
AVEVAWORLD

AVEVA PI System + AI: Advances in Future Grid Control Rooms

April 8, 2025

Seong Choi, Engineering Lead

Photo by Dennis Schroeder, NREL 55200

NREL eGridGPT: Control Room of the Future

Proof of Concept:
eGridGPT talks to Control room applications

Utilities shown interests in NREL's eGridGPT

Utilities
- ISO
- IOU
- Etc.

Vendors
- EMS
- Cloud
- Etc.

Researchers
- National Labs
- Universities

NREL Transforming ENERGY

eGridGPT
Trustworthy AI

Secure, Reliable, Affordable & Resilient Operations

Assist at All Scales, T&D + DER

On-premise &

To run on a laptop

Cyber secure & NERC Compliant

AI: What We Heard

Vendors are asking…

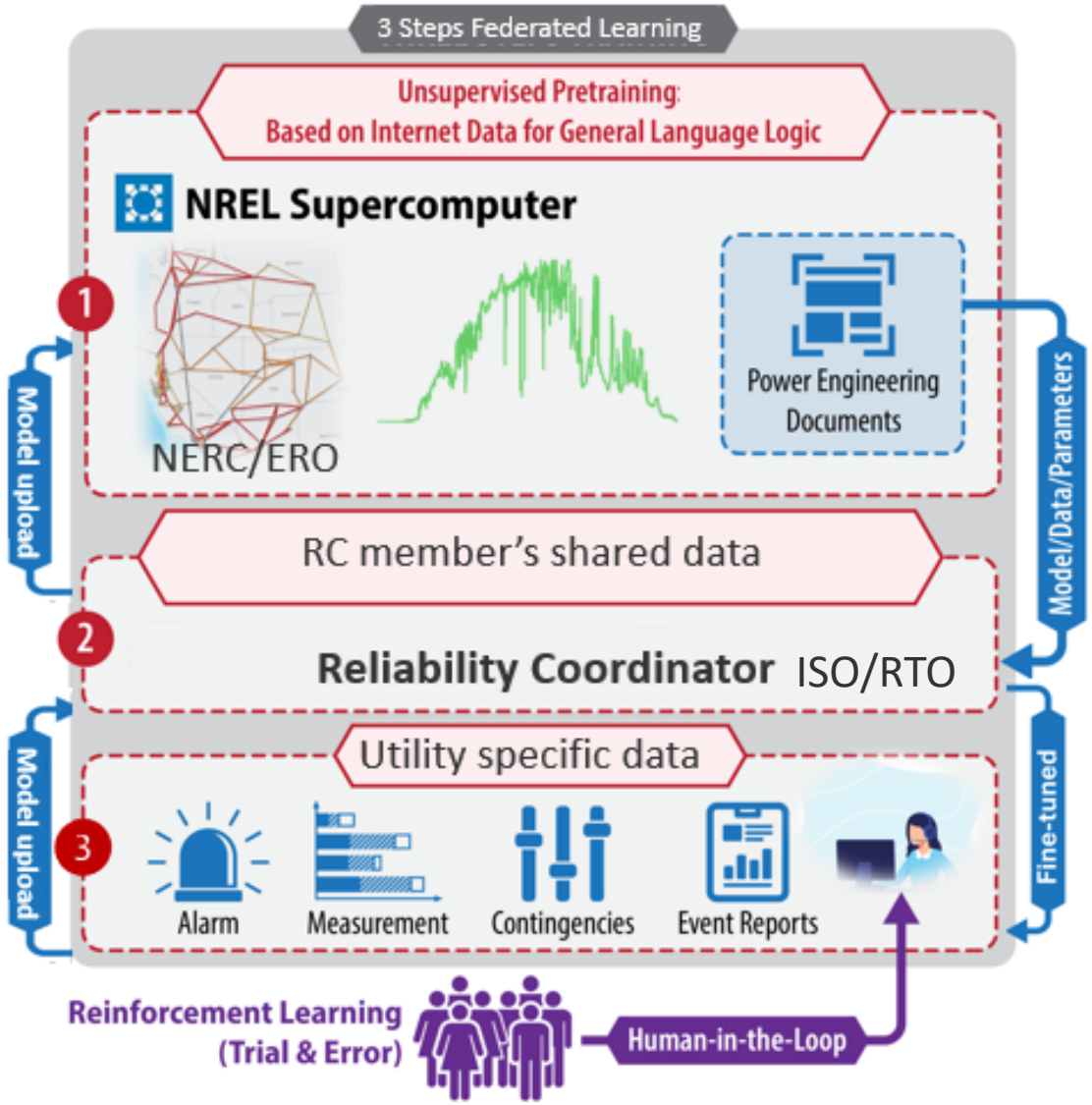
- Should AI be embedded into their software or stand-alone AI interface with their software?
- Seong**: AI application should be modularized. Progress of AI is hard to keep up with.**

Collaboration Opportunities with NREL

Department of Energy, National Labs & Vendors

RC & ISO/RTO

Your company

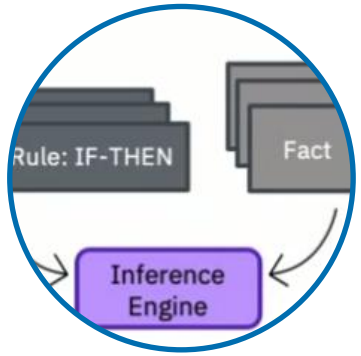


Utilities Gain Attention for Data Centers & AI, Not Blackouts

Data Center

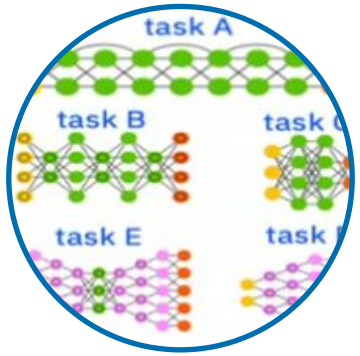
- Aging infrastructure
- Transmission upgrade
- Capacity expansion

Evolution in AI



1980s Expert System

1990s Machine Learning



2000s Deep Learning

2020s Generative AI

Human supervision:
Like PLC/SCADA, engineer coding, labeling, or verifying output

Less supervision:
AI process natural language

Utilities' Grid Modernization Strategy

Vision:
- To become the leading …

Goals:
- Improve …
- Enhance …

Functions:
- Reliability
- Customer satisfaction

Process:
- Contingency analysis
- Customer support

Technology:
- Energy management system
- Call center IVR

Technology Toolbox for achieving future goals

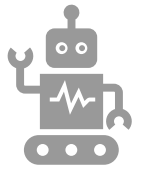
Measuring Technology Maturity

Technology Trend

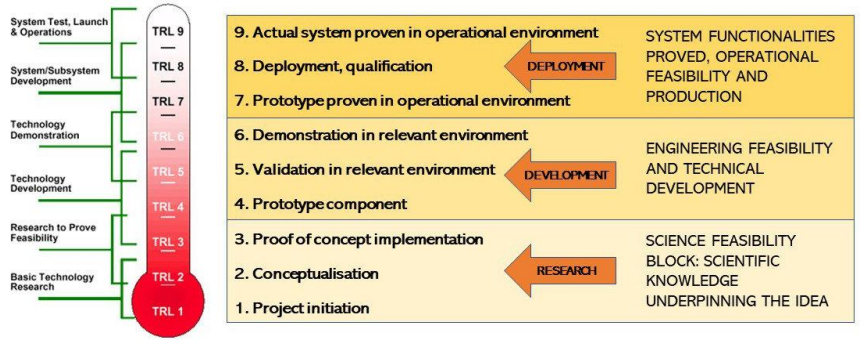
Mapping future goals to Technologies

Generative AI

Digital Twin



Robot/Drone



eGridGPT
Trustworthy AI

EMS
Digital Twin EMS

eGridGPT Supports Control Room Operator Transition by Integrating AI + Digital Twin

LADWP

Past

No computer/Analog

PeakRC

Present

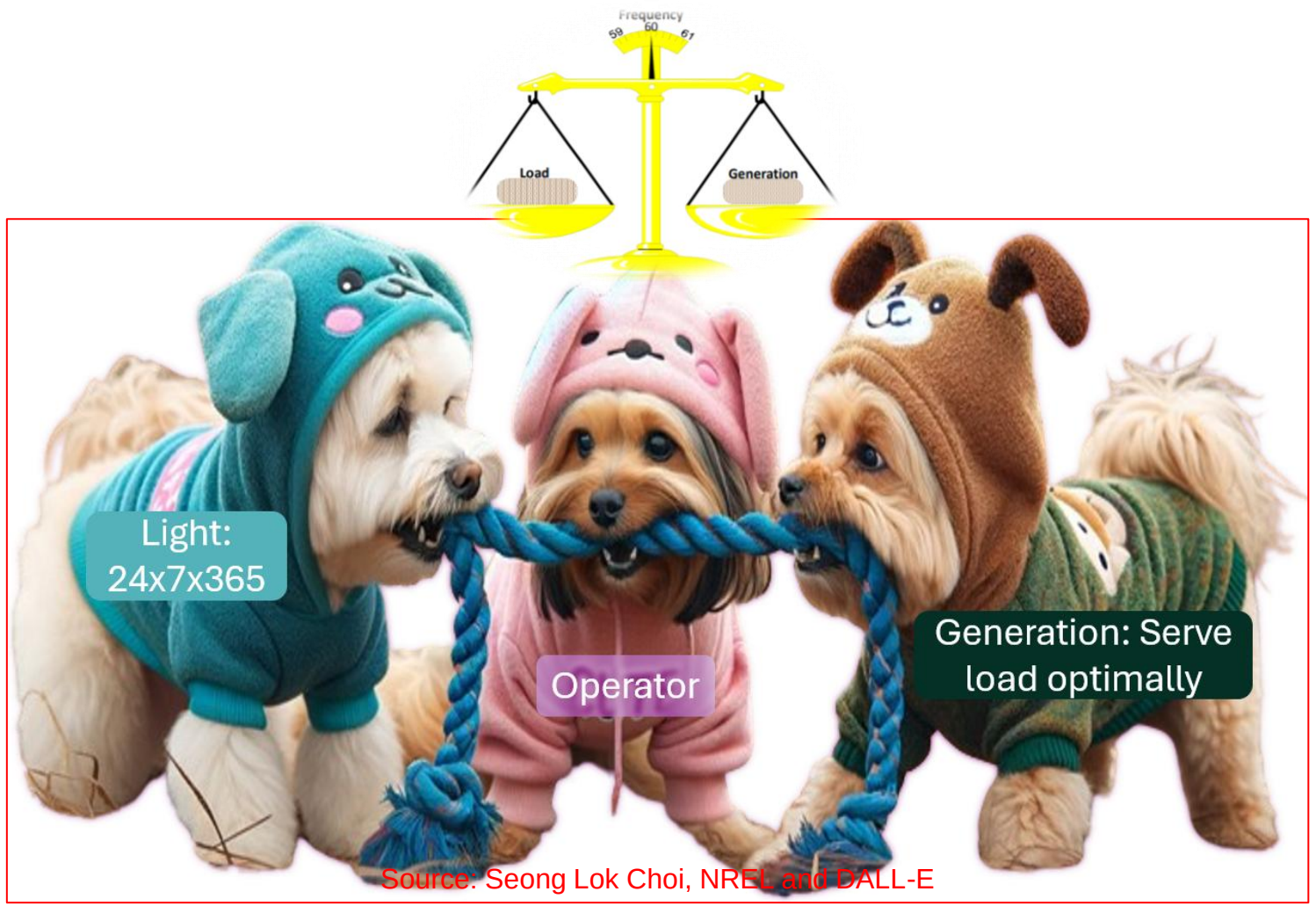
Computer/Digital

Future

NREL

Digital transformation

Importance of the Control Room Operator



Source: Seong Lok Choi, NREL and DALL-E

System Reliability

- What happens if something goes wrong?

Stability

- Secure power flow to prevent abnormal conditions

Affordability

- Optimal cost

Resilience

- Quickly restore

What Does Operator Do?

Back to normal

Schedule

- Day-ahead

Dispatch

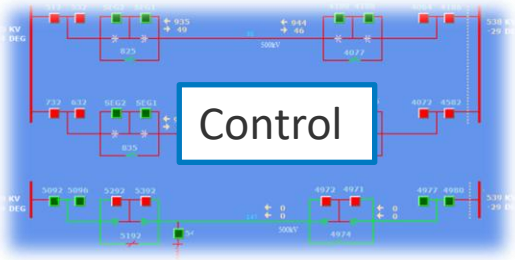
- Intra-day

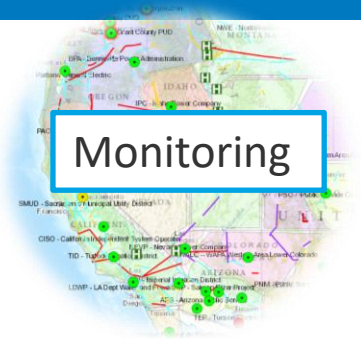
Abnormal operation

Mitigation

Greatest need for assistance

Recognition-Primed Decision (RPD)





Operating instructions

SITUATION

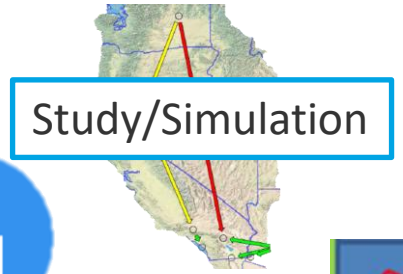
CUES

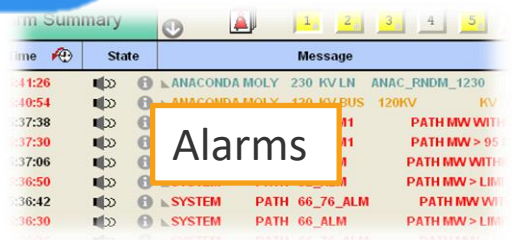
PATTERNS

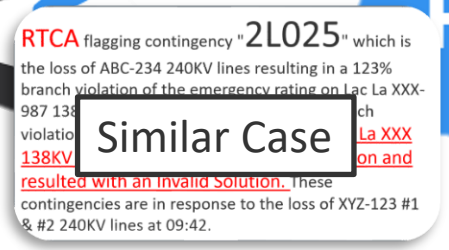
MODELS

ACTION PLANS

SIMULATION

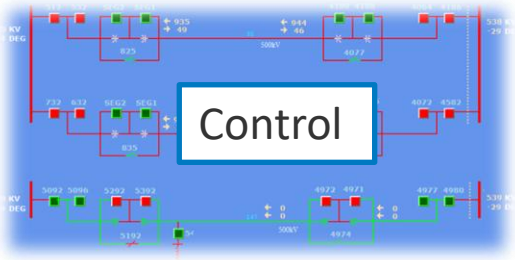


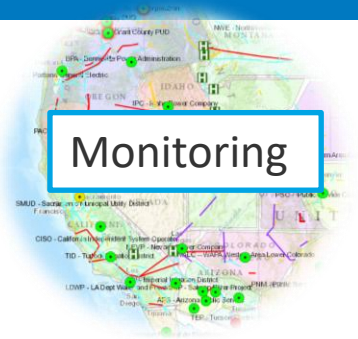




Klein, G. A. (1993). A recognition-primed decision (RPD) model of rapid decision making.

Technologies to Assist Operators





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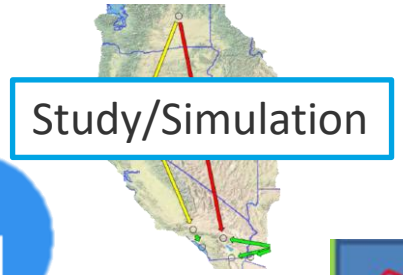

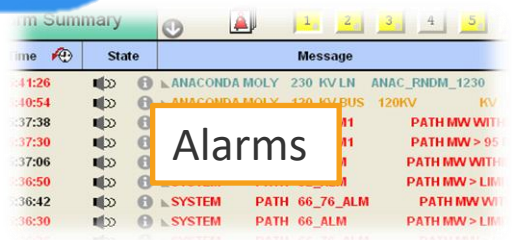

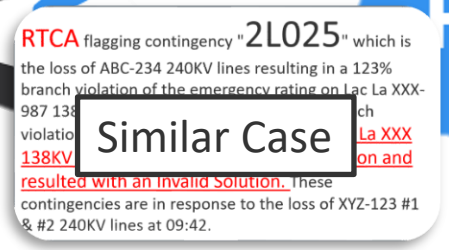

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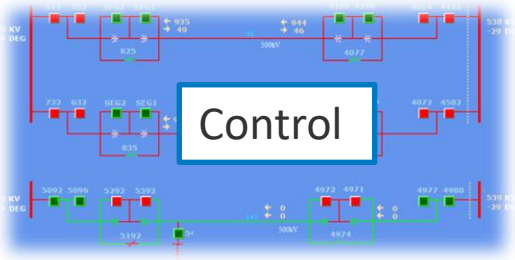

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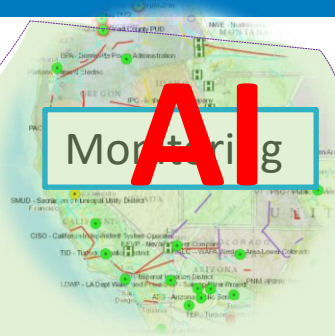

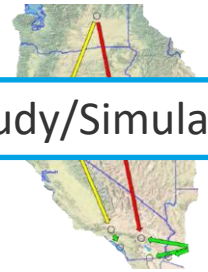

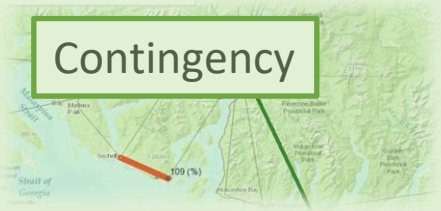

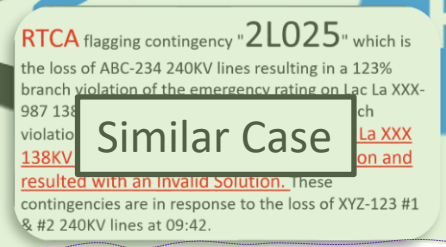

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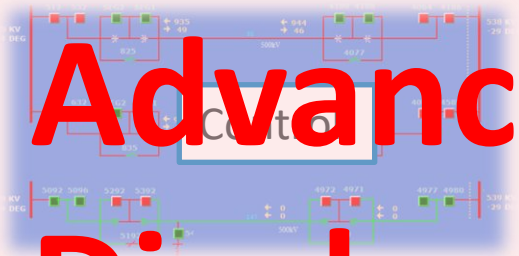

Advanced Display

Operating instructions

AI Digital Twin

SITUATION

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SIMULATION

ACTION PLANS

Study/Simulation

Redispatch

Monitoring

Alarms

Contingency

Similar Case

RTCA flagging contingency "2L025" which is the loss of ABC-234 240KV lines resulting in a 123% branch violation of the emergency rating on Lac La XXX-987 138 ch violatio La XXX 138KV on and resulted with an Invalid Solution. These contingencies are in response to the loss of XYZ-123 #1 & #2 240KV lines at 09:42.

Why Digital Twin?
Automation + Many Simulations

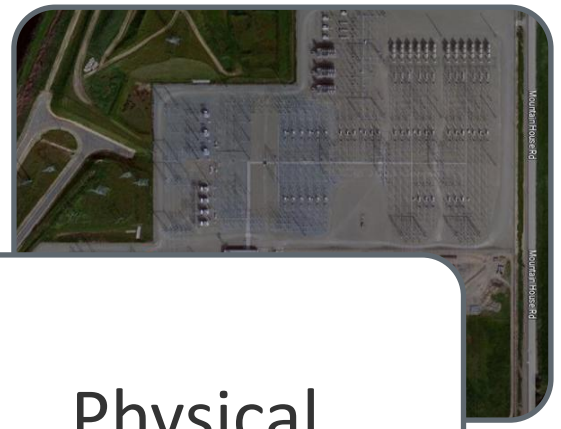
Dispatcher Training Simulator (DTS)

Training Network Model

Operation Model

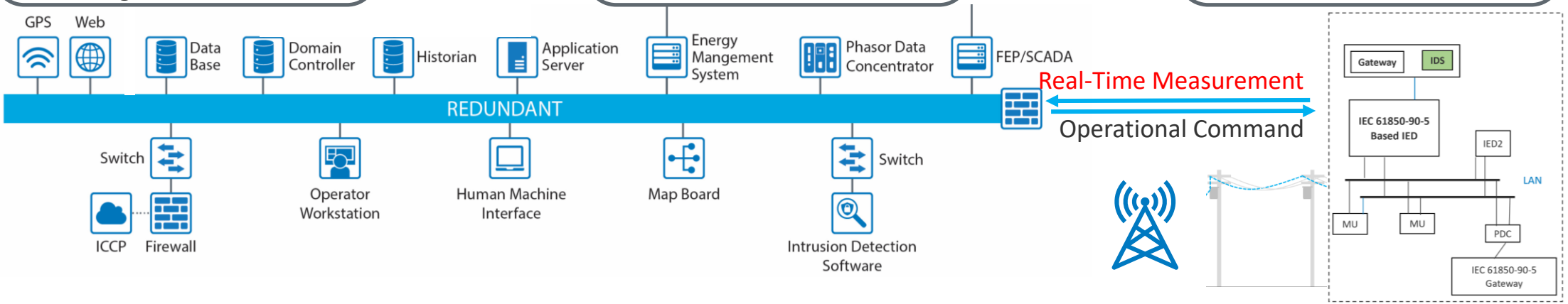
Physical Network Model

Real-Time Measurement



Physical Model

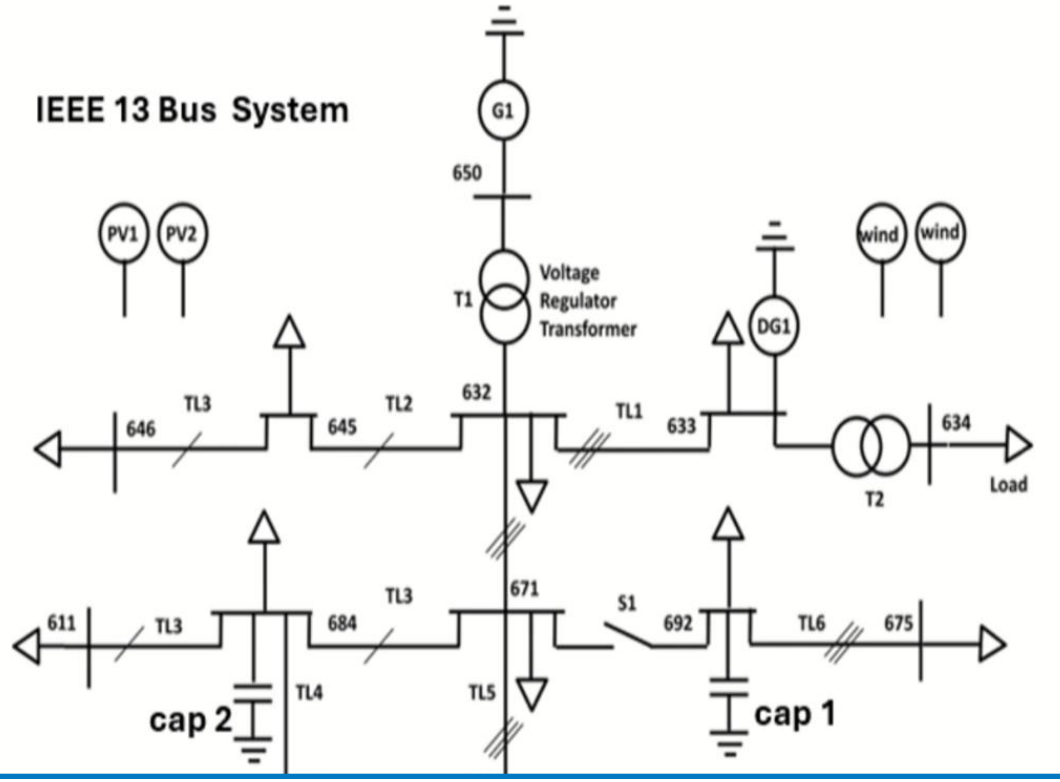
Real-Time Measurement



FEP: Front-End Processor, ICCP: Inter-control Center Communications Protocol, IDS: Intrusion Detection System , IED: Intelligent Electronic Device, MU: Merging Unit, PDC: Phasor Data Concentrator

Next Step: Expanding eGridGPT Automation

Open-Source Distribution System Simulator

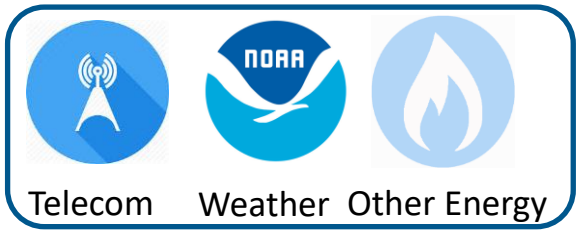


NREL Transforming ENERGY

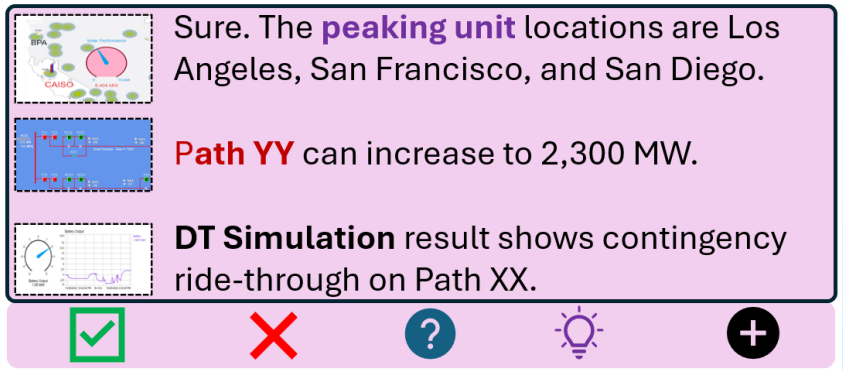
eGridGPT Trustworthy AI

Proof of Concept: Automate Study Process
eGridGPT studies operational impacts

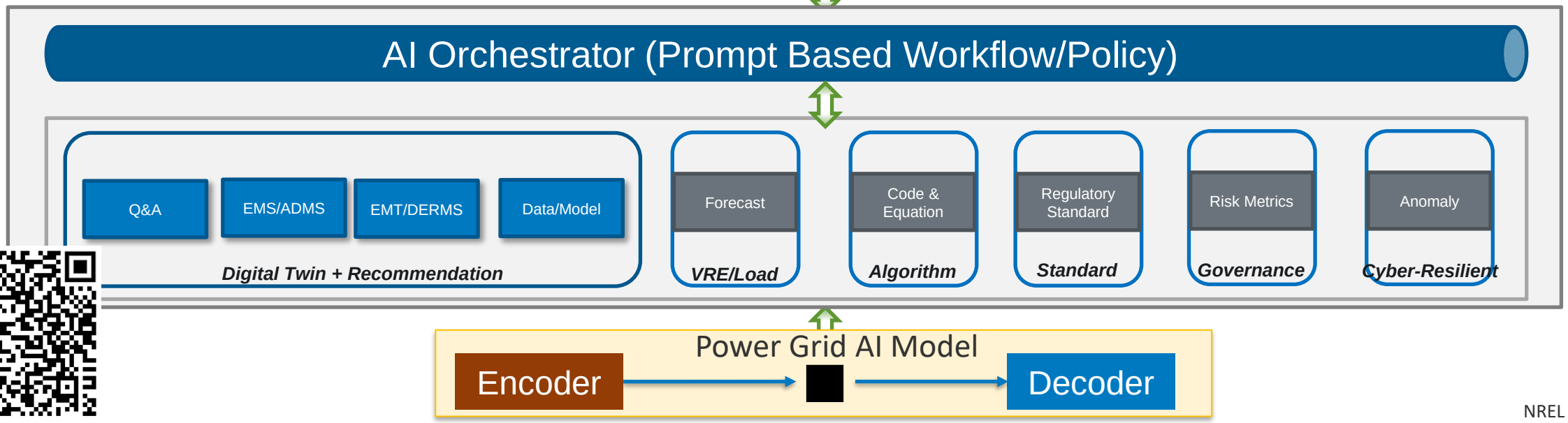
Next Step: Fully Automated Digital Twin + eGridGPT Orchestration



Interdomain Coordination by Operator

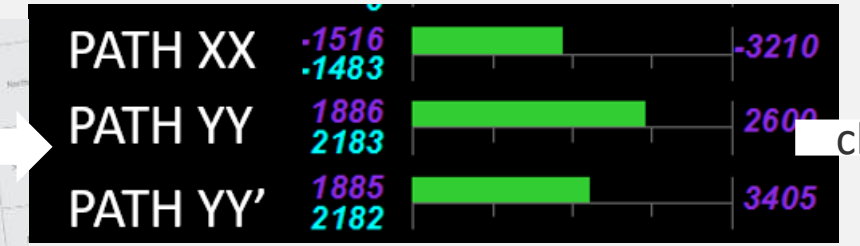


Advanced Display by Prompt Answer



From Manual Search to Intelligent Briefing

click



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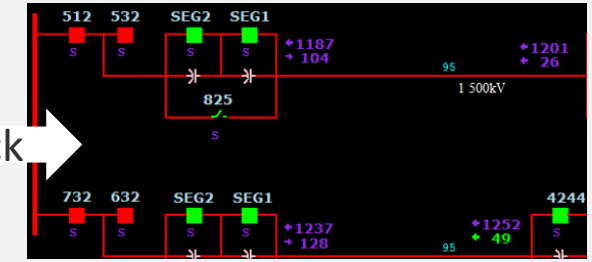
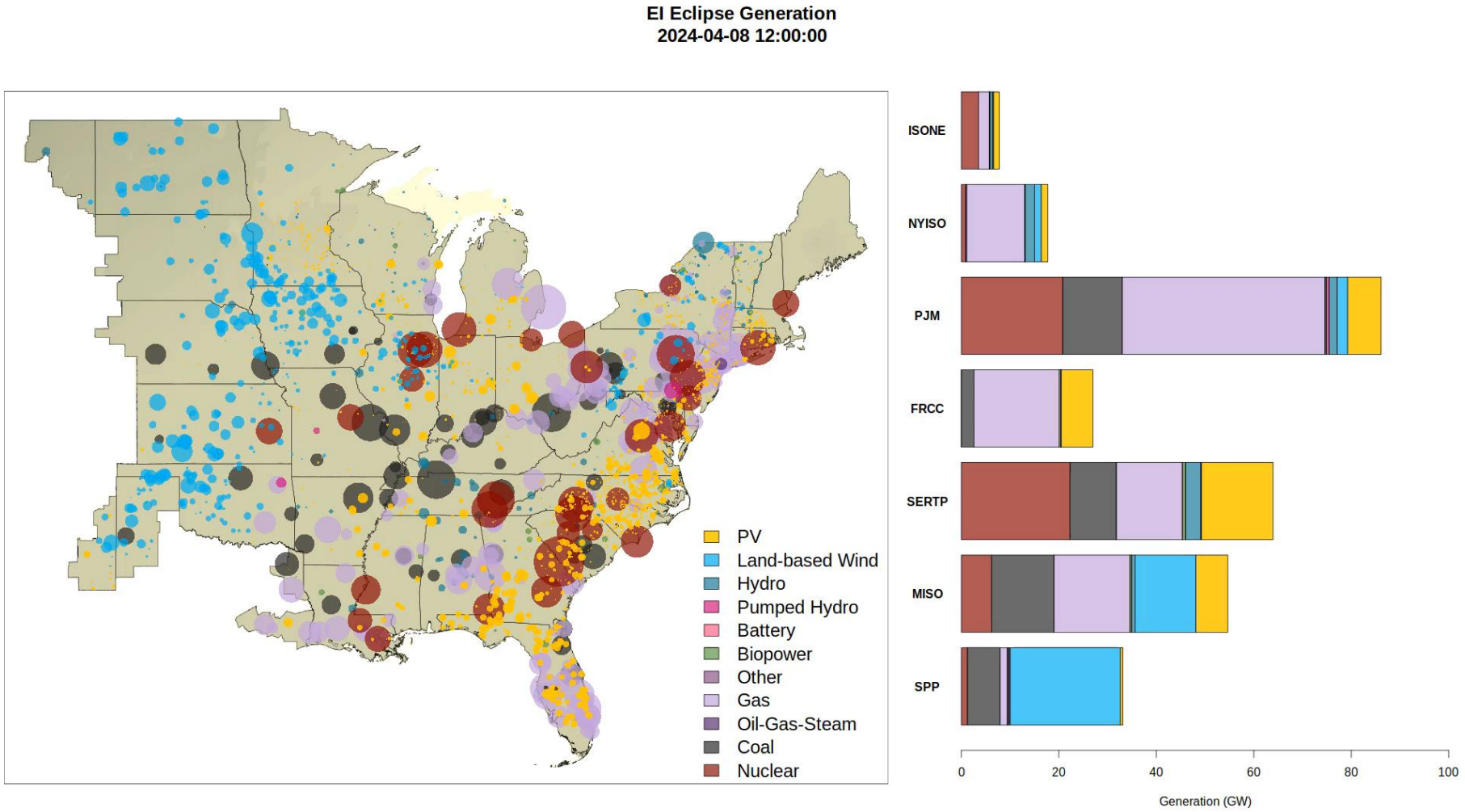


Operators need to know where information is located and evaluate before next steps.

Next Step: Prompt Based Advanced Display

Futuristic Prompt: During the solar eclipse, can you animate ramping up/down by other generation sources to meet the demand?



Source: Kenny Gruchalla, NREL

National Renewable Energy Laboratory | Golden, CO

NREL eGridGPT Leads Control Room of the Future Discussion

Challenge

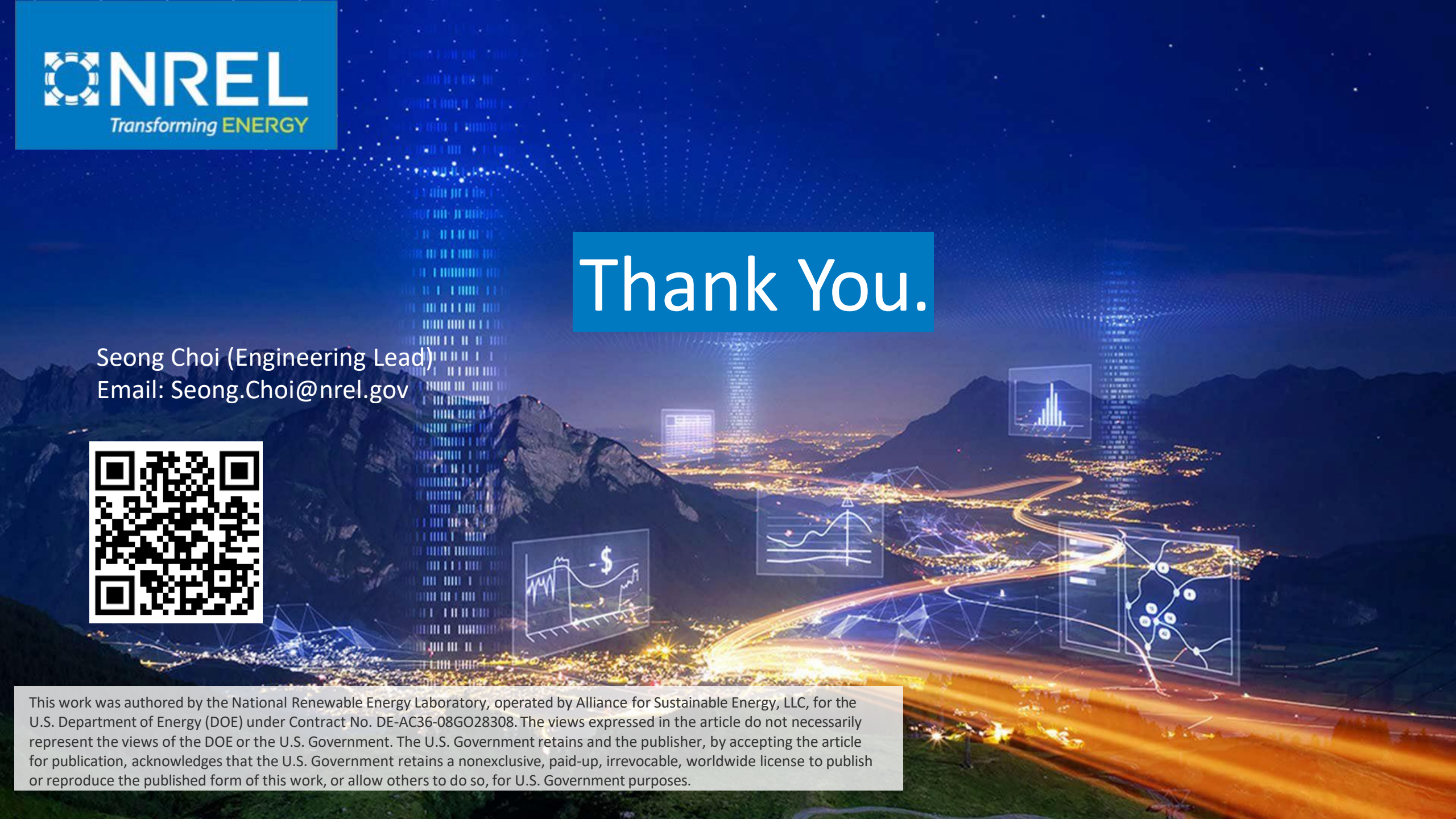
- With the rise in variable generations, operators, engineers, and IT professionals are facing data overload
- The presence of behind-the-meter rooftop generation restricts operators' visibility, leading to uncertainty in operations reliability
- Businesses are currently discussing which technologies to invest in to tackle issues related to big data, visibility, and situational awareness.

Solution

- AVEVA™ PI System™ facilitates the interpretation of real-time data within the context of the user. eGridGPT (combining PI System, AI, and Digital Twin) manages the sourcing of data to enhance responses.

Results

- **Provides timely assistance to operators on-site**
- **Accelerates the onboarding process for new engineers**
- **On-going collaboration and development with vendors, utilities, and research institutions to improve eGridGPT**



Thank You.

Seong Choi (Engineering Lead)
Email: Seong.Choi@nrel.gov