

# ICF CONSULTING'S GHG EMISSIONS MANAGEMENT SYSTEM

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## **1.0 INTRODUCTION**

Methane is a significant anthropogenic greenhouse gas (GHG) whose global warming potential is well documented. The natural gas industry is a major source of methane emissions from fugitive leaks and vents. In 1994, natural gas systems worldwide emitted 40 Terragrams (Tg) of methane. Because the United States relies on voluntary emission inventory and reduction programs many natural gas companies are beginning to develop inventories of their GHG emissions in anticipation of more stringent requirements, to better understand their carbon footprint, and to identify opportunities to profitably reduce methane emissions. What most inventory efforts lack however is an inventory approach that is integrated with mitigation strategies. ICF Consulting provides a **GHG Emissions Management System (GEMS™)** that structures an inventory in a way that helps companies to evaluate the economics of alternative, lower emitting technologies. This system makes planning and tracking of emissions reductions more robust.

## **2.0 GREENHOUSE GAS EMISSIONS INVENTORY**

In the absence of a globally adopted strategy for GHG emission reductions, many companies have voluntarily taken steps to prepare in advance by measuring their GHG emissions. These initial steps often include a GHG inventory to identify emissions sources, a baseline estimation of emissions, and annual updating of the inventory. Through the U.S. Environmental Protection Agency's Natural Gas STAR Program, natural gas companies also identify economic GHG emission reduction measures.

### **2.1 FEATURES OF A GHG INVENTORY**

A complete GHG inventory consists of protocols and reporting guidelines. Protocols provide a methodology for estimating GHG emissions and baseline reference case. The methodology will define all emissions sources, emissions factors and activity factors. The baseline is the historical start-up year or business-as-usual forecast against which annual emission inventories can be compared. Reporting guidelines define data requirements and controls, company or project boundaries (e.g. direct and indirect emissions), record retention and auditing policies, and change management (acquisitions/divestitures, consistency, transparency).

### **2.2 RISKS ASSOCIATED WITH EMISSIONS REDUCTION INITIATIVES**

Without internationally accepted guidelines, corporations implementing a GHG reduction program face policy and project-related risks. Policy risks stem from valuation and recognition of GHG emissions reductions that are

subject to the uncertainties associated with national government regulations on GHGs. These risks include types of GHGs and sources included in national programs, time horizons (reference year for baseline and compliance periods), and geographic location (important for multi-national corporations with facilities in several countries with differing GHG policies).

Project risks are also significant. Developing a baseline that is representative of corporate activity is critical. Should the company account for both direct and indirect emissions? Legal entitlement to claimed reductions needs to be clear. Project monitoring and verification procedures must be defined. Data management systems must be adequate for intended uses.

### **3.0 GHG EMISSIONS MANAGEMENT – BEYOND GHG INVENTORY**

#### **3.1 BENEFITS OF GHG EMISSIONS MANAGEMENT**

An effective GHG emissions management strategy is one that evaluates environmental and economic benefits, enables a corporation to manage policy and project risks, and is integrated into all levels of a corporation's operating and capital planning decisions. To facilitate these objectives, the GHG inventory data must be available at a level that is useful and actionable. In the absence of these features, a GHG inventory is simply a snapshot, rather than a motion picture with a story. The data must identify both sources of emissions and the operational practices or technologies of each source. Constructed in this detail, the inventory allows evaluation of alternative cost-effective emission reductions. Further, the data should enable annual comparisons with a set baseline to better account for real changes in emissions as opposed to changes in accounting methods.

#### **3.2 AVAILABLE METHANE EMISSIONS INVENTORY SOFTWARE**

Other available methane inventory software products provide a Tier 3 inventory (Table 1). These tools rely on a widely accepted approach used for estimating emissions from the natural gas and oil industries based on a 1996 study by the U.S. EPA and Gas Research Institute (GRI): "*Methane Emissions from the Natural Gas Industry*," and a 1998 U.S. EPA study "*Estimates of Methane Emissions from the U.S. Oil Industry*." The objective of these landmark studies was to characterize U.S. natural gas and oil industry methane emissions by sources. The studies developed emission and activity factors based on natural gas and oil facilities such as wells, dehydration units, compressors, tanks, pipelines, etc. The field data for emission factors incorporated a cross section of many different technologies and practices. While this approach is entirely adequate for estimating industry-wide emissions, it is not suited to company-specific emissions management decision-making or analyzing the emission reductions possible from alternative technologies and practices.

For example, the EPA/GRI study determined an emissions factor for gas pneumatic instruments for the production, transmission and processing sectors. These factors are based on survey data that bundled together low bleed and high bleed devices in the proportions that existed in 1993 and 1994 (when the field data was collected). Using these emissions factors will provide

an average total emissions estimate that does not reflect the changing distribution from high- to low-bleed pneumatic devices. Further, if a corporation chooses to install low-bleed devices in place of high-bleed, these bundled emissions factors will not reflect the reduction in the emissions inventories for years following the replacements.

**Table 1. GHG Emissions Estimating Methods**

Tier	Description
Tier 1	National, top down statistics
Tier 2	Industry based, broad top down approach
Tier 3	More detailed industry based, sources of emission by industry sector and equipment – GRI/EPA 1996 study for natural gas industry
<b>Tier 4</b>	<b>ICF’s most detailed approach based on technologies and practices within each emission source and industry sector</b>

**4.0 ICF CONSULTING’S GREENHOUSE GAS EMISSIONS MANAGEMENT SYSTEM (GEMS™)**

ICF’s GEMS™ goes beyond Tier 3 based tools. GEMS™ is not just a more detailed emissions inventory tool, it also allows the user to manage their emission reduction program. Some of the key features of ICF’s GEMS™ are:

- It uses a bottoms-up approach to report GHG emissions by technology and operating/maintenance practice for each source and sector.
- It segregates all fugitive and vented emissions to better evaluate and track emissions reductions.
- It provides choices in emission factors, ranging from simple defaults to operationally tailored emission factors.
- It evaluates emission reduction economics that can be achieved by selecting alternative technologies and practices.
- It provides robust quantification and valuation of emission reduction credits.
- It evaluates the potential value of trading in a carbon market through potential emissions reductions.
- It establishes a more rigorous emissions baseline and can identify causes of emissions reductions/changes in the future years through an annual comparison.
- It is scalable in that it can be implemented at a single facility or at a corporate-wide level.
- It is available in a user-friendly Microsoft Excel® format. It can also be configured for Microsoft Access® or a web-based platform.

GEMS™ is a suite of three tools that can be configured to the client needs:

1. Inventory Reporting Tool
2. Inventory Compilation Tool
3. Alternative Technology Analytical Tool

GEMS™ is a very powerful tool at the corporate, business unit or facility level. Users can develop an inventory and build summary reports at any level, from the plant to the corporation using only the inventory and compilation tools. However, the maximum benefit is the ability to evaluate and plan changes. GEMS™ can help evaluate alternative technologies that achieve emissions reductions cost-effectively.


#### **4.1 INVENTORY TOOL**

Figure 1 shows a snapshot of the data entry form for vented methane emissions from the gathering/boosting sector of natural gas operations. For each emissions source, e.g. pneumatic devices, the user has the option of selecting a “recommended” or a “simple” methodology. The recommended methodology disaggregates the source into specific technologies. For pneumatic devices this includes high-bleed, low-bleed and non-bleeding isolation valves. This enables the user to quantify emissions at the most disaggregated equipment level. The simple method is consistent with a Tier 3 approach that group devices together for an industry average plant or operating site.

The emissions factors used in the recommended methodology are based on published studies including the original data collected by EPA/GRI, unbundled by source and then rebundled by technology type. Data gaps were thus identified and supplemented with published technical surveys of field measurements, process simulation model analyses, equipment vendor specifications, and in rare cases industry expert judgments.

One feature in the inventory tool is the option to tailor emission factors to operating conditions. In the inventory spreadsheet, Figure 1, the user selects “Get Default” which presents a table like Figure 2. Here the user may enter site specific operating values, or choose an industry average default value for any variable: the more site-specific data that is used in the inventory, the more accurate the emissions estimate, and subsequently, the more accurate the analysis of technology alternatives in the Analytical Tool.

The recommended method also enables the user to enter “user-defined” activity and emission factors. Figure 1 shows this as the last option in the Recommended method for each emission source. This option may be used to input direct measurement of emissions, or user developed factors. By selecting the button “Consult Table” the user can see industry sector average values for activity factors and emission factors.

Overview	Facility Info	Vented Instructions	Fugitive Inventory	Emissions Summary	Facility/BU Information		
 <b>GEMS™ Emissions Inventory Workbook</b> Vented Methane Emissions					Facility Name: <b>Compressor Station 1</b> Business Unit: <b>Central</b> Reporting Year: <b>2003</b>	Reported By: <b>GEM S C u s t o m e r</b> Date: <b>08/15/2003</b>	

**INSTRUCTIONS**

To complete the Vented Methane Emissions Reporting Form, follow STEPS 1 to 4 by filling in the requested input data. Click on the "Vented Instructions" button on top of screen to get more instructions. Detailed information is also provided as comments in respective cells all throughout this worksheet.

**HELP:**

For questions, contact your BU EHS manager

GHG Emitting Sources by Operating Sector	STEP 1 Choose Aggregation Level	Aggregation Level	GHG Emitting Technology Category or Process	STEP 2 Insert Activity Data		STEP 3 Choose Default or Insert User-Defined Emission Factor				Annual Emissions			STEP 4 Comments	
				Activity Factor	Units	User-Defined	Calculate Default Value	Default Value	Use Default Factor? Check Box if Yes	Units	MMscf/ Yr	Short Tons of CO2e		Metric Tonnes of CO2e
<b>Transmission Sector</b>														
Gas Dehydrator	<input checked="" type="radio"/> Recommended <input type="radio"/> Simple	Recommended	TEG Dehydrator with FTS, with Gas Pump	1.1	MMscf/d		Get Default	1.0	<input checked="" type="checkbox"/>	MMscf/ yr per MMscf gas throughput / day	1.1	2.1	2.5	
			TEG Dehydrator with FTS, with Electric Pump	1.0	MMscf/d		Get Default	1.0	<input checked="" type="checkbox"/>	MMscf/ yr per MMscf gas throughput / day	1	1.9	2.3	
			TEG Dehydrator without FTS, with Gas Pump	0.9	MMscf/d		Get Default	1.0	<input checked="" type="checkbox"/>	MMscf/ yr per MMscf gas throughput / day	0.9	1.7	2.1	
			TEG Dehydrator without FTS, with Electric Pump	0.9	MMscf/d		Get Default	1.0	<input checked="" type="checkbox"/>	MMscf/ yr per MMscf gas throughput / day	0.9	1.7	2.1	
			User-defined				Consult Table							
		Simple	Glycol Dehydrator		# of stations with Glycol Dehydration				<input type="checkbox"/>	MMscf/ station				
Reciprocating Compressor Seals	<input checked="" type="radio"/> Recommended <input type="radio"/> Simple	Recommended	Recip Compressor Seals Vented	9000	Compressor operating hours	0.1	Get Default		<input type="checkbox"/>	MMscf/ compressor hr	0	0.0	0.0	
			User-defined				Consult Table							
			Simple	Recip Compressor Seals Vented	20	# of reciprocating compressors			1.0	<input checked="" type="checkbox"/>	MMscf/ compressor	20	38.0	45.6

Note: all emission factors in this snapshot are artificial factors of 10<sup>x</sup> to conceal proprietary information.

**Figure 1. GEMS™ Inventory Tool**



## GEMS™ Emissions Inventory Workbook Glycol Dehydrator Recommended E.F. Default Values

**Instructions:** Either Enter a User-Defined Value for each parameter or Use Defaults (Check Box)

Sector: Storage		
Dehydrator Type: TEG DEHYDRATOR WITH FTS, WITH GAS PUMP		
Parameter	User Defined	Default
Glycol Circulation Rate (GPH)		<input checked="" type="checkbox"/> 10
Flash Tank Separator Pressure (PSIA)	800	<input type="checkbox"/> 100
Is Stripping Gas Used? (Check box if Stripping Gas Used, Uncheck if Stripping Gas is Not Used.)	<input type="checkbox"/>	
Stripping Gas Emission Factor (MMcfy/MMcfd Gas Throughput)		<input type="checkbox"/> 0.001

OK

Note: default values are factors of  $10^x$  to conceal proprietary information.

**Figure 2.** GEMS™ Inventory Tool Emission Factor Customization

### 4.2 COMPILATION TOOL

The compilation workbook electronically compiles and provides management reports on all inventories received from reporting entities. Emissions are presented in metric or English units for methane and CO<sub>2</sub> equivalent, grouped by fugitive sources, vented sources and total sources. An exception report on the emission inventories compiled is also generated as part of quality assurance and control. The compiled emissions inventories can be sorted by eleven options including similar facilities, industry sectors, business unit, the whole company, etc. Each sort includes output reports in the form of tables, bar charts and pie charts.

### 4.3 EMISSIONS MANAGEMENT TOOL

The analytical tool, shown in Figure 3, enables a user to evaluate alternative technologies that would result in lower methane emissions. This worksheet is based on the “source and technology” sort of the compiled inventories in the inventory workbook. The activity factors and total emissions represent the company’s actual inventory, for all reporting entities compiled. The user can compile the whole company, or any sub-sector of the company, and then analyze the alternative technologies and economics for that compilation.

For sources and technologies that have lower methane emitting alternatives, the user can open a “drop-down” menu in the Alternative Technologies or Practices column. This presents the lower emitting alternatives. Selecting any alternative, and clicking the “Calculate” button, results in the analysis shown in the columns to the right for that source and technology. Emissions reductions are displayed in million cubic feet of methane per year, or carbon credits (expressed in alternative units selected in the global settings above; i.e. metric tonnes per year CO<sub>2</sub>e). The values represent costs, benefits and economics for replacing all technologies compiled to the alternate choice. For example, if the user compiled just one business unit of the company, the reductions and economics apply to all of the selected source and technologies represented in the inventory for that BU.

**ICF** **GEMS™** Emissions Management Workbook  
 Vented Emissions Reduction Potential Through Technology Upgrades

Global Parameters		
Price of Gas	\$/ Mcf	\$ 3.00
Value of each Carbon Credit	\$/Metric Tonne	\$ 2.00
Discount Factor for NPV Calculations	%	10%
Cost Indices for the Current Year Cost Index for New Equipment: 1264.6 Cost Index for Operating Costs: 448.2		

GHG Emitting Sources by Operating Sector	GHG Emitting Technology Category or Process	Activity Factor		Total Emissions MMscf CH4/ Yr	Alternative Technologies or Practices	Calculate Savings	Number of New Technology Units Required	Emissions Reduction		Net First Year Cost \$	Net Annual Savings (Cost) \$/yr	Net Present Value \$	IRR	Payback Period (years)	Breakeven Value for Carbon Credit \$/Credit	Comments / Conditions	
		Total Activity Factor	Units					MMcft/yr	Carbon Credits Gained								
<b>Gathering/Boosting Sector</b>																	
<b>Pneumatic Devices</b>																	
	High-bleed devices	60	# of High-bleed devices	1.17	Replace with Instrument Air	Calculate	60	1.17	474.83813	\$ 15,072.60	\$ 17,086.59	\$ 45,180.94	1.10627345	0.882130256	\$ (25.61)		
	Low-bleed devices	1	# of low-bleed devices	0.03	Replace with Instrument Air	Calculate	1	0.03	14.245144	\$ 251.00	\$ 512.60	\$ 1,355.43	1.10627345	0.963903089	\$ (34.37)		
	Non-bleed isolation valves	1	# of stations with gas isolation valves	3.11	Replace with Instrument Air	Calculate	1	3.11	1424.5144	\$ 5,023.00	\$ 5,125.78	\$ (0.01)	1.10627345	0.8896	\$ (25.12)		
	User-defined	1.1		1.00	No Upgrades Available												
	All Pneumatic Devices	1	# of stations with pneumatic devices	1.00	No Upgrades Available												
<b>Gas Dehydrator</b>																	
	TEG Dehydrator with FTS, with Gas Pump	20	MMscf/d	10.00	Replace Gas Pump with Electric Pump	Calculate	1	0.26	102	\$ 3,105	\$ 698	\$ (418)	0.04010858	4.45	\$ 3.14		
	TEG Dehydrator with FTS, with Electric Pump	1.1	MMscf/d	1.00	Replace with Desiccant Dehydrator	Calculate	1	0.56	205	\$ 37,912	\$ (8,409)	\$ (63,443)	0.003	No Payback	\$ 10.04		
	TEG Dehydrator without FTS, with Gas Pump	1.1	MMscf/d	1.00	Install Flash Tank	Calculate	1	0.44	174	\$ 4,429	\$ 16,767	\$ 53,754	7.65715437	0.26	\$ (6.75)		
	TEG Dehydrator without FTS, with Electric Pump	1.1	MMscf/d	1.00	No Change	Calculate	0	-	0	\$ -	\$ -	\$ -					
	User-defined	1.1		1.00	No Upgrades Available												
	TEG Dehydrator	1.1	# of stations with Glycol Dehydration	1.00	No Upgrades Available												

Note: all emission factors in this snapshot are artificial factors of 10<sup>x</sup> to conceal proprietary information.

**Figure 3.** GEMS™ Management Tool

Values calculated for the alternate choice include, in addition to the emissions reductions: number of new technologies required, net first year investment costs, net annual savings (including saved gas value and other differential operations and maintenance costs), and economic indicators of relative value. If the economics of the alternate are positive, then a positive net present value, an internal rate of return, and a simple payback are displayed. If the economics are negative, then a break-even carbon credit is calculated, indicating the value that would have to be recovered in a carbon trading market to bring the economics up to a break-even.

The economics are based on a five-year discounted cash flow analysis. In the upper-left corner of the worksheet in Figure 3 are global settings for these calculations. The user may specify a price for the natural gas (including zero), a price for a carbon market credit (or zero), a discount rate, and cost indices for the year of analysis. These cost indices are published quarterly, and the reference is shown in the instructions. The indices update equipment investment costs and labor costs from the bases in the GEMS™ program to real dollars for the date of analysis. The global setting also include choices in units, which will include both English and metric volumes and weights, and U.S. and foreign currencies.

The user may choose alternatives for any and all sources in the compiled inventory. The user can then test different mitigation alternatives for sources. The results can be expressed as a marginal abatement cost (MAC) curve that ranks the mitigation opportunities in a way useful for managers. Managers then can choose to implement those technology alternatives that appear attractive with the gas price and prospective carbon market in an entire program of change for the compiled inventory. The sum of all chosen alternates is displayed on the bottom of the spreadsheet.

Inter-year comparisons in GEMS™ allow a company to distinguish between emission changes resulting from reduction efforts and those resulting from business climate changes, and separately, the emissions changes associated with changing calculation methods or acquiring/divesting facilities. This is a powerful tool in substantiating real GHG emission reductions.

## **5.0 CONCLUSION**

ICF's GEMS™ is not just an inventory tool, it is a new concept in GHG emissions management. The concept can be applied to any GHG gas, any industry, and updated periodically to reflect new alternatives and changing economics.