

AI for Transmission Operations and Planning

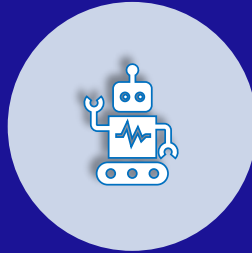
Early Learnings and Direction of R&D at EPRI



Aidan Tuohy
ESIG Fall Workshop, 2025
Philadelphia, PA

State of the AI in Energy Industry - Summary

**Need for
Automation**



**The need for
automation (and AI)**



**AI for Process
Automation / AI for
Decision Making**

**Developing Use
Cases**



**Good ideas but
generally low level of
maturity and adoption.**



**Difficult to set value
use case ideas to
prioritize**

**Solutions,
Platforms and
Technology**



**Platforms, cloud HPC
solutions**



**Software technology
providers, startups,
developing solutions.**

Embedding AI in EPRI R&D



INSIGHTS COMPLEMENT
OUR EXPERTISE

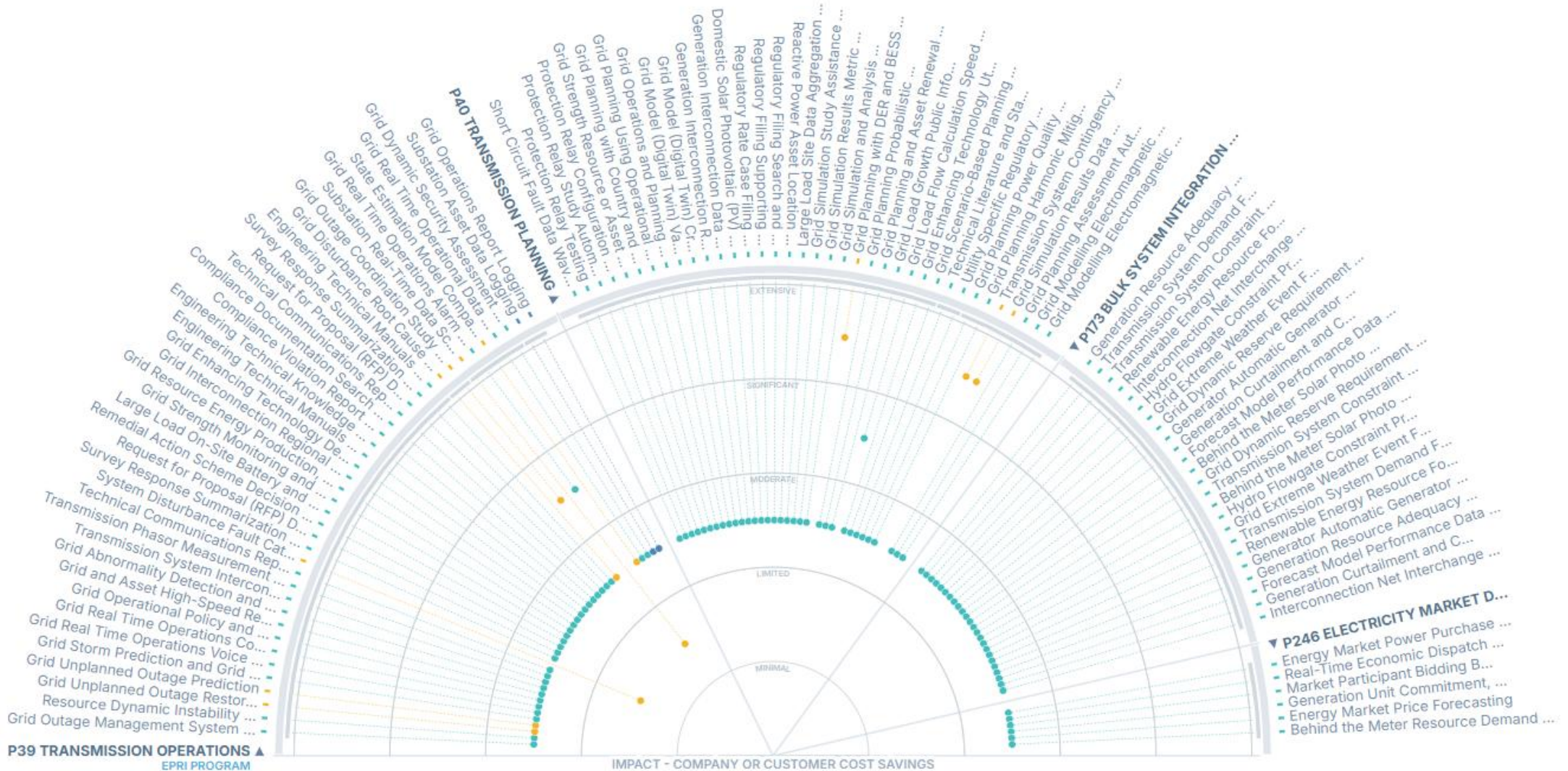


INTEGRATING INTO EPRI
SOFTWARE SOLUTIONS



SUPPORTING ADOPTION
BY MEMBERS

Energy Sector AI Use Case Repository (coming soon)



Operators and Planners Need to Solve Problems

To do this, they:

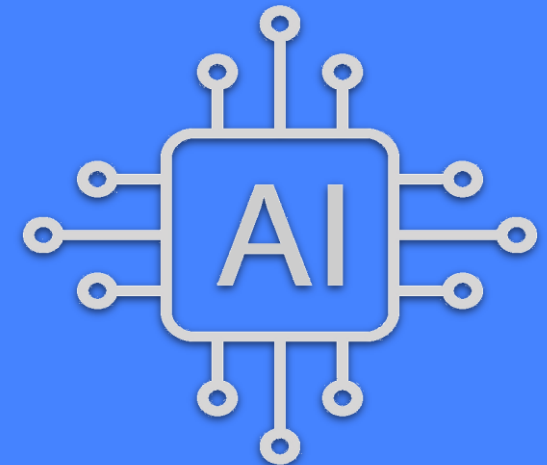
- **Make sense** of models, alarms, trends, guidelines, reports, etc.
- **Make decisions** based on forecasts, simulations, risk
- **Take actions** by writing reports, dispatching, investing, etc.

The challenge:

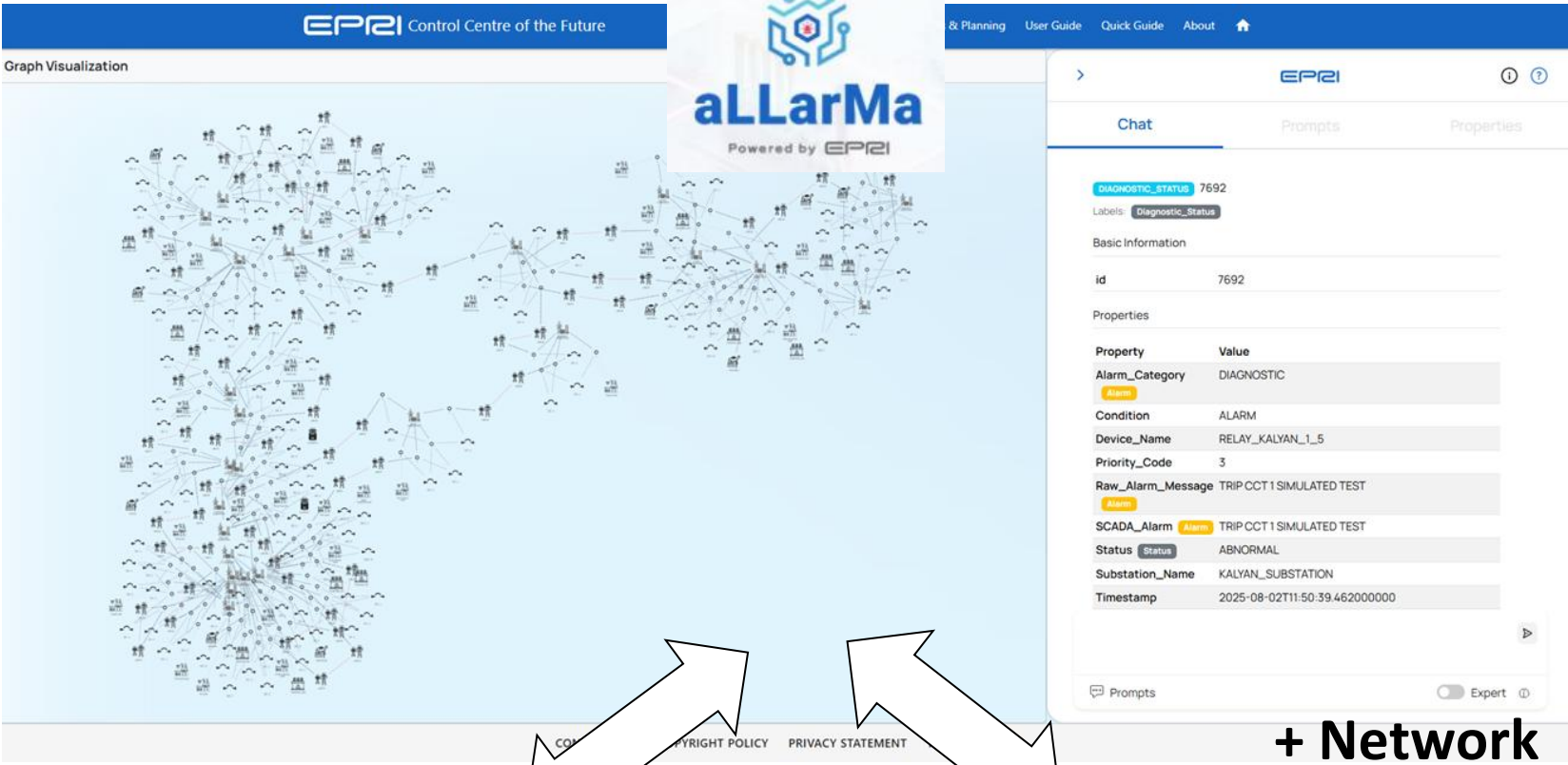
- **More data** to manage and scenarios to consider
- **Less experience** in dealing with new conditions
- **Greater complexity** with higher pace of change

AI as a solution:

- **Engineering process automation** – make sense of data, automate reports, etc.
- **Decision-making automation** – simulate large amounts of data

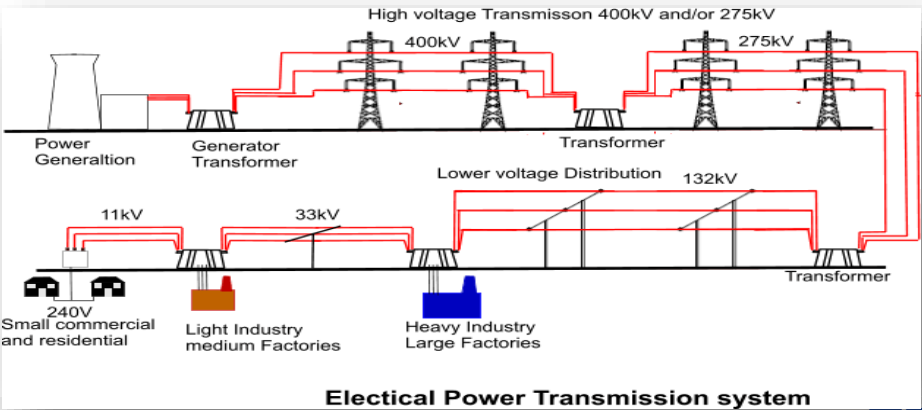


Safely use LLMs with Alarm and Operational Data



Alarm Data

EventTimeStamp	SCADA_Category	TOC	AOR	Priority_Code	Substation	DeviceType	Device	event_message
01/05/2017 00:00	MH	TMS	TOCMSDOC	3	Substation1317	STN	STA_SERVICE	Substation1317 STN STA_SERVICE AC SERV VOLTAGE NORMAL CHG-DET
01/05/2017 00:00	ML	TMS	TOCPB	4	Substation1265	BLKCAR	STUTR_PR1_UPLC	Substation1265 BLKCAR STUTR_PR1_UPLC CARRIER LEVEL LOW CHG-DET
01/05/2017 00:00	MH	TMS	TOCPB	3	Substation1459	BLKCAR	Device285	Substation1459 BLKCAR Device285 CARRIER LEVEL LOW CHG-DET
01/05/2017 00:00	MH	TMS	TOCPB	3	Substation1459	BLKCAR	Device285	Substation1459 BLKCAR Device285 SIGNAL RECEIVED NORMAL CHG-DET
01/05/2017 00:00	MH	TMS	TOCGR	3	Substation275	FIBOPT	LABAR_X_311L	Substation275 FIBOPT Device4576 PRI #2 OPTIC/CH NORMAL CHG-DET
01/05/2017 00:00	MH	TMS	TOCBM	3	Substation749	RELAY	L37_P2_SEL411L	Substation749 RELAY L37_P2_SEL411L RELAY FAILURE NORMAL CHG-DET
01/05/2017 00:00	MH	TMS	TOCBM	3	Substation256	RELAY	L532_SEL421313	Substation256 RELAY L532_SEL421313 SYSTEM NORMAL CHG-DET
01/05/2017 00:00	MH	TMS	TOCPA	3	Substation113	RELAY	L513_SEL411_P2	Substation113 RELAY L513_SEL411_P2 RELAY FAILURE NORMAL CHG-DET
01/05/2017 00:00	MH	TMS	TOCPA	3	Substation460	RELAY	L461	Substation460 RELAY L461 BKUP SYSTEM FAIL NORMAL CHG-DET
01/05/2017 00:00	ML	TMS	TOCED	4	Substation232	BLKCAR	Device689	Substation232 BLKCAR Device689 SIGNAL RECEIVED NORMAL CHG-DET
01/05/2017 00:00	MH	TMS	TOCGR	3	Substation1322	RELAY	Device1492	Substation1322 RELAY Device1492 #1 PRIMARY RELAY NORMAL CHG-DET



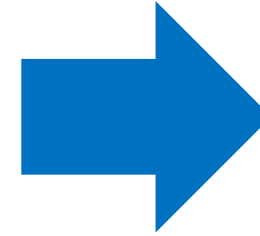
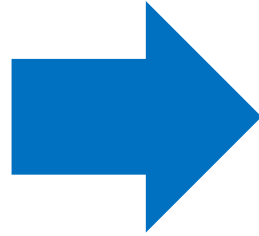
EPRI AI Grid Planning Assistant: Objectives in, Solutions Out

EPRI AI Planning Assistant



Solutions:
Data, Charts
Reports
Conclusions
Solutions

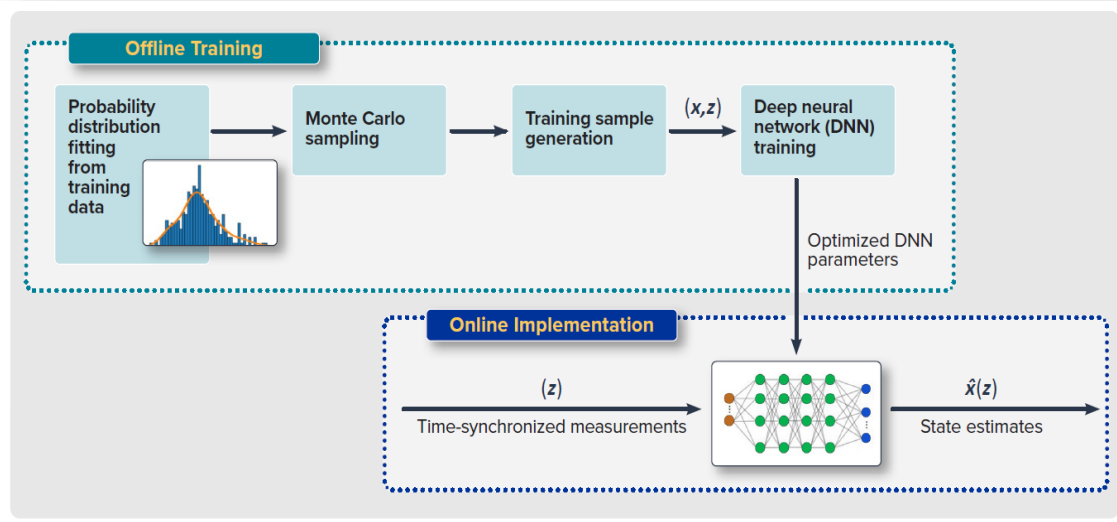
Objectives:
Description
of what you
want



- Engineering concepts, equations, standards
- Local documents, guides, reports
- Grid Models, forecasts, restrictions
- Tools
- Memory

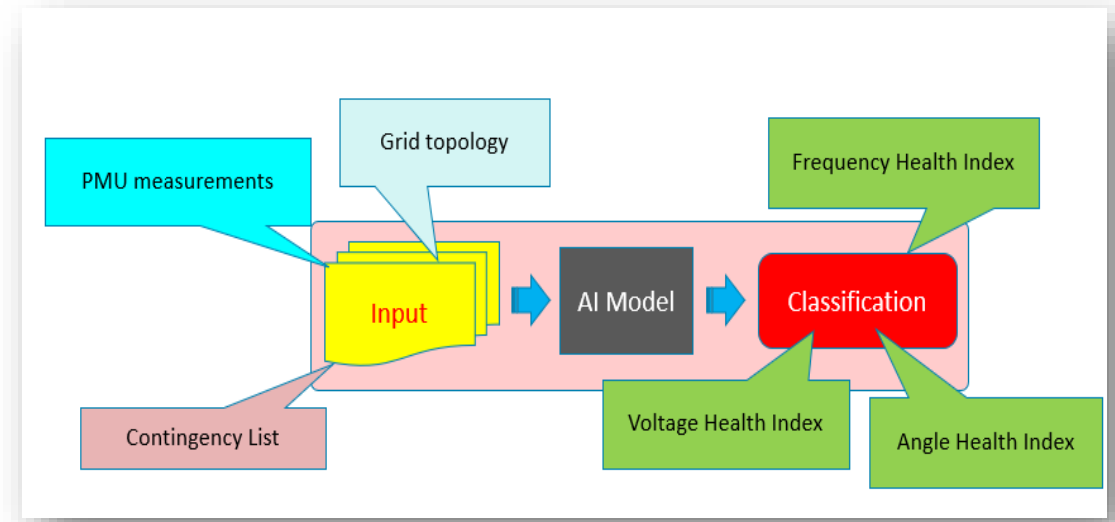
Machine Learning / AI Using Synchrophasor Measurements

ML & PMU Based State Estimation



- Network model independent
- Deep neural network based
- Full system observability with limited number of PMUs
- AI Model Training: EMS state estimation snapshots

ML & PMU Based Security Assessment



- Network model independent
- Graph neural network based
- Health indices prediction: Voltage, frequency, and angle stability
- AI Model Training: Dynamic simulations

AI-ccele^rating Production Cost Modeling Competition



AI-CCELERATING UNIT COMMITMENT

 **\$25,000**

Edit Participants Submissions Dumps Migrate

ORGANIZED BY: EPRI (ai-uc_competition@epri.com)
CURRENT ACTIVE PHASE: None
CURRENT SERVER TIME: October 21, 2025 At 5:07 PM GMT+2
Docker image: aporras/uc_competition_env:uv_1111
Secret url: https://www.codabench.org/competitions/11178/?secret_key=876361ec-1247-4c31-876a-58f272ee7456

Nov 2025 Dec 2025 Jan 2026 Feb 2026 Mar 2026

Get Started Phases My Submissions Results Forum

Competition

Welcome! This repository aims to lay the foundations for the official AI-ccele^rating Unit Commitment organized by EPRI.

What happens when you open up a complex energy problem to the global community? You spark and fresh ideas. That's the goal of the AI-UC Competition, an open competition inviting participants help shape the future of power system planning.

The challenge focuses on a key question: how can we decide, day by day, which power plants to run demand reliably and affordably? It's a tough puzzle, and we're calling on innovators to build AI tools accurately, and in a way that people can trust.

Participants will design digital assistants that propose smart, realistic schedules for power generation and showing how confident they are in their choices. These tools could one day support designers, and planners working on everything from daily operations to long-term energy planning. Opening the doors to a wide community of problem-solvers, the UC Challenge aims to accelerate energy planning tools more transparent, efficient, and accessible.

Unit Commitment Problem

The solution of the Unit Commitment (UC) problem is the most economically operating point of generation/off status and their production levels. Therefore, the main objective of this problem is to

Why it Matters:

Production cost modeling is vital for power system planning, but it's computationally demanding.

The AI Advantage:

AI can dramatically speed up production cost modeling by reducing computational load potentially without sacrificing accuracy, especially in long-term planning.

Competition Goal:

- Develop AI models that accelerate production cost modeling
- Real-world scenarios from the Irish Power System
- Submit AI agents for evaluation
- In-depth analysis of results post-launch



Scan to access competition [website](#)

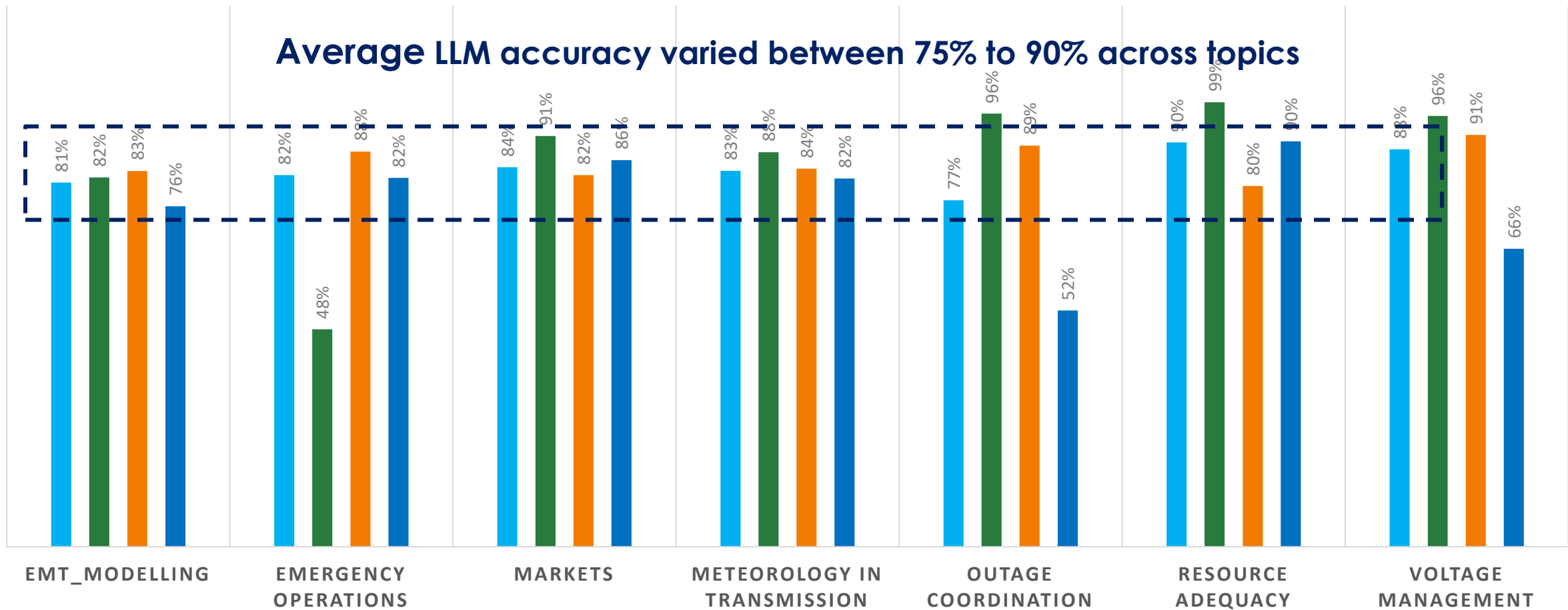


Competition Launch: November 3rd

Benchmarking Large Language Models for Knowledge of Power Systems

ACCURACY ACROSS TOPICS

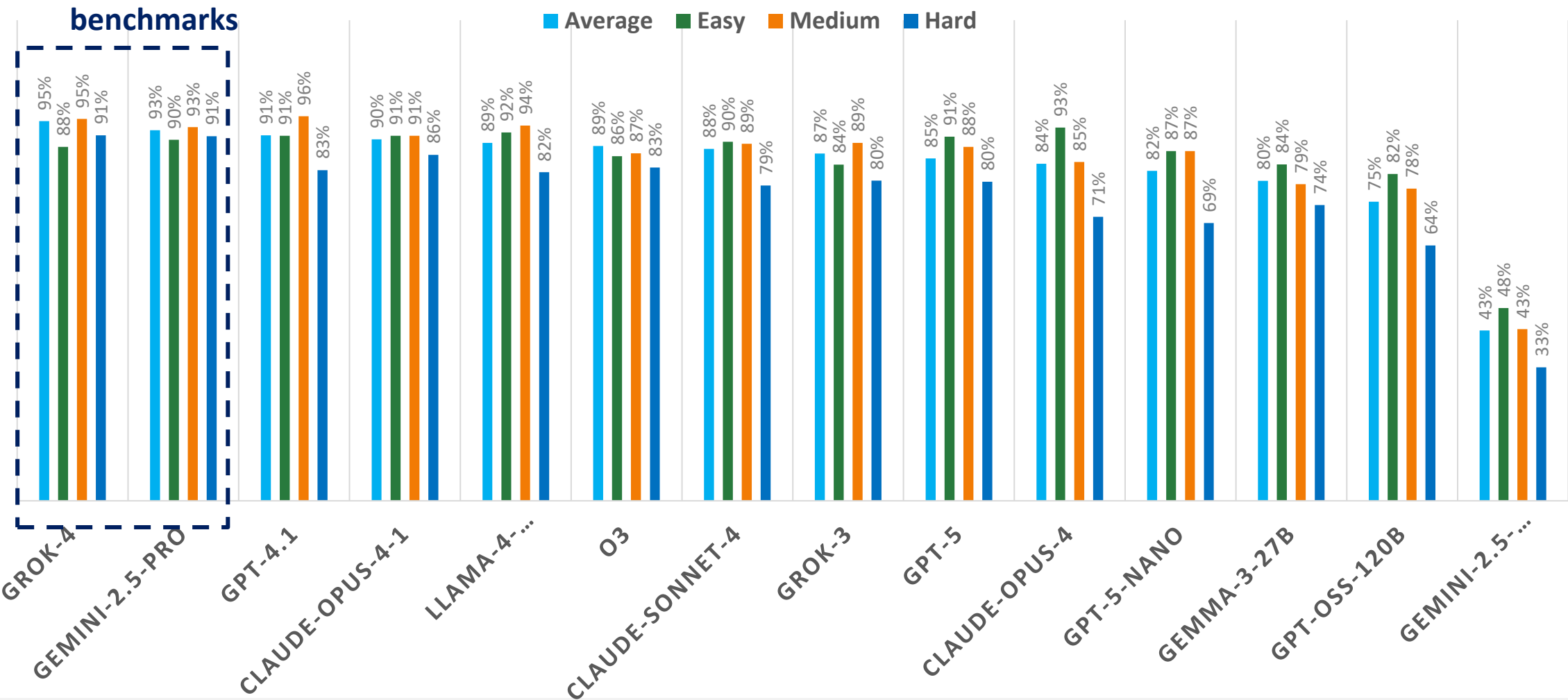
Average Easy Medium Hard



Preliminary Results

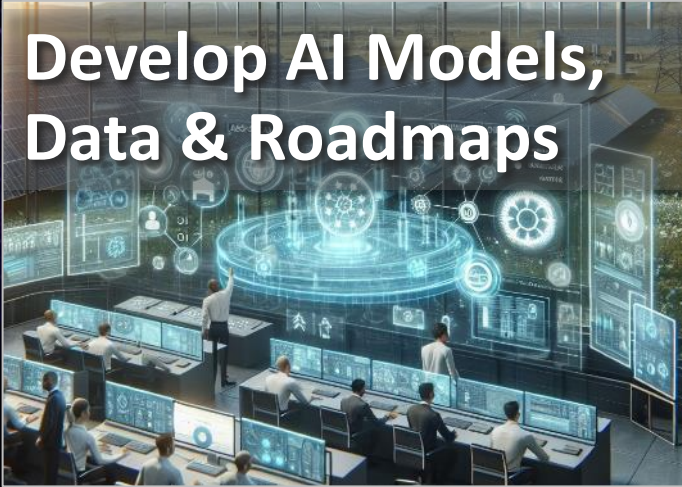
‘Grok-4’ and ‘Gemini-2.5-pro’ are top performers consistent with external benchmarks

AVERAGE LLM PERFORMANCE



Open Power AI Consortium – Key Objectives

**Develop AI Models,
Data & Roadmaps**



**Create an AI
Sandbox**



**Implementation and
Lessons Learned**



**Create an ecosystem for stakeholders to identify, develop,
validate and deploy AI solutions to transform the electric sector**



OPAI Use Cases Workstream – Survey Launch



Collated 260 use case titles and descriptions across the energy sector



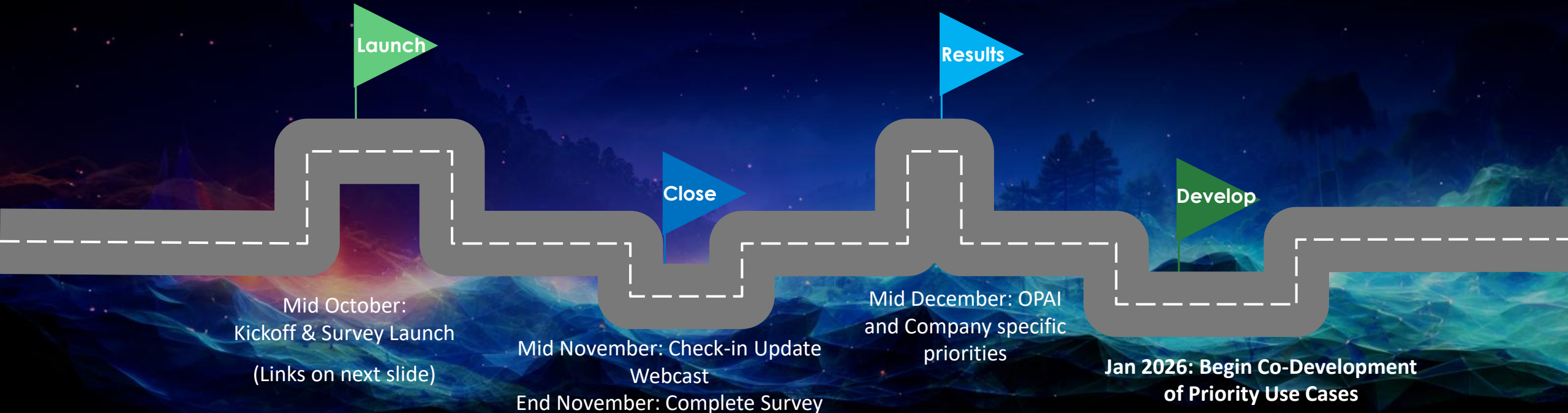
Need utilities to complete one of two surveys:



Utilities: To grade the use case for priority and describe demos



Tech Providers: To match their technology to the use case and describe demos



OPAI Use Case Survey



Energy Utility Survey



Technology Provider Survey

Same Use Case – Different Response

4. Advanced Metering Infrastructure (AMI) Data Validation

AI validates smart meter data by detecting anomalies, missing values, or implausible readings. Models compare real-time data against historical patterns and neighboring meters. Errors are flagged and corrected or imputed before billing or analysis. This ensures accurate consumption records and strengthens customer trust.

	Limited	Minimal	Moderate	Significant	Extensive
Impact - Company or Customer Cost Saving	☐	☐	☐	☐	☐
Impact - Reliability of Resilience	☐	☐	☐	☐	☐
Impact - Safety or Security	☐	☐	☐	☐	☐
Implementation Complexity	☐	☐	☐	☐	☐
Data Availability	☐	☐	☐	☐	☐
Risk of Misoperation	☐	☐	☐	☐	☐

Do you have an existing project for this use case in your company?....if so please describe

<https://www.surveymonkey.com/r/OPAI-Use-Cases-Utilities>

4. Advanced Metering Infrastructure (AMI) Data Validation

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TRL 1: Basic principles observed and reported	TRL 2: Technology concept formulated	TRL 3: Proof of concept	TRL 4: Laboratory validation	TRL 5: Relevant environment validation	TRL 6: Demonstration in relevant environment	TRL 7: Prototype demonstration in operational environment	TRL 8: System completed and qualified	TRL 9: Actual system proven in operational environment
☐	☐	☐	☐	☐	☐	☐	☐	☐

Is your entity working with an energy utility on a demo of your technology for this use case? If so please elaborate

<https://www.surveymonkey.com/r/OPAI-USE-Cases-Tech-Providers>

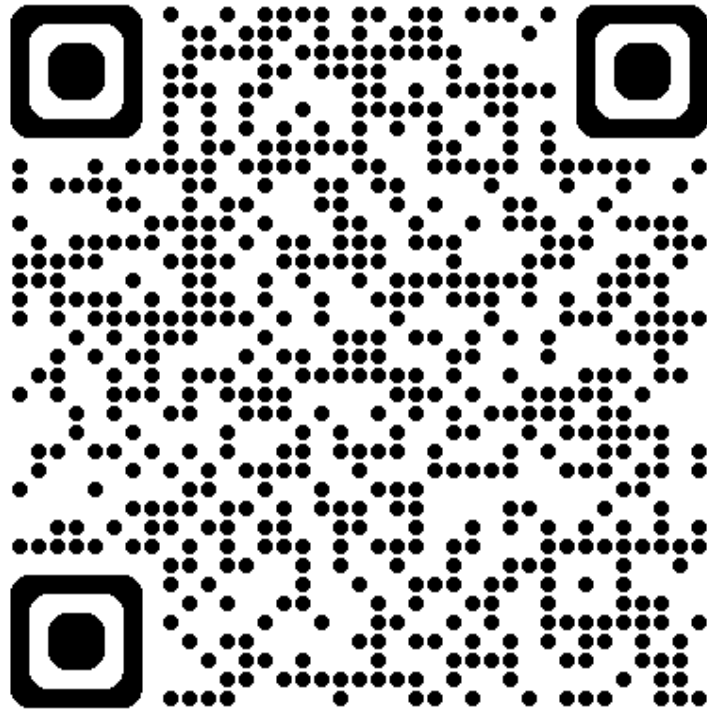
OPAI Use Case Survey Links



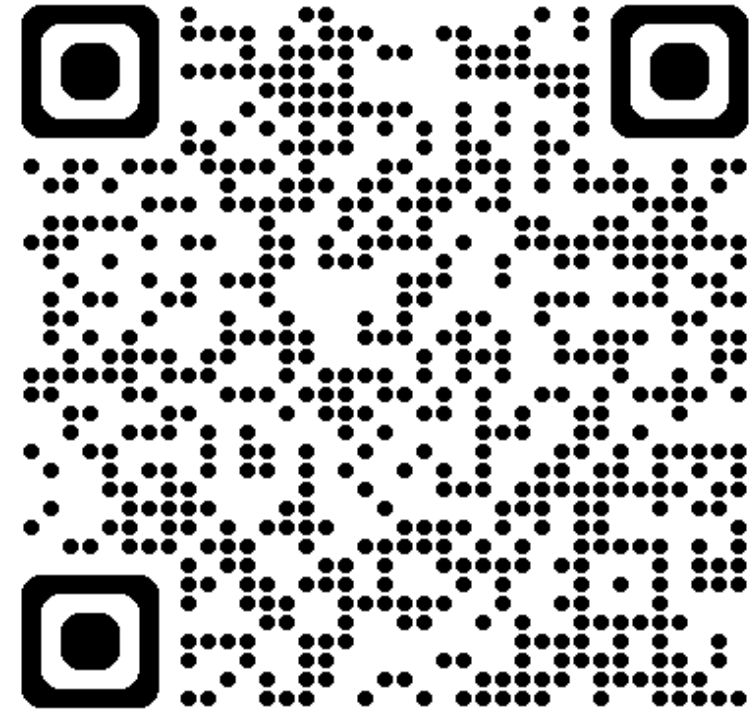
Energy Utility Survey



Technology Provider Survey



Click or Scan



<https://www.surveymonkey.com/r/OPAI-Use-Cases-Utilities>

<https://www.surveymonkey.com/r/OPAI-USE-Cases-Tech-Providers>



TOGETHER...SHAPING THE FUTURE OF ENERGY®