In-line inspection system advances and future outlook

Timo Moritz

ROSEN Technology and Research Center

The ROSEN Group

ROSEN
empowered by technology

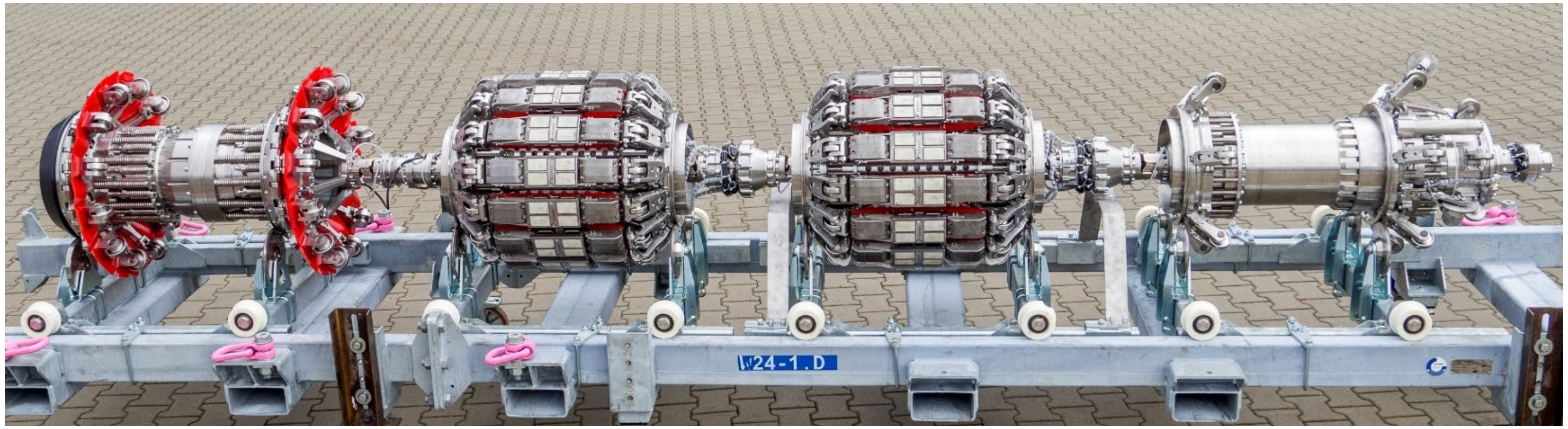
THE INLINE INSPECTION SYSTEM
STATUS QUO

Market Demands	Technical Opportunities
• Addressing new or complex threats • Higher accuracies • Faster developments • Getting more out of data • Reducing operational impacts • …	• Artificial Intelligence • New development approaches • Technology advancements • Computing Power • Combination of technologies • ….

- ➢ Solutions for future needs resulting in more complicated developments
- ➢ Technical Systems are getting more complex

THE INLINE INSPECTION SYSTEM
WHAT THE MAJORITY HAS IN MIND

ROSEN
empowered by technology



THE INLINE INSPECTION SYSTEM
WHAT THE TECHNICAL SYSTEM ACTUALLY IS

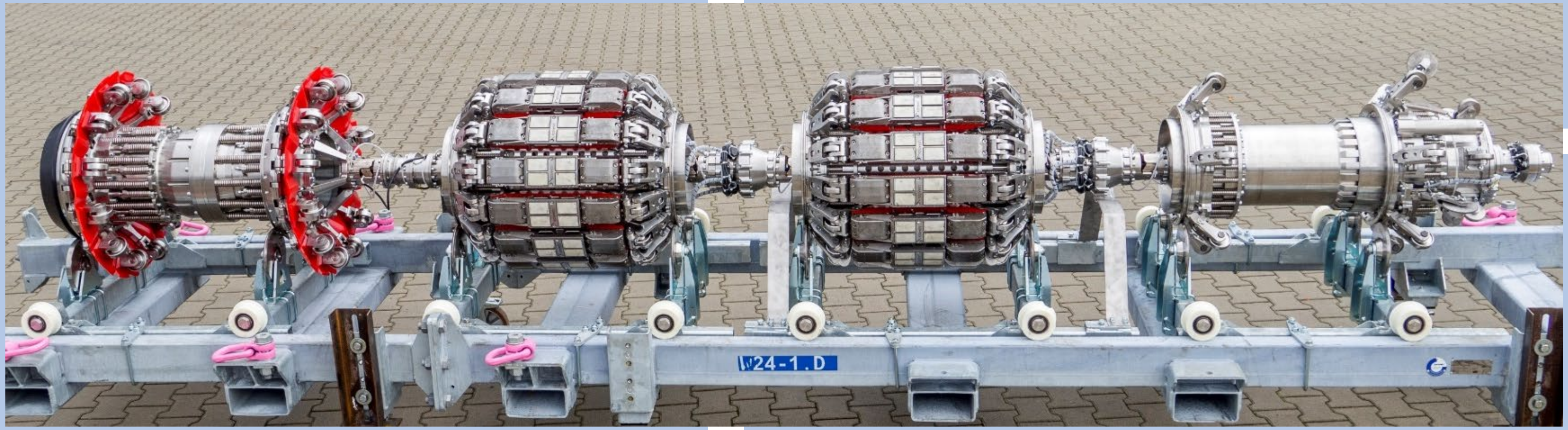
ROSEN
empowered by technology

Processes

- Sales Process
- Supply Chain
- Product Lifecycle Mgmt.
- Continuous Improvement
- Operations Process
- Evaluation - Process
- Maintenance - Process

Software

- Evaluation Software
- Tool Software
- Reporting Software
- Business Software



Documentation

- Sales Flyer
- Technical Documentation
- Training
- Specifications
- Contracts

Auxiliaries

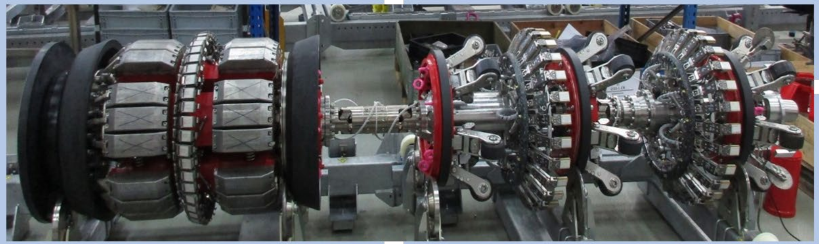
- Accessories (Devices)
- Launching & Receiving
- Tracking & Locating

THE INLINE INSPECTION SYSTEM
WHAT THE TECHNICAL SYSTEM ACTUALLY IS

- Creating more complexity by combining multiple technical systems to one solution concept…

Processes
- Sales Process
- Supply Chain
- Product Lifecycle Mgmt.
- Continuous Improvement
- Operations Process
- Evaluation - Process
- Maintenance - Process

Software
- Evaluation Software
- Tool Software
- Reporting Software
- Business Software

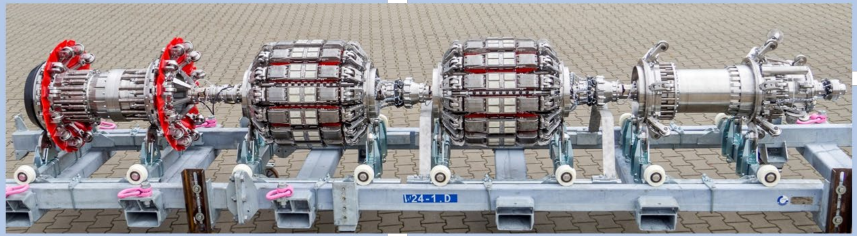


Documentation
- Sales Flyer
- Technical Documentation
- Training
- Specifications
- Contracts

Auxiliaries
- Accessories (Devices)
- Launching & Receiving
- Tracking & Locating

Processes
- Sales Process
- Supply Chain
- Product Lifecycle Mgmt.
- Continuous Improvement
- Operations Process
- Evaluation - Process
- Maintenance - Process

- Evaluation Software
- Tool Software
- Business Software



Documentation
- Sales Flyer
- Technical Documentation
- Training
- Specifications
- Contracts

Auxiliaries
- Accessories (Devices)
- Launching & Receiving
- Tracking & Locating

THE TECHNICAL SYSTEM
SUMMARY

- The ILI System is more than just the visible inspection device
- Trend from hardware to data and algorithm development
- Focus on data management and data analysis (machine learning, AI, etc.)

Data Gathering → Data to Information → Information to (new) Information → Information to Decision

Main message:

→ Support the change from Inspection (or Assessment) to Data Management

→ Combining of data from different sources becomes more and more important

→ Framework for implementation in process world


VUCA World
change
business
making
volatility
success
consider
dimensions
purpose
evolving
agile
choice
confusion
confused
opportunities
strategy
alternatives
dilemmas
focus
question
solve
management
dealing
world
understood
preferences
outstanding
mission
adaptable
analysis
leaders
decision
counseling
initiative
competencies
problems
predictability
uncertainty
learning
complex
talent
leadership
doubt
events
profits
complexity
ambiguity
future
problem
changing
uncertain
journey
choose
trends
seeking

Artificial Intelligence

ARTIFICIAL INTELLIGENCE
DEVELOPMENT IN PIPELINE INDUSTRY

ROSEN
empowered by technology

today → future

Supportive AI	Predictive AI	Generative AI
Reviews big data to provide additional information for human decisions	aims to forecast outcomes and decision-making based on existing data	focused on creating new content or data that wasn't in the original dataset
e.g. Quality Control	e.g. Virtual ILI	e.g. Autonomous Data Evaluation

- Current industry focusing on supportive AI
- But predictive and generative AI is likely to be used on a large scale in the next 10 years

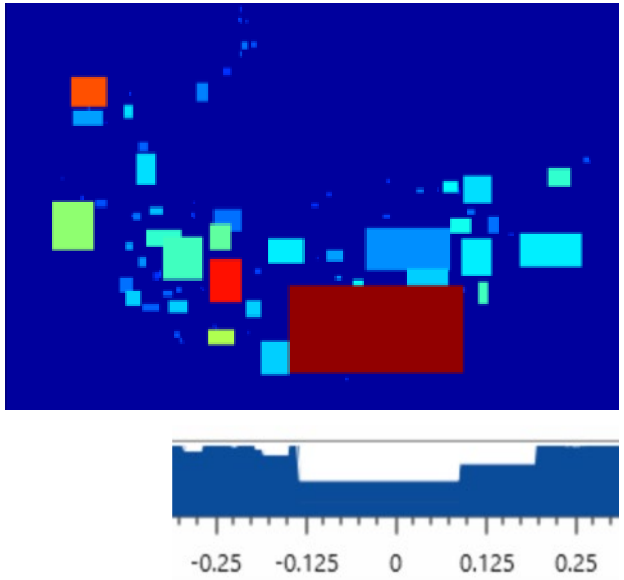
ARTIFICIAL INTELLIGENCE
ADOPT INTERNATIONAL AND INDUSTRY REGULATIONS

ARTIFICIAL INTELLIGENCE
EXAMPLE: DATA FUSION

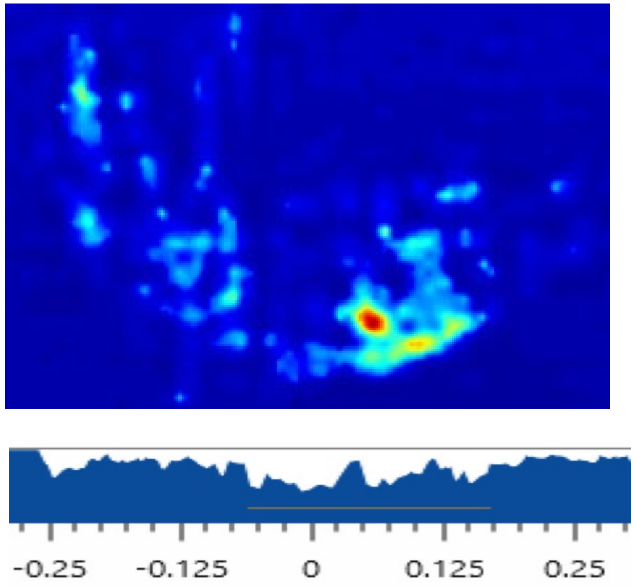
Fuse complementary information from MFL-A and MFL-C, to reconstruct the depth profile of metal loss - corrosion anomalies.

Boxes vs Profiles

Boxes



Profile

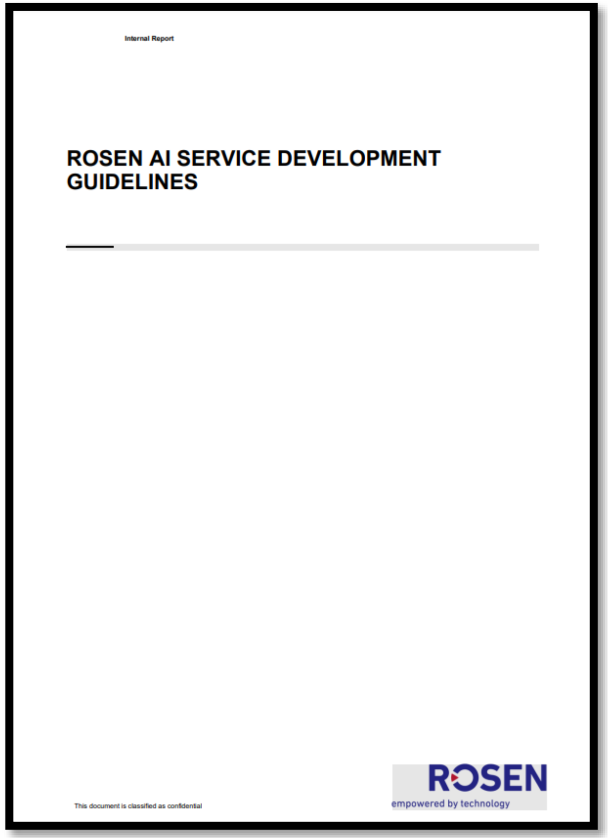


→ Failure pressure calculations are much less sensitive to individual depth measurements of the river-bottom profile and avoids introducing conservatism by boxing areas of metal loss - corrosion

- Feature boxes outdated
- 3D profiles of anomalies should be the future goal

ARTIFICIAL INTELLIGENCE
GUIDELINE

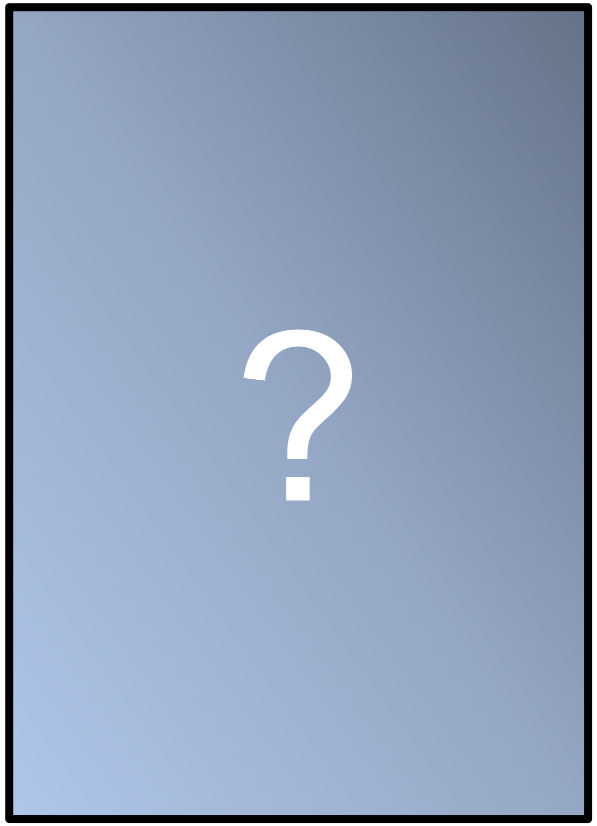
ROSEN internal AI guideline established


Internal Report

ROSEN AI SERVICE DEVELOPMENT GUIDELINES

This document is classified as confidential

Industry guideline for AI needed



Guideline for
Implementation and Usage
of Artificial Intelligence

ARTIFICIAL INTELLIGENCE
GUIDELINE

- AI applications open-up a wide range of new technical possibilities.
- Guidelines for the Usage and Implementation are currently missing
- The basis for AI applications are large volumes of high-quality data
- Standardized data formats (e.g. field documentation) are not available
- Quality of data varies greatly
- Data is not often shared

Main message:

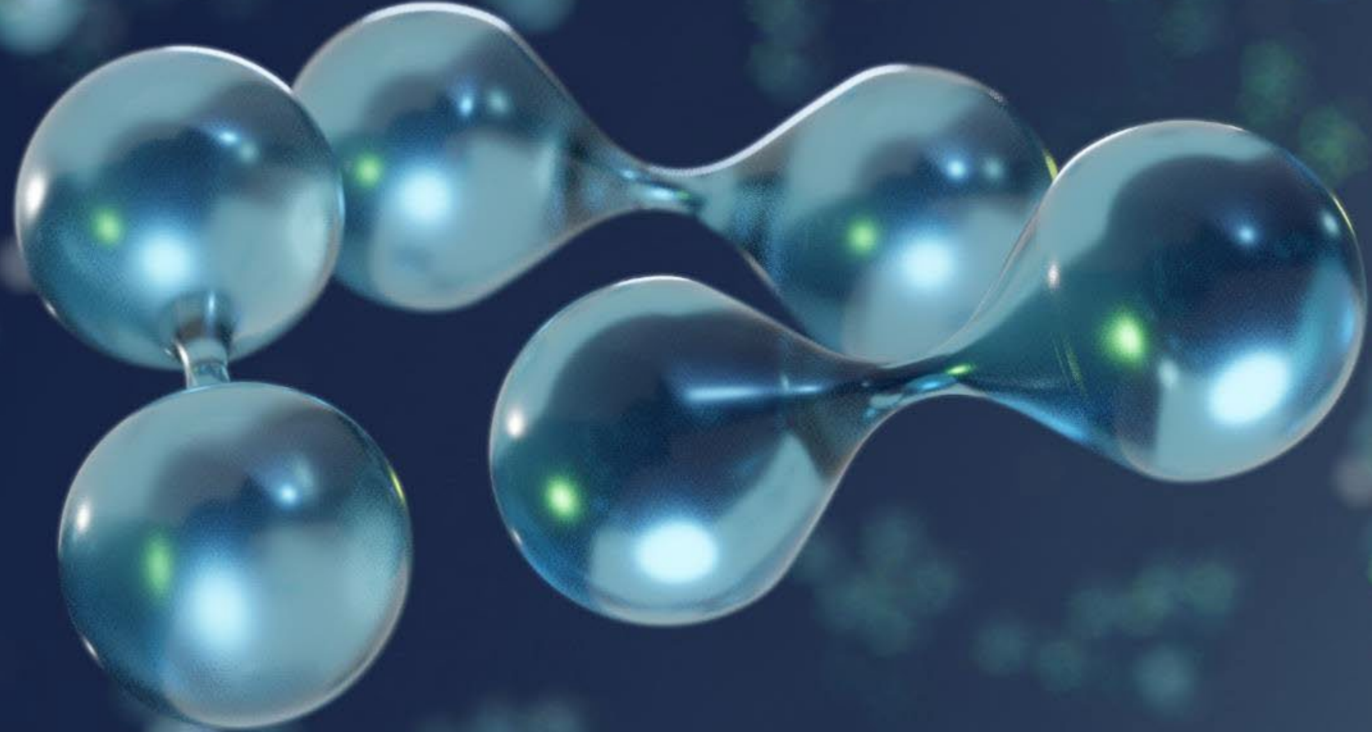
→ Existing standards need to be reviewed and adapted

→ Data Exchange formats required (e.g. in-field results)

→ Data Sharing is beneficial for the industry

→ Enable AI possibilities

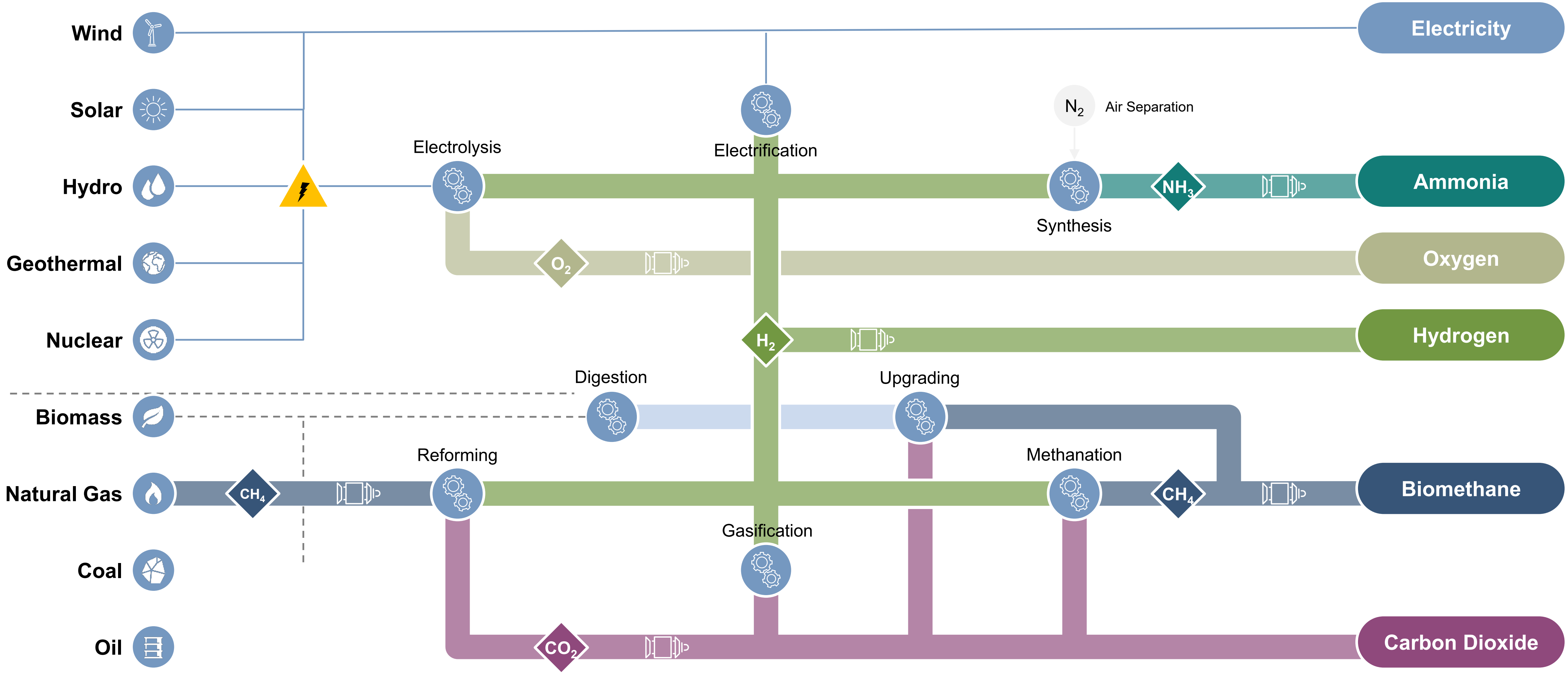
empowered by technology



Emerging Fuels

EMERGING FUELS
MORE DIVERSIFIED FUTURE ENERGY SYSTEM

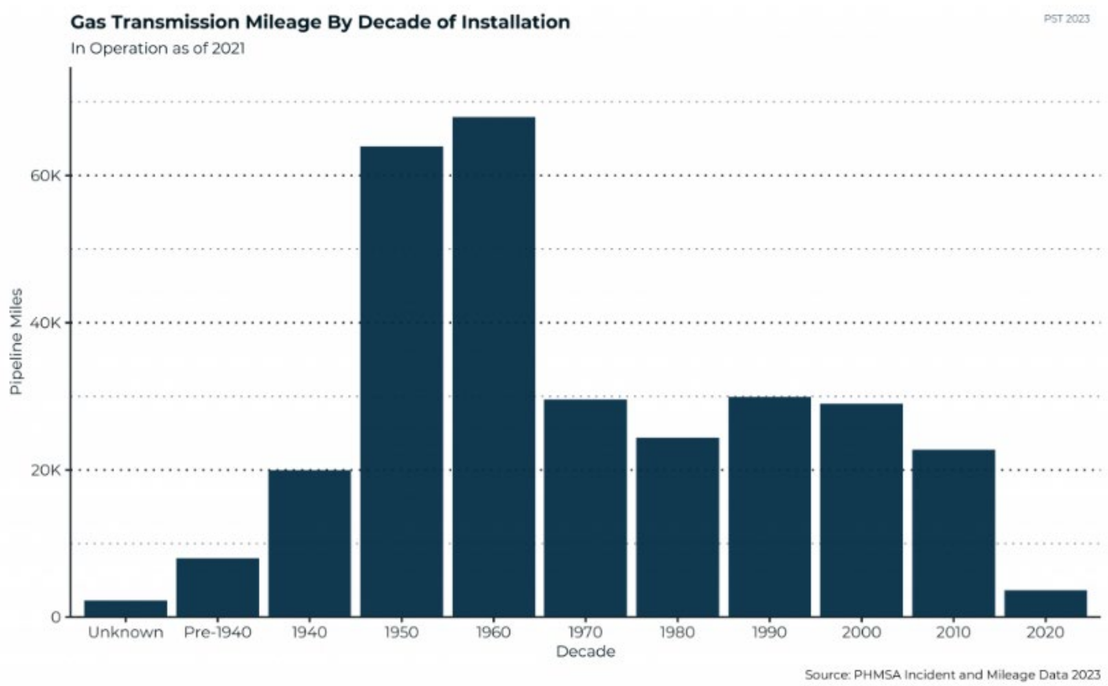
ROSEN empowered by technology



EMERGING FUELS
THREATS TO MANAGE IN FUTURE FUEL PIPELINES

ROSEN
empowered by technology

Root Cause of the Threat	Threat	Feature Type
Standard threats for pipelines, not product related	external corrosion	metal loss
	third party damages	dents, gouges
	geo hazard	bending strain
	manufacturing / construction (materials and welding)	crack-like / cracks
	external environmental assisted cracking (EAC)	cracks
Hydrogen	material embrittlement	low fracture toughness under H2 environment
	hydrogen cracking damages	cracks
	additional considerations	hard spots, geometry anomalies, bending strain
Carbon dioxide	Ductile fracture	low material toughness
	internal corrosion	metal loss
	internal SCC	cracks
Ammonia	internal SCC	cracks
	internal corrosion	metal loss



Key question: What does the anomaly population in a pipeline look like?

EMERGING FUELS
WHAT IS NECESSARY TO MAKE IT A SUCCESS?

ROSEN
empowered by technology

- A key enabler for the energy transition is the ability to safely and economically transport emerging fuels
- We've learned a lot in 50 years when we introduced oil and gas transportation via pipeline
- We do not have the next 50 years for the emerging fuels.

→ We must learn effectively how to manage pipelines operated with emerging fuels

→ Quick access to meaningful results

Main message:

- Material testing is necessary
- Sharing of experiences and results is beneficial for effective learning
- Adjustment of integrity assessment standards (e.g. ASME B31.12 to ASME B31.8)

THANK YOU

FOR JOINING THIS PRESENTATION