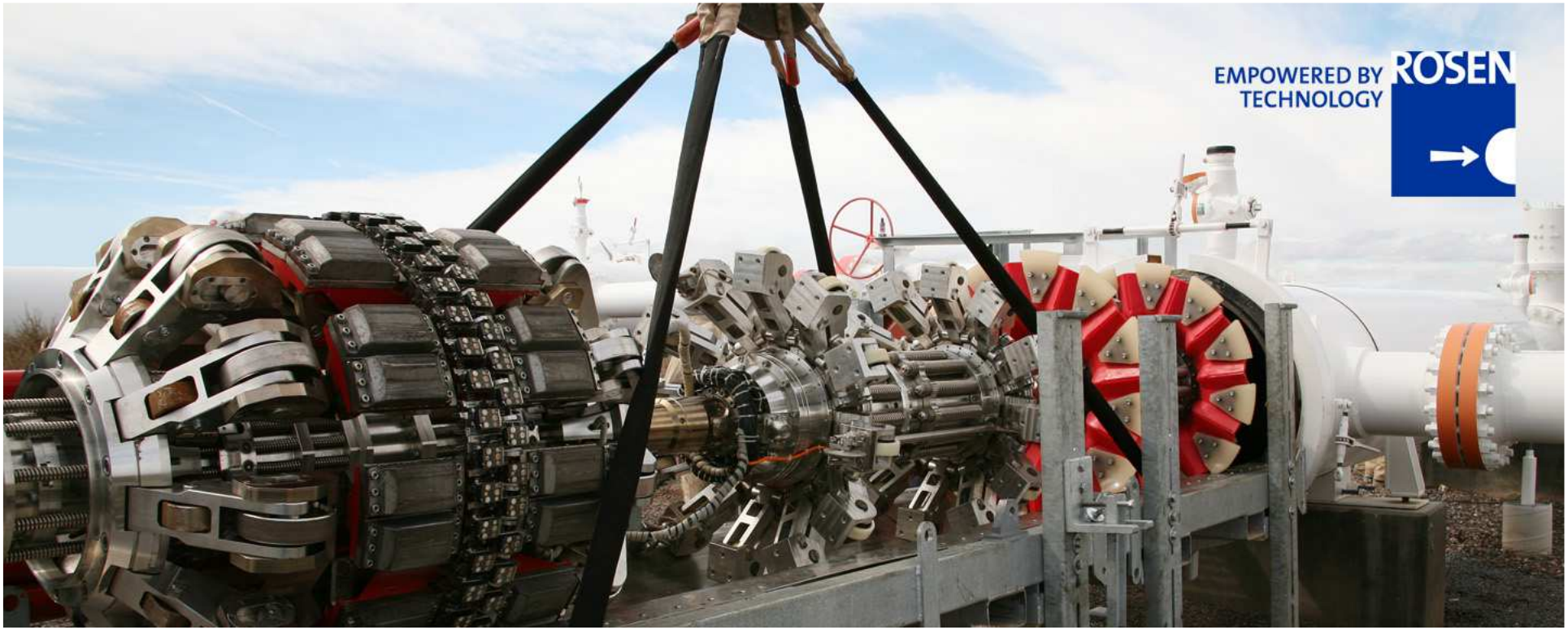

Water Pipelines:

Reducing the Costs of Corrosion through In-Line Inspection

Wechselspannungskorrosion / Messe in Luzern / Wasserleitungen Mai 2012

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Some Market Highlights

- *2009-10: 2.5 million m3/d water in England and Wales lost through leakage.
- **Alone in the USA there are 240,000 water main breaks per year.
- The number of breaks are increasing substantially near the end of their system's service life.
- ***The US EPA has estimated that if spending for capital investment, operations and maintenance remain at current levels, the potential gap in funding for 2000–2019 would be approximately $263 billion for our drinking water infrastructure.
- ***2,000 years since the Romans built their aqueducts. 200 years since Philadelphia began using cast-iron. The 6-inch-Wooden pipe still delivers drinking water on Nixon Street!

*UK Department for Environment Food and Rural Affairs
**US EPA
***The New York Times

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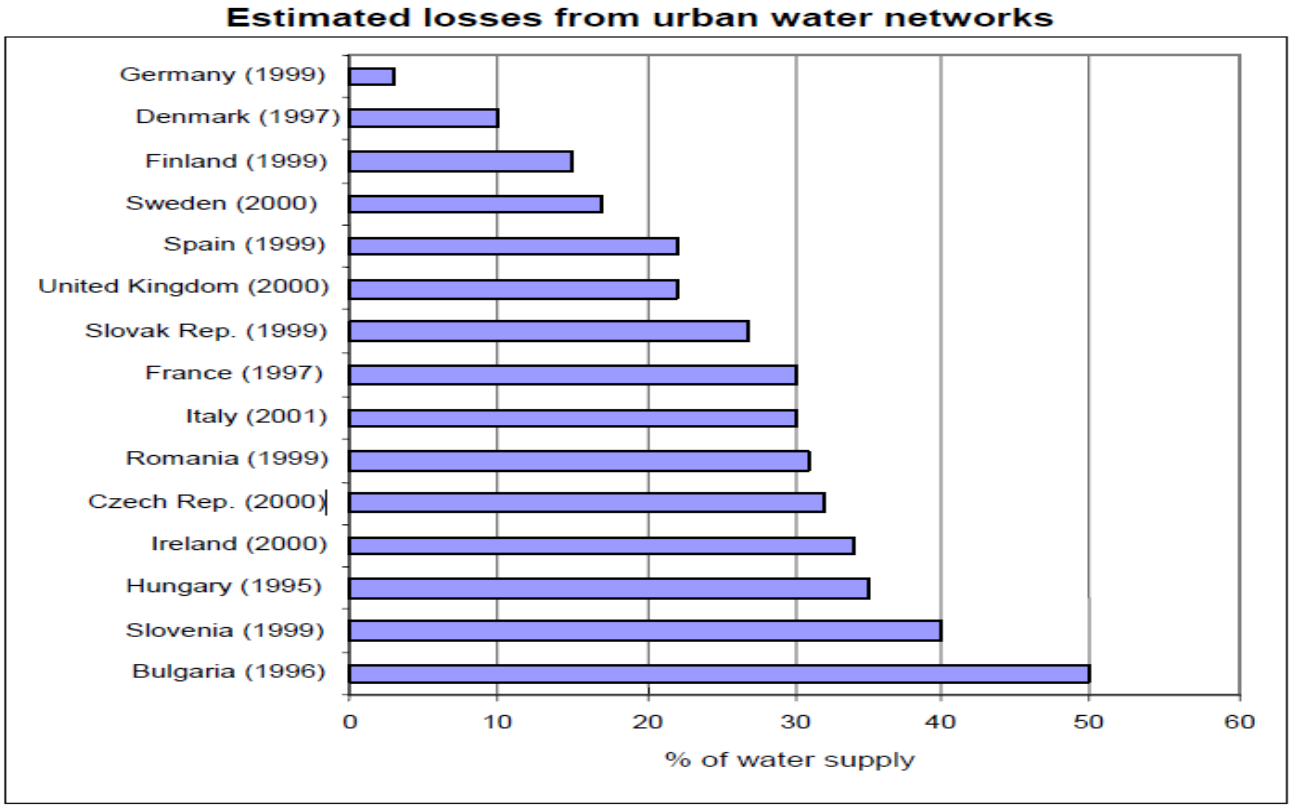
European Statistics



Source: EEA, from different sources

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Example: USA

Aging water infrastructure will cost the U.S. $147 billion over the next decade

- Water Infrastructure in The US is aging and overburdened and investment isn't keeping up with need.
- In 2020, it is projected that there will be a shortfall of more than $80 billion.
- According to EPA reports the $80B shortfall will be required for:
  - ✓ Treatment Plants. Upgrading and Replacement
  - ✓ Pipe related. Drinking Water 60% are pipe related. Waste Water 28% are pipe related
- In 2020 total cost burdens will be: Household at $60B; Businesses at $150B and over $400B loss in GDP

*Water World Weekly Dec 2011

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Factors Causing Deterioration

Al-Barqawi and Zayed (2006), classified the cumulative detrimental effects on piping into Physical, Environmental and Operational categories

Physical Factors

- Age & Material
- Wall Thickness
- Diameter
- Joint type
- Lining and Coating
- Dissimilar metals
- Installation
- Manufacture

Environmental Factors

- Bedding
- Trench Backfill
- Soil Type
- Ground Water
- Climate
- Pipe Location
- Disturbances
- Stray Electric Currents

Operational Factors

- Internal Water Pressure
- Leakage
- Water Quality
- Flow Velocity
- Backflow potential
- Operation & maintenance practices

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What Technologies are available?

	Metal	Concrete	Plastic
Visual Inspection	Yes	Yes	Yes
Pit Depth	Yes		
Acoustic Inspection	Yes	Yes	Yes
Ultrasonic Inspection	Yes	Yes	
Radiographic Testing	Yes		
Thermographic Testing	Yes		
Sensor Technologies	Yes	Yes	
Electromagnetic Inspection	Yes	Yes	

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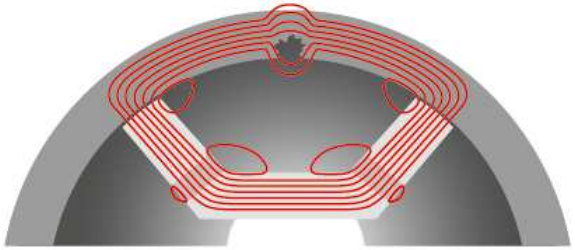
Water Pipeline Inspection today

Magnet Flux Leakage Inspection Method

Application: Iron & Steel pipelines (In Service)

Metal loss features in the wall of a pipe, saturated with magnetic flux, will cause some of the magnetic field to leak out of the pipe. This leakage field can be detected and used to assess feature classification, geometry and severity.



RoCorr-CMFL measurement principle

Acoustic Methods

Application: All Pipelines (In Service)

Acoustic sensors have been developed over the last years which have the capability to detect leaks. These work by detecting the specific acoustic signals typically produced in a leaking area of pipeline.

4water Ltd

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Water Pipeline Inspection today

Visual Inspection

Application: Large Diameter All Pipelines (Off-Line)

Visual inspection involves physically entering a pipe for visual for detection of any features such as longitudinal cracks and other problems that may be apparent.

Robotic Methods

Application: All Pipelines

There are various robotic methods of inspection and they all tend to employ either visual, acoustic or magnetic detection methods..

R&R Visual Inc

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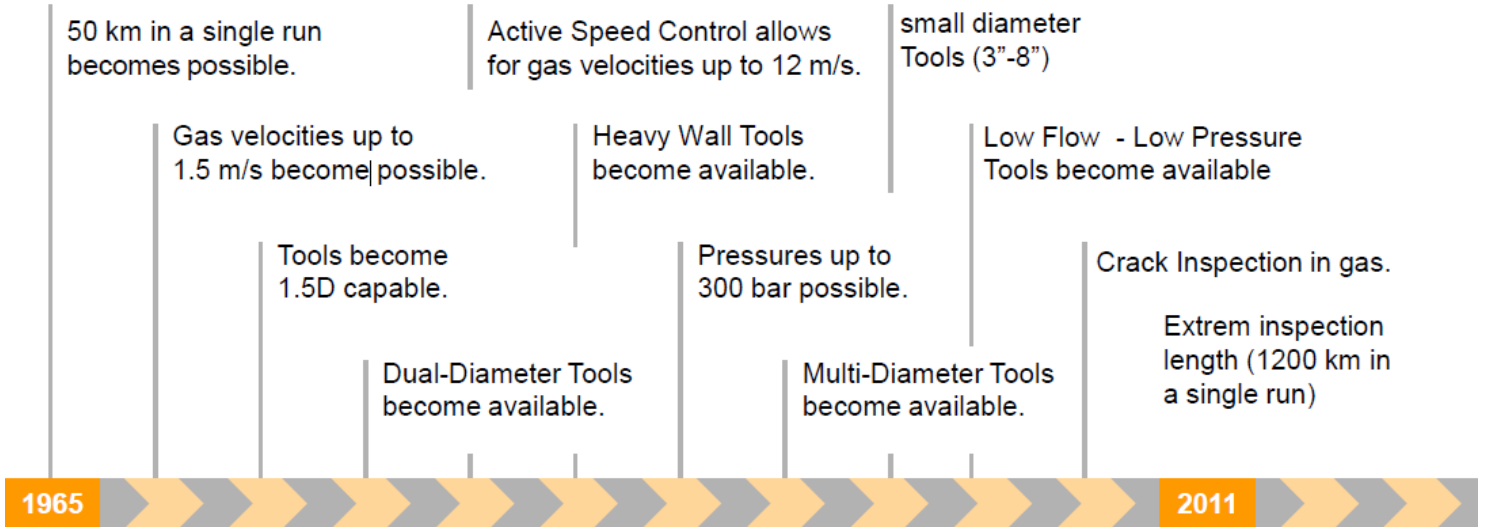
Energy Pipeline Inspection today

The In-line inspection of oil and gas pipelines is a common process with roughly 250,000km of pipelines inspected with in-line inspection tools each year by the industry.

Evolutional Process



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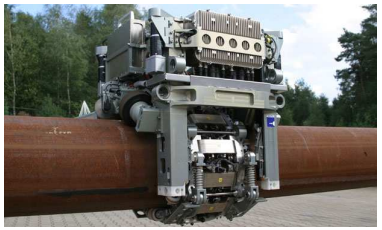
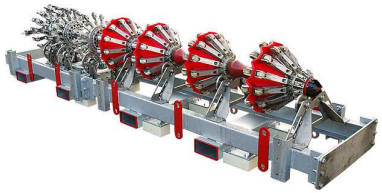
Energy Pipeline Inspection today

Development has lead to a highly specific and specialized industry.

- Ultrasonic Crack Detection
- Multi Diameter
- Mapping
- Optical
- MFL Metal Loss
- Ultrasonic Corrosion
- MFL / UT Combo
- MFL / SIC Combo
- Bi Directional
- Robotic
- EMAT Crack Detection
- EMAT Corrosion





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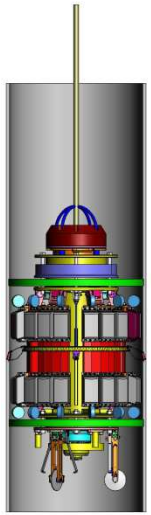
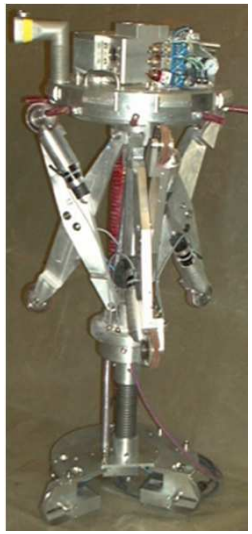
From Energy to Water Pipeline Inspection

Years of development within the Energy sector means that expertise and experience are at hand.





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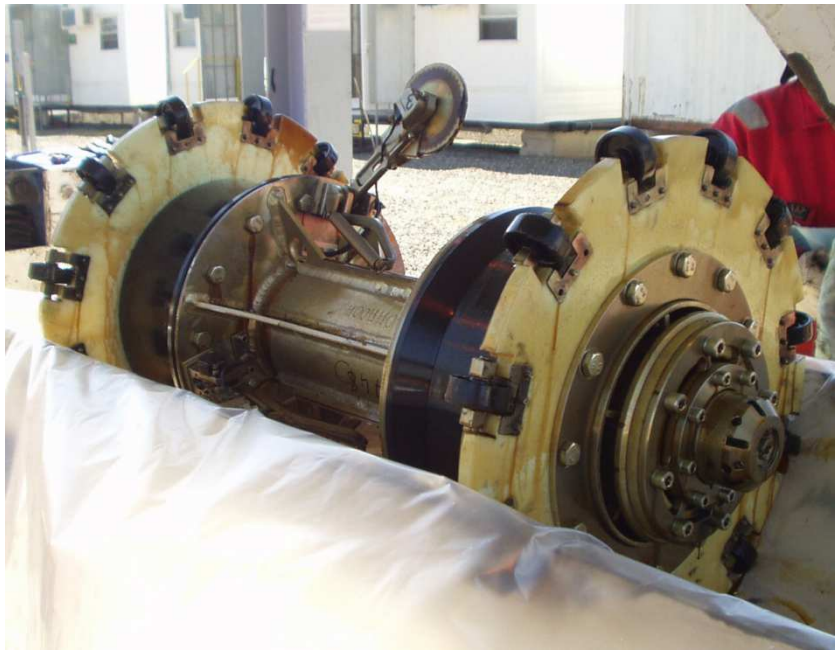
From Energy to Water Pipeline Inspection

Years of development within the Energy sector means that expertise and experience are at hand.

In-service Leak Detection

In the event of a leak in a pipeline, the liquid moves from a high pressure area to a low pressure area. As it passes through the leak site, a turbulent flow is generated which is associated with strong ultrasonic components.



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From Energy to Water Pipeline Inspection

Years of development within the Energy sector means that expertise and experience are at hand.

An in-service Solution for:

- Leak Detection in Water Pipelines
- Estimation of leak size
- Reporting of leak location
- Pipeline diameters 16” to 64”
- During operation Pipelines pressurized but without flow

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The Challenge to Inspect

- **Energy Pipelines** have evolved from pipes to structures which accommodate ILI Inspection Technology

  Unpiggable to piggable:
  - Accommodating bends
  - Unified Pipe diameters
  - Launch capabilities
  - Exit capabilities

- **Water Pipelines** are well over service lifetime and little has changed to accommodate inspection technologies over the last decades.

- **Energy Pipelines** have been under continuous inspection and rehabilitation for many years making systems easier to control.

- **Water Pipelines** on the whole, have been neglected for the majority of their lifetime and there exists major disrepair making any attempt at inspection difficult

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The Drive to Inspect

Why Inspect pipelines:

- Loss of Production
- Safety
- Company Image

For an Energy company, all three points are paramount.

- Loss of production leads to loss in profits.
- Safety, or lack of, can mean catastrophic loss of life.
- Environmental issues or safety issues can severely effect image and can even shut a company down

For a Water company, all three points are concerns.

- Loss of production leads to hose pipe bans
- Safety is a small concern since damage is relatively confined to property
- Environmental issues or safety issues are relatively low key

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Without a large overall risk, Inspection will be limited!

Risk = Probability x Consequences

$R_e = P_e \times C_e$	
Oil & Gas Consequences	Water Consequences
Leak leading to: - Environmental clean-up and high associated cost - Explosion Hazard - High risk of multiple loss of life - Loss of production - High shut down and remedial costs - Image loss in a competitive market	Leak leading to: - Interruption of Domestic supply leading to shortage - Interruption of Industrial supply leading to down time - Flooding of residential and industrial areas - Property damage - Low risk of loss of life

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Water Pipeline Inspection case Study

Years of development within the Energy sector means that expertise and experience are at hand.

ROSEN Research and Development were charged with the task of inspecting a dual freshwater pipeline in the UAE.

A desalination plant on the East coast of the UAE, producing 380 million liters of drinking water per day, was transporting water into the desert areas. This was done using 64” (1,63m dia) dual pipelines at 180km in length. In a short time, ROSEN had successfully inspected the complete system for ovality and dents. A record was broken in producing the largest such tool for the water pipeline inspection.

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The Conclusion

- For decades global water systems under state control – little commercial pressure for remediation
- Much of world's water systems so old that defects must be prioritized by inspection to save huge costs
- Inspection of water pipelines has been driven in recent years by higher demand via population increase, adverse changes in weather patterns and political pressures
- As demand for inspection by water companies increases, ILI vendors will develop customized inspection solutions for them

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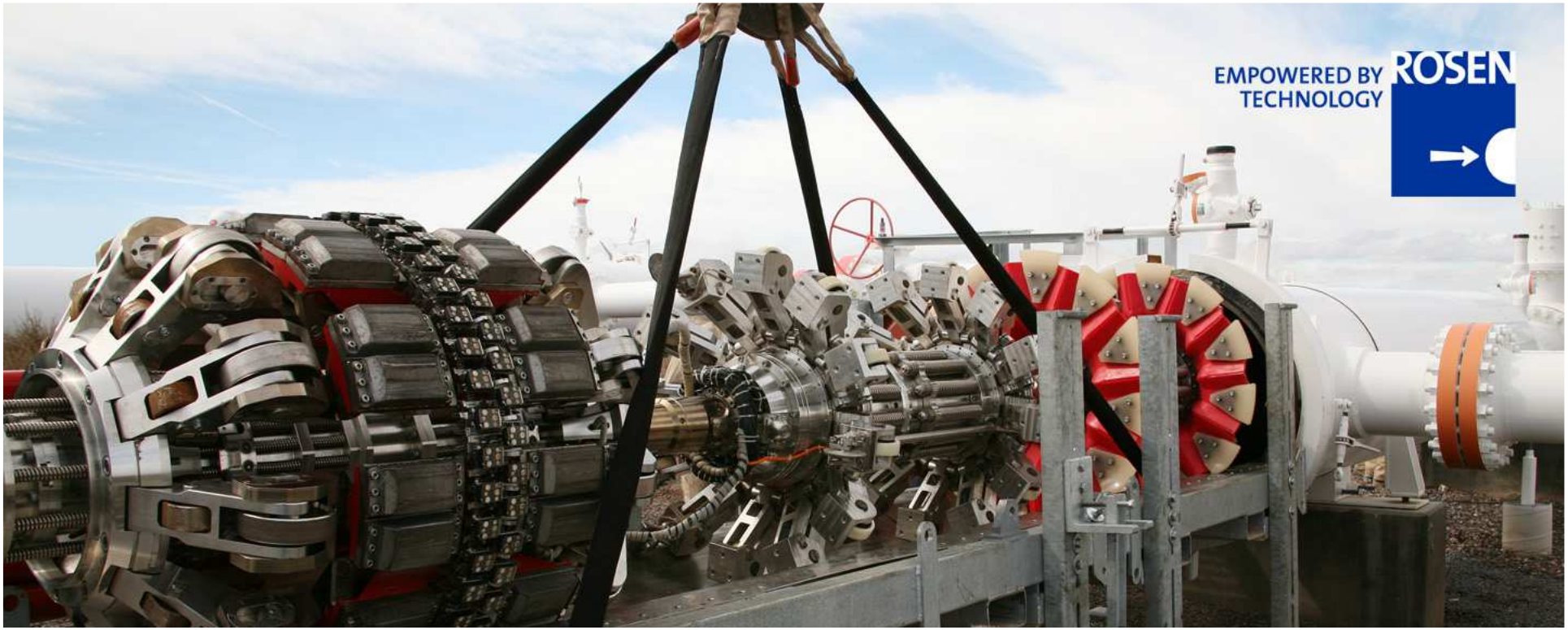

Thank you for joining this presentation.

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