

GPG Outbrief 28

Non-Invasive, Low-Cost Gas Submeter

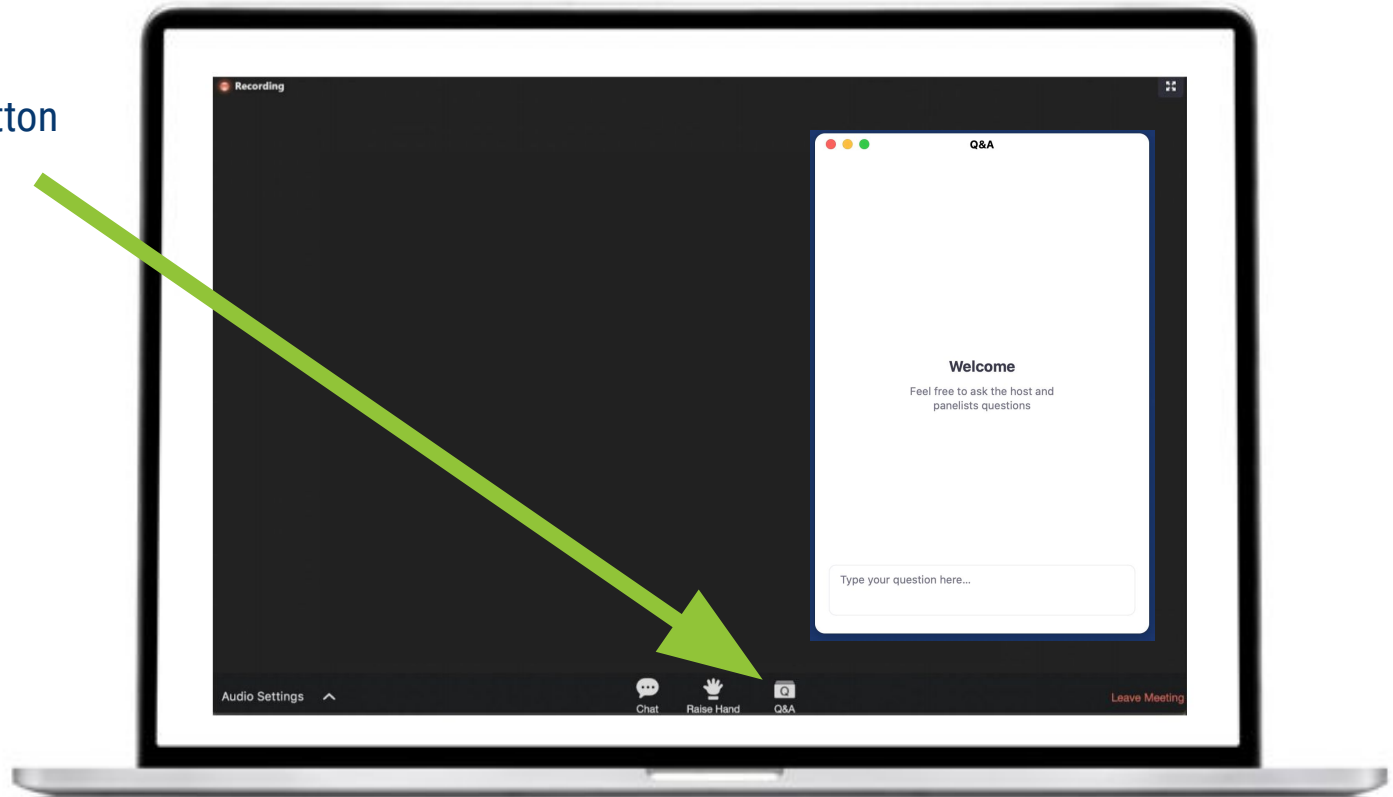
Emerging Building Technologies, GPG Program | U.S. General Services Administration | February 9, 2023

The logo for the U.S. General Services Administration (GSA), consisting of the letters "GSA" in white on a dark blue square background.

GSA

How to Ask Questions

Click the Q&A button to ask questions.



GPG-051 Non-Invasive, Low-Cost Gas Submeter @ gsa.gov/gpg

- ❑ Infographic
- ❑ 4-page Findings
- ❑ Full Report

The screenshot shows the GSA website page for GPG-051. The page is titled "Submeters and Analytics: Non-Invasive Gas Meter" and is part of the "Center for Emerging Building Technologies" findings. The page includes a navigation menu, a search bar, and a sidebar with a list of findings. The main content area features a large green banner with the title "051 NON-INVASIVE, LOW-COST GAS SUBMETER" and a section titled "OPPORTUNITY" stating that 30% of energy use in the U.S. comes from natural gas. Below this is a "TECHNOLOGY" section with an image of the submeter and a graph.

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Home > Governmentwide Initiatives > Climate Action and Sustainability > Center for Emerging Building Technologies > Published Findings > Energy Management > Submeters and Analytics: Non-Invasive Gas Meter

Center for Emerging Building Technologies

Overview

About Green Proving Ground (GPG)

Published Findings

- Building Envelope
- Energy Management
- Advanced Power Strips
- Chiller Plant Control Optimization
- Energy Management Information System with Automated System Optimization
- Socially Driven HVAC
- Submeters and Analytics: Full Panel
- Submeters and Analytics: Non-Invasive Gas Meter**
- Submeters and Analytics: Single-Circuit Meter
- Submeters and Analytics: Wireless CTs
- Wireless Pneumatic Thermostats
- Wireless Sensor Networks

Submeters and Analytics: Non-Invasive Gas Meter

Leaked natural gas is 34 times worse than CO₂ emissions, and tracking leaks and gas inefficiencies can be challenging.

The non-invasive submeter integrates into the BAS to facilitate anomaly detection, off-hour usage, and gas leaks. It straps to the side of the building's existing gas meters eliminating any disruption to building operations and most hardware and labor costs.

[View full-size infographic.](#) [PDF - 338 KB]

4-PAGE REPORT SUMMARY

[\[PDF - 795 KB\]](#)

FULL REPORT—DECEMBER 2022

051 NON-INVASIVE, LOW-COST GAS SUBMETER

DECEMBER 2022

OPPORTUNITY

How much energy use comes from natural gas?

30% OF ENERGY USE IN THE U.S. COMES FROM NATURAL GAS¹

Leaked natural gas is 34x worse than CO₂ emissions²

TECHNOLOGY

How does the non-invasive submeter work?

Straps on to any existing utility meter to measure real-time, high-resolution data. Integrated into BAS for improved visibility.

Measures water & gas
Only gas was evaluated.

Webinar Recording and Slides Available on gsa.gov/gpg

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Center for Emerging Building Technologies

- Overview
- About Green Proving Ground (GPG)
- Published Findings
- Ongoing Assessments
- Request for Information
- About Pilot to Portfolio (P2P)
- GPG Webinars**
- GSA Technology Deployment Maps

GPG Webinars

GPG webinars present results from real-world evaluations and feedback from facility managers at test-bed locations. Following each presentation, researchers and other GSA subject-matter experts answer questions. Attendees are eligible to receive continuing education credits from the American Institute of Architects for attending webinars.

Get GPG program updates

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Upcoming webinars

GSA/DOE RFI for Net-Zero Carbon Buildings
Thursday, November 10, 2022, at 1 p.m. ET

Energy Management Information System with Automated System Optimization
Thursday, December 1, 2022, at 1 p.m. ET

On-demand technology webinars

Category	Topic	Date	Video
Building Envelope	Electrochromic Windows for Office Space	2018-04	
Building Envelope	Lightweight Secondary Windows	2022-03	

Emerging Building Technologies YouTube Channel

The webinar is being recorded.

The recording and slides will be shared by email and posted to gsa.gov.

Webinar Agenda

- ❑ **Introduction (5 minutes)**
Kevin Powell, Director, Center for Emerging Building Technologies
- ❑ **Non-Invasive, Low-Cost Gas Submeter (25 minutes)**
Sean Pachuta, Research Engineer, National Renewable Energy Laboratory
- ❑ **On-the-Ground Feedback (15 minutes)**
Joshua Banis, GPG Program Manager, GSA
- ❑ **Q&A (15 minutes)**

Opportunity

30%

OF ENERGY USE IN THE U.S. COMES FROM
NATURAL GAS

The global warming potential of leaked natural gas
is 34x worse than CO₂ emissions

Measurement & Verification



Sean Pachuta

Research Engineer

National Renewable Energy Laboratory

GPG-051

Non-Invasive Low-Cost Gas Submeter



General Services Administration
Public Buildings Service



GPG-051 | DECEMBER 2022

NON-INVASIVE LOW-COST GAS SUBMETER



Easy-to-Install Strap-On Submeter Provides 99% Accuracy

More than 30% of the energy consumed in the United States comes from natural gas (a common energy source for heating, hot water, and industrial process), and nearly 20% of that is used by the commercial sector.¹ Leaked natural gas is 34 times worse than CO₂ emissions² and tracking leaks and gas inefficiencies is challenging for two reasons: First, many utilities don't readily provide access to this type of data, or they send the data infrequently. Second, utility data is not often integrated into the building automation system (BAS), making it difficult for building owners/managers to access and evaluate metering data. The non-invasive submeter integrates into the BAS to facilitate anomaly detection, including programming and set-back errors, thermostat failures, off-hour usage, and gas leaks. It straps to the side of the building's existing gas meters (diaphragm, rotary, or turbine), eliminating any disruption to building operations and most hardware and labor costs.

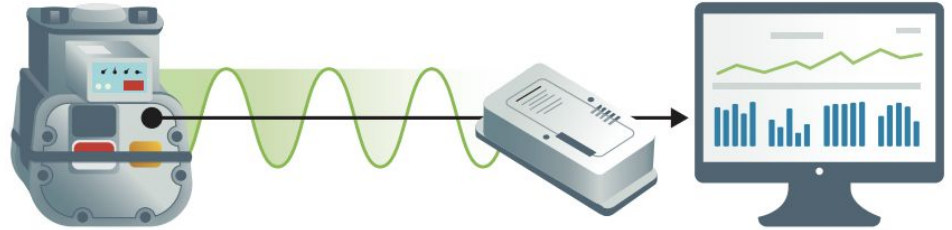
GSA collaborated with the National Renewable Energy Laboratory (NREL) to test the technology's efficacy at two locations in Dallas, Texas. Researchers found that the submeter was 99% accurate compared to the utility meter, was simple to install, and was 70% to 90% less expensive than previous submeters (e.g., \$3,000 vs. \$10,000 to \$30,000). Non-invasive submetering should be considered for all facilities that need real-time gas data; it can help GSA meet policy goals and Energy Independence and Security Act (EISA)³ reporting requirements.

The GPG program enables GSA to make sound investment decisions in next-generation building technologies based on their real-world performance.

What is a Non-Invasive Gas Submeter?

Straps on to an existing utility meter to measure real-time, high-resolution data. Integrated into BAS for improved visibility.

Measures water & gas
Only gas was evaluated.



Meter: Diaphragm, Rotary, or Turbine
As gas flows, the meter rotates/oscillates, creating a fluctuating magnetic field

Sensor Probe
Detects the oscillating field magnetic field

Sensor
Resolves meter rotations and calculates flow

BAS
Translated data is sent to the BAS to be analyzed

Strap-on Gas Submeter from Vata Verks

Compatible With > 95% of Existing Gas Meters:

diaphragm, rotary, and most turbine



Diaphragm



Rotary



Turbine

Key Use Cases:

- Detect gas anomalies and prevent overuse or misuse of gas
- Run buildings more efficiently using real-time, high-resolution gas metering data
- Meet policy goals and provide data for EISA reporting requirements

Vendor-Noted Product Features

Data Communication Options

- Modbus Transmission Control Protocol (TCP)
- Modbus Remote Terminal Unit (RTU)
- Message Queuing Telemetry Transport (MQTT)
- Pulse
- Hypertext Transfer Protocol (HTTP) Push
- Onboard Logger

Resolution

- Meter dependent, but can be measured and adjusted to the customers' needs
- Upgradability available to make the sensor probe 100 times greater than the standard high resolution

Non-Invasive Gas Submeter Testbeds



A. Maceo Smith Federal Building

- 198k ft²
- 9 stories
- Constructed 1971, acquired by GSA 1983

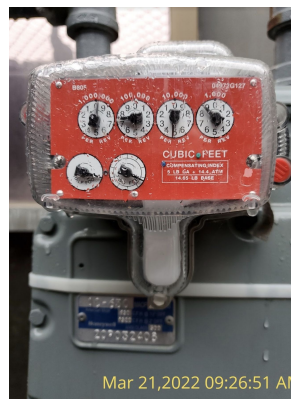
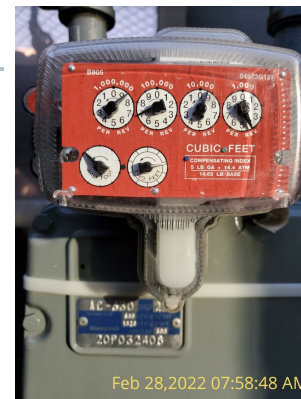


Terminal Annex Federal Building

- 253k ft²
- 5 stories & basement
- Constructed 1937

Evaluation Framework and Schedule

- Accuracy was measured by comparing interval data from the submeter to weekly manual utility meter readings
- Evaluation method used was absolute mean error
- Data quality and number of data dropouts recorded
- 6 month planned schedule for the project



M&V Test Bed Performance Objectives

PERFORMANCE OBJECTIVE	SUCCESS CRITERIA	RESULTS	
		Terminal Annex FB	A. Maceo Smith FB
Strap-on sensor accuracy	Less than +/-3% error for more than 90% of the time	Absolute mean error: 0.77%	Absolute mean error: 0.95%
Installation and integration	<30 days for installation and integration	2 weeks (14 days)	6 weeks* (45 days)
Cost-effectiveness	Similar in cost or less expensive than previous options used by the GSA, which have ranged from \$10,000–\$30,000	Installed cost: \$3,032	Installed cost: \$3,072

*The installation was delayed due to circumstances beyond the vendor's control.

99% Accurate Compared to Utility Meter

SUBMETER READINGS	RESULTS	
	Terminal Annex FB	A. Maceo Smith FB
Average accuracy	99.23%	99.05%
Largest difference	2.03%	2.23%
# of days evaluated	48	48



Straight-Forward, Quick Installation

- The on-site cabling and mounting of the device took 1 day to complete.
- No plumbers, pipe cutting, or interaction with the utility was required.
- Connecting the submeter to the BAS took a few days; initial BAS programming took place during the next few days.



Calibration

- Calibration (k-factor adjustment) requires comparing vendor's time-series data to utility meter reads
- Adjustments to the k-factor, depending on the set up, require staff to go to the physical meter
- Adjustments can be made to improve accuracy of submeter solution
- Vendor provides instructions on adjusting k-factor per different types of utility meters

Lessons learned from calibration at the testbeds led the vendor to update their installation instructions, which should simplify subsequent deployments.

70% to 90% Cheaper than Incumbent Gas Submeters

	Previous GSA Installations of Gas Submetering	Non-Invasive Strap-On Submeter
Equipment + Installation	\$10,000 to \$30,000	\$3,032 to \$3,072 \$757 for ultra-high-resolution option \$2,275 to \$2,315 for installation

Deployment Recommendation

Deploying non-invasive gas submeters:

- Supports policy/reporting goals, including requirements for the Energy Independence and Security Act
- Are best suited to buildings that have an integrated BAS and whole-building or equipment-specific meters

Submeter can also be used to measure water flow, we will be evaluating this functionality in another GSA building



GSA Feedback



Joshua Banis

Program Manager, Green Proving Ground

Formerly, Lead Regional Sustainability Program Manager, GSA Region 7

Set up and Installation

- R7 Smart and Sustainable Buildings (SSB) Team installed the technology at the Terminal Annex FB
- Ran cabling through existing conduit for pulse head pickup that was attached to the old gas meter.
- Cabling was routed to a JACE in the basement and the SSB team integrated the meter into the BAS.
- Process took one day onsite.
- Submeter was programmed using information provided by the vendor.
- Requires a terminal emulator, such as PuTTY.

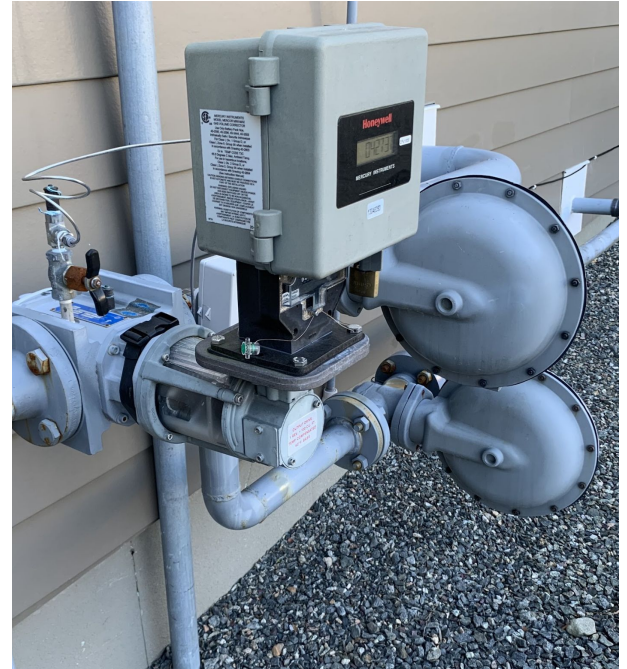


Integration: JACE or Network Switch

Integration is simpler with a JACE but available ports may be limited. The network switch requires additional permissions to communicate on the GSA network.

Before integration:

- Establish IP assignments and whitelisting
- Ensure there is port availability and that it's configured correctly
- Update the riser diagrams and switch matrix as necessary



Calibration: Lessons Learned

Lesson Learned	Rationale
Install when gas is being consumed	Calibrating during winter months is more accurate, especially for compensated gas meters. The vendor keeps a library of gas meter k-factors, which can streamline calibration.
Allow for k-factor adjustment within the BAS wire sheet	Updates can then be made in the BAS, instead of physically connecting to the submeter. Non-GSA sites can remote into the device using Telnet or a web server.
User terminal emulators	Terminal emulators such as Terra Term or PuTTY are needed to configure the submeter.

User Experience

How would you rate the experience with installation of the strap-on submeter compared to previous submeter options?

"Installation and integration was easier than expected."

Rate the usefulness of this real-time gas and water consumption data over current practices?

"Same information. More consistent, accurate and available."

Would you install or would you like to see this meter in other buildings?

"Yes. It's basic and simple and does the job. One potential limitation is that software updates have to be done manually because the GSA version doesn't allow for HTTPS."

Best Practices and Lessons Learned



- ❑ Select the ultra-high resolution submeter option, 10% price increase
- ❑ Work with a single contractor and install in an enclosure
- ❑ Work with the BAS subcontractor for integration

Deployment

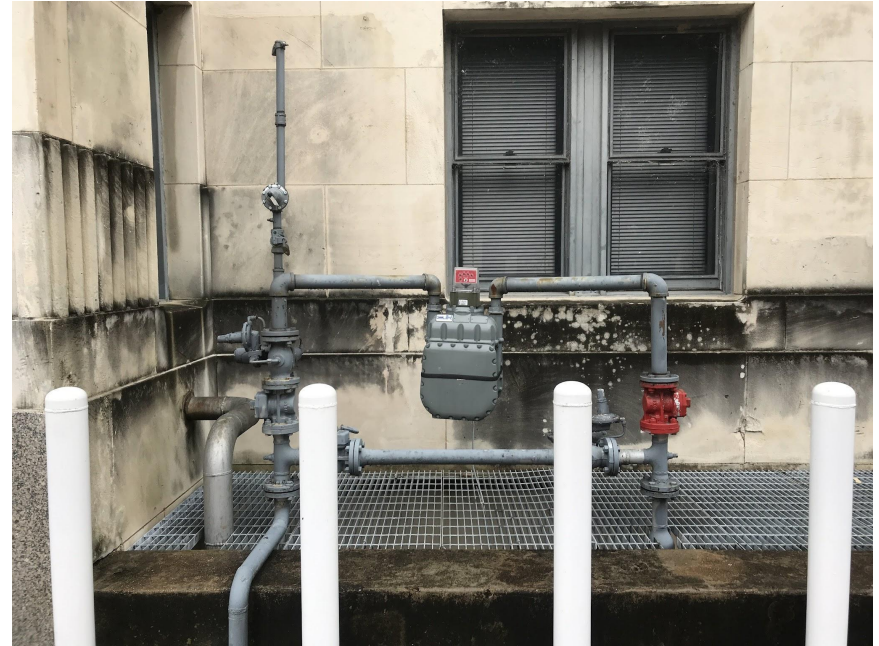
- Duplicating this technology at other locations with compatible BASs can be a simple “copy and paste” of the Modbus integration.
- Already remediated for GSA IT-Security



Common Questions

Integration Applicability

- Schneider Electric PME 2020 database
- SE Meter
- Most BAS systems that allow for MODBUS Programming



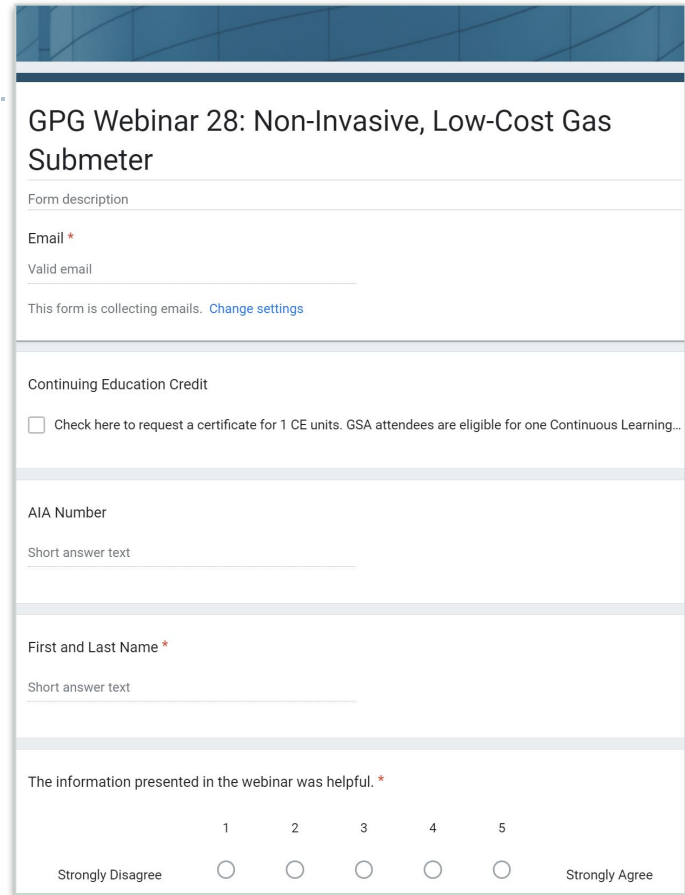
Q & A

Survey and Continuing Education Credit

GPG webinars offer 1 Continuing Education Learning Unit through the American Institute of Architects. GSA attendees are eligible for 1 Continuous Learning Point (CLP).

To receive credit:

Complete the post-webinar email survey.



The screenshot shows a survey form with the following sections:

- Title:** GPG Webinar 28: Non-Invasive, Low-Cost Gas Submeter
- Form description:** (Empty)
- Email ***: A required field with the label "Valid email" and a note "This form is collecting emails. [Change settings](#)".
- Continuing Education Credit:** A checkbox labeled "Check here to request a certificate for 1 CE units. GSA attendees are eligible for one Continuous Learning..."
- AIA Number:** A "Short answer text" field.
- First and Last Name *:** A required "Short answer text" field.
- Rating:** A question "The information presented in the webinar was helpful. *" with a 5-point Likert scale. The scale is represented by five radio buttons labeled 1, 2, 3, 4, and 5. Below the scale, "Strongly Disagree" is aligned with 1 and "Strongly Agree" is aligned with 5.

Thank you



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