Energy Transition

The Implications of Digitalization, Automation and AI

Abhay Chand – Petro IT

A book about spices

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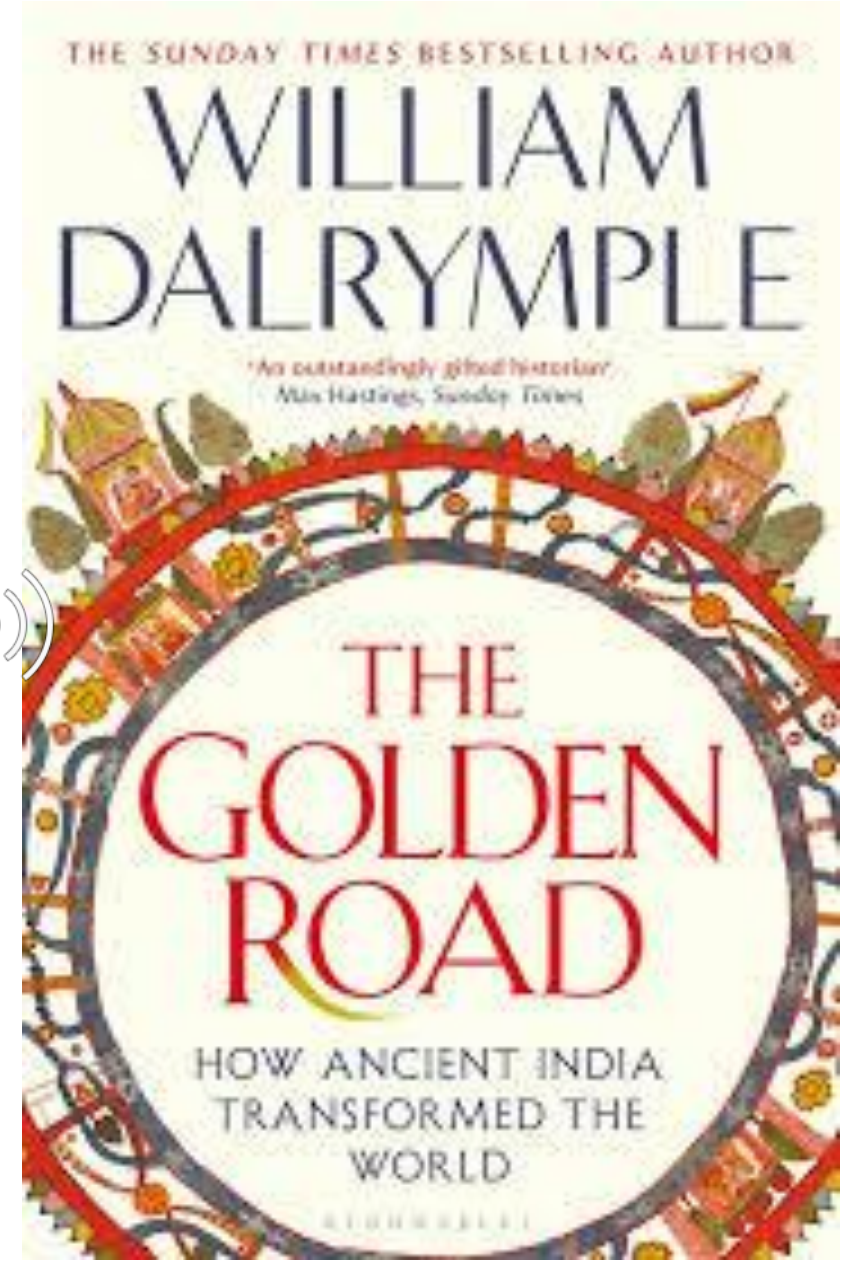


What does energy transition mean for the pipeline industry ?

Wind, solar, hydrogen, biofuels , CCUS

- Hydrogen needs new transportation infrastructure
- CO_2 needs new infrastructure to transport and sequester
- Wind and solar power need more efficient transportation methods too

Implications of energy transition

- Shift in Pipeline Material and Design
- Increased Focus on Decarbonization and Sustainability
- Decline in Traditional Oil and Gas projects
- Retrofitting and Repurposing Existing Pipelines
- Integration with Renewable Energy Projects
- New Business Models
- Regulatory Changes
- More Cross-Border and Transnational Projects

Infrastructure investment needed

- Energy transition investments need to grow by $4 trillion annually to meet the net-zero targets by mid-century.
- So what does this estimate translate to pipelines ?

Source: IEA

Pipelines

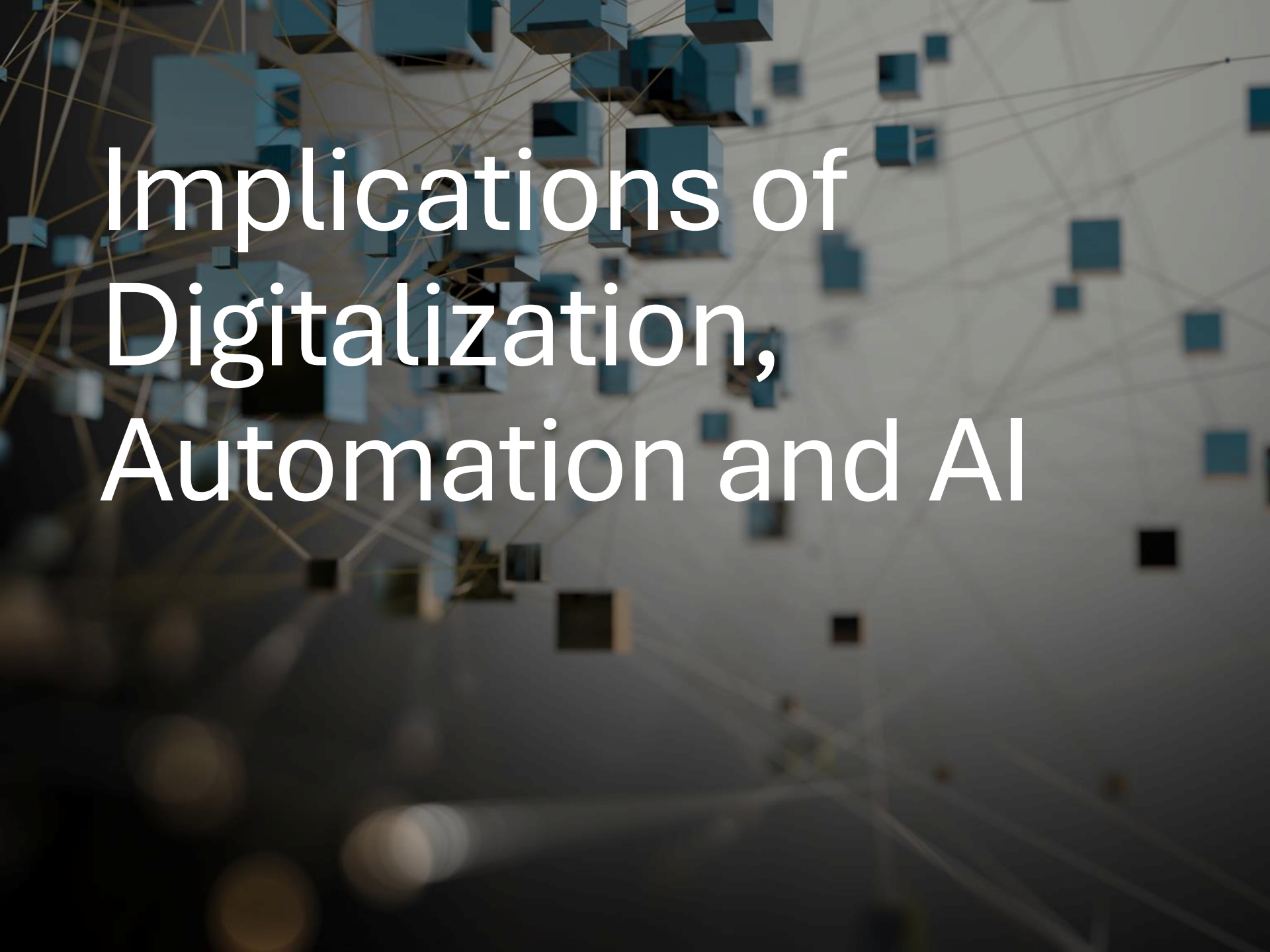
- By 2030 estimates are that $637 Billion will be invested in Hydrogen pipelines globally
- $50 - $100 Billion from 2024 to 2027
- Investment in Hydrogen infrastructure will have an estimated CAGR of 25% - 30%

Source: Bloomberg Energy Finance, IEA

Pipelines

- Investment in CCUS over the next 3 years is estimated at $10 - $15 Billion
- Re-purposing of natural gas lines and bio-fuel related infrastructure is estimated at $10-$30 Billion
- **Estimated total value - $75-$145 Billion over the next 3 years**

Source Bloomberg Energy Finance, IEA


Implications of
Digitalization,
Automation and AI

How Will Digitalization and Automation Help

Improving efficiency

Reducing costs

Enhancing safety

Minimizing environmental impact

Energy Transition and Technology

- AI and Automation assist in the design of pipelines capable of transporting renewable fuels:
  - New materials, new physical and chemical properties, new implications as related to traditional oil and gas.
- Decarbonization and sustainability in the construction process:
  - Digitalization can help optimize energy consumption and reduce emissions during construction by streamlining processes and minimizing waste. AI can also help identify carbon-intensive practices and suggest alternatives that are more environmentally friendly.
- Enhanced monitoring with IoT and real time analysis of patterns:
  - Predictive analytics and risk reduction.

AI in Pipeline Engineering

Design and Optimization:

- AI can assist in the design phase by optimizing pipeline routes and layouts. Machine learning algorithms can analyze vast amounts of geographical, geological, and environmental data to determine the most efficient and least disruptive paths for pipelines.
- AI can also simulate different design scenarios to find the most cost-effective and sustainable solution.

Digital Twins and 3D Modeling

- During construction, digital twins can help track project progress, identify potential issues, and simulate the impact of different design or operational changes, leading to better decision.
- Engineers can create detailed 3D virtual models that simulate the lifecycle of the pipeline from construction to operation. This can reduce errors and enhance precision in project planning.

Digital Supply Chain

- **Supply Chain Optimization**: Traceability tools and AI-powered software optimize the supply chain by predicting material needs, tracking inventory, and ensuring timely deliveries. This prevents material shortages or excesses, reducing delays and costs.
- **Blockchain** : Blockchain technology is being explored to increase transparency in the pipeline supply chain. It can track every piece of material used in pipeline construction, ensuring that it meets regulatory standards – and automates the completion of the transaction and enforces a digital contract.

Automation in Pipeline Construction

Advanced Robotics:

- The current automated welding moving to robotic welding systems. Higher accuracy and precision welding and reduction of human error.
- Autonomous vehicles and construction machinery such as excavators, trenchers and pipelayers – machines that can operate with minimal human intervention.
- Automation would reduce the number of workers that will be needed or placed in hazardous environment, increasing safety.

Quality Control and Risk Management:

- AI-powered image recognition and machine learning systems can be used to inspect welds, joints, and materials during the construction process. These systems can detect defects that might be missed by human inspectors, improving quality control.
- Additionally, AI can assess risks in real-time by analyzing environmental conditions, safety protocols and processes, thus improving overall safety.

Automation in Pipeline Construction

Automated Data Collection and Analysis:

- Automated systems collect vast amounts of data during construction.
- This data can be analyzed in real time, helping QA/QC Managers and Projects Managers identify, issues and risks and adjust plans and actions as needed.
- Real time insights are available into project performance, cost tracking and risk management.

Centralized Project Management:

- Cloud platforms allow real-time data sharing across multiple stakeholders, including engineers, contractors, and regulators. This centralizes communication and ensures everyone has access to the latest information.

Automation in Pipeline Construction

Drones and UAVs:

- Drones equipped with LiDAR, photogrammetry, or thermal imaging are being used for detailed land surveys before construction begins.
- Algorithms help map out terrain, identify obstacles, and ensure compliance with environmental regulations.
- During construction, drones are used to monitor progress and inspect the quality of work. They can capture real-time images and data, which can be processed through AI algorithms to detect any issues that need attention.

Automation in Pipeline Construction

Augmented Reality (AR) and Virtual Reality (VR):

Training and Safety

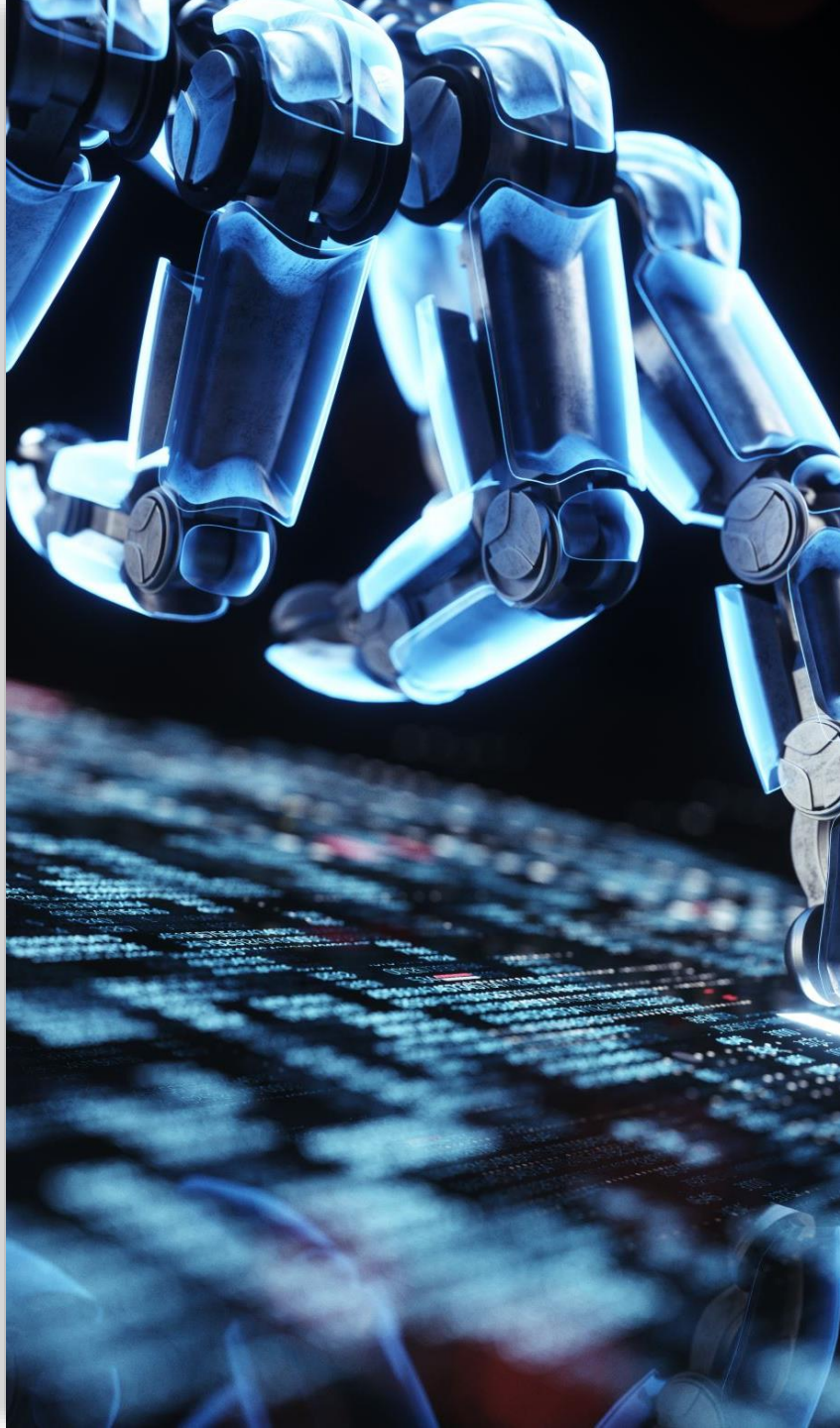
- AR and VR can be used to train workers in pipeline construction and safety procedures.
- Workers can simulate real-world situations in a safe, virtual environment, improving their skills and reducing the likelihood of accidents.

Real Time Construction Assistance:

- AR glasses or headsets allow workers to overlay digital blueprints on physical structures during construction.

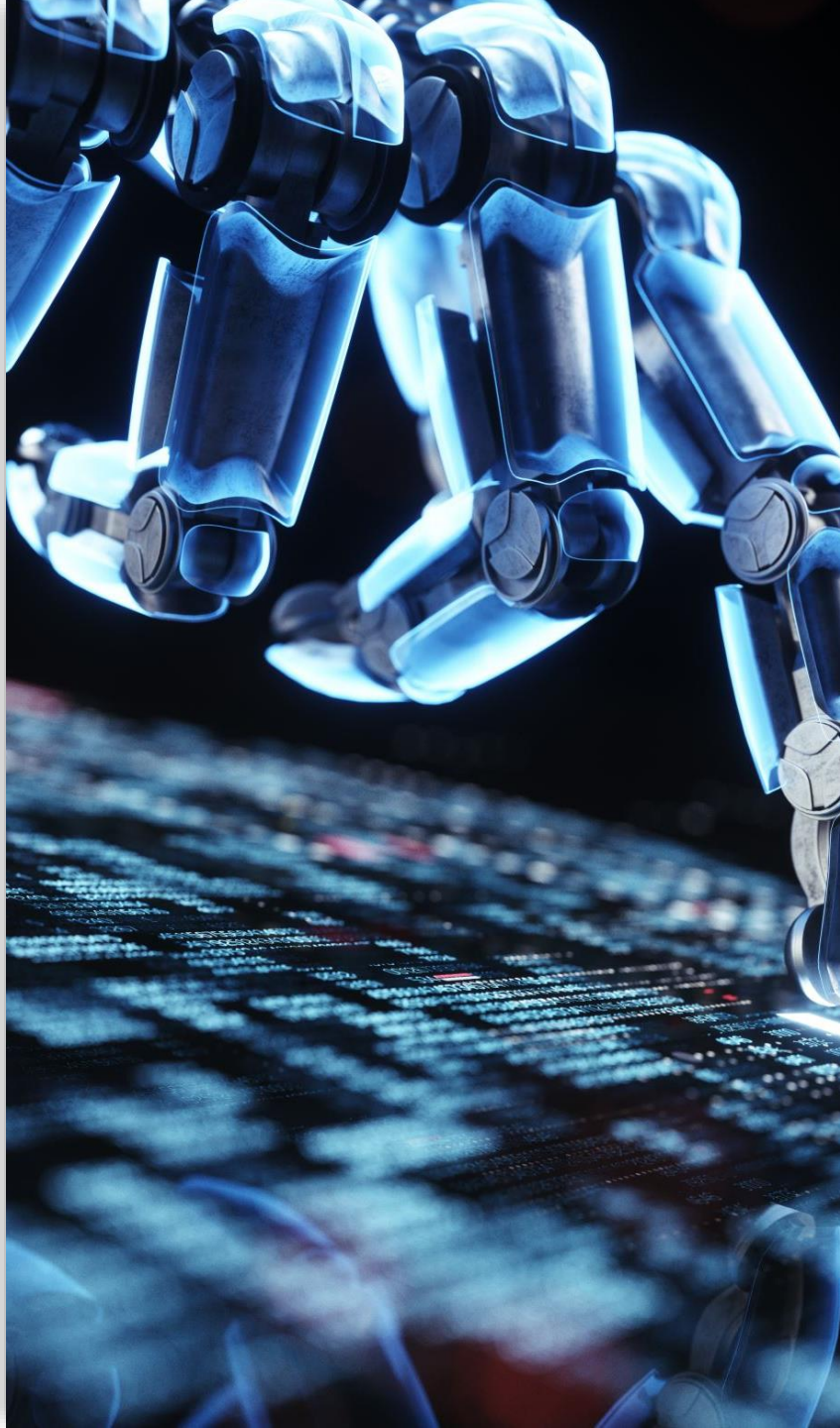
Impact on the Workforce and Skills

- **Reskilling and Upskilling**: As automation takes over many manual tasks, the demand for **skilled workers** who can operate and maintain advanced technologies will increase. Engineers and technicians will need to be trained in the use of digital tools, AI systems, and robotics.
- **Data analytics** and **cybersecurity** will also become essential skills as digital infrastructure becomes a core part of pipeline operations.



Impact on the Workforce and Skills

- **Job Displacement and Creation**: While automation may lead to job displacement in certain areas (e.g., manual labor roles), it will also create new jobs in fields like **robotics management**, **AI algorithm development**, and **digital maintenance**.
- The focus will shift from the purely physical tasks to overseeing and optimizing automated systems.



Conclusion

The integration of **digitalization, automation, and AI** into **pipeline engineering and construction** will soon reshape the industry.

Particularly in the context of the **energy transition**. These technologies offer significant advantages in terms of **efficiency**, **safety**, and **sustainability**.

However, they also require the industry to adapt by reskilling the workforce and embracing new ways of designing, building, and maintaining critical infrastructure.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