



ADNOC Accelerator Programme

Artificial Intelligence

COHORT 2

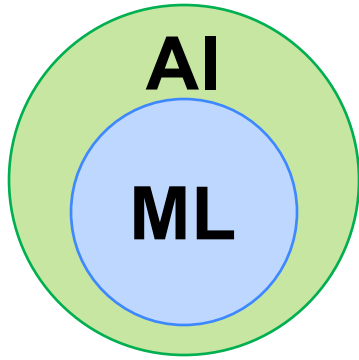
Foundations of AI in the Energy Industry

Foundations of AI in the Energy Industry



- 1 Define AI and ML concepts**
- 2 Leverage predictive capabilities to manage uncertainty**
- 3 Explore ADNOC's AI use cases**
- 4 Examine AI applications by industry leaders**

What is artificial intelligence and machine learning?



ANALOGY

A chess student
learns by...

AI (artificial intelligence) refers to machines or software performing tasks that usually require human intelligence

- ✓ **Rule-based** human instructions
- ✓ **Experience-based**, learning from data

- ✓ **Memorising rules and strategies**
- ✓ Practicing and playing against opponents, **learning from mistakes and successes** to improve over time

ML (machine learning) enables computers to learn from data, identify patterns, and improve over time without explicit programming

- ✓ **Experience-based**, learning from data

- ✓ Practicing and playing against opponents, **learning from mistakes and successes** to improve over time



How does AI fit into the energy industry?

AI/ML can predict **safety issues**, **equipment failures**, and **volatile consumer demand** to reduce uncertainty

UPSTREAM

Exploration & Production



MIDSTREAM

Storage & transportation after production



DOWNSTREAM

Oil refining, Supply & Trading, Product Marketing, Wholesale & Retail



Worker safety can be enhanced during drilling

Pipeline maintenance can be intelligently forecasted and automated

Optimising operations can reduce emissions

ADNOC's top 10 AI use cases

 Upstream
  Downstream
  Support
  Sustainability

Value chain	AI use case	Description	Technology type
	1. ROBOWELL	Autonomously operates wells	Optimisation models
	2. AR360	Boosts new well production & extends existing well lifespan	Predictive analytics
	3. SMARTi	Improves vessel safety and security	Image and video analysis
	4. DRILLTECT	Detects anomalies in real-time from surface drilling data	Predictive analytics
 	5. CORROVISION	Automates corrosion detection and classification	Image and video analysis
	6. Extruder predictive analysis	Enhances production as less extruder equipment shutdowns	Predictive analytics
	7. AI polymer optimisation	Cuts transition time and speeds new grade development	Predictive analytics
	8. ILMS	AI Logistics Management System	Optimisation models
	9. Skill Sphere	Advises and coaches on career paths	Conversational AI
	10. EmissionX	Monitors, reports & forecasts emissions data across facility	Predictive analytics

RoboWell empowers fully remote operations while maximising production efficiency



Solution

Cloud-based optimisation models enabling autonomous well control for 300+ wells



Goals

- Improve well safety
- Increase production capacity
- Reduce travel and physical interventions
- Lower emissions



Metrics

- 30% gas lift optimisation
- 5% boost in operating efficiency



Advanced Reservoir (AR) 360 enhances recovery rates and extends well lifespan in refineries



Solution

Centralised forecasting platform to optimise field development planning and enhance reservoir management across 30+ reservoirs



Goals

- Increase new well output
 - Extend well lifespan
 - Accelerate planning cycles
 - Optimise injection
 - Improve forecasting
 - Reduce emissions
-
- 20% increase in well lifespan
 - 10% boost in oil recovery from waterflooding
 - 10% reduction in infill well drilling costs
 - 75% faster model review and opportunity generation



Metrics



SMARTi elevates maritime safety by enabling proactive prevention and real-time detection



Solution

CCTV image and video analysis to monitor safety behavior, incidents, and hazards across 86+ vessels



Goals

- Reduce safety incidents
- Increase safety compliance



Metrics

- 90% image processing accuracy for violation detection
- Less than 2-second alert response time
- 24/7 system for business continuity



AI can solve many more industry challenges



Upstream

- **Exploration**
How can we identify oil and gas reservoirs faster with greater accuracy?
- **Drilling and extraction**
How can optimise drilling operations?



Midstream

- **Transportation**
How can we maintain the integrity of pipelines efficiently?
- **Storage**
How can we monitor tank levels and detect leaks?



Downstream

- **Refining crude oil, petrochemicals, other chemicals**
How can we ensure safety and environmental compliance in refinery operations?
- **Processing natural gas**
How can we reduce energy costs in processing natural gas?
- **Gas and petroleum liquefaction**
How can we prevent cryogenic equipment failure?
- **Marketing and distribution**
How can we forecast demand in petroleum and LNG markets?



Other operations

- **Logistics and services**
How can we optimise maritime routes to ship our products more efficiently?
- **Chemicals production**
How can we enhance yield in production of chemicals such as ammonia?



Let's explore how we could build two of these examples



Upstream

- **Exploration**
How can we identify oil and gas reservoirs faster with greater accuracy?
- **Drilling and extraction**
How can optimise carbon storage?



Midstream

- **Transportation**
How can we maintain the integrity of pipelines efficiently?
- **Storage**
How can we monitor tank levels and detect leaks?



Downstream

- **Refining crude oil, petrochemicals, other chemicals**
How can we ensure environmental compliance in refinery operations?
- **Processing natural gas**
How can we reduce energy costs in processing natural gas?
- **Gas and petroleum liquefaction**
How can we prevent cryogenic equipment failure?
- **Marketing and distribution**
How can we forecast demand in petroleum and LNG markets?



Other operations

- **Logistics and services**
How can we optimise maritime routes to ship our products more efficiently?
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Simulation #1: Carbon capture and storage (CCS)



Determining where, how much and what pressure to inject CO₂ into underground reservoirs is difficult. **How can we improve storage efficiency and reduce leak risk?**

Proposed solution	Data required	Potential models	Outcome
Optimised CCS Predictive model can simulate reservoir behavior and predict outcomes based on various injection parameters.	Real-time Data • Pressure • Temperature • Flow rates Intermittent data • Rock permeability • Seismic activity • Ground deformations Source • Sensor data • INSAR satellite data	• Gradient boosting trees (GBT) model creates multiple decision tress to predict outcomes based on different injection settings • Neural net can model complex relationships between variables to predict CO₂ plume spread	• Increased carbon storage volume through optimisation • Reduced leak risk from finding optimal storage conditions in reservoirs and detecting anomalies in sensor readings

Without data,
there can be
no AI/ML solution



Simulation #2: Refinery emissions



Refineries used rules-based systems to operate large fired heaters and boilers to burn fuel, which contribute CO₂ and NOX emissions. **How can we reduce emissions at refineries?**

Proposed solution	Data required	Potential models	Outcome
AI carbon footprint optimiser tool AI leverages emission and resource usage data to suggest small real-time adjustments to the air/fuel ratio, burner configurations, or operating conditions to maximise combustion efficiency and minimise emissions	Real-time Data • Fuel type, flow rate • Oxygen levels • Power usage • Air to fuel ratio • Emission readings • Flare analysis Source • Sensor data • Process control sys. • FLIR camera	• Random forest predicts • Reinforcement learning uses real-time data in dynamic system to interact with environment and learn optimal action sequences to achieve low emissions target	• Reduced CO₂ emissions from reduced fuel usage • Reduced NOX emissions from being able to avoid oxygen rich or deficient environments • Improved environmental compliance



AI/ML adoption by industry leaders

	Digital oil field product maximises oil production	AI Solar Mapper reduces carbon footprint	Demand forecasting reduces production / inventory errors
Goal	Maximise oil production	Solarise all service stations	Predict demand fluctuations for production and inventory adjustment
Solution	Genetic algorithms and digital twins optimised upstream assets, boosting oil production by 60% in one field	Solar Mapper optimises solar adoption by estimating panel output for 1,000+ critical sites across 90% of France	Developed forecasting tool for petrochemical products, reducing errors by 25%
Data	Sensors, seismic data	Google Earth Engine, with ML methods enhancing 3D data in remote regions	Market trends, production facilities, and transportation networks

Foundations of AI in the Energy Industry



In this session, we covered:

- ✓ **How AI and ML integrate into the oil and gas value chain**
- ✓ **Problems AI and ML can solve in the industry**
- ✓ **Real-world examples of AI and ML applications by industry leaders**

