

AVEVA PI WORLD

Augmented Intelligence for Pipelines

Leveraging AVEVA Enterprise Pipeline Management, PI System, and AWS to infuse Artificial Intelligence with existing operational capabilities

Presented By: Sandeep Sidhu, USNG Product Delivery, TC Energy



TC Energy's Network

Natural gas pipelines

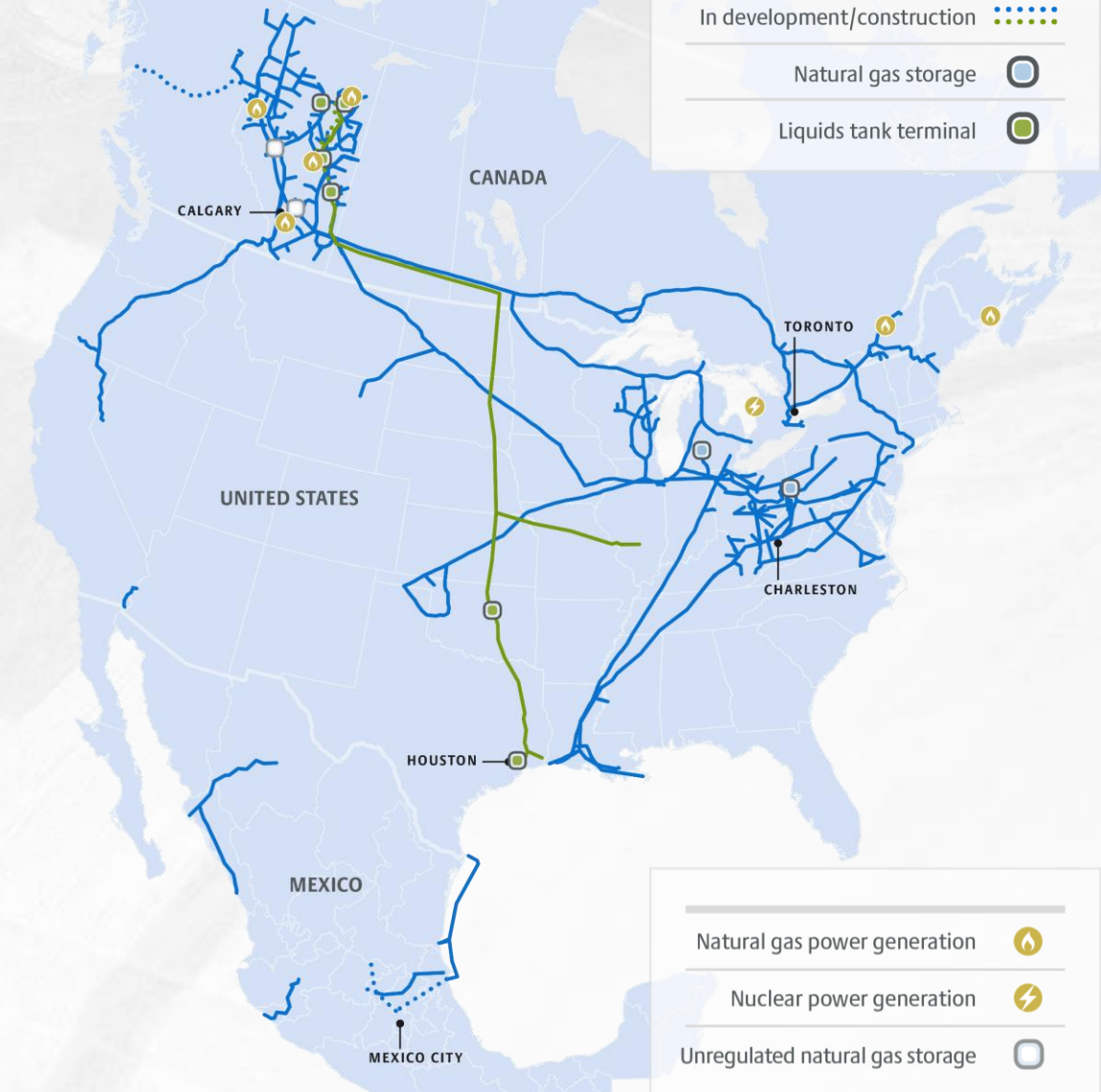
25% of the natural gas that North America uses every day.

Oil and liquids pipelines

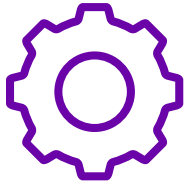
~20% of the western Canadian oil that goes to the U.S. Midwest and Gulf Coast.

Power generation

Powering more than 4 million homes.



Highly-efficient pipeline operations



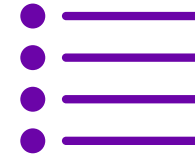
Challenge

- Enable gas controllers to optimize system operations by providing:
 - Past, present and future operating conditions
 - Optimal recommendations
 - Linepack forecasting



Solution

- A one-page operational summary of the pipeline built on a streamlined application framework
- The framework extends the existing use of AVEVA's Pipeline Management Solution and PI AF by integrating it with Amazon Web Services (AWS)



Benefits

- \$8MM+ in demonstrated value for TC Energy by providing targeted opportunities through forecasting and better operational decision-making through machine learning
- An application framework that enables rapid development, rollout, and sustainment of a scalable operational intelligence product

Business Challenge

How can we be better at operating our pipelines?

- Be better prepared to capture revenue generating and cost saving opportunities
- Provide new gas controllers with a decision framework by leveraging senior controllers' knowledge and experience
- Leverage our existing datasets and the PI System to gain insights with machine learning and strategic dashboards

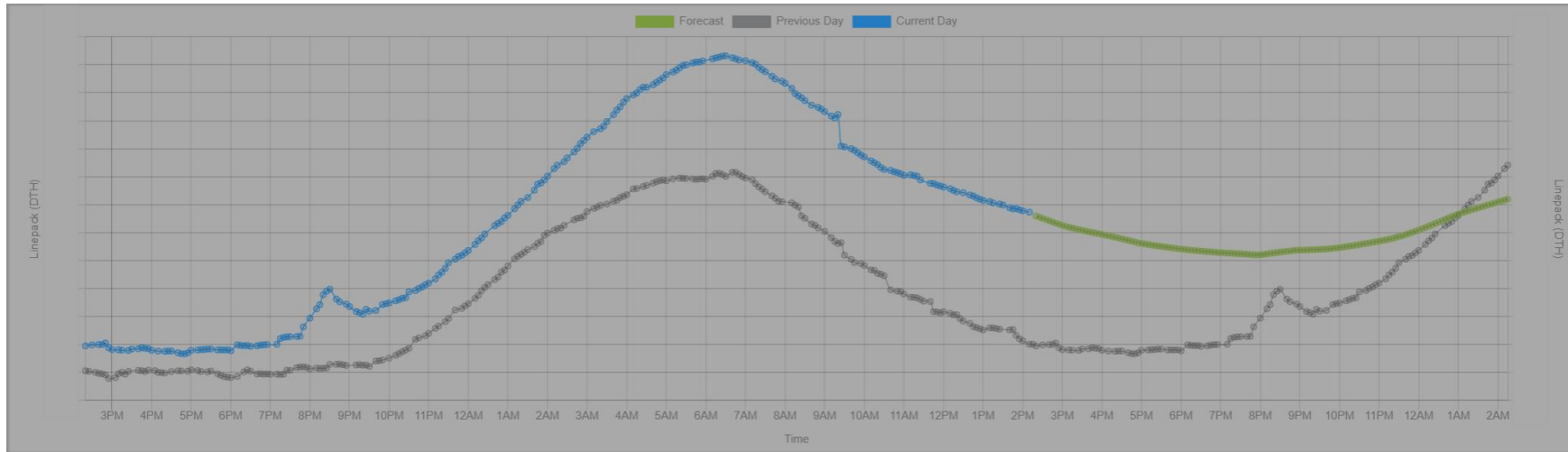


Pipeline Terminology

- **Linepack** is the total volume of gas contained within the pipeline system
- **Compressor Stations** are facilities which help transport gas from one part of the pipeline to another
- **Park transactions** allow customers to 'park' their gas on our pipelines for a period-of-time
- **Loan transactions** allow customers to withdraw gas from our pipelines for a period-of-time

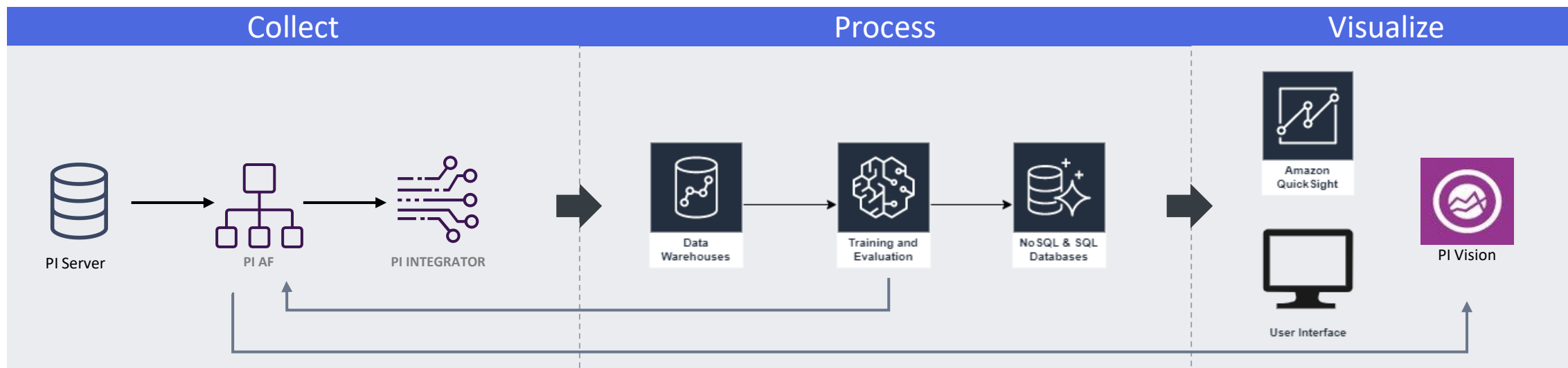


Implementation Details



- **Forecasts** consolidate data such as weather and flow rate to identify opportunities in demand and linepack
- **Recommendations** provide real-time decision-making confidence in pressure, flow, and engine settings
- **Alerts** trigger advanced responses to oversights and changing market conditions
- **Strategic displays** that consolidate large datasets and generate visualizations from which actionable insights can be garnered

Leveraging the AVEVA System



- PI AF enables us to categorize the raw data that we receive from AVEVA's SCADA system and to create a framework using it
- AF's templates ensure that we only create the framework once which:
 - Enables us to deploy quickly across other pipelines
 - Simplifies maintenance by using a single template instead of maintaining multiple assets
- PI Integrator provided us a way to quickly and effectively move this data to AWS in both the prototyping and production stages

Machine Learning with the PI System/PI AF & AWS

How do we leverage the power of both these systems?



- Data Scientists can focus more on machine learning training instead of data cleansing due to the PI System
 - Raw sensor data is transformed into the necessary shapes required for training and consumption
 - Contextualized data is easily exported to AWS using PI Business Integrator where we can store it in S3 and Redshift
- Real time model results are pushed down from AWS to the PI System via PI Interface for Relational Database to analyze model performance using PI Vision



What are the benefits?

\$8MM in demonstrated value for TC Energy

- Provide targeted opportunities through forecasting
- Better operational decision-making through machine learning
- Decision-making confidence through real-time information
- Next generation application framework that provides the capability to develop highly scalable, production grade applications quickly

Summary

- ① Highly effective data flow by utilizing AVEVA's Pipeline Management Solution and PI System with Amazon Web Services
- ② Ability to evaluate millions of potential scenarios to create recommendations and forecasts for our operations teams
- ③ Leveraged a framework that can be utilized from a rapid prototype to a highly-scalable production grade application



Transformed a complex scenario planning process into a one-page, real-time operational summary of the pipeline



Sandeep Sidhu

Systems Architect

- USNG Product Delivery, TC Energy
- sandeep_sidhu@tcenergy.com

[illegible]

This presentation may include predictions, estimates, intentions, beliefs and other statements that are or may be construed as being forward-looking. While these forward-looking statements represent our current judgment on what the future holds, they are subject to risks and uncertainties that could result in actual outcomes differing materially from those projected in these statements. No statement contained herein constitutes a commitment by AVEVA to perform any particular action or to deliver any particular product or product features. Readers are cautioned not to place undue reliance on these forward-looking statements, which reflect our opinions only as of the date of this presentation.

The Company shall not be obliged to disclose any revision to these forward-looking statements to reflect events or circumstances occurring after the date on which they are made or to reflect the occurrence of future events.

 [linkedin.com/company/aveva](https://www.linkedin.com/company/aveva)

 [@avevagroup](https://twitter.com/avevagroup)

ABOUT AVEVA

AVEVA, a global leader in industrial software, drives digital transformation for industrial organizations managing complex operational processes. Through Performance Intelligence, AVEVA connects the power of information and artificial intelligence (AI) with human insight, to enable faster and more precise decision making, helping industries to boost operational delivery and sustainability. Our cloud-enabled data platform, combined with software that spans design, engineering and operations, asset performance, monitoring and control solutions delivers proven business value and outcomes to over 20,000 customers worldwide, supported by the largest industrial software ecosystem, including 5,500 partners and 5,700 certified developers. AVEVA is headquartered in Cambridge, UK, with over 6,000 employees at 90 locations in more than 40 countries. For more details visit: www.aveva.com