PAYNE INSTITUTE COMMENTARY SERIES: VIEWPOINT

A DIGITAL CANOPY: GETTING TO TRANSPARENCY

By Jim Crompton, Morgan D. Bazilian, Will Fleckenstein, Dorit Hammerling, Linda Battalora, and Jordy Lee

Earlier we wrote a Comment titled, "LEANING IN: MOVING AHEAD OF REGULATIONS FOR NATURAL GAS EMISSIONS." That Comment stressed that one of the key steps for oil and gas operators is to establish transparency across their operations, which will help support a 'social license to operate' from the community, regulators, and investors. This is a critical step in moving towards "responsibly-sourced" oil and gas.

Operators, government, and local communities are seeking more detailed information about emissions from the oil and gas sectors.

Energy companies are facing criticism from many angles, and face a bewildering balancing act to define and secure their futures. How these companies navigate this maze could determine the winners and losers in a lower-carbon, and lower commodity price future.

We consider practical and affordable solutions for the identification, quantification and remediation of methane leaks in oil and gas production equipment and facilities. There is an increasingly large amount of data collected from oil and gas operations through the combination of satellite monitoring, drone or plane surveillance, and on-location sensors. Together, these provide the basic elements of a "digital canopy".

We briefly describe each of these technologies:

- **Satellite remote sensing** is one approach to answer some of the more regional or global questions. Satellites can help detect active flares especially during nighttime, away from major urban areas and then be used to calibrate the estimation for flared gas volumes. An orbiter called the Tropospheric Monitoring Instrument (Tropomi), contains state-of-the-art sensors launched by the European Space Agency (ESA) in October, 2017. By April 2018, it had begun to produce data mapping the plumes of methane, carbon dioxide, nitrogen oxides, carbon monoxide and various aerosols over industrial facilities and cities as it passed over Europe, Asia, Africa and South America. Tropomi can get its resolution down to about three square miles on Earth. The resolution of different satellite monitoring tools vary with the satellite orbit and type of sensor package onboard. The Landsat 8 satellite has a spatial resolution of 15-100 meters with a temporal sample rate of 16.0 days. The VIIRS satellite source has a spatial resolution of 375-750 meters with a temporal sample rate of 0.5 days. The Landsat 8 image should be able to identify smaller flares compared to VIIRS images, although the longer satellite revisit time poses a challenge to identify less persistent flares. Other satellites will have different measurement specifications. The GEMS and TEMPO satellites developed by Ball Aerospace, will be part of a three satellite, geostationary ultraviolet/visible spectrometer, will provide daylight measurements of ozone, nitrogen dioxide, sulfur dioxide, formaldehyde and aerosols across the globe.[1]

- **Drones** provide many possibilities in a wide range of commercial and industrial applications—from aerial photography and video shooting, to surveys and inspection of structures. Custom drone designs with special sensors are becoming common in the oil and gas industry, where they are helping to safely and cheaply monitor their assets remotely. The Environmental Protection Agency requires oil producers to monitor their fields for leaks. Currently, is the producers send workers armed with infrared cameras to walk around their wells. Other than the usual photography, the drone technologies can gather additional information such as gas leaks and thermal images. Pairing the drones with the appropriate sensors enables companies to gather comprehensive data from the remote locations at a fraction of the costs of traditional methods. Drones with laser-based sensors can fly over a field for 40 minutes on a single charge and beam back data. Additionally, this type of sensor can determine the extent of the leak, whereas the infrared camera can only detect its presence, not its severity. The drone is also loaded with custom software that allows it to plan its own flight and analyze the data it gathers. The methane detection drones detect the leaks by the use of light reflection and absorption sensors. The sensors emit eye-safe lasers, which are reflected back in specific ways upon hitting certain matter such as gases. Analyzing the reflected beam enables the drones to pinpoint leaks, including the very small ones. Generally, the sensors can identify the methane spectral signature based on the reflected light and determine the presence or absence of the gas.[2] Further technology improvements may allow drones to inspect buried pipelines and flowline to provide qualitative warnings prior to a catastrophic leakage event.

- According to a presentation in 2016 by CCAC (Climate and Clean Air Coalition) methane emissions detection and quantification should start with a field survey similar to a focused inspection and maintenance practice with an initial baseline survey with follow-up surveys based on detection of incidents or a routine maintenance schedule. **Direct measurement** is deemed the most accurate method for quantifying annual methane emissions. Direct measurements also contribute to greater certainty on emissions levels and economic costs and benefits, allows for decisions based on fact, and accurate field data. Identification techniques include: Optical leak imaging (IR camera), Laser leak detector (RMLD), Soap bubble screening, Organic Vapor Analyzers (OVAs) and Toxic Vapor Analyzers (TVAs) and Acoustic Leak Detection. Quantification techniques include: Turbine meters, Thermal Dispersion Flow Meters, Calibrated vent bag, Vane anemometer, Hotwire anemometer and High volume sampler. On-site solutions that can continuously monitor Methane and Volatile Organic Compounds (VOCs) at the wellsite are starting to emerge. Unlike intermittent methods, the unit detects when and where an emissions leak is occurring in real-time, enabling an operator to rapidly mobilize a team to the site and minimize fugitive emissions.[3]

Each of the techniques and technologies described has its opportunities and challenges, but while analysts have to make the best of the data from each level, an integrated view a "digital canopy", could bring in additional

[1] https://www.scientificamerican.com/article/meet-the-satellites-that-can-pinpoint-methane-and-carbon-dioxide-leaks/
[2] http://info.industrialskyworks.com/blog/using-drones-to-detect-methane-gas-in-the-oil-and-gas-industry
[3] https://www.epa.gov/sites/production/files/2016-04/documents/mon7ccacemissurvey.pdf

insights for policy makers, investors, regulators, oil and gas operators, midstream transportation and processing companies, as well as local communities.

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Jim retired from Chevron in 2013 after almost 37 years with the major international oil & gas company. After moving from Houston to Colorado Springs, Colorado, Jim established the Reflections Data Consulting LLC to continue his work in the area of data management and analytics for Exploration and Production industry.

Jim was a Distinguished Lecturer for the Society of Petroleum Engineers in 2010-2011, speaking on the topic of "Putting the Focus on Data." He is a frequent speaker at SPE conferences on Digital/Intelligent Energy and the Data Foundation. His interests lie in the full spectrum of the information value chain from data capture, data management, data visualization, data access, modeling and analytics, simulations and serious gaming.

Jim graduated from the Colorado School of Mines (BS in Geophysical Engineering in 1974 and MS in Geophysics in 1976) before joining Chevron in Denver, Colorado. He later earned an MBA degree (1996) from Our Lady of the Lake University (San Antonio, Texas).

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