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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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.

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.

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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