General Services Administration
Public Buildings Service

051 | DECEMBER 2022

NON-INVASIVE LOW-COST GAS SUBMETER

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

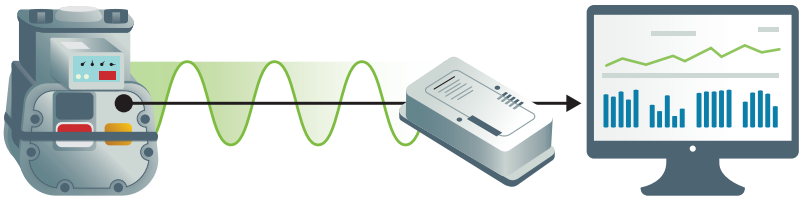
More than 30% of the energy consumed in the United States comes from natural gas (a common energy source for heating, hot water, and industrial process), and nearly 20% of that is used by the commercial sector.[1] Leaked natural gas is 34 times worse than CO_2 emissions[2] and tracking leaks and gas 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.

INTRODUCTION

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.



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

"Having easy access to real-time high-resolution gas metering data helps us run our buildings more efficiently and helps us meet our reporting requirements. The strap-on gas submeter satisfies these requirements with a simpler installation, and a lower cost than our previous options."

– Joshua Banis
Sustainability Program Manager
Greater Southwest Region 7
U.S. General Services Administration

What Is This Technology

NON-DISRUPTIVE, NON-UTILITY GAS DATA ACQUISITION SOLUTION

The non-invasive, submeter straps a sensor probe onto the side of a gas or water utility line at the utility meter. As fluid flows, the probe measures oscillations within the magnetic field—from the movement of the utility meter and flow through the line—and transmits real-time high-resolution data to a sensor up to 200 feet from the probe. The sensor calculates consumption and transmits it to a Java Application Control Engine (JACE) Internet of Things (IoT) controller, BAS, or on-site gateway.

The resolution of the data collected is meter dependent but can be upgraded to ultra-high resolution, which is 100 times greater than the standard high-resolution meter. The submeter is compatible with several industry-standard data communications protocols (e.g., Modbus TCP, Modbus RTU, MQTT, HTTP Push, Pulse) and 95% of existing gas meters, including rotary, diaphragm, and turbine. The submeter also measures water flow, though this functionality was not tested as part of this evaluation. The technology evaluated was provided by Vata Verks.

What We Did

COMPARED THE TECHNOLOGY TO UTILITY METERS

NREL researchers tested an ultra-high resolution version of the non-invasive gas submeter at two separate GSA Region 7 facilities in Dallas, Texas. The Terminal Annex Federal Building is a five-story (with basement), 253,000 ft^2 building built in 1937. The Maceo Smith Federal Building is a nine-story, 198,000 ft^2 building, originally built in 1971 and acquired by GSA in 1983. The gas submeter at the Terminal Annex was installed as part of a CEBT evaluation of an Energy Management Information System with Automated System Optimization (EMIS with ASO), which allowed meter data to be read from a single-pane-of-glass dashboard. To calculate the accuracy of the submeter, two months of interval data was collected from both sites between March 14, 2022–May 2, 2022, and compared to utility meter readings. To gather feedback on ease of installation and integration, researchers conducted focus groups.

FINDINGS

99% ACCURATE Once calibrated, the submeter provided 99% accurate readings compared to the utility meter. For the A. Maceo Smith Federal Building, the submeter showed an average accuracy of 99.05%, with the largest difference of 2.23%. The Terminal Annex Federal Building showed a similar result of 99.23%, with the largest difference of 2.03%.

STRAIGHT-FORWARD INSTALLATION AND INTEGRATION 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. At both locations, the gas meters were installed during the cooling season—a time with minimal gas flow, which made the calibration take longer. Lessons learned from calibration at the testbeds led the vendor to update their installation instructions, which should simplify subsequent deployments.

POSITIVE USER FEEDBACK In focus group polling, participants rated a 4 out of 5 for the submeter's ease of installation. They found the data more consistent, accurate, and accessible than what they had previously and said they would continue to use the submeter and install it in other buildings. Duplicating this technology at other locations with compatible BASs can be a simple "copy and paste" of the Modbus integration.

70% TO 90% CHEAPER THAN INCUMBENT GAS SUBMETERS The meter is substantially less expensive than previous submeter installations at GSA buildings, which have typically ranged between $10K to $30K. At the A. Maceo Smith Federal Building, installation plus equipment costs totaled $3,072 ($2,315 for installation and $757 for the ultra-high resolution submeter); at the Terminal Annex Federal Building, costs totaled $3,032 ($2,275 for installation and $757 for ultra-high resolution submeter).

CONSIDER FOR ALL FACILITIES THAT NEED REAL-TIME GAS READINGS This submeter technology is an economical way to meet policy goals and EISA[3] reporting requirements. It is best suited to buildings with integrated BAS and whole-building or equipment-specific utility meters.

Low-Cost Submeter

Both equipment and installation are less expensive than previous submeter installations

	Previous GSA Installations	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

CONCLUSIONS

These Findings are based on the report, "Demonstration and Evaluation of a Non-Invasive, Low-Cost, Strap-On Sensor for Natural Gas Meters," which is available from the GSA website, www.gsa.gov/cebt

For more information, contact GSA's Center for Emerging Building Technologies cebt@gsa.gov

Footnotes

[1] September 2020 Report: U.S. Oil and Natural Gas: Providing Energy Security and Supporting Our Quality of Life, U.S. DOE

[1] United Nations Climate Change, Why Methane Matters, 7 August 2014

[2] Energy Independence and Security Act of 2007, U.S. DOE, Alternative Fuels Data Center

Technology for testbed measurement and verification provided by Vata Verks.

What We Concluded

STREAMLINES GAS SUBMETER DEPLOYMENT AND DATA INTEGRATION INTO OTHER SYSTEMS

Real-time, high-resolution gas metering data can help operators run their buildings more efficiently to detect leaks and prevent overuse or misuse of gas. Metering data also helps meet policy goals and provides the necessary data to meet EISA[3] reporting requirements. The strap-on, non-invasive gas submeter is a good option to achieve these goals. It was easy to install, 99% accurate, and less expensive than the submetering systems that GSA has previously used. The data can be integrated into the BAS or an EMIS to make it more accessible and usable by building operators. Non-invasive gas submetering should be considered for deployment throughout the portfolio. The submeter also measures water flow, and this capability should be considered though it was not tested as part of this evaluation.

Lessons Learned and Best Practices

Select the ultra-high-resolution version. For a cost difference of ~10%, you get additional functionality, including minimum, maximum, and instantaneous flow readings and higher resolution data that can help detect small leaks.

Select an integration option and establish GSA permissions. Decide if the submeter will be integrated into a JACE or a 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

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.

Work with a single contractor for installation, including running the cabling and installing an outlet to provide energy to the submeter. Ensure that the contractor is qualified to run cabling.

Install in an enclosure that has a dedicated electrical outlet to energize the device.

Terminal emulators are needed to configure the device (Terra Term or PuTTY).

Contract BAS integration as part of normally scheduled duties. This will streamline the process and reduce costs.