New Technologies Drive Operational Performance by Connecting Smart Stations to Distribution Networks

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Abstract

Natural Gas distribution companies have been historically slow to adopt new technologies, especially so-called “Smart” technologies, in their networks. Their counterparts in electric utilities, process plants, and even gas transmission have widely adopted connected components and solutions to quickly give them access to data to make decisions, improve the safety of their systems, and provide them with the functionality they need to improve their operations. Recently, the Natural Gas distribution segment has begun to catch up by adopting these types of technologies to enjoy similar results. Solution providers in the industry have developed customized systems for customers and when coupled with a digital ecosystem, they can drive substantial value for gas utility companies.

INDUSTRY CHALLENGES

There are several challenges that Natural Gas Transmission and Distribution companies are facing in these days.

Together with traditional Natural Gas sources, other sources are becoming relevant, such as LNG and fracking gas. The increased attention to the environment and the necessity to comply to European directives is incentivizing the use of Biomethane, coming from renewable sources; private and public companies are now interested in the production of Biomethane that can be injected into the Natural Gas grid. Of course, the gas supply diversification must be controlled. Gas utilities have clear objectives to meet the target quantity for each source, but they need to ensure that the gas quality is acceptable before injection. In addition, the unconventional sources must be seamlessly integrated into the grid, so operators can take advantages of them when they are available but can also count on traditional sources if necessary.

The environmental cause is driving also the need of a drastic reduction of emissions and energy consumption; the impact of GHG emissions on the atmosphere is well known, and the gas industry is evaluating different solutions to reduce emissions and optimize energy consumption.

The customer base has to be adjusted and expanded to include more users and new usages such as Natural Gas vehicles. In the meantime, it's necessary to remember that Natural Gas is potentially a dangerous fluid, so the attention to safety must be higher than ever to minimize accidents and their undesirable outcome: leakage, possible interruption in gas delivery and, in the worst cases, explosions that can cause harm to pipelines, devices and people. Among the safety concerns also noise must be included, as it can be considered as a potential issue; it's important to reduce it as much as possible, especially in the countries where pressure reducing stations are installed in areas with a high population density.

Figure 1: Axial Flow Pressure Regulators equipped with RAF system

Cost reduction is another important challenge for gas companies. In many cases budgets have been reduced, and companies have now to perform the same activities and reach the same goals with reduced resources. This brings the necessity to optimize resources and possibly reduce some of their activities on site. With reference to equipment, an improved reliability (achieved, from example, from avoiding working at stress limit) means reduced unplanned maintenance activities and, at the end, lower ownership costs.

At the distribution end, new pressure reducing and metering stations are oversized, include redundant layers of safety, and are set at higher than necessary pressure to anticipate further demand growth, or plan for failures and emergency demand picks. Several manual adjustments are required to modify the district station set point, in order to operate at the required pressure levels and fulfill variable demand requirements from users (seasonal demand variations but also different consumption values during the day). This activity is time consuming and requires dedicated personnel to be on site. This is more true and challenging if it is considered that gas grids are designed to satisfy the maximum demand in the extreme operating conditions, that typically happens once or twice a year (or sometimes never) and for a limited time frame. This means that gas grids are normally operated at the highest pressure level to ensure gas availability during high demand periods. These practices increase upfront investments, creates stress on the pressure management equipment, while higher set pressure results in downstream gas leakages.

OBJECTIVES & STRATEGIES

Several years ago, gas distribution companies launched their first foray into value-driving technology when they began to adopt smart metering to improve the accuracy and efficiency of their billing. Now in various parts of the world, these companies are more willing to experiment with technology that can give operators the ability to monitor system parameters, manage the flow of gas through their network, and control individual stations from remote locations. The complete system benefits include improvement in safety, reliability, operational efficiency and profitability, while giving operators greater visibility and control of their gas systems. This article explores the key strategies that gas distribution companies are employing today and how interconnected "Smart" systems are driving value for key stakeholders in these organizations.

During our analysis, we determined that companies in this space have four common themes which drive the basis of their strategic priorities:

1. System Risk Management
2. Improvement in Gas Delivery Efficiency
3. Emphasis on System Infrastructure and Design
4. Environmental Stewardship

All the critical strategies just described often come with execution challenges that cost operators unnecessary expenses and lost product.

However, advancements in technology available to gas distribution will effectively address all four of these common themes. Using innovative and interconnected solutions through the entire lifecycle of Natural Gas, especially in Distribution, allows companies to optimize their operations, keeping an optimal timing, utilizing resources in a more effective way and improve systems safety.

SOLUTIONS & METHODOLOGIES

What are the features and functionality of "Smart" gas systems, and how can they assist distribution companies in achieving their strategic goals?

Smart technologies are essentially scalable systems which enable local and remote control and monitoring of the pressure reducing stations. They are based on dedicated logic, and they can be customized to meet customers' specific requirements.

Figure 2: Smart Skid Demo Unit

These systems consist of a central unit which receives system parameters (temperature, pressure, flow), processes that information, controls pressure management equipment and interfaces with control loops. It could be used at an individual station or for multiple pressure reducing and metering points across the distribution grid. An interface can control various components such as solenoid valves, pressure transducers, and temperature sensors. Communication with existing networks is also vitally important for the success of any system upgrade. Local and remote communication capabilities (webserver, USB, Ethernet, GPRS, etc.) and the possibility to interface with existing SCADA system (through MODBUS, TCP/UIP Protocols) are desirable features of equipment in such networks.

Let's now analyze the more interesting functionalities.

SAFETY AND RISK MANAGEMENT:

The ability to remotely monitor and operate smart gas systems is one of the main advantages of this technology. Not only are operators able to manage the system quicker, but also fewer trips to the field are required, meaning fewer safety concerns from sending people to remote and potentially hazardous areas. Noise levels are a common concern at such stations; this technology enables maintenance personnel to distance themselves from high noise levels. The system is also able to split the total flow into more lines and control the flow through each regulator, further reducing the noise emitted from a station. In addition, the capability of precisely control the flow in each of the reducing line has a positive effect on the regulators, enabling them to work in their ideal range and avoiding unnecessary stress on these devices.

Figure 3: Axial Flow Pressure Regulators equipped with RAF system

Another application of Smart technologies is represented by odorant injection systems. Gas needs to be odorized to ensure that eventual leaks can be immediately smelled. The quantity of odorant liquid to inject into the gas must be very accurate; both under-odorization and over-odorization bring some issues. In case of under-odorization, the gas will not be correctly odorized and that brings a high safety concern in case of a leak. On the other end, over-odorization can expose all devices to a potential risk (odorant liquid is highly corrosive) and ownership costs will increase due to the high cost of the liquid. Moreover, a small discharge of gas during, for example, the opening of a relief valve, will cause an intense

odor resulting in many calls to the authorities. Smart equipment can be installed in odorant injection systems to reduce complexity of the process and ensure that a very accurate mixture of gas and odorant is injected into the grid.

GAS DELIVERY EFFICIENCY:

The ability to estimate gas flow where no meter is installed and monitor other parameters (temperature and pressure) at multiple points allows accurate flow/pressure mapping across the grid. During standard operation, the user could utilize this information to properly balance the grid by adjusting pressure setpoints, thereby remotely accommodating seasonal changes in downstream demand.

It will also be possible to control each regulating line, deciding the exact flow rate that flows through it, and even to close one line by bringing the pressure regulator in closing mode. This will allow the regulators to work in the proper range, avoiding stress limits and reducing unplanned maintenance interventions and risk of interrupted delivery.

Another great application of these smart technologies is relevant to the gas pre-heating. Natural Gas, depending on the weather conditions and the reference country, can have a very low temperature that can become dangerous when the pressure is reduced, causing the water particles inside the gas to freeze and possibly obstruct the small tubing inside the pilots. To avoid this, it is necessary to pre-heat the gas using, for example, gas/water heat exchangers. If the energy consumption is not optimized, there is the risk to heat the water when it's not necessary (for example in case of no flow), wasting energy. Smart technologies can now manage the boiler room and control, with a high accuracy, the inlet and outlet temperatures of both gas and water, optimizing energy consumption and reducing unnecessary costs.

In Fiscal Measurement applications, the possibility of controlling the flow capacity in each line will help guarantee Custody Transfer accuracy and ensure compliance to regulations. The system will close the line when the flow rate will decrease under the limit guaranteed to ensure the measurement accuracy requested by the Standards.

SYSTEM INFRASTRUCTURE AND DESIGN:

Often when distribution companies build out their infrastructure, they tend to oversize the regulating station because the commercial or residential demand downstream has yet to be established. When grid upgrades are considered, smart systems can limit oversizing. And as Natural Gas supply becomes more diverse, for example the expanded use of biomethane, new technologies can seamlessly balance various gas sources at grid injection points and manage gas quality for non-traditional gas sources with no change in system operating conditions.

Taking this a step further, control loops have been programmed to balance, locally and in real time, the supply/demand ratio. Additionally, the system can collect data to use in predictive analytics and forecasting which can later be used in elaborate predictive maintenance algorithms. This enables distribution companies to better utilize their manpower for maintenance tasks and operations that must be performed locally from the time of installation.

ENVIRONMENTAL STEWARDSHIP:

Through remote monitoring and tighter control of system pressure, the average pressure in the grid can be lowered, therefore lowering stress on system joints and piping. In addition, as there is a link between the operating pressure in a network and the leakage and emissions rate, it will be possible to limit this risk by lowering the grid pressure; this will result in cost saving, avoiding discharging gas into the atmosphere, and protection for the environment.

It has already been mentioned the system capability of working with Biomethane and integrating the new stations that are being built; Biomethane is considered a renewable gas and its injection into the grid contributes to meet the European Union renewable energy targets and contrast climate change.

RESULTS

Many control systems developed by industry experts can generate continuous savings and even a return on investment in less than a year, depending on the size of the network and the complexity of the system. At the network level, the system advances critical strategies of gas utilities through smarter grid management and savings in maintenance costs, lost gas, and more efficient resource deployment.

By embracing these new technologies and tapping into vast solution expertise in the space, distribution companies can reach peak operational performance while also improving their safety and environmental metrics in the process.

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