

The Role of AI in accelerating Decarbonization in Processing Industries

TNChE Asia 2024 Conference
20 June 2024

Thomas Luedi
Senior Partner

BAIN & COMPANY 



TNChE Asia 2024

An abstract graphic on the left side of the slide featuring a series of glowing red dots and lines that form a wave-like, digital pattern against a dark background.

Key messages

Process Industry Executives expect to **reach net zero carbon emissions between 2050 and 2070** and believe AI to be a major accelerator of decarbonization

Two thirds of surveyed executives are already or will use AI significantly in the next 1-2 years; **predictive maintenance, supply chain optimization, production innovation** are major use cases; first movers expected to gain sustainable competitive advantage

Deploying AI across maintenance, supply chain and product/process innovation delivers ~20% higher efficiency while **lowering carbon emission by 15% in each area**

GenAI is further amplifying these benefits

Implementing AI/GenAI is hard. **Think big, start small and scale fast.** Operating model adjustments and change management as critical as developing the right use cases

AGENDA

Executive Perspectives: Artificial Intelligence and Decarbonization

Harnessing AI to accelerate
Decarbonization in Process Industries

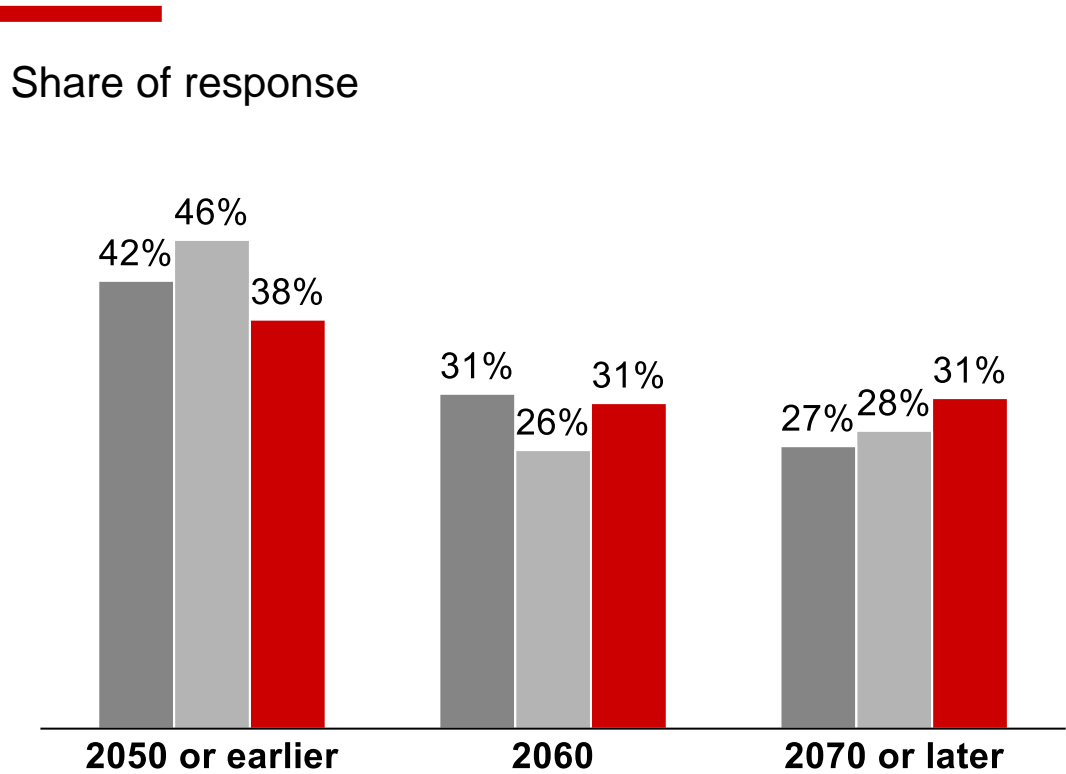
Key Insights: Implementing Successful
AI Transformations

Most energy and natural resources executives expect the world to reach net-zero emissions by 2060 or later

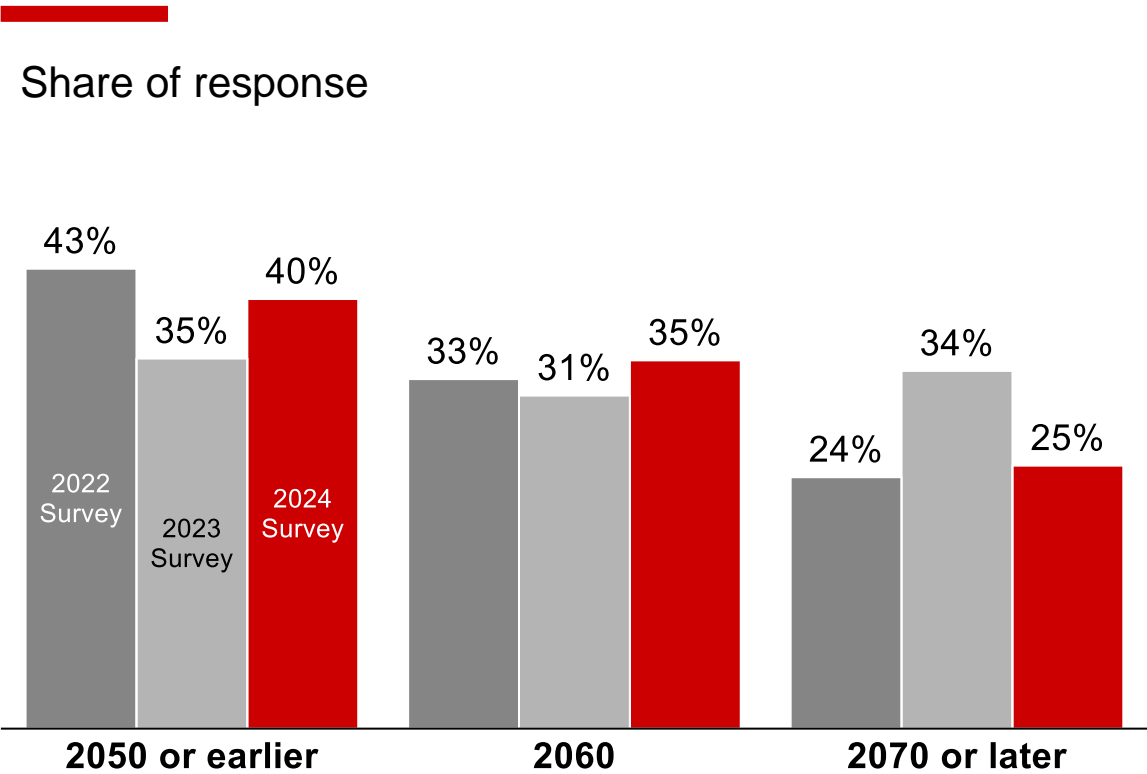
2022 Survey 2023 Survey 2024 Survey

How soon do you expect the world to reach Net Zero?

Energy & Natural Resources executives



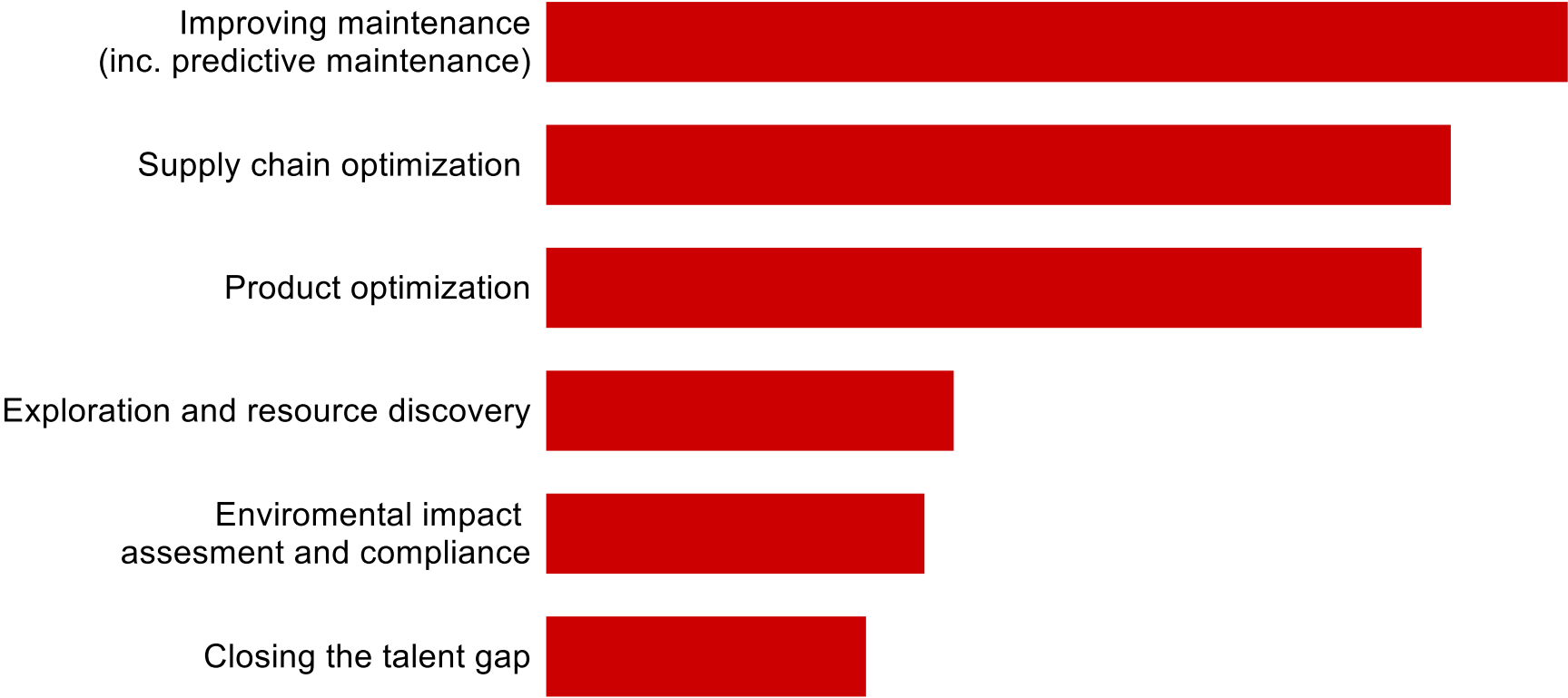
Chemical executives



Sources: Bain ENR Transition Survey 2022 (N=1037) - Chemicals (N=173); Bain ENR Transition Survey 2023 (N=608) - Chemicals (N=175); Bain ENR Transition Survey 2024 (N=638) – Chemicals (N=121)

Energy & Chemicals executives see AI as a technology that has the potential to help improve maintenance, optimize supply chains optimization, and innovate products

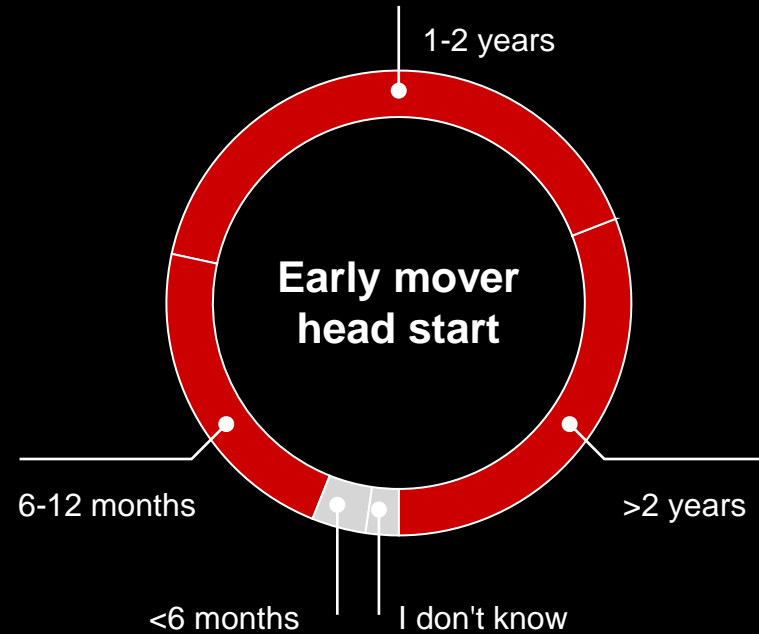
Share of executives who think that generative AI would have a significant impact on these function



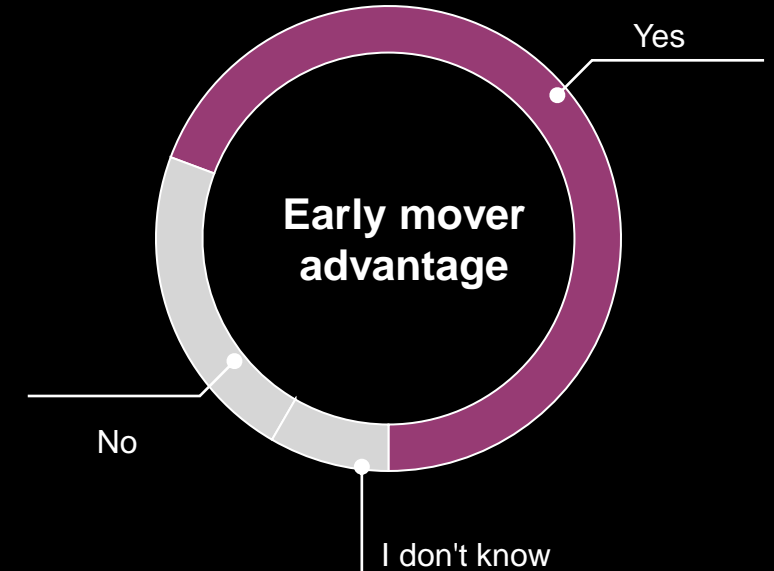
Note: Only includes response from those who expect significant impact from AI and digital technologies on their businesses by 2030; not all categories of potential generative AI use cases are shown
Source: Bain ENR Transition Survey 2024 (N=638) – Chemicals (N=120)

Substantive
change to basis of
competition,
leaving those who
“**wait-and-see**”
behind

2/3 of the industry participants
believe early movers will have
a sustained advantage which
will not level off



How far ahead would you
estimate AI early movers
are in your industry?



Do you believe these early
AI movers will have a
sustainable advantage?



AGENDA

Executive Perspectives: Artificial Intelligence and Decarbonization

**Harnessing AI to accelerate
Decarbonization in Process Industries**

Key Insights: Implementing Successful AI Transformations

Artificial Intelligence can already today, help to significantly reduce carbon emissions, while creating economic benefits

AI to improve maintenance

25%

Improved reliability

20%

Less energy usage

15%

Lower carbon emissions

AI to optimize supply chain

20%

Lower inventory holding costs

15%

Lower logistics costs

10%

Lower carbon emissions

AI to innovate products/processes

25%

Lower R&D costs

20%

Faster time to market

15%

Lower carbon emissions

AI is already widely used by Chemicals companies in (predictive) maintenance ...

Source: Literature search, company website, expert interviews, Bain analysis



The Chemical Company

AI-driven maintenance for steam cracking units

- AI monitors steam cracking units, analyzes sensor data for predictive maintenance
- Reduces unplanned outages, improves unit efficiency, lowers energy usage and emissions

Benefits 25% lower unplanned outages, 18% higher unit efficiency, 12% lower energy use, 15% emissions decrease



Predictive maintenance in polymer production

- AI monitors polymer production equipment, identifies wear and potential failures
- Improves reliability and reduces downtime, minimizes energy waste and carbon emissions.

Benefits: 22% higher reliability, 30% lower downtime, 15% less energy waste, 14% lower carbon emissions



AI-based maintenance for compressors and pumps

- AI enhances maintenance of compressors and pumps, analyzes vibration, temperature, and pressure data
- Extends equipment lifespan, reduces maintenance costs and environmental impact

Benefits: 20% longer equipment life, 18% lower maintenance costs, 12% higher equipment efficiency, 10% less environmental impact



AI-enhanced maintenance for distillation columns

- AI predicts maintenance needs for distillation columns, analyzes operational data for optimization
- Improves efficiency and reduces energy use, lowers greenhouse gas emissions

Benefits: 20% higher distillation efficiency, 15% lower energy use, 10% lower greenhouse gas emissions.



AI-driven demand forecasting and inventory management

- Implements AI for more accurate demand forecasting
- Optimizes inventory levels across the supply chain, reduces stockouts and overstock situations

Benefits: 20% reduction in inventory carrying costs, 25% better demand forecast accuracy. 15% reduction in lead times; 10% decrease in emissions due to optimized logistics and reduced waste



AI-enhanced supplier management

- Uses AI to evaluate supplier performance and risk
- Enhances supplier selection and relationship management, optimizes procurement processes

Benefits: 15% lower procurement costs, 20% better supplier reliability, 10% shorter lead times. 8% decrease in emissions due to efficient supplier networks and reduced waste



AI for end-to-end supply chain visibility

- AI provides real-time visibility across the supply chain
- Enhances decision-making with predictive analytics, optimizes logistics and reduces bottlenecks

Benefits: 18% lower logistics and transportation costs, 20% higher supply chain resilience, 10% decrease in emissions from improved logistics efficiency



Enriching lives through innovation

AI-powered inventory optimization

- AI optimizes inventory levels and reduces excess stock
- Balances supply with fluctuating demand, reduces inventory holding costs.

Benefits: 22% lower inventory costs, 18% higher order accuracy, 15% less stockouts and overages. 12% reduction in emissions from minimized waste and optimized transportation

...supply chain
optimization ...

...and product/process innovation

Source: Literature search, company website, expert interviews, Bain analysis



The Chemical Company

AI for chemical research and development

- Utilizes AI to accelerate discovery of new chemical compounds, uses machine learning to predict molecular properties and reactions
- Optimizes formulations for performance and sustainability

Benefits: 30% lower R&D costs, 25% faster time-to-market. Development of products with lower carbon footprint and 20% emission reduction from optimized production processes



AI for advanced material development

- Employs AI to design/develop high-performance materials, utilizes predictive modeling to assess material properties/performance
- Accelerates the innovation cycle for new materials.

Benefits: 15% lower procurement costs, 20% better supplier reliability, 10% shorter lead times. 8% decrease in emissions due to efficient supplier networks and reduced waste



AI for specialty chemical production

- Uses AI to optimize the production of specialty chemicals, improves process efficiency and product quality
- Reduces production variability and waste

Benefits: 15% lower production costs, 18% higher product quality, 12% lower emissions from optimized processes



AI for advanced material design

- Uses AI to design/ develop advanced materials, implements machine learning models to predict material properties
- Accelerates the discovery of high-performance materials

Benefits: 25% lower R&D costs, 20% faster material development cycles, 15% lower carbon emissions through efficient production methods

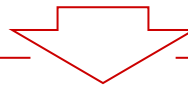
Generative AI creates new content unlike 'regular' AI

Traditional AI/ML

- Focuses on **solving specific tasks in one domain** and cannot generalize to different tasks or different data
- Uses machine learning to learn **patterns / structures in data** and can apply that learning to new data
- Output is usually a **number**
- Typically requires **lots of data** to be trained
- Generally **used to aid in decision support**. Examples:
 - Demand forecasting
 - Propensity to buy
 - Sentiment analysis
 - Object recognition

Generative AI

- **General purpose reasoning engines** that can be applied to many tasks with the right prompt and context
- Focuses on **generating new and original content** (that does not exist anywhere else)
- Output is often **content** (text, images, audio)
- Most advanced model using **much less data**
- Examples of use cases:
 - **Generating new** images, text, music, stories, code
 - **Summarizing** and data **extraction**
 - **Interacting using natural language** – Chatbots and ChatUX
 - ...

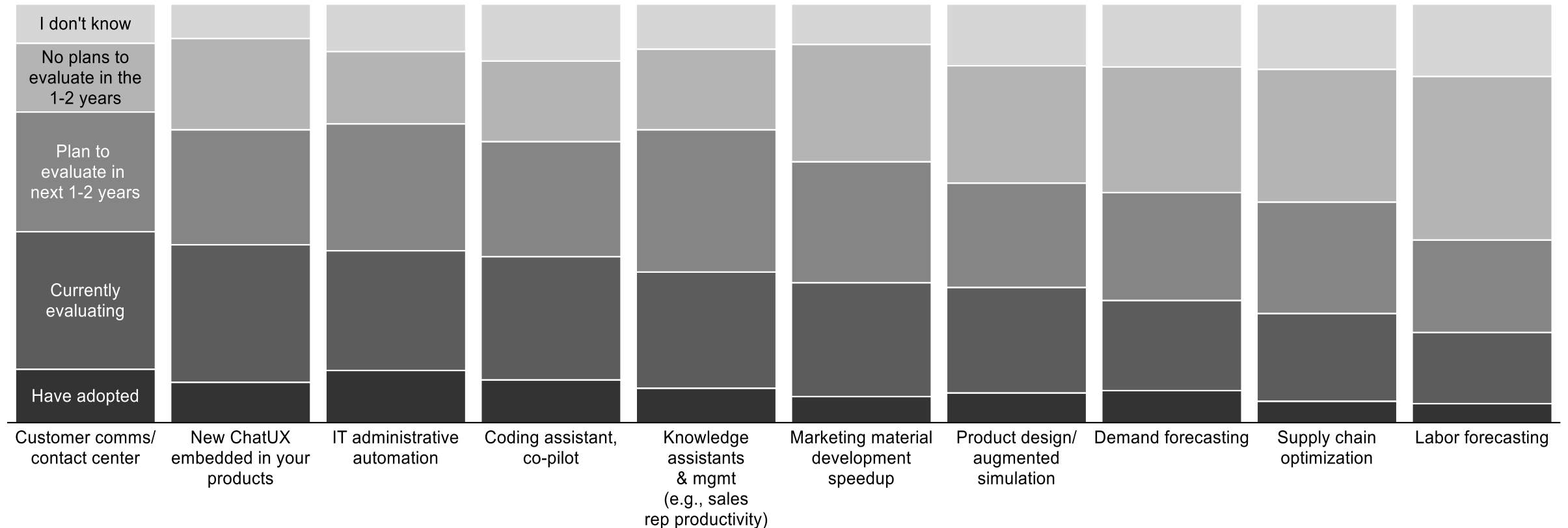


**Generative AI is enabling mostly new use-cases, although it can do some traditional AI/ML tasks.
Combining two can produce very powerful and valuable use-cases**

Two thirds of surveyed companies plan to deploy Generative AI

Top Generative AI use cases

% of enterprises at different stages of Foundation model / GenAI adoption
(across **non-Tech industries**) (N = 353)



GenAI is amplifying the already established benefits of AI

Engineering / maintenance support

AI-enabled chatbot for field operators
enforcing safety procedures and making
broad **technical procedures available** in their
native language

B Maintenance assistant | Empowering maintenance or engineering staff in Industrial

Empower maintenance staff to access procedures in their native languages from an app that enforces safety protocols and offers insights from the equipment's maintenance history. These procedures can be derived from maintenance manuals PDFs pre-processed using OpenAI technologies and linked to the company's maintenance systems for live access to records.

Key insights on maintenance history added to procedures

Integrating insights from maintenance history helps personnel in identifying root causes of issues and boosts requirements and potential pitfalls awareness.

Multi-language on-site guidance to complex procedures

Offering guidance to maintenance staff on complex processes that typically require experts can simultaneously enhance efficiency and decrease downtime.

Reinforce safety protocols to frontline personnel

Safety is a crucial concern for our clients, and emphasizing awareness of safety procedures and potential risks to the frontline is essential in creating a safer company.

TECHNOLOGY CAPABILITIES DEPLOYED

GPT-4 (text/text), Whisper (audio/text), PDF reading and processing, integration with ERP and other company systems (e.g., manuals database)

This demo was created using a Outotec HIGS regrounding mill generic manual and illustrative maintenance data

Use case demo during meeting

Capital project Quality assurance

Generative AI to improve speed and effectiveness of quality assurance for capital programs, therewith **reducing costs and impact on TCO of missed defects**

C Quality assurance | improve speed and effectiveness of quality assurance

Situation and issues to be addressed

- In the market, 30% of defects are missed by visual inspections, while almost 80% of all manufacturers state that quality assurance is most important use case for (Gen)AI
- Time it takes to assure quality (number of pages, number of entities that need to do checks)
- GenAI allows to quickly and accurately identify and describe discrepancies between requirements on one hand and lengthy & complex fulfillment documentation from OEMs, EPCs and inspection reports on the other hand
- Benefits include a) speed and therewith reduction of quality assurance costs and reduction of project duration and; b) accuracy and associated reduction of rework in construction phase and reduction of TCO and improvement of OEE post-construction, i.e. in operations

Examples of outcomes of GenAI quality assurance

Extract procedure requirements

The dial range shall be about twice the test pressure, but not less than 1.5 times nor greater than 4 times the test pressure.

Extract procedure report

Design Pressure:	15 PSI
Test Pressure:	20 PSI
Gauge A:	1 in. Gauge 4?
Test Temperature:	30 F
Range:	0-60 PSI

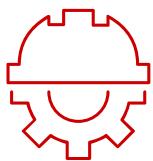
GenAI output

Compliance	Compliant
Reasoning	The requirement specifies that the dial range should be about twice the test pressure, but not less than 1.5 times nor greater than 4 times the test pressure. The test pressure was 20 PSI and the dial range was 0-60 PSI, which is 3 times the test pressure and therefore compliant with this requirement.

Maintenance assistant | Empowering maintenance or engineering staff in process industries

Empower maintenance staff to **access procedures** in their **native languages** from an app that **enforces safety protocols** and offers **insights from the equipment's maintenance history**.

These procedures can be derived from **maintenance manuals PDFs** pre-processed using OpenAI technologies and linked to the company's **maintenance systems** for live access to records.



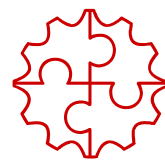
Reinforce safety protocols to frontline personnel

Safety is a crucial concern for our clients, and emphasizing awareness of safety procedures and potential risks to the frontline is essential in creating a safer company.



Multi-language on-site guidance to complex procedures

Offering guidance to maintenance staff on complex processes that typically require experts can simultaneously enhance efficiency and decrease downtime.

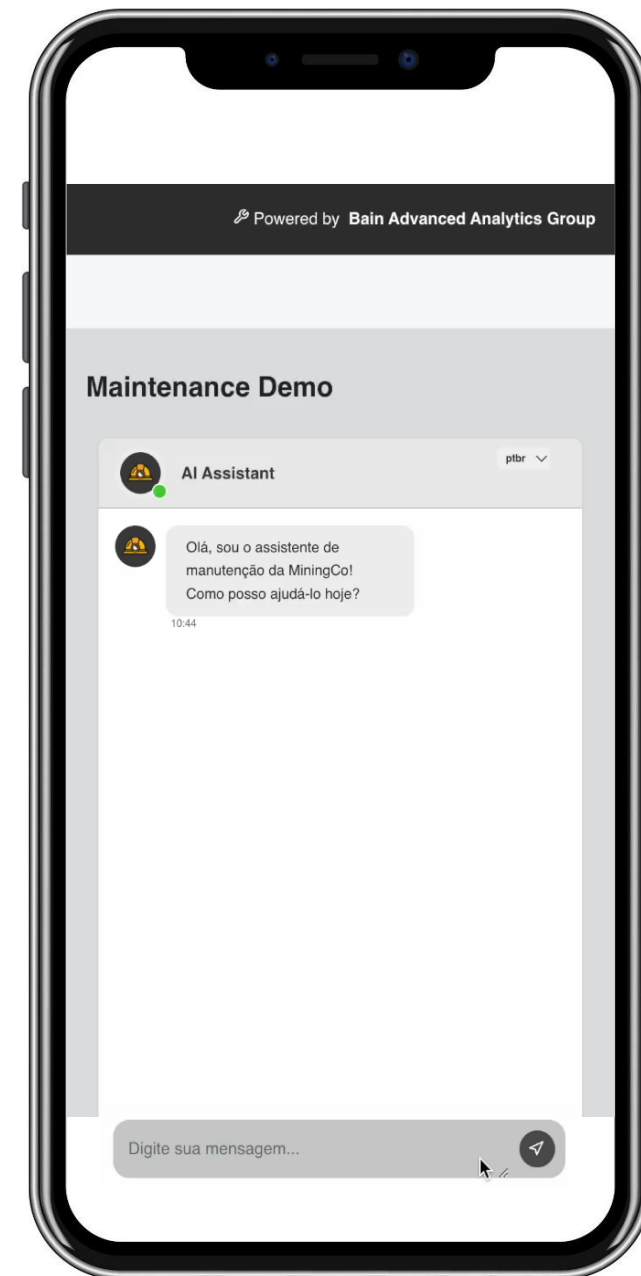


Key insights on maintenance history added to procedures

Integrating insights from maintenance history helps personnel in identifying root causes of issues and boosts requirements and potential pitfalls awareness.

TECHNOLOGY CAPABILITIES DEPLOYED:

GPT-4 (text/text), **Whisper** (audio/text), **PDF** reading and processing, **integration with ERP** and other company systems (e.g., manuals database)



Capital project Quality Assurance | Improve speed and TCO

Situation and issues to be addressed



30% of defects are missed by visual inspections



Traditionally long time required to assure quality (number of pages, number of entities that need to do checks)



GenAI allows to quickly and accurately identify and describe **discrepancies between requirements and lengthy & complex fulfilment documentation** from OEMs, EPCs and inspection reports



Benefits include a) speed and therewith **reduction of quality assurance costs and reduction of project duration** and; b) accuracy and associated **reduction of rework in construction phase** and reduction of TCO and improvement of OEE post-construction, i.e. in operations

Examples of outcomes of GenAI quality assurance

Extract procedure requirements

The dial range shall be about twice the test pressure, but not less than 1.5 times nor greater than 4 times the test pressure

Extract procedure report

Design Pressure: 15 PSI

Test Pressure: 20 PSI Gauge # 1 and Gauge # 2

Test Temperature: 60 F Range: 0-60 PSI



GenAI output

Compliance	Compliant
Reasoning	The requirement specifies that the dial range should be about twice the test pressure, but not less than 1.5 times nor greater than 4 times the test pressure. The test pressure was 20 PSI and the dial range was 0-60 PSI, which is 3 times the test pressure and therefore compliant with this requirement.

AGENDA

Executive Perspectives: Artificial Intelligence and Decarbonization

Harnessing AI to accelerate Decarbonization in Process Industries

Key Insights: Implementing Successful AI Transformations

To mobilize or accelerate an AI journey: **Think big, start small, scale fast**



Strategy and planning **“Think Big”**

Set target vision, expressed with clear metrics, leveraging leading technologies incl. GenAI: “Future Back & Today Forward”

Conduct maturity assessment of data and organization to define where to start AI-driven journey



Development **“Start Small”**

Define use case roadmap and mobilize “Orchestration Tower”

Rapid development of proof of concept and MVP solutions, owned by business leaders



Implementation **“Scale Fast”**

Comprehensive change management planning and execution support, incl.:

- Operating model and roles
- Business processes
- Tech systems and data assets
- Iterative improvement of use cases

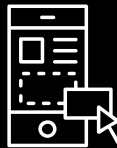
Pragmatic and value-oriented deliverables for each use case

Use case development



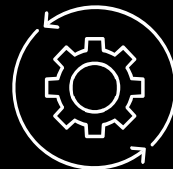
- **Proof of Concepts developed** with clear business case and transfer of source code / documentation
- **Scaling roadmap** towards full potential (incl. key milestones, required capabilities)
- Glide path towards **landing zone of full benefit delivery**
- **Knowledge transfer of GenAI solution development** to digital / AI team

Operating model



- **Key requirements / learnings** for repeatable development and scaling of future use cases
- **Vendor review** and decision on **make vs. buy**
- **Training documentation** for specific use cases and continuous training / capability improvement

Orchestration



- **Business alignment** around use case **definition, functionality and value**
- **End-users that understand and accept** the use of the GenAI solutions to deliver the benefits
- **Change management best practices** to secure required “skillset, toolset and mindset”

Closing thoughts

Wide use of AI/GenAI will be required to achieve the net zero carbon goals announced

AI is already used widely in the process industry; first movers are likely going to have a sustainable competitive advantage

Don't wait and start now. Think big, start small, scale fast. Getting the soft elements (operating model, change management) right, is more difficult than use case selection

The top portion of the image features an abstract, artistic background. It consists of numerous small, bright red dots that are arranged in fluid, undulating patterns, resembling a digital particle simulation or a nebula. These patterns flow from the top left towards the right, creating a sense of movement and depth. The overall color palette is a range of reds, from deep, dark maroon to bright, glowing crimson.

THANK YOU

