EB-2020-0293

Technical Conference

March 4, 2022

FRPO COMPENDIUM

TAB 1

With **Pipe Explorer**, There are no Unpiggable Pipes

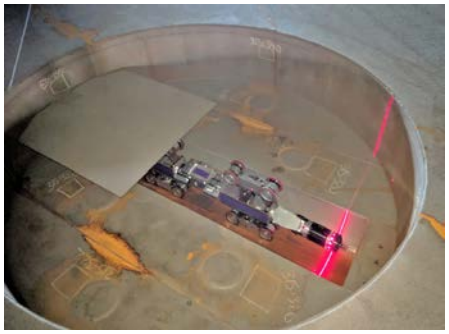
We have come to set the standard for robotic inline inspection services, providing superior knowledge and actionable insights enabling our customers to maintain safe operations and effectively preserve and protect their most valuable assets.

Typical Pipe Explorer Use Case Scenarios:

- 192 Compliance
- Risk Reduction and Asset Protection
- In lieu of Hydrotest or Pre-Hydrotest
- In lieu of External Corrosion Direct Assessment (ECDA) or validation of ECDA at difficult to access areas
- Inspection of cased crossings
- Natural gas inspection scenarios where service disruption is not a viable option
    - Roads, highways, and intersections
    - Urban buildings and suburban neighborhoods
    - Railways, railyards, and subways
    - Rivers, lakes, and canals
    - Bridges, overpasses, and other transport infrastructure
- Facility, terminal, and station pipeline inspection

Browse Some of Our Real **Pipe Explorer** Use Case Scenarios

Tank Farms in North Maryland and New Jersey



The client's tank farms which distribute diesel, gasoline, and oil had never previously been inspected and they were interested in accurately evaluating the integrity of their assets. The client also valued highly accurate data and a shorter time to complete inspections in order to minimize service disruptions.

The pipes at the tank farms had no launchers and no receivers. They also featured many bends, making them challenging for inline pipeline inspection.

Using an 18ft cutout for launch, we bidirectionally inspected the drained and cleaned pipes. From the entry point, the Pipe Explorer robot inspected toward the manifold side and then reversed direction to return to the entry point and proceed toward the tank side to complete the remainder of the inspection.

Pipe Explorer 20/26

Pipe Diameter: 24″
Self-Propelled Inspection Speed: 20ft/min
Length of Inspections: 860ft, 1050ft, 1800ft, 2000ft
+ See all robot specifications

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Terminal Pipes in North Carolina, Florida, and Texas

These gasoline and diesel terminal pipelines were never previously inspected, leaving our client concerned about the status of their assets.

After being drained and cleaned, our Pipe Explorer robots were launched via cutout segments of the pipe or via above ground features to complete inspections.

These terminal pipes had no launchers and no receivers. They also featured many bends, making them challenging for inline inspection. The client also valued a quicker inspection time in order to limit the time the terminal would be out of service. Our Pipe Explorer robots were able to complete multiple inspections over the course of a week to get our client the data they needed as efficiently as possible.

Pipe Explorer 8, 10/14, 16/18

Pipe Diameter: 8″, 10″, 16″
Self-Propelled Inspection Speed: 20ft/min
Length of Inspections: 1200ft, 1350ft, 1400ft
+ See all robot specifications

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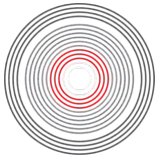
California

Using pre-existing inspection infrastructure is yet another attractive capability of our Pipe Explorer fleet. However, when a California client needed inspection of one of their pipelines that was difficult to inspect as it traversed a section of swampy wetland and typical methodologies were failing them. Although the pipeline could be inspected using traditional and conventional technologies, the customer was experiencing significant data degradation due to numerous speed excursions throughout the pipe.

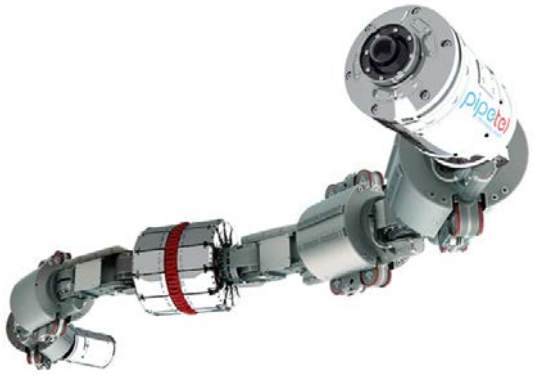
With what seemed like no alternative options, the customer turned to Pipetel. Using their existing entrance and exit tubes, we were able to deploy our Pipe Explorer 10/14 for the inspection. And because all our ILI robots operate under controlled speed, Pipe Explorer was able to extract extremely high-accuracy

data for the length of the pipeline inspection, providing the customer with the necessary data for them to accurately assess the status of their asset.



Pipe Explorer 10/14

Pipe Diameter: 10", 12", 14"
Rated Pressure: 750psi
Self-Propelled Inspection Speed: 20ft/min
Bypass: 50%
+ See all robot specifications



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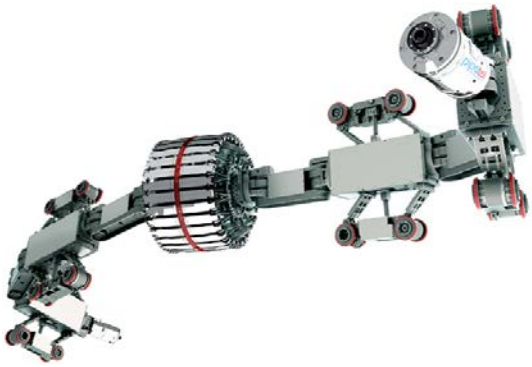
Mississauga, ON

One of our longest inspections required one of our largest robots. The Pipe Explorer 30/36 was used in a predominantly suburban setting where we needed to traverse a school, playground, soccer and baseball fields, as well as a number of homes. Using our inline charging technology, we were able to facilitate the long and winding inspection of 2 miles of pipelines with little disruption to the neighborhood and no interruption in gas service.

Pipe Explorer 30/36

Pipe Diameter: 30", 36"
Rated Pressure: 750psi
Self-Propelled Inspection Speed: 20ft/min
Bypass: 50%
+ See all robot specifications



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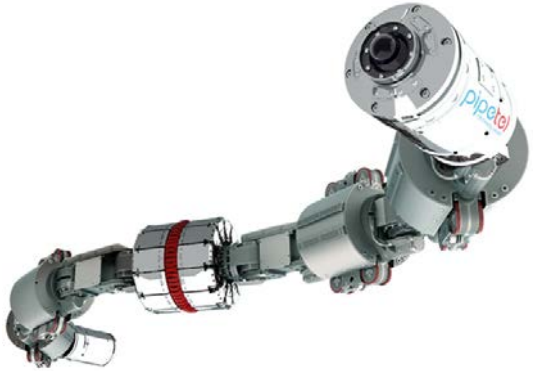
California

With a pipeline suspended from a bridge, our customer had virtually no options for an effective pipeline inspection. External Corrosion Direct Assessment (ECDA) was unfeasible and hydrotesting would produce few data points. Our Pipe Explorer 10/14 was a perfect solution for inline pipeline inspection without compromise. Untethered and self-propelled, we were not only able to extract near-perfect data from the pipeline, but we were able to provide far more sensor data than they had anticipated.

Pipe Explorer 10/14

Pipe Diameter: 10″, 12″, 14″
Rated Pressure: 750psi
Self-Propelled Inspection Speed: 20ft/min
Bypass: 50%
+ See all robot specifications



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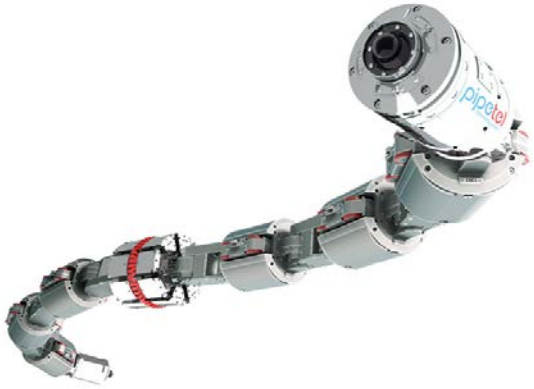
New York City, NY

When our client needed to inspect a pipeline in one of the most congested cities in the world, they turned to Pipetel for a solution. Not only did we require a nominal footprint for entry and exit, we were able to conduct the inline pipeline inspection extracting top-quality data, with a minimal impact on traffic and no impact on gas services.

Pipe Explorer 8

Pipe Diameter: 8″
Rated Pressure: 750psi
Self-Propelled Inspection Speed: 20ft/min
Bypass: 50%
+ See all robot specifications



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Jersey City, NY

When PSE&G needed 2.2 miles of pipeline integrity verified, they turned to Pipetel for their inspection. With more than 50% of their pipeline in the area unsuitable for conventional inspection, the client wanted a solution that eventually could scale. Using our Pipe Explorer 20/26, we were able to complete the inline pipeline inspection with no disruption to gas services while crossing challenging landscape and the Hackensack river.

PSE&G – Pig in a pipeline: New robot roots out trouble before it happens

By Karen A. Johnson – This article has been approved for reproduction by PSE&G

For years, utilities like PSE&G have used equipment called “pigs” to inspect the inside of gas pipes for corrosion, damage by excavators and other signs of trouble that could cause leaks and, in extreme cases, explosions like the one that rocked San Bruno, California, in 2010.

A pipeline pig, which is said to make a squealing noise as it moves through the pipe, normally is propelled by the speed of the gas flowing through the transmission main, while sensors measure corrosion and any thinning of the pipe wall.

"PSE&G maintains about 61 miles of gas transmission pipelines that serve our system," said George Ragula, distribution technical leader – gas asset strategy. "In about 30 of those miles, we are unable to use a standard pig because the flow of gas is too low to propel it. We need a more advanced way to perform inspections of these pipes to meet federal safety guidelines."

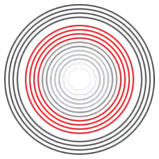
Working through NYSEARCH, a project management organization leading a research and development consortium, PSE&G and other utilities funded development of a new robotic "smart" pig called Explorer – a self-propelled, more flexible piece of equipment that can easily navigate a pipeline's twists and turns. Manufactured and operated by Pipetel, the robot also can provide lots of detailed information about the pipe's condition.

"PSE&G is the first utility in New Jersey to use this new robot, which recently inspected 2.2 miles of pipeline between Jersey City and Kearny, including under Newark Bay," Ragula said. "Thankfully, the robot didn't detect any immediate issues with the pipe, which was installed 40 years ago."

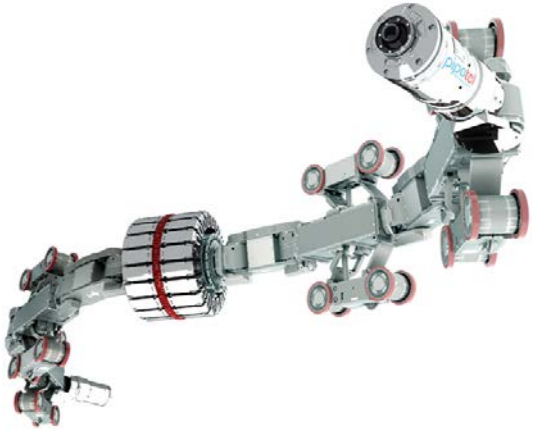
Ragula said PSE&G will use the more advanced pipeline pig to inspect most of its 30 miles of transmission pipes in the future. "Because it provides measurable data, this new robot will help PSE&G ensure that its infrastructure is as safe and reliable as it can be," he said.

Pipe Explorer 20/26

Pipe Diameter: 20″, 22″, 24″, 26″



Rated Pressure: 750psi
Self-Propelled Inspection Speed: 20ft/min
Bypass: 50%
+ See all robot specifications



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Poughkeepsie, NY

When Central Hudson Gas & Electric Corporation needed to inspect a 3,000-foot section of their natural gas transmission line, they turned to Pipetel. Using our Explorer ILI 16/18 series of robots, the inline pipeline inspection took a mere 8 hours and did not require disruption to transmission service nor did it interrupt roadway traffic. The data collected helped shape their maintenance programs, ensuring the reliability for the system while enhancing safety. Central Hudson has inspected over 18,500 feet of natural gas transmission line using our Pipe Explorer robots for inline pipeline inspection.

Story References

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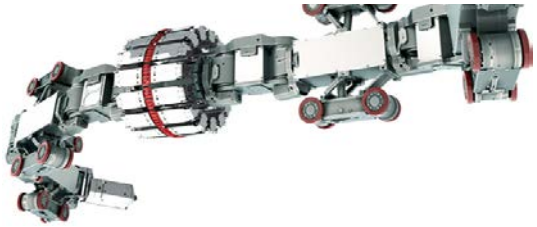
- centralhudson.com/news/news/october8_2015.html

Pipe Explorer 16/18

Pipe Diameter: 16″, 18″
Rated Pressure: 750psi
Self-Propelled Inspection Speed: 20ft/min
Bypass: 50%
+ See all robot specifications



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Contact Us About Your Project

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FRPO COMPENDIUM

TAB 2

Long Distance Inspection with Robotic Technology

Field Experience on Use of In-line Charging Technology

By: Scott Chamourian, Pipetel Technologies, Inc.

Manitoba Hydro is a natural gas and electricity supplier based out of Winnipeg, Manitoba, Canada with 580,000 electrical and 284,000 natural gas customers. Over the summer of 2019, Manitoba Hydro worked with Pipetel Technologies to plan and execute the robotic inspection of the Brandon lateral; approximately 5 miles (8.25 km) of 10-inch, otherwise "unpiggable" pipeline north of Brandon, Manitoba.

Across the globe, there are pipelines that prove difficult to inspect using traditional methods. Whether the infrastructure has challenging features, impassable components, or little to no flow; launching and receiving inline inspection pigs may be impractical or impossible.

Since 2011, Pipetel Technologies has been working to mitigate the challenges of traditional pigging by utilizing their fleet of tetherless robotic crawlers known as Explorer iLi. Ranging from 6 to 36 inches in diameter, Pipetel's Explorer iLi robots are able to perform Magnetic Flux Leakage (MFL) sensing, Laser Deformation Sensing (LDS), and video inspection on pipelines that are in or out of service. Additionally, Explorer iLi robots can be recharged inside the pipe using proprietary in-line charging (ILC) technology, allowing the inspection of long distances. The ILC system operates as illustrated in Figure 1.

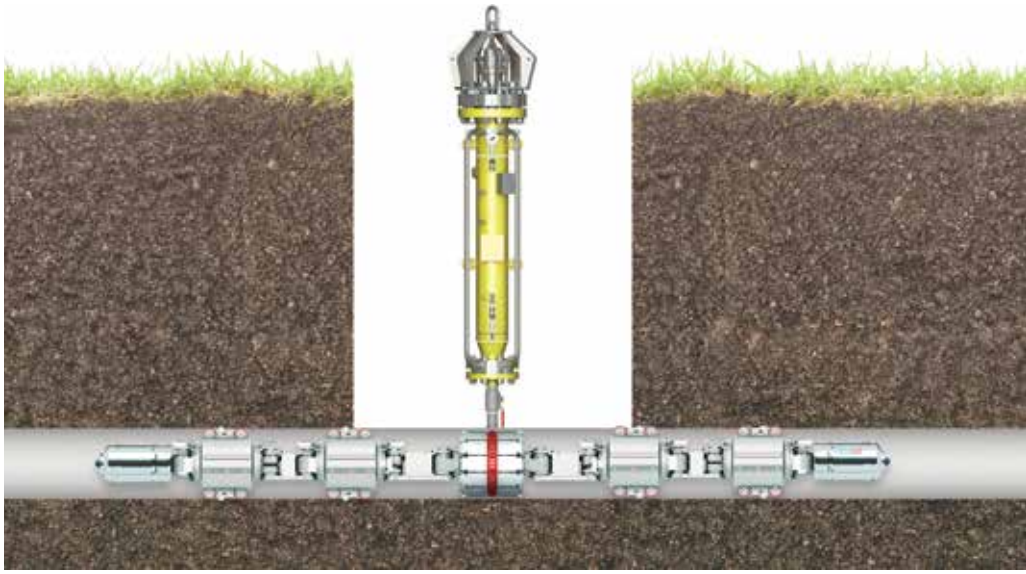


Figure 1: Explorer iLi with In-line Charger

THE PIPELINE INSPECTION CHALLENGE FOR MANITOBA HYDRO

The Brandon lateral stretches between the city of Brandon and the hamlet of Forrest; 5 miles of pipe that had never previously been inspected. The limits of the segment to be inspected were defined by a plug valve and a valve station; both unsuitable for launching and receiving traditional pigging equipment. Additionally, as the pipeline had been built in the 1950s, pipeline geometry, fittings, wall thickness, and cleanliness were all unknown factors. Furthermore, there was a possibility of different pipeline diameters within the segment and a feasible location to add a permanent pig launcher was not available. These were all reasons to look for an alternative inspection method.

The inspection of the Brandon lateral posed numerous challenges for inspection such as the unknown geometry of the pipeline, the number of fittings and excavations required, the trajectory of the pipeline through farmland, as well as potential weather delays. Given the uncertainties of the pipeline composition, the decision was made to inspect the pipeline out of service. In order to complete the project successfully, inspection solutions that can overcome these uncertainties and challenges were required.

Pipetel's Explorer iLi robots are tetherless and battery operated, which means they have a finite distance they are able to inspect before they must be recharged. In lieu of numerous size-on-size hot tap fittings, recharging stations were added to the pipeline thereby reducing the number of times the Explorer iLi robot would be removed from the line. Working together, Manitoba Hydro and Pipetel determined 13 sites were required along the pipeline length. Manitoba Hydro worked with the land owners and their farmland to determine the optimal locations.

Special consideration was given to how far equipment would need to travel over farmland, as rain and mud could make excavations inaccessible.

ROBOTIC PIPELINE INSPECTION

Given the 10-inch pipe to be inspected, the Explorer iLi 10/14 was used for the inspection of the pipeline. Explorer iLi 10/14, shown in Figure 2, is capable of inspecting 10- to 14-inch pipe both in and out of service.

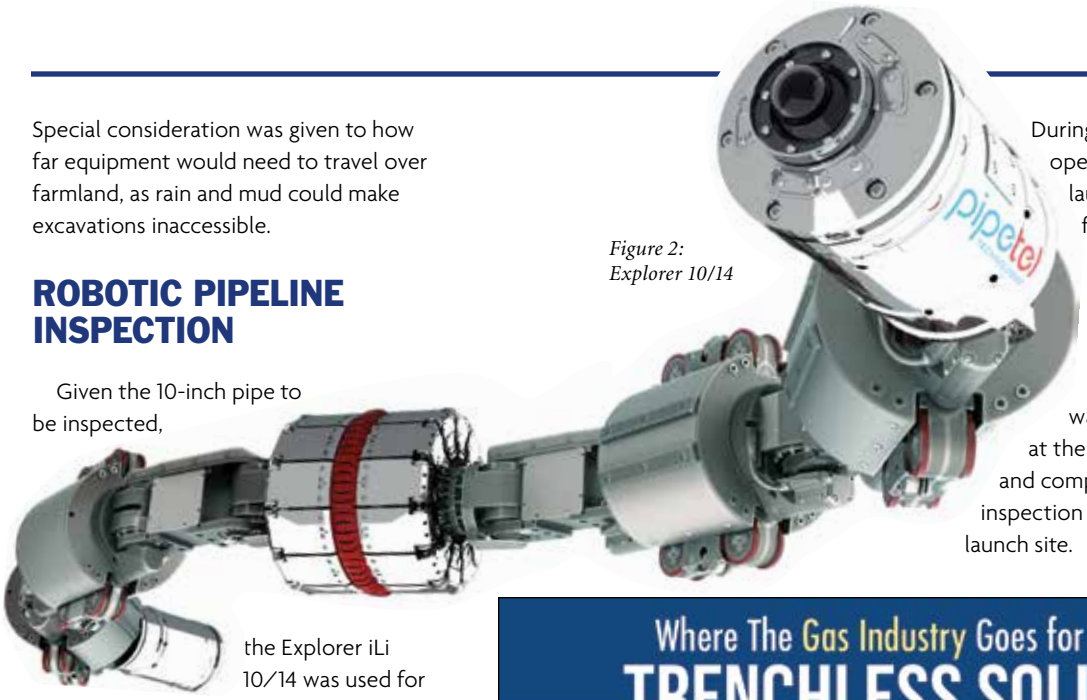


Figure 2: Explorer 10/14

Unlike a traditional pig, Explorer iLi robots are driven remotely by a Pipetel operator. The operator is able to control where the robot travels and how quickly it moves. Should the operator come across any previously unknown feature, it can be documented in real time and the decision to continue or turn back can be made. A view from the inside of one of the hot tap fittings is illustrated in Figure 3.

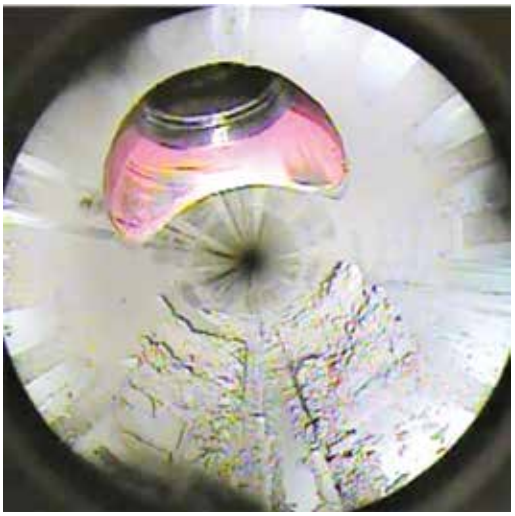


Figure 3: 10 Inch Hot Tap Fitting

Explorer iLi does not require permanent launchers and receivers to be installed on the pipeline. Instead, the robots are able to launch through size-on-size hot tap fittings. Manitoba Hydro set up four of these launch and receive sites along the 5 miles.

During an Explorer iLi inspection, operators have the ability to either launch and receive from a single fitting, or launch at one site and receive at another. Given the fittings on the pipeline, both methods would be utilized on the project. As outlined in Figure 4, Explorer iLi 10/14 was launched and received at the same location one time, and completed the remainder of the inspection by travelling from launch site to launch site.

Figure 4: Schematic of Brandon Lateral

Figure 5: In-line Charge Site on 10 inch Pipeline

Figure 6: Pipetel's Launch System for Explorer 10/14

As Explorer iLi robots are battery powered, their inspection range is limited by battery capacity. In an effort to extend the range of the Explorer iLi fleet, Pipetel implements a proprietary in-line charging (ILC) system. In effect, by adding "refueling" stations along the pipeline, the number of more costly entry and exit fittings can be reduced. Each charging location is much smaller than a launch site and proves less impactful on the pipeline surroundings. In total, nine charging sites were utilized during the inspection. An example of an In-line Charge site is shown in Figure 5.

By utilizing in-line charging technology, pipeline operators are able to execute longer robotic inspections than would otherwise be possible. Manitoba Hydro was able to leverage Pipetel's ILC such that the launch system, outlined in Figure 6, would only be utilized four times. Reducing the quantity of launch sites reduced capital expenditure and the time required for inspection. Since the Explorer iLi robot did not need to come out of line as frequently, the inspection was completed in nine days.

PIPETEL'S PERFORMANCE AND DATA

Whenever launching into a pipeline that has not been inspected before, the conditions of the pipeline are unknown. Be it pipe cleanliness, geometry, or inspection equipment malfunction; collecting high quality data can be challenging in these situations. For Explorer iLi, many of these challenges are mitigated by being able to control the robot in real time. While executing an inspection, real time video, MFL data, and deformation data are transmitted to the operator so that they are able to make informed decisions about tool passage and data quality.

Once the inspections began, the line was found to be quite clean, with minimal debris inhibiting Explorer iLi's travel. Through the 5 miles of inspection, Explorer iLi averaged over 99 percent for MFL and LDS data coverage respectively. Over the 5 miles, previously unknown taps and bottom out fittings were discovered.

SUMMARY

When inspecting the Brandon lateral, many of Manitoba Hydro's challenges and costs came from adding the multiple fittings required by the Explorer iLi robot and charging equipment. As Pipetel looks to the future, in order to reduce the required number of fittings on the pipeline, the range of Explorer iLi must be extended. Multiple initiatives are underway to both reduce the energy demands of Explorer iLi as well as optimize charging to prove less impactful on the inspection's surroundings.

Manitoba Hydro was successful in inspecting the 5-mile Brandon lateral using Pipetel's Explorer iLi and Pipetel was able to collect high quality MFL, Laser Deformation, and video data with over 99 percent coverage. By utilizing Pipetel's launcher and in-line charging, the long length of unpiggable gas line was inspected in only nine days.

ABOUT THE AUTHOR:

pipetel TECHNOLOGIES

Scott Chamourian *is a project manager and has worked with Pipetel Technologies since 2013. He has worked as part of the operations team as well as in his current role planning and executing inspections. Scott received his Bachelors of Engineering from Ryerson University.*

EB-2020-0293

Technical Conference

March 4, 2022

FRPO COMPENDIUM

TAB 3

DOCKETED	
Docket Number:	21-IEPR-05
Project Title:	Natural Gas Outlook and Assessments
TN #:	237856
Document Title:	Presentation - R&D and Innovation
Description:	06_Francois Rongere, PG&E
Filer:	Raquel Kravitz
Organization:	PG&E
Submitter Role:	Public
Submission Date:	5/19/2021 2:39:48 PM
Docketed Date:	5/19/2021

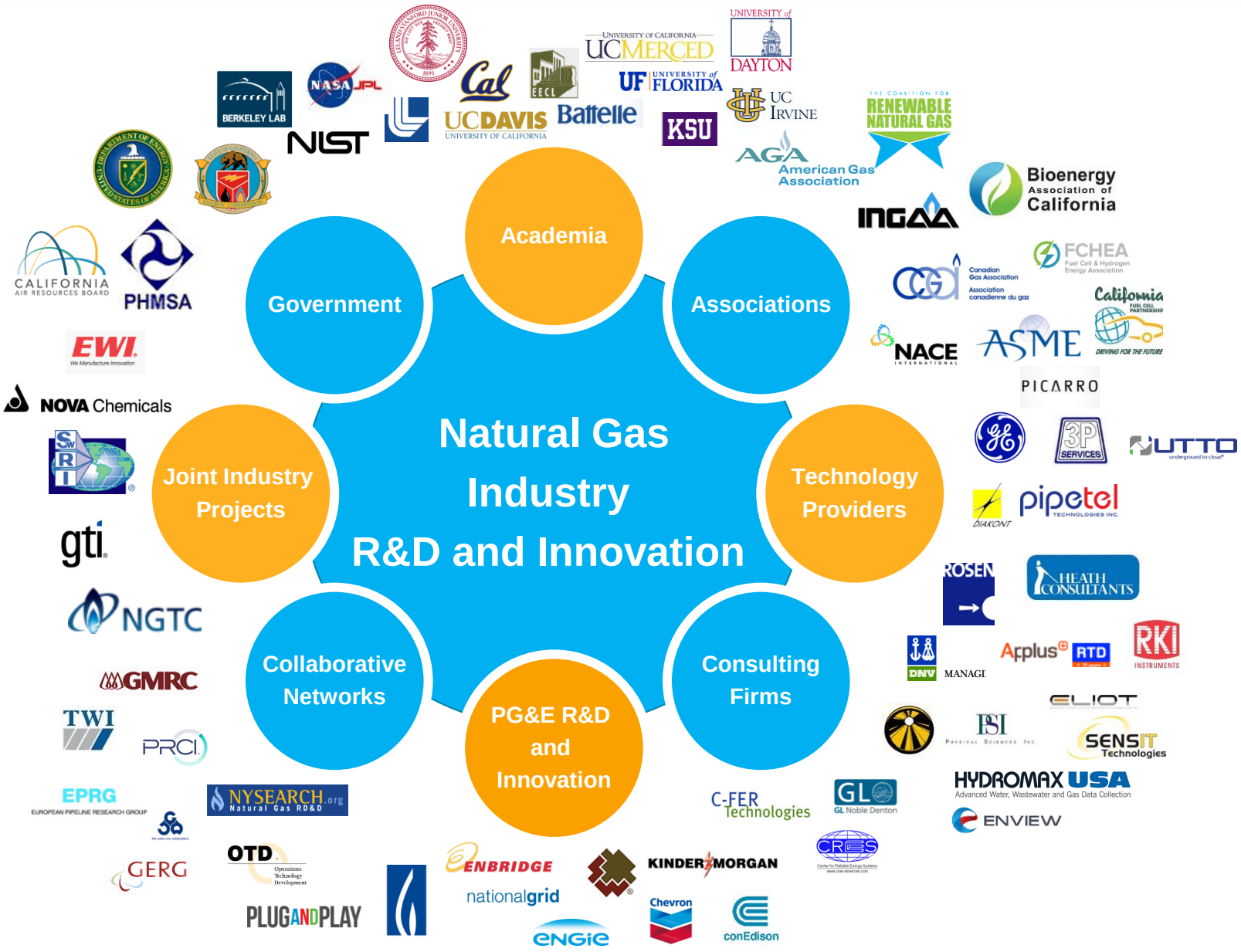
R&D and Innovation

François Rongere

May 2021

Together, Building
a Better California

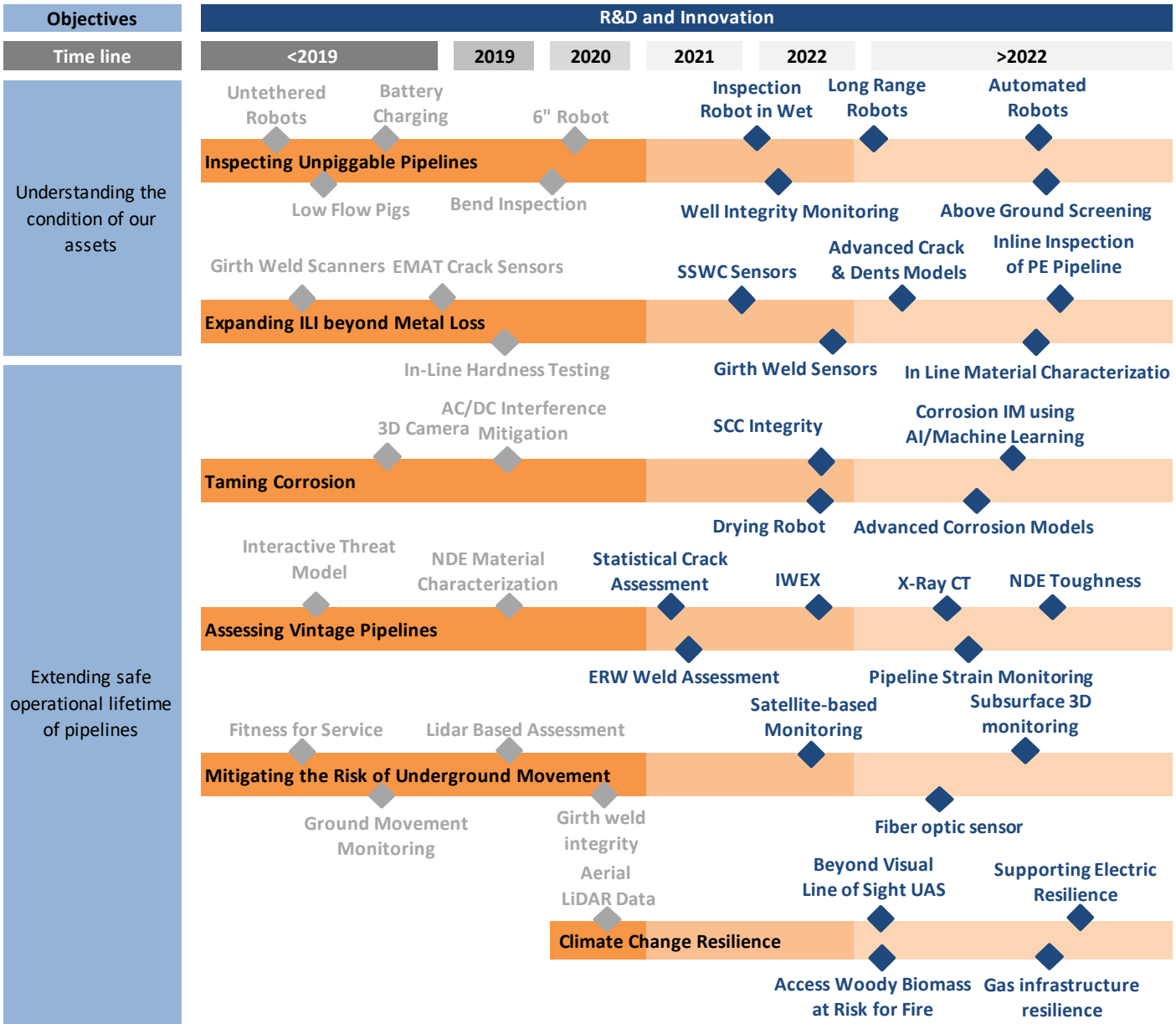
R&D and Innovation Network



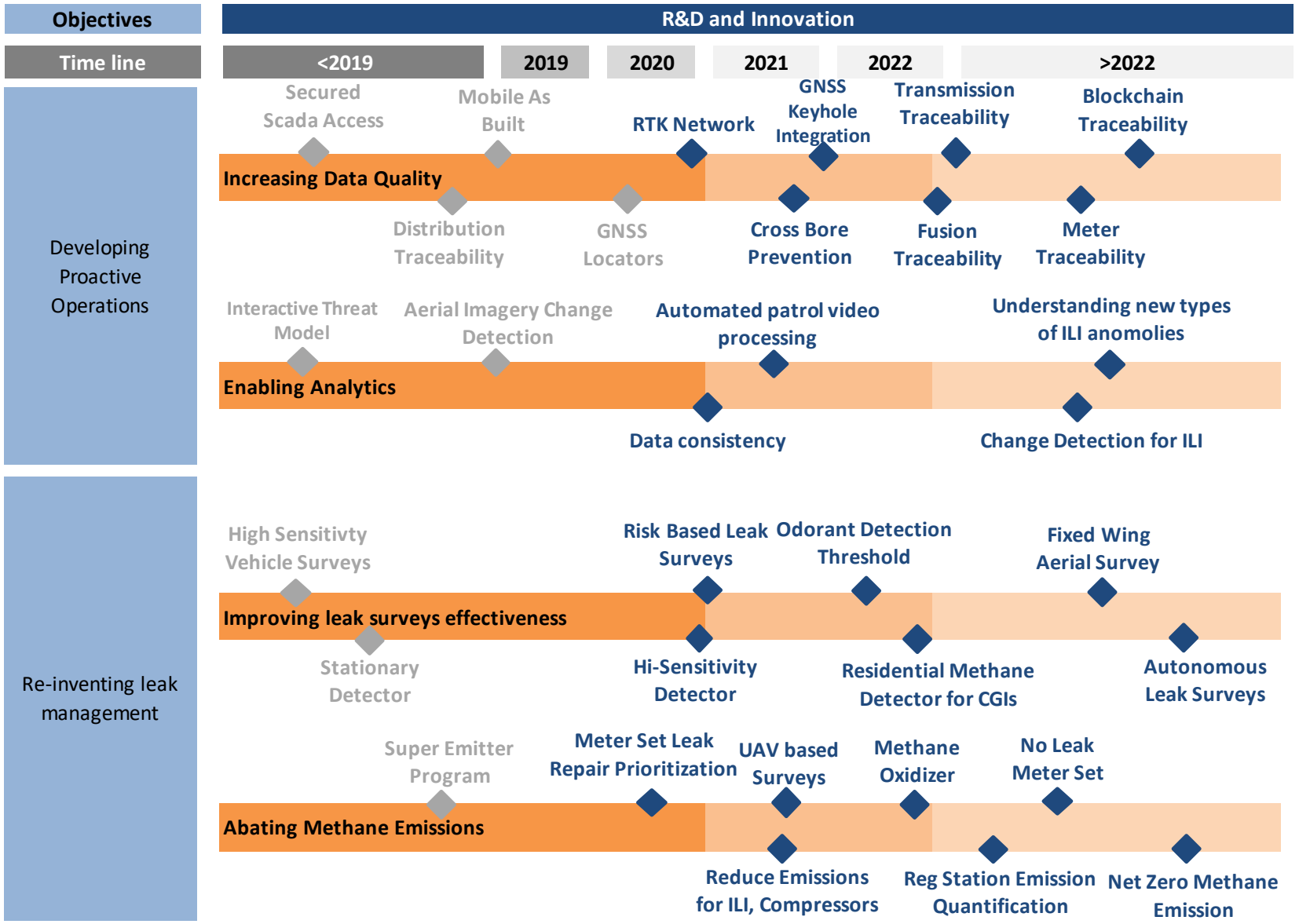
Seven Major Focus Areas

- Understanding the Condition of Our Assets
- Expanding Safe Operational Lifetime of Pipelines
- Developing Proactive Operations
- Reinventing Leak Management
- Eliminating Dig-ins
- Improving Construction Methods
- Decarbonizing the Gas System

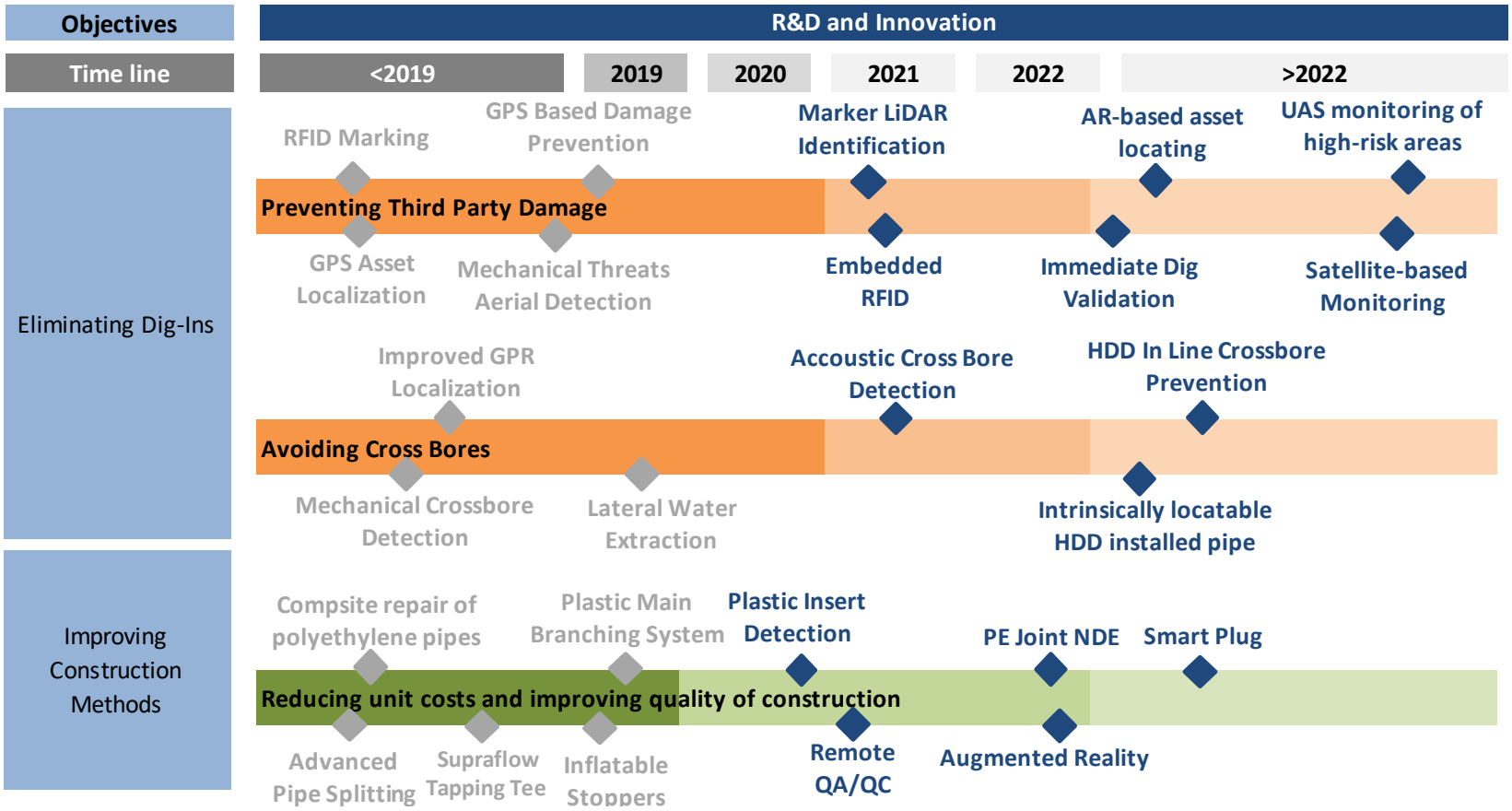
R&D and Innovation Road Map



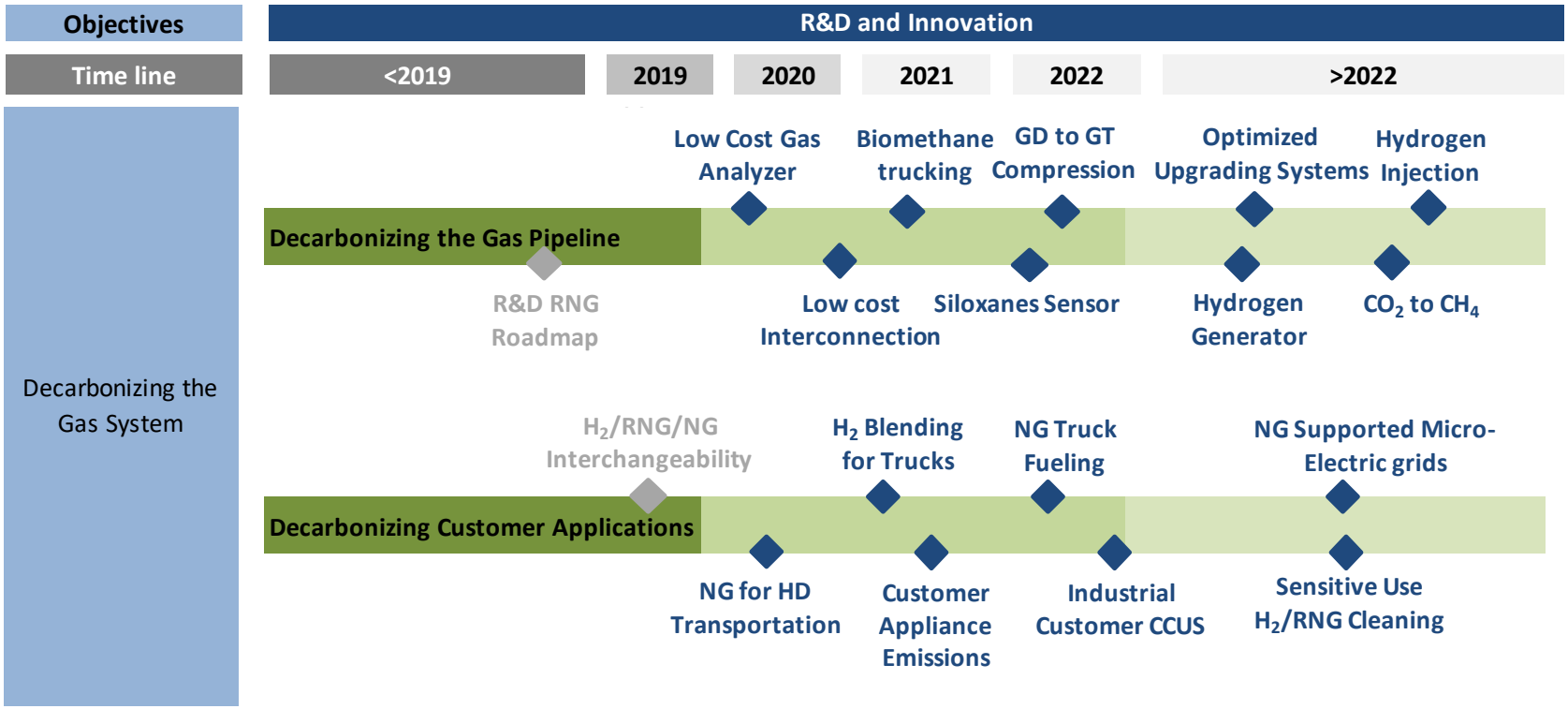
R&D and Innovation Road Map



R&D and Innovation Road Map



R&D and Innovation Road Map



Understanding the Condition of Our Assets

Robots to Inspect Un-Piggable Pipelines

Deployed since 2013:

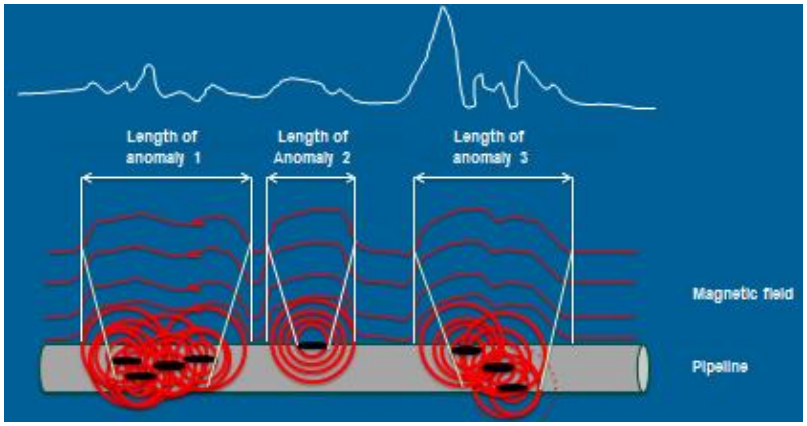
NYSEARCH.org Natural Gas RD&D

Diameter	# of inspections	Miles
8	5	2.9
10	5	0.95
12	14	5.65
16	7	2.58
20	11	4.02
22	1	0.19
24	18	9.54
26	1	0.36
30	2	0.85
36	1	1.06
Total	**65**	**28.10**

Recent new features:

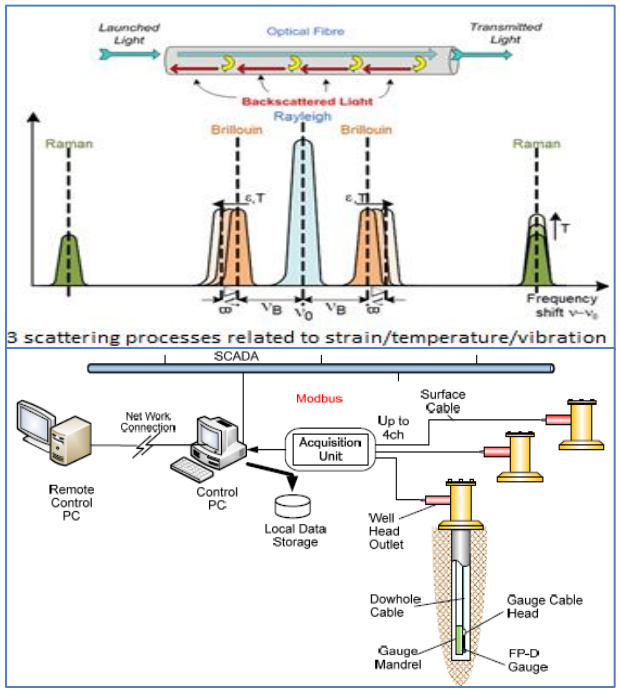
- TMFL module to detect crack-like features in seam welds
- In-Line Energy Harvesting to extend travel range
- Material characterization In-line hardness testing (completed in 2020)
- Automation – self driving with 3D cameras & IMU

Above-Ground Anomaly Screening & Monitoring



- Large Stand-off Magnetometry (LSM) detects passive geo-magnetization flux leakage at elevated stresses/strains in live pipeline
- Sensitive down to nano-tesla the sensor can be carried above ground by a technician or a drone
- Current projects
  - Modelling of the fundamental Physics
  - Field projects to support Geohazard Program with successful demonstration as a viable screening and complementary tool to the current practices

Fiber Optic Sensor



UGS Well monitoring overall system architecture

Pilot deployment and Strain Test Signal at a DIMP Fault Crossing Site

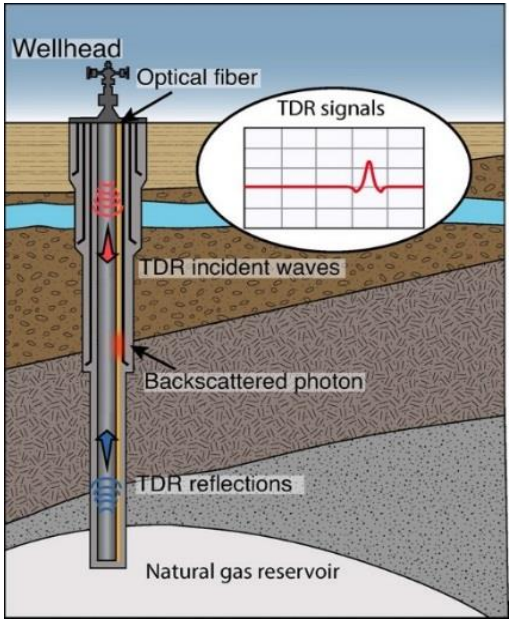
CALIFORNIA ENERGY COMMISSION

- UGS Well Integrity Monitoring
  - Distributed fiber optic sensor technologies for real-time temperature, acoustic/noise and strain monitoring
  - Field test at McDonald Island in collaboration CEC (#PIR-19-001 & 002)
  - Lab sensitivity test

PHMSA

- Pipeline Monitoring
  - Lab test funded by Paulsson in collaboration with PHMSA
  - Pilot Deployment at a DIMP Fault-Crossing site in Q4 2020 for monitoring from Q1 2021
  - Fault-Crossing Mitigation project in 2022 with UC Berkeley and Paulsson in collaboration with PHMSA

Electromagnetic Time Domain Reflectometry (EM-TDR)



Successful field operation test on an 800-ft deep oil well at Chevron's Cymric Oil field

- UGS Well Casing Monitoring/Screening
  - Electromagnetic guided-wave technology based on impedance change due to anomalies
  - Significant cost-saving potential of LBNL's non-intrusive EM-TDR for well casing application
  - Field test from Q2 2021 in collaboration with by CEC (#PIR-19-002)
- Pipeline Screening
  - High potential to complement UT guided-wave technology for screening or some difficult-to-inspect pipeline applications.
  - High interest from NYSEARCH members (proposal in development for March 2021 meeting)

Developing Proactive Operations

Distribution Mobile As-Built (MAB)

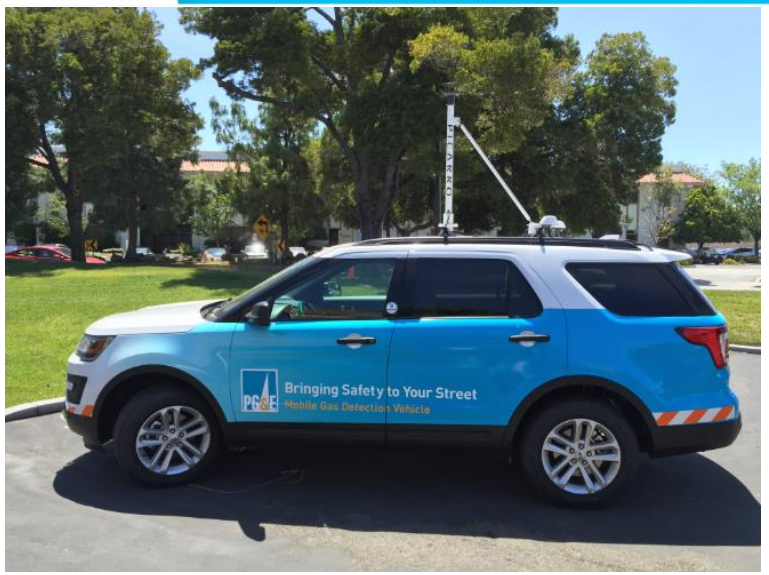
- First production roll-out to GC crews in Q3 2019
- All distribution mappers (~100) and GC field users (>100) trained with average GPS accuracy of 0.79 inches
- 705 total PM#s in-progress/completed with over 56 miles of gas mains and 34 miles of services recorded utilizing the MAB solution as of 2/28/21
- Paperless solution produces reliable, traceable, verifiable and complete as-built records
- Currently extended to transmission and contractors as well as integration with engineering

Re-Inventing Leak Management

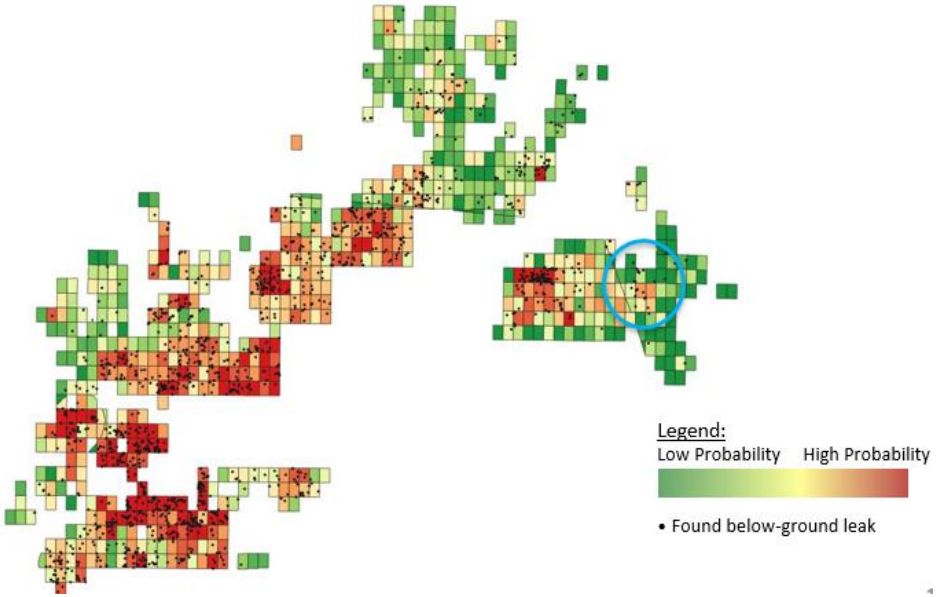
New Generation of Gas Survey Tools

- The Open Path Laser Spectrometer (OPLS) methane sensor is based on a prototype instrument design developed by NASA Jet Propulsion Laboratory (JPL) in 2014.
- Originally designed to hunt for traces of methane, which could be a sign of possible Mars life.
- This laser-based technology is lightweight and has superior sensitivity to methane.
- Unlike conventional technologies, designed with an open-path chamber which relies on passive migration of gas molecules into the sensor.
- Added features: cell-phone/tablet user interface, high accuracy GPS localization, ethane detection to confirm source, quantification algorithms, handheld and UAS mounted tool.

Risk Based Leak Surveys



Methane detection vehicle



Merging LoF and Leak Probability models

PICARRO

- Merges DIMP Likelihood of Failure (LoF) model and Mobile Monitoring model for leak probability
- Calculate the predicted numbers of found leaks for the existing list of plats to be surveyed.

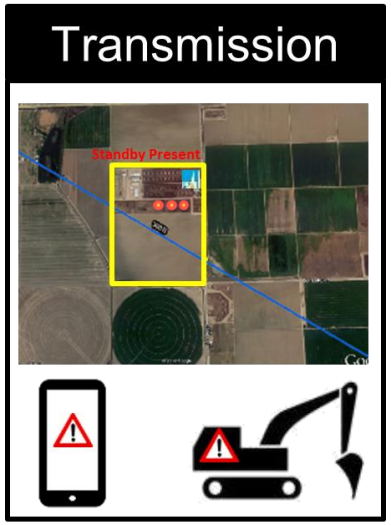
  Prioritize the plats to be surveyed to optimize number of leaks found, minimize the time leaks stay open

Eliminating Dig-Ins

GPS & Motion Sensor-Based Damage Prevention

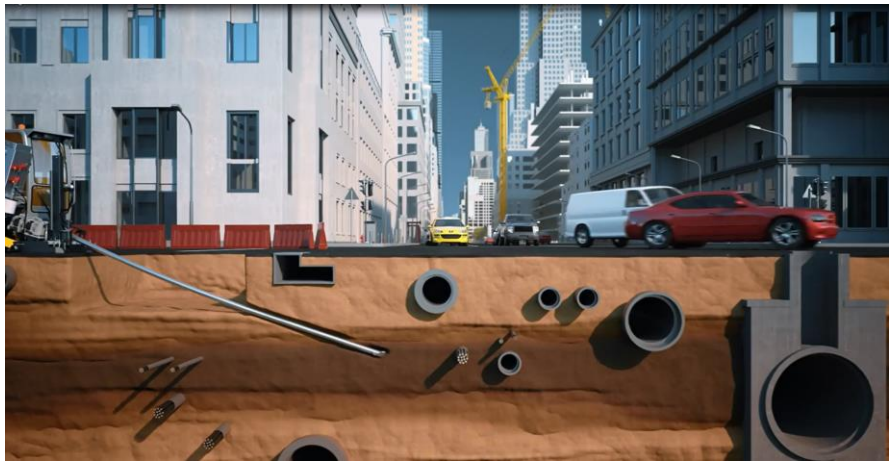
HYDROMAX USA
Advanced Water, Wastewater and Gas Data Collection

OTD Operations Technology Development

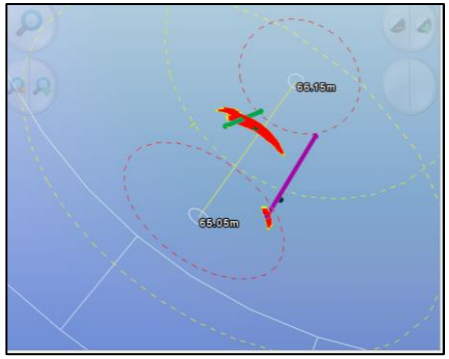


- Real-time activity monitoring of excavation equipment
- Alert Triggered when GPS indicates excavator within proximity to known pipeline location and/or AI detects when excavator is digging
- One Call Ticket incorporation allows for risk ranking and appropriate intervention when required

‘ORFEUS’ Borehead Radar



ORFEUS Demonstration full video (YouTube)



User interface showing detections

Installation of the Orfeus rod on a boring machine at PG&E in October 2017

- Ground Penetrating Radar embedded in drilling rods
- Real-time obstacle detection to increase the safety margins of HDD[1] utility installations
- Reduce likelihood of cross-bores
- Create agnostic retrofit compatible to any boring rig

[1]HDD: Horizontal Directional Drilling

Thank you!