Realizing the Benefits of Smart Gas Distribution

PwC Series:
The Promise and Potential of Smart Gas Distribution
Emerging technologies promise to enable smart gas distribution systems. How should utilities respond to realize that promise and translate smart gas distribution systems into real benefits?
The natural gas distribution industry is poised for a leap into an exciting future with smart gas distribution, currently the focus of unprecedented attention across the industry. Enabling technologies for data collection, analytics, and automation—and the potential benefits to be gained from them—are motivating utilities to step back and take a comprehensive view of their infrastructure and operations. Immeasurable benefits in safety, efficiency, rate base growth, workforce engagement, and customer satisfaction are possible. Everyone from utilities to industry trade groups, policy & research associations, and academic/governmental institutions is weighing in on the promise and potential of smart gas distribution.

No one can predict with absolute certainty what the future may hold once smart gas distribution becomes reality. However, by answering three overriding questions, the industry may be able to gain some clarity and begin making the necessary preparations for capturing the benefits of smart gas distribution systems:

1. **When we piece together all the components of smart gas distribution, what does the future look like?**

2. **How can utilities approach and get started with building out smart gas distribution systems?**

3. **What preparations can utilities begin making to realize the benefits of smart gas distribution?**

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**When we piece together all the components of smart gas distribution, what does the future look like (for you)?**

To date, there is no widely accepted definition of a smart gas distribution system. For the purposes of this paper, smart gas distribution refers to: “The implementation of a host of new technologies to provide real-time information about the end-to-end distribution system; analytics for enabling rapid decision-making aligned with both a proactive approach to pipeline safety and overall operational efficiency; and automated controls to help optimize both pipeline safety and efficiency.”

Figure 1 illustrates the essential components of a smart gas distribution system.
Many of the new technologies are expected to fundamentally change gas distribution operations: smart, connected sensors, controllers, and inspection technologies are being integrated with pipes, valves, regulators, and meters to provide comprehensive, real-time asset and system information and unprecedented control of system operations. Getting such a real-time, end-to-end view of the system, in turn, entails integrating the asset and system data that new technologies provide with other process and inspection information. Data from smart system components, consolidated and analyzed in the cloud, feeds the SCADA system to enable real-time optimization of system operations. Meanwhile, the integration of this data with operations, maintenance, and inspection information in enterprise systems enables enhanced risk and integrity management as well as better work planning and execution. Automated controls (excess flow valves, auto shut-off valves, and remote control valves) aid with rapid and precise execution.

We group these technologies—all of which have the ability to enable smart gas distribution and to disrupt existing systems and processes—into four categories (see Figure 2):

- Smart and mobile technology
- Advanced controls and automation
- Systems and records
- Data and analytics
Critical enablers and disruptors for smart gas distribution (Figure 2)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Critical elements</th>
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| 1. Smart pipeline and mobile technology | - Embedded sensors, inline robots/smart pigs, and ultrasonic inspection on smart pipeline assets connected to SCADA systems  
- Mobile methane detection and remote leak pinpointing and grading by car, ATV, and aerial drones  
- “Smart” gas meters with expanded functionality and connectivity to other home area network systems  
- Mobile devices with secure connectivity to enterprise and cloud-based systems |
| 2. Advanced controls and automation | - Remote control valves (RCVs) and automated shut-off valves (ASVs) connected to SCADA systems  
- Excess flow valves and remote disconnects integrated into smart gas meters  
- Gas distribution system visualization in gas operations control center |
| 3. Systems/records                  | - Materials traceability  
- Enterprise systems integration including GIS, EAM, CIS, RMS, etc.  
- Data, records, and information management, including automated validation and QA/QC to ensure ongoing quality information |
| 4. Data/analytics                   | - Data/connected analytics for all sources of asset information and relevant external sources of environmental information (e.g. weather, soil, seismography, traffic, etc.)  
- Tools for dynamic risk modeling and work prioritization based on threat probability and consequence |

Smart gas distribution technologies should not be evaluated in isolation.

In our view, systems and data integration may be the most challenging aspect of pursuing smart gas distribution. Individual sensors or controllers cannot have system-level impact without being integrated. This means that smart gas distribution technologies should not be evaluated in isolation. When a leading utility evaluated advanced leak-detection technology, it determined not only that the technology offered significant safety benefits, but that the anticipated increase in identified leaks was so great that processes and systems for leak reporting and leak repair planning/scheduling had to be overhauled in order to effectively deploy the technology and realize the safety benefits. Thus when piloting new technologies, utilities should also pilot the integration of the technology with existing processes and systems.

As the gas distribution industry takes initial steps towards defining smart gas distribution systems, it has reached a tipping point not unlike the one encountered by electric utilities at the advent of the smart grid—presenting potentially significant benefits but also new challenges. While smart gas distribution could create opportunities to grow rate base, dramatically
improve safety, engage and energize employees, and provide superior customer service, these are dependent upon the integration of multiple new technologies with existing operations processes and systems in order to realize the full benefits of smart gas distribution.

**How can utilities approach and get started with building out smart gas distribution systems?**

Building smart gas distribution systems will be an evolutionary process. Utilities should start by making sure that asset data is reliable, accurate, and readily accessible, and that strategically important decisions with ramifications for asset management and work management can be effectively made based on the data. Considerable and immediate benefits, including improvements in pipeline safety and return on asset investment can be gained from this first step. While there is currently much hype around topics such as “big data” and automation (including robots), we believe it is important not to pursue “blue-sky” visions of what analytics and automation can do without first determining that foundational capabilities are in working order. Figure 3 illustrates the enhanced integration of asset management and work management operations enabled by a smart gas distribution system.

**Smart gas distribution – “First step” – Asset and work management (Figure 3)**

Some gas utilities are already using new technology to move beyond compliance and support risk-based pipeline integrity management. Yet their operations are still motivated by iterative annual and long-term planning cycles, with investment, work, and resource planning based on a static view of limited asset and system data. Smart technology solutions can
“change the game” in this respect by enabling gas operators to focus on dynamic work and investment plans, which will prioritize the highest-value work to mitigate the most serious risks to pipeline safety and integrity based on a current view of asset condition and risks. Such an approach may also enable utilities to adopt best practices for operations work and resource management from other industries where monthly, weekly (and, within limits, even daily) work plans and schedules are updated in real time based on the latest view of prioritized work demand and internal and external resource supply.

Once monthly and weekly work plans are created to address the highest-priority work, resource assignments and schedules can be automated, and jobs dispatched electronically to company and contractor crews via mobile devices, based on availability, proximity, and capability, thus maximizing wrench time in the field.

Focusing on asset and work management improvement as a first step will yield tangible, “first step” benefits such as those shown below in Figure 4:

**Smart gas distribution – “First step” benefits (Figure 4)**

<table>
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<tr>
<th>Category</th>
<th>Value that can be attained (examples)</th>
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| Safety improvement        | • Step-change improvement in pipeline safety from availability of real-time asset condition, leak indications, and operational data that translates into real-time actions to mitigate the highest risks in the system  
                           | • Electronic records, analytics, and reporting to quickly explain what work was done, why, and failure modes or root causes of issues, as well as to provide traceable, verifiable, and complete records to regulators, other stakeholders                                                                                                      |
| Risk reduction            | • Risk-based prioritization of all inspection, maintenance, pipeline replacement and other capital investment projects based on the most up-to-date asset information                                                                                                                                                                                      |
| Operational effectiveness | • Optimized work and investment plans by year, quarter, month, week, or even day  
                           | • Potential 10–15% increase in work management productivity (increased wrench time) from efficiencies in work bundling, optimal scheduling and dispatch, and performance measurement                                                                                                                                                                                            |
| Long-term cost reduction  | • Better balancing of work and resource requirements—both internal company resources and contract crews—with potential for ~10–20% O&M cost reduction  
                           | • Improved inspection and maintenance scheduling, execution, resulting in extended life for assets                                                                                                                                                                                                                                                                  |
| Capital efficiency        | • Improved controls and data for management of new construction work, resulting in better on-schedule, on-budget work completion                                                                                                                                                                                                                                      |
| Customer satisfaction     | • Reduction in customer complaint calls for leaks and other maintenance activities, resulting in increased customer satisfaction                                                                                                                                                                                                                                       |
What preparations can utilities begin making to realize the benefits of smart gas distribution?

As we have noted, building a smart gas distribution system is an evolutionary process. Utilities need a multi-dimensional, long-term path that includes people, process, and technologies. This calls for a comprehensive planning effort that considers the evolution of gas distribution along three dimensions: pipeline safety culture; risk-based integrity and asset management; and efficient, smart-tech-enabled field and customer operations (Figure 5).

Key evolution factors for smart gas distribution (Figure 5)

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<tr>
<th>Dimensions</th>
<th>Current state</th>
<th>Expected future shifts</th>
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<tr>
<td>Pipeline safety culture</td>
<td>• Compliance-driven risk and work management</td>
<td>• Proactive asset and integrity management</td>
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<td>• Pipe replacement, pressure testing, and capital projects treated as special programs</td>
<td>• Safety enhancements and capital projects managed together with normal operations work types</td>
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<td></td>
<td>• Multi-year cases based on historical trends with little linkage to current work priorities and risks</td>
<td>• Utilities interaction with regulators based on current view of risks and actual performance to plan/budget</td>
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<td>Risk-based integrity and asset management</td>
<td>• Asset, system, and customer data resides in disparate legacy systems/databases.</td>
<td>• Asset, system, and customer data is validated and maintained in enterprise systems/data warehouses.</td>
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<td>• No formal asset management standards</td>
<td>• Adoption of PAS 55/ISO 55000 standards</td>
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<td></td>
<td>• Multi-year rate cases and annual investment planning and budgeting</td>
<td>• Strategic (annual/quarterly) and tactical (monthly/weekly) asset and work planning cycles</td>
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<td></td>
<td>• Limited linkage between system risk (integrity management and work prioritization)</td>
<td>• Analytics and risk modeling linked with monitoring technology and enterprise asset management (EAM) systems to enable dynamic work identification and prioritization</td>
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<td>Efficient, smart-tech-enabled field &amp; customer operations</td>
<td>• Leak survey, atmospheric corrosion and other inspection on 3-5 year cycles using outdated technology</td>
<td>• Frequent inspection and continuous monitoring of asset condition enabled by mobile technology and smart sensors</td>
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<td>• Low degree of system control and automation</td>
<td>• SCADA systems connected to a wider array of ASVs/RCVs/sensors with real-time system visualization at centralized control center</td>
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<td>• Decentralized field and district ops model</td>
<td>• Centralized field and district ops model with increased contractor usage to reduce unit costs</td>
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<td>• Limited utility interaction with customer beyond meter</td>
<td>• Utilities provide expanded info/services, including 3rd party vendors and partners, with greater customer input on work identification/scheduling</td>
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How can utilities evolve the needed operational capabilities and successfully integrate them with the new technologies becoming available? Utilities should identify specific business outcomes they want to achieve and create an aligning vision of how their operations should look to reach these outcomes. The vision, in turn, should drive selection and at least preliminary prioritization of technology and integration initiatives, keeping in mind five critical considerations:

- **Pilot individual initiatives.** Utilities should test both technical feasibility and how well technology and processes can be integrated in a given instance.

- **Use benefits-driven prioritization.** Utilities should prioritize initiatives that are most likely to bring demonstrable and measurable benefits—and use these results to build a case for further build-out of smart gas distribution.

- **Have a roadmap but be flexible.** Integration is a complex process that may create unforeseen issues that must be resolved in ways that maintain direction and momentum.

- **Engage employees.** Like any major change management effort, successful implementation of smart gas distribution may depend on employee “buy-in.” Employees committed to the success of smart gas distribution will likely be more motivated to uncover ways to use the system to achieve breakthrough performance.

- **Recognize that smart gas distribution requires a cultural shift.** Smart gas distribution is more than a matter of technology and processes. It introduces a whole new way of thinking about organizational purposes and goals—not unlike the industry shift occurring in response to pipeline safety issues, as utilities think and move beyond compliance to create cultures and businesses committed to safety.

Utilities should identify specific business outcomes they want to achieve and create an aligning vision of how their operations should look to reach these outcomes.
Smart gas distribution will play a starring role in the energy landscape of the future.

Some of the enabling technologies supporting the evolution of smart gas distribution are here, with others likely arriving soon. Yet it is not just these enabling technologies that are creating unprecedented opportunities for gas distribution utilities. These opportunities—for achieving transformative change in safety, efficiency, rate base growth, customer satisfaction, and employee engagement and growth, to name a few—will be created not so much from investment in new technology as from learning to integrate this technology to evolve new and innovative ways of operating. This learning is the major task that lies ahead for gas utilities.
Leading gas operations for safe and reliable energy delivery

With 4,500+ industry-focused professionals in our global network, our Power & Utilities practice is positioned to help across a wide range of operational excellence initiatives. We lead with the priorities of your business—owning, operating and maintaining a safe pipeline system. This forms the foundation of our strategy and recommendations for our clients to achieve a balance between business outcomes and public safety.

From strategy through execution, we help our clients anticipate and minimize potential risks by "knowing" their assets so that capital is allocated and projects are executed to drive safety vigilance, systems and processes are deployed to reduce life cycle costs, and a stronger case can be presented to regulators on investment recovery.

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