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Industry Solution Sheet: Oil, Gas, and Petrochemicals

Challenges and Capabilities

This is a time of unprecedented change and unparalleled complexity for the oil, gas, and petrochemicals industry. To navigate the competitive dynamics of today's business landscape, enterprises across the entire value chain – from global giants to smaller players involved in upstream, midstream, and downstream operations – must be able to overcome numerous major business challenges including:

- Market volatility: Oil, gas, and petrochemical players must deal with constant price fluctuations, which are spurred by sudden, significant shifts in supply and demand and disruptions.
- Cost pressure: Operating in an industry that is capital intensive (requiring huge, long-term investments in infrastructure such as drilling platforms and refineries) but has tight and changing margins, oil, gas, and petrochemical companies continuously face intensifying cost pressure – and must always strive to function as efficiently as possible.
- The certainty of uncertainty: Managing uncertainty – in terms of demand, prices and costs, production quantity and quality, raw material uncertainty, and even transportation time uncertainty – is a huge challenge for industry players.
- Environmental regulation and policy changes: Oil, gas, and petrochemical companies must be able to accurately assess the impact of sweeping regulatory and policy changes and adapt their plans, processes, and practices accordingly.
- Operational complexity: It's impossible to overstate the complexity of operations in the oil, gas, and petrochemical industry – which involves:
  - Sprawling global supply chain networks across numerous processing and production locations,
  - Complicated procurement, drilling, extraction, blending, production, inventory management, and distribution processes,
  - Multi-scale operations that vary widely in scope (geographic, time, and size) and must be centralized to realize economies of scale,
  - Multiple modes of transport including rail, truck, ship, and pipeline,
  - Continuous, 24/7 operations – leaving little time for maintenance shutdowns,
  - Loads of real-time data and cutting-edge automation technologies including RPA, drones, IoT, advanced process control, and real-time optimization as well as state-of-the-art drilling and refining technologies,
  - Coordination with third-party vendors for specific services including pipeline operations, shipping, and inspections, and
  - Tricky tax and financial rules and contract structures.

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To tackle these and other critical challenges, oil, gas, and petrochemical companies rely on an array of AI tools including machine learning, heuristics, and mathematical optimization – which empower them to use their data to drive digital transformation and improved business outcomes.

Mathematical optimization, in particular, is a trusted AI tool, which has been used for more than half a century by leading oil, gas, and petrochemical enterprises in a wide variety of off-the-shelf and custom-built applications to address a whole host of business problems including batch production planning and scheduling, product portfolio allocation, multi-period blending, network design, sales and operations planning, and multi-modal transportation planning.

With mathematical optimization, oil, gas, and petrochemical companies can:

- Generate optimal strategic, tactical, and operational plans and make optimal decisions – in order to fuel greater efficiency and profitability across the entire value chain from exploration to development, production, distribution, and sales.
- Explore and evaluate what-if scenarios to gain a deep understanding of the competitive landscape, assess risks, and identify opportunities.
- Achieve their business goals in a number of key areas, including:
  - Value creation: Maximizing value across integrated business units and geographies, and maintaining volumes – in terms of reserves, throughput, and economies of scale – for long-term value generation.
  - Operational efficiency: Bolstering the flexibility and robustness of business operations – in order to better handle the complexity, cost pressure, regulatory changes, uncertainty, and volatility of the oil, gas, and petrochemical industry.
  - Business performance: Consistently delivering the highest-quality products to customers and the highest profit margins to shareholders – while ensuring compliance with changing environmental regulations and policies.

Although mathematical optimization is a well-established technology in the oil, gas, and petrochemical industry, we are seeing – with the increase in data availability, quantity, and quality in recent years – new, cutting-edge applications of this AI technology such as integrated planning and scheduling, digital twins and multi-scale modeling in combination with machine learning, environmental impact assessment, and real-time optimization and advanced process control.

We are also seeing a concerted effort by oil, gas, and petrochemicals companies (along with software vendors) to build first principle (often application-specific) simulation and mathematical optimization models – thereby creating a rich archive of applications that be easily deployed and used by companies to boost the efficiency of various industry-wide processes.

Today – as the oil, gas, and petrochemical industry enters into a new era of change and complexity – mathematical optimization remains an essential AI tool for enterprises across the value chain, empowering them to optimize their business operations and outcomes and overcome the challenges that they face.

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Opportunities for Optimization

Mathematical optimization is used by leading oil, gas, and petrochemical companies around the world today to optimize many different planning and decision-making processes including:

Strategic

- Supply Chain Network Design
- Fleet sizing and management
- Process design
- Evaluation of capital investments
- Oilfield development design and execution planning
- Risk assessment and management
- Product portfolio management

Tactical

- Batch production planning and scheduling
- Optimal multi-period blending
- Inventory management
- Technology and vendor selection
- Sales and operations planning

Operational

- Real-time optimization and advanced process control
- Maintenance and downtime planning
- Continuous production planning and scheduling
- Multi-mode transportation planning (Ship, rail, truck, pipeline)
- Inventory routing
- Optimal integrated manufacturing

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Business Benefits

Oil, gas, and petrochemical enterprises utilizing mathematical optimization are able to realize numerous business benefits including:

- Increased operational efficiency and profitability
- Improved reliability and customer satisfaction
- Better resource allocation and utilization
- Increased revenue growth and shareholder value
- CAPEX and OPEX optimization
- Enhanced end-to-end supply chain visibility, agility, and alignment
- Improved compliance with government regulations and strategy
- Lower safety stock inventory levels and fewer stock-outs
- Superior strategic portfolio management
- Optimal strategic, tactical, and operational decision making