higher marginal costs to reflect the cost to society of the more expensive alternative resources and to reflect externality costs not captured by the market system, omits tax credits and capital costs in the year in which they occur and uses a societal discount rate.
22 23 24		• The Program Administrator ("PA") Cost Test – This test is designed to measure the cost-effectiveness of a conservation and energy efficiency measure as a utility resource alternative.
25	Q.	PLEASE DESCRIBE THE PARTICIPANT TEST.
26	А.	As the name implies, the Participant Test is designed to measure the cost-effectiveness of
27		a utility conservation and energy efficiency measure from the standpoint of the individual
28		or group who installs the measure. It is generally considered a "threshold" test because,
29		if the measure is not cost-effective for the individual who is expected to install the

^{2 &}lt;u>California Standard Practice Manual: Economic Analysis of Demand-Side Management Programs</u>, October 2001, available at http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF

1	measure, it is not likely to be cost-effective for any other affected party. The Benefit (B_P)
2	and Cost (C _P) terms are defined as follows:
3	$B_P = \sum_{t=1}^{N} rac{BR_t + TC_t + INC_t}{(1+d)^{t-1}} + \sum_{t=1}^{N} rac{AB_{at} + PA_{at}}{(1+d)^{t-1}}$
4	
5	$C_{P} = \sum_{t=1}^{N} \frac{PC_{t} + BI_{t}}{(1+d)^{t-1}}$
6	
7	Where:
8	$BR_t = Bill$ reductions in year t
9	TC_t = Tax credits in year t
10	INC_t = Incentives paid to the participant by the sponsoring utility in year t
11	$AB_{at} = Avoided bill from alternate fuel in year t$
12	PA_{at} = Participant avoided costs in year t for alternate fuel devices (costs
13	of devices not chosen)
14	PC_t = Participant costs in year t to include: initial capital costs, including
15	sales tax, ongoing operation and maintenance costs including fuel
16	cost, removal costs, less salvage value and value of the customer's
17	time in arranging for installation, if significant
18	BI_t = Bill increases in year t
19	d = Discount rate
20	N = Measure life
21	The logic of this test is fairly straightforward. The implementation of any conservation
22	and energy efficiency measure should cause a change in the utility bill in either the

2 e 23 positive (BIt) or negative direction (BRt). In some cases, the participant will get a tax 24 credit (TC_t) or an incentive payment (INC_t) to install the measure, both of which count as 25 benefits. If alternative fuels are involved in the implementation of the measure, the participant will likely experience bill savings for the alternative fuel (ABat) and avoided 26 costs for alternative fuel equipment (PACat). Any participant out-of-pocket costs to 27 28 implement the conservation and energy efficiency measures are also included as costs 29 (PC_t) .

1

Q. PLEASE DESCRIBE THE RATEPAYER IMPACT MEASURE TEST.

A. The RIM Test is designed to measure the rate impacts of a utility conservation and
energy efficiency measure. Because rate impacts will largely fall on those ratepayers
who do not participate in the conservation and energy efficiency programs, it is
alternatively referred to as the non-participants test. The Benefit (B_{RIM}) and Cost (C_{RIM})
terms are further defined as follows:

 $B_{RIM} = \sum_{t=1}^{N} \frac{UAC_{t} + RG_{t}}{(1+d)^{t-1}} + \sum_{t=1}^{N} \frac{UAC_{at}}{(1+d)^{t-1}}$

8

9

10

$C = -\sum_{k=1}^{N} \frac{1}{k}$	$UIC_t + RL_t + PRC_t + INC_t$	$\sum_{t=1}^{N} RL_{at}$
$C_{RIM} = \sum_{t=1}^{n}$	$(1+d)^{t-1}$	$\sum_{t=1}^{n-1} \frac{1}{(1+d)^{t-1}}$

13	UACt	=	Utility avoided supply costs in year t
14	RGt	=	Revenue gain from increased sales in year t
15	UACat	=	Utility avoided supply costs for the alternate fuel in year t
16	UICt	=	Utility increased supply costs in year t
17	RL_t	=	Revenue loss from reduced sales in year t
18	PRCt	=	Program Administrator costs in year t
19	RL _{at}	=	Revenue loss from avoided bill payments for alternate fuel
20			in year t (i.e., device not chosen in a fuel substitution
21			program)

22 Under the logic of this test, if the costs avoided by implementation of the conservation 23 and energy efficiency measure (UAC_t and UAC_{at}) or the revenue gains (RG_t) exceed the costs of the program (UICt, PRCt, or INCt) or the revenue losses (RLt and RLat), then 24 25 there will be downward pressure on rates and the conservation and energy efficiency 26 measure will pass the test. In the case of natural gas utilities, this is a very difficult test 27 for conservation or energy efficiency program to pass because a natural gas utility's avoided cost very rarely exceeds the revenue loss associated with conservation programs. 28 29 This problem can be solved by moving toward more rational rate designs that better

reflect the underlying economics of the cost of supplying natural gas. Alternatively, programs for natural gas utilities can be limited to those that only reduce peak usage (load management programs) or those that build load (load building and fuel switching programs). Most regulatory jurisdictions would not disapprove a program simply because the program fails the RIM Test and view the issue as a policy determination. For example, as described more fully below, benefit/cost testing by the Public Utility Commission of Texas ("PUC") favors the Program Administrator Cost Test.

8 Q.

PLEASE DESCRIBE THE TOTAL RESOURCE COST TEST.

9 A. The TRC Test is generally regarded as the controlling test of any conservation and energy 10 efficiency measure because it attempts to measure the societal cost consequences of the 11 measure and is therefore a broad measure of cost-effectiveness. The TRC Test is 12 sometimes referred to as the All-Ratepayers Test because it is a mathematical 13 combination of the Participant Test and the RIM Test; i.e., it measures the impact on all 14 ratepayers. This test compares all benefits from a conservation and energy efficiency 15 measure to all costs of that program. The Benefit (B_{TRC}) and Cost (C_{TRC}) terms are 16 defined as follows:

17
$$B_{TRC} = \sum_{t=1}^{N} \frac{UAC_t + TC_t}{(1+d)^{t-1}} + \sum_{t=1}^{N} \frac{UAC_{at} + PAC_{at}}{(1+d)^{t-1}}$$

18

19
$$C_{TRC} = \sum_{t=1}^{N} \frac{PRC_{t} + PCN_{t} + UIC_{t}}{(1+d)^{t-1}}$$

20 All terms have been previously defined.

21 Thus, implementation of a conservation and energy efficiency measure will result 22 in benefits to society as a result of costs avoided by the affected utilities (UAC_t and 23 UAC_{at}), tax credit benefits to participants (TC_t) and equipment costs avoided by the participants (PAC_{at}). These benefits will be balanced by costs incurred by utilities
 (PRC_t), costs incurred by participants (PCN_t), and any costs associated with increased
 load (UIC_t).

The major deficiency of this test is that it does not measure income redistribution 4 5 effects associated with conservation and energy efficiency measures. In particular, many 6 programs will produce significant participant benefits that accrue only to those who 7 receive a conservation and energy efficiency treatment and rate increase consequences 8 that are paid for by all ratepayers on the utility system. As a consequence, non-9 participants are forced to pay for those programs that benefit another group of customers. 10 This is particularly true of programs that are focused on only one subset of customers. 11 This problem can be overcome by offering a range of programs that target all customers. 12 By doing so, the programs, as a group, will have minimal or no negative income 13 redistribution consequences.

14

Q. PLEASE DESCRIBE THE SOCIETAL COST TEST.

A. As stated above, the Societal Cost Test is structurally similar to the TRC test but modifies input assumptions to incorporate higher marginal costs to reflect the cost to society of the more expensive alternative resources and to reflect externality costs not captured by the market system, omits tax credits and capital costs in the year in which they occur and uses a societal discount rate. Because these changes in assumptions only serve to make a program *more* cost-effective than would be indicated by the TRC Test, if a program passes the TRC test, information provided by the Societal Cost Test is often redundant.

22 Q. PLEASE DESCRIBE THE PROGRAM ADMINISTRATOR COST TEST.

6

7

A. The PA Cost Test is used to compare the costs of a conservation and energy efficiency
 measure to an alternative supply side resource. Therefore, it is the best test to determine
 if an aggressive strategy of substituting conservation and energy efficiency resources for
 supply side resources is appropriate. It is calculated using the following formulas:

5
$$B_{PA} = \sum_{t=1}^{N} \frac{UAC_t}{(1+d)^{t-1}} + \sum_{t=1}^{N} \frac{UAC_{at}}{(1+d)^{t-1}}$$

$$C_{PA} = \sum_{t=1}^{N} \frac{PRC_{t} + INC_{t} + UIC_{t}}{(1+d)^{t-1}}$$

8 All terms have been previously defined.

- 9 The net cost of a conservation and energy efficiency program as a resource option 10 is equal to the costs avoided by the affected utilities (UAC_t and UAC_{at}) less the costs 11 incurred to acquire the resources, out-of-pocket costs (PRC_t), incentive costs (INC_t), and 12 any costs associated with increased load (UIC_t).
- 13 As indicated above, benefit/cost testing by the Texas PUC is based on P.U.C.
- 14 SUBST. R. 25.181, where costs and benefits are defined in section (d):
- 15 The cost of a program includes the cost of incentives, measurement and 16 verification, any shareholder bonus awarded to the utility, and actual or allocated 17 research and development and administrative costs. The benefits of the program 18 consist of the value of the demand reductions and energy savings, measured in 19 accordance with the avoided costs prescribed in this subsection. The present value 20 of the program benefits shall be calculated over the projected life of the measures 21 installed or implemented under the program.
- 22 This description is consistent with the Program Administrator Cost Test.

23Q.HAVE YOU APPLIED THESE TESTS TO THE CONSERVATION AND24ENERGY EFFICIENCY PROGRAMS PROPOSED BY TGS?

1	A.	Yes, and the results are provided in Exhibit PHR-3. Of course, these results are critically
2		dependent upon a set of evaluation assumptions. Therefore, the next section of my
3		testimony is devoted to a presentation and discussion of these evaluation assumptions.
4 5		VII. ASSUMPTIONS USED TO EVALUATE THE COMPANY'S CONSERVATION AND ENERGY EFFICIENCY PROPOSALS
6 7	Q.	WHAT ASSUMPTIONS DID YOU MAKE IN PERFORMING THESE EVALUATIONS?
8	A.	The major assumptions that I have made can be grouped into two different categories:
9		general assumptions that apply equally to all measures and measure-specific assumptions.
10		The general assumptions relate to the following variables:
11		• TGS discount rate, 7.61% (the Company's proposed rate of return);
12		• Participant discount rate, 15%;
13		• Societal discount rate, 2.5%;
14 15		• Long-term inflation rate, 1.85% (the latest inflation forecast from the Federal Reserve Bank of Cleveland);
16		• The externality cost associated with consumption of natural gas;
17 18		• The rates associated with reduced volumes of natural gas as a result of the programs; and
19		• Avoided costs of reduced volumes of natural gas.
20	Q.	WHY DID YOU ASSUME A SOCIETAL DISCOUNT RATE OF 2.5%?
21	A.	I assumed a societal discount rate of 2.5% to ensure consistency with my source of the
22		externality cost associated with consumption of natural gas, Technical Support
23		Document: Technical Update of the Social Cost of Carbon for Regulatory Impact
24		Analysis Under Executive Order 12866. As stated in the Executive Summary of that
25		document:

1 The purpose of the "social cost of carbon" (SCC) estimates presented here is to 2 allow agencies to incorporate the social benefits of reducing carbon dioxide 3 (CO2) emissions into cost-benefit analyses of regulatory actions that impact 4 cumulative global emissions. The SCC is an estimate of the monetized damages 5 associated with an incremental increase in carbon emissions in a given year. It is 6 intended to include (but is not limited to) changes in net agricultural productivity, 7 human health, property damages from increased flood risk, and the value of 8 ecosystem services due to climate change.

- 9 The SCC estimates are values based on the average SCC from three integrated
- 10 assessment models (IAMs), at discount rates of 2.5, 3, and 5 percent. The average SCCs,
- 11 discounted at 2.5%, are used in my development of the Societal Cost test. Therefore, I
- 12 also used a 2.5% discount rate when applying that test.
- 13 In order to develop the externality cost associated with consumption of natural gas
- 14 from these SCC estimates, I assumed that each therm of natural gas saved as a result of
- 15 the proposed programs will reduce equivalent carbon dioxide emissions (CO2e) by
- 16 14.713 pounds. This estimate is taken from the Gas Technology Institute's Source
- 17 Energy and Emissions Analysis Tool, which can be found at www.cmictools.com.

18 Q. WHY DO YOU NEED TO MAKE ASSUMPTIONS WITH RESPECT TO RATES 19 ASSOCIATED WITH REDUCED THERM CONSUMPTION AS A RESULT OF 20 THE PROGRAMS?

A. The rates associated with reduced therm consumption are needed to calculate lost revenues as a result of the programs, which are a key component of the RIM test. To develop an average rate associated with reduced therm consumption, I determined the rate for marginal consumption by month, which I then applied to the monthly reduction in therm consumption as a result of the Company's programs. Marginal consumption in each month is determined from the typical load profiles of TGS customers.

Q. WHAT ASSUMPTIONS DID YOU MAKE WITH RESPECT TO THE AVOIDED COSTS?

1	A.	Each year, the U.S. Department of Energy's Energy Information Administration (EIA)
2		prepares its Annual Energy Outlook. The latest of these, Annual Energy Outlook 2015
3		(AEO2015), presents long-term annual projections of energy supply, demand, and prices
4		through 2040. The projections, focused on U.S. energy markets, are based on results from
5		EIA's National Energy Modeling System (NEMS). NEMS enables EIA to make
6		projections under alternative, internally-consistent sets of assumptions, the results of
7		which are presented as cases. The analysis in AEO2015 focuses on six cases: Reference
8		case, Low and High Economic Growth cases, Low and High Oil Price cases, and High
9		Oil and Gas Resource case. In these evaluations, I relied on the EIA projection of
10		delivered natural gas prices to Southwest Residential and Commercial customers as my
11		estimate of the avoided cost. These estimates have a number of desirable properties:
12 13 14		• The estimates are developed through 2040, and this time frame is required for an evaluation of long-lived conservation and energy efficiency investments;
15 16 17		• The estimates remove Company judgment from the calculation of avoided cost, relying instead on projections developed by an unbiased Federal agency;
18 19 20		• The estimates allow for sensitivity analysis of the Company's proposals with respect to avoided costs using alternative, but internally-consistent sets of assumptions; and
21 22 23		• The estimates are generally consistent with the avoided cost assumptions that are used to guide conservation and energy efficiency activities in other state regulatory jurisdictions.
24 25	Q.	WHAT MEASURE-SPECIFIC ASSUMPTIONS ARE REQUIRED FOR SCREENING PURPOSES?
26	A.	Exhibit PHR-2 summarizes the measure-specific assumptions utilized in my benefit/cost
27		evaluations. In general, five measure-specific evaluation assumptions are required: the
28		measure life, the measure cost, the incentive paid, program participation levels and the

1		measure savings. Measure life assumptions are obtained from the Measure Life Report,
2		Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates,
3		June 2007 as well as mandated values from the California Public Utility Commission.
4		For direct install measures, the cost of the measure is the price of the measure quoted by
5		the Conservation Service Provider ("CSP") that the Company has chosen to deliver the
6		measure. For other measures, the cost of the measure is based on a survey of the costs
7		realized by other utilities that offer incentives for the measure in question.
8		Energy Savings are developed from two sources. For direct install measures, the
9		savings are the quoted savings from the relevant CSP. For other measures, the savings
10		are developed using savings formulas from a statewide technical reference manual. The
11		incentive levels and participation levels have been provided by the Company.
12 13		VIII. EVALUATION RESULTS FOR THE COMPANY'S CONSERVATION AND ENERGY EFFICIENCY PROPOSALS
14	Q.	WHAT ARE THE RESULTS OF YOUR ANALYSIS?
15	А.	The results of my analysis are provided in Exhibit PHR-3. This exhibit lists each
16		proposed measure, grouped by program, with administrative costs associated with the
17		conservation and ratemaking efficiency plan either assigned to the portfolio as a whole or
18		to individual programs when such administrative, education, or outreach costs are not
19		otherwise directly assignable.

20Q.PLEASE DESCRIBE THE RESULTS OF YOUR EVALUATION OF THE21COMPANY'S COMMERCIAL PROGRAMS.

A. Exhibit PHR-3 demonstrates that the Commercial Programs are cost-effective from all
 five perspectives described above. These summary results include an allocation of small
 commercial educational expenses, as appropriate, to the TRC, the Societal costs, the PA

1 costs and the RIM costs.

2 **Q**. EXHIBIT PHR-3 INDICATES THAT CERTAIN SPECIFIC MEASURES BEING 3 PROMOTED WITHIN THE LARGER GROUP OF COMMERCIAL 4 PROGRAMS ARE NOT COST-EFFECTIVE. SHOULD THESE COST-5 **INEFFECTIVE PROGRAMS BE REJECTED FROM THE PORTFOLIO?**

A. I do not believe so, for two reasons. First, it has been my experience with other state reviewed utility programs that regulatory authorities do not require each individual rebate
 program to be cost-effective, only that the overall portfolio meet the criteria for cost effectiveness.

For example, the Oklahoma Corporation Commission has specified that "individual programs or individual measures for a specific program do not have to be cost-effective if their inclusion is expected to provide for greater comprehensiveness, customer or trade ally participation, or address hard-to-reach customer participation." The Pennsylvania Public Utilities Commission and the Maryland Public Service Commission have similar rebate program rules regarding cost-effectiveness.

16 Second, the rationale for focusing on the cost-effectiveness of the total rebate 17 portfolio is the general desire to offer programs to improve the efficiency with which 18 natural gas is used in all applications and to invite greater participation across all aspects 19 of the rebate portfolio. All of the Company's offerings, including some that are not cost-20 effective, improve the efficiency of natural gas use in the home and commercial 21 establishments.

22 Q. PLEASE DESCRIBE THE RESULTS OF YOUR EVALUATION OF THE 23 COMPANY'S RESIDENTIAL PROGRAMS.

A. Exhibit PHR-3 also demonstrates that the Residential Programs are also cost-effective
 from all five perspectives described above. The summary results include an allocation of

Residential educational expenses, as appropriate, to the TRC, the Societal costs, the PA
 costs and the RIM costs. The exhibit shows the same mix of cost-effective and
 ineffective measures as the Commercial Portfolio, although the total portfolio of
 Residential Programs is generally cost effective from all perspectives.

5 Q. HAVE YOU ALSO EVALUATED THE ENTIRE PORTFOLIO FROM THE 6 PERSPECTIVE OF EACH OF THE BENEFIT/COST TESTS?

7 A. Yes, I have. The results of applying these benefit/cost tests, after including all remaining 8 Portfolio Overhead Expenses, are provided on the last line of Exhibit PHR-3. While 9 overall portfolio performance declines after consideration of overhead expenses, the 10 overall TGS rebate portfolio is cost-effective from the standpoint of the TRC and the 11 Program Administrator Cost Test. In my experience, the TRC test is most often used in 12 jurisdictions around the country as the primary determinant of program cost 13 effectiveness. The TRC includes the costs and benefits experienced by all utility 14 customers, including energy efficiency program participants and non-participants. As documented above, the Program Administrator Cost Test is favored by the Texas PUC in 15 its evaluation of electricity utility sponsored conservation and energy efficiency 16 17 programs.

18

IX. SUMMARY AND RECOMMENDATIONS

19 Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A. My testimony describes the evaluation of a comprehensive set of conservation and energy
 efficiency programs for Commercial and Residential customers in the Company's
 CTCSA. My testimony first describes the evaluation of six conservation and energy
 efficiency programs whose primary focus is Commercial customers in the CTCSA:

- 11.A Commercial Water Heater Equipment Program, which provides incentives for2the installation of high-efficiency water heating equipment used by its3Commercial customers.
- A Commercial Dryer Program, which provides incentives for the installation of
 high-efficiency natural gas clothes drying equipment used by its Commercial
 customers.
- A Commercial Food Service Program, which provides incentives for the installation of ENERGY STAR® rated natural gas convection ovens, fryers, griddles and steam cookers. This equipment is commonly used in Commercial cooking applications.
- 114.A Commercial Direct Install Program, delivered by a conservation service12provider, CLEAResult, to install a number of low-cost, high impact conservation13measures in the businesses of Commercial customers throughout the CTCSA.
- 145.A Commercial Natural Gas Vehicle Program, which provides rebates for the15purchase of new or recently converted natural gas vehicles as well as for the16purchase and installation of a new natural gas vehicle home refueling unit.
- 176.A Commercial Education Program within which TGS will provide its18Commercial customers with information about the benefits of conservation and19energy efficiency in general and about the Company's specific conservation and20energy efficiency programs so that Commercial customers can actively participate21in these offerings.
- 22 My testimony also describes the evaluation of eight conservation and energy
- 23 efficiency programs whose primary focus is Residential customers in the CTCSA:
- 241.A Residential Water Heater Equipment Program, which provides Residential25customers with financial incentives to install both storage and tankless high-26efficiency water heaters. In addition, rebates will be provided for the installation27of solar water heaters with a natural gas backup under this program.
- 282.A Residential Space Heating Program, which provides Residential customers with29financial incentives to purchase and install new high-efficiency (>92%) natural30gas furnaces and high-efficiency (>85%) boilers, as well as incentives to perform31natural gas furnace checks and tune-ups of existing heating systems.
- 323.A Residential Natural Gas Vehicle Program, which provides rebates for the33purchase of new or recently converted natural gas vehicles as well as for the34purchase and installation of a new natural gas vehicle home refueling unit.
- 354.A Residential Dryer Program, which provides incentives for the installation of36high-efficiency Residential natural gas clothes drying equipment.

- 1 5. A Residential Home Improvement Program, which provides rebates to Residential 2 customers who engage in HVAC system duct sealing, replacement or insulation, 3 those who upgrade their attic insulation or those who install a Wi-Fi thermostat. 6. A Residential Low Income Program within which TGS will provide a number of 4 5 free services for customers on fixed or moderate incomes, as well as the elderly and those with disabilities. 6 7 7. A Residential Whole Home Program within which TGS will promote whole home 8 energy efficiency by encouraging the installation of both a new high-efficiency 9 natural gas storage water heater with an energy factor greater than 0.67 and a new 10 high-efficiency natural gas furnace with an AFUE greater than .92. 11 8. A Residential Education Program within which TGS will provide its Residential customers with information about the benefits of conservation and energy 12 efficiency in general and about the Company's specific conservation and energy 13 efficiency programs so that Residential customers can actively participate in these 14 15 offerings. 16 My evaluation of these programs was performed at the measure level, using the 17 benefit/cost tests commonly employed to evaluate the cost effectiveness of conservation 18 and energy efficiency programs such as these around the country. These tests include the 19 Participant Test, the RIM Test, the TRC Test, the Program Administrator Cost Test and 20 the Societal Cost Test. 21 This analysis shows that the selected programs are cost-effective, can support a 22 reasonable level of overhead expenses as well as a Company incentive, and will generally 23 remain cost-effective under the alternative delivered natural gas price scenarios discussed 24 above. WHAT DO YOU RECOMMEND? 25 **O**. 26 A. I recommend that the Commission approve the programs as proposed. DOES THAT COMPLETE YOUR DIRECT TESTIMONY AT THIS TIME? 27 **Q**.
- A. Yes, it does.

PAUL H. RAAB

Mr. Raab's consulting focus is on the regulated public utility industry. His experience includes mathematical and economic analyses and system development and his areas of expertise include regulatory change management, load forecasting, supply-side and demand-side planning, management audits, mergers and acquisitions, costing and rate design, and depreciation and life analysis.

PROFESSIONAL EXPERIENCE

Mr. Raab has directed or has had a key role in numerous engagements in the areas listed above. Representative clients are provided for each of these areas in the subsections below.

Regulatory Change Management. Mr. Raab has recently been assisting both electric and natural gas utilities as they prepare to operate in an environment that is significantly different from the one they operate in today. This work has involved the development of unbundled cost of service studies; the development of strategies that will allow companies to prosper in a restructured industry; retail access program development, implementation, and evaluation; and the development of innovative ratemaking approaches to accompany changes in the regulatory structure. Representative clients for whom he has performed such work include:

- Texas Gas Service
- Virginia Natural Gas
- UGI Utilities, Inc. Gas Division, UGI Penn Natural Gas, Inc., and UGI Central Penn Gas, Inc.
- The Peoples Natural Gas Company d/b/a Dominion Peoples
- National Fuel Gas Distribution Corporation
- Columbia Gas of Pennsylvania, Inc.
- o Aquila
- Kansas Corporation Commission
- Atmos Energy Corporation
- Electric Cooperatives' Association
- Cleco
- Washington Gas
- Western Resources
- Kansas Gas Service
- Mid Continent Market Center.

Load Forecasting. Mr. Raab has broad experience in the review and development of forecasts of sales forecasts for electric and natural gas utilities. This work has also included the development of elasticity of demand measures that have been used for attrition adjustments and revenue requirement reconciliations.

Representative clients for whom he has performed such work include:

- Washington Gas Energy Services
- Central Louisiana Electric Company
- Washington Gas
- Saskatchewan Public Utilities Review Commission
- Union Gas Limited
- Nova Scotia Power Corporation
- Cajun Electric Power Cooperative
- Cincinnati Gas & Electric
- Commonwealth Edison Company
- Cleveland Electric Illuminating
- Public Service of Indiana
- Atlantic City Electric Company
- Detroit Edison Company
- Sierra Pacific Power
- Connecticut Natural Gas Corporation
- Appalachian Power Company
- Missouri Public Service Company
- Empire District Electric Company
- Public Service Company of Oklahoma
- Wisconsin Electric Power Company
- Northern States Power Company
- o Iowa State Commerce Commission
- Missouri Public Service Commission.

Supply Side Planning. Mr. Raab has assisted clients to determine the most appropriate supply-side resources to meet future demands. This assistance has included the determination of optimal sizes and types of capacity to install, determination of production costs including and excluding the resource, and an assessment of system reliability changes as a result of different resource additions. Much of this work for the following clients has been done in conjunction with litigation:

- Enstar Natural Gas
- AGL Resources
- Washington Gas
- Soyland Electric Cooperative
- Houston Lighting and Power
- City of Farmington, New Mexico
- Big Rivers Electric Cooperative
- City of Redding, California
- o Brown & Root
- Kentucky Joint Committee on Electric Power Planning Coordination
- Sierra Pacific Power.

Demand Side Planning. Demand Side Planning involves the forecasting of future demands; the design, development, implementation, and evaluation of demand side management programs; the determination of future supply side costs; and the integration of cost effective demand side management programs into an Integrated Least Cost Resource Plan. Mr. Raab has performed such work for the following clients:

- UGI Utilities
- Dominion Peoples Gas
- National Fuel Gas Distribution Corporation
- Columbia Gas of Pennsylvania
- Kansas Gas Service
- Atmos Energy Corporation
- Black Hills Gas Company
- Oklahoma Natural Gas Company
- Washington Gas Light Company
- Piedmont Natural Gas Company
- Chesapeake Utilities
- Pennsylvania & Southern Gas
- Montana-Dakota Utilities.

Management Audits. Mr. Raab has been involved in a number of management audits. Consistent with his other experience, the focus of his efforts has been in the areas of load forecasting, demand- and supply-side planning, integrated resource planning, sales and marketing, and rates. Representative commission/utility clients are as follows:

- Public Utilities Commission of Ohio/East Ohio Gas
- Kentucky Public Service Commission/Louisville Gas & Electric
- New Hampshire Public Service Commission/Public Service Company of New Hampshire
- New Mexico Public Service Commission/Public Service of New Mexico
- New York Public Service Commission/New York State Electric & Gas
- Missouri Public Service Commission/Laclede Gas Company
- New Jersey Board of Public Utilities/Jersey Central Power & Light
- New Jersey Board of Public Utilities/New Jersey Natural Gas
- Pennsylvania Public Utilities Commission/ Pennsylvania Power & Light
- California Public Utilities Commission/San Diego Gas & Electric Company.

Mergers and Acquisitions. Mr. Raab has been involved in a number of merger and acquisition studies throughout his career. Many of these were conducted as confidential studies and cannot be listed. Those in which his involvement was publicly known are:

- ONEOK, Inc./Southwest Gas Corporation
- Western Resources

• Constellation.

Costing and Rate Design Analysis. Mr. Raab has prepared generic rate design studies for the National Governor's Conference, the Electricity Consumer's Resource Council, the Tennessee Valley Industrial Committee, the State Electricity Commission of Western Australia, and the State Electricity Commission of Victoria. These generic studies addressed advantages and disadvantages of alternative costing approaches in the electric utility industry; the strengths and weaknesses of commonly encountered costing methodologies; future tariff policies to promote equity, efficiency, and fairness criteria; and the advisability of changing tariff policies. Mr. Raab has performed specific costing and rate design studies for the following companies:

- New Mexico Gas
- SEMCO Gas
- Enstar Natural Gas
- Atmos Energy Corporation
- Southern Maryland Electric Cooperative, Inc.
- Comcast Cable Communications, Inc.
- Cable Television Association of Georgia
- Devon Energy
- o Aquila
- Oklahoma Natural Gas
- Semco Energy Gas Company
- Laclede Gas
- Western Resources
- Kansas Gas Service Company
- Central Louisiana Electric Company
- Washington Gas Light Company
- Piedmont Natural Gas Company
- Chesapeake Utilities
- Pennsylvania & Southern Gas
- KPL Gas Service Company
- Allegheny Power Systems
- Northern States Power
- Interstate Power Company
- o Iowa-Illinois Gas & Electric Company
- Arkansas Power and Light
- o Iowa Power & Light
- o Iowa Public Service Company
- Southern California Edison
- Pacific Gas & Electric
- New York State Electric & Gas
- Middle South Utilities
- Missouri Public Service Company
- Empire District Electric Company

- Sierra Pacific Power
- Commonwealth Edison Company
- South Carolina Electric & Gas
- State Electricity Commission of Western Australia
- State Electricity Commission of Victoria, Australia
- Public Service Company of New Mexico
- Tennessee Valley Authority.

Depreciation and Life Analysis. Mr. Raab has extensive experience in depreciation and life analysis studies for the electric, gas, rail, and telephone industries and has taught a course on depreciation at George Washington University, Washington, DC. Representative clients in this area include:

- Champaign Telephone Company
- Plains Generation & Transmission Cooperative
- CSX Corporation (Includes work for Seaboard Coast Line, Louisville & Nashville, Baltimore & Ohio, Chesapeake & Ohio, and Western Maryland Railroads)
- Lea County Electric Cooperative, Inc.
- North Carolina Electric Membership Cooperative
- Alberta Gas Trunk Lines (NOVA)
- Federal Communications Commission.

TESTIMONY

The following table summarizes Mr. Raab's testimony experience.

Jurisdiction	Docket Number	Subject
Alaska	U-09-069, U-09-070 U-14-010	Rate Design Rate Design
Colorado	14AL-0300G	Costing/Rate Design
District of Columbia	834 905 917 921 922 934 989 1016 1053 1054	Demand Side Planning Costing/Rate Design Costing/Rate Design Demand Side Planning Rate Design Rate Design Rate Design Rate Design Costing/Rate Design Rate Design

Jurisdiction	Docket Number	Subject
District of Columbia	1079 1093	Rate Design Costing/Rate Design
Georgia	18300-U	Costing/Rate Design
Indiana	36818	Capacity Planning
Iowa	RPU-05-2	Costing/Rate Design
Kansas	174,155-U 176,716-U 98-KGSG-822-TAR 99-KGSG-705-GIG 01-KGSG-229-TAR 02-KGSG-018-TAR 02-WSRE-301-RTS 03-KGSG-602-RTS 03-AQLG-1076-TAR 05-AQLG-367-RTS 06-KGSG-1209-RTS 07-AQLG-431-RTS 08-WSEE-1041-RTS 10-KCPE-415-RTS 10-KCPE-415-RTS 10-KCPE-415-RTS 10-KGSG-421-TAR 12-WSEE-112-RTS 12-KGSG-835-RTS 12-GIMX-337-GIV 12-KG&E-718-CON 13-WSEE-629-RTS 14-ATMG-320-RTS 15-WSEE-181-TAR 15-KCPE-116-RTS 16-ATMG-079-RTS	Retail Competition Costing/Rate Design Rate Design Restructuring Rate Design Rate Design Cost of Service Cost of Service/Rate Design Cost of Service/Rate Design Cost of Service/Rate Design Cost of Service/Rate Design Demand Side Planning Demand Side Planning Cost of Service/Rate Design Cost of Service/Rate Design Cost of Service/Rate Design Cost of Service/Rate Design Cost of Service/Rate Design Demand Side Planning Cost of Service Cost of Service/Rate Design Demand Side Planning Cost of Service/Rate Design Cost of Service/Rate Design Cost of Service/Rate Design Cost of Service/Rate Design Demand Side Planning Cost of Service/Rate Design Cost of Service/Rate Design Cost of Service/Rate Design
Kentucky	9613 97-083 2009-00354 2013-00148	Capacity Planning Management Audit Cost of Service Cost of Service
Louisiana	U-21453	Restructuring/Market Power

Jurisdiction	Docket Number	Subject
Maryland	8251	Costing/Rate Design
	8259	Demand Side Planning
	8315	Costing/Rate Design
	8720	Demand Side Planning
	8791	Costing/Rate Design
	8920	Costing/Rate Design
	8959	Costing/Rate Design
	9092	Costing/Rate Design
	9104	Costing/Rate Design
	9106	Costing/Rate Design
	9180	Capacity Planning
	9267	Costing/Rate Design
Michigan	U-6949	Load Forecasting
	U-13575	Costing/Rate Design
	U-16169	Costing/Rate Design
Missouri	GR-2002-356	Rate Design
Montana	D2005.4.48	Costing/Rate Design
Nebraska	NG-0001, NG-0002, NG-0003 NG-0041	Rate Design Rate Design
Nevada	81-660	Load Forecasting
New Jersey	OAL# PUC 1876-82 BPU# 822-0116	Load Forecasting
New Mexico	2087 11-00042-UT	Capacity Planning Rate Design
New York	27546	Costing/Rate Design
Ohio	81-1378-EL-AIR	Load Forecasting

Jurisdiction	Docket Number	Subject
Oklahoma	27068 PUD 200400610 PUD 200700449 PUD 200800348 PUD 200900110 PUD 201000143 PUD 201100170 PUD 201200029 PUD 201300007 PUD 201300032 PUD 201400069 PUD 201500138	Load Forecasting Costing/Rate Design Demand Side Planning Costing/Rate Design Costing/Rate Design Demand Side Planning Demand Side Planning Demand Side Planning Demand Side Planning Demand Side Planning Demand Side Planning
	PUD 201500213	Costing/Rate Design
Pennsylvania	R-0061346 M-2009-2092222, M-2009- 2112952, M-2009-2112956 M-2009-2093216 M-2009-2093217 M-2009-2093218 M-2010-2210316 R-2010-2214415 M-2012-2334387, M-2012- 2334392, M-2012-2334398 M-2012-2334388 M-2015-2177174	Costing/Rate Design Demand Side Planning Demand Side Planning Demand Side Planning Demand Side Planning Demand Side Planning Demand Side Planning Demand Side Planning
Tennessee	PURPA Hearings	Costing/Rate Design
Texas	GUD No. 9762 GUD No. 10170 GUD No. 10174 GUD No. 10506	Costing/Rate Design Costing/Rate Design Costing/Rate Design Demand Side Planning
US Tax Court	4870 4875	Life Analysis Life Analysis

Jurisdiction	Docket Number	Subject
Virginia	PUE900013	Demand Side Planning
-	PUE920041	Costing/Rate Design
	PUE940030	Costing/Rate Design
	PUE940031	Costing/Rate Design
	PUE950131	Capacity Planning
	PUE980813	Costing/Rate Design
	PUE-2002-00364	Costing/Rate Design
	PUE-2003-00603	Costing/Rate Design
	PUE-2006-00059	Costing/Rate Design
	PUE-2008-00060	Demand Side Planning
	PUE-2009-00064	Demand Side Planning
	PUE-2012-00118	Demand Side Planning
	PUE-2012-00138	Demand Side Planning
West Virginia	79-140-E-42T	Capacity Planning
-	90-046-E-PC	Demand Side Planning
Wisconsin	05-EP-2	Capacity Planning

In addition, Mr. Raab has presented expert testimony before the Federal Energy Regulatory Commission, the Pennsylvania House Consumer Affairs Committee, the Michigan House Economic Development and Energy Committee and the Province of Saskatchewan. He is a member of the Advisory Board of the <u>Expert Evidence Report</u>, published by The Bureau of National Affairs, Inc.

EDUCATION

Mr. Raab holds a B.A. (with high distinction) in Economics from Rutgers University and an M.A. from SUNY at Binghamton with a concentration in Econometrics. While attending Rutgers, he studied as a Henry Rutgers Scholar.

PUBLICATIONS AND PRESENTATIONS

Mr. Raab has published in a number of professional journals and spoken at a number of industry conferences. His publications/ presentations include:

 "Natural Gas as an Electric DSM Tool," <u>American Gas Association</u> <u>Membership Services Committee Meeting</u>, Williamsburg, VA, September 15, 2009.

- "Electric-to-Gas Fuel Switching," <u>NARUC Summer Meeting</u>, Seattle, WA, July 20, 2009.
- "The Future of Fuel in Virginia: Natural Gas," <u>The Twenty-Seventh</u> <u>National Regulatory Conference</u>, Williamsburg, VA, May 19, 2009.
- "Revenue Decoupling for Natural Gas Utilities," <u>Energy Bar Association</u> <u>Midwest Energy Conference</u>, Chicago, IL, March 6, 2008.
- "Responses to Arrearage Problems from High Natural Gas Bills," <u>American Gas Association Rate and Regulatory Issues Seminar</u>, Phoenix, AZ, April 8, 2004.
- "Factors Influencing Cooperative Power Supply," <u>National Rural Utilities</u> <u>Cooperative Finance Corporation Independent Borrower's Conference</u>, Boston, MA, July 3, 1997.
- "Current Status of LDC Unbundling," <u>American Gas Association</u> <u>Unbundling Conference: Regulatory and Competitive Issues</u>, Arlington, VA, June 19, 1997.
- "Balancing, Capacity Assignment, and Stranded Costs," <u>American Gas</u> <u>Association Rate and Strategic Planning Committee Spring Meeting</u>, Phoenix, AZ, March 26, 1997.
- "Gas Industry Restructuring and Changes: The Relationship of Economics and Marketing" (with Jed Smith), <u>National Association of</u> <u>Business Economists, 38th Annual Meeting</u>, Boston, MA September 10, 1996.
- "Improving Corporate Performance By Better Forecasting," <u>1996 Peak</u> <u>Day Demand and Supply Planning Seminar</u>, San Francisco, CA, April 11, 1996.
- "Natural Gas Price Elasticity Estimation," <u>AGA Forecasting Review</u>, Vol. 6, No. 1, November 1995.
- "Assessing Price Competitiveness," <u>Competitive Analysis & Benchmarking</u> <u>for Power Companies</u>, Washington, DC, November 13, 1995.
- "Avoided Cost Concepts and Management Considerations," Workshop on Avoided Costs in a Post 636 Gas Industry: Is It Time to Unbundle Avoided Cost? Sponsored by the Gas Research Institute and Wisconsin Center for Demand-Side Research, Milwaukee, WI, June 29, 1994.

- "Estimating Implied Long- and Short-Run Price Elasticities of Natural Gas Consumption," <u>Atlantic Economic Conference</u>, Philadelphia, PA, October 10, 1993.
- "Program Evaluation and Marginal Cost," <u>The Natural Gas Least Cost</u> <u>Planning Conference</u>, Washington, DC, April 7, 1992.
- "The New Environmentalism & Least Cost Planning," Institute for Environmental Negotiation, University of Virginia, May 15, 1991.
- "Development of Conditional Demand Estimates of Gas Appliances," <u>AGA</u> <u>Forecasting Review</u>, Vol. 1, No. 1, October 1988.
- "The Feasibility Study: Forecasting and Sensitivities," <u>Municipal</u> <u>Wastewater Treatment Facilities</u>, The Energy Bureau, Inc., November 18, 1985.
- "The Development of a Gas Sales End-Use Forecasting Model," <u>Third</u> <u>International Forecasting Symposium</u>, The International Institute of Forecasting, July 1984.
- "New Forecasting Guidelines for REC's A Seminar," (Chairman), Kansas City, Missouri, June 1984.
- "A Method and Application of Estimating Long Run Marginal Cost for an Electric Utility," <u>Advances in Microeconomics</u>, Volume II, 1983.
- "Forecasting Under Public Scrutiny," <u>Forecasting Energy and Demand</u> <u>Requirements</u>, University of Wisconsin - Extension, October 25, 1982.
- "Forecasting Public Utilities," <u>The Journal of Business Forecasting</u>, Vol. 1, No. 4, Summer, 1982.
- "Are Utilities Underforecasting," <u>Electric Ratemaking</u>, Vol. 1. No. 1, February, 1982.
- "A Polynomial Spline Function Technique for Defining and Forecasting Electric Utility Load Duration Curves," <u>First International Forecasting</u> <u>Symposium</u>, Montreal, Canada, May, 1981.
- "Time-of-Use Rates and Marginal Costs," <u>ELCON Legal Seminar</u>, March 20, 1980.
- "The Ernst & Whinney Forecasting Model," <u>Forecasting Energy & Demand</u>

<u>Requirements</u>, University of Wisconsin - Extension, October 8, 1979.

 "Marginal Cost in Electric Utilities - A Multi-Technology Multi-Period Analysis" (with Frederick McCoy), <u>ORSA/Tims Joint National Meeting</u>, Los Angeles, California, November 13-15, 1978.

Exhibit PHR-2 TEXAS GAS SERVCE COMPANY PROGRAM-SPECIFIC EVALUATION ASSUMPTIONS

Number Program Messure (M Messure (Col Indicamely Participants Expenditures Sovings (MMRiti) Soving (MMRiti) Soving (MMRiti)	Program/ Measure				PAC Equip	ment	Effective		Pr	rogram	Per Participant Site Energy	Total Site Energy	Total Source Energy Savings	Site Natural Gas	Site Alternate
1 a Commercial Water Heater 13 s 30,000 0 s s 60,000 0 2 s 5 30,000 0 64.84 s 32,47 3 30,09 3 32,44 (8 s) - 2 Commercial Deprer 15 s 50,000 5 <	Number	Program	Measure Life	Measure Cost	Cost		Inducement	Participants	Expe	enditures	Savings (MMBtu)	Savings (MMBtu)	(MMBtu)	Savings (therms)	Energy Savings
1b Commercial Tankes Water Heater 13 5 750.00 5 5 10,000 12,5 96,010 1,472,44 14,422,511 - - 5 96,010 1,032,91 1,272,44 14,422,80 1,55,694 14,428,80 - 5 225,00 4 5 1,000 370,700 1,442,80 1,55,694 1,428,80 - 5 310,00 5 312,00 32,000 22,172 7,283,23 82,7745 75,24,454 - 75,832,90 - 5 313,00 80 30,00 5 1,300 80 31,00 80 31,00 80 31,00 80 31,00 80 44,70 8 44,707 78 78,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,90 72,832,	1 a	Commercial Water Heater	13	\$ 30,000.00	\$	- \$	6,000.00	5	\$	30,000	64.894	324.47	340.69	3,244.68	-
2 Commercial Derger 15 9 964.1 8 225.0 4 5 900 1.75 7.90 8.30 [13,29] 2.283.00 . 4 Faucet Arator Direct Install 10 5 13.00 5 12.00 25 13.00 2.36.0 5 12.00 22.31.20 7.88.329 8.27.745 7.88.329 6.24.45.44 4 Pre-Resprovable Direct Install 10 5 13.00 5 13.00 2.01 5 13.00 2.31.20 2.24.54.44	1 b	Commercial Tankless Water Heater	13	\$ 750.00	\$	- \$	600.00	25	\$	15,000	56.100	1,402.51	1,472.64	14,025.11	-
3 Commercial Food Service 12 S 20000 S - 5 25000 4 S 1000 370-700 1.482-80 1.482-80 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -	2	Commercial Dryer	15	\$ 966.41	\$ 8	38.25 \$	225.00	4	\$	900	1.975	7.90	8.30	(153.95)	2,283.20
4 a fauce therator Direct Install 10 0 5 13.00 5 5 13.00 24.72 7.883.29 8.877.45 7.883.29 4.77 4 b Pre-Rines Spry Valve Direct Install 10 0 5 13.00 5 5 13.00 24.75 5 44.64 55.06.77 52.445.44 55.06.77 52.445.44 55.06.77 52.445.44 55.06.77 52.445.44 55.06.77 52.445.44 55.06.77 52.445.44 55.06.77 52.456.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.466.97 52.47 52.466.97 52.47 52.466.97 52.47 52.47 52.47 52.47 52.47 52.47	3	Commercial Food Service	12	\$ 2,000.00	\$	- \$	250.00	4	\$	1,000	370.700	1,482.80	1,556.94	14,828.00	-
4-b pre-Rines Gynry Wate Direct Install 5 5 1400.0 5.23 3.2,000 22.2,17 5,244.54 5,506.77 52,445.44 - 4-c Showehad Direct Install 10 5 13.00 5 21.00 231 5 4,040 0.559 44.78 44.98 136.09 12.06.12 - 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 5 12.00 12.00 12.00 12.00 </td <td>4 a</td> <td>Faucet Aerator Direct Install</td> <td>10</td> <td>\$ 13.00</td> <td>\$</td> <td>- \$</td> <td>13.00</td> <td>3,630</td> <td>\$</td> <td>47,190</td> <td>2.172</td> <td>7,883.29</td> <td>8,277.45</td> <td>78,832.90</td> <td>-</td>	4 a	Faucet Aerator Direct Install	10	\$ 13.00	\$	- \$	13.00	3,630	\$	47,190	2.172	7,883.29	8,277.45	78,832.90	-
4 c Showehead Direct Install 10 S 13.00 S - S 13.00 S 5 13.00 S 5 13.00 S 4.70 S 4.470 A 4.400 A 4.470	4 b	Pre-Rinse Spray Valve Direct Install	5	\$ 140.00	\$	- \$	140.00	235	\$	32,900	22.317	5,244.54	5,506.77	52,445.44	-
4 Handheld Showerhead Direct Install 10 \$ 2,100 \$ \$ 21,00 \$ \$ 21,00 731 \$ 4,851 0.561 129.61 136.09 1,296.12 (1,246.10 1,087.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.70 1,097.	4 c	Showerhead Direct Install	10	\$ 13.00	\$	- \$	13.00	800	\$	10,400	0.559	447.08	469.43	4,470.78	-
5 Natural (as Vehicle Commercial Rebate 11 \$ 4,000,00 \$ \$ 2,288,96 2.3 \$ 6,6,00 1.09 2.390 2.5.0 (1,044,60) 1,069,70 5 16,000,00 5 16,000,00 5 224,641 16,946 17,793 167,944 3,353 7 a High Efficiency Water Heater Residential Rebate (>.67) 13 \$ 17,500 \$ - \$ 1,000,00 3 \$ 4,300 1,352 58,13 61,03 58,128 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -	4 d	Handheld Showerhead Direct Install	10	\$ 21.00	\$	- \$	21.00	231	\$	4,851	0.561	129.61	136.09	1,296.12	-
6 Small Commercial S 16,000 \$ 16,000 \$ 16,000 7.a High Efficiency Water Heater Residential Rebate (>67) 13 \$ 17,000 \$ 100,000 43 \$ 4,300 1.352 58,13 61,033 58,12.8 - 7.a High Efficiency Water Heater Residential Rebate 13 \$ 17,000 \$ - \$ 4,000 1.352 58,13 61,003 55,812.74 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -	5	Natural Gas Vehicle Commercial Rebate	11	\$ 4,000.00	\$	- \$	2,886.96	23	\$	66,400	1.039	23.90	25.10	(1,044.60)	1,069.70
Subtotal Small Commercial 4,957 5 224,641 16,946 17,793 167,944 3,353 7 a High Efficiency Water Heater Residential Rebate (>.67) 13 5 17.00 5 - 5 600.00 1.608 5 964,800 3.471 5,581.97 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7 55,819.7	6	Small Commercial Educational Program				\$	16,000.00		\$	16,000					
7 a High Efficiency Water Heater Residential Rebate 13 \$ 175 0 \$ \$ 10000 43 \$ 4,300 1.352 58.13 61.03 581.28 - 7 b Tankless Water Heater Residential Rebate 20 \$ 3,950.00 \$ - \$ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - <t< td=""><td></td><td>Subtotal Small Commercial</td><td></td><td></td><td></td><td></td><td></td><td>4,957</td><td>\$</td><td>224,641</td><td></td><td>16,946</td><td>17,793</td><td>167,944</td><td>3,353</td></t<>		Subtotal Small Commercial						4,957	\$	224,641		16,946	17,793	167,944	3,353
7 a High Efficiency Water Heater Residential Rebate 13 5 175000 5 100000 43 5 4,300 1.322 58.13 61.03 55.81.27 - 7 b Tankles Water Heater Residential Rebate 13 5 75000 5 60000 1.608 5 964.800 3.471 55.81.97 5.81.93 55.81.97 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -															
7 b Tankless Water Heater Residential Rebate 13 \$ 7 c. 5 00 r 1.00 r \$ 9 40,00 r 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 7 c 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 7 c 6 7 c 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 5,581.97 7 c 7 c 5,319.27 7 c 7 c 3 f 7 c 5 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c 3 c	7 a	High Efficiency Water Heater Residential Rebate (>.67)	13	\$ 175.00	\$	- \$	100.00	43	\$	4,300	1.352	58.13	61.03	581.28	-
7 c Solar Water Heater Residential Rebate 20 8 3 3 3 5 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - <td>7 b</td> <td>Tankless Water Heater Residential Rebate</td> <td>13</td> <td>\$ 750.00</td> <td>\$</td> <td>- \$</td> <td>600.00</td> <td>1,608</td> <td>\$</td> <td>964,800</td> <td>3.471</td> <td>5,581.97</td> <td>5,861.07</td> <td>55,819.74</td> <td>-</td>	7 b	Tankless Water Heater Residential Rebate	13	\$ 750.00	\$	- \$	600.00	1,608	\$	964,800	3.471	5,581.97	5,861.07	55,819.74	-
8 a Furmace Tunnace Residential Rebate 3 s 9 a 1 s 9 a 1 s 9 a 9 a 1 s 9 a 9 a 1 s 9 a 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 9 a 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s 1 s	7 c	Solar Water Heater Residential Rebate	20	\$ 3,950.00	\$	- \$	-	-	\$	-	-	-	-	-	-
8 b High Efficiency Furnace Residential Rebate (>92%) 18 8 300.0 5 - 5 675.00 486 5 328,050 3.514 1,707.87 1,793.27 17,078.74 - 8 c Hydronic Heating Residential Rebate 18 5 300.00 5 5 430.77 13 5 505.00 45.93 59.71 62.70 (2,611.60) 2,674.30 10 Natural Gas Vehicle Residential Rebate 15 5 366.41 5 305.22 2,558 5 780,750 1.975 5,502.97 5,305.62 (98,452.30) 1,460,106.40 11 Attural Gas Vehicle Residential Rebate 18 5 155.00 1.735 2 269,080 5.38 9,351.81 9,321.89 93,541.81 . 12 Residential Mireles Thermostat 11 5 1749.48 5 25.00 56 14,000 2.263 1,41.30,01 12,673.41 . 13 5 751.67 1,153.00 6 330.00 36 2 2,980 1,412 330.01 2.163.00 <th< td=""><td>8 a</td><td>Furnace Tune-up Residential Rebate</td><td>3</td><td>\$ 91.35</td><td>\$</td><td>- \$</td><td>40.00</td><td>385</td><td>\$</td><td>15,400</td><td>1.382</td><td>531.93</td><td>558.52</td><td>5,319.27</td><td>-</td></th<>	8 a	Furnace Tune-up Residential Rebate	3	\$ 91.35	\$	- \$	40.00	385	\$	15,400	1.382	531.93	558.52	5,319.27	-
8 c Hydronic Heating Residential Rebate 18 5 9 0000 5 - 5 125.00 54 54.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14 545.14	8 b	High Efficiency Furnace Residential Rebate (>92%)	18	\$ 320.00	\$	- \$	675.00	486	\$	328,050	3.514	1,707.87	1,793.27	17,078.74	-
9 Natural Gas Vehicle Residential Rebate 11 \$ 4,000.00 \$ - \$ 430.77 13 \$ 5,600 4.593 59.71 62.70 (2,611.60) 2,674.30 10 Natural Gas Orper Residential Rebate 15 \$ 966.41 \$ 838.25 \$ 305.22 2,558 \$ 7,80,750 1.975 5,02.97 5,03.62 (98,452.30) 1,460,106.40 11 Attural Gas Orber Residential Rebate 18 \$ 155.00 \$ 155.00 1,776 \$ 269,080 5.388 9,354.18 9,821.89 93,541.81 - 11 c Residential Wireles Entermostat 11 \$ 194.48 \$ - \$ 250.00 \$ 14,000 2.63 1,427.30 2,41.41 - - - 2,673.41 - - 1,350.00 \$ 269,080 5.388 9,354.18 9,821.89 93,541.81 - - - 2,03 2,03 2,103 1,267.341 - - - - 2,03 2,03 2,103 1,267.341 <t< td=""><td>8 c</td><td>Hydronic Heating Residential Rebate</td><td>18</td><td>\$ 900.00</td><td>\$</td><td>- \$</td><td>125.00</td><td>546</td><td>\$</td><td>68,250</td><td>0.951</td><td>519.18</td><td>545.14</td><td>5,191.84</td><td>-</td></t<>	8 c	Hydronic Heating Residential Rebate	18	\$ 900.00	\$	- \$	125.00	546	\$	68,250	0.951	519.18	545.14	5,191.84	-
10 Natural Gas Dryer Residential Rebate 15 \$ 966.41 \$ 888.25 \$ 305.22 2,558 \$ 780,750 1.975 5,052.97 5,305.62 (98,452.30) 1,460,106.40 11 a Attic Insulation Residential Rebate 25 \$ 154.00 \$ - \$ 154.00 588 \$ 90,552 12.86 7,283.14 7,647.30 7,283.14 - 11 b Duct Efficiency Improvement Residential Rebate 18 \$ 155.00 \$ 5 155.00 \$ 1775.00 48 \$ 14,000 2.263 1,267.34 1,330.71 12,673.41 - 12 b Free Equipment Water Heater Residential Rebate 13 \$ 175.00 \$ 830.00 36 \$ 29,880 1.88 96.20 71.42 20.03 40,644.00 12 b Free Equipment Water Heater Residential Rebate 15 \$ 751.67 \$ 1,33.00 42 \$ 13,800 1.73 72.79 76.43 727.90 - 12 d Free Equipment Furace Residential Rebate 15	9	Natural Gas Vehicle Residential Rebate	11	\$ 4,000.00	\$	- \$	430.77	13	\$	5,600	4.593	59.71	62.70	(2,611.60)	2,674.30
11 a Attic Insulation Residential Rebate 25 \$ 154.00 \$ - \$ 154.00 58 \$ 90,552 12.366 7,283.14 7,647.30 72,831.44 - 11 b Duct Efficiency Improvement Residential Rebate 18 \$ 155.00 \$ - \$ 155.00 1,736 \$ 269,080 5.388 9,354.18 9,354.18 - - 12 a Free Equipment Water Heater Residential Rebate 13 \$ 175.00 \$ 25.00 560 \$ 14,000 2.263 1,260.31 1,330.71 12,673.41 - 12 a Free Equipment Water Heater Residential Rebate 15 \$ 751.67 \$ 1,153.00 \$ 830.00 36 \$ 29,880 1.889 68.02 71.42 (3,466.93) 40,644.00 12 c Free Equipment Dryce Residential Rebate 15 \$ 966.41 \$ 838.25 \$ 1,100.00 12 \$ 13,200 1,975 23.70 24.89 (461.86) 6,849.60 13 a Whole Home Program - Nyace Heating <td>10</td> <td>Natural Gas Dryer Residential Rebate</td> <td>15</td> <td>\$ 966.41</td> <td>\$ 8</td> <td>38.25 \$</td> <td>305.22</td> <td>2,558</td> <td>\$</td> <td>780,750</td> <td>1.975</td> <td>5,052.97</td> <td>5,305.62</td> <td>(98,452.30)</td> <td>1,460,106.40</td>	10	Natural Gas Dryer Residential Rebate	15	\$ 966.41	\$ 8	38.25 \$	305.22	2,558	\$	780,750	1.975	5,052.97	5,305.62	(98,452.30)	1,460,106.40
11 b Duct Efficiency Improvement Residential Rebate 18 \$ 155.00 \$ 155.00 \$ 155.00 \$ 269,080 5.388 9,354.18 9,821.89 93,541.81 - 11 c Residential Wireless Thermostat 11 \$ 194.48 \$ - \$ 25.00 560 \$ 14,000 2.263 1,267.34 1,330.71 12,673.41 - 12 a Free Equipment Water Heater Residential Rebate 13 \$ 175.07 \$ 1,153.00 \$ 883.00 366 \$ 29,880 0.417 20.03 21.04 20.04 - 12 b Free Equipment Water Heater Residential Rebate 18 \$ 320.00 \$ - \$ 3,330.00 42 \$ 13,200 1,733 77.79 76.43 727.90 - 12 d Free Equipment Furnace Residential Rebate 18 \$ 320.00 \$ - 12.25 13,200 1,733 77.79 76.43 727.90 - 6.84.960 6.84.960 6.84.960 6.84.960 6.84.960 6.84.960 <t< td=""><td>11 a</td><td>Attic Insulation Residential Rebate</td><td>25</td><td>\$ 154.00</td><td>\$</td><td>- \$</td><td>154.00</td><td>588</td><td>\$</td><td>90,552</td><td>12.386</td><td>7,283.14</td><td>7,647.30</td><td>72,831.44</td><td>-</td></t<>	11 a	Attic Insulation Residential Rebate	25	\$ 154.00	\$	- \$	154.00	588	\$	90,552	12.386	7,283.14	7,647.30	72,831.44	-
11 c Residential Wireless Thermostat 11 s 194.48 s - s 25.00 560 s 14,000 2.263 1,267.34 1,30.71 12,673.41 - 12 a Free Equipment Water Heater Residential Rebate 13 s 175.00 s - s 1,775.00 48 s 85,200 0.417 20.03 21.04 200.34 - 12 b Free Equipment Stove Residential Rebate 15 s 751.67 s 1,153.00 s 29.880 1.889 68.02 71.42 (3,466.93) 40.644.00 12 c Free Equipment Furace Residential Rebate 15 s 966.41 s 3330.00 42 s 13,860 1.733 72.79 76.43 77.90 - 12 d Free Equipment Dryer Residential Rebate 15 s 966.41 s 888.25 s 1,100.00 12 s 13,200 1.975 23.70 24.89 (461.86) 6849.60 13 a Whole Home Program - Water Heating 18 s 320.00 s - s 3,900 5 s 3,900 - s - s - s	11 b	Duct Efficiency Improvement Residential Rebate	18	\$ 155.00	\$	- \$	155.00	1,736	\$	269,080	5.388	9,354.18	9,821.89	93,541.81	-
12 a Free Equipment Water Heater Residential Rebate 13 \$ 175.00 \$ - \$ 1,775.00 48 \$ 85,200 0.417 20.03 21.04 200.34 - 12 b Free Equipment Stove Residential Rebate 15 \$ 751.67 \$ 1,153.00 \$ 830.00 36 \$ 29,880 1.889 68.02 71.42 (3,466.93) 40,644.00 12 c Free Equipment Furnace Residential Rebate 18 \$ 320.00 \$ - \$ 3,330.00 42 \$ 13,900 1.733 72.79 76.43 727.90 - 12 d Free Equipment Dryce Residential Rebate 15 \$ 966.41 \$ 838.25 \$ 1,100.00 1.975 2.30 2.4.89 (461.66) 6,499.60 13 a Whole Home Program - Water Heating 13 \$ 175.00 \$ - 12 \$ - 1.352 16.22 17.03 162.22 - - 1.352 1.62.9 1.975 3.14 42.17 44.28 421.70 -	11 c	Residential Wireless Thermostat	11	\$ 194.48	\$	- \$	25.00	560	\$	14,000	2.263	1,267.34	1,330.71	12,673.41	-
12 b Free Equipment Stove Residential Rebate 15 \$ 751.67 \$ 1,153.00 \$ 830.00 36 \$ 29,880 1.889 68.02 71.42 (3,466.93) 40,644.00 12 c Free Equipment Furnace Residential Rebate 18 \$ 320.00 \$ - \$ 3,330.00 42 \$ 139,860 1.733 72.79 76.43 727.90 - 12 d Free Equipment Furnace Residential Rebate 15 \$ 966.11 \$ \$ 3330.00 42 \$ 139,860 1.733 72.79 76.43 727.90 - 13 a Whole Home Program - Water Heating 13 \$ \$ 966.11 \$ \$ 838.25 \$ 1,100.00 12 \$ 13.05.2 1.350 16.22 17.03 16.22 - - 13 a Whole Home Program - Water Heating 18 \$ 320.00 \$ - \$ - 12 \$ - 1.351 42.17 44.28 421.70 - 13 a Whole Home Program - Incentive \$ 3,900.00 \$ 3,353.918 31,659 33,242 159,557 1,510.274 14 Residential Educational Program	12 a	Free Equipment Water Heater Residential Rebate	13	\$ 175.00	\$	- \$	1,775.00	48	\$	85,200	0.417	20.03	21.04	200.34	-
12 c Free Equipment Furnace Residential Rebate 18 \$ 320.00 \$ - \$ 3,330.00 42 \$ 139,860 1.733 72.79 76.43 727.90 - 12 d Free Equipment Dryer Residential Rebate 15 \$ 966.41 \$ 838.25 \$ 1,00.00 12 \$ 13.920 1.733 72.79 76.43 727.90 - 13 a Whole Home Program Water Heating 13 \$ 170.00 \$ 1.2 \$ 13.920 1.352 13.00 24.89 (461.86) 6,849.60 6.849.60 1.352 16.22 17.03 16.22 - - 1.352 16.22 1.703 16.22 - - - - 3.900 - - 3.900 - - 3.900 - - 3.900 - - 5.41,096.00 5 5.41,096.00 5 5.41,096.00 5 5.41,096.00 5 5.41,096.00 5 5.41,096.00 5 5.41,996.00 5 5.41,996.00 5 5.41,996.00 5 5.41,996.00	12 b	Free Equipment Stove Residential Rebate	15	\$ 751.67	\$ 1,1	53.00 \$	830.00	36	\$	29,880	1.889	68.02	71.42	(3,466.93)	40,644.00
12 d Free Equipment Dryer Residential Rebate 15 \$ 966.41 \$ 838.25 \$ 1,100.00 12 \$ 13,200 1.975 23.70 24.89 (461.86) 6,849.60 13 a Whole Home Program - Water Heating 13 \$ 175.00 \$ - \$ - 12 \$ - 1.352 16.22 17.03 162.22 - 13 b Whole Home Program - Space Heating 18 \$ 320.00 \$ - \$ - 12 \$ - 3.514 42.17 44.28 421.70 - 13 c Whole Home Program - Incentive \$ 3,900.00 \$ 541,096.00 \$ 541,096 - 1.659 33,242 15,57 1,510,274 14 Residential Educational Program Subtotal Residential 541,096.00 \$ 541,096 \$ 3,353,918 31,659 33,242 159,557 1,510,274 Totals Totals 5 439,451 543,909 \$ 48,605 51,036 327,501 1,513,627	12 c	Free Equipment Furnace Residential Rebate	18	\$ 320.00	\$	- \$	3,330.00	42	\$	139,860	1.733	72.79	76.43	727.90	-
13 a Whole Home Program - Water Heating 13 \$ 175.00 \$ - \$ - 12 \$ - 1.352 16.22 17.03 162.22 - 13 b Whole Home Program - Space Heating 18 \$ 320.00 \$ - \$ - 12 \$ - 3.514 42.17 44.28 421.70 - 13 c Whole Home Program - Space Heating 18 \$ 320.00 \$ - \$ 3.900 - 3.514 42.17 44.28 421.70 - 14 Residential Educational Program - Incentive \$ 3.900.00 \$ 541.096.00 - 541.096 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -	12 d	Free Equipment Dryer Residential Rebate	15	\$ 966.41	\$ 8	38.25 \$	1,100.00	12	\$	13,200	1.975	23.70	24.89	(461.86)	6,849.60
13 b Whole Home Program - Space Heating 18 \$ 320.0 \$ - \$ - 12 \$ - 3.514 42.17 44.28 421.70 - 13 c Whole Home Program - Incentive \$ 3,900.00 \$ 3,900.00 \$ 3,900 \$ 3,900 \$ 3,900 \$ 3,900 \$ 3,900 \$ 3,900 \$ 3,900 \$ 3,900 \$ 3,900 \$ 3,900 \$ 3,900 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$ 541,096 \$	13 a	Whole Home Program - Water Heating	13	\$ 175.00	\$	- \$	-	12	\$	-	1.352	16.22	17.03	162.22	-
13 c Whole Home Program - Incentive \$ 3,900.00 \$ 3,900 14 Residential Educational Program Subtoal Residential \$ 541,096.00 \$ 541,096 0verhead Expenses 0verhead Expenses \$ 439,451 \$ 13,659 327,501 1,513,627	13 b	Whole Home Program - Space Heating	18	\$ 320.00	\$	- \$	-	12	\$	-	3.514	42.17	44.28	421.70	-
14 Residential Educational Program \$ 541,096.00 \$ 541,096 Subtotal Residential 8,685 \$ 3,353,918 31,659 33,242 159,557 1,510,274 Overhead Expenses \$ 439,451 \$ 439,451 \$ 1,513,627 Totals 13,642 \$ 4,018,009 48,605 51,036 327,501 1,513,627	13 c	Whole Home Program - Incentive				\$	3,900.00		\$	3,900					
Subtotal Residential 8,685 \$ 3,353,918 31,659 33,242 159,557 1,510,274 Overhead Expenses \$ 439,451 \$ 439,451 \$ 1,510,274 \$ 1,510,274 \$ 1,510,274 \$ 1,510,274 \$ \$ 1,510,274 \$ \$ 1,510,274 \$ \$ 1,510,274 \$ \$ \$ 1,510,274 \$ \$ 1,510,274 \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	14	Residential Educational Program				\$	541,096.00		\$	541,096					
Overhead Expenses \$ 439,451 Totals 13,642 \$ 4,018,009 48,605 51,036 327,501 1,513,627		Subtotal Residential	-					8,685	\$	3,353,918		31,659	33,242	159,557	1,510,274
Totals 13,642 \$ 4,018,009 48,605 51,036 327,501 1,513,627		Overhead Expenses							\$	439,451					
		Totals						13,642	\$	4,018,009		48,605	51,036	327,501	1,513,627

Initial Year Utility Cost of Capital Participant Discount Rate Societal Discount Rate 1/ Inflation Rate 2/

2017

7.61% TGS Cost of Capital

15.00% Assumption

2.50% To be consistent with the externality cost estimate.

1.85% 1/15/16 10 year expected inflation forecast, Cleveland Fed

Exhibit PHR-3 TEXAS GAS SERVICE COMPANY SUMMARY OF BENEFIT/COST EVALUATIONS

		PARTICIPANT TEST									TOTAL RESOUR	CEC	COST TEST			SOCIETAL COST TEST						
Program/																						
Measure																						
Number	Program		BENEFITS	COST	N	IET BENEFIT	BENEFIT/COST		BENEFITS		COST	Ν	NET BENEFIT	BENEFIT/COST		BENEFITS	COST		NET BENEFIT	BENEFIT/COST		
1 a	Commercial Water Heater	\$	45,099.86 \$	150,000.00	\$	(104,900.14)	0.30	\$	28,746.80	\$	150,000.00	\$	(121,253.20)	0.19	\$	36,335.22 \$	150,000.00)\$	(113,664.78)	0.24		
1 b	Commercial Tankless Water Heater	\$	80,269.03 \$	18,750.00	\$	61,519.03	4.28	\$	124,257.84	\$	18,750.00	\$	105,507.84	6.63	\$	157,058.76 \$	18,750.00)\$	138,308.76	8.38		
2	Commercial Dryer	\$	4,647.82 \$	3,865.64	\$	782.18	1.20	\$	4,129.46	\$	3,865.64	\$	263.82	1.07	\$	4,378.36 \$	3,865.64	1\$	512.72	1.13		
3	Commercial Food Service	\$	67,099.26 \$	8,000.00	\$	59,099.26	8.39	\$	123,720.04	\$	8,000.00	\$	115,720.04	15.47	\$	153,005.24 \$	8,000.00) \$	145,005.24	19.13		
4 a	Faucet Aerator Direct Install	\$	363,232.88 \$	47,190.00	\$	316,042.88	7.70	\$	569,219.00	\$	47,190.00	\$	522,029.00	12.06	\$	675,542.35 \$	47,190.00) \$	628,352.35	14.32		
4 b	Pre-Rinse Spray Valve Direct Install	\$	161,366.32 \$	32,900.00	\$	128,466.32	4.90	\$	205,161.98	\$	32,900.00	\$	172,261.98	6.24	\$	221,941.47 \$	32,900.00) \$	189,041.47	6.75		
4 c	Showerhead Direct Install	\$	28,322.47 \$	10,400.00	\$	17,922.47	2.72	\$	32,281.62	\$	10,400.00	\$	21,881.62	3.10	\$	38,309.89 \$	10,400.00) \$	27,909.89	3.68		
4 d	Handheld Showerhead Direct Install	\$	10,046.89 \$	4,851.00	\$	5,195.89	2.07	\$	9,358.74	\$	4,851.00	\$	4,507.74	1.93	\$	11,106.39 \$	4,851.00) \$	6,255.39	2.29		
5	Natural Gas Vehicle Commercial Rebate	\$	67,414.44 \$	92,000.00	\$	(24,585.56)	0.73	\$	1,864.38	\$	92,000.00	\$	(90,135.62)	0.02	\$	2,257.12 \$	92,000.00)\$	(89,742.88)	0.02		
6	Small Commercial Educational Program	\$	- \$	-	\$	-	-	\$	-	\$	16,000.00	\$	(16,000.00)	-	\$	- \$	16,000.00) \$	(16,000.00)	-		
	Subtotal Small Commercial	\$	827,498.96 \$	367,956.64	\$	459,542.32	2.25	\$	1,098,739.85	\$	383,956.64	\$	714,783.21	2.86	\$	1,299,934.80 \$	383,956.64	1\$	915,978.16	3.39		
7 a	High Efficiency Water Heater Residential Rebate (>.67)	Ś	7.008.81 \$	7.525.00	ŝ	(516.19)	0.93	Ś	6.573.69	Ś	7.525.00	Ś	(951.31)	0.87	Ś	6.500.70 \$	7.525.00) Ś	(1.024.30)	0.86		
7 b	Tankless Water Heater Residential Rebate	ŝ	1.224.924.62 \$	1.206.000.00	ŝ	18.924.62	1.02	ŝ	631,266,04	Ś	1.206.000.00	ŝ	(574,733,96)	0.52	ŝ	624.256.47 \$	1.206.000.00) Ś	(581,743,53)	0.52		
7 c	Solar Water Heater Residential Rebate	ŝ	- ś	-	ŝ	-	-	Ś	-	Ś	-	ŝ	-	-	ŝ	- Ś	-	Ś	-	-		
8 a	Eurnace Tune-up Residential Rebate	Ś	24.178.37 \$	35,169,75	ŝ	(10.991.38)	0.69	Ś	16.359.03	ŝ	35,169,75	ŝ	(18.810.72)	0.47	ŝ	13.674.84 \$	35,169,79	5 5	(21,494,91)	0.39		
8 b	High Efficiency Eurnace Residential Rebate (>92%)	Ś	423.665.23 \$	155,520,00	ŝ	268.145.23	2.72	Ś	243,299,68	ŝ	155.520.00	ŝ	87.779.68	1.56	ŝ	274.178.96 \$	155.520.00) Ś	118.658.96	1.76		
80	Hydronic Heating Residential Rebate	ŝ	97.316.47 \$	491,400.00	ŝ	(394,083,53)	0.20	Ś	73.961.69	ŝ	491,400.00	ŝ	(417,438,31)	0.15	ŝ	83.348.81 \$	491,400.00) Ś	(408.051.19)	0.17		
9	Natural Gas Vehicle Residential Rebate	ŝ	8.137.52 \$	52.000.00	ŝ	(43,862,48)	0.16	Ś	5.946.00	ŝ	52.000.00	ŝ	(46.054.00)	0.11	ŝ	5.630.85 \$	52.000.00) Ś	(46.369.15)	0.11		
10	Natural Gas Drver Residential Rebate	ŝ	3.177.811.45 \$	2.472.076.78	ŝ	705.734.67	1.29	Ś	2,778,219,43	ŝ	2.472.076.78	ŝ	306.142.65	1.12	ŝ	2,799,078,59 \$	2.472.076.78	3 5	327.001.81	1.13		
11 a	Attic Insulation Residential Rebate	ŝ	546.404.24 \$	90.552.00	ŝ	455.852.24	6.03	Ś	1,277,050,57	ŝ	90.552.00	ŝ	1,186,498,57	14.10	ŝ	1.656.284.43 \$	90.552.00) Ś	1.565.732.43	18.29		
11 b	Duct Efficiency Improvement Residential Rebate	ś	792,773,41 \$	269.080.00	ŝ	523,693,41	2.95	ŝ	1.332.574.72	ŝ	269.080.00	ŝ	1.063.494.72	4.95	ś	1.501.703.39 \$	269.080.00	ŝ	1.232.623.39	5.58		
11 c	Residential Wireless Thermostat	Ś	69.553.50 \$	108,908,80	ŝ	(39,355,30)	0.64	Ś	126,194,44	ŝ	108,908,80	ŝ	17.285.64	1.16	ŝ	122.240.54 \$	108,908.80) Ś	13.331.74	1.12		
12 a	Free Equipment Water Heater Residential Rebate	Ś	86,133,61 \$	8.400.00	ŝ	77.733.61	10.25	Ś	2,265.67	ŝ	8.400.00	ŝ	(6.134.33)	0.27	ŝ	2.240.51 \$	8.400.00) Ś	(6,159,49)	0.27		
12 b	Free Equipment Stove Residential Rebate	ŝ	74,791,14 \$	27.060.12	ŝ	47.731.02	2.76	Ś	50.041.93	ŝ	27.060.12	ŝ	22.981.81	1.85	ŝ	50.322.72 \$	27.060.12	, ,	23.262.60	1.86		
12 c	Free Equipment Eurnace Residential Rebate	ŝ	142.675.15 \$	13.440.00	ŝ	129,235,15	10.62	Ś	10.369.50	ŝ	13,440.00	ŝ	(3.070.50)	0.77	ŝ	11.685.58 \$	13,440.00) Ś	(1.754.42)	0.87		
12 d	Free Equipment Dryer Residential Rebate	ŝ	24 445 00 \$	11 596 92	ŝ	12 848 08	2 11	Ś	13 033 09	Ś	11 596 92	Ś	1 436 17	1 12	ŝ	13 130 94 \$	11 596 93	2 5	1 534 02	1 13		
13	Whole Home Program	*	- ,,	,	+						,	Ŧ	_,			,	,		_,			
13 a	Whole Home Program - Incentive	\$	3,900.00 \$		\$	3,900.00	-	\$		\$	-	\$	-	-	\$	- \$	-	\$	-	-		
13 b	Whole Home Program - Water Heating	\$	755.95 \$	2,100.00	\$	(1,344.05)	0.36	\$	1,834.52	\$	2,100.00	\$	(265.48)	0.87	\$	1,814.15 \$	2,100.00) \$	(285.85)	0.86		
13 c	Whole Home Program - Space Heating	\$	2,360.87 \$	3,840.00	\$	(1,479.13)	0.61	\$	6,007.40	\$	3,840.00	\$	2,167.40	1.56	\$	6,769.85 \$	3,840.00) \$	2,929.85	1.76		
13	Total Whole Home Program	\$	7,016.82 \$	5,940.00	\$	1,076.82	1.18	\$	7,841.92	\$	5,940.00	\$	1,901.92	1.32	\$	8,584.00 \$	5,940.00) \$	2,644.00	1.45		
14	Residential Educational Program	Ś	- \$	_	Ś	-	-	Ś	-	ŝ	541.096.00	ŝ	(541.096.00)	-	Ś	- \$	541.096.00) Ś	(541.096.00)	-		
	Subtotal Small Commercial	\$	6,706,835.34 \$	4,954,669.37	\$	1,752,165.97	1.35	\$	6,574,997.39	\$	5,495,765.37	\$	1,079,232.02	1.20	\$	7,172,861.33 \$	5,495,765.37	7 \$	1,677,095.96	1.31		
	Overhead Expenses	\$	- \$	-	\$	-	-	\$	- :	\$	439,451.00	\$	(439,451.00)	-	\$	- \$	439,451.00) \$	(439,451.00)	-		
		Ś	7.534.334.30 Ś	5.322.626.01	Ś	2.211.708.29	1.42	Ś	7.673.737.24	Ś	6.319.173.01	Ś	1.354.564.23	1.21	Ś	8.472.796.13 \$	6.319.173.0	L Ś	2.153.623.12	1.34		

Exhibit_____(PHR-3) (cont.) TEXAS GAS SERVICE COMPANY SUMMARY OF BENEFIT/COST EVALUATIONS

PROGRAM ADMINSTRATOR COST TEST

RATE IMPACT MEAURE TEST

Program	BENEFITS	COST	NET BENEFIT	BENEFIT/COST	BENEFITS	COST	NET BENEFIT	BENEFIT/COST
Commercial Water Heater	\$ 28,746.80	\$ 30,000.00	\$ (1,253.20)	0.96	\$ 28,746.80	\$ 51,332.66	\$ (22,585.86)	0.56
Commercial Tankless Water Heater	\$ 124,257.84	\$ 15,000.00	\$ 109,257.84	8.28	\$ 124,257.84	\$ 107,210.27	\$ 17,047.57	1.16
Commercial Dryer	\$ 776.46	\$ 900.00	\$ (123.54)	0.86	\$ 776.46	\$ 1,485.88	\$ (709.42)	0.52
Commercial Food Service	\$ 123,720.04	\$ 1,000.00	\$ 122,720.04	123.72	\$ 123,720.04	\$ 92,040.37	\$ 31,679.66	1.34
Faucet Aerator Direct Install	\$ 569,219.00	\$ 47,190.00	\$ 522,029.00	12.06	\$ 569,219.00	\$ 460,212.84	\$ 109,006.16	1.24
Pre-Rinse Spray Valve Direct Install	\$ 205,161.98	\$ 32,900.00	\$ 172,261.98	6.24	\$ 205,161.98	\$ 178,470.42	\$ 26,691.56	1.15
Showerhead Direct Install	\$ 32,281.62	\$ 10,400.00	\$ 21,881.62	3.10	\$ 32,281.62	\$ 33,822.07	\$ (1,540.44)	0.95
Handheld Showerhead Direct Install	\$ 9,358.74	\$ 4,851.00	\$ 4,507.74	1.93	\$ 9,358.74	\$ 11,641.27	\$ (2,282.53)	0.80
Natural Gas Vehicle Commercial Rebate	\$ 1,864.38	\$ 66,400.08	\$ (64,535.70)	0.03	\$ 1,864.38	\$ 67,761.35	\$ (65,896.97)	0.03
Small Commercial Educational Program	\$ -	\$ 16,000.00	\$ (16,000.00)	-	\$ -	\$ 16,000.00	\$ (16,000.00)	-
Subtotal Small Commercial	\$ 1,095,386.85	\$ 224,641.08	\$ 870,745.77	4.88	\$ 1,095,386.85	\$ 1,019,977.13	\$ 75,409.72	1.07
High Efficiency Water Heater Residential Rebate (>.67)	\$ 6,573.69	\$ 4,300.00	\$ 2,273.69	1.53	\$ 6,573.69	\$ 8,126.55	\$ (1,552.86)	0.81
Tankless Water Heater Residential Rebate	\$ 631,266.04	\$ 964,800.00	\$ (333,533.96)	0.65	\$ 631,266.04	\$ 1,332,260.08	\$ (700,994.04)	0.47
Solar Water Heater Residential Rebate	\$ -	\$ -	\$ -	-	\$ -	\$ -	\$ -	-
Furnace Tune-up Residential Rebate	\$ 16,359.03	\$ 15,400.00	\$ 959.03	1.06	\$ 16,359.03	\$ 24,759.52	\$ (8,400.49)	0.66
High Efficiency Furnace Residential Rebate (>92%)	\$ 243,299.68	\$ 328,050.00	\$ (84,750.32)	0.74	\$ 252,249.37	\$ 480,412.40	\$ (228,163.03)	0.53
Hydronic Heating Residential Rebate	\$ 73,961.69	\$ 68,250.00	\$ 5,711.69	1.08	\$ 76,682.34	\$ 114,567.29	\$ (37,884.94)	0.67
Natural Gas Vehicle Residential Rebate	\$ 5,946.00	\$ 5,600.01	\$ 345.99	1.06	\$ 5,946.00	\$ 9,005.11	\$ (3,059.11)	0.66
Natural Gas Dryer Residential Rebate	\$ 633,975.93	\$ 780,752.76	\$ (146,776.83)	0.81	\$ 633,975.93	\$ 1,155,862.05	\$ (521,886.13)	0.55
Attic Insulation Residential Rebate	\$ 1,277,050.57	\$ 90,552.00	\$ 1,186,498.57	14.10	\$ 1,277,050.57	\$ 931,642.80	\$ 345,407.77	1.37
Duct Efficiency Improvement Residential Rebate	\$ 1,332,574.72	\$ 269,080.00	\$ 1,063,494.72	4.95	\$ 1,381,593.01	\$ 1,103,582.89	\$ 278,010.12	1.25
Residential Wireless Thermostat	\$ 126,194.44	\$ 14,000.00	\$ 112,194.44	9.01	\$ 126,194.44	\$ 88,598.01	\$ 37,596.42	1.42
Free Equipment Water Heater Residential Rebate	\$ 2,265.67	\$ 85,200.00	\$ (82,934.33)	0.03	\$ 2,265.67	\$ 86,518.85	\$ (84,253.18)	0.03
Free Equipment Stove Residential Rebate	\$ 8,533.93	\$ 29,880.00	\$ (21,346.07)	0.29	\$ 8,533.93	\$ 34,929.34	\$ (26,395.40)	0.24
Free Equipment Furnace Residential Rebate	\$ 10,369.50	\$ 138,600.00	\$ (128,230.50)	0.07	\$ 10,750.94	\$ 145,093.73	\$ (134,342.79)	0.07
Free Equipment Dryer Residential Rebate	\$ 2,974.09	\$ 13,200.00	\$ (10,225.91)	0.23	\$ 2,974.09	\$ 14,959.70	\$ (11,985.61)	0.20
Whole Home Program								
Whole Home Program - Incentive	\$ -	\$ 3,900.00	\$ (3,900.00)	-	\$ -	\$ 3,900.00	\$ (3,900.00)	-
Whole Home Program - Water Heating	\$ 1,834.52	\$ -	\$ 1,834.52	-	\$ 1,834.52	\$ 1,067.87	\$ 766.64	1.72
Whole Home Program - Space Heating	\$ 6,007.40	\$ -	\$ 6,007.40	-	\$ 6,228.38	\$ 3,762.03	\$ 2,466.34	1.66
Total Whole Home Program	\$ 7,841.92	\$ 3,900.00	\$ 3,941.92	2.01	\$ 8,062.90	\$ 8,729.91	\$ (667.01)	0.92
Residential Educational Program	\$ -	\$ 541,096.00	\$ (541,096.00)	-	\$ -	\$ 541,096.00	\$ (541,096.00)	-
Subtotal Small Commercial	\$ 4,379,186.89	\$ 3,352,660.77	\$ 1,026,526.12	1.31	\$ 4,440,477.94	\$ 6,080,144.22	\$ (1,639,666.28)	0.73
Overhead Expenses	\$ -	\$ 439,451.00	\$ (439,451.00)	-	\$ -	\$ 439,451.00	\$ (439,451.00)	-
TOTAL PORTFOLIO	\$ 5,474,573.74	\$ 4,016,752.85	\$ 1,457,820.89	1.36	\$ 5,535,864.79	\$ 7,539,572.35	\$ (2,003,707.56)	0.73