Energy & Environmental Research Center (EERC)

iPIPE 1.0, 2.0 and Next Phase 3.0
iNTELLIGENT PIPELINE INTEGRITY PROGRAM

Oil and Gas Research Program

December 15, 2023

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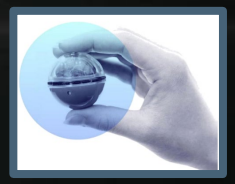
EERC Assistant Director for Energy, Oil, and Gas

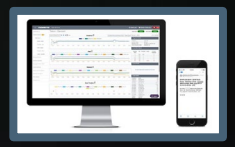
EERC | UND UNIVERSITY OF NORTH DAKOTA

iPIPE
INTELLIGENT PIPELINE INTEGRITY PROGRAM

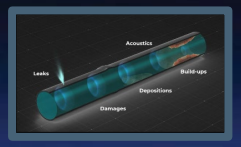
Leak Detection Innovation



In-line inspection
“small diameter”

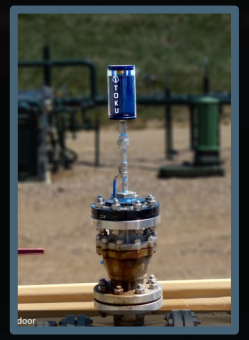


Artificial intelligence
monitoring



Advanced acoustics

Subsurface polymer
absorption monitoring



Intelligent sensors
for early detection
anywhere

Advanced aerial
sensor technology

New generation
monitoring from
space

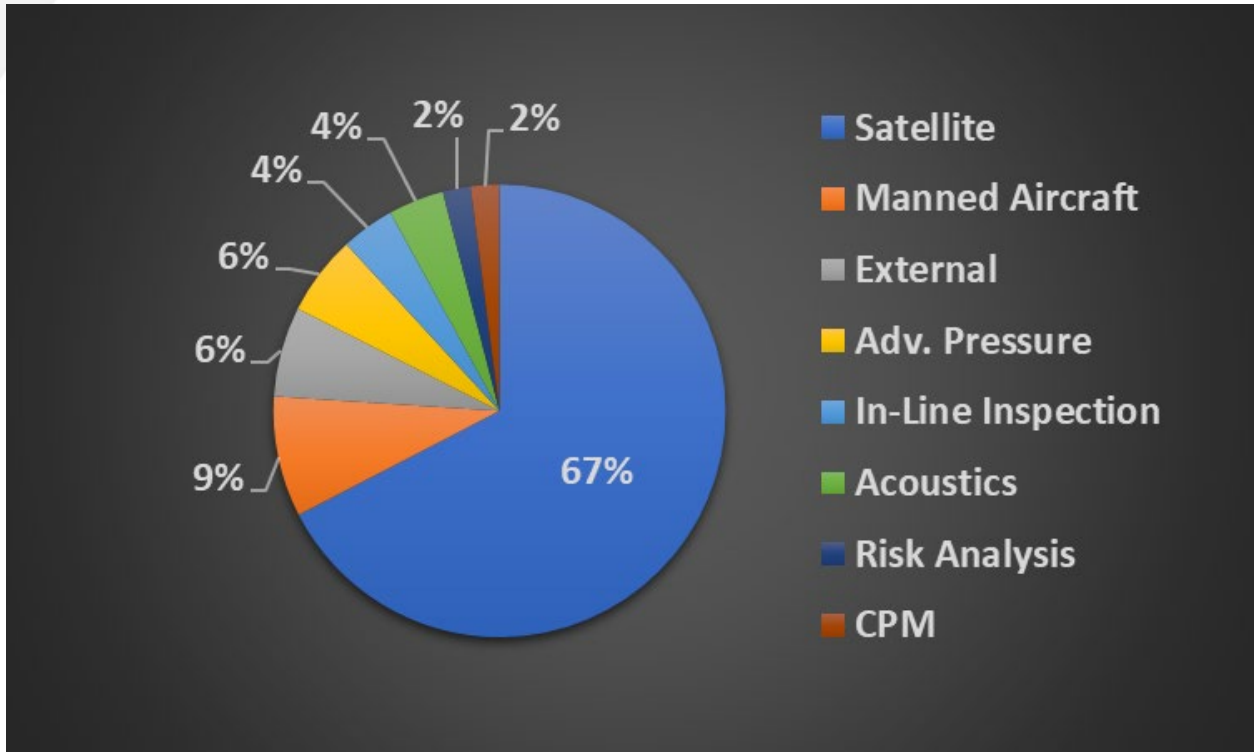
North Dakota oil & gas research program | ENERGY TRANSFER | dcp Midstream | ENBRIDGE Life Takes Energy | HESS | MPLX | TC Energy | ONEOK

Program History

Timeframe	Program	Subcontract Total	Subcontracts			
2018	iPIPE 1.0	$563K	INGU Solutions 26%	Satelytics 1 74%		
2019		$745K	Direct C 14%	Satelytics 2 86%		
2020		$1,395K	OSK 43%	Satelytics 3 57%		
2021		$382K	Pipeline Risk 20%	Satelytics 4 24%	Toku 56%	
2022–2023	iPIPE 2.0	$689K	Flyscan 47%	Seismos 22%	Syscor 20%	Flowstate 11%
2024–2025	iPIPE 3.0	$2,923,500*	TBD			

* Proposed Value

iPIPE Technology Investment



* Computational Pipeline Monitoring (CPM)

HESS CORPORATION
2022 Sustainability Report

Intelligent Pipeline Integrity Program

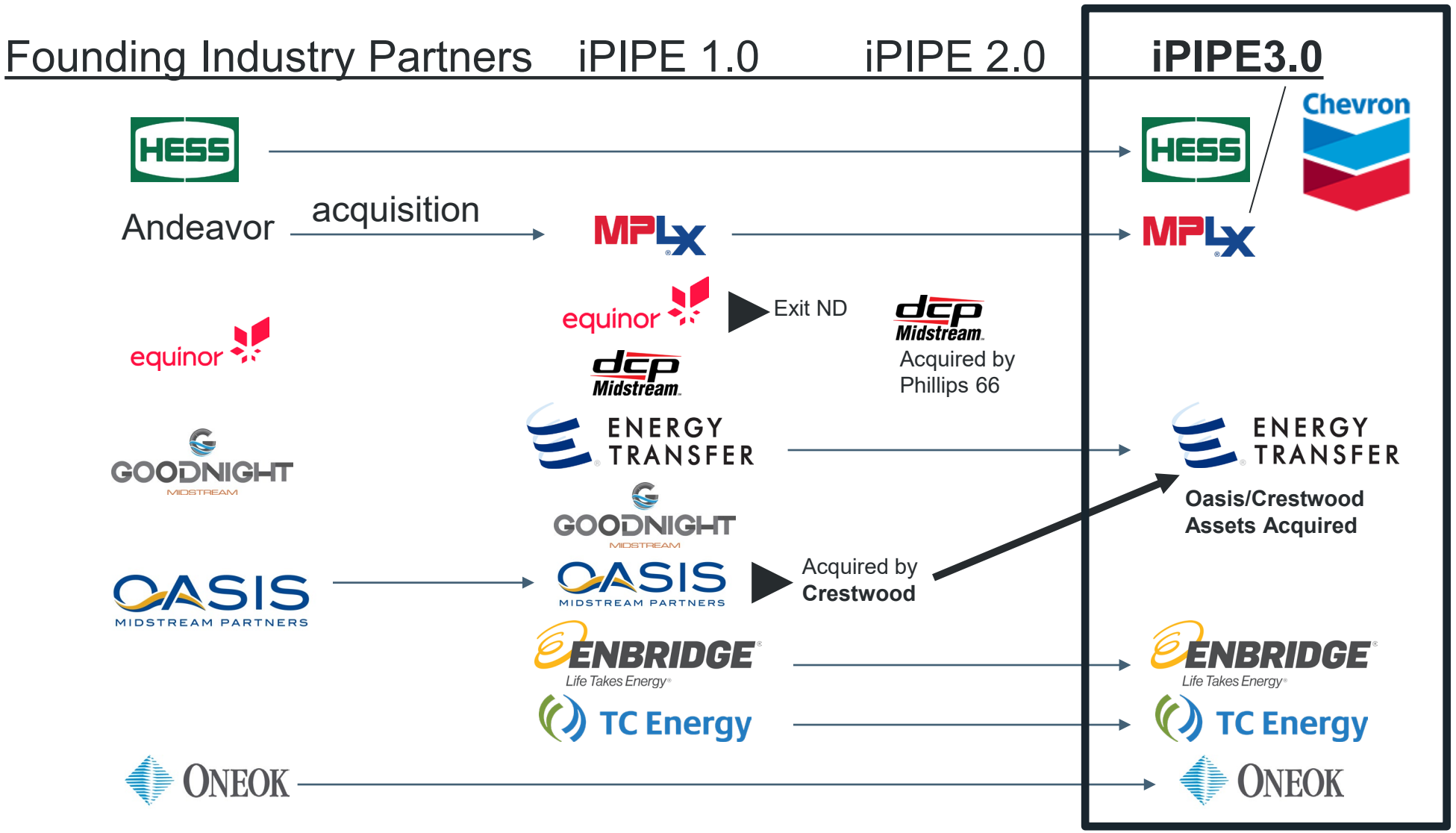
Hess continues active involvement in iPIPE, a collaboration of oil and gas operators and the University of North Dakota's Energy and Environmental Research Center, which aims to review advanced technologies that enhance pipeline integrity efforts (including remote emissions monitoring by drones). Hess works with iPIPE members to review a range of technologies and choose a few for additional investment and testing.

Our initial implementation of this technology is focused on detecting liquid releases, such as hydrocarbons and produced water. The technology will ultimately be used to detect land movement and erosion, encroachments on right of ways, vegetation management and coarse resolution methane detection.

Financials

	NDIC Funding	Industry-Cash	In-kind Contributions	Remaining Balance
iPIPE 1.0	$2,600,000	$2,577,000	$3,451,597	$303,817
iPIPE 2.0	$400,000	$1,050,000	$356,317	$569,399
	$3,000,000	**$3,627,000**	**$3,807,914**	**$873,216**

Membership Evolution



MEMBER RECOGNITION

PARTICIPATION IN KEY RESEARCH PARTNERSHIPS

With our sights set on the future, we continue to collaborate and partner with key organizations inside and outside the energy industry, including the:

- Pipeline Research Council International (PRCI), a community of the world's leading pipeline companies established to develop and deploy research solutions improving pipeline safety and performance,
- PIPE SAFE Group (PSG), an international group of gas transmission companies established to collaborate in the study of the hazards and risks involved in gas transmission by pipelines,
- Emerging Fuels Institute (EFI), of which we are a founding member, addressing the most pressing knowledge gaps in hydrogen,
- Center for Hydrogen Safety group promoting hydrogen safety and best practices worldwide, and
- Intelligent Pipeline Integrity Program (iPIPE) focused on advancing detection of pipeline hazards and leaks.

Transforming Energy Future Continued

In addition, ONEOK Capital Ventures is focused on exploring and investing in innovative technologies that tie to our core business and seek to provide solutions for a transforming energy future. We work with other energy companies to support new technologies and also may make direct equity investments in early-stage energy technology companies that are intended to help improve our operations and are aligned with the energy transformation. Recent investments include:

- **Energy Technology Startup Hub Initiative** - ONEOK, along with leading energy companies and organizations, committed funds towards a new venture capital fund aimed at transforming Oklahoma into a hub for energy technology startups. The initiative intends to attract energy technology startups to the region through access to resources such as free office space, early-stage capital and services to accelerate innovation to meet growing energy demands and create a more sustainable future. By fueling research and development and forward-looking technologies, the initiative is expected to create more than 1,700 jobs across the energy industry.
- **Orbital Sidekick** - ONEOK made a minority direct equity investment in Orbital Sidekick (OSK), a startup company that aims to generate space-based data intelligence using its proprietary constellation of satellites equipped with hyperspectral sensors. Using these satellites, OSK will monitor assets for sustainable operations, ESG and security goals. Hyperspectral imaging (HSI) is a technology that analyzes a wide spectrum of light reflecting off Earth's surfaces. Companies could use the information collected to monitor critical infrastructure, minimize emissions, exceed regulatory requirements and support a lower-carbon future. This technology could also allow companies to scan assets within a day to inspect for damage after a storm.

Prior to investing, ONEOK helped Orbital Sidekick test its technology through participation in the Intelligent Pipeline Integrity Program (iPIPE). ONEOK sees multiple potential future application benefits and potential industry-wide scalability of Orbital Sidekick's technology, including potential opportunities for right-of-way monitoring, vegetation management and erosion monitoring.

Orbital Sidekick satellite

ACKNOWLEDGMENTS

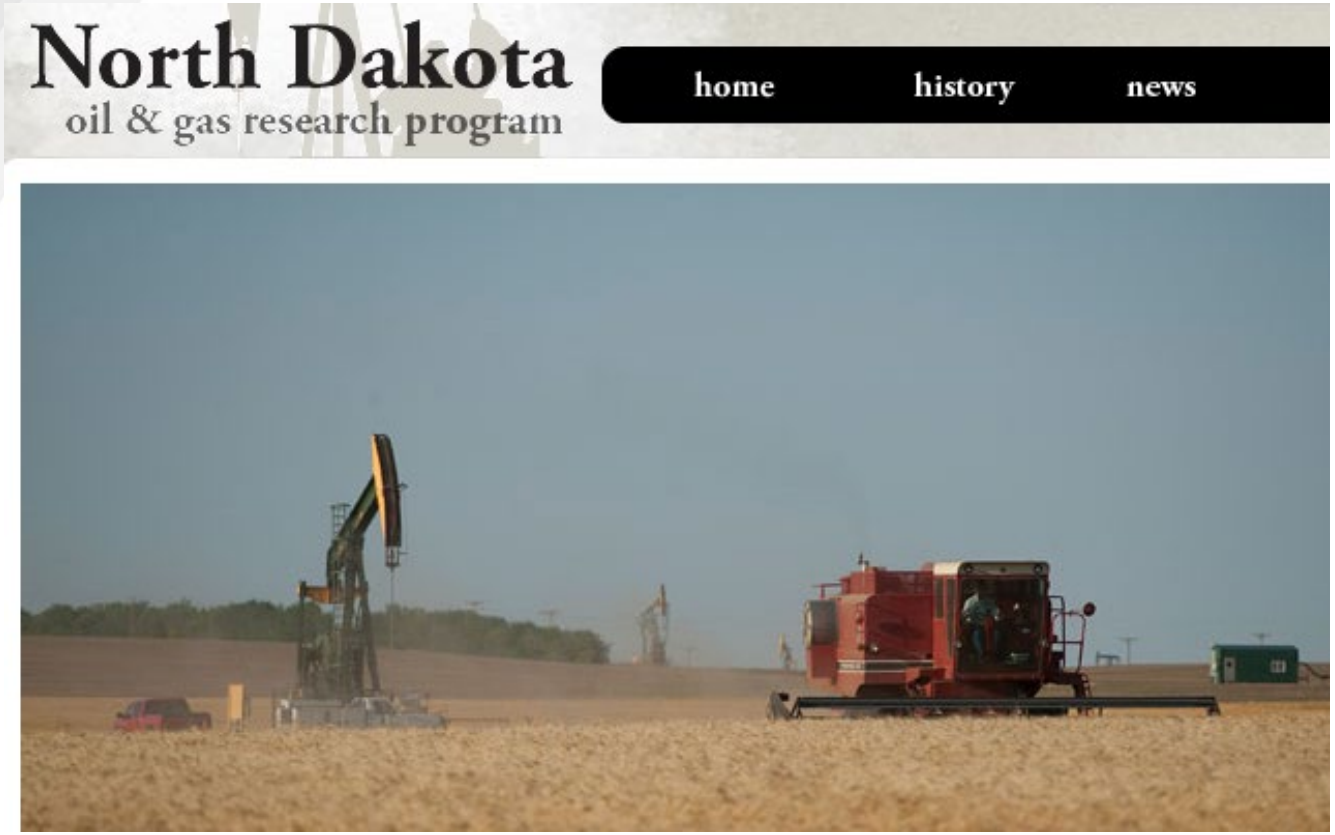
- Media attention
  - 100+ mentions of iPIPE in the media
  - Feature article in *Pipeline & Gas Journal*
  - Feature article in SPE's *Journal of Oil & Gas Facilities*
  - Feature article in *Pipeline Technology Journal*
  - Six-episode series focused on iPIPE on "The Pipeliners Podcast"

- Awards
  - API Industry Innovation Award (Nov 2018)
  - IOGCC Chairman's Stewardship Award (Aug 2019)

TECHNOLOGY SCOUTING: 145+ Vetted, 12 projects

iPIPE RFP Statistics					
	2018	2019	2020	2021	2022
Proposals Received	7	10	13	24	14
Invited to Pitch	7	9	8	10	9
Selected	2	2	2	2	4

OPERATIONS



- Established in 2018
- Support
  - Members
  - North Dakota Oil and Gas Research Program
- Membership meets monthly
- Support and execute projects
  - TRL3–6
- Scout technology
- Execute projects

FLYSCAN

- ROW collaboration.
- Real-time analysis:
  - Threat detection (RGB camera)
  - Passive LDS (hyperspectral)
- Expand application to produced water.
- Improve software to deliver to multiple operators in one flight.
- Completed preliminary tests in Canada
- Ready to complete ND flights

FLOWSTATE

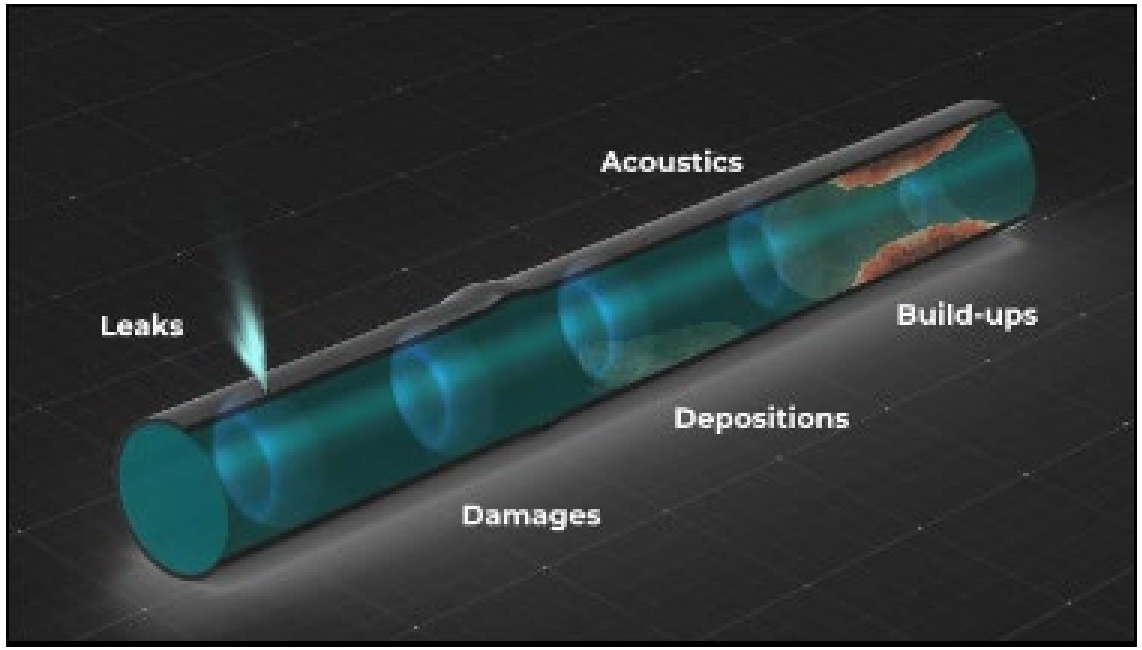
- Computational pipeline monitoring (CPM).
- Reduced time to detection by application of ML to volume imbalance determination.
- Alarm algorithms:
  - Leak signature
  - Statistical volume imbalance
  - Over/short monitoring
  - Rupture detection
- Project to apply technology to produced water.
- Demonstration to begin with MPLx.

SYSCOR

- Combination of polymer absorption sensor (PAS) technology with IR camera to monitor water bodies.
- Application to high-consequence areas (HCAs) – river/lake crossings.
- Product development and testing.
- Pre-alpha prototype completed,
- Alpha prototype completed.
- Beta prototype completed.
- Final test occurring by end of 2023.

SEISMOS

- PPHM™ – Predictive Pipeline Health Management.
- Acoustic survey of pipeline.
- Applies to lines that cannot be pigged.
- Experience with single-phase fluids.
- Test to determine detection thresholds.
- Baseline test completed in October.
- 2nd run week of December 18th.
- Final run in February.



ORBITAL SIDEKICK

Computer rendering of an OSK satellite, which monitors methane emissions on Earth. Courtesy of Orbital Sidekick

iPIPE 3.0 Proposal

Program Elements

- Objective: Advance technologies that reduce the frequency and duration of pipeline releases.

- 2-year program
- $3,000,000 NDIC; $900,000 Industry; $2,100,000 Subcontract cost share
- Total NDIC support based on technology selection outcome

- Outcomes:
  - Realize early adoption of technology
  - Scout new technology and conduct projects (*methane detection)
  - Annual forum

Schedule

Activity	2024				2025			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technology Selection		*						
iPIPE Member Forum				*				*
Program Update to OGRP				*				*
Quarterly Reporting	*	*	*	*	*	*	*	*
Comprehensive Final Report								*
Technology Contracting Period		■			■			
Member Financial Commitments	*				*			
Decision for Ongoing Program							*	
Completion of All Technology Projects								*

Budget

Project-Associated Expense	NDIC Share (cash)	NDIC Contingent (cash)	Member Share (cash and in-kind)	Member Contingent (cash)	Total Project
Labor	$0	$0	$499,307	$0	$499,307
Travel	$0	$0	$28,953	$0	$28,953
Supplies	$0	$0	$1,200	$0	$1,200
Subcontractor – Technology Selection #1	$487,250	$0	$0	$0	$487,250
Subcontractor – Technology Selection #2	$487,250	$0	$0	$0	$487,250
Subcontractor – Technology Selection #3	$487,250	$0	$0	$0	$487,250
Subcontractor – Technology Selection #4	$487,250	$0	$0	$0	$487,250
Subcontractor – Technology Selection #5	$0	$487,250	$0	$0	$487,250
Subcontractor – Technology Selection #6	$0	$487,250	$0	$0	$487,250
Printing and Duplicating	$0	$0	$580	$0	$580
Food	$0	$0	$3,540	$0	$3,540
Freight	$0	$0	$443	$0	$443
Laboratory Fees and Services					
Document Production Service (Graphics, Editing, and Workflow)	$0	$0	$10,332	$0	$10,332
Software Solution Services	$0	$0	$1,722	$0	$1,722
Technical Software Fee	$0	$0	$145	$0	$145
Engineering Services Fee	$0	$0	$2,859	$0	$2,859
Field Safety Fee	$0	$0	$13,419	$0	$13,419
Total Direct Costs	$1,949,000	$974,500	$562,500	$0	$3,486,000
Facilities and Administration	$51,000	$25,500	$337,500	$0	$414,000
Total Cash Requested	**$2,000,000**	**$1,000,000**	**$900,000**	**$0**	**$3,900,000**
In-Kind Cost Share					
Technology Providers	$0	$0	$1,100,000	$1,000,000	$2,100,000
Total In-Kind Cost Share	**$0**	**$0**	**$1,100,000**	**$1,000,000**	**$2,100,000**
Total Project Costs	**$2,000,000**	**$1,000,000**	**$2,000,000**	**$1,000,000**	**$6,000,000**

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THANK YOU

Critical Challenges. Practical Solutions.

iPIPE 1.0 Projects

PIPELINE RISK

iPIPE

Application

- Advanced risk identification.
- Leverage ML processes and technology to support pipeline and facility risk mitigation.

Development

- Explored application with customer and regional data.

Success

- Application identifies higher-risk areas of pipeline segments and ranks risk.

DIRECT-C

Sensing of Hydrocarbons and Produced Water

Application

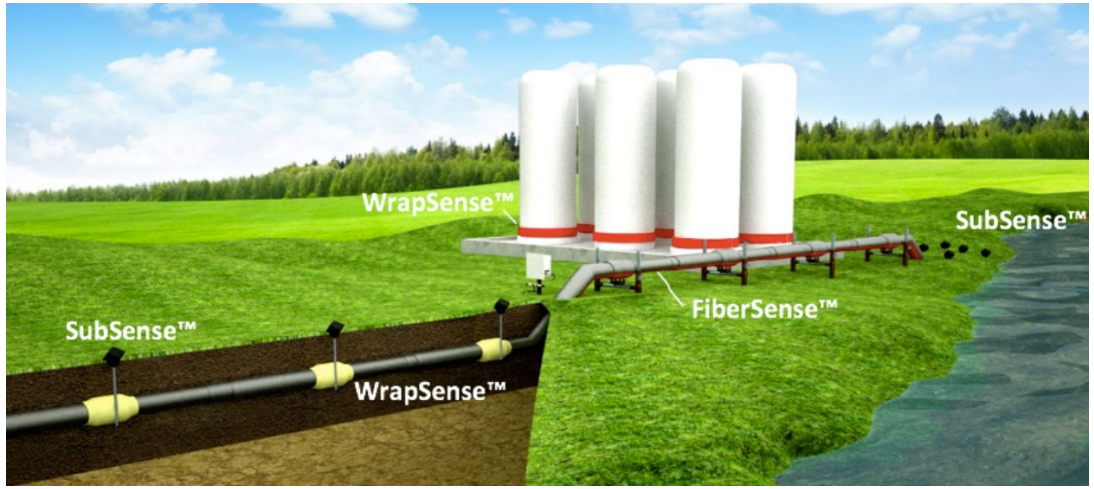
- Useful in focused areas.
- Attached on or near pipe and equipment.

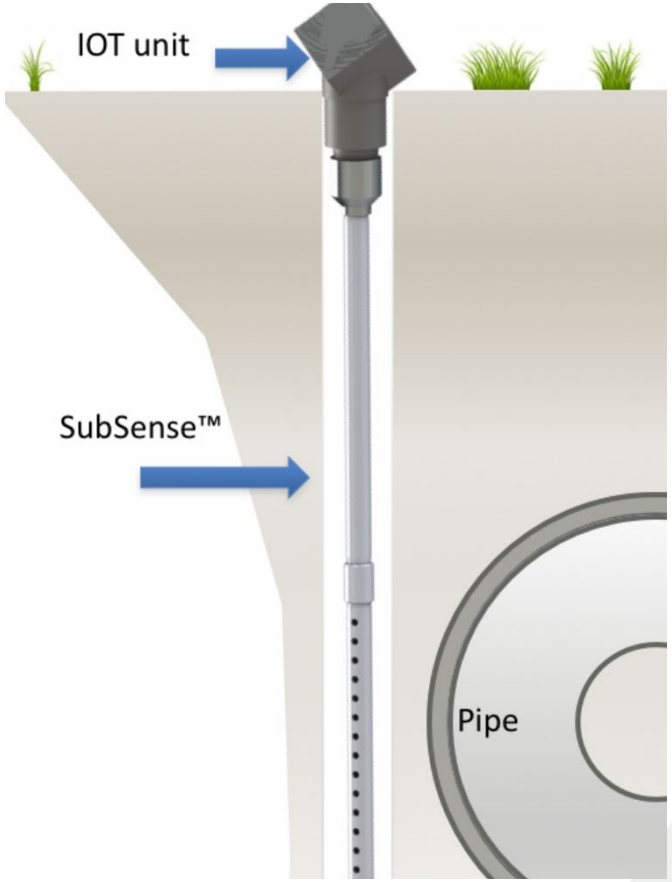
Development

- Pushed technology beyond HC application exploring PW.
- Enhanced installation methods, product hardware, alarm algorithms, and remote communications.

Success

- In use in North Dakota.
- Achieved growth in eight states, Canada, and Europe.





INGU SOLUTIONS

Application

- Advanced in-line inspection.
- Advanced technology for gathering lines that are otherwise difficult to inspect.

Development

- Demonstrated Pipers capability in operational pipelines.
- Developed launch and receive methods.
- Validated repeatability between free-floating and cleaning pig deployments.

Success

- INGU has operated in North Dakota and inspected over 300 pipelines for over 100 customers in 15 countries, building a network of nine agents.

SATELYTICS

Application

- Leak detection from space.
- Advanced processing and algorithms of satellite data to provide actionable alerts.

Development

“We often state that iPIPE was beneficial in providing copious amounts of data to train our algorithms. With 3 years of weekly monitoring, our algorithms were provided with an extensive training opportunity.” – Sean Donegan, Satelytics President and CEO.

Success

- Deployed on Hess assets in North Dakota
- Deployed commercially in North Dakota on the Pelican Pipeline system.
- Projects with BP: leak detection and chemical and carbon accounting.
- Duke Energy (methane), Central Hudson Gas & Electric, Washington Gas, Southern Company, ADNOC, SoCalGas, ItalGas, Oxy, Dominion Energy.

TOKU

Application

- Leak detection.
- Advanced pressure sensing applying ML.
- Ability to detect anywhere along a pipeline system.

Development

- Distinguish between operational signals such as pump-off vs. leaks in gathering lines.
- Completed tests and advanced ML algorithms.
- Development of Illumass (customer monitoring package).

Success

- ML can distinguish similar signatures, operational vs. leaks.
- Can detect leaks in the presence of changes occurring simultaneously.
- Sensors presently in use in North Dakota.