Agendas

1. Introduction to O&G Industry
2. Potential Use Case
3. Benefits and Challenges
4. Process Implementation
5. Project Methodology
6. Use case
7. Next steps

1 Introduction to O&G industry

- The Oil & Gas industry is crucial to the global economy, supplying the world's energy needs.
- The industry is divided into three main segments: Upstream, Midstream, and Downstream.
- Upstream focuses on exploration and production.
- Midstream handles transportation and storage.
- Downstream covers refining and distribution.

2 Potential Use Cases for O&G

Segments	Upstream	Midstream	Downstream
Process	**- Exploration**: Finding oil and gas reservoirs beneath the earth's surface. **- Drilling & Extraction:** Bringing crude oil and natural gas to the surface. **- Production:** Managing wells to optimize oil and gas flow.	It's Transportation & Storage which involves the movement of crude oil and natural gas from production sites to refineries or processing plants. Main activities are Pipelines, Tankers, and Rail Transport; Storage facilities and terminals; Gas processing (removing impurities like water, sulfur, and CO2).	This is the final stage, where crude oil is refined into usable products like gasoline, diesel, jet fuel, and petrochemicals. These products are then distributed to consumers through retail networks.
Few Use Cases	- Seismic Data Interpretation - Predictive Maintenance for Equipment - Reservoir Optimization - Drilling Optimization - Well Log Analysis	- Pipeline Integrity Monitoring - Flow Assurance - Logistics Optimization - Demand Forecasting for Storage - Real-Time Monitoring with Edge AI	- Process Optimization in Refineries - Predictive Maintenance for Refinery Equipment - Supply and Demand Forecasting - Quality Control: Predict Product Quality - Retail and Distribution Optimization
Benefits	**High-risk, high-cost operations benefit from AI's ability to reduce uncertainty and downtime.**	**Long, remote infrastructure networks leverage AI for real-time monitoring and predictive analytics.**	**Complex refining processes and market dynamics gain from AI's optimization and forecasting capabilities.**

3 AI/ML in O&G: ROI, Benefits, and Challenges

- **Increased Production:** Optimize production, reduce downtime, and increase yields.

  Example of Predictive maintenance solution and achieved a remarkable 20% reduction in downtime. This reduction in downtime also led to a substantial increase in production, exceeding 500,000 oil barrels annually

- **Cost Savings:** Streamline processes and reduce manual labor and maintenance costs.

  Industry expectations suggest that savings ranging from $237 billion to $813 billion could be realized due to lower production expenses and shorter project timelines resulting from automation

- **Enhanced Safety:** Predict and mitigate safety risks to protect workers and the environment.

  Companies that have implemented AI-driven monitoring systems have reported a significant 50% decrease in the number of safety incidents

- **Improved Sustainability:** Optimize energy consumption and reduce environmental impact.

  Energy efficiency measures could potentially contribute to reduction of total emissions by up to 20%

- **Challenges:** High upfront investment and skilled workforce needed.

4 Process from Problem Discovery to Implementation

PROBLEM DISCOVERY & FRAMING

Identify a high-impact problem and assess its feasibility

1

DATA COLLECTION AND PREPARATION

Gather and preprocess data for modeling.

2

MODEL DEVELOPMENT AND TESTING

Build, train, and validate the AI/ML model

3

PILOT DEPLOYMENT

Test the solution in a controlled operational setting

4

FULL-SCALE IMPLEMENTATION

Roll out the solution across the Units or entire organization

5

MONITORING AND CONTINUOUS IMPROVEMENT

Maintain and enhance the solution over time

6

4.1

Process from Problem Discovery to Implementation

PROBLEM DISCOVERY & FRAMING

Identify a high-impact problem and assess its feasibility

1

1. What are you trying to accomplish?
2. What is the value to have a ‘better answer’? Are you saving time? Are you reducing the risk? Are you having a better ROI?
3. What data you have access to?
4. What is your team’s technical capabilities and capacity?
5. Is this one time problem or on-going?
6. Who is end user?

More things to think:

1. Proving that works: how we are going to demonstrate the solution and who will need to convince? etc
2. What do your end users need?: Format? Delivery Cadence? Interface? Integration with other tools?
3. Maintenance & Upkeep: Who will be responsible for running, monitoring, updating your solutions? What will be required?

4.2

Process from Problem Discovery to Implementation

DATA COLLECTION AND PREPARATION

Gather and preprocess data for modeling.

2

Data Sources and Types

→ Operational systems (e.g., SCADA, IoT sensors), historical records (e.g., maintenance logs), geoscientific data (e.g., seismic surveys)
→ External data (e.g., weather, market prices) and unstructured data (e.g., PDFs, images)
→ Time-series (e.g., pressure), spatial (e.g., coordinates), categorical (e.g., equipment type), text, multimedia

Data Quality and Scale

→ Completeness, consistency, accuracy, noise-free, suitable granularity

→ Size (e.g., GB/TB), frequency (e.g., real-time), historical span (e.g., years)

Domain and Operational Details

→ Physical parameters (e.g., viscosity), equipment metadata (e.g., age), operational context (e.g., flow rates)

→ Safety/regulatory flags (e.g., emissions), remote ops challenges (e.g., data gaps), harsh environment effects (e.g., sensor reliability)

Accessibility& Preprocessing

→ Storage (e.g., cloud), connectivity (e.g., remote bandwidth), interoperability (e.g., SCADA-ERP), ownership (e.g., third-party)
→ Cleaning (e.g., missing values), normalization (e.g., units), feature engineering (e.g., averages), labeling (e.g., failures), dimensionality reduction

Security & Compliance

→ Sensitivity (e.g., encrypt proprietary data), audit trails, cybersecurity (e.g., IoT risks)
→ Regulatory compliance (e.g., safety fields), legacy systems (e.g., digitization needs)

4.3

Process from Problem Discovery to Implementation

MODEL DEVELOPMENT AND TESTING

Build, train, and validate the AI/ML model

3

Problem& Algorithm Selection

→ Define ML task (e.g., classification for failure prediction, regression for Oil/Gas production forecast)

→ Select algorithms (e.g., Random Forests, LSTMs for time-series, CNNs for seismic data)

→ Align with oil/gas use case (e.g., predictive maintenance, reservoir optimization)

Data and Training Setup

→ Split data into training, validation, and test sets (e.g., 70-20-10 split)

→ Use domain-specific data (e.g., sensor readings, well logs, seismic grids)

→ Incorporate historical Oil/Gas scenarios (e.g., equipment wear, production trends)

Model Training and Optimization

→ Train model on prepared data (e.g., time-series from SCADA, geological features)

→ Tune hyperparameters (e.g., learning rate, tree depth) for performance

→ Address overfitting/ underfitting (e.g., regularization, cross-validation)

Testing and Validation

→ Test on unseen data (e.g., recent pump failures, new seismic surveys)

→ Evaluate against KPIs (e.g., 90% precision, reduced downtime, ROI)

→ Simulate real-world conditions (e.g., extreme weather, operational stress)

Industry-Specific Considerations

→ Validate with domain constraints (e.g., physical limits like pressure thresholds)

→ Ensure safety/reliability (e.g., avoid false negatives in leak detection)

Iterate based on feedback from oil/gas experts (e.g., engineers, geologists)

4.4

Process from Problem Discovery to Implementation

PILOT DEPLOYMENT

Test the solution in a controlled operational setting.

4

Scope and Objectives

→ Define pilot scope (e.g., specific assets like 10 pumps, one refinery unit)
→ Set clear goals (e.g., reduce downtime by 20%, validate model accuracy)
→ Establish duration (e.g., 3 months) and success criteria (e.g., KPIs like precision, cost savings)

System Integration

→ Integrate model with operational systems (e.g., SCADA, IoT platforms, ERP)
→ Ensure real-time data flow (e.g., sensor inputs for predictive maintenance)
→ Test compatibility with existing workflows (e.g., maintenance schedules, alerts)

Deployment Environment

→ Select deployment site (e.g., onshore rig, offshore platform, refinery)
→ Account for connectivity (e.g., edge computing for remote locations)
→ Verify hardware/software readiness (e.g., cloud infrastructure, on-site servers)

Monitoring and Performance Tracking

→ Monitor model outputs in real time (e.g., failure predictions, production forecasts)
→ Track KPIs (e.g., accuracy, response time, operational impact)
→ Collect data for post-pilot analysis (e.g., false positives, user feedback)

Stakeholder Engagement and Adjustments

→ Train end users (e.g., operators, engineers) on interpreting outputs
→ Gather feedback from field teams (e.g., usability, reliability)
→ Refine model/system based on pilot results (e.g., adjust thresholds, fix integration bugs)
→ Ensure safety/ compliance (e.g., align with OSHA, API standards)

4.5

Process from Problem Discovery to Implementation

FULL-SCALE IMPLEMENTATION

Roll out the solution across the Units or entire organization

5

Planning and Scaling Strategy

→ Define full-scale scope (e.g., all upstream assets, entire refinery network)
→ Set long-term goals (e.g., 30% cost reduction, 99% uptime)
→ Develop rollout plan (e.g., phased by region, simultaneous deployment)
→ Allocate budget/ resources (e.g., hardware, personnel, training)

Infrastructure and System Integration

→ Scale infrastructure (e.g., cloud platform, edge devices for remote sites)
→ Integrate with enterprise systems (e.g., SCADA, ERP, maintenance software)
→ Ensure real-time data pipelines (e.g., sensor feeds, production updates)
→ Test system reliability under full load (e.g., peak operational demand)

Deployment Execution

→ Deploy across all target sites (e.g., offshore rigs, pipelines, refineries)
→ Verify connectivity in remote areas (e.g., satellite for offshore platforms)
→ Automate workflows (e.g., predictive alerts trigger work orders)
→ Confirm backup systems (e.g., failover for critical operations)

Training and Stakeholder Buy-In

→ Train all end users (e.g., operators, engineers, managers) on system use
→ Provide documentation (e.g., user manuals, troubleshooting guides)
→ Address feedback from pilot (e.g., simplify UI based on operator input)
→ Secure leadership support (e.g., align with business objectives)

Compliance, Safety, and Monitoring

→ Ensure regulatory compliance (e.g., OSHA, API, environmental standards)
→ Validate safety measures (e.g., no missed critical alerts)
→ Set up continuous monitoring (e.g., dashboards for performance tracking)
→ Establish maintenance plan (e.g., retrain model quarterly, update software)

4.6 Process from Problem Discovery to Implementation

MONITORING AND CONTINUOUS IMPROVEMENT

Maintain and enhance the solution over time

6

Performance Tracking

→Monitor key metrics (e.g., model accuracy, precision, downtime reduction)
→ Use real-time dashboards (e.g., track pump failure predictions, production rates)
→ Compare against baseline KPIs (e.g., pre-implementation costs, safety incidents)

Data and Model Maintenance

→ Collect new data (e.g., updated sensor readings, operational logs)
→ Retrain model periodically (e.g., quarterly with fresh data)
→ Detect and address drift (e.g., data drift from equipment aging, concept drift from new processes)

Operational Feedback

→ Gather input from end users (e.g., operators, engineers on usability)

→ Identify pain points (e.g., false alerts, slow response times)

→ Adjust system based on feedback (e.g., tweak thresholds, improve UI)

Safety and Compliance Assurance

→ Verify safety-critical performance (e.g., no missed leak detections)
→ Ensure ongoing regulatory compliance (e.g., emissions reporting, OSHA standards)
→ Audit system regularly (e.g., check for biases, errors in predictions)

Innovation and Expansion

→ Explore enhancements (e.g., add new features like anomaly detection)
→ Apply to related use cases (e.g., extend pump maintenance to pipelines)
→ Test advanced techniques (e.g., reinforcement learning for optimization)

5 Project Methodology

01

Initiate

Start with Phase 1 to define the problem and align stakeholders.

02

Iterate

Move through Phases 2–4, refining based on testing and pilot results..

03

Scale

Execute Phase 5 for full deployment.

04

Sustain

Maintain and improve via Phase 6 indefinitely.

✦ **Review** : At each phase, revisit prior steps if issues arise (e.g., poor data quality in Phase 2 requires revisiting Phase 1).

6 Application of Composite AI in the Oil and Gas Industry

Business Objective	→ **Increase operational efficiency:** Reduce equipment and well downtime through predictive maintenance and real-time optimization. → **Enhance exploration strategies:** Accurately identify oil and gas reserves from seismic data to lower exploration risks and costs. → **Optimize supply chain and logistics:** Forecast oil demand, manage inventory efficiently, and extract valuable insights from drilling reports. → **Ensure safety and sustainability:** Mitigate risks of incidents by early anomaly detection and resource optimization.

6 Application of Composite AI in the Oil and Gas Industry

Potential Use Cases	
Potential Use Cases	→ **Predictive maintenance scheduling:** Monitor equipment (pumps, rigs, pipelines) using real-time IoT data to predict failures and minimize disruptions. **Benefit:** Extend equipment lifespan and reduce unnecessary maintenance costs. → **Seismic analysis and reservoir modeling:** Identify potential oil and gas reserves from 3D seismic data, improving exploration efficiency. **Benefit:** Reduce the risk of dry wells and optimize initial investment costs. → **Real-time drilling optimization:** Adjust drilling parameters (pressure, torque, vibration) to enhance performance and safety. **Benefit:** Shorten drilling time and increase well productivity. → **Supply chain and logistics optimization:** Forecast oil demand, manage inventory, and extract insights from technical drilling reports. **Benefit:** Minimize resource waste and improve supply chain efficiency.

6 Application of Composite AI in the Oil and Gas Industry

Cutting-edge AI technologies (few)

1. Hybrid Models:

- **LSTM and Transformers**: Process time-series data from IoT for production forecasting and anomaly detection in equipment.
- **XGBoost**: Enhance accuracy in production predictions and predictive maintenance.

2. Image and seismic data analysis:

- **CNNs (UNet, ResNet)**: Analyze 3D seismic data for reservoir modeling and reserve identification.

3. Reinforcement Learning:

- Optimize real-time drilling parameters based on pressure, vibration, and torque.

4. Large Language Models (LLMs):

- Analyze drilling reports and technical documents to extract insights and support supply chain management.

5. Knowledge Graphs:

- Integrate domain-specific data (reservoir characteristics, drilling history) for deeper analysis and decision support.

6. Physics-Informed AI:

- Combine technical simulations and physical principles to improve predictive maintenance and operational optimization.

6 Small MVP- Oil Production Forecast

A small pilot project was conducted, integrating **LSTM** for oil production forecasting with an **LLM** for data analysis. While Retrieval-Augmented Generation (RAG) and fine-tuning have not yet been incorporated, initial results highlight the potential of Composite AI, though further refinement is needed to address with more relevant data to specific Oil and Gas Industry