



AI-driven CNG Gas Demand Forecasting

Transforming CNG Availability:

Smarter Supply Chains with AI-Powered Insights

Background

Compressed Natural Gas (CNG) offers a cleaner fuel alternative than gasoline or diesel. Despite its advantages, widespread adoption faces challenges such as insufficient infrastructure, inconsistent supply, and fluctuating demand, leading to customer dissatisfaction and operational inefficiencies.

This PoV explores how AI-driven demand forecasting, integrated with Azure's scalable ecosystem, can transform CNG supply chains. By leveraging predictive analytics and real-time insights, the solution optimizes inventory, ensures consistent fuel availability, and reduces costs. Beyond immediate operational improvements, the framework supports strategic planning for energy transition, paving the way for a cleaner and more efficient future.

Introduction

In our day-to-day life, long queues at CNG gas stations are a common sight. The availability of Compressed Natural Gas (CNG) at fueling stations is currently insufficient, creating a significant supply-demand gap. This issue is particularly pressing given that CNG emits up to 90% fewer polluting fumes compared to gasoline or diesel, making it a much cleaner alternative for vehicle fuel. However, several factors contribute to the limited availability of CNG, including infrastructure limitations, distribution challenges, and fluctuating demand. These constraints not only inconvenience consumers, who often face long wait times at CNG stations, but also pose significant environmental risks. When CNG is not readily available, users may resort to more polluting fuels, undermining the environmental benefits of CNG. Additionally, the slow adoption of CNG vehicles can be attributed to these challenges, as potential users are discouraged by the uncertainty of a consistent fuel supply. Addressing these issues is essential to promote the widespread use of CNG and fully realize its environmental benefits.

According to Grand View Research, the global CNG market is on the rise, valued at USD 159 billion in 2023 and projected to grow at a rate of 12% annually from 2024 to 2030. This surge is driven by the increasing demand for cleaner energy options and supportive government policies. As CNG becomes a preferred fuel for transportation due to its lower emissions compared to gasoline and diesel, its potential can be fully realized through effective solutions.

[For more detailed insights, check out the full report here.](#)



Possible Solutions



AI-driven Demand Forecasting

AI-powered demand forecasting is a critical solution to address the supply-demand gap in Compressed Natural Gas (CNG) availability. Accurate demand forecasting ensures that supply meets consumer needs, minimizing shortages and surpluses. This cost-effective approach optimizes resource allocation and reduces waste. Additionally, demand forecasting is adaptable, allowing for real-time adjustments based on market conditions. However, it requires extensive data collection and analysis, which can be challenging.



Expanding Infrastructure

Expanding infra is another vital strategy for enhancing CNG availability. Increasing the number of CNG stations offers a long-term solution, improving accessibility for consumers and reducing wait times. This, in turn, encourages the adoption of CNG vehicles. However, high costs associated with building and maintaining storage infrastructure and the time-intensive nature of such present significant challenges.

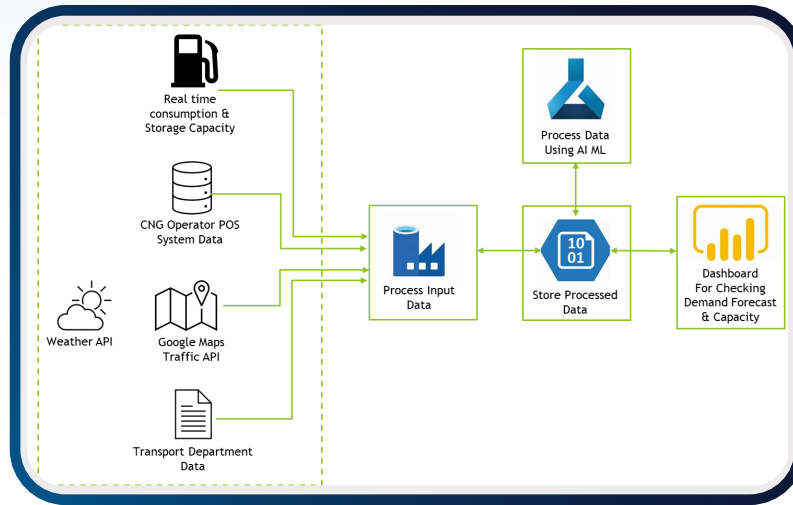


Efficient Supply Management

This strategy focuses on optimizing the existing CNG supply chain to meet immediate user demand. This approach can have a short-term impact by ensuring that CNG is distributed to areas with the highest demand. However, it relies heavily on the current infrastructure and can be expensive to scale up. Effective supply management requires a well-coordinated supply chain and the ability to respond quickly to fluctuations in demand.

AI-driven demand forecasting is crucial for bridging the supply-demand gap in CNG availability. It's cost-effective, optimizes resources, and also reduces waste. This adaptable method allows for real-time market adjustments though it requires extensive data collection and analysis. Despite the challenges, it is essential for an efficient and balanced CNG supply chain.

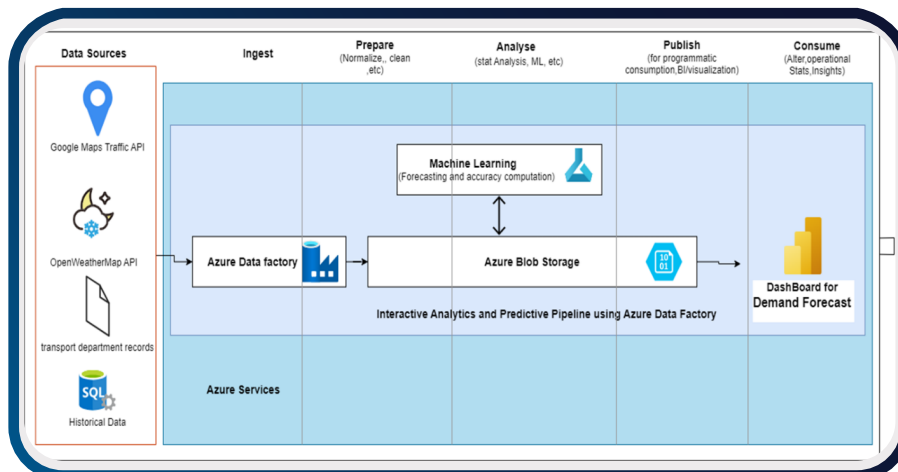
Technical Flow



To begin with, first, we integrate multiple input data sources, including CNG station's point of sale (POS) system data, weather APIs, traffic APIs, transport department data, and historical data. These inputs are consolidated into a single storage system. Using data engineering principles, the data is extracted and refined. The processed data is then fed into AI/ML models, and the forecasted outputs are displayed through comprehensive reports. This streamlined process ensures accurate and actionable insights for effective demand forecasting.


Technical Architecture

To address the complexities of demand forecasting for CNG supply, here's a comprehensive technical architecture that leverages Azure's robust ecosystem:



The solution uses the Azure cloud ecosystem to ensure efficient and accurate demand forecasting for CNG. The architecture is designed to handle large volumes of data from diverse sources, process it efficiently, and generate actionable insights through advanced AI/ML models. Below is a step-by-step breakdown of the solution:





Data Ingestion: The first step in our technical architecture is data ingestion. We utilize Azure Data Factory Services to fetch data from various sources, including APIs for real-time data such as weather conditions, traffic patterns, and historical data stored in SQL databases. This data is ingested into Azure Data Lake Storage (ADLS) or Azure Blob Storage, serving as our centralized data repository. This setup ensures that all relevant data is consolidated in a single location, making it easier to manage and process.

Data Processing and Refinement: Once the data is ingested, it undergoes a series of processing and refinement steps. Using data engineering principles, the data is then cleaned, transformed, and organized to ensure it is in optimal format for analysis. This involves removing inconsistencies, filling in missing values, and standardizing data formats. After this, the refined data is ready to be fed into the AI/ML models.

Machine Learning Models: The core of our technical architecture is the machine learning models that generate the demand forecasts. We use Azure Auto ML, which provides a range of forecasting time series and regression models. These models are trained in historical data to learn patterns and trends that can be used to predict future demand. Then, the models are selected based on their performance and accuracy, ensuring that the most effective algorithms are used for our specific use case.

Model Training and Evaluation: Training the models involves feeding them historical data and allowing them to learn from it. This process is iterative, with the models continuously improving as they are exposed to more data. Later, the models are evaluated using various performance metrics to ensure they are accurate and reliable. This is a very important step as it determines the effectiveness of our demand forecasts.

Forecasting and Reporting: Once the models are trained and evaluated, they are used to generate demand forecasts. These forecasts are then displayed using reporting tools like Power BI and Tableau. These tools provide interactive and visually appealing dashboards that make it easy to interpret the forecasted data. Additionally, users can explore the data, identify trends, and make informed decisions based on the insights provided.

Continuous Improvement: Our technical architecture is designed to be flexible and adaptable. Continuous monitoring of the models is done to check their performance and adjust as and when needed. This involves retraining the models with new data, fine-tuning the algorithms, and updating the data processing pipelines. Improving our system continuously ensures that our demand forecasts remain accurate and relevant.



Business Values/Impact

Optimized inventory management, powered by accurate demand forecasting, enables gas stations to maintain an ideal stock of Compressed Natural Gas (CNG). This approach reduces excess inventory, freeing up both capital and storage space. Predictive models play a critical role in preventing stockouts, ensuring consistent availability of CNG. By aligning inventory levels with actual demand, gas stations can significantly lower infrastructure and transportation costs, leading to meaningful cost savings.

Reliable CNG availability enhances customer satisfaction, attracting and retaining loyal customers while encouraging the adoption of CNG vehicles. Maintaining adequate stock ensures uninterrupted service, boosting sales revenue. Moreover, analyzing long-term demand trends supports strategic decisions regarding station expansions or new location setups. Insights from historical data offer valuable market intelligence, while accurate demand forecasts can help secure long-term supply contracts at favorable rates from producers and distributors.

In summary, effective demand forecasting and inventory management do more than enhance operational efficiency—they also drive cost reduction, maximize revenue, and support strategic planning. Together, these benefits build a more sustainable and profitable CNG supply chain.

Optimized Inventory Management: Accurate demand forecasting helps gas stations stock the right amount of CNG, reducing excess inventory and freeing up capital and storage space. Predictive models prevent stockouts, guaranteeing consistent CNG availability. Aligning inventory levels with actual demand lowers infrastructure and transportation costs, leading to significant savings.

Customer Satisfaction and Revenue: Reliable CNG availability enhances customer satisfaction, thereby attracting and retaining customers. Plus, adequate stock ensures uninterrupted service, boosting sales revenue and promoting the adoption of CNG vehicles.

Strategic Planning: Long-term demand trends guide decisions on station expansion and new locations. Moreover, running an analysis of historical data provides valuable market insights. All these factors contribute to an accurate demand forecast, thus helping secure long-term supply contracts at lower prices from producers and distributors.

Overall Benefits

Integrating demand forecasting into the CNG ecosystem offers transformative advantages:



Enhanced operational efficiency



Significant cost reduction and revenue maximization



Informed strategic planning for growth



A robust, sustainable, and profitable CNG supply chain

By emphasizing these outcomes, organizations can address current challenges while positioning themselves for long-term success.



Other Applicable Areas

Crude Oil and Petrol/Diesel Demand Forecasting



Forecasting demand across upstream, midstream, and downstream domains by considering geographical areas, distances, and weather conditions ensures efficient transportation to stations or refineries.

Electric Vehicle Charging Infrastructure



Forecasting demand by analyzing EV adoption rates, peak demand hours, traffic patterns, fuel prices, and weather conditions aids efficient infrastructure planning.

LTIMindtree Evolving Energy Value Chain

The energy sector is undergoing a significant transformation, driven by the integration of traditional and renewable value chains. This evolution is propelled by several key accelerators such as:

- **Investing in decarbonization**
- **Leveraging partnerships for innovation**
- **Empowering consumers as energy contributors**
- **Advocating for supportive policies**

Organizations must invest in renewable energy technologies, develop innovative business models, and harness the power of data and digitalization to navigate the current transformation. This approach not only addresses the unique value chain of the energy industry but also fosters a convergence where traditional and renewable sources collaborate, creating a secure, reliable, and sustainable energy ecosystem.

Find the more details on LTIMindtree's E-book title, “[Staying Ahead of the Evolving Energy Value Chain](#)” - [Energy Value Chain & Automation in Oil and Gas: Transforming Electric Utilities](#).

Conclusion

All in all, demand forecasting is an essential tool for bridging the supply-demand gap in CNG availability. By integrating AI, advanced technology, and business insights, it ensures accurate and efficient predictions. This approach also helps optimize resource allocation, minimize shortages and surpluses, and allows for real-time adjustments based on market conditions. This comprehensive solution enhances the reliability of the CNG supply chain while supporting sustainable and cost-effective operations. For both providers and consumers, adopting demand forecasting creates a more balanced, efficient, and environmentally friendly ecosystem.

Contact Us to know how LTIMindtree can help you in enabling Smarter Supply Chains with AI-Powered Insights.

About the Author



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Pritamkumar is a specialist in Azure Cloud solutions, driving impactful digital transformation within LTIMindtree's Digital Engineering practice. His deep knowledge of Microsoft technologies, combined with expertise across industries such as manufacturing, healthcare, banking, and energy, allows him to deliver tailored solutions that address unique business challenges. He is passionate about enabling organizations to harness the potential of cloud technologies to enhance operational efficiency and achieve sustainable growth.

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About LTIMindtree

LTIMindtree is a global technology consulting and digital solutions company that enables enterprises across industries to reimagine business models, accelerate innovation, and maximize growth by harnessing digital technologies. As a digital transformation partner to more than 700 clients, LTIMindtree brings extensive domain and technology expertise to help drive superior competitive differentiation, customer experiences, and business outcomes in a converging world. Powered by 84,000+ talented and entrepreneurial professionals across more than 30 countries, LTIMindtree — a Larsen & Toubro Group company — solves the most complex business challenges and delivers transformation at scale. For more information, please visit <https://www.ltimindtree.com/>.