AI in Grid Operations and Planning

- ISO NE Initiatives

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Needs for AI in Grid Operations and Planning

- Evolving resource mix has created much more **uncertainty** in bulk power system operations
  - Renewable generations are greatly affected by weather conditions
  - Forecasting is essential to reliable system operation and planning
- Increasing level of resource integration significantly **complicated** business processes in system operations and planning
  - FERC order 2023 requires cluster study for faster resource integration
  - Business process automation plays a key role to operational efficiency improvement
- Decades of grid operation and deployment of advanced measurement technique generate massive amount of **data** for the grid operator
  - Machine learning (ML) and Big data analytics become more and more important in grid operator's decision making process

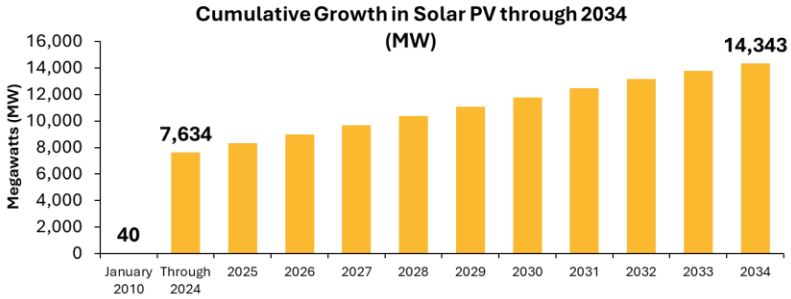
FORECASTING

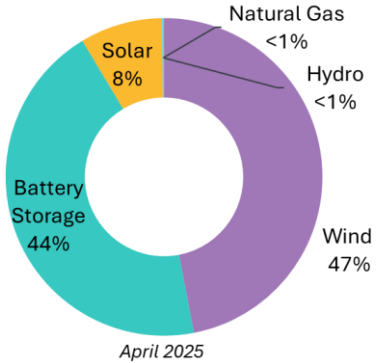
Load forecasting is the most successful application of AI/ML in grid operations

- ISO-NE has been using ANN-based short-term (up to 7 days) load forecast for over 20 years
- The goal of short-term LF error in ISO NE has been 1.8% (Oct – May) and 2.6% (June – August)

	Neural Network Models	
Similar Day (Hands-On Approach)	**Regional Neural Networks**	**Zonal Models** (8 zones)
Forecaster makes adjustments to historic loads using differences between historic weather and forecasted weather as guide.	Historic weather and loads are input to computer program with an output of forecasted load for all of New England.	The same neural network approach, but on smaller areas. Eight zones are aggregated into one regional forecast.

The need for probabilistic forecasting is on the rise

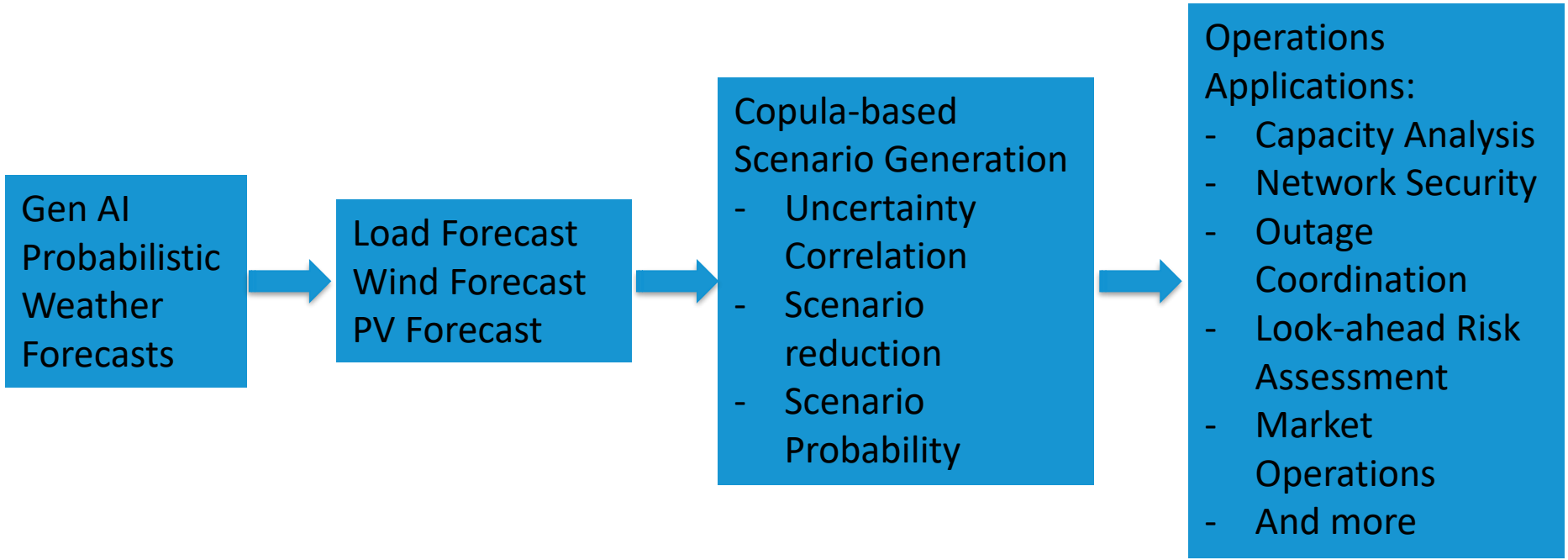




- Probabilistic forecasts can quantify the uncertainty with increasing renewables.
- It allows for better risk management, more efficient resource allocation, and improved decision-making in the face of uncertainty.
- Data-Driven ML-based probabilistic forecasts can capture complex dependencies and non-linearities of underlying patterns and relationships that traditional forecasting methods might miss.

Uncertainty quantification is fundamental to the shift to risk-based planning and operations

- An uncertainty quantification framework

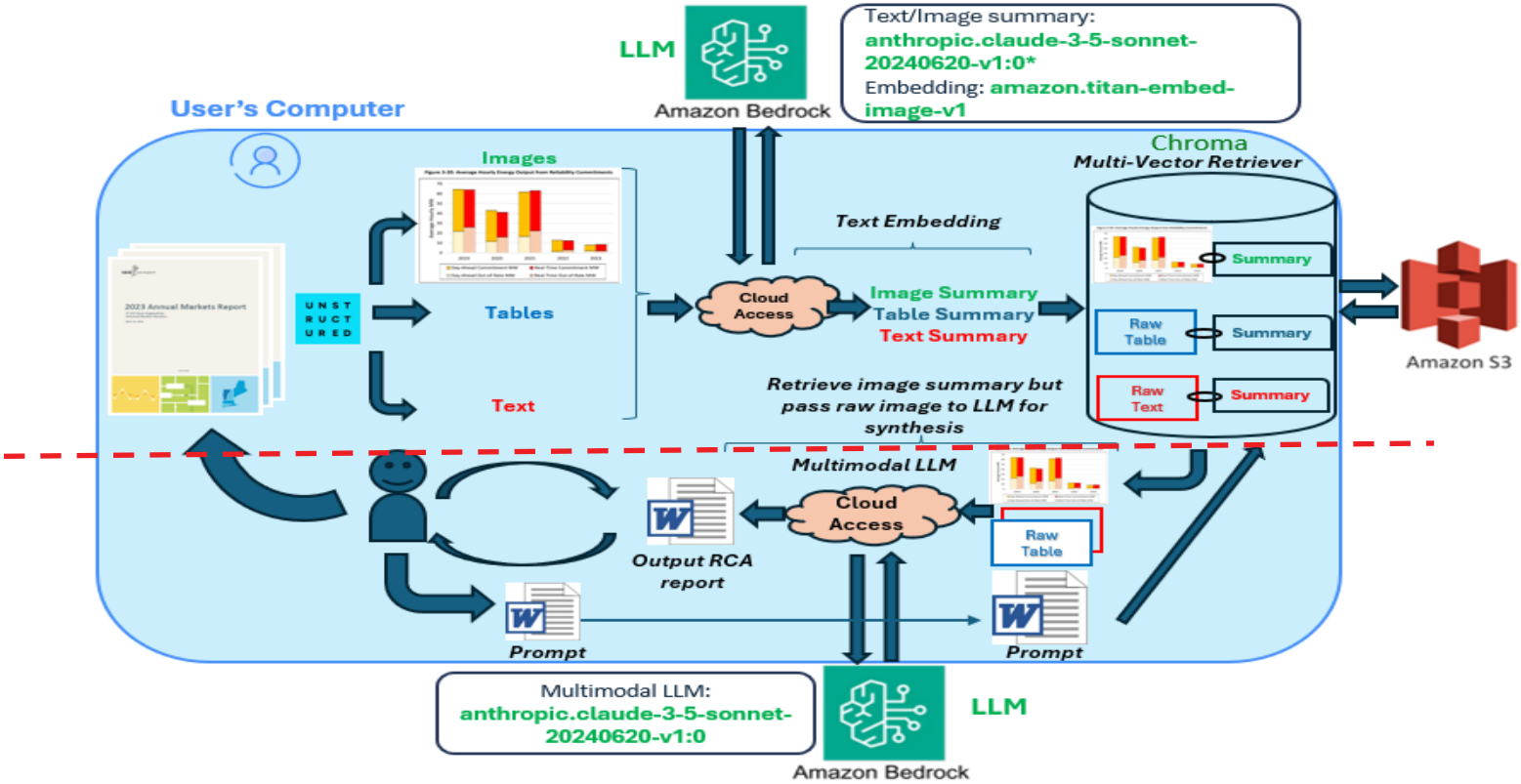


PROCESS AUTOMATION

Building ISO NE domain knowledge chatbot

- The need for an organizational **chatbot**
  - A huge knowledge base spreads out through the organization, and is presented in many forms such as documents, videos/audios, images, database, and webpages etc…
  - Easy access to this knowledge base can significantly increase the efficiency of business operation and speed up employee training/development.
- Pilot **chatbot** implementation
  - A Chatbot was developed in a pilot mode using the Amazon Q for Business connecting many internal data sources
  - Current testing shows that the retrieval-augmented generation (RAG) architecture works very well with private data sources

Generating Report Using RAG Architecture

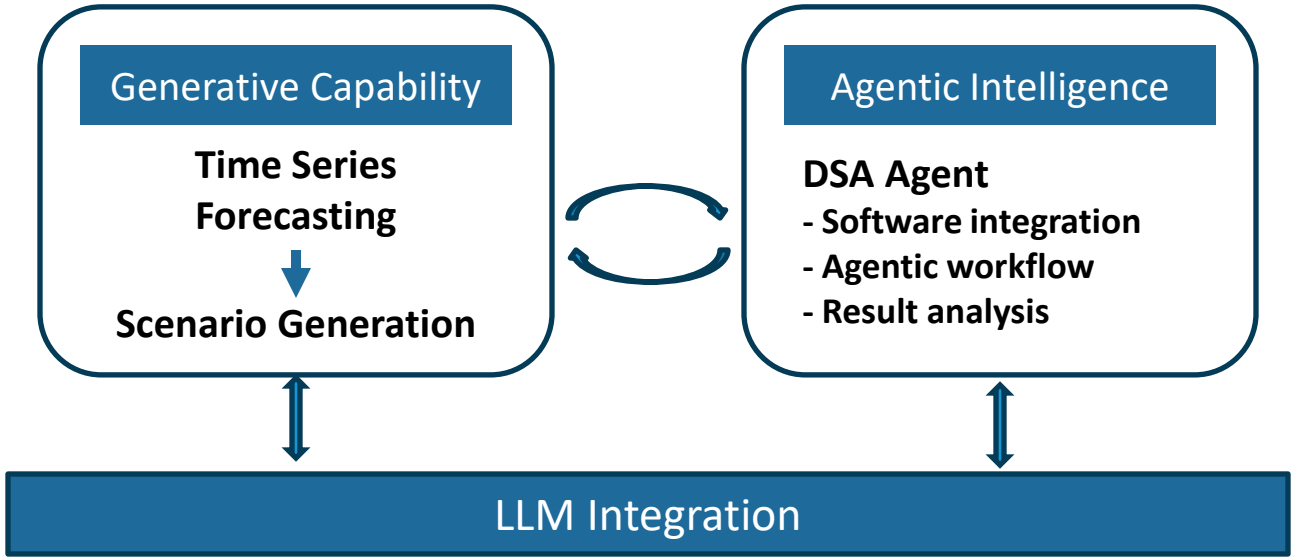


Agentic AI is a promising technology for process automation

- Agentic AI is an autonomous system that can reason and take actions to achieve a predefined goal with limited human interactions.
- Key benefits
  - Improve the efficiency of business operation – better workflow management
  - Integration with existing software system
  - Integration with LLM
- ISO NE is exploring the potential of Agentic AI for various business processes

GenAI Enabled Transmission Dynamic Security Assessment

A collaboration with Harvard University



ML AND BIG DATA ANALYTICS

Developing Weather-aware Operational Risk Assessment

- New England is exposed to extreme weather such as tropical and wintry weather patterns. Serious power outages have occurred due to hurricanes and nor'easters.
- Predicting the impact of extreme weather events and developing mitigation actions will help system operators making informed decision.
- ISO New England has developed an online Weather Look-ahead Study (OWLS) tool to enhance the control room situation awareness
  - Predict the outage probability of transmission line based on weather forecast
  - Alert system operators potential transmission outages with elevated outage probability
  - Integrated with online cascading analysis to provide the probabilistic assessment of cascading failures

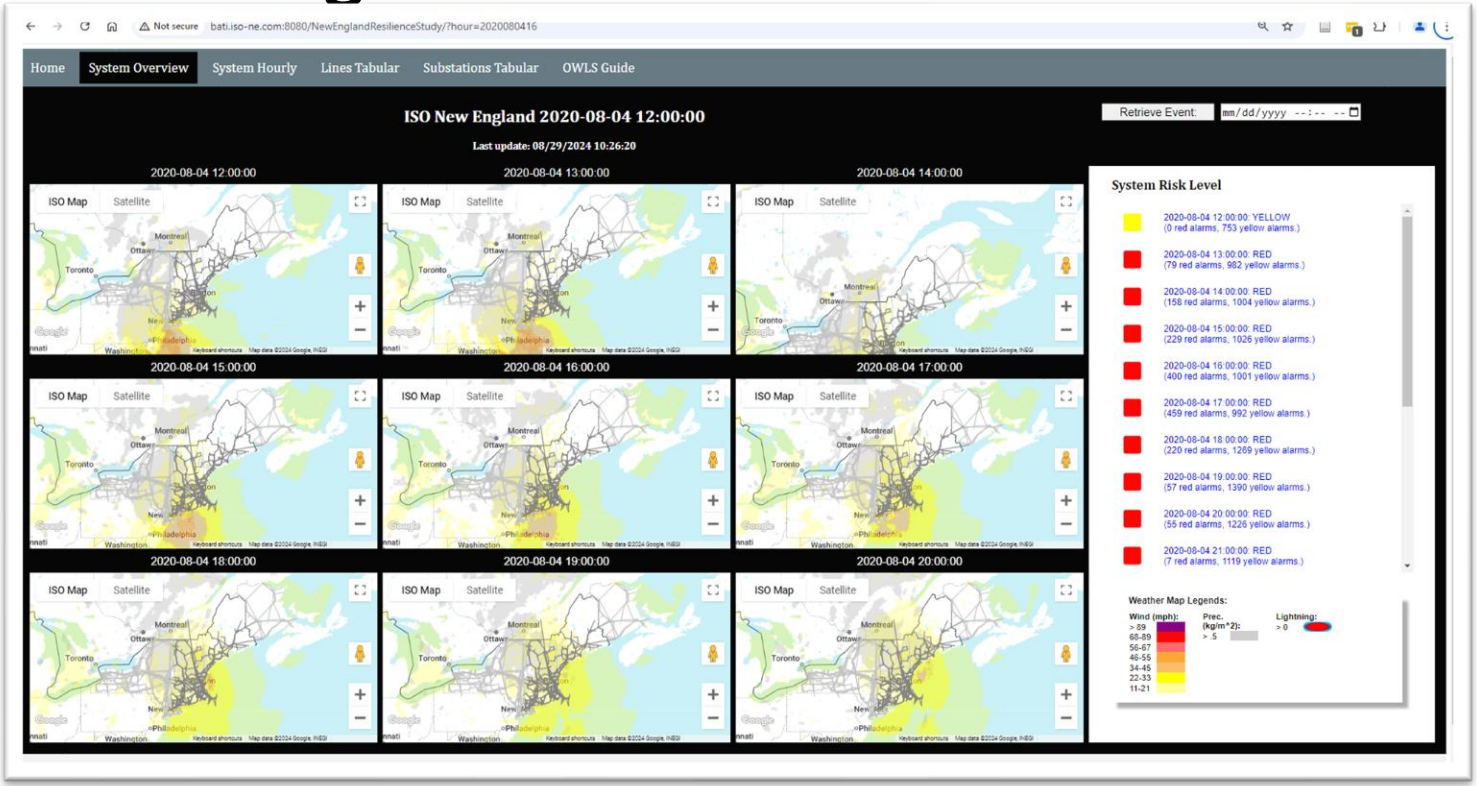
ML techniques are used to derive transmission outage probabilities

- A collaboration with Eversource Center, University of Connecticut
- Use binary classification methods:
  - Logistic Regression (LR).
  - Extreme Gradient Boost (XGBoost) with Natural Gradient Boost (NGBoost) for probability calibration.
- Model input data: After feature importance analysis

Storm Type	Windstorm	Thunderstorm	Snowstorm
Feature 1	WIND Average	CAPE	WIND Average
Feature 2	GUST	CIN	WEASD
Feature 3	LAI	LTNG	Snow-Density
Feature 4	-	-	LAI

LAI: Leaf Area Index; **CAPE**: Convective Available Potential Energy; **CIN**: Convective Inhibitive Energy; **WEASD**: Water Equivalent of Accumulated Snow Depth; **Snow-Density** = WEASD/Snow Depth.

OWLS provides a better outlook of potential system outages



Key Takeaways

- Grid operations and planning are becoming increasingly uncertain and complex
- Big data analytics and machine learning techniques are being used in the exiting operational environment, but will play even more important role under clean energy transition
- Generative AI has a great potential in business automation and informed decision making, but remains challenging in cyber security, and trustworthiness for grid operations that require high reliability standards

Questions